GPIB CODE SUMMARY

SELECTION OF ANALYZER FUNCTION

Wide Band Level	M1
Narrow Band Level Very Wide	M4
Narrow Band Level Wide	M5
Narrow Band Level Medium	M6
Narrow Band Level Narrow	M7
High Pass Level	M8
Low Pass Level	M9
THD + N Ratio	S3
THD + N Level	M3
SMPTE IMD	S5
CCIF IMD	S4
Set Filter center/corner frequency in Hz	SFnn--nnHZ
Set Filter center/corner frequency in kHz	SFnn--nnKZ
DC Volts	DC
Phase	PZ

SELECTION OF FILTERS

Enable 400Hz HP Filter	H1
Disable 400Hz HP Filter	H0
Enable 30kHz LP Filter	L1
Enable 80kHz LP Filter	L2
Enable SPCL Filter	L3
Enable Aux 1 Filter	L4
Enable Aux 2 Filter	L5
Enable Aux 3 Filter	L6
Enable Aux 4 Filter	L7
Disable All Weighting Filters	L0

INPUT SELECTION AND CONFIGURATION

Select External Input A	IA
Select External Input B	IB
Select Generator Out A	IO
Select Generator Out B	BO
Set 100kΩ Input Termination	Z0
Set 600Ω Input Termination	Z1
Set 150Ω Input Termination	Z2

DETECTOR TYPE AND SYNC

Select rms Detection	D0
Select Average Detection	D1
Select Quasi-peak Detection	D2
Sync on Input Frequency	FI
Sync on Oscillator Frequency	FO
Detector Speed	(see SPCL FNCT 29)

DISPLAY FORMATTING

Select Volts Units	VO
Select dBV Units	BV
Select dBm Units	BM
Select Watts Units	WA
Select Log Units	LG
Select Linear Units	LN
Enable Relative Mode	R1
Disable Relative Mode	R0
Enter Relative Ref in Volts	REnn--nnVL
Enter Relative Ref in mV	REnn--nnMV
Enter Relative Ref in µV	REnn--nnUV
Enter Relative Ref in dBV	REnn--nnDV
Enter Relative Ref in dBm	REnn--nnDM
Enter Relative Ref in dB	REnn--nnDB
Enter Relative Ref in %	REnn--nnPE

SET SOURCE PARAMETERS

Set Source Amplitude in Volts	APnn--nnVL
Set Source Amplitude in mV	APnn--nnMV
Set Source Amplitude in µV	APnn--nnUV
Set Source Amplitude in dBV	APnn--nnDV
Set Source Amplitude in dBm	APnn--nnDM
Set Source Frequency in Hz	FRnn--nnHZ
Set Source Frequency in kHz	FRnn--nnKZ

INCREMENT MODE

Set Source Freq Incr in Hz	FNnn--nnHZ
Set Source Freq Incr in kHz	FNnn--nnKZ
Set Source Freq Incr in %	FNnn--nnPE
Set Source Ampl Incr in Volts	ANnn--nnVL
Set Source Ampl Incr in mV	ANnn--nnMV
Set Source Ampl Incr in µV	ANnn--nnUV
Set Source Ampl Incr in dB	ANnn--nnDB
Set Source Ampl Incr in %	ANnn--nnPE
Set Filter Freq Incr in Hz	SNnn--nnHZ
Set Filter Freq Incr in kHz	SNnn--nnKZ
Step Frequency Up, Increment	(FR) UP
Step Frequency Down, Decrement	(FR) DN
Step Amplitude Up, Increment	(AP) UP
Step Amplitude Down, Decrement	(AP) DN

INTERMODULATION DISTORTION PARAMETERS

Set IMD LF or OF in Hz	IFnn--nnHZ
Set IMD LF or OF in kHz	IFnn--nnKZ
Select CCIF IMD Mode	S4
Select SMPTE IMD Mode	S5
Select IMD Ampl. Ratio	(see SPCL FNCT 35)

OUTPUT CONFIGURATION

Enable Output	01
Disable Output	00
Select Output Channel A Only	C0
Select Output Channel B Only	C1
Select Output Channel A and B	C2
Select Output Channel A and -B	C3
Select Output Float Mode	OF
Select Output Ground Mode	OG
Set Output Impedance to 600Ω, balanced	P0
Set Output Impedance to 150Ω, balanced	P1
Set Output Impedance to 50Ω, unbalanced	P2

GPIB PARAMETERS

Select Free Run Mode	T0
Select Hold Mode	T1
Select Trigger Immediate	T2
Select Trigger With Settling	T3
Read Left Amplitude Display	RL
Read Right Frequency Display	RR
Trigger Measurement Cycle	CL

MISCELLANEOUS

Set Automatic Operation	AU
SPCL Function	nn--nnSP
Store Instrument Set Up (n = 2 to 11)	nST
Partial Set Up Recall (n = 0 to 11)	nRC
Full Set Up Recall (n = 0 to 11)	n.1RC

NOTES

1) nn-nn refers to a series of one or more digits with or without a decimal point.

Example:

AP4.02DV (Set amplitude to 4.02 dBV)

FN1000Hz (Set frequency to 1000 Hz)

FN1.00KZ (Set frequency to 1.00 kHz)

2) No spaces are required between codes.

3) Items in ( ) are optional.

4) 0 = numeric character zero
O = alpha character oh

AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

OWNER'S MANUAL

SECTION 1

GENERAL INFORMATION

Issue 07 January 1989

1.0 GENERAL OVERVIEW

The model 5500 is a complete stimulus/measurement system and contains both a programmable generator and a comprehensive level/noise/distortion meter. Although they share the same enclosure and front panel, there is little connection between the transmitter (generator) and the receiver (level/noise/distortion meter). Each section is autonomous and does not necessarily have to operate with its internal mate.

The front panel controls for the meter are generally on the left while those for the generator are generally on the right. In most cases, operating controls for the meter will not affect the generator and vice versa (an exception is IMD and NARROW BAND LEVEL discussed in detail later).

Two numeric displays are provided on the front panel. These generally indicate measured values provided by the meter section but can be changed to indicate user programmed values of the generator section. In addition, the right hand display doubles as a keyboard entry indicator while data is being entered. At the conclusion of manual data entry, the right display returns to its previous function (indicating measured input frequency).

Meter inputs are on the left and generator outputs on the right of the front panel. Two monitor outputs are also provided on the left for an external oscilloscope or additional processing. The rear panel contains AC mains input, GPIB port, optional serial port and possibly auxiliary signal inputs and outputs.

The displays are also used to inform the user of error conditions. These may be due to improper keyboard operation, incorrect input signals for a particular function or other errors. The error code number informs the operator of the nature of the error and its likely cause.

Some keys on the front panel have more than one function. The primary function is indicated with a beige label above the key. The secondary function, if there is one, is indicated in green below the key. To operate the secondary or "shift" function, the operator pushes and holds the green SHIFT key while pushing the desired function key. The SHIFT key may not lock but be active only while being pushed. When released, all keys revert to their normal (beige) functions. (See Section 6 for information on how to convert the SHIFT key into a "prefix" key.)

1.1 DISPLAYS

Two displays are provided. The left hand display generally indicates a measured value of the function selected. For example, AC millivolts (mV) in the LEVEL mode or percent distortion in the DISTORTION mode. The UNITS key to the right of the display chooses one of several available measurement units for a particular measurement function. These are grouped into LINEAR such as Volts, % or Watts and LOG such as dBV, dBm or dB. The choice between linear and log is a shifted function of the UNITS key. The unshifted UNITS key selects one from the available linear units or one from the available log units.

In the LEVEL modes the available units are Volts (including mV and μV), Watts (including mW and μW), dBm and dBV. Successive pushes of the UNITS key, both shifted and unshifted, will step through all four possibilities. In the DISTORTION modes only two units are available: % in the linear mode and dB in the log mode. Thus only the shifted operation of the units key has an effect.

The RELATIVE key to the right of the display allows the user to determine the ratio of the current measured value to a user chosen reference. For example, to determine the gain of a device, the ratio of the output level to the input level would be presented. Use of this feature is explained in more detail later.

The right hand display usually indicates the frequency of the INPUT signal. However, while data is being entered on the numeric keyboard, it will indicate the keystrokes as they are entered. When the data entry is complete, the display returns to its normal function of indicating INPUT frequency. (This display can also be switched to indicate the frequency of the internal oscillator or generator. In this case, an OSC legend will illuminate next to the display. See Special Function 37, Section 3.3.3, page 3-45.)

1.2 SPECIFICATIONS

All specifications apply to the basic system with option 201 High Performance Group and without options except where specified.

1.2.1 SIGNAL SOURCE

Frequency range:	10 Hz to 100 kHz
Frequency setting resolution:	0.25% normal mode 0.005% fine mode
Frequency setting accuracy:	20 Hz to 20 kHz : ±0.5% 10 Hz to 100 kHz: ±2.0%
Amplitude range:	10 V rms to <1 mV rms open circuit
Amplitude setting resolution:	Maximum output to 1 mV: 0.03 dB or better
Generator off attenuation:	10 Hz to 100 kHz: >100 dB, typically >130 dB at 1 kHz
Output amplitude accuracy (at 1kHz):	Maximum output to 1 mV: ±0.1 dB
Output amplitude flatness (maximum output to 1 mV):	20 Hz to 20 kHz : ±0.1 dB 10 Hz to 50 kHz : ±0.2 dB 50 kHz to 100 kHz: ± 0.35 dB
Output source impedance:	600 ohms, ±1%
Total harmonic distortion (passive notch/analysis method): The higher of:	50 Hz to 10 kHz: <0.0005% (-106 dB) 20 Hz to 50 kHz: <0.003% (-90 dB) 10 Hz to 100 kHz: <0.01% (-80 dB)
Configuration:	Unbalanced, floating or grounded output

1.2.2 ADDITIONAL SPECIFICATIONS for Option 001 High Level Balanced Output

Output source impedance: (±1% ±1 Ω)	Balanced 600 Ω Balanced 150 Ω Unbalanced 50 Ω	
Maximum output level: (at 1 kHz)	600 Ω, open circuit :	33 V rms
	600 Ω source, 600 load :	+26.5 dBm
	150 Ω source, 600 load :	+30.0 dBm
	50 Ω source, open circuit:	16.5 V rms
	50 Ω source, 600 load :	+23.5 dBm

1.2.3 If option 007 Stereo Output is added, all above specifications apply for both A and B outputs.

Channel A to B isolation (crosstalk) 10 Hz to 100 kHz: >100 dB

1.2.4 ADDITIONAL SPECIFICATIONS for option 002 IMD

Frequency range,

	SMPTE mode:	HF 2 kHz to 100 kHz LF 40, 50, 60, 80, 100, 125, 250 and 500 Hz
	CCIF mode :	Mean frequency: 2 kHz to 100 kHz Difference frequency: 80, 100, 120, 160, 200, 250, 500, 1 kHz

Amplitude mix ratio

	SMPTE mode:	LF:HF	1:1, 2:1, 4:1, 10:1
	CCIF mode:		1:1

ANALYZER SECTION

1.2.5 LEVEL & NOISE MEASUREMENT

Frequency range:	8.5 Hz to >500 kHz
Level range:	100 V rms/+40 dBV to <10μV rms/-100 dBV
Level display resolution:	dBV, dBm : 0.01 dB Volts, Watts : 4 digits

Level accuracy (at 1 kHz using rms detector):

100 V/+40 dBV to 30 mV/-30 dBV: ±0.1 dB
30 mV/-30 dBV to 1 mV/-60 dBV: ±0.15 dB

Level flatness (relative to 1 kHz using rms detector):

100V/+40 dBV to 30 mV/-30 dBV, 20 Hz to 20 kHz: ±0.1 dB
100V/+40 dBV to 1 mV/-60 dBV, 10 Hz to 100 kHz: ±0.25 dB

Residual noise (wide band mode, rms detector):

Input ≤600 Ω, flat: <12.3 μV/-96 dBm
Input ≤ 600 Ω, 20 Hz to 20 kHz or "A" Weighting: <2.5 μV/-112 dBm

Residual noise (narrow band mode, rms detector):

Input ≤ 600 Ω, 1 kHz bandpass: <0.7 μV/-123 dBm

LEVEL & NOISE MEASUREMENT (contd.)

CMRR 50 Hz to 20 kHz: >70 dB for inputs up to 2.5 V or +10 dBm

Input impedance: Balanced mode at 1 kHz:

100 k Ω ± 0.1% each side to ground
600 Ω ± 1.0%
150 Ω ± 1.0%

Input isolation (crosstalk channel A to B or B to A):

Both inputs ≤ 600 Ω, 10 Hz to 100 kHz: >130 dB

Detectors: true rms, average, quasi-peak

1.2.6 FREQUENCY MEASUREMENT

Range: 8.5 Hz to >500 kHz

Display Resolution: 5 digits

Frequency Accuracy: Better than 100 ppm

Minimum signal level for frequency measurement:

Level Modes: 1 μV/-120 dBV
Distortion and auto-tune narrow band modes: 30 mV/-30 dBV

1.2.7 THD + N MEASUREMENT

Frequency range: 9.5 Hz to 105 kHz

THD + N range: >32% to 0.0000% (>-10.0 dB to -120.0 dB)

Display resolution: 0.1 dB or 2 significant digits in %

Minimum input level for THD + N: 30 mV/-30 dBV

THD + N accuracy: 20 Hz to 20 kHz : ± 1 dB
10 Hz to 100 kHz: ± 2 dB

Fundamental rejection: the greater of 120 dB or 10 dB below highest harmonic

Residual THD + N (including 5500 generator and all error sources, signal level >300 mV rms)

50 Hz to 10 kHz, 30 kHz BW : <0.0018%/-95 dB
50 Hz to 10 kHz, 20 kHz BW : typically <0.001%/-100 dB
20 Hz to 50 kHz, 500 kHz BW : <0.005%/-86 dB
10 Hz to 100 kHz, 500 kHz BW: <0.01%/-80 dB

1.2.8 ADDITIONAL SPECIFICATIONS for Option 002 IMD (same as THD + N except as follows:)

Frequency range: SMPTE	HF 3 kHz to 100 kHz
	LF 40 Hz to 500 Hz
CCIF mean	4 kHz to 100 kHz
difference	80 Hz to 1 kHz

Residual IMD (including 5500 generator)

SMPTE, 4:1 amplitude ratio: 3 kHz to 10 kHz : <0.003%/-90 dB
10 kHz to 100 kHz: <0.01%/-80 dB

CCIF 4 kHz to 10 kHz: <0.001%/-100 dB

1.2.9 FILTERS

Standard filters:

400 Hz high pass: 60 dB per decade, Butterworth response
30 kHz low pass : 60 dB per decade, Butterworth response
80 kHz low pass : 60 dB per decade, Butterworth response

SPCL filter:

One of the following : ANSI/IEC "A" Weighting (standard)
CCIR 468-3 (option 101)
Psophometric CCITT P53 (option 102)

Optional filters: See ordering information.

1.2.10 IEEE-488 INTERFACE FUNCTION SUBSET

SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP0, DC1, DT1, C0

1.2.11 PROGRAMMABILITY

All front panel functions may be controlled via the external interface. All measured values may be read via the external interface formatted in the same modes available from the front panel. Up to 10 instrument setups may be stored in non-volatile internal storage. The instrument powers up in a factory predetermined default state and the user may easily recall the previous state that was present at power down.

1.2.12 INTERFACE

The instrument is supplied with an IEEE-488 GPIB Interface as standard. An optional RS232 Serial Interface capability may also be supplied. (EIA RS232C specification: 9600 baud, full duplex, jumper configures as DCE or DTE, X-on, X-off handshake, no parity, 8 data bits, 1 stop bit.)

1.2.13 GENERAL SPECIFICATIONS

Readings per second:	>2.5 typical >3.5 with option 200
Temperature range :	Within specification: 25°C ± 5°C Operation 0°C to +50°C Storage -20°C to +60°C
Power requirements :	100, 120, 220, 240 V AC +5% -10% 48 Hz to 66 Hz 150 VA maximum
Weight :	45 lbs/20.5 kgs maximum
Dimensions:	7.5 in. H x 16.5 in. W x 20.25 in. D (19.1 cm x 419 cm x 514 cm)

All specifications subject to change without notice.

1.3 INPUTS AND OUTPUTS

The instrument provides both balanced and unbalanced inputs, unbalanced and optionally balanced output(s). All unbalanced inputs and outputs, monitors and auxiliary inputs and outputs on the rear panel are industry standard BNC connectors for coaxial shielding, reliability and ease of use. All balanced inputs and outputs use telephone style (or military style) tip-ring-sleeve phone jacks. These require mating telephone (military) style phone plugs such as WE310 or PJ051. Do not use the similar but different stereo headphone style phone plug. They will not make proper contact and will damage the jacks. The telephone style connectors have a special design to avoid momentary shorting during insertion and removal and achieve long, reliable life. The tip and ring have different dimensions than the "stereo" style connectors.

Telephone style plug-to-banana binding post adapters are available from Amber and various cables and adapters with this style of plugs are available from the popular suppliers of this equipment (Pomona, Switchcraft, ADC, etc.).

The following pages show simplified diagrams of the input, output and grounding structure in the 5500 to assist in interface to external equipment.

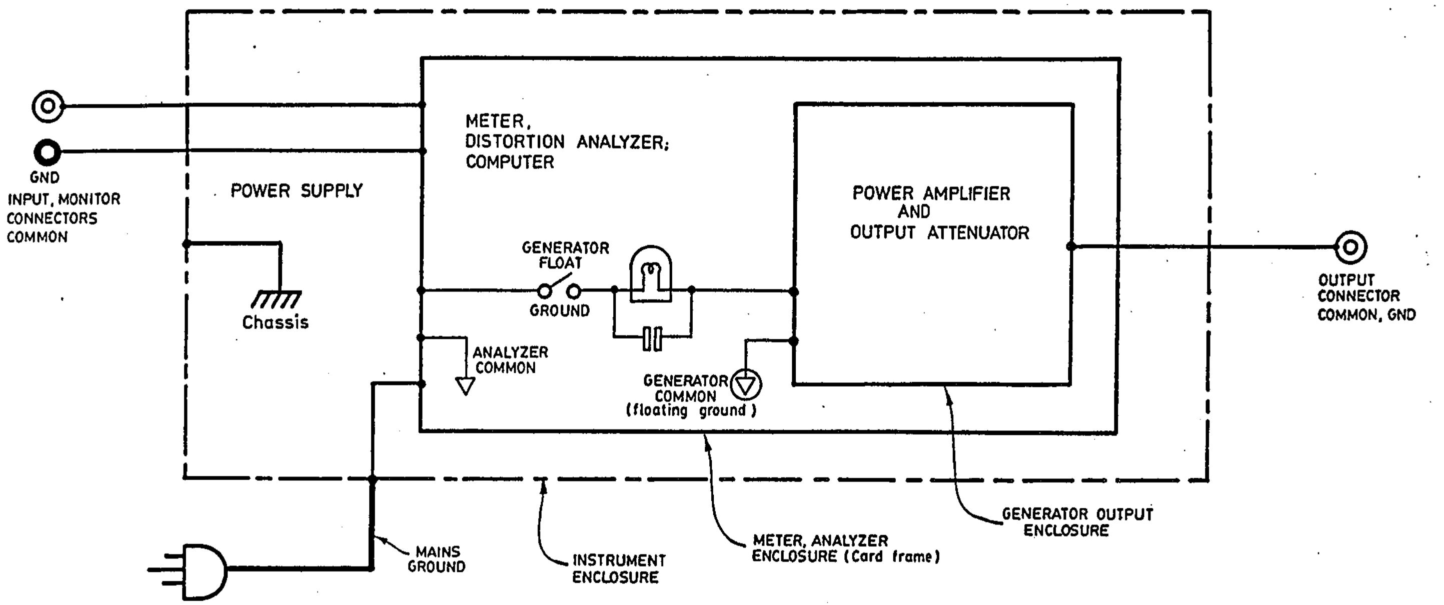
1.4 OPTIONAL FEATURES

In most cases, the 5500 main frame is wired for most available options even if they have not been purchased. Similarly, the front panel may contain pushbuttons for features not resident in the instrument. This is done to facilitate field installation and upgrade of instruments.

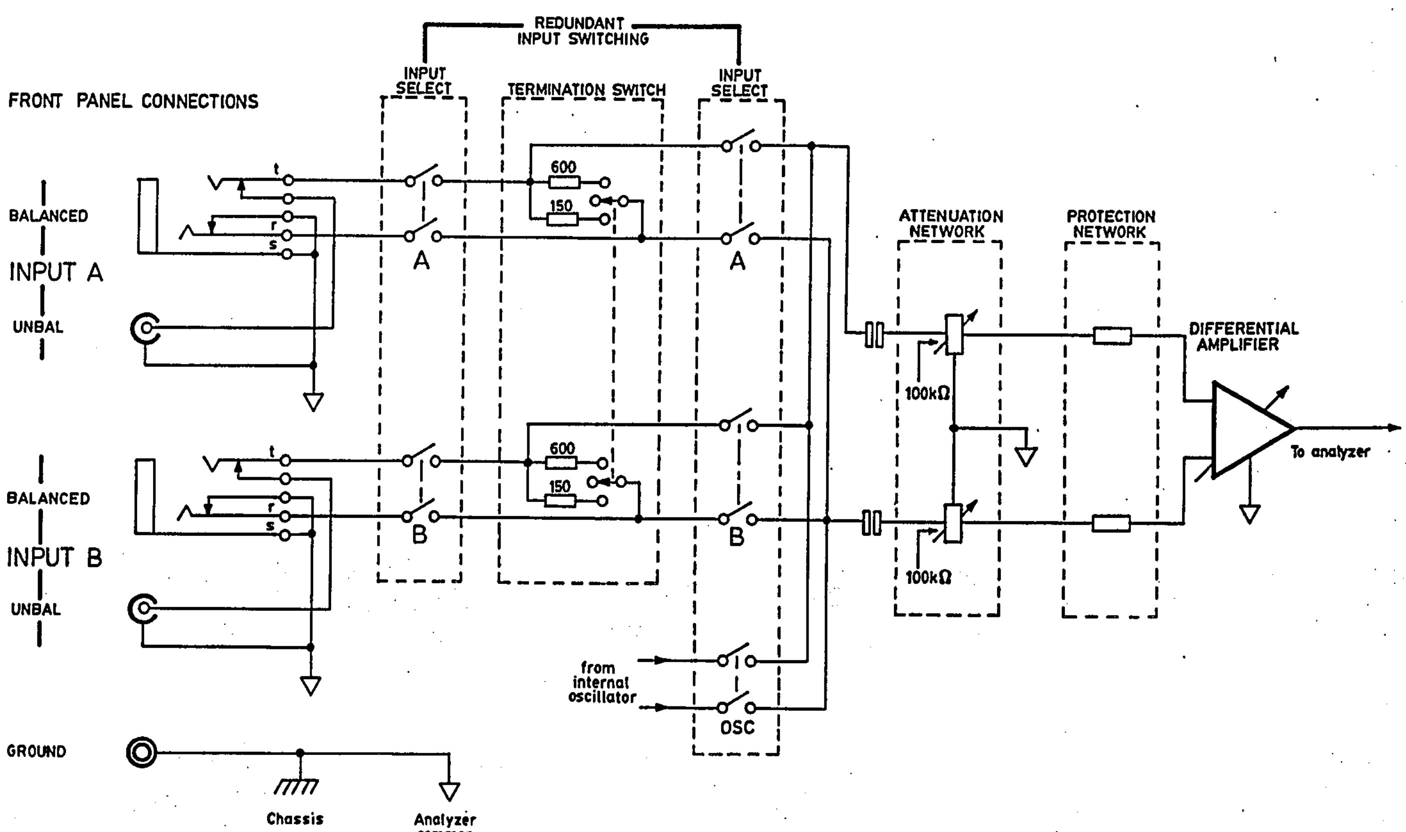
To determine the options present in a particular instrument, check the five digit option code against Chart 1.5 following. The five digit option code may be found on the instrument serial number plate located on the rear panel of the instrument. The MODEL number box on this plate will show a 9 digit number: 5500-XXXXX where the suffix XXXXX represents the option code for the instrument. For example, 5500-00000 is an instrument without any options while 5500-13100 would be an instrument with options 001, 002 and 005.

Although certain options may not be resident in the system, pushing the associated button will have no effect. That is, the buttons are not inhibited if the option is not installed. The resulting readings shown on the display will, of course, be meaningless.

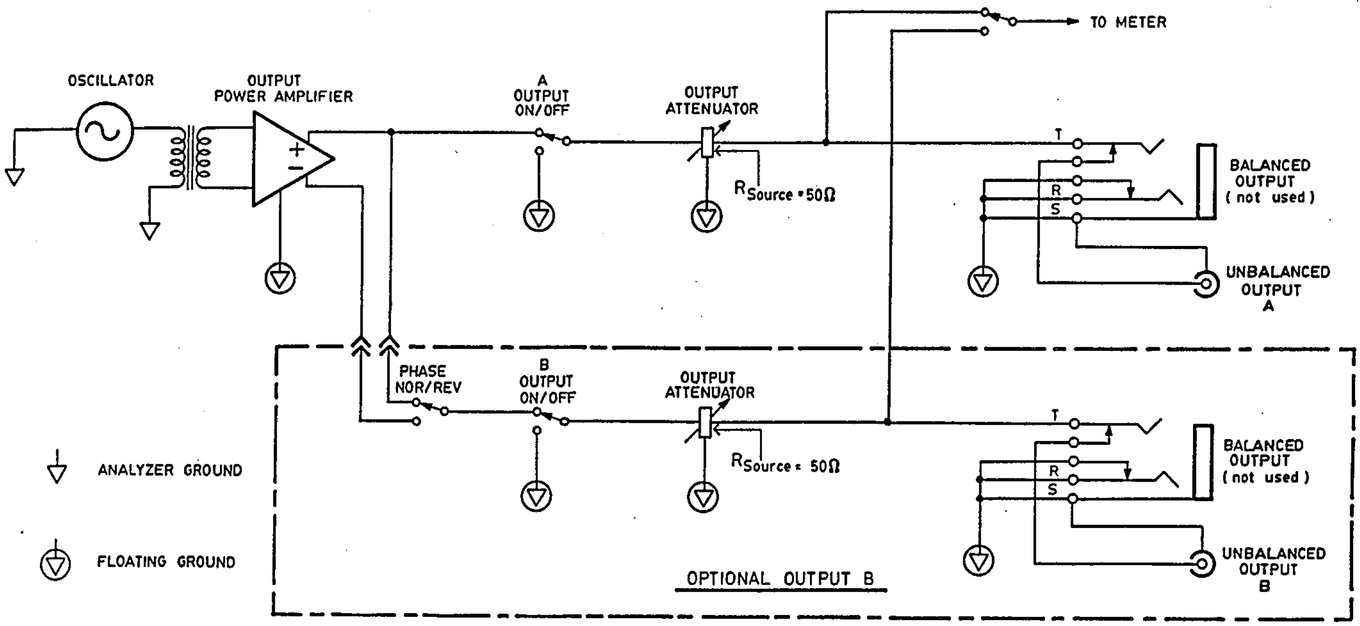
The same condition is true of input/output connectors. Output B is an option (007) which may or may not be present, yet the output jacks will always be present as will the output pushbuttons and indicators. However, no signal will be found on this jack without the addition of the internal module necessary to provide this function.



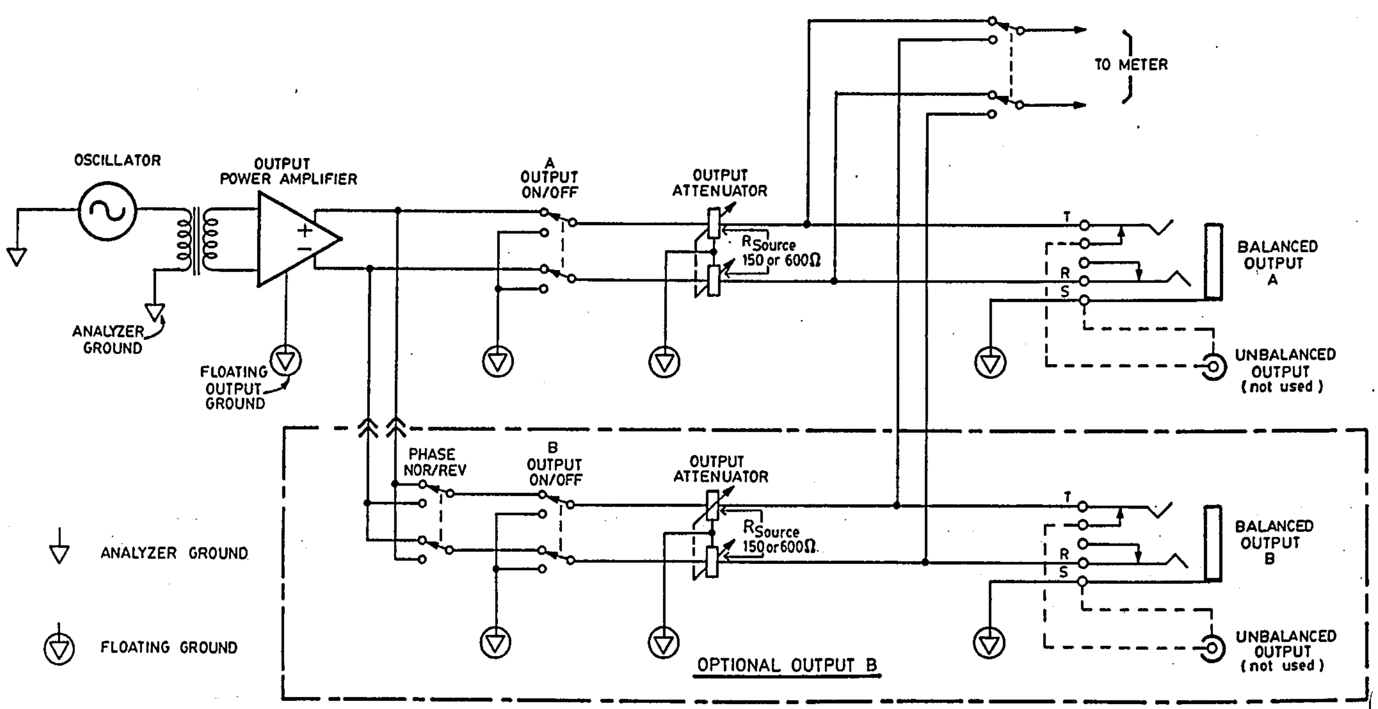
SHIELDING AND GROUNDING SIMPLIFIED



SIMPLIFIED INPUT STRUCTURE



SIMPLIFIED OUTPUT STRUCTURE
UNBALANCED MODE



SIMPLIFIED OUTPUT STRUCTURE
BALANCED MODE

1.5 OPTION DECODE CHART

5500 OPTION ORDERING CODE

5 5 0 0 - [ ][ ][ ][ ][ ]

GENERATOR FEATURES	WEIGHTING FILTERS	MEASUREMENT FEATURES	SPECIAL FEATURES	INTERFACE & CPU
0 None	0 ANSI A	0 None	0 None	0 488 only
1 001	1 101	1 002	1 054	1 488+232
2 001+007	2 102	2 008	2 201	2 488+200
3	3 005	3 002+008	3 201+054	3 488+232 +200
4	4 006	4 009	4	4
5	5 005+102	5 008+009	5	5
6	6 006+101	6 002+008 +009	6	6
7	7 006+102	7 002+009	7	7
8	8 056	8	8	8
9	9 Custom	9	9	9

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AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

OWNER'S MANUAL

SECTION 2

OPERATING INSTRUCTIONS

Issue 07 January 1989

2.0 INTRODUCTION

This section of the manual contains a detailed description of front panel operation. Included are details on the generator, the receiver (or analyzer) and some of the special functions.

For a more detailed description of some of the special functions and operations via the interface ports refer to Section 3, Programming Operation.

The reader should refer to the front panel of the instrument to locate the various keys described in this section. A reproduction of the front panel graphics is included at the end of this section.

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2.1 RECEIVER SECTION

The RECEIVER section contains a level measuring function (also called an AC voltmeter, dB meter, noise meter, etc.) and a distortion meter (also called distortion factor meter or, incorrectly, a distortion analyzer). As the level meter has a high sensitivity and selectable response weighting, it may also be used as a noise meter.

Most operations of the receiver require a single key stroke and are independent (one function is not conditional on another). In general, they result from a desire of the operator to choose a mode of operation, modify a measurement or change a method of data presentation (as opposed to an internal requirement of the instrument such as "nulling" or "ranging" as found on earlier manual instruments).

2.1.1 IMPEDANCE

Impedance is a significant factor in several areas of the 5500. There are eight major parameters that are concerned with impedance. Each of these can have an effect on measured and/or generated values. They are:

a) Generator Source Impedance - This is the output impedance of the 5500 generator, that is, the drive impedance seen by the load looking back into the generator. See Section 2.2.5.

b) Generator Load Impedance - This is usually the input impedance of the external device under test. While its nominal value may be known, only an actual measurement can determine the precise value. (E.g., a device may have a nominal 600 ohm input impedance but the actual impedance may be 603.7 ohms.)

c) Specified Generator Load Impedance - This is the user entered value telling the 5500 the actual device under test input impedance or the 5500 generator external load. It is entered on the keyboard, stored in non-volatile memory and used to determine generator output level. (Note there are two values - one for dBm, one for V and dBV.) See Section 2.2.6.

d) Generator dBm Reference Impedance - When the generator output amplitude is specified in dBm, the reference impedance used to calculate the dBm value is the specified load impedance. E.g., if the external load is specified as 600 ohms, a requested output amplitude of 0 dBm will produce 0.7746 V rms in the external 600 ohm resistor. However, if the external load is specified as 150 ohms, a requested output amplitude of 0 dBm will produce 0.3873 V rms into an external 150 ohm load.

e) Device Under Test Output Impedance - The output source impedance of the device under test will form a voltage divider with its load, usually the input impedance of the 5500, to affect its output level. E.g., a device with a 600 ohm output impedance and producing 0 dBV into an open circuit will produce -0.052 dBV into a 100 k ohm load, the unbalanced high impedance input of the 5500.

f) 5500 Input Impedance - This is the load placed by the 5500 on the output of the external device under test. It is chosen by the user from 3 possibilities. See Section 2.1.9.

g) 5500 dBm Measuring Impedance - As dBm is in fact a power measurement, both the voltage level and impedance are used to calculate dBm. This is set either by the user-chosen input impedance or the user-chosen dBm reference impedance (Special function 26). It is not the same reference used for output dBm calculations. See Section 2.4.2.

h) Watts Impedance Reference - Like dBm, Watts is a power measurement. It is indicated on the 5500 by measuring Voltage and calculating power using a user specified load impedance value. This value is only the calculation value, the actual load must be supplied by the user externally. See Section 2.4.1.

Careful attention to each of the above factors will avoid errors, ambiguities and other problems.

2.1.2 FUNCTION

The row of buttons in the FUNCTION group chooses the basic function of the instrument. Two subgroups are possible - LEVEL and DISTORTION. LEVEL may be wide band or narrow band and DISTORTION may be total harmonic or intermodulation (if the IMD option 002 is provided).

2.1.3 WIDE BAND LEVEL

This function is the AC voltmeter or dB meter mode. The 5500 will automatically measure and display the level of a signal in the range of +40 dBm (100 V) to approximately -100 dBm (10 μV) (lower readings may be possible with band limiting). The reading can be expressed in Volts, mV or μV; in Watts, mW or μW or in dBm or dBV. The frequency range of measurement is 10 Hz to over 500 kHz.

This mode always internally measures the AC Voltage on the input even when the measured result is displayed in Watts or dBm. These "power" readings are derived by calculation from the Voltage measurement by assuming an (internal or external) load impedance. In the case of Watts, the default impedance is 8 ohms, in the case of dBm the default impedance is 600 ohms. Both impedances can be user modified. See Reference Impedance in Section 2.4.

2.1.4 NARROW BAND LEVEL

This mode is similar to Wide Band Level except a programmable filter is inserted into the measurement path. Dynamic range, overall bandwidth and available display units are all the same as the wide band level mode.

The filter type may be selected from a choice of three available configurations: Band Pass, Low Pass or High Pass. In the Band Pass mode, four bandwidths (or filter Q's) are available: very narrow, narrow, medium, and broad (Section 4 describes the shape factors of these filters in detail). The High Pass and Low Pass modes are each 2-pole Butterworth characteristic with 12 dB per octave roll-off. Each of these six shapes is selected one at a time, as the NARROW BAND key is pushed repeatedly.

The center frequency of the band pass response or corner frequency of the high or low pass response may be specified in one of two possible ways. The default condition is for the filter to follow the internal oscillator. Thus it is automatically set to the same frequency as the generator every time a Source Frequency is specified (see Section 2.2.1). Alternatively, the band pass filter may automatically track the input in an auto-tune mode. This requires first that the input signal be -30 dBm/30 mV or greater and second, in the frequency range 10 Hz to 100 kHz. The instrument will then measure the input frequency and automatically and continuously tune the filter to this frequency. To turn on the auto-tune mode, select Special Function 28.2. To return to the normal "follow oscillator" mode, select Special Function 28.0.

2.1.5 TOTAL HARMONIC DISTORTION plus NOISE (THD + N)

This mode measures the THD+N of the input signal by the common fundamental rejection method. That is, the fundamental of the input signal is eliminated by an automatic rejection circuit, the remaining residual signal is measured and its amplitude is expressed as a ratio of the input signal amplitude. Depending on the nature of the input signal, this residual may be predominantly harmonics, noise or some combination of each. Hence the nomenclature Total Harmonic Distortion plus Noise.

The result of the ratio calculation may be expressed as either a dB figure or a percentage figure under control of the shifted UNITS key.

Note that the fundamental rejection circuits and ratiometric measurement and calculation circuits are all totally automatic in operation. Frequency tuning, ranging and nulling are all automatically controlled by the internal computer in response to the input signal.

The instrument will measure the THD+N of signals with levels between - 30 dBm (30 mV) and +40 dBm (100 V) and fundamentals between 10 Hz and 100 kHz. Signals outside this range will generate an error condition. (Error 20 or 21 and Error 26 respectively)

If the input signal is particularly noisy and unstable but the test signal source originates from the 5500 generator, it might be desirable to override the automatic tuning to inhibit random "hunting". An example of such a situation might be SINAD measurements on a communications receiver or distortion measurements on a loud speaker or tape recorder with poor signal-to-noise ratio. It is possible to suppress the auto-tuning and force the THD notch filter to always track or follow the internal oscillator. In this mode, every time a new Generator Source frequency is entered (Section 2.2.1), the THD filter will be set to and held at this same frequency. To select this mode, select Special Function 6.1. To return to the normal auto- tune mode, select Special Function 6.0.

A more generalized case of the "track oscillator" mode can be enacted by using Special Function 37. Whereas Special Function 6 concerns the tuning mode of the notch filter in the THD mode only, Special Function 37 affects filter tuning in all modes (THD and Narrow band level) and also the detector integration time constants and the displayed frequency value. Each of these under normal conditions is determined by the frequency of the INPUT signal. That is, the auto-tuning of the notch in THD and the band pass filter in Narrow band, the detector integration time in all modes and the displayed frequency value in all modes is determined by a measurement of the input signal. By selecting Special Function 37.1, all of these functions are instead slaved to the internal oscillator; 37.0 returns to the normal default state.

37.1 is useful to gain a speed advantage in almost all THD measurement situations (but the frequency of the INPUT test signal must be close to that of the 5500 generator). If the input signal is constantly being interrupted, for example as multiple devices under test are sequenced, this mode will prevent the tuning lock interruption as the input signal is changed. The filter will remain tuned to the internal oscillator (and the FREQUENCY display will continue to give the oscillator frequency) even when the input signal is removed. When the input is reconnected, the filter nulling will proceed faster as the filter is already tuned. To select the oscillator tuning mode, set Special Function 37.1. To return to the normal input tune mode, set Special Function 37.0. Remember that if Special Function 37.1 is set, the input signal must be the same frequency as the 5500 source. If not, an erroneous reading will result. Also remember that this mode changes the FREQUENCY display to be GENERATOR FREQUENCY rather than INPUT FREQUENCY.

2.1.6 INTERMODULATION DISTORTION (IMD) (Requires option 002)

This mode measures the intermodulation products generated in a device under test when stimulated by an appropriate dual frequency signal. This is the only function of the receiver section that has an influence on the generator section. When this mode is selected, the generator changes to a twin tone signal from its normal single tone mode.

Two types of IMD are measured (and generated). The primary mode is SMPTE or DIN consisting of a high frequency signal and a low frequency signal mixed in a 1:4 amplitude ratio. When the mode is entered, if the generator (HF) frequency is below 2 kHz, it is set to 7 kHz but may be later changed to any high frequency between 2 kHz and 100 kHz. The low frequency is the one most previously used but may be changed to one of eight low frequencies between 40 Hz and 500 kHz (see Section 2.2.2). Note that when this function is first selected after a default state power-up, the low frequency is at the default value of 60 Hz.

The second IMD mode is CCIF and is selected by using the shift key. This mode measures the low frequency difference component of a twin tone high frequency test signal. The difference frequency may be any frequency from 80 Hz to 1 kHz while the mean frequency of the dual tone high frequency may lie between 2 kHz and 100 kHz. As in THD+N, the results may be expressed as a dB ratio or a percentage.

2.1.7 DC Measurement (Requires option 008)

Instruments equipped with option 008 are able to measure DC Voltage with three selectable ranges. This function is selected as a SHIFT of WIDE BAND LEVEL.

The instrument measures the DC component of the selected input: A or B. It will respond to either polarity and correctly enunciate the sign in the readout.

The default range is 100V full scale with a 100 mV resolution. Two additional ranges are provided that can accommodate down to 1V full scale with 1mV of resolution. Ranges are selected by Special Function 2. The following table shows the range, resolution and method for selection for each range.

Table 2.1.7 DC Volts Range Select

Measurement Range	Resolution	Selection
100.0 to 0.0	100 mV	2.0 SPCL
10.00 to 0.00	10 mV	2.1 SPCL
1.000 to 0.000	1 mV	2.2 SPCL

2.1.8 Phase Measurement (Requires option 009)

The instrument is able to measure the relative phase difference between two signals of the same frequency with the addition of option 009. This mode is selected as a SHIFT of NARROW BAND LEVEL.

The system measures the relative phase between the signal presented to INPUT A and the **selected** input. That is, if input B is selected on the INPUT SELECT control, the phase difference between the signals at A and B will be measured. Alternatively, if INTERNAL OSC A is selected, the phase shift between the Generator A Output and INPUT A will be measured. The phase measurement facility is the only one on the instrument to use two signals simultaneously.

Two ranges are provided to allow accurate measurements over a full 360° range. As is typical with phase meters, measurements of two signals with very small phase differences can give ambiguous results (for example, near 0° or 360°). Changing to a different range inverts the reference and adds 180° to the reading to avoid this ambiguity. The net effect of the double inversion (signal polarity reversal and mathematical addition of 180 to the measured value) ensures that the displayed reading is always correct.

The phase ranges are selected by Special Function 8. The following table shows the recommended operation of this phase range selection.

Table 2.1.8 Phase Range Selection

Total Range	Recommended Range	Selection
±180°	-170° to +170°	8.0 SPCL
0 to 360°	10° to 350°	8.1 SPCL

Note that the choice of ranges is transparent to the readout. For example, a value of +60° could be read equally on either range. However, a value of 182° would be best read on the 0 to 360° range (8.1 SPCL) while a value of 2° would be best measured on the ±180° range (8.0 SPCL).

2.1.9 FILTERS

Several band limiting and noise weighting filters are available. These are useful to reduce the effects of extraneous noise during distortion measurements or provide frequency response weighting for noise measurements.

Four standard filters are provided and four more are optional.

The 400 Hz High Pass filter can be used to reject low frequency noise and mains hum. It is a 3-pole Butterworth filter and provides over 40 dB rejection at 50 or 60 Hz. It may be used when making THD+N measurements of signals with fundamentals of 1 kHz or greater. The filter is selected and deselected on a push on/push off basis with the first filter key. This filter is independent of other filters and may be selected in conjunction with others.

The 30 kHz and 80 kHz Low Pass filters may be used to reduce the measurement bandwidth in THD+N and other modes. These are 3-pole Butterworth filters (18 dB per octave roll-off). They are generally used in THD+N if the fundamental of the signal being measured is less than one third to one fifth of the filter cutoff frequency (e.g. 10 kHz fundamental or lower for 30 kHz filter, etc.).

The fourth filter (SPCL) will be one of 3 possibilities:

Standard	ANSI/IEC A Weighting
Option 101	CCIR 468-3
Option 102	Psophometric (CCITT P53A)

The choice of which of these three is determined at the factory at the time of order and indicated by a suitable panel label over the button.

In addition to these four standard filters, four optional additional filters may be provided.

The optional group of four additional filters may be one of the following two groups:

1) **Option -005 Audio**
contains the following four filters:

a) Audio band pass, 36 dB per octave roll-off at each end. Specify 20 Hz to 20 kHz or 22.4 Hz to 22.4 kHz
b) IHF Band Pass : 200 Hz to 15 kHz with 19 kHz notch.
c) ANSI "A" Weighting (also called NAB).
d) CCIR 468-3 weighting (also called Dolby).

2) **Option -006 Telecommunications**
contains the following four filters:

a) 3 kHz Flat (Bell 41009 or IEEE 743).
b) 15 kHz Flat (Bell 41009 or IEEE 743).
c) Program (DIN 45405 and Bell 41009/IEEE 743).
d) C Message with notch (Bell 41009 or IEEE 743).

On special order, a mix of filters from options -005 and -006 may be supplied to a maximum of four auxiliary filters.

Note that with the exception of the 400 Hz High Pass filter, only one of the remaining up to seven filters may be selected at any one time.

2.1.10 INPUT SELECTION

One of three (four) possible inputs may be selected: INPUT A, INPUT B or OSCillator A (or OSC B). A and B are two identical inputs on the front panel. OSC is the signal at the generator output and is used for self-check, send level verification, etc. To select the oscillator output, push and hold the SHIFT key and the A button. If the optional B OUTPUT is provided, it may be selected by pushing and holding the shift button while pushing the B button.

2.1.11 INPUT TERMINATION

All inputs are normally high impedance bridging (100 k ohms) but may also be set to a 600 or 150 ohm termination. (Note that the input termination operates on external INPUT A or external INPUT B but not internal OSC).

The input defaults to a 100 k ohm input impedance. By pushing the SHIFT key and the INPUT TERMINATION button, a 600 or 150 ohm input termination may be selected. Two independent operations happen when 600 or 150 is selected: if (external) INPUT A or B is selected, a physical termination resistor is placed across this selected input and secondly, the dBm reference impedance used to calculate the dBm reading is set to 600 or 150 ohms, as required. This impedance reference will remain until either changed by Special Function 26 or a new input termination is selected. Note that selecting 100 k ohms will remove the input termination but retain the last used (600 or 150) impedance for the dBm reference.

To illustrate, using an example: if an external source of 0.775 V open circuit and 600 ohm source impedance is connected to INPUT A, the LEVEL mode will indicate 0 dBm in the 100 k ohm mode, -6 dBm in the 600 ohm mode and -7.96 dBm in the 150 ohm mode.

Again note that the physical termination resistors only affect the INPUT A or INPUT B external sources. The internal OSC connection cannot be terminated (except of course by using an external cable between GENERATOR OUTPUT and analyzer INPUT).

CAUTION

Note that the input termination resistors can dissipate a maximum of 1 Watt continuously. This is represented by the following conditions:

INPUT TERMINATION	MAXIMUM dBm	MAXIMUM Volts
600 ohms	+30 dBm	24.5 V rms
150 ohms	+30 dBm	12.3 V rms

Input conditions greater than this can permanently damage the termination resistors. If an input is selected, a termination is on and the input conditions exceed the 1 Watt limit, the instrument will automatically disconnect the termination to avoid damage. All terminations are also temporarily disconnected during instrument fatal error states and reset after the errors are cleared.

See Section 1.3 for more information on input configurations.

2.1.12 DETECTORS

The 5500 has three amplitude detectors, selectable by the user. The detectors are true rms, average and quasi-peak. All three detectors are calibrated to read the rms value of a pure sine wave.

True rms will yield the most accurate results of a complex waveform such as noise or distortion. Average will allow comparison of readings with those from older average responding instruments. Quasi-peak measures noise to particular standards such as CCIR 468-3.

The choice of one of three detector characteristics is made by the DETECTOR button (above the SHIFT key).

2.1.13 INTEGRATION

Notably absent from the 5500 is any means to choose the integration time (sometimes called averaging time or smoothing). This is because this function is automatically handled internally. Since the 5500 always measures the frequency of the input signal, it is able to choose the optimal time constants automatically.

If desired, this automatic time constant selection can be overridden using Special Function 29.

A further feature enhances integration. The 5500 uses a proprietary process called Synchronous Integration that yields an excellent result to the usual settling-time/ripple compromise present in AC level measurements. Under normal conditions, satisfactory integration of low frequency detection to yield acceptable smoothness and accuracy also implies very long settling time.

The 5500 avoids this trade-off and is able to yield virtually ripple free readings within one cycle of the input signal - a time improvement of up to an order of magnitude.

2.1.14 RELATIVE MODE

The relative mode allows the current measured value to be expressed as a ratio (dB or %) of a stored reference. For example, signal to noise is the ratio of noise to the peak or program level. Gain is the ratio of output level to input level.

Two distinct operations must be performed to use the relative mode. First, the reference must be stored (if not previously done) and secondly, the relative mode must be selected. These two operations may be done in any order.

The reference may be stored in two ways: as a keyboard entered value or as the currently measured value (of the input signal).

To store a relative reference, push the REFERENCE prefix key (bottom key in the column below the RELATIVE KEY). Then enter the desired reference value on the numeric keys. Finally, terminate the entry with the dBm, dBV, V or % keys (note that % is a shifted key), for example, to enter a reference of +8 dBm, key in:

Or, for a reference of 226 Volts :

To enter the presently **measured** value simply push the "*" key after the prefix. No terminator is required. For example, to set the currently measured program level as the reference (assuming this value is currently being displayed on the left display) push:

Having thus stored a reference, the relative mode can be enacted by pushing the RELATIVE key. Absolute readings are again selected by a second push. The stored reference is not altered until a new reference is entered.

For example, assume a reference of +8 dBm has been previously stored and the noise level being measured is say -65 dBm. If the RELATIVE key is pushed, the reading will change to -73 dB (the ratio between +8 and -65). When the key is pushed again, the absolute value of -65 dBm returns.

Another example: assume a value of 0.46 V was stored as a reference and the current measured value is 3.6 V. If the RELATIVE key is pushed, a reading of 783% will be displayed as the ratio of 0.46 to 3.6. That is, the new measured value is 783% of the stored reference. This could be easily converted to a dB figure by selecting a log units display. Push and hold the SHIFT key and push the UNITS key to see +17.88 dB.

Setting the relative mode and storing the current measured value as the reference can also be accomplished as a single operation. The shifted mode of the RELATIVE key accomplishes this. To set, push and hold the SHIFT key and then the RELATIVE key. The display will now change to 0.0 dB or 100% and all future readings will be relative to this current value.

Note: A separate reference is maintained in memory for both DISTORTION and LEVEL measurements. The DISTORTION reference is stored as a ratio and the LEVEL reference as an absolute value.

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2.2 GENERATOR SECTION

The generator consists of a programmable frequency, high performance oscillator, a high power output amplifier, a programmable output attenuator and configuration switching. If the IMD option 002 is provided, a second low frequency oscillator is included as well as the ability to generate a twin tone high frequency signal.

Many generator parameters are set by multiple key strokes. The normal syntax of data entry is :

PREFIX - DATA - TERMINATOR

The PREFIX establishes what is going to be set such as frequency or amplitude. DATA is entered as a numeric value on the numeric keyboard. The TERMINATOR, typically a units key, functions as an "ENTER" key and executes the just entered parameters. As soon as the first data key is pushed, the right hand display changes from its previous role (of frequency indicator) to a "data entry" indicator. Digits will enter at the right and move left. When the terminator key is pushed, the display clears and reverts back to its previous function.

2.2.1 GENERATOR FREQUENCY SELECTION

In all modes, except the optional IMD mode, the generator may be set to any frequency between 10 Hz and 100 kHz. To set the generator to a particular frequency, first push the FREQUENCY prefix key followed by one to five data keys followed by the Hz or kHz terminator key. For example:

FREQ 1 kHz

FREQ 1 0 0 0 Hz

FREQ 1 . 2 5 6 kHz

The right hand display will usually be indicating the actual *measured* frequency of the oscillator (if OSC input is selected or INPUT A or B contains the oscillator signal via the device under test). The measured value will almost invariably be at least slightly different from the programmed value (or user entered frequency). Bear in mind that the frequency indication is 5 digits of resolution, a resolution of 0.01% while the oscillator is *not* a synthesizer. It has a typical frequency accuracy of ±1%, normal for a low distortion RC type oscillator. The frequency meter resolution is 100 times the oscillator frequency accuracy and will tend to magnify the appearance of the error.

The user can see the *programmed* frequency (rather than the measured frequency) by pushing and holding the FREQUENCY prefix key.

If an invalid frequency entry is attempted, an error will be displayed. Examples of errors would be requesting a frequency outside the generator range (e.g., 1 MHz), keying in too many data digits (more than 5) or an improper terminator (Volts, for example).

A special method of frequency entry may be useful in certain circumstances. If the 5500 is reading the frequency of an external source (not the 5500 internal oscillator) and it is desired to set the internal oscillator to that frequency, the first inclination would be to key in the digits of that measured frequency. However, a simpler way exists. The "*" key uses the currently measured value as DATA. So, to set the internal oscillator to the measured external frequency, just push the FREQ prefix key followed by the * (no terminator is required). The oscillator should now be programmed to the frequency of this external source.

2.2.2 IMD FREQUENCY (requires option 002 IMD)

The FREQUENCY prefix key in the IMD mode sets the HF component of the SMPTE/DIN signal or the mean frequency of the CCIF signal. The lower limit of the analyzer is 2 kHz. If a lower frequency is entered in the IMD mode, the resulting measurement will be non-valid.

The LF component of the SMPTE/DIN signal or offset frequency in the CCIF mode is set using the IMD LOW FREQUENCY prefix key. Eight frequencies are available: 40, 50, 60, 80, 100, 125, 250 or 500 Hz. If a number other than these is entered, the available frequency closest to the entered value will be automatically selected.

Note that when the SMPTE/DIN IMD function is selected, if the HF is below 2 kHz, it is automatically set to 7 kHz. The LF is set to the last used value. The user may then override these values with additional numeric entries. If another function is selected and IMD SMPTE/DIN again selected, the previously used frequencies will be used (unless the HF has been set to below 2 kHz while another function was selected).

On first power-up, the LF oscillator is set to its default value of 60 Hz. Therefore, the first time the IMD function is selected after default state power-up, 60 Hz will be used. If the LF oscillator is manually changed to a different frequency, it will remain at this new manually entered frequency until either again manually changed or until the instrument is powered down.

The offset frequency in the CCIF mode is one half the difference frequency. For example, if a high frequency/mean frequency of 10 kHz and a low frequency/offset frequency of 60 Hz is selected, then the following outputs will be observed:

SMPTE mode :	HF:	10 kHz
	LF:	60 Hz
CCIF mode :	F1:	10060 Hz
	F2:	940 Hz

2.2.3 NARROW BAND FREQUENCY

One of the four meter functions is Narrow Band Level. This mode inserts a band pass, low pass or high pass filter in the measurement path. The center frequency of the band pass or the corner frequency of the high or low pass can be entered by setting the generator to the desired frequency. The filter will automatically be set to the same frequency as the internal generator. It is also possible to have the filter automatically track the frequency of the INPUT signal (if the INPUT is -30 dBm/30 mV or greater) by setting SPECIAL FUNCTION 28.2. SPECIAL FUNCTION 28.0 returns the filter to the manual mode (see Section 2.1.4).

2.2.4 GENERATOR AMPLITUDE (requires option 001 High Level Balanced Output)

The generator output amplitude is a function of several factors:

a) Requested amplitude as specified by a keyboard entry (or GPIB command)

b) Specified external load impedance (also keyboard or GPIB)

c) Actual external load impedance

d) Generator source impedance (50, 150 or 600 ohms)

e) Units used: dBm, dBV or Volts

All of the above factors will have an effect on the signal level delivered to the load. Insufficient attention to this detail can lead to unanticipated errors. For example, if the user specifies a load impedance of 600 ohms but the actual load is say, 592 ohms, the signal will be low by about 1% with a generator source impedance of 600 ohms or about 0.1% with a 50 ohm source.

Section 2.2.6 following describes how to set the specified external load impedance. The values entered will be used for all output amplitudes. The default conditions are infinity (open circuit) in the Volts or dBV mode and 600 ohms in the dBm mode.

To select a generator output level push the AMPLITUDE prefix key followed by one to five data entry keys followed by a units terminator key. The requested level will then be presented to the user defined load (assuming the specified load and the actual load are identical).

The output range, in the balanced mode, into an infinite load (open circuit) is 33 V rms maximum to below 300 μV rms (+30 dBV to -70 dBV). The output range, in the balanced mode, into an external 600 ohm load from a 150 ohm source is +30 dBm to -70 dBm. Maximum signal levels in the unbalanced mode are approximately one half of the balanced levels. Lower signal levels can be requested and achieved but with progressively degraded resolution and signal-to-noise ratio. The normal amplitude resolution is better than approximately 0.03 dB or 0.3% (i.e. 3 mV at 1 V).

CAUTION

The maximum output levels available from the 5500 are higher than typically available from bench generators by a factor of 2 to 4. Damage to a device under test can result under certain conditions. Use levels above +10 dBm/dBV/3V with caution. The output power amplifier is capable of delivering several Watts of power to an external load. It is internally protected against overload conditions and short circuits, nevertheless, unnecessary sustained operation at maximum output into low impedance loads should be avoided to minimize internal heat dissipation. The generator gives the same performance with or without a load; if the device under test is a high impedance input, it is not necessary to provide a dummy load termination to the generator.

As in the frequency mode, the * key can also be used to set the generator output amplitude to the currently measured INPUT amplitude. For example, if the 5500 is reading +8 dBm from an external source in the Level mode and the AMPL and * keys are pushed in sequence, the generator would then be set to +8 dBm output.

If an amplitude of 0 V is entered as the generator amplitude, the output is set to zero and the oscillator will be internally turned off to avoid any possibility of signal leak through.

The user programmed amplitude can always be displayed by pushing and holding the AMPL key. This displays the current programmed generator output amplitude (as opposed to the measured amplitude) while the key is held.

2.2.5 OUTPUT SOURCE IMPEDANCE (requires option 001 High Level Balanced Output)

Three output source impedances and configurations are possible:

SOURCE IMPEDANCE	CONFIGURATION
600 ohms	Balanced
150 ohms	Balanced
50 ohms	Unbalanced

The three possibilities are selected by successive pushes of the CONFIGURATION button. In the balanced modes the output should be taken from the tip-ring-sleeve jack, in the unbalanced mode the signal should be taken from the BNC jack. The signal is available on both jacks in both modes but erroneous levels and/or grounding problems may occur if the wrong jack is used. The panel graphics clearly indicate the correct jack to use. Note that when a plug is inserted into the BAL jack, the UNBAL jack is disconnected.

The highest drive level will be obtained by selecting the 150 ohm balanced configuration. This mode will permit a +30 dBm drive into an external 600 ohm load (1 Watt). The 600 ohm balanced mode should be used for equipment that requires a true 600 ohm source impedance. The 50 ohm unbalanced configuration should be used for unbalanced equipment such as consumer audio components that could be damaged by the high signal levels possible in the balanced modes.

2.2.6 OUTPUT LOAD IMPEDANCE

The 5500 stores two internal values of external load impedance, one for dBm and another for all other units (V, dBV). These stored values are used to calculate the actual generator output drive level to produce the correct level in the external load. The calculation also takes into account the specified output level and the generator source impedance. Every time any of these is changed, the level is recalculated to insure the correct value in the external load.

The load impedance default values are as follows:

dBm:	600 ohms
dBV and Watts :	infinity (open circuit)

The values can be changed by using a special function. In the dBm case, the assumed load can take values from 1 to 9999 ohms. In dBV and Volts, the load can be 1 to 9998 ohms or infinity (open circuit). Note that dBm, being a unit of power, cannot assume an infinite load. For dBm the SPCL FNCT is 5, for Volts and dBV it is SPCL FNCT 4. To enter a value, key in the SPCL FNCT number (4 or 5) followed by a decimal point followed by the value in ohms from 1 to 9999 and terminated by the SPCL key. (In the dBV or Volts case, the value of 9999 will represent infinity or open circuit). For example, to set the dBm external load to 150 ohms, key in:

Note that in the dBm case the load impedance is also the dBm reference impedance, that is, the output level will be set using the true meaning of dBm, not using dBu or dBm referenced to 600 ohms.

To determine the currently stored load impedance, key in 4.0 SPCL or 5.0 SPCL. The left hand display will show the stored value.

2.2.6.1 MINIMUM LOAD IMPEDANCE

The power amplifier used in the generator is subject to certain constraints. One of these is the maximum voltage it can produce. A second is the internal dissipation it can handle. To provide protection for the latter, the power amplifier has a current limit feature. This insures that no damage will occur even if the output is short circuited.

The combination of the voltage constraint and current limit will define the maximum output capability for various source and load impedance combinations. Conditions that exceed these limits will cause the amplifier to current limit (to clip) as a dissipation protection but without warning the user.

The user must specify the value of the external load impedance, the generator source impedance and the desired signal level delivered to the external load. The 5500 computer then calculates the power amplifier drive level required to produce this desired signal level in the external load. If the drive level exceeds the power amplifier voltage capability, an error condition is generated. However, if the voltage is within limits but the current is exceeded, no error is generated. Similarly, if an external load impedance below the specified load impedance is used, the amplifier may current limit (clip).

Certain extreme conditions of overload can actually shut down the entire 5500 instrument due to power supply protective fault monitoring.

Table 1 illustrates the minimum value of external load impedance that can be used without causing the power amplifier to current limit. As a single power amplifier is used to drive both the A and optional B output, the limit changes depending on whether one or both outputs are being used.

Table 2 illustrates the maximum output in dBm that is possible under various source and load impedance variations. Note that the dBm value follows the strict definition as power relative to 1 mW - not dBm/600 ohms or dBu as is read on most dBm meters. Also, remember that the 5500 uses this mathematically correct dBm interpretation when calculating its output level. If the instrument is told the external load for dBm is 150 ohms for example (5.150 SPCL), then an impedance of 150 ohms is used in the dBm calculation. 0 dBm will be 1 mW or 0.387 V in the external 150 ohm load in this case.

TABLE 2.4.1

MINIMUM EXTERNAL LOAD IMPEDANCE THAT WILL NOT CAUSE CURRENT LIMITING

OUTPUT (SOURCE) IMPEDANCE	MAXIMUM OPEN CIRCUIT VOLTAGE	MINIMUM LOAD IMPEDANCE & RESULTING LOAD VOLTAGE	
		USING A ONLY OR B* ONLY	USING BOTH A & B*
50 ohms unbalanced	16.5 V	50 ohms / 8.3 Volts	150 ohms / 12.4 Volts
150 ohms balanced	33 V	50 ohms / 8.3 Volts	250 ohms / 21 Volts
600 ohms balanced	33 V	0 ohms / 0 Volts	0 ohms / 0 Volts

*NOTE: Use of Output B requires Option 007.

TABLE 2.4.2

MAXIMUM OUTPUT POWER IN dBm (relative to 1 mW) for various output load impedances (rms Volts delivered to load)

OUTPUT (SOURCE) IMPEDANCE	EXTERNAL LOAD IMPEDANCE (OHMS)				
	50	100	150	300	600
50 ohms unbalanced	+31.3 dBm (8.3 Volts)	+30.8 dBm (11.0 Volts)	+30.1 dBm (12.4 Volts)	+28.2 dBm (14.1 Volts)	+25.9 dBm (15.2 Volts)
150 ohms balanced	+31.3 dBm (8.3 Volts)	+32.4 dBm (13.2 Volts)	+32.6 dBm (16.5 Volts)	+32.1 dBm (22.0 Volts)	+30.7 dBm (26.4 Volts)
600 ohms balanced	+21.2 dBm (2.5 Volts)	+23.5 dBm (4.7 Volts)	+24.6 dBm (6.6 Volts)	+26.1 dBm (11.0 Volts)	+26.6 dBm (16.5 Volts)

2.2.7 GROUND/FLOAT

The shifted mode of the CONFIGURATION button allows the output to be ground referenced or floated. The normal mode is internal GND reference. If the output is ground referenced via the external equipment being measured, the FLOAT mode may be selected to avoid a ground loop. The output must have a ground reference from one of the several possible paths: output GND mode, through the device under test or via an external ground connection.

In the GND mode, the center tap of the BALANCED output is connected to chassis and the low side of the UNBALANCED output is connected to chassis. This chassis connection is via a voltage dependent resistor/capacitor network for protection.

2.2.8 OUTPUT ON/OFF

The top push button in the OUTPUT group is the output ON/OFF function. This can be used for signal-to-noise ratio measurements or other applications requiring a quiet termination. When the output is OFF, the source impedance remains the same as in the ON mode.

2.2.9 B OUTPUT (if option 007 provided)

The shifted mode of the ON/OFF key selects the optional dual output. If the second (B) output module is provided, the output may be set to feed A only, B only, A and B in phase or A and B out of phase. Both outputs have the same level, source impedance and configuration. The two outputs are resistively isolated but come from a common power amplifier. See Tables 1 and 2 for combined output load limitations.

2.2.10 EXTERNAL INPUT

An external input is provided on the rear panel of the 5500 to allow the user to supply an external special source signal (such as a function generator, square wave, pink noise, etc.). To select the external source, key in 14.4 SPCL. To select the internal oscillator (default condition), key in 14.1 SPCL. The external source must have a nominal signal level of +10 dBV/3.16 V and will benefit from output power amplifier transformer isolation, output attenuator, output configuration and amplitude setting provision.

Every time a new FUNCTION is selected, the default signal source is again selected. For example, if the instrument is in the WIDE BAND LEVEL mode and Special Function 14.4 is selected, the external signal source will be on. If the THD function is now selected, the internal source (that is, the default source or 14.1 SPCL) will be selected at the same time that THD is entered. To use the external source in this new THD mode, again key in 14.4 SPCL.

2.2.11 SIGNAL SOURCES

Special Function 14 has a more general application. It may also be used to select any of the optional special signal sources that may be provided on the 5500. Table 2.2.11 lists the signal sources, special function code and conditions. As with the external input

(14.4 SPCL) described above, any change in FUNCTION always reselects the default internal sine wave source (unless IMD is selected. See below.)

This feature allows selection of a special source in an abnormal mode. For example, when the IMD function is selected, the appropriate IMD composite test signal source is automatically selected. This also means that the IMD test signal can only be selected in the IMD measurement mode. However, the IMD signal source can be selected in the WIDE BAND LEVEL mode by entering 14.2 SPCL. This allows measurement of the rms level of the composite IMD test signal, for example.

It is of course possible to enter illegal modes. Selecting an IMD twin-tone source in the THD mode will usually yield errors and at best a meaningless value. As the source is not explicitly indicated on the front panel and an unaware user could have difficulty sorting out an invalid state, the 5500 always clears the signal source to its default state at every function change. The default state in the LEVEL and THD modes is a single fixed frequency sine wave. In IMD it is a two frequency composite waveform. In the SWEEP mode, it is the swept sine wave source for LEVEL or THD and a swept composite source for IMD.

TABLE 2.2.11

SPECIAL FUNCTION 14
SELECTING GENERATOR SOURCE SIGNALS

SPCL FNCT	SIGNAL SOURCE	CONDITIONS
14.0	None	
14.1	Internal Sine Wave	Default source for level and THD
14.2	Internal IMD composite signal	Requires option 002. Default source for IMD. If selected in other modes, will be SMPTE or CCIF depending on last mode used.
14.4	External Input	Accepts rear panel input signal.
14.5	External Input and IMD	Requires option 002. Mixes external input with internal LF oscillator to produce composite SMPTE or CCIF source signal.
14.7		Internal Square Wave
14.8	Auxiliary Source 1	Requires option 003 Special Signals Group.
14.9	Auxiliary IMD Source	Requires option 002 and 003.
14.10	Auxiliary Source 2	Requires option 003.
14.11	Auxiliary Source 3	Requires option 003.
14.12	Auxiliary Source 4	Requires option 003.

2.2.12 FREQUENCY INCREMENT

In addition to the direct frequency entry described previously, generator frequency may be specified as a change relative to the current value. The amount of the change is set by the operator by using the increment mode. The generator frequency is changed by using the UP or DOWN MODIFY keys.

To enter the increment mode, push and hold the SHIFT while pushing the FREQ prefix. Next enter the desired increment value and then the proper units terminator. Terminators may be Hz, kHz or % (note that % is a shifted function). For example, the increment may be specified as 100 Hz, 1.1 kHz, 10%, 62%, etc. A Hz or kHz value will yield linearly spaced increments, % increments will yield log spaced increments. After the terminator key is pushed, the increment entry mode will be cancelled and the instrument will return to the direct entry mode. Then the UP and DOWN buttons will increment (or decrement) the generator frequency by the previously specified incremental value.

Avoid trying to increment to an invalid frequency. For example, setting an increment of 1 kHz, pushing DOWN when the current frequency is 1 kHz and thus requesting a new frequency of 0 Hz (Error 7).

The UP and DOWN keys are repeat keys. They can be held down for continuous stepping. The frequency will step sweep up or down at approximately 2 steps per second after an initial start delay of approximately 2 seconds. The measurement circuits of the meter may not respond fast enough at this speed to allow results to be displayed but, if the generator output is viewed on an oscilloscope, the increment sequence can be seen. Or SPCL function 10 may be selected to see the programmed (or set value) which will respond at the required speed to see the effect.

2.2.13 AMPLITUDE INCREMENT

The amplitude increment mode allows changing the generator output level by a user defined value. For example, stepping the output level in 1 dB, 0.1 dB or 100 mV steps. To use the increment mode first set the increment value. Push the AMPLITUDE INCREMENT prefix (SHIFT + AMPL keys). Then key in the value and finally the terminator. Valid terminators are dB, Volts and % (remember that % is a shifted key). After entry of a valid increment value, the increment entry mode will be cancelled and the AMPLITUDE mode automatically set. Then the UP and DOWN keys can be used to step the output amplitude by the previously set increment. As on the frequency mode, the UP/DOWN keys are repeat keys.

Note that the modify keys (UP, DOWN) act on generator frequency or generator amplitude depending on which prefix key has been pushed. Each mode (FREQ and AMPL) has its own stored increment value which remains until changed by the user.

2.2.14 IMD AMPLITUDE RATIO (requires option 002 IMD)

In the IMD modes, two oscillators produce a twin tone signal. The relative amplitude of the two signals can be user defined in the SMPTE mode. In the CCIF mode, the two signals are fixed at a 1:1 or equal amplitude but in the SMPTE/DIN mode, four relative amplitudes are possible: 1:1, 1:2, 1:4 and 1:10. When the SMPTE/DIN IMD mode is selected, the 1:4 ratio is automatically set (the SMPTE/DIN standard). A different ratio can be selected by using a SPECIAL FUNCTION (SPCL). Special Function 35 is reserved for IMD ratio. 35.1 SPCL sets a 1:1 ratio, 35.2 sets a 1:2 ratio, 35.4 sets a 1:4 ratio and 35.10 sets a 1:10 ratio (special functions do not require a prefix key). To set a ratio, key in the correct numeric code (e.g. 35.4) and terminate by pushing the SPCL key. Special Function 35.0 can be used to view the currently set ratio.

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2.3 INSTRUMENT SETUP STORES

Twelve non-volatile memories are provided in the 5500 to store instrument setups. Two positions are reserved for power-on default state and last power-down state respectively while the remaining ten positions are user accessible.

The instrument normally powers up in a factory defined default state stored in memory position 0. This clears any unusual settings and assures the user of a known start configuration. A list of the position 0 default states is given in Section 2.6. (Alternatively, the instrument can be changed to power up in Memory 1 state, use SPCL FNCT 23.1. See the note on the next page.)

Position 1 is the complete state of the instrument when power was last turned off.

Positions 2 through 11 are ten user definable memories for convenient recall of special test setups.

Note that the instrument always stores its complete status, that is, **everything** that can be set by the front panel, in the selected memory. The user may subsequently elect to request either a partial recall, that is, only the frequency and amplitude of the oscillator or a total recall.

To recall a total instrument setup, key in a number from 0 to 11, the decimal point, the digit 1 then terminate with the RECALL key. For example:

4 . 1 RCL

This will effect a **total** recall of what the user previously stored in memory 4 (if nothing has been stored, error 6 is generated). For a partial recall, omit the decimal and digit 1. That is, 4 RECALL will recall only the frequency and amplitude of the generator previously stored in position 4.

To store the current status of the instrument, key in a number from 2 to 11 followed by the STORE terminator (STORE is a shifted version of RECALL).

4 SHIFT STORE

Remember the instrument always does a **total** store but the user may elect either a partial or total recall. User available storage positions are 2 through 11. Positions 0 and 1 are automatically stored and only available for user recall.

Note :

When recalling a complete instrument state (i.e. 2.1 through 11.1), the current instrument state is automatically stored in memory 1 prior to the total recall. (This does not occur on a partial recall - 2 to 11.) Thus it is possible to alternate between a just used setup and a previously stored setup. Or, if the recalled memory inadvertently contains an unwanted instrument setup, the operator can quickly return to the previous state by keying in 1.1 RCL.

The storing of the complete instrument state in position 1 at power down is only guaranteed if the instrument is powered down using the front panel POWER push button. If power down is effected by removal of mains from the rear panel, the instrument may properly store its state in position 1 but this is not guaranteed. (This is related to power supply filter capacitor holdup voltage time. The sequence of events is predictable when using the front panel POWER push button but not with a simple removal of mains.)

As stated earlier, the instrument always powers up in its default state (Memory 0). Alternatively, the instrument can be modified to power up in the same state it was in during a valid power-down sequence.

To change the instrument to power up in the last power down state, key in 23.1 SPCL. The **next** time the instrument is powered up, it will start in the last power-down state. To return to the normal default power-up state, key in 23.0 SPCL.

If the last state at power-down was not successfully stored for any reason, at next power up, the default status will be recalled rather than an erroneous and possibly illegal state. The instrument always checks the validity of data prior to a recall to avoid placing the instrument in an invalid state.

2.4 SPECIAL FUNCTIONS

There are several lesser used parameters that can be set using SPECIAL FUNCTIONS. Examples are dBm impedance reference, certain GPIB functions, etc. SPECIAL FUNCTIONS are also used for diagnostic purposes, special programming, to override auto-ranging and other unusual situations.

The syntax for Special Function entry is the special code followed by the SPCL key. No prefix is required. Many special functions have a two part code separated by a decimal point. The first part of the code specifies the function while the second part of the code the sub-function, value, etc.

For example, the dBm impedance can be set using Special Function 26. To set a 150 ohm reference, enter 26.150 SPCL. The following are some of the more commonly used special functions.

2.4.1 WATTS IMPEDANCE REFERENCE

The meter can express the input signal level as a power reading by calculating a Watts value using the measured input Voltage and a stored impedance reference. The default value is 8 ohms but the user can change the stored reference to be any value between 1 and 999 ohms inclusive. Use Special Function 25 followed by a decimal followed by the desired impedance followed by the SPCL terminator key. For example, to set a value of 16 ohms key in :

[2] [5] [.] [1] [6] [SPCL]

The currently stored impedance reference can be displayed by using Special Function 25.0.

2.4.2 dBm IMPEDANCE REFERENCE

dBm is in fact a power ratio measurement expressing a measured signal level relative to a power of 1 mW. The 5500, like most dBm meters, measures dBm by measuring volts and calculating the power presuming a reference impedance. The default impedance is 600 ohms. However, the user can change the reference to be any value from 1 to 999 ohms inclusive using Special Function 26. To set a dBm impedance reference of 150 ohms, for example, key in:

[2] [6] [.] [1] [5] [0] [SPCL]

To display the currently set value of dBm impedance reference use Special Function 26.0.

Remember that the 600 and 150 ohm input terminations automatically select 600 and 150 ohms respectively as the reference. Also, the dBm reference described here is for LEVEL measurements only and does not affect Generator level dBm settings which have their own independent reference.

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2.5 ERROR CONDITIONS

The 5500 has a comprehensive set of error trapping programs to avoid ambiguous results, prevent instrument damage or warn the operator if invalid operations are attempted.

The errors are of several classes depending on their origin and are handled according to an established level of priority.

2.5.1 COMMAND ENTRY ERRORS

These result from an erroneous front panel operation by the operator (for example, requesting a frequency of 1 Volt). They are cleared by pushing the CLEAR key and starting again. The following table lists the errors by number.

2.5.2 MEASUREMENT ERRORS

These errors result from invalid signals present at the input. For example, with a signal below -30 dBm (30 mV), no distortion reading can be obtained. They are cleared by correcting the input signal within approximately 20 seconds of the condition. After this time, the condition must be corrected and the CLEAR key pushed.

For example, if a signal of -60 dBV (1 mV) is being measured in the LEVEL mode and then one of the distortion modes is selected, error 21 will be displayed (signal level too low for distortion). If the signal is increased in level to -30 dBV or more within 20 seconds, the error will be cleared and a distortion reading will be displayed. If longer, and the signal is both raised and the CLEAR key pushed, the distortion reading will be displayed. If the signal amplitude cannot be increased, a new (valid) function could be selected, LEVEL for example, to clear the error.

ERROR CODE SUMMARY

COMMAND INPUT ERROR CODES

1	Invalid Special Function suffix
2	Unrecognized command
3	Invalid string character
4	Invalid numeric string
5	Invalid terminator
6	Invalid command operand
7	Operand out of range
8	Invalid Special Function prefix
9	GPIB input code error

MEASUREMENT EXCEPTION CODES

11	Signal at PGA out over range: PGA gain decremented
12	Signal at PGA out under range: PGA gain incremented
13	Signal at PGB out over range: PGB gain decremented
14	Signal at PGB out under range: PGB gain incremented
15	Signal at PGC out over range: PGC gain decremented
16	Signal at PGC out under range: PGC gain incremented
17	SVF not tuned to input signal: SVF frequency adjusted

MEASUREMENT ERROR CODES

20	Signal at PGA out over range and can't adjust
21	Signal at PGA out under range and can't adjust
22	Signal at PGB out over range and can't adjust
24	Signal at PGC out over range and can't adjust

MEASUREMENT ERROR CODES

26	Signal frequency is out of range for SVF tuning
27	Can't tune SVF due to lack of frequency reading.
28	Can't measure distortion due to lack of hardware synch'd amplitude reading
29	IMD mix mismatch
30	Level calculation overflow or DC too negative
31	Can't tune SVF due to frequency counter overflow
32	DC too positive
34	Can't auto-range due to instability of input signal
35	Can't tune SVF due to instability of input signal
37	Level calculation underflow
38	Distortion calculation underflow
39	Ratio Calculation Underflow
40	Ratio Calculation Overflow
41	Distortion calculation overflow
42	Level/distortion display overflow
44	Measurement readings lost
47	Can't get frequency reading
49	Frequency calculation overflow
50	Frequency display overflow
60	AUTOCAL failure
99	ROM failure

2.6 DEFAULT STATES

The following table gives the instrument default states at power on.

These are stored in memory position 0 and are automatically set into the instrument at power on.

PARAMETER	DEFAULT STATE
Detector Speed	SLOW
Detector Selected	RMS
HP Filter	OFF
Weighting Filters	OFF
Input Selected	A
Servo	OFF
PGA Gain/Attenuation	-35 dB
PGB Gain	0 dB
PGC Gain	0 dB
Input Termination	100 k Ohms
Output A	OFF
Output Reference	GROUND
Output Structure	600 Ohms (BAL)
Programmed Source Amplitude Units	V
Ouput Load Impedance Reference, Level	INFINITY
Ouput Load Impedance Reference, Power	600 Ohm
Source Amplitude	0.0 V
Source Frequency	1.0 kHz
SVF Frequency	1.0 kHz
IMD Offset Frequency (requires option 002)	60 Hz
Distortion Reference	100.0 %
Level Reference	1.0 V
Source Amplitude Increment	1.0 V
Source Frequency Increment	1.0 Hz
SVF Frequency Increment	1.0 Hz
dBm Impedance	600 Ohms
Watts Impedance	8 Ohms
Operating Mode	AUTO
Amplitude Display Units	V
Amplitude Display Decimal Point Position	DDD.DD
Frequency Display Units	Hz
Frequency Display Decimal Point Position	DDD.DD
Frequency Measurement Source	INPUT

PARAMETER	DEFAULT STATE
Narrow Band Measurement Type	VERY WIDE BP
Front Panel Special Amplitude Display	OFF
Front Panel Special Frequency Display	OFF
Amplitude Display Units Operating Mode	FLOATING
Amplitude Display Decimal Operating Mode	FLOATING
Frequency Display Decimal Operating Mode	FLOATING
PGA Operating Mode	AUTO
PGB Operating Mode	AUTO
PGC Operating Mode	AUTO
SVF Tuning Mode	HOLD
Detector Speed Mode	AUTO
Numeric Entry Mode	SOURCE AMPLITUDE
IMD Mix Ratio (requires option 002)	1:1
Measurement Mode	FREE RUN
Relative Measurement Enable	OFF
Measurement Type	WIDE BAND
Output B (requires option 007)	OFF
Power amp source select	INTERNAL
Absolute Units	V
Output Configuration	A ONLY
Output Enable	OFF
Programmed Source Amplitude	0.0 V
DC Range (requires option 008)	100 V
Phase Scale (requires option 009)	± 180
DC Volts Measurement Mode (requires option 008)	OFF
Phase Measurement Mode (requires option 009)	OFF
DC Feedback (requires option 008)	FULL
DC DAC A (requires option 008)	0
DC DAC A (requires option 008)	0
DC Multiplexer (requires option 008)	OUTPUTS OFF
DC Digital Utility (requires option 008)	0

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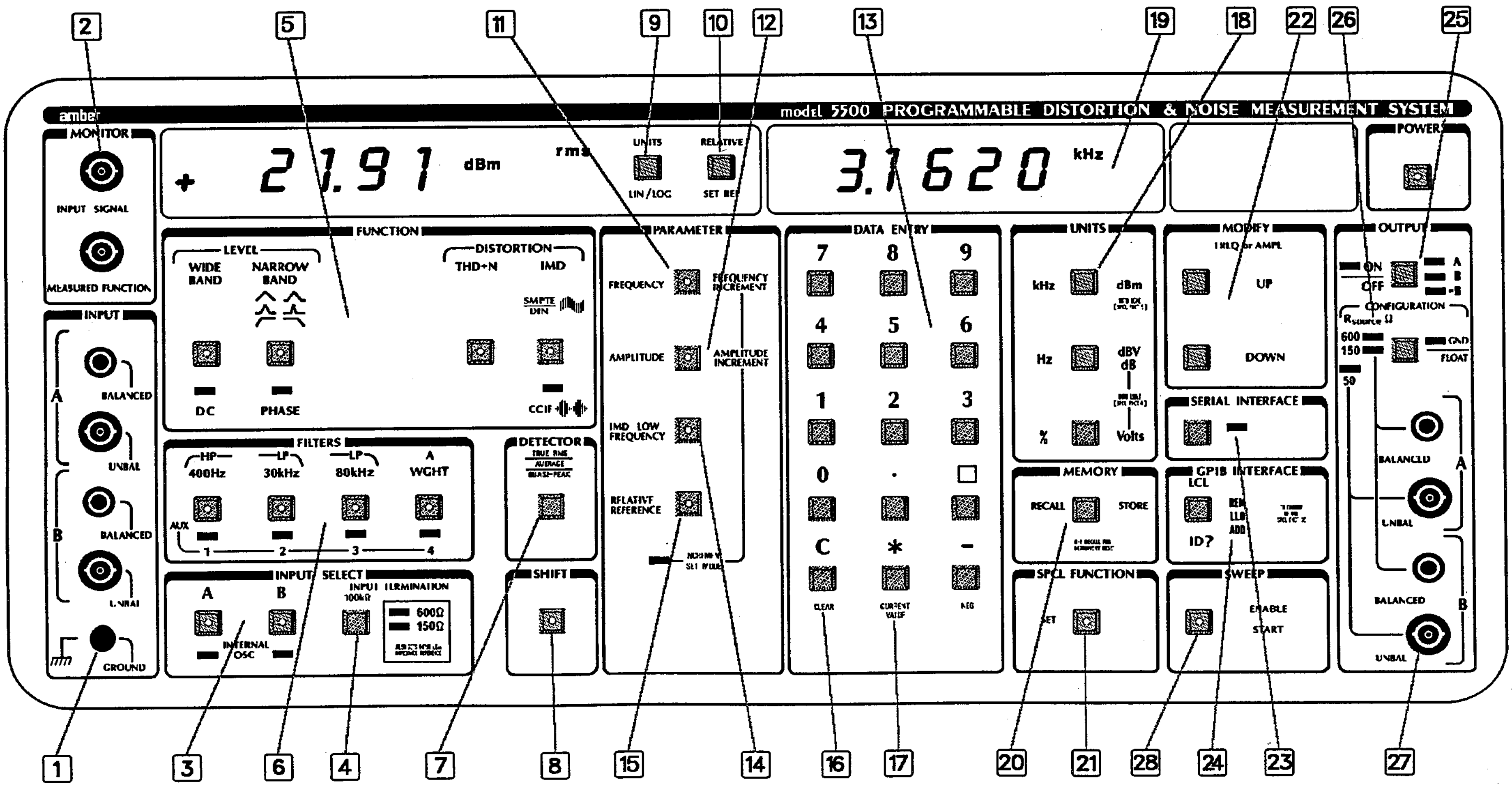
amber
model 5500 PROGRAMMABLE DISTORTION & NOISE MEASUREMENT SYSTEM
MONITOR
INPUT SIGNAL
MEASURED FUNCTION
INPUT
A
BALANCED
UNBAL
B
BALANCED
UNBAL
GROUND
+ 21.91 dBm rms
UNITS
LIN/LOG
RELATIVE
SET REF
3.1620 kHz
POWER
FUNCTION
LEVEL
WIDE BAND
NARROW BAND
DISTORTION
THD+N
IMD
SMPTE
DIN
DC
PHASE
CCIF
FILTERS
HP
400Hz
LP
30kHz
LP
80kHz
A
WGHT
AUX
1
2
3
4
INPUT SELECT
A
B
INTERNAL OSC
INPUT TERMINATION
100kΩ
600Ω
150Ω
DETECTOR
TRUE RMS
AVERAGE
QUASI-PEAK
SHIFT
PARAMETER
FREQUENCY
FREQUENCY INCREMENT
AMPLITUDE
AMPLITUDE INCREMENT
IMD LOW FREQUENCY
RELATIVE REFERENCE
DATA ENTRY
7
8
9
4
5
6
1
2
3
0
.
□
C
*
-
CLEAR
CURRENT VALUE
NEG
UNITS
kHz
dBm
Hz
dBV
dB
%
Volts
MEMORY
RECALL
STORE
SPCL FUNCTION
SET
MODIFY
FREQ or AMPL
UP
DOWN
SERIAL INTERFACE
GPIB INTERFACE
LCL
REM
LLO
ADD
ID?
SWEEP
ENABLE
START
OUTPUT
ON
OFF
A
B
-B
CONFIGURATION
Rsource Ω
600
150
50
GND
FLOAT
BALANCED
UNBAL
1
2
3
4
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10
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1) Connect output of device under test to either BALANCED or UNBALanced input connector. Balanced jack is telephone style tip/ring/sleeve and requires mating WE310 or PJ051 type plug. GROUND post is chassis; connect to chassis of device under test.

2) Connect dual trace oscilloscope to INPUT and MEASURED FUNCTION outputs to monitor signal. INPUT is auto-ranged input signal; MEASURED FUNCTION is input signal after any weighting filters in WIDE BAND LEVEL, input signal after weighting and tunable filter in NARROW BAND LEVEL and distortion residual products (i.e. signal with fundamental removed) after weighting filters in all DISTORTION modes.

3) Select one of two inputs or one of two outputs as the input signal to the meter/analyzer.

4) Select input termination impedance on both A and B inputs. Selecting 600 or 150 ohms also sets dBm reference impedance for dBm measurements (may be changed using SPCL FNCT 26). Do not exceed power rating of termination resistors. (See Section 2.1.9 of user's manual.) Note: terminations only apply to EXTERNAL inputs, not internal oscillator connection.

5) Select measurement function. WIDE BAND LEVEL measures signals and noise from 10 Hz to over 500 kHz and +40 dBm/dBV/100 V to below -120 dBm/dBV/1 V. NARROW BAND LEVEL same as WIDE BAND but 10 Hz to 100 kHz set by FREQUENCY command (see 11 below). THD requires fundamental between 10 Hz and 100 kHz and signal level between +40 dBm/dBV/100 V and -30 dBm/dBV/ 30 mV. IMD same except lower frequency limit for HF component is 2 kHz. SMPTE is mix of a high and a low frequency signal with measurement of AM products of HF signal. CCIF is mix of two HF signals with measurement of difference frequency component. Note: IMD function requires option 002.

6) Select weighting or band limiting filters. Permissible selection includes HP filter plus one of remaining 7 filters. Four auxiliary filters require option 005 or 006. Avoid selection of a filter that would eliminate a frequency band of interest.

7) Select DETECTOR characteristic. TRUE RMS accepts crest factors AVERAGE is fastest and yields average of absolute value. QUASI-PEAK measures to CCIR 468-3 spec. All detectors are rms calibrated (will indicate same value on a pure sine wave).

8) SHIFT key. All front panel functions labelled in green require pushing and holding SHIFT key while selecting the green, shifted function.

9) Select display units. LEVEL modes have a choice of four units, two in log (dBV, dBm) and two in linear (V, W). DISTORTION modes have a choice of two units : dB in log and % in linear. LIN/LOG choice is a shifted function. (see SPCL FNCT 25 for Watts and SPCL FNCT 26 for dBm impedance reference)

10) Relative mode shows current measured value in comparison to a previously stored reference (see 15 below). In log, units are dB, in linear units are %. First push enables relative mode (using previously stored reference), second push disables relative mode and returns to absolute mode (without altering stored reference). If in the absolute mode, pushing SHIFT and RELATIVE simultaneously modifies the stored reference to be the currently measured value and enables the relative mode - display will show 0dB or 100% until measured value changes.

11) FREQUENCY prefix is used to enter a generator (and filter) frequency. SHIFT of FREQUENCY is the FREQUENCY INCREMENT prefix. Next entry is DATA (see 13 below) followed by a UNITS terminator (see 18 below). Example, FREQUENCY 100 Hz.

12) AMPLITUDE prefix is used to enter a generator output amplitude. SHIFT of AMPLITUDE is the AMPLITUDE INCREMENT prefix. Next entry is DATA (see 13 below) followed by a UNITS terminator (see 18 below). Example, AMPLITUDE 2 0. 0 dBm. Amplitude is always into user specified external load (see SPCL FNCT 4 and 5).

13) DATA keys. Used to enter a numeric quantity for FREQUENCY, AMPLITUDE, REFERENCE, MEMORY or SPCL FNCT.

14) Prefix for entering IMD low frequency. Data entry will define the SMPTE LF frequency and the CCIF Offset frequency (one half of difference frequency). Choices are 40, 50, 60, 80, 100, 125, 250 and 500 Hz. Other entries will be rounded to closest available value. (Requires IMD option 002.)

15) Prefix for relative reference. Next entries should be data followed by dBm, dBV, dB, V or % terminator (also see 10 and 17).

16) CLEAR key. Used to cancel an uncompleted data entry, correct errors, etc. Also cancels SPCL FNCT 10.

17) CURRENT VALUE. Can be used with any prefix key in lieu of manual data entry (13 above). Uses current measured value as data. Does not require a terminator.

18) Terminator keys. Used to terminate a data entry begun by pressing a prefix key. Note: when terminating an AMPLITUDE entry, the dBm units terminator uses user specified external load impedance selected by SPCL FNCT 4; dBV and V units terminators that of SPCL FNCT 5.

19) OSC indicator in FREQUENCY display. When lit, SPCL FNCT 37 is enabled. Means indicated frequency and auto-tuning is referenced to the internal oscillator rather than the (external) signal on the INPUT.

20) MEMORY terminator. To store an instrument setup, select a memory from 2 to 11 using the data entry keys then push SHIFT and MEMORY (store) as a terminator. To partially recall (frequency and amplitude of generator only), select the memory location using the DATA key (2 to 11) then push the RECALL button. A full state recall is N.1 followed by RECALL where N is the memory number.

21) SPCL FUNCTION terminator (see the SPCL FNCT code summary). To enter a special function, key in the required digits and terminate with the SET key.

22) MODIFY keys. Pushing UP (or DOWN) will increment (or decrement) the FREQUENCY or AMPLITUDE by the previously user stored INCREMENT value. Push FREQUENCY or AMPLITUDE prefix key first then UP or DOWN.

23) Enables data output from serial port (if option 232 is provided). When enabled, output data can be viewed on an external suitably configured data terminal. Adds a time burden to instrument when enabled. (Serial port input is always enabled to accept commands.)

24) GPIB INTERFACE. If instrument in REMOTE mode and not LOCAL LOCKOUT, pushing this key will return the instrument to LOCAL. Pushing SHIFT and this key (ID?) displays the instrument's GPIB address and status.

25) OUTPUT status. Push on, push off button enables selected output(s) or provides quiet termination. SHIFTED mode of button selects outputs : A only, B only, A and B in-phase and A and B out-of-phase. (Note B output only present if option 007 is installed.)

26) OUTPUT CONFIGURATION. This key determines the style of the output. The primary mode selects 600 ohm balanced, 150 ohm balanced or 50 ohm unbalanced. IMPEDANCES refer to the generator source impedance (as opposed to the user specified external load impedance). Be sure to take the signal from the appropriate output connector. Pushing SHIFT and this key alternately selects GND (generator common or balanced center tap connected via approximately 500 ohms to analyzer ground) or FLOATing. Correct selection will avoid ground loops or ungrounded, floating circuits. Note: Balanced Output modes require option 001.

27) Connect INPUT of device under test to either the BALANCED or UNBALanced OUTPUT connector. Balanced jack is telephone style tip/ring/sleeve and requires mating WE310 or PJ051 type plug.

28) SWEEP enable key. (Requires option 054.) When pushed, places 5500 in SWEEP mode freezing all auto-ranging and measurement activity. Pushing any front panel key or sending any command to the GPIB or SERIAL ports will cancel the SWEEP mode and return the 5500 to normal operations.

SPECIAL FUNCTION CODE SUMMARY

INTERNAL GAIN/LOSS CONDITIONS

Set PGA Autorange Mode	1.0 SPCL
Hold Current PGA Gain	1.1 SPCL
Select & Hold -30dB PGA Loss	1.2 SPCL
Select & Hold -25dB PGA Loss	1.3 SPCL
Select & Hold -20dB PGA Loss	1.4 SPCL
Select & Hold -15dB PGA Loss	1.5 SPCL
Select & Hold -10dB PGA Loss	1.6 SPCL
Select & Hold -5dB PGA Loss	1.7 SPCL
Select & Hold -0dB PGA Loss	1.8 SPCL
Select & Hold +5dB PGA Gain	1.9 SPCL
Select & Hold +10dB PGA Gain	1.10 SPCL
Select & Hold +15dB PGA Gain	1.11 SPCL
Select & Hold +20dB PGA Gain	1.12 SPCL
Select & Hold +25dB PGA Gain	1.13 SPCL
Select & Hold +30dB PGA Gain	1.14 SPCL
Select & Hold +35dB PGA Gain	1.15 SPCL
Set PGB Autorange Mode	3.0 SPCL
Hold Current PGB Gain	3.1 SPCL
Select & Hold 0dB PGB Gain	3.2 SPCL
Select & Hold +20dB PGB Gain	3.3 SPCL
Select & Hold +40dB PGB Gain	3.4 SPCL
Select & Hold +60dB PGB Gain	3.5 SPCL
Select & Hold +80dB PGB Gain	3.6 SPCL
Set PGC Autorange Mode	27.0 SPCL
Hold Current PGC Gain	27.1 SPCL
Select & Hold 0dB PGC Gain	27.2 SPCL
Select & Hold +10dB PGC Gain	27.3 SPCL
Select & Hold +20dB PGC Gain	27.4 SPCL
Select PGA, PGB & PGC Autorange Automatic Detector Speed & Tuning	9.0 SPCL
Hold PGA, PGB, PGC Detector Speed & Tuning	9.1 SPCL

RELATIVE MODE

Disable Relative Mode	11.0 SPCL
Display Level Relative Reference	11.1 SPCL
Display Distortion Relative Ref.	11.2 SPCL
Enable Relative Using Stored Ref.	11.3 SPCL
Enable Relative Using Current Value	11.4 SPCL

IMPEDANCE REFERENCES

Watts Measurement Impedance	25.nnn SPCL
dBm Measurement Impedance	26.nnn SPCL
Output dBm Load Impedance	5.nnnn SPCL
Output Volts/dBV Load Impedance	4.nnnn SPCL

SERIAL INTERFACE

Enable Serial Interface transmit	38.1 SPCL
Disable Serial Interface transmit	38.0 SPCL

TUNING MODES & DETECTOR SPEED

THD Notch Filter Follow Osc	6.1 SPCL
THD Notch Filter Auto Tune to Input	6.0 SPCL
Narrowband Follow Oscillator	28.0 SPCL
Narrowband Auto Coarse Tune	28.2 SPCL
Frequency Tuning & Sync to Input	37.0 SPCL
Frequency Tuning & Sync to osc.	37.1 SPCL
Select Detector Speed Automatic	29.0 SPCL
Hold Current Detector Speed	29.1 SPCL
Select Very Slow Detector Speed	29.2 SPCL
Select Slow Detector Speed	29.3 SPCL
Select Fast Detector Speed	29.4 SPCL
Select Very Fast Detector Speed	29.5 SPCL

MEASUREMENT PARAMETERS

Set 1 to 1 IMD Amplitude Ratio	35.1 SPCL
Set 2 to 1 IMD Amplitude Ratio	35.2 SPCL
Set 4 to 1 IMD Amplitude Ratio	35.4 SPCL
Set 10 to 1 IMD Amplitude Ratio	35.10 SPCL
Select THD Level Measure Mode	36 SPCL

GPIB FUNCTIONS

Select Left Displ (AMPL) to GPIB	20.0 SPCL
Select Right Displ (FREQ) to GPIB	20.1 SPCL
Display GPIB Address Status	21.0 SPCL
SRQ on GPIB Input error Only	22.0 SPCL
SRQ on GPIB Input or Fatal error	22.1 SPCL
SRQ on GPIB Input, Fatal error or Data Ready	22.2 SPCL
Set GPIB Address (address = nn)	33.nn SPCL
Set GPIB to Talk and Listen	34.0 SPCL
Set GPIB to Listen Only	34.1 SPCL
Set GPIB to Talk Only	34.2 SPCL

SPECIAL DISPLAYS
Front Panel Only

Display Source Settings	10 SPCL
Display Level Relative Ref.	11.1 SPCL
Display Distortion Relative Ref.	11.2 SPCL
Display Watts Impedance Ref.	25.0 SPCL
Display dBm Impedance Ref.	26.0 SPCL
Display IMD Ampl Mix Ratio	35.0 SPCL
Display Volts/dBV Load Impedance	4.0 SPCL
Display dBm Load Impedance	5.0 SPCL

MISCELLANEOUS

Start AUTO-CAL Sequence	24 SPCL
Select EXT IN as Output	12.1 SPCL
Select OSC as Output	12.0 SPCL
Power up in Default State	23.0 SPCL
Power up in last power down State	23.1 SPCL

DISPLAY FORMATTING

Amplitude Auto-range Units	30.0 SPCL
Ampltude Hold Current Units	30.1 SPCL
Amplitude Hold Volts	30.2 SPCL
Amplitude Hold mV	30.3 SPCL
Amplitude Hold µV	30.4 SPCL
Amplitude Hold Watts	30.5 SPCL
Amplitude Hold mW	30.6 SPCL
Amplitude Hold µW	30.7 SPCL
Select Float Pt Amplitude Display	31.0 SPCL
Hold Current Dec Pt Position	31.1 SPCL
Set DDDDD. Decimal Point	31.2 SPCL
Set DDDD.D Decimal Point	31.3 SPCL
Set DDD.DD Decimal Point	31.4 SPCL
Set DD.DDD Decimal Point	31.5 SPCL
Set D.DDDD Decimal Point	31.6 SPCL
Set .DDDDD Decimal Point	31.7 SPCL
Select Float Pt Frequency Display	32.0 SPCL
Hold Current Dec Pt Position	32.1 SPCL
Set DDDDD. Decimal Point	32.2 SPCL
Set DDDD.D Decimal Point	32.3 SPCL
Set DDD.DD Decimal Point	32.4 SPCL
Set DD.DDD Decimal Point	32.5 SPCL
Set D.DDDD Decimal Point	32.6 SPCL
Set .DDDDD Decimal Point	32.7 SPCL
Phase ±180° range	8.0 SPCL
Phase 0 - 360° range	8.1 SPCL

DC AND DIGITAL UNITY
(option 008)

DC Range 100V F.S.	2.0 SPCL
DC Range 10V F.S.	2.1 SPCL
DC Range 1V F.S.	2.2 SPCL
Optional DC gain change	85.1 SPCL
DC Utility DAC A (0 to 2.55V)	86.nnn SPCL
DC Utility DAC B (0 to 2.55V)	87.nnn SPCL
DIGITAL output (0 = off or 1 to 8)	88.n SPCL
Digital 8 bit utility (0 to 255)	89.nnn SPCL

SIGNAL SOURCE

Default Source	14.1 SPCL
IMD Composite Source	14.2 SPCL
Swept Sine Wave	14.3 SPCL
External Input	14.4 SPCL
External In and IMD LF	14.5 SPCL
Swept Sine IMD	14.6 SPCL
Square Wave	14.7 SPCL
Aux Source 1	14.8 SPCL
Aux IMD Source	14.9 SPCL
Aux Source 2	14.10 SPCL
Aux Source 3	14.11 SPCL
Aux Source 4	14.12 SPCL
Fine tune default sine	13.nnn SPCL

10500 HZ

949 HZ

AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

OWNER'S MANUAL

SECTION 3

PROGRAMMING INFORMATION

Issue 07 January 1989

3.1 COMMAND USAGE

3.1.1 FRONT PANEL SYNTAX

DOCUMENTATION CONVENTIONS

The front panel keys are referred to in the following documentation by their associated labels on the front panel shown in bold sans serif type. Examples are **FREQUENCY** and **WIDE BAND**. References may also be prefixed by an additional label which describes a distinct set of keys on the front panel, for example, -OUTPUT-**ON/OFF**.

Although it isn't apparent in the documentation, green labelled functions are always accessed by a shift of the associated key, for example, amplitude display units are selected via the **UNITS** key while linear and log amplitude display formats are selected via the **LOG/LIN** key which, in effect, refers to the **UNITS** key shifted. The green **SHIFT** key must be depressed and held while pressing the desired key.

FRONT PANEL FUNCTION KEYS:

Key Reference: Documentation Section References:

UNITS	3.5.4 Amplitude Display Units & Operating Mode
LIN/LOG	3.5.3 Amplitude Display Lin/Log Format
RELATIVE	3.5.1 Relative Mode

- FUNCTION -

WIDE BAND	3.3.1 Measurement Type
DC	3.2.16 DC Volts Measurement Mode
NARROW BAND	3.3.1 Measurement Type
PZ	3.2.19 Phase Measurement Mode
THD	3.3.1 Measurement Type

IMD SMPTE	3.3.1 Measurement Type
IMD CCIF	3.3.1 Measurement Type

- FILTERS -

HP 400Hz	3.2.11 High Pass Filter
AUX 1	3.2.10 Weighting Filters
LP 30kHz	3.2.10 Weighting Filters
AUX 2	3.2.10 Weighting Filters
LP 80kHz	3.2.10 Weighting Filters
AUX 3	3.2.10 Weighting Filters
SPCL	3.2.10 Weighting Filters
AUX 4	3.2.10 Weighting Filters

- DETECTOR -

DET	3.2.13 Detectors

- INPUT SELECT -

A	3.2.1 Input Select
B	3.2.1 Input Select
OSC A	3.2.1 Input Select
OSC B	3.2.1 Input Select

- INPUT TERMINATION -

100 k	3.2.2 Input Termination
600/150	3.2.2 Input Termination

- PARAMETER -

FREQUENCY	3.4.3 Source Frequency 3.1.5 Numeric Entry and Modification Mode
FREQUENCY INCREMENT	3.1.5 Numeric Entry and Modification Mode
AMPLITUDE	3.4.1 Source Amplitude 3.1.5 Numeric Entry and Modification Mode

AMPLITUDE INCREMENT	3.4.2 Source Amplitude Increment 3.1.5 Numeric Entry and Modification Mode
IMD LOW FREQUENCY	3.4.5 IMD Offset Frequency 3.1.5 Numeric Entry and Modification Mode
RELATIVE REFERENCE	3.5.2 Relative Mode Reference 3.1.5 Numeric Entry and Modification Mode

- INCR -

UP	3.1.5 Numeric Entry and Modification Mode
DOWN	3.1.5 Numeric Entry and Modification Mode

- OUTPUT -

ON/OFF	34.7 Output Enable
A/B/-B	3.4.11 Output Configuration

- OUTPUT CONFIGURATION -

Rsource	3.4.9 Output Impedance and Structure
GND/FLOAT	3.4.8 Output Reference

- SERIAL INTERFACE -

SERIAL INTERFACE	3.9.1 Serial Port Usage

- GPIB INTERFACE -

LCL	3.8.2 Selecting Local/Remote Operation

- SWEEP -

ENABLE	See 054 manual

NUMERIC KEYS AND TERMINATOR KEYS

Numeric key closures are echoed on the frequency display. Once numeric entry is started, only DATA ENTRY (excluding **CURRENT VALUE**) and terminator keys are allowed; use of any other key will prematurely terminate the entry and cause an "Invalid Terminator" (error 5) to be generated. Numeric entry can be validly terminated by one of the terminator keys, labelled UNITS, MEMORY, and SPCL FUNCTION. Once correctly terminated, the currently selected frequency display is restored.

CLEAR aborts the current entry while **NEG** changes its sign. **CURRENT VALUE** enters the last measured amplitude, distortion, or frequency, depending on the currently selected numeric entry parameter, and doesn't need to be terminated.

The context of any value entered is determined by the currently selected numeric entry mode and the choice of terminator. If one of the -UNITS- keys is entered as terminator, the entered value is interpreted as the newly selected Source Frequency or Amplitude, IMD Frequency, Reference or Increment setting depending on which parameter was last selected. The -UNITS- keys themselves are context dependent so that if the **kHz/dBm** key terminates the entry and the currently selected numeric entry parameter is a frequency type, as for example Source Frequency, the entered value will be presumed to be in kHz. Refer to 3.1.5 Numeric Entry and Modification Mode. If one of the -MEMORY- keys, **RECALL** and **STORE**, is used to terminate an entry, the numeric value will be interpreted as the specification for a Recall or Store Machine State command. Refer to 3.7 Command Functions - Store and Recall of Machine Status. If the **SPCL FUNCTION** key is used to terminate an entry, the entered value will be interpreted as the special function number and operand. Refer to 3.1.4 Special Functions.

REPEAT KEYS

Holding any front panel keys, except those labelled -PARAMETER- and -INCR-, will have no effect on the instrument other than slowing it down while it processes the input.

Holding one of the -PARAMETER- keys will enable a temporary display of that parameter's current programmed setting. If either the **FREQUENCY,** the **FREQUENCY INCREMENT**, or the **IMD* LOW FREQUENCY** key is held, the current programmed Source Frequency, Source Frequency Increment or IMD* Frequency setting will be displayed on the frequency display. Similarly, if either the **AMPLITUDE**, the **AMPLITUDE INCREMENT**, or the **RELATIVE REFERENCE** key is held, the current programmed Source Amplitude, Source Amplitude Increment, or Relative Reference setting will be displayed on the amplitude display. In the case of Relative Reference, if a distortion type measurement is currently selected, then the distortion reference will be displayed, otherwise the level reference will be displayed. In all cases once the held key is released, the last selected front panel display mode is restored.

Holding the **UP** key or the **DOWN** key will increment or decrement the currently selected numeric entry parameter, if applicable, by the current Increment setting at a rate of 2 to 3 times a second. This is true only if the currently selected numeric entry parameter is Source Amplitude, Source Frequency, or SVF Frequency and the associated Increment parameter setting is non-zero. Attempting to increment or decrement any other parameter will cause "Unrecognized Command" (error 2) to be generated. Refer to 3.1.5 Numeric Entry and Modification Mode.

*NOTE: IMD function requires option 002, IMD.

LOCAL LOCKOUT

If the instrument is in Remote mode, only the -DATA ENTRY-**CLEAR** key, in its triggering capacity, and the -GPIB INTERFACE-**LCL** key are functional. If the instrument is in Remote With Lockout mode, none of the front panel keys are functional. Refer to 3.8.2 Selecting Remote/Local Operation and 3.8.3 Local Lockout.

3.1.2 GPIB COMMAND SYNTAX

All GPIB command and terminator mnemonics consist of 2 ASCII characters, a letter followed by a letter or number. Refer to 3.12.2 for a list of valid GPIB mnemonics. If the GPIB device is configured to respond to data messages (see Section 3.8, page 3-93), it will accept all variable length ASCII strings made up of valid command mnemonics and numeric strings delimited by terminator mnemonics (e.g. IO2.5VL). A command string may contain any ASCII alphanumeric characters, as well as the following special characters: '+', '-', '.', space, carriage return, and line feed. If any characters other than those specified above are detected in the input string, an 'Invalid GPIB Command Input' error will be generated and the processing of the current command will be aborted.

Valid numeric strings are of the form
SD.DDDDESDDTM where:

S refers to '+' or '-' sign which may be omitted, in which case, a positive value is presumed.

D.DDDD refers to a mantissa made up of up to 20 ASCII digits and a decimal point which may be anywhere in the string or may be omitted, in which case, a decimal point at the extreme right is presumed.

ESDD refers to an exponent (base 10) which must be preceded by 'E', may include a '+' or '-' sign or no sign in which case a positive value is presumed, and up to 2 ASCII digits. If the exponent is altogether omitted, an exponent value of 0 is presumed.

TM refers to terminator. Following is a list of valid terminator mnemonics:

MNEMONIC	FUNCTION
DB	dB units
DM	dBm units
DV	dBV units
HZ	Hz units
KH or KZ	kHz units
MV	mV units
PE	% units
VL	V units
UV	μV units
RC	Recall command (refer to 3.7.2 and 3.7.3)
SP	Special command function (refer to 3.1.4)
ST	Store command (refer to 3.7.1)

3.1.3 SERIAL PORT COMMAND SYNTAX (requires option 232, Serial Port)

All references to the serial port or terminal CRT are to be taken as synonymous.

Serial port commands are entered as follows: command **operand operand** or numeric-string terminator. In the latter case the numeric string and terminator are used with the current numeric entry mode (N MMODE) and must be compatible with it.

Commands and operands always have to be separated by at least one space. Depending on the command function, the operand may be altogether omitted or 1 operand or 2 operands, separated by spaces, must be entered. Refer to Serial Port Commands for a list of valid command mnemonics and to the individual command functions for the valid operand mnemonics associated with each command.

Numeric-strings take the form SD.DDDDESNN where SD.DDDD represents the signed mantissa. If the sign (S) is omitted, a positive value will be presumed. The decimal point may be anywhere in the mantissa string; if omitted, the decimal point will be presumed to be to the right of the last mantissa digit.

ESNN represents the signed exponent. If ESNN is altogether omitted, the exponent value is presumed to be zero. If the sign (S) is omitted, the exponent is presumed positive. The exponent value itself cannot exceed 2 decimal digits.

Numeric-strings may not contain any embedded spaces or any non-numeric characters other than '.', '+', '-' and 'E'. They have to be terminated by at least 1 space followed by a valid terminator.

Following is a list of valid terminator mnemonics:

MNEMONIC	FUNCTION
DB	dB units
DBM	dBm units
DBV	dBV units
HZ	Hz units
KHZ	kHz units
OHM	Ohms units
V	V units
MV	mV units
UV	μV units
%	% units
SP	Special function command (refer to 3.1.4)
RC	Recal function (refer to 3.7.2 and 3.7.3)
ST	Store function (refer to 3.7.1)

The only editing available is **<BACKSPACE>**.

3.1.4 SPECIAL FUNCTIONS

Refer to 3.12.3, Special Functions, for a list of instrument special functions and to the individual command functions for a description of valid special function operands. These functions are always entered as numeric strings and terminated by the **SPCL FUNCTION** key from the front panel and the SP terminator mnemonic from the serial port and GPIB interfaces. The numeric string that specifies a special function has to be of the form N.O where N refers to the special function number and determines which command function is being invoked and O refers to a valid operand associated with that function. If the 0th operand is selected, N.0 may be entered simply as N, with the decimal point and operand omitted. In most cases, the 0th operand of a special function is its default state. The SPCL FUNCTION LED is turned on whenever a non-default state of a special function is selected. This doesn't hold for the special display type functions (refer to 3.6.3) or certain other functions that don't support default states (refer to the individual Command Functions descriptions).

See Section 3.12.4 for a list of instrument default states.

3.1.5 NUMERIC ENTRY AND MODIFICATION MODE

Numeric entry and modification mode determines the context of numeric entry and the increment or decrement functions. It allows the user to specify a reference parameter to which all subsequent numeric entries, if terminated by a -UNITS- key or mnemonic, will be applied and to which all subsequent increment and decrement commands will be applied. If, for example, the current numeric entry and modification parameter is Source Amplitude and the value 5.5 is entered and terminated by the **kHz/dBm** key, Source Amplitude will be set to 5.5 dBm. If the same value is entered and terminated by the **Hz/dBV/dB** key, the new setting will be 5.5 dBV. If, however, under the same conditions, a numeric entry is terminated by the **%** key, an "Invalid Terminator" (error 5) will be generated because the assigned units are not compatible with the currently selected parameter, amplitude. As another example, if the currently selected numeric entry and modification parameter is Source Frequency and 5.5 is entered and terminated by the **kHz/dBm** key, Source frequency will be set to 5.5 kHz. In this case, both the **V** and **%** keys will cause an Invalid Terminator error to occur.

If either Source Amplitude, Source Frequency or SVF Frequency is the currently selected numeric entry parameter and the UP or DOWN command is invoked, the selected parameter will be incremented or decremented by the current Increment setting. If the currently selected numeric entry parameter is other than the ones mentioned above, using the UP and DOWN commands will result in "Unrecognized Command" (error 2).

SELECTING NUMERIC ENTRY AND MODIFICATION PARAMETERS

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Source Amplitude	**AMPLITUDE**	SRCAMP	AP
Source Amplitude Increment	**AMPLITUDE INCREMENT**	AMPINC	AN
Source Frequency	**FREQUENCY**	SRCFRQ	FR
Source Frequency Increment	**FREQUENCY INCREMENT**	FRQINC	FN
SVF Frequency	-	SVFFRQ	SF
SVF Frequency Increment	-	SVFINC	SN
IMD Offset Frequency	**IMD LOW FREQUENCY**	IMFREQ	IF
Relative Reference	**RELATIVE REFERENCE**	REF	RE

Default Setting: Source Amplitude

ANNUNCIATION

In all cases, except SVF Frequency and SVF Frequency increment, the front panel LED associated with the currently selected parameter is on; in the case of Source Amplitude and Frequency Increment parameters, the INCREMENT SET MODE LED will also be on. Caution, if SVF Frequency or SVF Frequency Increment are selected via the serial port or GPIB interface, the front panel annunciation of these conditions are identical to that of Source Frequency and Source Frequency Increment being selected.

Serial Port Header: NMMODE.

NOTES

For additional information concerning the individual parameters:

Parameter	References
Source Amplitude	3.4.1
Source Amplitude Increment	3.4.2
Source Frequency	3.4,3
Source Frequency Increment	3.4.4
SVF Frequency	3.2.7
SVF Frequency Increment	3.2.8
IMD Offset Frequency	3.4.5
Relative Reference	3.5.2

3.2 MEASUREMENT CONFIGURATION COMMANDS

3.2.1 INPUT SELECT

DESCRIPTION

Selects input signal for measurement. Options include external inputs A, B and internal sources A, B.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Input A	-INPUT- **A**	INSEL A	IA
Input B	-INPUT- **B**	INSEL B	IB
A output	-INPUT- **OSC A**	INSEL AOUT	IO
B output *	-INPUT- **OSC B***	INSEL BOUT *	BO*

-INPUT- **OSC A** and **OSC B** represent the shift of -INPUT- **A** and **B** key closures, respectively.

* NOTE: Output B requires Option 007.

DEFAULT SETTING

Input A

ANNUNCIATION

Current status always displayed by front panel **INPUT** LEDs.

Serial Port header: INSEL

NOTES

Selecting the internal source as input will not enable its output.

The A and B inputs may be either balanced or unbalanced depending on which input connector is used. The balanced input connector is a telephone style ring-tip-sleeve jack, while the unbalanced connector is a two terminal BNC jack. The normalizing contacts of the balanced jack are configured such that if a plug is inserted into it, the unbalanced jack is automatically disconnected.

Output Enable & Configuration should be adjusted appropriately before selecting internal source. Refer to 3.4.7 and 3.4.11 respectively.

3.2.2 INPUT TERMINATION

DESCRIPTION

Selects input termination for the A and B inputs. Options include Hi - Z (100 k ohms unbalanced, 200 k ohms balanced) (default option), 150 ohms and 600 ohms.

PROCEDURE

OPTIONS	FRONT PANEL	SERIAL	GPIB
100 k ohms	-input- **100 K**	INPZSEL HIZ	Z0
150 ohms	-input- **600/150**	INPZSEL IMP150	Z1
600 ohms	-input- **600/150**	INPZSEL IMP600	Z2

Front panel **100 k Ω** key always selects high impedance. **150 Ω/600 Ω** (i.e. SHIFT of **100 k Ω**) will select 600 Ω termination with the first push and 150 Ω on the second push, 600 Ω on the third push, etc.

DEFAULT SETTING

100 k ohms

ANNUNCIATION

Current status always displayed by front panel **INPUT TERMINATION** LEDs.

Serial Port header : INPZ

NOTES

The input termination is applied to either external A and B inputs depending on which, if either, is selected. The input termination is temporarily removed if a fatal error is detected and is restored by clearing the error.

It is the user's responsibility to avoid excessive dissipation in the input loading resistors but the software provides limited protection. If the current input termination setting is 150 ohms and input signal level, as calculated by the measurement process, exceeds approximately 15 V, input termination will be reset to its default option, 100 k ohms. Similarly, if the current setting is 600 ohms and input signal level exceeds approximately 30 V, input termination will be reset to its default option. Note that this protection is only available on the currently selected input while measuring, the selected input is not protected while the instrument is in the hold mode.

Selecting 150 or 600 ohms input impedance always forces dBm reference impedance to 150 or 600 ohms, respectively. Switching to 100 k ohms termination does not affect the dBm reference. This will remain until the dBm reference impedance is changed, either by selecting 600 ohms input termination or by explicitly setting the reference impedance. Reference impedance may always be reselected by the user, regardless of input termination status.

3.2.3 AUTOMATIC OPERATION

DESCRIPTION

Sets PGA, PGB, PGC, and detector speed operating modes to auto. If current measurement type is THD, selecting automatic operation will also set SVF tuning mode to auto and turn the servo on. Automatic operation is always the default state of the instrument.

PROCEDURE

FRONT PANEL	SERIAL	GPIB
9.0 **SPCL**	AUTO	AU

DEFAULT

Automatic operation enabled

ANNUNCIATION

If no other special functions are currently in effect, the **SPCL FUNCTION** LED should turn off.

NOTES

Special Function 9 supports one other valid option, Hold Settings (9.1), which freezes current settings. Refer to Section 3.2.4.

Selecting automatic operation simultaneously selects the auto option of several functions, all of which may be specified individually.

Refer to Sections :

3.2.5 PGA Level and Operating Mode
3.2.6 PGB Level and Operating Mode
3.2.12 PGC Level and Operating Mode
3.2.14 Detector Speed and Operating Mode
and 3.2.9 SVF Tuning Mode.

If Hold Settings operating mode is selected, the instrument is no longer considered to be in auto mode.

3.2.4 HOLD SETTINGS

DESCRIPTION

Sets PGA, PGB, PGC, and detector speed operating modes to hold, freezing current settings. If current measurement type is THD, selecting the hold settings option will also set SVF tuning mode to hold (but leave the servo on).

PROCEDURE

FRONT PANEL	SERIAL	GPIB
9.1 **SPCL**	HOLD	9.1SP

DEFAULT

Automatic operation is the default state of the instrument.

ANNUNCIATION

SPCL FUNCTION LED, if not already on, should turn on.

NOTES

Special Function 9 supports one other valid option, Automatic Operation (9.0). Refer to Section 3.2.3. Selecting Hold Settings simultaneously selects the hold current setting option of several functions, all of which may be handled individually.

Refer to Sections:

3.2.5 PGA Level and Operating Mode
3.2.6 PGB Level and Operating Mode
3.2.12 PGC Level and Operating Mode
3.2.14 Detector Speed and Operating Mode
and 3.2.9 SVF Tuning Mode

3.2.5 PGA LEVEL AND OPERATING MODE

DESCRIPTION

Selects PGA operating mode. If hold mode is selected, gain/attenuation may be frozen at the current setting or at a specified setting between -30 dB and +35 dB.

(PGA : Programmable Gain stage A - the input preamp and attenuator)

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Automatic	1.0 **SPCL**	PGA AUTO	1.0SP
Hold current	1.1 **SPCL**	PGA HOLD	1.1SP
Hold -30 dB	1.2 **SPCL**	PGA -30DB	1.2SP
Hold -25 dB	1.3 **SPCL**	PGA -25DB	1.3SP
Hold -20 dB	1.4 **SPCL**	PGA -20DB	1.4SP
Hold -15 dB	1.5 **SPCL**	PGA -15DB	1.5SP
Hold -10 dB	1.6 **SPCL**	PGA -10DB	1.6SP
Hold -5 dB	1.7 **SPCL**	PGA -5DB	1.7SP
Hold 0 dB	1.8 **SPCL**	PGA 0DB	1.8SP
Hold +5 dB	1.9 **SPCL**	PGA +5DB	1.9SP
Hold +10 dB	1.10 **SPCL**	PGA +10DB	1.10SP
Hold +15 dB	1.11 **SPCL**	PGA +15DB	1.11SP
Hold +20 dB	1.12 **SPCL**	PGA +20DB	1.12SP
Hold +25 dB	1.13 **SPCL**	PGA +25DB	1.13SP
Hold +30 dB	1.14 **SPCL**	PGA +30DB	1.14SP
Hold +35 dB	1.15 **SPCL**	PGA +35DB	1.15SP

DEFAULT SETTINGS

Automatic operation with initial setting at -30 dB.

ANNUNCIATION

If any of the hold options is selected, the **SPCL FUNCTION** LED should light. If the auto option is selected and if no other special functions are in effect, then the **SPCL FUNCTION** LED should be turned off.

Serial Port headers: PGASTS and PGAMD

NOTES

In automatic operating mode, PGA level is adjusted by the measurement process to optimize signal level. Holding level may lead to fatal errors, "Signal at PGAout overrange" (error 20) with any measurement type and "Signal at PGAout underrange" (error 21) during distortion or tracking bandpass type measurements.

Whenever a fatal error is generated, PGA level is temporarily set to -30 dB. This is not annunciated. Once the error condition is cleared, PGA level is restored to its original setting.

PGA operating mode and level may also be set by Automatic Operation and Hold Settings functions. Refer to Sections 3.2.3 and 3.2.4.

3.2.6 PGB LEVEL AND OPERATING MODE

DESCRIPTION

Selects PGB operating mode. If hold mode is selected, gain may be held at the current setting or at a specified setting between 0 dB and +80 dB.

(PGB: Programmable Gain stage B - the post filter/notch gain)

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Automatic	3.0 **SPCL**	PGB AUTO	3.0SP
Hold current	3.1 **SPCL**	PGB HOLD	3.1SP
Hold 0 dB	3.2 **SPCL**	PGB 0 DB	3.2SP
Hold +20 dB	3.3 **SPCL**	PGB +20 DB	3.3SP
Hold +40 dB	3.4 **SPCL**	PGB +40 DB	3.4SP
Hold +60 dB	3.5 **SPCL**	PGB +60 DB	3.5SP
Hold +80 dB	3.6 **SPCL**	PGB +80 DB	3.6SP

DEFAULT SETTING

Automatic operation with initial setting of 0 dB.

ANNUNCIATION

If any of the hold options is selected, the **SPCL FUNCTION** LED should light. If the auto option is selected and if no other special functions are in effect, then the **SPCL FUNCTION** should be turned off.

Serial Port headers: PGBSTS and PGBMD

NOTES

In automatic operating mode, PGB level is adjusted by the measurement process to optimize signal level. Holding level may lead to fatal error "Signal at PGBout overrange" (error 22) during measurement. PGB operating mode and level may also be set by Automatic Operation and Hold Settings functions. Refer to Sections 3.2.3 and 3.2.4.

3.2.7 SVF FREQUENCY

DESCRIPTION

Selects SVF frequency setting. (This function is not accessible from the front panel.) SVF frequency will automatically be set whenever source frequency setting is adjusted. Further, if SVF tuning is enabled, SVF frequency will track the input signal frequency as measured at PGA out. Valid range is from 10 Hz to 100 kHz.

(SVF: State Variable Filter - the notch or bandpass filter)

PROCEDURE

METHODS AVAILABLE	SERIAL	GPIB
Select SVF frequency numeric entry mode:	SVFFRQ	SF
Enter new setting: Numeric entry followed by units code, e.g.	1.5 KHZ	1.5KH
note: valid units are	KHZ, HZ	KH, KZ, HZ
Increment current setting by SVF frequency increment.	UP	UP
Decrement current setting by SVF frequency increment	DOWN	DN
Set to last measured frequency	DUP	-

Increment and decrement amounts are set by SVF Frequency Increment function. Refer to Section 3.2.8.

DEFAULT SETTING

1 kHz

ANNUNCIATION

Current SVF frequency setting will only be written to the serial port when changed. It is not otherwise annunciated. SVF Frequency numeric entry mode is in effect if **SOURCE FREQUENCY** LED is on. Note that this is ambiguous with source frequency numeric entry mode but, because this mode cannot be entered from the front panel, no conflict is generally encountered.

Serial Port header: SVFFRQ

NOTES

SVF frequency tracks main oscillator frequency and will be set whenever oscillator frequency is adjusted. If, during THD and BP type measurement, SVF auto-tuning is enabled then SVF frequency tracks the selected input signal, i.e., if the difference between the currently set SVF frequency and the measured input frequency exceeds 2.5% then SVF frequency will be set to the measured frequency by the measurement process.

Selecting a new SVF frequency outside the range of 10 Hz to 100 kHz will cause an "Operand Out Of Range" (error 7) to be generated. This is true for any of the above described methods except during auto-tune mode operation, in which case the range is extended from 9.5 Hz to 105 kHz to allow for errors in setting the source frequency.

3.2.8 SVF FREQUENCY INCREMENT

DESCRIPTION

Selects SVF frequency increment setting. This function is not explicitly accessible from the Front Panel.

PROCEDURE

METHODS AVAILABLE	SERIAL	GPIB
Select SVF frequency increment numeric entry mode:	SVFINC	SN
Enter new setting: Numeric entry followed by units code, e.g.	.75 KHZ	.75KH
note: valid units are:	KHZ, HZ, %	KH, KZ, HZ, PE
Set to last measured frequency	DUP	

DEFAULT SETTING

1 Hz

ANNUNCIATION

Current SVF frequency increment will only be written to the serial port when changed. There is no other annunciation. Percentage increments will be displayed as the specified amount + 100%.

SVF Frequency increment numeric entry mode is in effect if **SOURCE FREQUENCY** and **INCREMENT SET MODE** LEDs are both on, which is ambiguous with source frequency increment but, because the mode cannot be entered from the front panel, no conflict is generally encountered.

Serial Port header: SVFINC

NOTES

SVF frequency increment is used to increment or decrement the current SVF frequency. Refer to Section 3.2.7. Modified SVF frequency is always checked and may, if the new value is out of the allowable range, cause an "Operand Out Of Range" (error 7) to be generated without attempting to set the new value.

The algorithm used to set relative increment adds 100% to the entered value, divides the result by 100 and preserves this value to be used as a multiplier of SVF frequency. Decrement is implemented by taking the reciprocal of this number as a multiplier. Thus relative increments, when displayed in %, will always be displayed + 100%.

Once a new SVF frequency increment value has been entered, the instrument will automatically revert to SVF frequency numeric entry mode.

3.2.9 SVF TUNING/TRACKING MODE

DESCRIPTION

The SVF tuning and tracking functions enable or disable SVF auto- tuning and the fine tune servo. The tuning function (special function 6), which may only be used during THD type measurements, allows the user to enable or disable auto-tuning but prohibits the disabling of the servo. The tracking function (special function 28), which may only be used during BP (band pass) type measurements, allows the user to enable or disable both auto-tuning and the servo.

Auto-tuning is the coarse tuning of the filter in response to the frequency of the INPUT signal. Servo is the fine tuning (nulling) of the filter to the frequency of the INPUT signal.

PROCEDURE

CASE OF THD TYPE MEASUREMENT ONLY			
CHOICES	**FRONT PANEL**	**SERIAL**	**GPIB**
Enable auto-tuning and servo	**6.0 SPCL**	**TUNE AUTO**	**6.0SP**
Disable auto-tuning & enable Servo (notch lock mode)	**6.1 SPCL**	**TUNE HOLD**	**6.1SP**

CASE OF BP TYPE MEASUREMENT ONLY			
CHOICES	**FRONT PANEL**	**SERIAL**	**GPIB**
Disable auto-tuning (follow oscillator)	**28.0 SPCL**	**TRACK OFF**	**28.0SP**
Enable auto-tuning (follow input)	**28.2 SPCL**	**TRACK TON**	**28.2SP**

DEFAULT

SVF auto-tuning disabled in all measurement types except THD where it is enabled.

ANNUNCIATION

If no other special functions are in effect during THD measurement and 'auto' option is selected, the **SPCL FUNCTION** LED should turn off. If the 'hold' option is selected, the **SPCL FUNCTION** should light.

If no other special functions are in effect during BP measurement and tracking is turned off, the **SPCL FUNCTION** LED should turn off. If any other option is selected, the **SPCL FUNCTION** should light.

Serial Port headers: SRVST and TUNEMD

NOTES

When THD type measurement is selected, SVF auto-tuning and servo are automatically enabled. Auto-tuning may subsequently be disabled via special function 6. Attempting to use special function 28 in this case will cause an "Unrecognized Command" (error 2) to be generated.

When any non-THD type measurement is selected, SVF auto-tuning and servo are automatically disabled. In BP type measurement, auto-tuning may subsequently be enabled via special function 28. In non-BP type measurement, attempting to use other than the 'tracking off' option of special function 28 will cause an "Unrecognized Command" (error 2) to be generated. In both cases, attempting to use special function 6 will cause an "Unrecognized Command" (error 2) to be generated.

During THD type measurement, the Automatic Operation and Hold Settings functions will, respectively, enable and disable auto-tuning.

3.2.10 WEIGHTING FILTERS

DESCRIPTION

Selects 1 of 7 weighting filters or disables them all.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Disable all	See Notes below	FILSEL OFF	L0
30kHz LP	-filters- **30k**	FILSEL 30K	L1
80kHz LP	-filters- **80k**	FILSEL 80K	L2
Special	-filters- **SPCL**	FILSEL SPCL	L3
Auxiliary 1 *	-filters- **AUX1**	FILSEL SP0	L4
Auxiliary 2 *	-filters- **AUX2**	FILSEL SP1	L5
Auxiliary 3 *	-filters- **AUX3**	FILSEL SP2	L6
Auxiliary 4 *	-filters- **AUX4**	FILSEL SP3	L7

* NOTE: Auxiliary filters 1 through 4 require Option 005 or 006.

DEFAULT

All weighting filters disabled.

ANNUNCIATION

Current status always displayed by Front Panel **FILTERS** LEDs.

Serial Port header: WFSEL

NOTES

The logic of the filter select for the front panel is such that selecting any filter will disable the currently selected filter. Reselecting the currently selected filter will therefore turn it off.

3.2.11 HIGH PASS FILTER

DESCRIPTION

Enables or disables the 400 Hz HP filter.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Disable HP	-filters- **HP**	HPFIL OFF	H0
Enable HP	-filters- **HP**	HPFIL ON	H1

DEFAULT

HP filter disabled

ANNUNCIATION

Current status always displayed by Front Panel **FILTERS** LEDs.

Serial Port header: HPSEL

NOTES

The HP filter is automatically disabled when IMD type measurement is selected. Any subsequent attempts to turn it on will result in an "Unrecognized Command" (error 2).

The front panel **HP** filter key alternates on and off so that if the HP filter is enabled, the next pressing of the **HP** key will turn it off, and if disabled, the next pressing will enable it.

3.2.12 PGC LEVEL AND OPERATING MODE

DESCRIPTION

Selects PGC operating mode. If hold mode is selected, the gain may be frozen at the current setting or at a specified setting between 0 dB and +20 dB.

(PGC: Programmable Gain stage C - post weighting filter gain)

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Automatic	27.0 **SPCL**	PGC AUTO	27.0SP
Hold current setting	27.1 **SPCL**	PGC HOLD	27.1SP
Hold 0 dB	27.2 **SPCL**	PGC 0DB	27.2SP
Hold +10 dB	27.3 **SPCL**	PGC +10DB	27.3SP
Hold +20 dB	27.4 **SPCL**	PGC +20DB	27.4SP

DEFAULT SETTING

Automatic operation with initial gain of 0 dB

ANNUNCIATION

If any of the hold options is selected, the **SPCL FUNCTION** LED should light. If the auto option is selected and if no other special functions are in effect, then the **SPCL FUNCTION** should be turned off.

NOTES

In automatic operating mode, PGC level is automatically adjusted by the measurement process to optimize signal level. Holding the setting may lead to fatal error "Signal at PGC out overrange" (error 24) during measurement.

PGC operating mode may also be set by Automatic Operation and Hold Settings functions. Refer to sections 3.2.3 and 3.2.4.

3.2.13 DETECTOR SELECT

DESCRIPTION

Selects RMS, average of absolute value or quasi-peak type detection characteristic.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
True rms	**DETECTOR**	DETSEL RMS	D0
Average	**DETECTOR**	DETSEL AVE	D1
Quasi-Peak	**DETECTOR**	DETSEL QPK	D2

DEFAULT SETTING

RMS

ANNUNCIATION

The currently selected detector is always displayed to the right of the Front Panel left display.

Serial Port header: DETSEL

NOTES

Successive depressions of the front panel **DETECTOR** key will select detectors in the following order: RMS-AVE-QPK-RMS ... etc.

3.2.14 DETECTOR SPEED AND OPERATING MODE

DESCRIPTION

Selects RMS detector speed operating mode. If hold mode is selected, speed may be frozen at its current setting or at a specified setting between very slow and very fast.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Automatic	29.0 **SPCL**	DETSPD AUTO	29.0SP
Hold current	29.1 **SPCL**	DETSPD HOLD	29.1SP
Hold very slow	29.2 **SPCL**	DETSPD VSLOW	29.2SP
Hold slow	29.3 **SPCL**	DETSPD SLOW	29.3SP
Hold fast	29.4 **SPCL**	DETSPD FAST	29.4SP
Hold very fast	29.5 **SPCL**	DETSPD VFAST	29.5SP

DEFAULT SETTING

Automatic operation with initial speed set to very slow.

ANNUNCIATION

If any of the hold options is selected, the **SPCL FUNCTION** LED should light. If the auto option is selected and if no other special functions are in effect, the **SPCL FUNCTION** should be turned off.

Serial Port header: DETSPD

NOTES

The implementation of the 5500 hardware and software only requires that the RMS detector's averaging time constant be changed to accommodate varying input frequencies. Both the average value and quasi-peak response are optimized by the actions of the synchronous integration measurement cycle which permits minimal response times without perceptible ripple even at 10 Hz.

In automatic operating mode, detector speed is adjusted by the measurement process according to the calculated input signal frequency. Holding detector speed may result in loss of accuracy but will not generate any errors during measurement. Refer to Measurement Flow Description 3.10.1 through 3.10.7.

A situation may arise during automatic operation that will lead to readings of slightly less accuracy than expected because of the way that frequency is computed. The input signal frequency is derived from input signal zero crossings which, theoretically, do not necessarily reflect the signal energy content. Thus if a composite input signal containing significant amounts of low frequency energy also contains enough high frequency energy to activate the zero crossing detector, the software may choose an inappropriate detector speed for the low frequency component.

This situation may easily be encountered when making noise measurements but normally noise is not measured to the full accuracy of the instrument and the resulting readings are entirely adequate. A more noticeable example of this error would be the rms level measurement of a two frequency composite signal - the CCIF twin-tone signal, for example. Typically such a signal would be two relatively high frequency signals with a low difference frequency. The frequency measuring detector of the 5500 would usually interpret the "frequency" of this twin-tone signal as approximately the mean value of the two individual signals and thus set the rms detector time constant to this high frequency value. It would then not be responsive to the low frequency difference component and the resulting rms value would have an error of up to 1 dB. This situation may, however, be avoided in these special situations by holding the detector speed at one which is appropriate for the measurement being performed. As mentioned above, this will only apply to the RMS type detector.

Detector speed and operating mode may also be set by Automatic Operation and Hold Settings functions. Refer to Sections 3.2.3 and 3.2.4.

3.2.15 AUTOMATIC CALIBRATION

DESCRIPTION

This function will generate a number of calibration constants that are used during measurement and instrument setup. When selected, it executes a series of measurements and uses the results to re-calculate the V-F scale factor and offsets, the detector normalization factors, and source and SVF frequency scale factors. For a description of the usage of these data, refer to the Measurement Flow Descriptions of Section 3.10.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Re-calibrate	24 **SPCL**	24 SP	24SP

NOTES

The auto-cal procedure requires that all external loads and inputs be disconnected from the fully warmed up instrument. The process requires approximately 30 seconds and stores its results in non- volatile RAM along with a CRC to guarantee the validity of the data. No other command will be responded to while the auto-cal process is executing although any input will be buffered under interrupt to the limit of the various input buffers. The instrument state is saved in memory location 1 prior to the auto-cal call and will thus overwrite any information contained there. Upon exiting the auto-cal procedure, the previous instrument state will be restored. Note that all parameters are derived from two primary system constants, the DC VREF generator on the detector module and the master crystal clock oscillator on the CPU module. It is especially important not to disturb the VREF calibration control on the detector module without having a precision DC voltmeter available to calibrate it to its specified accuracy (see detector module calibration procedure). The auto-cal procedure may generate Error 60 if it determines that it cannot measure certain parameters due to hardware failure. In this case please refer servicing to qualified service personnel.

3.2.16 DC VOLTS MEASUREMENT MODE (requires option 008)

DESCRIPTION

Enables DC Volts measurement mode. DC Volts measurement is disabled by selecting any other measurement type.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Enable	**DC**	DC	DC

DC represents the shift of the **WIDE BAND** key on the instrument front panel.

DEFAULT SETTING

DC Volts measurement disabled.

ANNUNCIATION

The current status is always displayed on the Front Panel by the -DC- LED below the **WIDE BAND** key.

Serial Port header: DCMODE. If DC Volts measurement is enabled the DCMODE segment displays DC.

NOTES

The DC signal measurement chain is independent of the AC measurement chain up to the detector module. The AC chain continues to provide the signal that is measured by the frequency counter, and thus will set the measurement synchronization. This allows the instrument measuring circuits to reject the AC component of a composite AC-DC signal. While DC volts measurement is enabled, frequency data produced by the instrument will depend on the current state of Measurement Sync. Only in the case of DC volts type measurement: if frequency readings are not available, Error 47 "Can't get frequency reading" will never be generated. Instead, the instrument will display a frequency reading of 0.0 Hz. This can be used to extend the measurement resolution by selecting "Internal" as the frequency counter source and setting the source amplitude to 0 Volts. In this case the measurement will be made over the longest integration time and yield the highest resolution results. See "DC Range Select' for possible errors.

DC scale is selected by Special Function 2. Refer to 3.2.17.

For a more detailed description of DC Volts measurement refer to the Measurement Flow Descriptions of Section 3.10.

Note that the display formatting functions are not available during DC and Phase type measurements.

3.2.17 DC RANGE SELECT
requires option 008)

DESCRIPTION

Selects full scale range for DC Volts measurement. Choices include 100 V, 1 V and 1 V ranges.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
100 Volt full scale	2.0 **SPCL**	2.0 SP	2.0SP
10 Volt full scale	2.1 **SPCL**	2.1 SP	2.1SP
1 Volt full scale	2.2 **SPCL**	2.2 SP	2.2SP

DEFAULT SETTING

100 Volt range.

ANNUNCIATION

Serial Port header: DCSCL

NOTES

The operator is responsible for the range selection for DC Volts measurements. Error 30 will be produced if either input is more negative than the allowable input range and Error 32 will be produced if either input is more positive than the allowable input range. These errors will only be produced if the input significantly exceeds the specified input over-range capabilities.

3.2.18 DC FEEDBACK SELECT (requires Option 008)

DESCRIPTION

This function affects the feedback around the input amplifier in the DC measurement chain. This provides the user with the ability to define the gain or other characteristic of this stage.

PROCEDURE

Enter the special function code followed by 0 or 1 to select the default (full feedback) or other (user defined feedback).

CHOICES	FRONT PANEL	SERIAL	GPIB
Full feedback	85.0 **SPCL**	85.0 SP	85.0SP
Special Feedback	85.1 **SPCL**	85.1 SP	85.1SP

DEFAULT SETTINGS

Full feedback.

ANNUNCIATION

None.

NOTES

This provides the user with a means of scaling the DC input channel to a value other than the default of unity gain. The actual feedback term is chosen by the user by means of component choice on the DC signals module. It is assumed that this function will only be exercised by users familiar with the design of feedback circuits around operational amplifiers. The actual measuring circuits have no way of determining what gain is actually set and will assume a unity gain value for purposes of displaying the measurement results.

An example of an application of this feature would be to modify the scaling so the digital readout represented a particular value based on an external transducer - for example, temperature in °F using an external temperature to DC converter.

3.2.19 PHASE MEASUREMENT MODE (requires option 009)

DESCRIPTION

Enables Phase measurement. Phase measurement is disabled by selecting any other measurement type.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Enable	**PZ**	PZ	PZ

PZ represents the shift of the **NARROW BAND** key on the instrument front panel.

DEFAULT SETTING

Phase measurement disabled.

ANNUNCIATION

The current status is always displayed on the Front Panel by the -PZ- LED below the **NARROW BAND** key.

Serial Port header: DCMODE. If Phase measurement is enabled the DCMODE segment displays PZ.

NOTES

While phase measurement is enabled, frequency data produced by the instrument will depend on the current state of Measurement Sync.

Phase scale is selected by Special Function 8. Refer to 3.2.19.

For a more detailed description of Phase measurement refer to the Measurement Flow Descriptions of Section 3.10.

Note that the display formatting functions are not available during DC and Phase type measurements.

3.2.20 PHASE SCALE SELECT (requires option 009)

DESCRIPTION

Selects reference scale for Phase measurement. Choices include 0 to 360 and 180.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
± 180°	8.0 **SPCL**	8.0 SP	8.0SP
0° to 360°	8.1 **SPCL**	8.1 SP	8.1SP

DEFAULT SETTING

± 180°

ANNUNCIATION

Serial Port header: PZSCL

NOTES

The operator is responsible for selecting which scale will be used for phase measurements. This function affects not only the display format but also the phase measurement hardware.

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3.3 MEASUREMENT CONTROL COMMANDS

3.3.1 MEASUREMENT TYPE

DESCRIPTION

Selects type of measurement to be performed.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Wide band level	**WIDE BAND**	AMPMSM WB	M1
Very wide band pass level	**NARROW BAND**	AMPMSM BPVW	M4
Wide band pass level	**NARROW BAND**	AMPMSM BPW	M5
Medium band pass level	**NARROW BAND**	AMPMSM BPM	M6
Narrow band pass level	**NARROW BAND**	AMPMSM BPN	M7
High pass level	**NARROW BAND**	AMPMSM HP	M8
Low pass level	**NARROW BAND**	AMPMSM LP	M9
THD (ratio)	**THD**	AMPMSM THD	S3
THD level	**36.0 SPCL**	AMPMSM THDL	M3
* IMD CCIF (option 002)	**IMD CCIF**	AMPMSM CCIF	S4
* IMD SMPTE (option 002)	**IMD SMPTE**	AMPMSM SMPTE	S5
* DC Volts (option 008)	**DC**	DC	DC
* Phase (option 009)	**PHASE**	PZ	PZ

- the **NARROW BAND** key is a "rotary" key. Successive depressions of the key will select measurement type in the following order: BP very wide, BP wide, BP medium, BP narrow, HP - LP - BP very wide.

- whenever narrow band is reselected, the last narrow band type used will be automatically restored.

* These modes require certain optional features to be resident in the instrument.

DEFAULT SETTING

Wide band level

ANNUNCIATION

Current status is always displayed by Front Panel -FUNCTION- LEDs.

Serial Port header: AMPMSM

NOTES

If THD type measurement is selected, SVF auto-tuning is automatically enabled and the servo turned on; in all other cases, SVF auto-tuning is disabled and the servo turned off. The tuning function (special function 6) may only be used during THD type measurement while the tracking function may only be used during BP type measurement. Refer to Section 3.2.9.

If IMD SMPTE* type is selected, IMD ratio is automatically set to 1:4; in all other cases, IMD ratio is set to 1:1. Refer to Section 3.4.6.

If IMD SMPTE* or CCIF* type is selected, the high pass filter will be automatically turned off and any attempts to turn it on during IMD measurement will result in an "Unrecognized Command" (error 2). Refer to 3.2.11.

If IMD SMPTE* or CCIF* type is selected and current source frequency is set to less than 2 kHz, the source frequency will automatically be reset to 7 kHz. Refer to 3.4.3.

If the current measurement type is distortion, THD or IMD*, and the relative mode is enabled, then selecting non-distortion type measurement will automatically disable relative mode. Similarly if current type is level type and relative mode is enabled, then selecting distortion type will disable relative mode. Refer to 3.5.1.

If the current measurement type is distortion and level type measurement is selected, then the last specified absolute amplitude display units will be restored unless display mode has been modified, in which case, the appropriate log or linear version of the last specified absolute units will be selected. If a distortion type measurement is selected, the amplitude display unit will always default to % if in linear, and to dB, if in log display mode. Refer to 3.5.3 and 3.5.4.

The different types of measurement are described in more detail by Sections 3.10.1 through 3.10.7.

*IMD functions require Option 002.

3.3.2 MEASUREMENT MODE

DESCRIPTION

Select measurement control mode. In normal operating mode, the free- run mode, the instrument is continuously executing measurements and hardware settling delays are always on to provide time for the hardware to settle after making any change to the gains or SVF frequency. It may also be configured to only execute a measurement when triggered and to ignore settling delays. The measurement mode may only be modified via the GPIB.

PROCEDURE

CHOICES	GPIB
Free-run mode	T0
Hold mode	T1
Trigger then Hold mode (with settling disabled)	T2
Trigger then Hold mode (with settling enabled)	T3

DEFAULT SETTING

Free-run mode

ANNUNCIATION

Measurement mode is not annunciated on the Front Panel. Serial Port header: MSMODE

NOTES

In the free-run mode, measurement is continuous; the end of one measurement starts the next. In either of the triggered modes, a single measurement attempt is performed initially while subsequent measurement attempts are performed when triggered. In the hold mode, the instrument prepares itself for measurement and awaits commands; measurements must always be triggered explicitly.

Note that a measurement proceeds until complete or aborted by an error or an exception. The result of a triggered measurement may therefore return an error or exception instead of a measured value. In an automation environment it is necessary to check the values returned for error or exception codes and proceed accordingly. See Sections 3.11.1 and 3.11.2.

A single measurement may be triggered in either of two ways:

FRONT PANEL	SERIAL	GPIB
1. **CLR**	CLEAR	CL
2. -	-	GET (bus command)

The front panel will only trigger a measurement if not in "local lockout".

Refer to Sections 3.8.3 and 3.8.1.

Hardware settling delays are disabled only in Trigger with settling disabled mode.
Refer to measurement descriptions, Section 3.10.

3.3.3 MEASUREMENT SYNC

DESCRIPTION

Determines source of measurement synchronization for the synchronous integration interval and/or displayed frequency measurement.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
External	37.0 **SPCL**	FRQMSM IN	FI
Internal	37.1 **SPCL**	FRQMSM OSC	FO

DEFAULT SETTING

External

ANNUNCIATION

Current measurement sync status is always displayed by Front Panel **OSC** LED which is turned off if external input is selected and on if internal sync is selected.

Serial Port header: FRQMSM.

NOTES

This function may have a serious effect on a number of instrument parameters and should be used with discretion by persons having a good understanding of the measurement flow descriptions.

Primarily, this function selects the source that the measurement will use to set the synchronous integration period, the reciprocal of which is the frequency displayed on the left display in all cases except IMD*. In all measurement types but IMD*, the external sync select will cause the frequency of the input signal, as measured by the zero crossing detector, to be the sync input for synchronous integration and the internal sync select will use the main internal oscillator as the sync source. In this latter case, the synchronous integration will yield the frequency of the internal source for display and will give the shortest possible measurement time when the instrument is providing the stimulus for the device under test in real time.

In the case of IMD*, the external option will cause the measurement sync to be taken from the low frequency component of the input signal and the internal option will use the internal IMD* low frequency oscillator as the sync source. When the sync source is specified as external (default option), an additional measurement is performed to measure the recovered high frequency component of the input signal which will be displayed on the left display. When the internal sync option is chosen, the instrument will not take another measurement but will display the frequency of the internal LF oscillator. This latter case will give the shortest possible measurement time when the instrument is providing the stimulus for the device under test in real time.

*IMD function requires Option 002.

TABLE 3.3.3

MEASUREMENT SYNC SOURCE

INSTRUMENT FUNCTION	SYNC MODE (SPCL FNTC)	SYNC SOURCE (integration)	FREQUENCY INDICATION (right hand display)
LEVEL, THD	INPUT (37.0)	INPUT SIGNAL	INPUT SIGNAL FREQUENCY
LEVEL, THD	OSC (37.1)	GENERATOR SIGNAL	GENERATOR SIGNAL FREQUENCY
IMD, SMPTE* (option 002)	INPUT (37.0)	LF component of INPUT signal	HF component of INPUT signal
IMD, SMPTE* (option 002)	OSC (37.1)	LF component of OUTPUT signal	LF component of OUTPUT signal
IMD, CCIF* (option 002)	INPUT (37.0)	Offset frequency of INPUT signal	Mean freq. of INPUT of INPUT signal ± 10%
IMD, CCIF* (option 002)	OSC (37.1)	Offset frequency of OUTPUT signal	Offset frequency of OUTPUT signal
DC, PHASE* (options 008, 009)	INPUT (37.0)	AC phase of INPUT signal	Freq. of AC component or 0 Hz
DC, PHASE* (options 008, 009)	OSC (37.1)	Freq. of internal main oscillator	Internal main oscillator freq.

* requires the indicated options

3.4 SIGNAL GENERATION COMMANDS

3.4.1 SOURCE AMPLITUDE

DESCRIPTION

Notes on setting or modifying source amplitude.

The actual output level setting depends on three variables: programmed source amplitude (as described below), source impedance, and output load impedance reference (either level or power depending on the choice of programmed source amplitude units).

In addition, the MAXIMUM allowable output level setting depends on three variables: generator output configured as balanced or unbalanced, source impedance, and output load impedance reference (either level or power depending on the choice of programmed source amplitude units.)

Variables used in the following equations:

A_S (V) :	Maximum Source Amplitude in Volts
A_S (dBV):	Maximum Source Amplitude in dBV
A_S (dBm):	Maximum Source Amplitude in dBm
Z_S :	Source Impedance
$Z_L^{(L)}$:	Load Impedance (Level - V or dBV)
$Z_L^{(P)}$:	Load Impedance (Power - dBm)
V_{MAX} =	Maximum Output Voltage (33.11 V if Z_S = 150 or 600 Ω, 16.56 V if Z_S = 50 Ω)

If the amplitude setting is entered in Volts or dBV units and the output load impedance (Volts or dBV) is currently specified as infinity, the unloaded or open circuit case, maximum level is 33.11 Volts in the balanced case (source impedance configured at 600 or 150 ohms) and 16.56 Volts in the unbalanced case source impedance of 50 ohms).

For amplitude settings in Volt units where the LEVEL output load impedance reference $Z_L^{(L)}$ is currently specified at 1 to 9998 ohms, the maximum level is:

$$A_s\,(V) = V_{MAX} \left[\frac{Z_L^{(L)}}{Z^{(L)} + Z_s} \right]$$

For amplitude settings in dBV units where the LEVEL output load impedance reference $Z_L^{(L)}$ is currently specified at 1 to 9998 ohms, the maximum level is:

$$A_s\,(\text{dBV}) = 20 \log \left[V_{MAX} \left[\frac{Z_L^{(L)}}{Z^{(L)} + Z_s} \right] \right]$$

For amplitude settings in dBm units where the POWER output load impedance reference $Z_L^{(P)}$ is currently specified at 1 to 9999 ohms, the maximum level is:

$$A_s\,(\text{dBm}) = 10 \log \left[\frac{\dfrac{\left[V_{MAX} \left[\dfrac{Z_L^{(P)}}{Z_L^{(P)} + Z_S} \right] \right]^2}{Z_L^{(P)}}}{0.001} \right]$$

METHODS AVAILABLE

First select Source amplitude numeric entry mode, then use one of the following methods to set the new value:

CHOICES	FRONT PANEL	SERIAL	GPIB
SET "AMPL" MODE	**AMPLITUDE**	SRCAMP	AP
Enter a new value: e.g. 1.5 Volts valid units:	 **1.5 V** **V, dBm, dBV**	 1.5 V V,MV,UV, DBM,DBV	 1.5VL VL,MV,UV, DM,DV
Set source amplitude to last measured value	*	DUP	-
Increment current source amplitude setting	**UP**	UP	UP

Increment and decrement values are determined by the current Source Amplitude Increment setting. Refer to Section 3.4.2.

DEFAULT SETTING

0 V

ANNUNCIATION

Source amplitude numeric entry mode is in effect if **AMPLITUDE** LED is on.

The current source amplitude setting will be displayed on the front panel left display if the **AMPLITUDE** key is held or if special function 10 is selected. Refer to 3.6.2 and 3.6.3.

Serial Port header: SRCAMP

NOTES

Selecting a source amplitude setting outside the range of 0 V to the maximum level, as described above, will cause an "Operand Out Of Range" (error 7) to be generated. This is true for any of the above described methods of modifying source amplitude.

Modifying output structure, (refer to 3.4.9) or output load impedance reference (refer to 3.4.10) will cause source amplitude to be reset and may cause an "Operand Out Of Range" (error 7) to be generated. If this occurs, the actual level setting will not correspond to the programmed source amplitude. Source and output load impedance configuration and source amplitude should be reselected.

Selecting 0 V automatically turns the main oscillator off; entering any non-zero value turns it on again.

The sequence used to modify the gain and attenuation of the output amplifier and attenuator is designed to avoid presenting transient voltages higher than either the old or the new setting to the output connector.

Source amplitude will always be displayed in the original entry units regardless of the currently selected display units.

It should be carefully noted that source amplitude will always be determined in terms of the current output load impedance reference whereas measurement data displayed in power units will be calculated in terms of the current input impedance reference and that the two sets of references are uncorrelated.

3.4.2 SOURCE AMPLITUDE INCREMENT

DESCRIPTION

Selects new source amplitude increment setting which is used for the increment and decrement functions.

METHODS AVAILABLE

First select Source Amplitude Increment numeric entry mode, then use one of the following methods to set the new value:

CHOICES	FRONT PANEL	SERIAL	GPIB
SET "AMPL INCR" MODE	**AMPL INCR**	AMPINC	AN
Enter new value: e.g. 1.5 Volts	1.5 **V**	1.5 V	1.5VL
Valid units:	**V, %, dB**	V,MV,UV,%, DB	VL,MV,UV, PE, DB
Set to last measured amplitude	*	DUP	-

DEFAULT SETTING

1.0 V

ANNUNCIATION

Source amplitude increment numeric entry mode is in effect if **AMPLITUDE** and **INCREMENT SET MODE** LEDs are on.

The current source amplitude increment will be displayed on the front panel left display if the **AMPL INCR** key is held. Refer to 3.6.2.

Serial Port header: AMPINC.

NOTES

Source amplitude increment is used to increment or decrement the current source amplitude. Refer to Section 3.4.1. Modified source amplitude is checked and may, if the new value is out of range, cause an "Operand Out Of Range" (error 7) to be generated.

Relative increment values, if displayed in % units, will always be displayed + 100 %.

The algorithm used to set relative increment adds 100% to the entered value if specified in percent, divides the result by 100 and preserves this value to be used as a multiplier of source amplitude. Decrement is implemented by taking the reciprocal of this number as a multiplier. Thus relative increments, when displayed in %, will always be displayed + 100%.

Once a new source amplitude increment value has been entered, the instrument will automatically revert to source amplitude numeric entry mode.

3.4.3 SOURCE FREQUENCY

DESCRIPTION

Sets or modifies the programmed source frequency. Valid range is from 10 Hz to 100 kHz.

METHODS AVAILABLE

First select Source Frequency numeric entry mode then use one of the following methods to set the new value:

CHOICES	FRONT PANEL	SERIAL	GPIB
SET "FREQ" MODE	**FREQUENCY**	SRCFRQ	FR
Enter new values: e.g. 1.5 kHz Valid units:	 1.5 **kHz** **Hz, kHz**	 1.5 KHZ KHZ, HZ	 1.5KH KH, KZ, HZ
Increment setting by source frequency measurement	**UP**	UP	UP
Decrement setting by source frequency measurement	**DOWN**	DOWN	DN
Set to last measured frequency	*	DUP	-

Increment and decrement amounts are set by Source Frequency Increment function. Refer to Section 3.4.4.

DEFAULT SETTING

1 kHz

ANNUNCIATION

Source frequency numeric entry mode is in effect if **FREQUENCY** LED is on. Note that this is ambiguous with narrow band filter (SVF) frequency numeric entry mode. Refer to Section 3.2.7.

The current source frequency setting will be displayed on the front panel right display if the **FREQUENCY** key is held or if special function 10 is selected. Refer to 3.6.2 and 3.6.3.

Serial Port header: SRCFRQ.

NOTES

SVF frequency tracks source frequency and will be automatically adjusted whenever oscillator frequency is modified. Refer to 3.2.7.

If IMD* type measurement is selected and the current setting is under 2 kHz, source frequency will be automatically reset to 7 kHz. Refer to 3.3.1.

Selecting new frequency outside the range of 10 Hz to 100 kHz will cause an "Operand Out Of Range" (error 7) to be generated. This is true for any of the above described methods.

* IMD function requires Option 002.

HIGH RESOLUTION FINE TUNE (Requires option 201)

Special Function 13 allows fine tuning at the oscillator to a resolution at better than 0.005% over approximately a one percent range. An operand value at 0 to 255 sets the trim value.

To modify the current oscillator frequency, enter 13.nnn SPCL FNCT, where nnn is a value from 0 to 255.

This is an uncalibrated adjustment and is only used to effect minor changes manually.

3.4.4 SOURCE FREQUENCY INCREMENT

DESCRIPTION

Sets the source frequency increment value which is used for the increment and decrement functions.

METHODS AVAILABLE

First, select Source Frequency Increment numeric entry mode then use one of the following methods to set the new value.

CHOICES	FRONT PANEL	SERIAL	GPIB
SET "FREQ INCR" MODE	**FREQ INCR**	FRQINC	FN
Enter new value:			
e.g. 0.75 kHz	**.75 kHz**	.75 KHZ	.75KH
Valid units:	**kHz, Hz, %**	KHZ,HZ,%	KH,HZ,PE
Set to last measured frequency	*	DUP	-

DEFAULT SETTING

1 Hz

ANNUNCIATION

Source frequency increment numeric entry mode is in effect if **FREQUENCY** and **INCREMENT SET MODE** LEDs are both on. Note that this is ambiguous with narrow band filter (SVF) frequency increment mode. See Section 3.2.8.

The current frequency increment setting will be displayed on the front panel right display if the **FREQ INCR** key is held. Refer to 3.6.2.

Serial Port header: FRQINC

NOTES

Source frequency increment is used to increment or decrement the current source frequency. Refer to Section 3.4.3. Modified frequency is always checked and may, if the new value is out of range, cause an "Operand Out Of Range" (error 7) to be generated.

Relative increments, when displayed in %, will always be displayed + 100 %.

The algorithm used to set relative increment adds 100% to the entered value if entered in percent, divides the result by 100 and preserves this value to be used as a multiplier of source frequency. Decrement is implemented by taking the reciprocal of this number as a multiplier. Thus relative increments, when displayed in %, will always be displayed + 100%.

Once a new source frequency increment value has been entered, the instrument will automatically revert to source frequency numeric entry mode.

3.4.5 IMD OFFSET FREQUENCY (requires option 002)

DESCRIPTION

Selects new IMD offset frequency setting. Allowable settings are 40 Hz, 50 Hz, 60 Hz, 80 Hz, 100 Hz, 125 Hz, 250 Hz and 500 Hz. All entered values will be rounded to the nearest allowable setting (i.e, if 185 Hz is selected, IMD frequency will be set to 250 Hz). The offset frequency referred to in this manual is the low frequency component of the composite test signal in the SMPTE/DIN IMD method and the offset from mean frequency in the CCIF "twin-tone" IMD method (i.e. one half the difference frequency).

METHODS AVAILABLE

First, select IMD Low Frequency numeric entry mode then use one of the following methods to set the new value:

CHOICES	FRONT PANEL	SERIAL	GPIB
SET "IMD LF" MODE	**IMD LOW FREQ**	IMFREQ	IF
Enter new value: e.g. 80 Hz Valid units:	 **80 Hz** **kHz, Hz**	 80 HZ KHZ,HZ	 80 HZ KH, KZ, HZ
Set to last measured frequency	*	DUP	-

DEFAULT SETTING

60 Hz.

ANNUNCIATION

IMD frequency numeric entry mode is in effect if **IMD LOW FREQ** LED is on.

The current IMD frequency setting will be displayed on the front panel right display if the **IMD LOW FREQ** key is held. Refer to 3.6.2.

Serial Port header: IMFREQ

NOTES

IF REQUESTED FREQUENCY IS	ACTUAL SETTING IS
<45 Hz	40 Hz
≥45 Hz and < 55 Hz	50 Hz
≥55 Hz and <70 Hz	60 Hz
≥70 Hz and < 90 Hz	80 Hz
≥90 Hz and <112.5 Hz	100 Hz
≥112.5 Hz and <187.5 Hz	125 Hz
≥187.5 Hz and < 375 Hz	250 Hz
≥375 Hz	500 Hz

Since all entries are rounded to the nearest valid setting, entering out-of-range values should not generate an error.

The offset frequency is actually the operating frequency of the internal IMD low frequency oscillator. The term "offset frequency" is used instead of "difference frequency" or "low frequency" to avoid ambiguity especially in the case of CCIF IMD, where the difference frequency is twice the offset frequency and "low frequency" may be misconstrued as the lower of the two sidebands.

If the offset frequency is set to 100 Hz and the "main" (i.e., high or mean) frequency is 10 kHz then in SMPTE/DIN the two frequencies will be 100 Hz and 10 kHz. In CCIF the two frequencies provided by the generator will be 9.9 kHz and 10.1 kHz (the difference frequency being twice the offset frequency i.e., 200 Hz).

3.4.6 IMD MIX RATIO
(requires option 002)

DESCRIPTION

Selects IMD HF:LF amplitude ratio setting. Valid choices include 1:1, 1:2, 1:4, and 1:10.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
1:1	35.1 **SPCL**	IMRATIO 1:1	35.1SP
1:2	35.2 **SPCL**	IMRATIO 1:2	35.2SP
1:4	35.4 **SPCL**	IMRATIO 1:4	35.4SP
1:10	35.10 **SPCL**	IMRATIO 1:10	35.10SP

DEFAULT SETTING

See notes.

ANNUNCIATION

The current IMD ratio setting will be displayed on the front panel left display when Special Function 35.0 is selected. Refer to 3.6.3.

Special Function 35 status is not maintained (i.e., entering any of the above described options will not affect special function status as displayed by the **SPCL FUNCTION** LED).

Serial Port header: IMDRAT

NOTES

IMD ratio is automatically set to 1:4, whenever the SMPTE type IMD measurement is selected, and to 1:1, whenever any other type of measurement is selected.

During IMD SMPTE type measurement, if the calculated HF level is not in the correct range (as measured internally at the output of the HF recovery circuit), measurement will be aborted and error 29, "IMD Mismatch", reported. Refer to 3.10.7.

The mix ratio affects both the generator and the analyzer. If the instrument is the source of the test signal for the device under test, the analyzer will be set up correctly. If the test signal is coming from another source (or is not performed in real time), set the ratio to that of the signal being analyzed. Failure to observe this may lead to Error 29 "IMD Mix Mismatch."

3.4.7 OUTPUT ENABLE

DESCRIPTION

Disabling output turns off both the A and the B outputs while enabling output reconfigures the A and B outputs according to the currently selected output configuration. Refer to 3.4.11.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Disable	-OUTPUT- **ON/OFF**	OUTENBL OFF	O0
Enable	-OUTPUT- **ON/OFF**	OUTENBL ON	O1

Front Panel key alternates ON and OFF

DEFAULT SETTING

Output disabled

ANNUNCIATION

If the output is enabled it will be annunciated by the - OUTPUT- **ON** LED.

Serial Port header: OUTPUT

NOTES

When the output is disabled, the output attenuator is disconnected from the power amplifier and terminated in a way that provides no disturbance to the output impedance. The oscillator is not disabled unless a zero source amplitude is specified to avoid the delays caused by oscillator turn on settling when switching the output.

3.4.8 OUTPUT REFERENCE

DESCRIPTION

Selects ground or floating output reference.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Ground	-OUTPUT- **GND/FLOAT**	OUTREF GROUND	OG
Float	-OUTPUT- **GND/FLOAT**	OUTREF FLOAT	OF
-OUTPUT- **GND/FLOAT** key alternates between ground and float.			

DEFAULT SETTING

Grounded

ANNUNCIATION

Grounded output is displayed by -OUTPUT- **GND** LED.

Serial Port header: OUTREF

NOTES

The "grounded" output reference connects the output reference point (the "low" terminal when unbalanced, the "center tap" (electrical) or "sleeve" (mechanical) terminal when balanced) to the analyzer analog common through a protective network.

The floating mode galvanically isolates the output common from the analyzer common and chassis.

3.4.9 OUTPUT IMPEDANCE & STRUCTURE (requires option 001)

DESCRIPTION

Selects main source output impedance and structure. Valid options include 600 Ohms (balanced), 150 Ohms (balanced), and 50 Ohms (unbalanced).

PROCEDURE

OPTIONS	FRONT PANEL	SERIAL	GPIB
600 Ohms	-OUTPUT- **Rsource**	OUTIMP IMP600	P0
150 Ohms	-OUTPUT- **Rsource**	OUTIMP IMP150	P1
50 Ohms	-OUTPUT- **Rsource**	OUTIMP IMP50	P2

-OUTPUT- **Rsource** is a "rotary" key which selects impedance in the following order: 600 Ohms - 150 Ohms - 50 Ohms - 600 Ohms, etc.

DEFAULT SETTING

600 Ohms

ANNUNCIATION

Current status always displayed by -OUTPUT- **150 Ohms**, [600 Ohms], and **50 Ohms** LEDs.

Serial Port header: OUTSTS

NOTES

Changing the source structure will cause the source amplitude to be recalculated. The sequence taken avoids the application of higher than specified voltages appearing at the output terminals.

Inserting a plug in the ring-tip-sleeve (balanced) jack will disconnect the BNC (unbalanced) jack independent of the source structure. If the balanced structure is specified and there is no plug present in the balanced jack, a signal of half the programmed source amplitude will appear at the unbalanced BNC connector.

3.4.10 OUTPUT LOAD IMPEDANCE REFERENCES

DESCRIPTION

Selects power (dBm) and level (dBV, V) output load impedance references. In both cases, level and power, valid options range from 1 to 9999 ohms. In the case of level reference, however, the selection of 9999 ohms assumes a load impedance of infinity. Refer to 3.4.1.

PROCEDURE

LEVEL output load impedance reference is selected by special function 4 and is entered in the form 4.nnnn where nnnn is an integer value in the range 1 to 9999 and is the special function designator for the port.

POWER output load impedance reference (dBm) is selected as above except that special function 5 is used.

EXAMPLES	FRONT PANEL	SERIAL	GPIB
Level, 600 ohms	4.600 **SPCL**	4.600 SP	4.600 SP
Level, infinity	4.9999 **SPCL**	4.9999 SP	4.9999SP
Power, 800 ohms	5.800 **SPCL**	5.800 SP	5.800 SP

DEFAULT SETTINGS

Level output impedance reference = infinity
Power output impedance reference = 600 ohms

ANNUNCIATION

Currently selected level and power output impedance references will be displayed on the Front Panel amplitude display when special functions 4.0 and 5.0 are entered, respectively.

Serial Port headers : OIRL (level) and OIRP (power)

NOTES

Whenever output load impedance reference is selected, source amplitude is reset. This may result in a source amplitude "Out Of Range" (error 7) and leave an incongruity between programmed source amplitude and the actual fine output attenuator settings. Refer to the description of source amplitude maximum level in 3.4.1 before modifying output reference impedance.

The output load impedance references are used exclusively in determining source amplitude setting and have no effect on input impedance references used to display measurement data in power units.

3.4.11 OUTPUT CONFIGURATION

DESCRIPTION

Selects A and B output configuration. Valid choices include A output only, B output only, both A and B outputs, and A and -B outputs. If output is currently disabled (refer to 3.4.7), only the programmed output configuration may be modified, i.e. both A and B outputs will remain disabled. If output is subsequently enabled, the programmed output configuration will be implemented. Note that for Output B to be operational, the 5500 must be equipped with option 007.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
A only	-OUTPUT- **A/B/-B**	OUTCNF A	C0
B only *	-OUTPUT- **A/B/-B**	OUTCNF B	C1
A & B *	-OUTPUT- **A/B/-B**	OUTCNF A & B	C2
A & -B *	-OUTPUT- **A/B/-B**	OUTCNF A & -B	C3

* requires option 007

-OUTPUT- **A/B/-B** is a "rotary" key which selects output configuration in the following order: A only - B only - A & B - A & -B - A only.

DEFAULT SETTING

The default output configuration is A only, however, all outputs will be disabled due to the default state of Output Enable.

ANNUNCIATION

Current status always displayed by the -OUTPUT- **A, B,** and **-B** LEDs.

Serial Port header: OUTCNF

NOTES

Input Select includes the choice of A output and B output. Refer to 3.2.1.

3.4.12 POWER AMP SOURCE SELECT

DESCRIPTION

This function allows the user to specify the source which will be used as the input to the power amp module and therefore the Generator Output signal.

DEFAULT SETTING

Wide and narrow band level modes: internal fixed frequency sine

THD + N mode : Internal fixed frequency sine

SMPTE IMD mode : Internal fixed frequency SMPTE IMD composite signal

CCIF IMD mode : Internal fixed frequency CCIF IMD composite signal

ANNUNCIATION

None

NOTES

Any time the instrument FUNCTION is changed, the default source is automatically selected.

Certain sources can be invalid in certain modes and may produce errors.

PROCEDURE

The power amp source is selected by invoking Special Function 14 with the appropriate operand.

CHOICES *	FRONT PANEL	SERIAL	GPIB
No source	14.0 **SPCL**	14.0 SP	14.0 SP
Fixed freq. sine	14.1 **SPCL**	14.1 SP	14.1 SP
Fixed freq. IMD (composite signal) (requires option 002)	14.2 **SPCL**	14.2 SP	14.2 SP
Swept sine (requires option 054)	14.3 **SPCL**	14.3 SP	14.3 SP
External source	14.4 **SPCL**	14.4 SP	14.4 SP
External HF source for IMD (requires option 002)	14.5 **SPCL**	14.5 SP	14.5 SP
Swept HF IMD (composite signal) (requires options 002 & 054)	14.6 **SPCL**	14.6 SP	14.6 SP
Square wave (requires option 201)	14.7 **SPCL**	14.7 SP	14.7 SP
AUX Source 1 (requires option 003)	14.8 **SPCL**	14.8 SP	14.8 SP
AUX IMD source (requires option 002)	14.9 **SPCL**	14.9 SP	14.9 SP
Source 2 (requires option 003)	14.10 **SPCL**	14.10 SP	14.10 SP
AUX Source 3 (requires option 003)	14.11 **SPCL**	14.11 SP	14.11 SP
AUX Source 4 (requires option 003)	14.12 **SPCL**	14.12 SP	14.12 SP

* NOTE: All operands except 1 require that certain optional features be resident in the 5500 frame.

3.4.13 DC UTILITY DACs (requires option 008)

DESCRIPTION

This function allows the user to control two general purpose eight bit multiplying digital to analog converters.

PROCEDURE

The Special Function code is entered followed by a decimal value representing the byte which will be sent to the DAC.

CHOICES	FRONT PANEL	SERIAL	GPIB
Set DAC A	86.nnn **SPCL**	86.nnn SP	86.nnnSP
Set DAC B	87.nnn **SPCL**	87.nnn SP	87.nnnSP

Where nnn represents a decimal number in the range of 0-255.

DEFAULT SETTINGS

Both DACs are set to 0 (see warning).

ANNUNCIATION

None.

NOTES

The two DACs provide user controllable analog output signals. Each DAC is provided with complementary outputs such that the voltage appearing on the main output is multiplied by -1 on the complementary output. The DACs may be configured by the user to operate in either an unsigned binary or an offset binary mode. The DACs' reference inputs may be connected to an internal precision reference voltage or their reference inputs may be derived from external signals. The user may modify the scale factor by changing the value of a single resistor for each DAC.

WARNING

If either DAC is configured for offset binary operation, the default value for that DAC will cause the main and complement outputs to go to their negative and positive full scale values, respectively. There is no way explicitly provided to avoid this condition.

3.4.14 DC MULTIPLEXER CONTROL (requires option 008)

DESCRIPTION

This function provides a one of eight multiplexer utility.

PROCEDURE

The Special Function code is followed by the designation of the required output.

CHOICES	FRONT PANEL	SERIAL	GPIB
Set mux	88.n **SPCL**	88.n SP	88.nSP

Where n is the designated output to select in the range of 0 to 8.
0 represents all outputs off.

DEFAULT SETTINGS

All outputs off.

ANNUNCIATION

None.

NOTES

The outputs provided are mutually exclusive active high logic signals that can provide a fan out of five TTL unit loads. The user is expected to provide the jumpers on the DC and digital module to connect the outputs in such a way as to perform the desired control.

This function is usually used in conjunction with other resources on the DC and digital module. For example, it may be used to drive some of the utility relays to provide an analog mux-demux facility. Software provides delays between the actuation of the various outputs so that a non-overlap time longer than that required for any on-board relays can be expected. For loads that might be damaged by an overlap condition lasting less than a few milliseconds, however, it is advisable to provide protection in the form of cascaded relay configurations. The user has complete freedom as to which outputs are to be used for what purpose.

3.4.15 DC DIGITAL UTILITY
(requires option 008)

DESCRIPTION

This function provides the user with an eight bit TTL latched output port.

PROCEDURE

The Special Function code is followed by the decimal value that represents the desired bit pattern.

CHOICES	FRONT PANEL	SERIAL	GPIB
Set bits	89.nnn **SPCL**	89.nnn SP	89.nnnSP

Where nnn represents the decimal number in the range of 0 to 255.

DEFAULT SETTINGS

ANNUNCIATION

None.

NOTES

The user is responsible for defining the application of this utility. The bits in the output register may be defined as affecting one or several separate distinct circuit functions, but it should be noted that there is no way to read the current state of the port internally. It is thus necessary for the user to remember which bits were set in an independent application and modify them as required.

Although it may seem inconvenient to refer to bit patterns by decimal values, any other data format would have been inconsistent with the existing special function operand processor. It is thought that the high degree of flexibility provided more than offsets any inconvenience of use.

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3.5 DISPLAY FORMATTING

3.5.1 RELATIVE MODE

DESCRIPTION

When the relative mode is enabled, the ratio of measured level or distortion to a specified reference is displayed; when disabled, the actual measured level or distortion is displayed.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Disable	**RELATIVE**	RATIO OFF	R0
Enable using previous reference	**RELATIVE**	RATIO OLD	R1
Enable and set shift reference to last measured value	**RELATIVE**	RATIO NEW	11.4SP

- The **RELATIVE** key alternates between disable and enable, using currently stored reference.

- Closure of the shift of **RELATIVE** always attempts to enable relative mode with the last measured value.

DEFAULT SETTING

Relative mode disabled

ANNUNCIATION

Current relative mode status is always displayed by Front Panel **REL** LED. Further, if no other special function is in effect and the relative mode is disabled then the **SPCL FUNCTION** LED will turn off. If the relative mode is enabled, the **SPCL FUNCTION** LED will turn on.

Current reference will be displayed on the left display by Special Functions 11.1 or 11.2. Refer to 3.5.2 and 3.6.3.

Serial Port header: RATIO

NOTES

Two different relative references are always maintained, a distortion reference and a level reference. If the relative mode is enabled then whenever valid measurement data is available, the ratio of measured level to the current level reference will be calculated and displayed; in the case of distortion type measurement, the ratio of measured distortion to the current distortion reference will be calculated and displayed.

If relative mode is disabled, or enabled using the **RELATIVE** key, the RATIO OLD or R1 commands, the currently stored references remain unchanged. If relative mode is enabled via Special Function 11.4 and level type measurement is in effect then the level reference is reset to the last valid level measurement result while the distortion reference remains unchanged. Similarly, if a distortion type measurement is in effect, the distortion reference is reset to the last valid distortion measurement result while the level reference remains unchanged.

References may be changed at any time by selecting relative reference numeric entry mode and entering a new value. If a distortion type measurement is in effect then only the distortion reference may be modified. Similarly, if a level type measurement is in effect, only the level reference may be modified. Refer to 3.5.2.

Relative values are displayed in % or dB units depending on whether linear or log amplitude display mode is currently selected.

If the relative mode is enabled while a level type measurement is in effect and then a distortion type measurement is selected, the relative mode will be automatically disabled. If the relative mode is enabled while a distortion type measurement is in effect and then a level type measurement is selected, the relative mode will be automatically disabled. Refer to 3.3.1.

When the relative mode is disabled while measuring level then the last specified absolute amplitude display units will be restored unless display mode has been modified, in which case, the appropriate log or linear version of the last specified absolute units will be selected. This will not affect distortion units as they can only be in dB or %.

This function is disabled during DC Volts* or Phase* type measurements. Note that if changes are made to this function while either DC Volts or Phase measurement modes are selected, the display mode will be unaffected until an AC measurement mode is selected.

***NOTE**: DC Volts and Phase Measurement require options 008 and 009 respectively.

3.5.2 RELATIVE MODE REFERENCE

DESCRIPTION

Selects new relative reference value, either distortion or level, depending on whether the currently selected measurement is distortion or level.

METHODS AVAILABLE

First select the Relative Reference numeric entry mode then use one of the following methods to set the new value:

CHOICES	FRONT PANEL	SERIAL	GPIB
SET "REFERENCE" MODE	**[REFERENCE]**	**REF**	**RE**
Enter new value:			
e.g.(level) 2.5 Volts	**2.5 V**	2.5 V	2.5VL
Valid units: for level	**V, dBV, dBm**	V,MV,UV,DBM, DBV	VL,MV,UV, DM,DV
e.g.(distortion) 2.5%	**2.5 %**	2.5 %	2.5PE
Valid units: for distortion	**%, dB**	%,DB	PE,DB
Set to last valid level or distortion measurement	*	DUP	-
- Relative reference may also be automatically stored when relative mode is enabled. Refer to Section 3.5.1.			

DEFAULT SETTING

Distortion reference is 100 %

Level reference is 1 V

ANNUNCIATION

Reference numeric entry mode is in effect if the **RELATIVE REFERENCE** LED is on.

If a level type measurement is in effect, the currently selected level reference will be displayed on the amplitude display if the **RELATIVE REFERENCE** key is held; if a distortion type measurement is in effect, the current distortion reference will be displayed when the **RELATIVE REFERENCE** key is held. Refer to 3.6.2.

Regardless of the type of measurement in effect, the currently selected level reference will be displayed whenever Special Function 11.1 or serial port command, RATIO DSPL, is entered. The currently selected distortion reference will be displayed whenever Special Function 11.2 or serial port command, RATIO DSPD, is entered. Refer to 3.6.3.

Serial Port headers are: DSTREF and LVLREF

NOTES

There are no limits on the choice of distortion and level references.

While the relative mode is enabled and whenever valid measurement data is available, the ratio of measured level or distortion to the currently stored level or distortion reference will be calculated and displayed.

If the relative mode is enabled using Special Function 11.4 or the serial port command, RATIO NEW, the reference to be used will be automatically set to the last valid distortion or level measurement result. Refer to 3.5.1.

This function is disabled during DC Volts* or Phase* type measurements. Note that if changes are made to this function while either DC Volts or Phase measurement modes are selected, the display mode will be unaffected until an AC measurement mode is selected.

***NOTE**: DC Volts and Phase Measurement require options 008 and 009 respectively.

3.5.3 AMPLITUDE DISPLAY LIN/LOG FORMAT

DESCRIPTION

Enables the amplitude display values to be expressed in either linear or logarithmic units.

PROCEDURE

OPTIONS	FRONT PANEL	SERIAL	GPIB
Linear units	**LIN/LOG**	LIN	LN
Log units	**LIN/LOG**	LOG	LG
- The **LIN/LOG** key alternates between selecting linear and log units.			

DEFAULT SETTING

Linear units

ANNUNCIATION

The current lin/log status is not explicitly annunciated as such on the Front Panel or serial port. It is however evident in the selection of units in which data is expressed on the amplitude (left) display and the serial port AMP display.

NOTES

If a distortion type measurement is in effect or the relative mode is enabled and the linear units mode selected, measurement results will be expressed in % units. If log units are selected, measurement results will be expressed in dB units. If a level type measurement is in effect and the relative mode is disabled and linear units are selected, measurement results may be expressed in V, mV, μV, W, mW, or μW units. If log units are selected, measurement results may be expressed in dBV or dBm units. The choice of voltage or power units depends on the currently selected amplitude display units. Refer to 3.5.4.

If the amplitude display operating mode is in the fixed mode (see Section 3.5.4) and the lin/log status is changed, the operating mode will be automatically reset to the floating mode.

If the amplitude display is in linear mode and log units are specifically selected by any of the functions described by Section 3.5.4, the log mode is automatically enabled. Similarly, if the log mode is currently enabled and linear units are selected then the linear mode will be automatically enabled.

When switching between linear and log power units, the appropriate impedance reference is selected for Watts or dBm. Refer to 3.5.6.

The choice of linear or log display modes also affects special amplitude displays. Refer to 3.6.2 and 3.6.3.

The effect of amplitude display mode on the GPIB output data format is explained in Section 3.8.1.

This function is disabled during DC Volts* or Phase* type measurements. Note that if changes are made to this function while either DC Volts or Phase measurement modes are selected, the display mode will be unaffected until an AC measurement mode is selected.

***NOTE**: DC Volts and Phase Measurement require options 008 and 009 respectively.

3.5.4 AMPLITUDE DISPLAY UNITS AND OPERATING MODE

DESCRIPTION

Enables floating or fixed operation and selects units in which measurement data is expressed on the Front Panel amplitude display and the serial port AMP display. It will also affect GPIB output data. Decimal point position is not affected.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Float V	**UNITS**	AMPFRMT V	VO
Float W	**UNITS**	AMPFRMT W	WA
dBV	**UNITS**	AMPFRMT DBV	BV
dBm	**UNITS**	AMPFRMT DBM	BM
Float current selected units:	30.0 **SPCL**	AMPUNIT FLOAT	30.0SP
Hold current selected units:	30.1 **SPCL**	AMPUNIT HOLD	30. 1SP
Hold V	30.2 **SPCL**	AMPUNIT V	30.2SP
Hold mV	30.3 **SPCL**	AMPUNIT MV	30.3SP
Hold μV	30.4 **SPCL**	AMPUNIT UV	30.4SP
Hold W	30.5 **SPCL**	AMPUNIT W	30.5SP
Hold mW	30.6 **SPCL**	AMPUNIT MW	30.6SP
Hold μW	30.7 **SPCL**	AMPUNIT UW	30.7SP

If a distortion type measurement is in effect or the relative mode is enabled, the **UNITS** key has no effect; otherwise, if the linear mode is enabled, the **UNITS** key alternates between V and W and if the log mode is enabled, it alternates between dBV and dBm.

DEFAULT SETTING

Floating V

ANNUNCIATION

The currently selected units are displayed by the units LEDs of the amplitude display. If floating units operating mode is selected and no other special function is in effect then the **SPCL FUNCTION** LED is turned off. If the hold units operating mode is selected, the **SPCL FUNCTION** LED is turned on.

Serial Port header: AUNITS

NOTES

If floating units operating mode is enabled and the selected units are V or W then the amplitude display data will be expressed in V, mV, and μV or W, mW, and μW, depending on data fit.

Selecting units using any of the above commands, except special function 30.1 through 30.7 or AMPUNIT HOLD through UW, automatically enables floating units operating mode.

If the currently selected units are V, mV or μV and log mode is enabled, dBV units and float operating mode will be automatically selected. If the currently selected units are W, mW or μW and log mode is enabled, dBm units and float operating mode will be automatically selected. See Section 3.5.3.

If the currently selected units are V, mV, μV, W, mW, or μW and a distortion type measurement is selected or the relative mode is enabled then % units and the float operating mode will be selected. If the currently selected units are dBV or dBm and a distortion type measurement is selected or the relative mode is enabled then dB units and the float operating mode will be selected. If the log mode is enabled and linear units are specifically selected, the linear mode will be automatically enabled. Similarly, if the linear mode is enabled and log units are specifically selected then the log mode will be automatically enabled. See 3.5.3.

When switching between linear and log power units, the appropriate impedance reference is automatically selected. Refer to 3.5.6.

Special displays will be expressed in currently selected units if possible. Refer to 3.6.2 and 3.6.3.

The effects of amplitude display mode on the GPIB output data format is explained in Section 3.8.1.

If units are being held, measurement data and special displays may overflow and a "Level/distortion display overflow" (error 42) may be generated.

This function is disabled during DC Volts* or Phase* type measurements. Note that if changes are made to this function while either DC Volts or Phase measurement modes are selected, the display mode will be unaffected until an AC measurement mode is selected.

***NOTE**: DC Volts and Phase Measurement require options 008 and 009 respectively.

3.5.5 AMPLITUDE DISPLAY DECIMAL POINT POSITION & OPERATING MODE

DESCRIPTION

Selects floating or fixed decimal point and fixed decimal point position on amplitude display.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Float	31.0 **SPCL**	AMPDPNT FLOAT	31.0SP
Hold current position	31.1 **SPCL**	AMPDPNT HOLD	31.1SP
Hold DDDDD.	31.2 **SPCL**	AMPDPNT DDDDD.	31.2SP
Hold DDDD.D	31.3 **SPCL**	AMPDPNT DDDD.D	31.3SP
Hold DDD.DD	31.4 **SPCL**	AMPDPNT DDD.DD	31.4SP
Hold DD.DDD	31.5 **SPCL**	AMPDPNT DD.DDD	31.5SP
Hold D.DDDD	31.6 **SPCL**	AMPDPNT D.DDDD	31.6SP
Hold .DDDDD	31.7 **SPCL**	AMPDPNT .DDDDD	31.7SP

DEFAULT SETTING

Floating decimal point

ANNUNCIATION

If floating decimal point is selected, the **SPCL FUNCTION** LED should turn off. If any of the hold options is selected and if no other special function is in effect, the **SPCL FUNCTION** LED should turn on.

Serial Port header: ADPNT

NOTES

If the decimal point is being held, measurement data and special displays may overflow and "Level/distortion display overflow" (error 42) will be produced.

3.5.6 IMPEDANCE REFERENCES FOR WATTS AND dBm

DESCRIPTION

Selects impedance references in the range of 1 to 999 Ohms for measured amplitude display data expressed in Watts or dBm power units.

PROCEDURE

The Watts impedance reference is selected by Special Function 25 and is entered in the form 25.nnn(n) , where nnn(n) is an integer value in the range 1 to 999 (9999) and is the special function designator for the port. Due to size restrictions of data entry display, the maximum value for the dBm or Watts impedance reference from the front panel is 999 while impedances entered via the GPIB or Serial Ports can take values up to 9999.

The dBm impedance reference is entered as above except that special function 26 is used.

EXAMPLES	FRONT PANEL	SERIAL	GPIB
Watts imp. = 10 Ohms	25.10 **SPCL**	25.10 SP	25.10SP
dBm imp. = 800 Ohms	26.800 **SPCL**	26.800 SP	26.800SP

DEFAULT SETTING

dBm impedance = 600 Ohms

Watts impedance = 8 Ohms

ANNUNCIATION

Currently selected Watts and dBm impedance references will be displayed on the Front Panel amplitude display when special functions 25.0 and 26.0 are entered, respectively.

Serial Port headers: WTSIMP and DBMIMP

3.5.7 FREQUENCY DISPLAY DECIMAL POINT POSITION & OPERATING MODE

DESCRIPTION

Selects floating or fixed decimal point and fixed decimal point position on frequency display.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Float	32.0 **SPCL**	FRQDPNT FLOAT	32.0SP
Hold current position	32.1 **SPCL**	FRQDPNT HOLD	32.1SP
Hold DDDDD.	32.2 **SPCL**	FRQDPNT DDDDD.	32.2SP
Hold DDDD.D	32.3 **SPCL**	FRQDPNT DDDD.D	32.3SP
Hold DDD.DD	32.4 **SPCL**	FRQDPNT DDD.DD	32.4SP
Hold DD.DDD	32.5 **SPCL**	FRQDPNT DD.DDD	32.5SP
Hold D.DDDD	32.6 **SPCL**	FRQDPNT D.DDDD	32.6SP
Hold .DDDDD	32.7 **SPCL**	FRQDPNT .DDDDD	32.7SP

DEFAULT SETTING

Floating decimal point

ANNUNCIATION

If the floating decimal point is selected, the **SPCL FUNCTION** LED should turn off. If any of the hold options is selected and if no other special function is in effect, the **SPCL FUNCTION** LED should turn on.

Serial Port header: FDPNT

NOTES

If the decimal point is being held, measurement data and special displays may overflow and "Frequency display overflow" (error 50) will be generated.

This function is disabled during DC Volts* or Phase* type measurements. Note that if changes are made to this function while either DC Volts or Phase measurement modes are selected, the display mode will be unaffected until an AC measurement mode is selected.

***NOTE**: DC Volts and Phase Measurement require options 008 and 009 respectively.

3.6 FRONT PANEL DISPLAY COMMANDS

3.6.1 CLEAR FRONT PANEL DISPLAYS AND ERRORS

DESCRIPTION

This command clears the front panel displays, fatal error conditions, and disables any special displays currently in effect. If the instrument is in hold or trigger measurement mode, the clear command will also trigger a measurement.

PROCEDURE

COMMAND	FRONT PANEL	SERIAL	GPIB
clear displays	**CLR**	CLEAR	CL

NOTES

The clear command may be used to clear any numeric entry in progress on the Front Panel without generating a syntax error, to clear a fatal error condition, to return the instrument to normal operating mode (i.e. measuring), and to disable any special Front Panel displays that are currently enabled (see 3.6.3 below).

If the instrument is in hold or trigger measurement mode, the clear command will also cause a single measurement to be performed. Refer to 3.8.4.

In remote mode all Front Panel keys, except the **CLR** and **LCL** keys, are disabled. If LLO bus command is detected, the instrument will go into remote with lockout state in which case all the Front Panel keys will be disabled. If the instrument is then returned to local mode, other than by the REM line going false, the **LCL** key will remain locked out and the **CLR** key will be locked out from triggering measurement but will remain otherwise functional.

3.6.2 DISPLAY CURRENT STATUS (Using the Parameter Keys)

DESCRIPTION

The same Front Panel keys that select numeric entry mode (see 3.1.1 and 3.1.5), if held, will display the current status of the associated parameter on the appropriate Front Panel display. The display is cleared when the key is released.

DISPLAY PARAMETER	FRONT PANEL
Source frequency	hold **FREQUENCY**
Source frequency increment	**SHIFT** & hold **FREQUENCY**
Source amplitude	hold **AMPLITUDE**
Source amplitude increment	**SHIFT** & hold **AMPLITUDE**
IMD offset frequency	hold **IMD LOW FREQUENCY**
Relative reference	hold **RELATIVE REFERENCE**

NOTES

When a parameter key is held, the numeric entry mode may also be modified as described in Section 3.1.5.

The current status of the parameter that is displayed is the programmed value as opposed to the actual or measured value. Not all numeric entry parameters may be viewed in this way (i.e. SVF frequency and SVF frequency increment). Source amplitude, amplitude increment and relative references will always appear on the amplitude (left) display, the others on the frequency (right) display.

The displayed status will be expressed in currently selected units if possible.

When the parameter key is released, the associated display will resume whatever it was doing before except in the case of fatal error, in which case, the fatal error condition will have been cleared by reselecting numeric entry mode. In the case of relative reference display, if the current type of measurement is distortion, the distortion reference will be displayed, otherwise the level reference will be displayed.

3.6.3 SPECIAL FRONT PANEL DISPLAYS

DESCRIPTION

Displays current status of the specified parameter on the Front Panel amplitude and/or frequency display.

PROCEDURE

PARAMETER(S)	FRONT PANEL	SERIAL	GPIB
Source amplitude and frequency	10 **SPCL**	10 SP	10SP
Distortion relative reference	11.2 **SPCL**	RATIO DSPD	11.2SP
Level relative reference	11.1 **SPCL**	RATIO DSPL	11.1SP
Watts impedance	25.0 **SPCL**	25.0 SP	25.0SP
dBm impedance	26.0 **SPCL**	26.0 SP	26.0SP
GPIB status	-GPIB- **ID?**	21.0 SP	21.0SP
IMD mix ratio *	35.0 **SPCL**	35.0 SP	35.0SP
Level output load impedance reference	4.0 **SPCL**	4.0 SP	4.0SP
Power output load impedance reference	5.0 **SPCL**	5.0 SP	5.0SP

*IMD Function requires option 002.

DEFAULT SETTING

All special displays disabled.

NOTES

Any of the above special displays may be disabled by the clear command or by selecting another special display. They may also be temporarily interrupted by numeric entry, held parameter key display, or fatal error display.

The current status of the parameter that is displayed is the programmed value as opposed to the actual or measured value.

Only the source frequency and IMD* offset frequency use the right display; all other special displays use only the left display.

The displayed status will be expressed in currently selected units if possible.

The GPIB status shows the current address that the GPIB interface is set to respond to as well as some details of the talk-only and listen-only status. Refer to Section 3.8.7.

***NOTE**: IMD Function requires option 002.

3.7 STORE AND RECALL COMMANDS

3.7.1 STORING CURRENT MACHINE STATE

DESCRIPTION

Stores the current machine state in non-volatile RAM, excluding I/O and calibration status, and assigns to it the specified store number which may then be used with the full or partial recall commands to recover the machine state. The store numbers which may be used are 2 through 11. Store numbers 0 and 1 are reserved for default and power-down machine states and may not be used with this function.

PROCEDURE

The entire machine state is preserved by entering an integer in the range 2 to 11 followed by the <STORE>command for the front panel and GPIB and the reverse for the serial port.

EXAMPLE	FRONT PANEL	SERIAL	GPIB
Save in 5	**5 STORE**	STORE 5	5ST

NOTES

The statuses which are saved by the store command are the same as those which comprise default machine state and are listed in Section 3.12.4.

Any machine states saved previously using the same store number will be lost.

Power-down machine state refers to the machine state that was automatically saved in store 1 during the last powering down of the instrument. The information in store 1 is over-written whenever the full machine state is recalled. Refer to Section 3.7.3.

The information is stored in non-volatile RAM along with a checksum to guarantee the integrity of the stored data. A write to store 1 is initiated at power down and requires some time to be successfully completed. It is possible that heavily loaded systems operating with a low line condition may not have enough time to finish the operation before the power supply falls out of spec and aborts all processor activity. It is for this reason that the recommended procedure for powering down the instrument is by the front panel power switch instead of an external line interruption.

3.7.2 RECALLING PARTIAL MACHINE STATE

DESCRIPTION

Recalls only source amplitude and frequency settings of the machine state associated with the specified store number. Store 0 (default machine state) and store 1 (power-down machine state) may always be used with this command. If a store command has previously assigned a machine state to store 2 through 11 then store numbers 2 through 11 may also be used.

PROCEDURE

The partial machine state is recalled by entering the number of the desired store followed by the <RECALL> command for the front panel and GPIB and the reverse for the serial port.

EXAMPLE	FRONT PANEL	SERIAL	GPIB
Recall 5	5 **RECALL**	RECPART 5	5RC

NOTES

To specify partial recall from the Front Panel always use the 0 suffix or no suffix at all; to specify full recall always use the 1 suffix. Refer to 3.7.3 below.

Power-down machine state refers to the machine state that was automatically saved in store 1 during the last powering down of the instrument or the last full machine state recall.

Using an invalid store number or attempting to recall a store which has not previously been saved will result in an "Invalid Command Operand" (error 6).

The information which is recalled is checked for validity with a three byte checksum. It is virtually inconceivable that invalid data could be used to reprogram the instrument.

3.7.3 FULL MACHINE STATE RECALL

DESCRIPTION

Recalls full machine state associated with the specified store number. Store 0 (default machine state) and store 1 (power-down machine state) may always be used with this command. If a store command has previously assigned a machine state to store 2 through 11 then store numbers 2 through 11 may also be used.

PROCEDURE

The full machine state is recalled by entering the desired store number with a ".1" suffix followed by the <RECALL> command for the front panel or the GPIB. The serial port only requires the <RECFULL>command and the store number to effect the recall.

EXAMPLE	FRONT PANEL	SERIAL	GPIB
Recall 5	5.1 **RECALL**	RECFULL 5	5.1RC

NOTES

All of the user specified generation and measurement functions of the instrument at power down can be recovered by recalling store 1.1. In all cases except for store 1, the current state is automatically saved in store 1 prior to recalling the entire machine state, overwriting the state from the last power down. Thus store 1 can also be used to recall the state immediately prior to the last full recall.

To specify partial recall from the Front Panel always use the 0 suffix or no suffix at all; to specify full recall always use the 1 suffix. Refer to 3.7.2.

Full machine state recall will not affect I/O or calibration status, which are never stored. Note particularly that the serial port status is not affected.

Using an invalid store number or recalling a store which has not previously been saved will result in an "Invalid Command Operand" (error 6).

The information which is recalled is checked for validity with a three byte checksum. It is virtually inconceivable that invalid data could be used.

3.7.4 DEFAULT POWER-UP MACHINE STATE

DESCRIPTION

Selects the machine state which is to be recalled on the next and subsequent power ups. Choices include the default and the power down machine states.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Default State	23.0 **SPCL**	23.0 SP	23.0SP
Power Down State	23.1 **SPCL**	23.1 SP	23.1SP

NOTES

Entering Special Function 23 will not affect the current machine state. The next time the instrument is powered up, it will be initialized to the default machine state as described by 3.12.4, if the default option of Special Function 23 was selected (23.0). If the power down option of Special Function 23 was selected (23.1), the instrument will be initialized to its last power-down state.

Power-down state refers to the machine state that was automatically saved in store 1 during the last powering down of the instrument. If the automatic saving of machine status on the last power down was unsuccessful and store 1 is invalid, the instrument will recall the default machine state on power up.

3.8 GPIB CONTROL COMMANDS

3.8.1 GPIB IMPLEMENTATION NOTES (See also Section 4, Application Notes)

DESCRIPTION

On power up, a path is opened to the GPIB port using the 5500 internal GPIB device descriptor module, "B0." If neither the address nor the talk and listen status have been redefined, the descriptor module resides in the system ROM, otherwise B0 resides in non-volatile RAM. If the address and talk and listen status indicate 'Interface Not Installed' condition then no path is opened. Otherwise the software always attaches the device and opens a path to it.

DEVICE ADDRESS

The GPIB address by which the instrument is identified on the bus is stored in the internal descriptor module. It may be modified by Special Function 33 to any value in the range 0 to 31. Refer to Section 3.8.7.

TALK AND LISTEN STATUS

The devices talk and listen status flags are stored in the internal descriptor module. They may be modified by Special Function 34. Refer to Section 3.8.7.

GPIB OPERATING MODE

The device address and talk and listen status determine the operating mode of the GPIB interface as follows:

ADDRESS	TALK FLAG	LISTEN FLAG	GPIB OPERATING MODE
=31	NA	NA	Interface Not Installed
<31	true	true	Talk Only
<31	true	false	Talk Only
<31	false	true	Listen Only
<31	false	false	Talk and Listen

GPIB OPERATING MODES (Interface Not Installed)

The GPIB device remains inactive i.e., the instrument will not communicate with any remote GPIB devices.

GPIB OPERATING MODES (Talk Only)

In this mode, the instrument is configured to send data messages whenever the bus is in data mode. In free-run measurement mode, data messages are written to the GPIB driver's output buffer only if the output buffer is empty. If either of these conditions does not hold, the data will be lost. Refer to 'Sending Data Messages'.

The instrument does not respond to any other GPIB bus commands or accept any data messages (e.g. it can't be addressed to listen).

The instrument will issue a Request for Service whenever any of the specified conditions hold and always on GPIB command input error. Refer to 'SRQ Implementation' below.

GPIB OPERATING MODES
(Listen Only)

In this mode, the instrument responds to DCL, LLO and GET bus commands but not to GTL, REN, IFC or a serial poll. It accepts data messages but can't send any.

GPIB OPERATING MODES
(Talk and Listen (normal operation)

In this mode, the instrument responds to bus commands, serial polls, and data messages.

In free-run measurement mode, data messages are written to the GPIB driver's output buffer only if the instrument has been addressed to talk and the buffer is empty. If either of these conditions is not true, the data will be lost. In hold or triggered measurement mode, data messages are always written to the output buffer. Refer to 'Sending Data Messages' and 'Output Buffer Overflow' below.

Once addressed to talk by the GPIB controller, the instrument then remains configured to talk until unaddressed.

The instrument will issue a Request for Service whenever any of the specified conditions is true and always on GPIB command input error. Refer to 'SRQ Implementation' below.

SENDING DATA MESSAGES

If the instrument is able to send data messages and is in free-run measurement mode (see 3.3.2), it will try to send amplitude or frequency display data to the remote device whenever data is available, the output buffer is empty and the device is addressed to talk. If any of these conditions is not true, the data will be lost.

If the instrument is able to send data messages and is in hold or triggered measurement mode, it will send amplitude or frequency display data to the remote device whenever data is available. Refer to 'Output Buffer Overflow' below.

Data is available for output to the remote device whenever amplitude measurement data, including non-fatal measurement errors and exceptions and fatal errors, are ready for display and the instrument has been configured to read the amplitude display to the GPIB or whenever frequency measurement, including non-fatal measurement errors and fatal errors, is ready for display and the instrument has been configured to read the frequency display to the GPIB. The Front Panel display which is to be read to the GPIB is selected by Special Function 20. Refer to Section 3.8.5

SENDING DATA MESSAGES

The data message sent to the GPIB listener by the 5500 is always of the form (ASCII)

SDDDDDESNNCRLF

where:

SDDDDD	= signed 5-digit decimal mantissa with the decimal point presumed to be to the right of the right most digit.
E	= ASCII 'E'
SNN	= signed 2-digit decimal exponent
CRLF	= ASCII carriage return/line feed sequence
The above floating point values are presumed to be in base units.	

The value is in Volts, watts, dBm, dBV, dB, %, Hz or ohms depending on which is currently selected; mV, μV, mW, μW and kHz are always converted back to V, W or Hz. The error message sent by the GPIB is always of the form (ASCII) +900DDE+05CRLF where:

DD = 2-digit error code.

OUTPUT BUFFER OVERFLOW

In hold or triggered measurement mode, the instrument is configured to send amplitude or frequency display data to the listener, whenever data is available, as described above. The data is automatically written to the GPIB driver's output buffer and regardless of the state of the output buffer and whether or not the instrument has been addressed to talk. If the data is not subsequently read by the listener, the output buffer will overflow and the instrument will appear to lock up until the remote device reads more data from the instrument. The buffer overflows after approximately 7 data messages have been written but not read by the remote device. The instrument goes to sleep until there is sufficient room in the buffer to complete the last write to it.

SRQ IMPLEMENTATION

The SRQ conditions determine when the GPIB interface will request service from the controller on the bus.

Allowable conditions are as follows:

- On GPIB input error only
- On any fatal instrument error including GPIB code errors
- On any fatal instrument error or data ready

The data ready condition is true whenever measurement data, including non-fatal measurement errors and exceptions, are available for output.

On power up, SRQ conditions always default to 'on GPIB input error only'. The conditions may then be modified by either Special Function 22, a SDC or a DCL command from the controller. The latter two commands force the SRQ conditions to their default status.

The interface will request service only if it is in Talk Only or Talk and Listen operating mode. The GPIB decoder calls the driver's 'put status' routine with the Status Byte:

IF STATUS BYTE	THEN CONDITION INDICATED IS
= 1	data ready
= 2	GPIB input error in effect
= 4	fatal instrument error in effect

Only the 3 least significant bits of the Status Byte are used by the decoder to indicate the condition in effect. The driver then sets b6 of the Status Byte and issues a Request for Service. If the controller on the bus responds with a serial poll the Status Byte will be sent in response. The implementation of the driver sets the "data ready" bit, b0, in the status register as long as data is available in the output buffer. Note that this does not affect the SRQ message, as the instrument need not be in SRQS and thus will not go into APRS if polled. The user software's serial poll routine should verify that the SRQ bit is set in the response byte to see if this unit has requested service. The ability to set the data ready bit without generating a Service Request allows the controller to verify whether the output buffer is empty at the instant the status is taken.

RECEIVING MESSAGES FROM THE REMOTE GPIB CONTROLLER

VALID BUS COMMANDS

MESSAGE	RECEIVED	EFFECT
Remote	REN true & addressed	Puts the instrument in Remote and locks out all front panel keys except Clear and Local.
Local	GTL or REN false	Returns the instrument to Local state.
Set Local Lockout	LLO	Locks out front panel Clear & Local Keys.
Clear Local Lockout	REN false	Enables front panel Clear & Local Keys.
Abort	IFC	Resets GPIB interface to the idle state.
Trigger	GET	If the instrument is in triggered or hold mode, a single measurement will be initiated and its results (depending on which display is currently selected) will be output to the bus. Note: Data is output to the bus only if the instrument is capable of talking i.e., in Talk Only or Talk & Listen mode. If no one is listening, the GPIB output buffer may overflow and lock up the instrument after approximately 7 attempts to transfer data.
Clear	DCL or	Sets SRQ conditions to GPIB code error SDC only. Selects left display for reading to GPIB and resets the instrument to its default machine state.

GPIB DATA COMMANDS

GPIB commands are received when the bus is in data mode and are always in the form of ASCII strings. Refer to the individual Command Functions and to Section 3.1.2. The GPIB driver strips line feeds, carriage returns and spaces from the input data stream. This is to prevent the situation where the instrument input processor has recognized a sweep command but has not yet processed any trailing whitespace characters. Because the design of the sweep support software is such that any input detected on any port will abort the sweep, it would be possible for this whitespace to abort the sweep immediately that it is recognized. Having the driver strip these characters eliminates this problem.

3.8.2 SELECTING REMOTE/LOCAL OPERATION

DESCRIPTION

Enables or disables remote control of the instrument via the GPIB. Refer to Section 3.8.1 for description of the GPIB interface.

Following are descriptions of all possible states the instrument can achieve:

STATE	DESCRIPTION
LOCS	Normal operating mode, all Front Panel keys functional
REMS	All Front Panel keys except **CLR** and **LCL** locked out
RWLS	All Front Panel keys locked out
LWLS	Front Panel **CLR** for the purposes of triggering and **LCL** keys locked out, all other keys functional

NEW STATE	OLD STATE	REMOTE GPIB DEVICE	FRONT PANEL
REMS	LOCS	asserts REN true and addresses the instrument	
RWLS	REMS	asserts LLO	
LOCS	REMS	asserts REN false or GTL	**LCL** key
LWLS	RWLS	asserts GTL	
LOCS	RWLS	asserts REN false	

ANNUNCIATION

Current state is always displayed by the **REM** and **LLO** LEDs. If REMS or RWLS states in effect, **REM** is turned on. If RWLS or LWLS states in effect, **LLO** turned on.

Serial Port header: FPANEL

3.8.3 LOCAL LOCKOUT

DESCRIPTION

The GPIB controller may, by asserting LLO, lock out the Front Panel **CLR** and **LCL** keys. Lockout is cleared only when REN goes false. Whenever the instrument is in REMS state, all front panel keys except **CLR** and **LCL** are locked out. If LLO is asserted, the instrument goes into RWLS state, in which case all front panel keys are locked out. Once in RWLS state, if REN goes false, the instrument will enter LOCS state and all front panel keys will be restored. If, however, GTL is asserted instead, the instrument will enter LWLS state in which case all front panel keys except **CLR** and **LCL** will be restored. Refer to 3.8.1 and 3.8.2. Note that the only function the **CLR** key has in this context is that of triggering measurement.

ANNUNCIATION

Current state is always displayed by the **REM** and **LLO** LEDs. If REMS or RWLS states in effect, the **REM** LED is turned on. If RWLS or LWLS states in effect, the **LLO** LED is turned on.

Serial Port header: FPANEL

NOTES

It is generally advisable to assert LLO before addressing the instrument. This avoids the possibility that the operator could depress the **LCL** key after the instrument was addressed and before the controller has asserted LLO. It is also good practice to send the SDC or DCL message immediately after this to initialize the instrument to a known state.

3.8.4 TRIGGERING MEASUREMENT

DESCRIPTION

Initiates a single measurement attempt, if the instrument is in hold or trigger mode. Refer to 3.3.2. In hold or trigger mode, the instrument is configured to send data messages to the GPIB whenever data is available. If the messages are not subsequently read by a listener, the instrument may lock up. Refer to 3.8.1 for a description of the GPIB implementation.

METHODS

COMMAND D	FRONT PANEL	SERIAL	GPIB
Clear	**CLR**	CLEAR	CL
GET	-	-	assert GET

For the **CLR** key to be functional, the instrument must not be in local lockout i.e., RWLS or LWLS state (see 3.8.2)

NOTES

It is important to understand that triggering a measurement does not guarantee valid measurement results. The instrument could return either exceptions or errors after being triggered and the listener should check the data for these conditions. In general, it is possible to ignore exceptions and trigger another measurement but a number of consecutive errors implies that there is a problem in the test setup.

3.8.5 SELECTING FRONT PANEL DISPLAYS TO BE READ TO THE GPIB

DESCRIPTION

The GPIB interface may be configured to send either left (amplitude) or right (frequency) front panel display data. Special front panel displays are never read to the GPIB, only floating point measurement results, non-fatal measurement errors or exceptions and fatal error. Fatal error messages, which take up both displays, will be sent regardless of which display has been selected. Refer to Section 3.8.1.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
Read left display	20.0 **SPCL**	20.0 SP	RL
Read right display	20.1 **SPCL**	20.1 SP	RR

DEFAULT SETTING

Read left (amplitude) display to the GPIB.

ANNUNCIATION

If no other special functions are in effect and the read left display choice is selected, then the **SPCL FUNCTION** LED should turn off. If the read right (frequency) display choice is selected, then the **SPCL FUNCTION** LED should turn on.

Serial Port header: GPREAD

3.8.6 SELECTING SRQ CONDITIONS

DESCRIPTION

If the instrument is configured to respond to a serial poll from the remote controller, it will issue a Request for Service whenever any of the selected conditions is in effect. When polled it responds with the Status Byte configured as follows:

b6	set
b0	set, if data ready
b1	set, if GPIB command input error detected
b2	set, if fatal error in effect

The instrument will always request service when a GPIB data input error is detected. The data ready condition is true if measurement data, including floating point results and non-fatal measurement errors or exceptions, is available for output and depends on which display has been selected for reading to the GPIB. Refer to 3.8.1 and 3.8.5.

PROCEDURE

CHOICES	FRONT PANEL	SERIAL	GPIB
GPIB input error only	22.0 **SPCL**	22.0 SP	22.0SP
Fatal error	22.1 **SPCL**	22.1 SP	22.1SP
Fatal error or data ready	22.2 **SPCL**	22.2 SP	22.2SP

Note that GPIB command input error is a fatal error.

DEFAULT SETTING

Request service only when GPIB command input error detected.

ANNUNCIATION

If no other special functions are in effect, and the "Only on GPIB Error" option is selected, then the **SPCL FUNCTION** LED should turn off; if any of the other options are selected, the **SPCL FUNCTION** LED should turn on.

Serial Port header: SRQST

NOTES

The conditions which will cause the instrument to assert SRQ are not maintained through power down as they are considered part of the communications status and subject to external control. The default state can also be achieved by sending the instrument a SDC or DCL message.

3.8.7 DEVICE ADDRESS & TALK/LISTEN STATUS CONFIGURATION

DESCRIPTION

Selects new GPIB address, in the range of 0 to 31, and new Talk and Listen status. In either case, the GPIB device descriptor is modified and saved in non-volatile RAM. The new GPIB status will not come into effect until the next time an attempt is made to open a path to the GPIB device i.e., next power-up. Refer to Section 3.8.1.

PROCEDURE

Special Function 33 specifies the new device address as its suffix (decimal) while Special Function 34 suffix specifies the new talk/listen configuration.

CHOICES	FRONT PANEL	SERIAL	GPIB
Set addr (e.g. 25)	33.25 **SPCL**	33.25 SP	33.25SP
Select talk/listen configuration			
Talk and Listen	34.0 **SPCL**	34.0 SP	34.0SP
Listen Only	34.1 **SPCL**	34.1 SP	34.1SP
Talk Only	34.2 **SPCL**	34.2 SP	34.2SP

DEFAULT SETTING

Device address = 28 and Talk and Listen status i.e., normal mode.

ANNUNCIATION

The current GPIB address and operating mode may be displayed on the Front Panel amplitude (left) display by entering Special Function 21 or the -GPIB- **ID?** key. If the GPIB interface is installed, the display takes the form: N - M
where N = Device Address and is an integer in the range 0 to 30 and M = Operating Mode:

= 1, interface in talk and listen mode
= 2, interface in talk only mode
= 3, interface in listen only mode

If the GPIB interface is not installed, the display will show "0-0."

Serial Port header: GPIBST

NOTES

Altering the device address or Talk/Listen configuration may alter the GPIB operating mode. Entering a new device address of 31 will always put the GPIB in "Interface Not Installed" mode, although it will be annunciated with an address of 0. Refer to Section 3.8.1 re: GPIB Operating Modes.

When the device address and Talk/Listen configuration are redefined, a new device descriptor module, B0, is created in non-volatile RAM. The old address or Talk/Listen configuration are replaced and the module's revision number incremented. From then on, at power up, the address and talk and listen status will be retrieved from the new module in non-volatile RAM.

Note that the codes used by the **ID?** key and Special Function 21 to display current GPIB operating mode are not the same as the codes used by Special Function 34 to enter new talk/listen configuration. Check the manual carefully when interpreting status or changing it.

In this implementation of the GPIB interface, the manual switches for device address, LON and TON status required by the standard are replaced by Special Functions 33, 34 and their respective bits in the device descriptor and non-volatile RAM.

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3.9 SERIAL PORT INFORMATION (requires option 232)

3.9.1 SERIAL PORT USAGE

The Amber Model 5500 is optionally provided with an asynch serial port which may be used to monitor the status of the instrument and to send it control information. The most common use of this feature is to view the instrument status on a video terminal but it may also be used to operate the instrument from a host computer. For the latter application it will be necessary to extract the desired information from the output data stream. All of the data messages have a "lead-in" sequence which is used to position the cursor on a specific type of CRT (Lear Siegler ADM5 or Qume QVT 102), but may be used to identify a particular message. The actual data messages are preceded by a title or header which is useful for viewing on a "live" CRT but is of little use when connected to a host computer. In general, it will be possible to monitor the output data stream and synchronize string matches to the occurrence of the first two characters in any lead-in sequence (i.e., hex - 1B, 3D). The data may be identified by the two characters which follow these universal ones.

It is important to note that the instrument does not automatically output information to the serial port. Invoking special function 38.1 will enable the output data stream and 38.0 will disable it. At any time that this special function is called, the instrument will send a "clear screen" character (i.e., hex - 1A). Also note that the command input characters are echoed back to the host but the instrument will precede them with a lead-in sequence that would have them appear at the appropriate place on the command line. Thus some care must be taken to avoid interpreting these echoed characters as data. In general, the software will accept upper and lower case alpha characters on the command line but will only output upper case except when echoing input. The command line is carriage return driven so that it is possible to use the backspace key for rudimentary editing. The command line processor will not clear the line after entry to allow the user to view the last entry. If the previous entry was longer than the present one, some spurious characters will appear to follow it on the line. These characters will not be recognized by the software and can safely be ignored.

The additional burden imposed on the software by the serial output routines will slow the instrument down by approximately 50% in typical usage, more if large amounts of data are being transmitted. As mentioned in the hardware description of the serial interface, the system does not recognize the use of RTS or DTR to hold off input but uses the standard Xon-Xoff protocol to allow the host to throttle the output data stream. It will itself use this mechanism to avoid allowing the host to overrun the serial port input buffer. This means that the host must also support the protocol bidirectional. If the serial port is held off for a significant percentage of the time while the output is enabled, the instrument will appear to behave sluggishly and if the Xoff character is sent without being released by an Xon, the whole instrument will appear to stop. Sending the required Xon character at this point will generally restore proper operation.

The output of information to the serial port may be enabled or disabled from the front panel via the **SERIAL INTERFACE** key. If the serial port screen is currently enabled, closure of this key will clear the screen and disable the output data stream. If the serial port screen is currently disabled, closure of the **SERIAL INTERFACE** key will update the screen and enable the output data stream.

3.9.2 SERIAL PORT PARAMETERS

The serial port defaults to the following conditions on instrument power-up:

Baud rate - 9600
Data Bits - 8
Stop Bits - 1
Parity - none
Handshake - XOn-Xoff

While the above conditions are fixed in the 5500 internal firmware, the baud rate may be modified by the user (see below). Additionally, the rear panel interface module may be configured to be either DTE or DCE, conditional on the installation of jumpers as defined below.

3.9.3 AUTOMATIC BAUD RATE SETTING INFORMATION

Although the 5500 serial port is only specific for operation at 9600 baud, it is possible under certain circumstances to have it operate at certain other baud rates. If the software detects a received break condition it will attempt to adjust the 5500 baud rate to conform with that of the remote serial device. The algorithm used will not attempt to change the baud rate until three successive break conditions have been detected, and then will cycle through its allowed baud rates on successive breaks until a confirmation is received. The software will set a new baud rate and output the string (enter carriage return to confirm baud rate), and wait for a response. If the received character is indeed a carriage return, the baud rate is fixed at a current value and control is returned to the applications program; any other response will cause it to try another baud rate. The allowed baud rates are as follows: 300, 600, 1200, 2400, 4800, 9600, 19.2 k.

Note that the default conditions, including the 9600 baud rate, are restored at instrument power-up. If an alternate baud rate is required, the above procedure must be followed after each power-up.

3.9.4 SERIAL PORT OUTPUT DATA FORMAT

All lead-in data in hexadecimal

The following information is organized in the same order that the commands are listed in the first sections of the manual where possible.

Function: Input select
Header String: INSEL:
Header Lead-in: 1B, 3D, 21, 20
Data: A, B, AOUT, or BOUT
Data Lead-in: 1B, 3D, 22, 20
References: 3.2.1

Function: Input termination
Header String: INPZ:
Header Lead-in: 1B, 3D, 30, 48
Data: HIZ, 150, 600
Data Lead-in: 1B, 3D, 31, 48
References: 3.2.2, 3.4.1 and 3.5.6

Function: PGA operating mode
Header String: PGAMD:
Header Lead-in: 1B, 3D, 21, 28
Data: AUTO or HOLD
Data Lead-in: 1B, 3D, 22, 28
References: 3.2.5, 3.2.3 and 3.2.4

Function: PGA status
Header String: PGASTS:
Header Lead-in: 1B, 3D, 21, 30
Data: -30 DB to +35 DB (in 5 dB steps)
Data Lead-in: 1B, 3D, 22, 30
References: 3.2.5, 3.2.3 and 3.2.4

Function: PGB operating mode
Header String: PGBMD:
Header Lead-in: 1B, 3D, 21, 58
Data: AUTO or HOLD
Data Lead-in: 1B, 3D, 22, 58
References: 3.2.6, 3.2.3 and 3.2.4

Function: PGB status
Header String: PGBSTS:
Header Lead-in: 1B, 3D, 21, 60
Data: 0 DB to +80 DB (in 20 dB steps)
Data Lead-in: 1B, 3D, 22, 60
References: 3.2.6, 3.2.3 and 3.2.4

Function: Programmed SVF frequency
Header String: SVFFRQ:
Header Lead-in: 1B, 3D, 21, 38
Data: 9.5000 HZ to 105.00 KHZ
Data Lead-in: 1B, 3D, 22, 38
References: 3.2.7, 3.2.9, 3.3.1 and 3.4.3

Function: Programmed SVF frequency increment
Header String: SVFINC:
Header Lead-in: 1B, 3D, 27, 60
Data: 0.0000 HZ to 100.00 KHZ (or 0 % to many %)
Data Lead-in: 1B, 3D, 28, 60
References: 3.2.8

Function: SVF tuning mode
Header String: TUNMD:
Header Lead-in: 1B, 3D, 24, 58
Data: AUTO or HOLD
Data Lead-in: 1B, 3D, 25, 58
References: 3.2.9, 3.2.3, 3.2.4 and 3.3.1

Function: Servo status
Header String: SERVO:
Header Lead-in: 1B, 3D, 21, 48
Data: OFF or ON
Data Lead-in: 1B, 3D, 22, 48
References: 3.2.9 and 3.3.1

Function: Weighting filter selected
Header String: FILSEL:
Header Lead-in: 1B, 3D, 21, 68
Data: OFF,30K,80K,SPCL,SP0,SP1,SP2,SP3
Data Lead-in: 1B, 3D, 22, 68
References: 3.2.10

Function: High pass filter state
Header String: HPFIL:
Header Lead-in: 1B, 3D, 24, 20
Data: OFF or ON
Data Lead-in: 1B, 3D, 25, 20
References: 3.2.11

Function: PGC operating mode
Header String: PGCMD:
Header Lead-in: 1B, 3D, 24, 30
Data: AUTO or HOLD
Data Lead-in: 1B, 3D, 25, 30
References: 3.2.12, 3.2.3 and 3.2.4

Function: PGC status
Header String: PGCSTS:
Header Lead-in: 1B, 3D, 24, 38
Data: 0 DB to 20 DB (in 10 dB steps)
Data Lead-in: 1B, 3D, 25, 38
References: 3.2.12, 3.2.3 and 3.2.4

Function: Detector type
Header String: DETSEL:
Header Lead-in: 1B, 3D, 24, 40
Data: RMS,AVE,QPK
Data Lead-in: 1B, 3D, 25, 40
References: 3.2.13

Function: Detector speed (RMS)
Header String: DETSPD:
Header Lead-in: 1B, 3D, 24, 48
Data: VFAST,FAST,SLOW,VSLOW
Data Lead-in: 1B, 3D, 25, 48
References: 3.2.14, 3.2.3 and 3.2.4

Function: Detector operating mode (RMS)
Header String: DETMD:
Header Lead-in: 1B, 3D, 24, 50
Data: AUTO or HOLD
Data Lead-in: 1B, 3D, 25, 50
References: 3.2.14, 3.2.3 and 3.2.4

Function: Measurement type
Header String: AMPMSM:
Header Lead-in: 1B, 3D, 21, 50
Data: WB,BPVW,BPW,BPM,BPN,HP,LP,THD,THDL,CCIF,SMPTE
Data Lead-in: 1B, 3D, 22, 50
References: 3.3.1

Function: Measurement mode
Header String: MSMODE:
Header Lead-in: 1B, 3D, 2D, 28
Data: RUN,HOLD,TRIG,TRIGWS
Data Lead-in: 1B, 3D, 2E, 28
References: 3.3.2

Function: Measurement sync
Header String: FRQMSM:
Header Lead-in: 1B, 3D, 24, 60
Data: IN or OSC
Data Lead-in: 1B, 3D, 25, 60
References: 3.3.1, 3.10.1 to 3.10.7

Function: Programmed source amplitude
Header String: SRCAMP:
Header Lead-in: 1B, 3D, 27, 20
Data: 0.0000 V to 33.000 V or dBV or dBm equiv.
Data Lead-in: 1B, 3D, 28, 20
References: 3.4.1, 3.5.6, 3.2.2 and 3.4.9

Function: Programmed source amplitude increment
Header String: AMPINC:
Header Lead-in: 1B, 3D, 27, 40
Data: 0.0000 V to 33.000 V (or % or dB)
Data Lead-in: 1B, 3D, 28, 40
References: 3.4.2, 3.5.6 and 3.2.2

Function: Programmed source frequency
Header String: SRCFRQ:
Header Lead-in: 1B, 3D, 27, 30
Data: 10.000 HZ to 100.00 KHZ
Data Lead-in: 1B, 3D, 28. 30
References: 3.4.3, 3.3.1 and 3.2.7

Function: Programmed source frequency increment
Header String: FRQINC:
Header Lead-in: 1B, 3D, 27, 50
Data: 0.0000 HZ to 100.00 KHZ (or 0 % to many %)
Data Lead-in: 1B, 3D, 28, 50
References: 3.4.4

Function: Programmed IMD offset frequency
Header String: IMFREQ:
Header Lead-in: 1B, 3D, 30, 38
Data: 40 HZ to 500 HZ (at specified steps)
Data Lead-in: 1B, 3D, 31, 38
References: 3.4.5 and 3.3.1

Function: Programmed IMD mix ratio
Header String: IMDRAT:
Header Lead-in: 1B, 3D, 24, 28
Data: 1:1,1:2,1:4,1:10
Data Lead-in: 1B, 3D, 25, 28
References: 3.4.6 and 3.3.1

Function: Output enable
Header String: OUTPUT:
Header Lead-in: 1B, 3D, 30, 20
Data: OFF or ON
Data Lead-in: 1B, 3D, 31, 20
References: 3.4.7

Function: Output reference
Header String: OUTREF:
Header Lead-in: 1B, 3D, 30, 28
Data: GROUND,FLOAT
Data Lead-in: 1B, 3D, 31, 28
References: 3.4.8

Function: Output structure and impedance
Header String: OUTSTS:
Header Lead-in: 1B, 3D, 30, 30
Data: IMP600,IMP150,IMP50
Data Lead-in: 1B, 3D, 31, 30
References: 3.4.9 and 3.4.1

Function: Output load impedance reference, level
Header String: OIRL:
Header Lead-in: 1B, 3D, 30, 50
Data: 1 OHM to 9999 OHM
Data Lead-in: 1B, 3D, 31, 50
References: 3.4.10

Function: Output load impedance reference, power
Header String: OIRP:
Header Lead-in: 1B, 3D, 30, 60
Data: 1 OHM to 9999 OHM
Data Lead-in: 1B, 3D, 31, 60
References: 3.4.10

Function: Output configuration
Header String: OUTCNF:
Header Lead-in: 1B, 3D, 2D, 60
Data: A, B, A & B, or A& -B
Data Lead-in: 1B, 3D, 2E, 60
References: 3.4.11

Function: Relative mode
Header String: RATIO:
Header Lead-in: 1B, 3D, 2D, 30
Data: OFF or ON
Data Lead-in: 1B, 3D, 2E, 30
References: 3.5.1 and 3.5.2

Function: Distortion ratio reference
Header String: DSTREF:
Header Lead-in: 1B, 3D, 2A, 40
Data: 0 % to many % (or log equivalent)
Data Lead-in: 1B, 3D, 2B, 40
References: 3.5.2 and 3.5.1

Function: Level ratio reference
Header String: LVLREF:
Header Lead-in: 1B, 3D, 2A, 50
Data: 0.0000 V to many V (or dBv or dBm equivalent)
Data Lead-in: 1B, 3D, 2B, 50
References: 3.5.2 and 3.5.1

Function: Amplitude units operating mode
Header String: AUNITS:
Header Lead-in: 1B, 3D, 2A, 60
Data: FLOAT or FIXED
Data Lead-in: 1B, 3D, 2B, 60
References: 3.5.4

Function: Amplitude units decimal point mode
Header String: ADPNT:
Header Lead-in: 1B, 3D, 2A, 68
Data: FLOAT or FIXED
Data Lead-in: 1B, 3D, 2B, 68
References: 3.5.5

Function: Watts reference impedance
Header String: WTSIMP:
Header Lead-in: 1B, 3D, 2A, 20
Data: 0 OHM to 999 OHM
Data Lead-in: 1B, 3D, 2B, 20
References: 3.5.6

Function: dBm reference impedance
Header String: DBMIMP:
Header Lead-in: 1B, 3D, 2A,30
Data: 0 OHM to 999 OHM
Data Lead-in: 1B, 3D, 2B, 30
References: 3.5.6, 3.2.2 and 3.4.1

Function: Frequency display decimal point mode
Header String: FDPNT:
Header Lead-in: 1B, 3D, 2D, 20
Data: FLOAT or FIXED
Data Lead-in: 1B, 3D, 2E, 20
References: 3.5.7

Function: Numeric entry mode
Header String: NMODE:
Header Lead-in: 1B, 3D, 2D, 38
Data: SRCAMP, SRCFRQ, IMFREQ, REF, AMPINC, FRQINC
Data Lead-in: 1B, 3D, 2E, 38
References: 3.4.1, 3.4.2, 3.4.3, 3.4.4, 3.4.5, 3.5.2

Function: Front panel status (re: GPIB)
Header String: FPANEL:
Header Lead-in: 1B, 3D, 2D, 40
Data: LOCS, LWLS, REMS, RWLS
Data Lead-in: 1B, 3D, 2E, 40
References: 3.8.1 and 3.8.2

Function: Display selected for GPIB read
Header String: GPREAD:
Header Lead-in: 1B, 3D, 2D, 48
Data: LEFT or RIGHT
Data Lead-in: 1B, 3D, 2E, 48
References: 3.8.5 and 3.8.1

Function: Conditions to set SRQ on GPIB
Header String: SRQST:
Header Lead-in: 1B, 3D, 2D, 50
Data: GPERR,DRDY,FTLERR
Data Lead-in: 1B, 3D, 2E, 50
References: 3.8.6 and 3.8.1

Function: GPIB configuration
Header String: GPIBST:
Header Lead-in: 1B, 3D, 2E, 58
Data: 1-0 to 3-31
Data Lead-in: 1B, 3D, 2D, 58
References: 3.8.7, 3.8.1

Function: DC scale
Header String: DCSCL:
Header Lead-in: 1B, 3D, 24, 68
Data: 100V, 10V, 1V
Data Lead-in: 1B, 3D, 25, 68
References: X.2.17, X.3.4

Function: Phase scale
Header String: PZSCL:
Header Lead-in: 1B, 3D, 2D, 68
Data: ±180 or 0-360
Data Lead-in: 1B, 3D, 2E, 68
References: X.2.17, X.3.5

Function: DC Volts & Phase measurement
Header String: DCMODE:
Header Lead-in: 1B, 3D, 33,68
Data: OFF, DC, or PZ
Data Lead-in: 1B, 3D, 34, 68
References: X.3.4

Function: Last measured amplitude or distortion
Header String: AMP:
Header Lead-in: 1B, 3D, 33, 20
Data: actual data
Data Lead-in: 1B, 3D, 34, 20
References:

Function: Last measured frequency
Header String: FRO:
Header Lead-in: 1B, 3D, 33, 30
Data: actual data
Data Lead-in: 1B, 3D, 34, 30
References:

Function: Amplitude or distortion measurement status
Header String: AMPSTS:
Header Lead-in: 1B, 3D, 33, 40
Data: if no error or exception, null, else error number
Data Lead-in: 1B, 3D, 34, 40
References: see error and exception definitions

Function: Frequency measurement status
Header String: FRQSTS:
Header Lead-in: 1B, 3D, 33, 48
Data: if no error or exception, null, else error number
Data Lead-in: 1B, 3D, 34, 48
References: see error and exception definitions

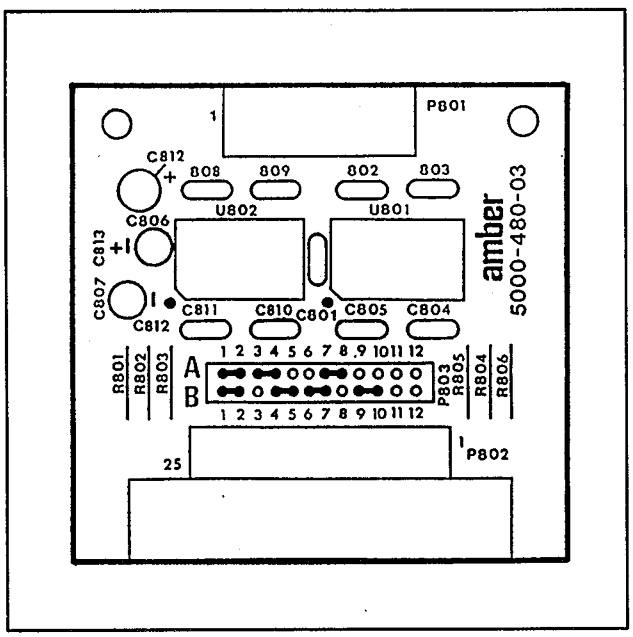
Function: Fatal error status
Header String: FLTERR:
Header Lead-in: 1B, 3D, 33, 50
Data: if no error, null, else error number
Data Lead-in: 1B, 3D, 34, 50
References: see error and exception definitions

Function: Input prompt
Header String: ENTER:
Header Lead-in: 1B, 3D, 36, 20
Data: echoes input characters
Data Lead-in: 1B, 3D, 36, 27-40
References: see command definitions

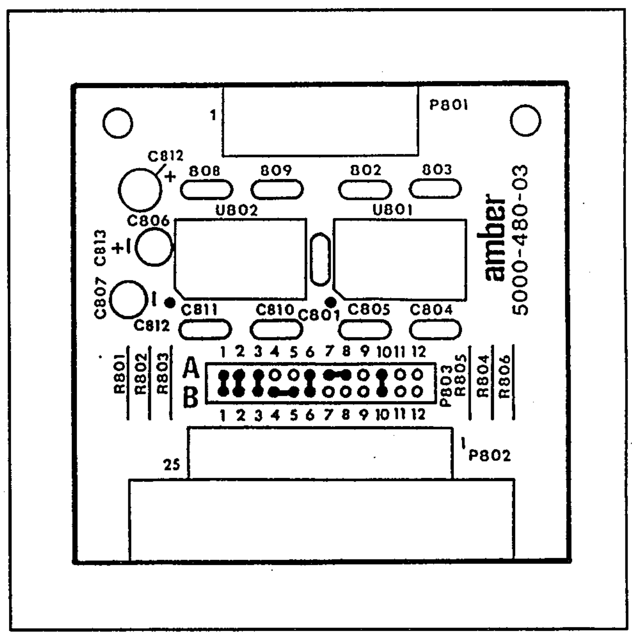
3.9.5 CONFIGURATION JUMPERS FOR RS 232-C INTERFACE BOARD

The serial interface board can be configured to act as either DTE or DCE. The current implementation of the device driver will set those control lines which an external device may require but ignore the lack of return control signals from an external device. Thus an external device cannot expect to hold off input by (illegally) forcing DTR to a false state as is done by some printers. The correct method for holding off input is by using the Xon-Xoff protocol, which is completely supported by the driver. The standard configurations for the serial port (P2 on the CPU) is as DCE. If the system must communicate with another which is also configured as DCE, it is simple to reconfigure the jumpers on the board to act as DTE.

The following diagrams represent the component side view of the interface board viewed with the external DB-25 connector down and show the jumpers that are usually installed on the 24 pin header.



Configured as DCE



Configured as DTE

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3.10 ERROR DEFINITIONS

3.10.1 MEASUREMENT EXCEPTIONS

Exceptions indicate any of a number of largely transitory conditions that can occur during measurement which cause it to be aborted. They are non-fatal in that they don't inhibit measurement and are automatically cleared by subsequent measurements. Exception occurrences are counted. In the case of auto-ranging exceptions, if consecutive measurements are aborted due to both over and under range conditions, and 3 over range exceptions as well as 3 under range exceptions have been counted, the exception counters are cleared and measurement error 24 is generated. In the case of exception 17, after 3 consecutive occurrences, measurement error 25 will be generated and the exception counters cleared. Note that any time instrument status is modified, the exception counters are cleared.

SERIAL PORT ANNUNCIATION

Exception codes are always displayed under AMPSTS along with the incomplete amplitude or distortion readings (under AMP) produced by the aborted measurement.

GPIB ANNUNCIATION

If the instrument is enabled to send amplitude or distortion results over the GPIB interface and measurement is aborted due to an exception, the exception code, in standard GPIB error format, will be sent instead of amplitude or distortion readings. If the SRQ "data available" condition is enabled, a request for service is issued and the status byte's data available bit is set.

FRONT PANEL ANNUNCIATION

Exception codes are not displayed on the front panel. On the first three occurrences of a particular exception, the front panel amplitude display will not be updated; subsequent occurrences will cause dashes to be displayed.

EXCEPTION CODES

11 Signal at PGAout over range:
PGA gain decremented

12 Signal at PGAout under range:
PGA gain incremented

13 Signal at PGBout over range:
PGB gain decremented

14 Signal at PGBout under range:
PGB gain incremented

15 Signal at PGCout over range:
PGC gain decremented

16 Signal at PGCout under range:
PGC gain incremented

17 SVF not tuned to input signal:
SVF frequency adjusted

If PGA, PGB, PGC or SVF tuning operating modes are not auto or if gain settings are at their minimum or maximum level and can't be further adjusted, the corresponding exceptions won't be generated although a number of measurement errors may (see 3.10.2 below). For a more detailed description of the conditions under which these exceptions will be generated, refer to the individual measurement descriptions in Section 3.10.

3.10.2 MEASUREMENT ERRORS

As with measurement exceptions, measurement errors indicate any of a number of conditions that can occur during measurement which cause it to be aborted. The conditions that generate these errors are not generally considered transient and will, if they persist, cause the instrument to enter a fatal error state. Measurement errors are initially non-fatal, i.e. they are automatically cleared by subsequent measurements. If, however, 128 consecutive measurements are aborted due to the same error, it becomes fatal and further measurement is inhibited until the error is cleared. If at any time instrument status is altered, the measurement error count is automatically reset to 0. A fatal error condition may be cleared by the CLEAR command (refer to 3.6.1); once cleared, the instrument will resume measurement.

SERIAL PORT ANNUNCIATION (requires option 232)

If the error is non-fatal, the error code is always displayed under AMPSTS along with the incomplete amplitude or distortion readings (under AMP); if the error is fatal, the error code is displayed under FTLERR.

GPIB ANNUNCIATION

If the instrument is enabled to send amplitude or distortion results over the GPIB interface and a non-fatal measurement error is generated, the error code, in standard GPIB error format, will be sent instead of amplitude or distortion readings. A fatal error, regardless of which display is selected for reading to the GPIB, will always be sent if the instrument is enabled to send data. If the SRQ "data available" condition is enabled and a non-fatal error occurs, a request for service will be issued and the data available bit of the status byte set; if a fatal error occurs, SRQ will be issued if the SRQ "fatal error" condition is enabled and in this case, the fatal error bit of the status byte will be set.

FRONT PANEL ANNUNCIATION

The first three occurrences of a non-fatal error will cause dashes to be displayed on the appropriate front panel display. The actual error code will be displayed on subsequent occurrences. In the case of fatal measurement error, the error code will be displayed on both front panel displays.

MEASUREMENT ERROR CODES

Error 20 Signal at PGAout over range and PGA gain/attenuation level can't be adjusted, either because PGA operating mode is in hold or the attenuation level is already at its maximum setting. This error will occur during distortion type measurement, and during BP level type measurement if SVF tuning is enabled, when the signal at PGAout is either over range or significantly over range. During level type measurements, if SVF tuning is disabled, this error will occur only if the signal at PGAout is significantly over range.

Error 21 Signal at PGAout under range and PGA gain/attenuation level can't be adjusted, either because PGA operating mode is in hold or the current gain level is already at its maximum setting. This error will only occur during distortion type measurement, and during BP level type measurement if SVF tuning is enabled, if the signal at PGAout is either over range or significantly over range.

Error 22 Signal at PGBout over range and PGB gain level can't be adjusted either because PGB operating mode is in hold or current PGB gain level is already at its minimum setting. This error occurs only if the signal at PGBout is significantly over range.

Error 24 Signal at PGCout over range and PGC gain level can't be adjusted either because PGC operating mode is in hold or current PGC gain level is already at its minimum setting. This error occurs only if the signal at PGCout is significantly over range.

Error 26 Signal frequency is out of range. This error will occur only during THD or BP type measurement if SVF tuning is enabled and the sampled signal frequency is outside the range of 9.5 Hz and 105 kHz.

Error 27 Can't tune SVF due to lack of frequency reading. Again this error will only occur during THD or BP type measurement if SVF tuning is enabled. It is generated if frequency measurement of the signal at PGAout with the sampling interval set to 10 ms is still incomplete after a 250 ms interval.

Error 28 Can't measure distortion due to lack of hardware sync'd amplitude reading of the signal at PGAout or, in the case of IMD* type measurement, the signal chosen for sync (either recovered LF or LF oscillator) is not available. This error will be generated if the hardware sync'd amplitude measurement with the sampling interval set to 10 ms is still incomplete after 250 ms.

Error 29 IMD* mix mismatch. This error will only be generated during IMD SMPTE type measurement if the sampled signal at the recovered HF is outside the range of 1 to 4 V.
*IMD Function requires option 002.

Error 30 Level calculation overflow. This error indicates that an overflow condition was detected at measurement time either during auto-ranging or level reading but prior to any distortion or display calculations. May also be caused by DC inputs too negative.

***IMD Function requires option 002.**

Error 31 Can't tune SVF due to frequency counter overflow. This error will only occur during THD or BP type measurement if SVF tuning is enabled. It is generated if an overflow condition is detected during frequency measurement of the signal at PGAout with the sampling interval set to 10 ms.

Error 32 DC level calculation overflow. Caused by DC inputs too positive. (Requires option 008.)

Error 34 Can't auto-range due to instability of input signal. This error will be generated if consecutive attempts at auto-ranging vacillate between under range and over range. Refer to 3.10.1 for a more precise description of the conditions under which this error will be generated.

Error 35 Can't tune SVF due to instability of input signal. This error will be generated if the SVF frequency is still not tuned to signal frequency, at PGAout, after 3 consecutive attempts to tune the filter. Refer to 3.10.1 for additional mention.

Error 37 Level calculation underflow. This error indicates that zero results or an underflow condition was detected at measurement time either during auto-ranging or level reading but prior to any distortion or display calculations.

Error 38 Distortion calculation underflow. This error can only occur if the low resolution reading of the signal amplitude at PGAout returns a zero or underflow result.

Error 39 Ratio calculation underflow. This error may be produced by an underflow error returned by the math package when calculating the ratio from level or distortion to the reference value.

Error 40 Ratio calculation overflow. This error may be produced by an overflow error returned by the math package when calculating the ratio from level or distortion to the reference value.

Error 41 Distortion calculation overflow. This error can only occur if, after auto-ranging is completed, the hi resolution reading of the signal amplitude at the selected detector returns a zero or underflow result.

Error 42 Level/distortion display overflow. This error indicates that measurement data doesn't fit the current display format and will only occur if amplitude units or decimal point position are being held.

Error 44 Measurement readings lost. This error indicates that low level hardware sync'd or software sync'd measurement data has been lost and measurement must be restarted.

Error 47 Can't get frequency reading. This error will occur if the hi resolution frequency reading with sampling interval specified at 50 ms is still incomplete after 250 ms.

Error 49 Frequency calculation overflow. This error will occur at measurement time if the hi resolution frequency reading, with sampling interval set to 50 ms, overflows.

Error 50 Frequency display overflow. This error indicates that frequency measurement data doesn't fit the current display format and will only occur if decimal point position is being held.

Note that display underflow will not generate an error. If measurement data doesn't fit the current display format because units or decimal point position is being held, 0.0 will be displayed.

Error 60 AUTOCAL failure. Indicates a hardware failure preventing the successful completion of an automatic calibrate sequence.

Error 99 ROM failure. This indicates a failure to complete the self- check sequence at instrument power-up.

3.10.3 COMMAND INPUT ERRORS

Input errors indicate invalid input command mnemonics, operands and numeric string entry. They are always fatal, i.e. measurement will be inhibited until the error is cleared via a CLEAR command (refer to 3.6.1).

SERIAL PORT ANNUNCIATION

The error code is always displayed under FTLERR.

GPIB ANNUNCIATION

A fatal error, regardless of which display is selected for reading to the GPIB, will always be sent if the instrument is enabled to send data. If the SRQ "fatal error" condition is enabled, a request for service will be issued and the fatal error bit of the status byte set.

FRONT PANEL ANNUNCIATION

The error code will be displayed on both front panel displays.

INPUT ERROR CODES

1 Invalid special function suffix

2 Unrecognized command

3 Invalid string character

4 Invalid numeric string

5 Invalid terminator

6 Invalid command operand

7 Operand out of range

8 Invalid special function prefix

9 GPIB input code error

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3.11 TABLES

3.11.1 SERIAL PORT COMMANDS

MNEMONIC	DESCRIPTION	REFERENCES
AMPFRMT	Select amplitude display units	3.5.4
AMPINC	Select source amplitude increment	3.4.2
AMPMSM	Select measurement type	3.3.1
AMPUNIT	Select amplitude display units	3.5.3, 3.5.4
AUTO	Select automatic operation	3.2.3
CLEAR	Clear front panel displays or trigger measurement in hold or triggered mode	3.6.1, 3.8.4
DBMIMP	Select dBm impedance reference	3.5.6
DC	DC Volts measurement mode	3.2.16
DETSEL	Select detectors	3.2.13
DETSPD	Select detector speed	3.2.14
DOWN	Decrement currently selected parameter	3.1.5
DUP	Set currently selected parameter to last measurement result	3.1.5
FILSEL	Select weighting filters	3.2.10
FRQDPNT	Select frequency display decimal point position	3.5.7
FRQINC	Select source frequency increment	3.4.4

MNEMONIC	DESCRIPTION	REFERENCES
FRQMSM	Select measurement synch	3.3.3
HOLD	Select hold settings operating mode	3.2.4
HPFIL	Enable or disable high pass filter	3.2.11
IMFREQ	Select IMD offset frequency	3.1.5, 3.4.5
INPZSEL	Select input termination	3.2.2
INSEL	Select input source	3.2.1
LIN	Select linear amplitude display units	3.5.3
LOG	Select log amplitude display units	3.5.3
OUTCNF	Select output configuration	3.4.11
OUTENBL	Enable or disable output	3.4.7
OUTIMP	Select output structure	3.4.9
OUTREF	Select output reference	3.4.8
PGA	Select PGA operating mode and level	3.2.5
PGB	Select PGB operating mode and level	3.2.6
PGC	Select PGC operating mode and level	3.2.12
PZ	Phase measurement mode	3.2.19
RATIO	Enable or disable relative mode, select reference	3.5.1, 3.5.2
RECDFLT	Recall default machine state	3.7.3
RECFULL	Recall full machine state	3.7.3
RECPART	Recall partial machine state	3.7.2

MNEMONIC	DESCRIPTION	REFERENCES
REF	Select relative reference	3.1.5, 3.5.2
SRCAMP	Select source amplitude	3.1.5, 3.4.1
SRCFRQ	Select source frequency	3.1.5, 3.4.3
STORE	Store full machine state	3.7.1
SVFINC	Select SVF frequency increment	3.1.5, 3.2.8
SVFFRQ	Select SVF frequency	3.1.5, 3.2.7
TRACK	Select SVF tuning mode for BP type measurement	3.2.9
TUNE	Select SVF tuning mode for THD type measurement	3.2.9
UP	Increment currently selected parameter	3.1.5
WTSIMP	Select Watts impedance reference	3.5.6

3.11.2 GPIB COMMANDS

MNEMONIC	DESCRIPTION	REFERENCES
AN	Select source amplitude increment	3.1.5, 3.4.2
AP	Select source amplitude	3.1.5, 3.4.1
AU	Select automatic operation	3.2.3
BM	Select dBm amplitude display units	3.5.3, 3.5.4
BO	Select input, B output (requires option 007)	3.2.1
BV	Select dBV amplitude display units	3.5.3, 3.5.4
C0	Select A only output configuration	3.4.11
C1	Select B only output configuration (requires option 007)	3.4.11
C2	Select A & B output configuration (requires option 007)	3.4.11
C3	Select A & -B output configuration (requires option 007)	3.4.11
CL	Clear displays, trigger measurement for hold or trigger measurement modes	3.6.1, 3.8.4
D0	Select RMS detector	3.2.13
D1	Select Absolute Value detector	3.2.13
D2	Select Quasi-peak detector	3.2.13
DC	Enable DC Volts measurement (requires option 008)	3.2.16
DN	Decrement currently selected parameter	3.1.5
FI	Select input measurement sync	3.3.3

MNEMONIC	DESCRIPTION	REFERENCES
FN	Select source frequency increment	3.1.5, 3.4.4
FO	Select main oscillator measurement sync	3.3.3
FR	Select source frequency	3.1.5, 3.4.3
H0	Enable high pass filter	3.2.11
H1	Disable high pass filter	3.2.11
IA	Select input A	3.2.1
IB	Select input B	3.2.1
IF	Select IMD offset frequency (requires 002)	3.4.5
IO	Select input, A output	3.2.1
L0	Disable weighting filters	3.2.10
L1	Enable 30k LP filter	3.2.10
L2	Enable 80k LP filter	3.2.10
L3	Enable SPCL filter	3.2.10
L4	Enable Auxiliary Filter 1 (requires option 005 or 006)	3.2.10
L5	Enable Auxiliary Filter 2 (requires option 005 or 006)	3.2.10
L6	Enable Auxiliary Filter 3 (requires option 005 or 006)	3.2.10
L7	Enable Auxiliary Filter 4 (requires option 005 or 006)	3.2.10
LG	Select log amplitude display units	3.5.3

MNEMONIC	DESCRIPTION	REFERENCES
LN	Select linear amplitude display units	3.5.3
M1	Select wide band level measurement type	3.3.1
M3	Select THD level measurement type	3.3.1
M4	Select very wide BP level measurement type	3.3.1
M5	Select wide BP level measurement type	3.3.1
M6	Select medium BP level measurement type	3.3.1
M7	Select narrow BP level measurement type	3.3.1
M8	Select HP level measurement type	3.3.1
M9	Select LP level measurement type	3.3.1
O0	Disable output	3.4.7
O1	Enable output	3.4.7
OG	Select ground output reference	3.4.8
OF	Select floating output reference	3.4.8
P0	Select balanced 600 Ohms output impedance	3.4.9
P1	Select balanced 150 Ohms output impedance	3.4.9
P2	Select unbalanced 50 Ohms output impedance	3.4.9
PZ	Enable Phase measurement (requires option 009)	3.2.19
R0	Disable relative mode	3.5.1
R1	Enable relative, use currently selected reference	3.5.1, 3.5.2
RC	Recall Instrument Setup	3.7.2, 3.7.3
RE	Select relative mode reference	3.1.5, 3.5.2

MNEMONIC	DESCRIPTION	REFERENCES
RL	Output frequency display measurement data to GPIB	3.8.5
RR	Output amplitude display measurement data to GPIB	3.8.5
S3	Select THD measurement	3.3.1
S4	Select IMD CCIF distortion measurement (requires option 002)	3.3.1
S5	Select IMD SMPTE distortion measurement (requires option 002)	3.3.1
SF	Select SVF frequency	3.1.5, 3.2.7
SN	Select SVF frequency increment	3.1.5, 3.2.8
SP	Special Function	3.1.4
ST	Store Instrument Setup	3.7.1
T0	Select free-run measurement mode	3.3.2
T1	Select hold measurement mode	3.3.2
T2	Select trigger immediate measurement mode	3.3.2
T3	Select trigger with settling measurement mode	3.3.2
UP	Increment currently selected parameter	3.1.5
VO	Select V amplitude display units	3.5.3, 3.5.4
WA	Select W amplitude display units	3.5.3, 3.5.4
Z0	Select 100k Ohms input termination	3.2.2
Z1	Select 150 Ohms input termination	3.2.2
Z2	Select 600 Ohms input termination	3.2.2

3.11.3 SPECIAL FUNCTIONS

#	DESCRIPTION	REFERENCES
1	Select PGA operating mode and level	3.2.5
2	Select DC range	3.2.17
3	Select PGB operating mode and level	3.2.6
4	Select level output load impedance reference	3.4.10
5	Select power output load impedance reference	3.4.10
6	Select SVF tuning mode re: THD measurement	3.2.9
7	Sweep functions	See 054 manual
8	Select phase scale (requires option 009)	3.2.20
9	Enable automatic or hold settings operating modes	3.2.3, 3.2.4
10	Display main source settings	3.6.3
11	Enable or disable relative mode, select or display relative references	3.5.1 3.6.3
12	Special source processing	See option 003
13	Oscillator fine tune	3.4.3
14	Power amp source select	3.4.12
15	Special option path select	See 054 manual
16	Special option DATA	See 054 manual
17	Future option	NA
18	Future option	NA
19	Future option	NA

#	DESCRIPTION	REFERENCES
20	Select left or right front panel display for output to GPIB	3.8.5
21	Display GPIB status	3.6.3, 3.8.7
22	Select GPIB SRQ conditions	3.8.6
23	Select power up machine state	3.7.4
24	Auto calibrate	3.2.15
25	Select or display Watts impedance reference	3.5.6
26	Select or display dBm impedance reference	3.5.6
27	Select PGC operating mode and level	3.2.12
28	Select SVF tracking mode re: BP measurement	3.2.9
29	Select detector speed operating mode and speed	3.2.14
30	Select amplitude display units operating mode and display units	3.5.3, 3.5.4
31	Select amplitude display decimal point position operating mode and position	3.5.5
32	Select frequency display decimal point position operating mode and position	3.5.7
33	Reconfigure GPIB address	3.8.7
34	Reconfigure GPIB talk and listen status	3.8.7
35	Select IMD mix ratio	3.4.6
36	Enable THD level type measurement	3.3.1
37	Select measurement sync	3.3.3
38	Enable or disable serial port screen display	3.9.1

#	DESCRIPTION	REFERENCES
85	DC feedback control	3.2.18
86	Utility DAC A	3.4.13
87	Utility DAC B	3.4.13
88	DC relay multiplexer	3.4.14
89	DC digital utility	3.4.15

3.11.4 DEFAULT STATES

PARAMETER	DEFAULT STATE
Detector Speed	SLOW
Detector Selected	RMS
HP Filter	OFF
Weighting Filters	OFF
Input Selected	A
Servo	OFF
PGA Gain/Attenuation	-35 dB
PGB Gain	0 dB
PGC Gain	0 dB
Input Termination	100 k Ohms
Output A	OFF
Output Reference	GROUND
Output Structure	600 Ohms (BAL)
Programmed Source Amplitude Units	V
Ouput Load Impedance Reference, Level	INFINITY
Ouput Load Impedance Reference, Power	600 Ohm
Source Amplitude	0.0 V
Source Frequency	1.0 kHz
SVF Frequency	1.0 kHz
IMD Offset Frequency	60 Hz
Distortion Reference	100.0 %
Level Reference	1.0 V
Source Amplitude Increment	1.0 V
Source Frequency Increment	1.0 Hz
SVF Frequency Increment	1.0 Hz
dBm Impedance	600 Ohms
Watts Impedance	8 Ohms
Operating Mode	AUTO
Amplitude Display Units	V
Amplitude Display Decimal Point Position	DDD.DD
Frequency Display Units	Hz

PARAMETER	DEFAULT STATE
Frequency Display Decimal Point Position	DDD.DD
Frequency Measurement Source	INPUT
Narrow Band Measurement Type	VERY WIDE BP
Front Panel Special Amplitude Display	OFF
Front Panel Special Frequency Display	OFF
Amplitude Display Units Operating Mode	FLOATING
Amplitude Display Decimal Operating Mode	FLOATING
Frequency Display Decimal Operating Mode	FLOATING
PGA Operating Mode	AUTO
PGB Operating Mode	AUTO
PGC Operating Mode	AUTO
SVF Tuning Mode	HOLD
Detector Speed Mode	AUTO
Numeric Entry Mode	SOURCE AMPLITUD
IMD Mix Ratio	1:1
Measurement Mode	FREE RUN
Relative Measurement Enable	OFF
Measurement Type	WIDE BAND
Output B	OFF
Power amp source select	INTERNAL
Absolute Units	V
Output Configuration	A ONLY
Output Enable	OFF
Programmed Source Amplitude	0.0 V
DC Range	100 V
Phase Scale	± +180
DC Volts Measurement Mode	OFF
Phase Measurement Mode	OFF
DC Feedback	FULL
DC DAC A	0
DC DAC A	0
DC Multiplexer	OUTPUTS OFF
DC Digital Utility	0

AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

OWNER'S MANUAL

SECTION 4

APPLICATIONS

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4.0 PROGRAMMING APPLICATION NOTES FOR THE MODEL 5500

The following several pages provide some information and hints to assist the user in preparing controller software to program the 5500 via the GPIB port.

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4.1 MANUAL PARAMETER SELECTION

The 5500 provides, as part of the internal software, a means of selecting the optimal gain setting for the various amplifier stages. This will cause it to attempt to adjust the gain settings if signal levels present at the outputs of each stage are not within the limits required to guarantee the system accuracy. As the signal levels are determined at the output of the stages and then used to correct the actual gain value, we have a classic negative feedback loop around each stage involving the gain block itself, the detector used to measure the output level, and the software which provides the error amplifier function. There are phase shifts associated with each of these elements and compensation is thus required to guarantee the loop stability. This compensation takes the form of a delay that the software waits after changing the gain before it again attempts to measure the output level.

The delays provided to allow disturbances to settle out can often be quite significant in an automated test setup that may be switching inputs and outputs of the device under test. It often happens, however, that the final signal levels present after the disturbance settles will be quite close to those of the last measurement pass. For this reason the 5500 provides a means to inhibit the automatic selection of gain for each stage independently.

By freezing the gains, the user may avoid the internal invocation of these delays but incurs certain responsibilities. Although the software will still check for gross error conditions, such as a signal that is seriously over-range, it will generally ignore signals that are under-range, except when measuring the signal at the input amplifier (PGA) in distortion or tracking filter measurement modes. These cases are exceptions because adequate level is required for the tuning circuits to properly lock to the input signal.

A further responsibility that the user assumes is that there will be adequate signal level presented to the final detector to permit measurements of the required accuracy. The detectors provide only about a 14 dB dynamic range for specified accuracy over frequency. Where accuracy specifications may be relaxed, it is often practical to reduce the gains below what the software might conservatively consider optimal. This will allow a larger range of input signals without risking over-range conditions which will cause the software to abort the current measurement cycle. This can also provide a means to allow the measurement of high crest factor signals.

Similarly, it is possible to inhibit the automatic selection of various frequency parameters in the instrument. It is possible to inhibit the automatic selection of RMS detector time constant or notch filter frequency, for example. The decision as to which stages to hold and which to leave in automatic operation must be decided on a case by case basis.

The recommended practice of using the instrument in the triggered modes of operation, while controlling it from the GPIB, provides further control of the situation. It should be observed that while the instrument is awaiting a trigger command it is not actively measuring. Thus it is possible to program some change to the configuration and allow the disturbance to settle before triggering another measurement. This gives the user control over the settling times. One could go a step beyond and imagine that the auto-ranging logic could to some extent be handled in the host controller. This can again be quite useful when measuring signals of high crest factor.

We provide here a list of the settling times that will inhibit measurement after each of the mentioned actions:

PARAMETER CHANGED	DELAY
Input amp (PGA)	50 msec
Residual amp (PGB)	150 msec
Detector amp (PGC)	150 msec
State variable filter F_o	200 msec

4.2 MEASUREMENT SYNC SELECTION

The technique used for amplitude measurement in the Model 5500 synchronizes the measurement interval to the zero crossings of the measured AC signal. If a signal of sufficient level is not presented to the zero crossing detector, a watchdog timer provides a means to gracefully end the measurement cycle. This timer, however, provides a delay of 250 milliseconds to allow for worst case synchronization of a 10 Hz signal. At any time that the peak value of the detected signal drops in amplitude below the zero crossing hysteresis, this delay may be encountered.

For the purpose of verifying the setting of the gains at the various amplifiers, the measurement interval is chosen as 10 msec or 1 cycle of the synchronizing signal, whichever is greater. The system will thus acquire the value of >100 Hz signals in approximately 10 msec, as long as there is sufficient level to trigger the zero crossing detector. For seriously under-range signals, the acquisition time stretches out to a software determined value of 50 msec. Note that this delay may be incurred at every attempt to set the gains at each of the three programmable gain stages.

For the majority of test applications, the 5500 will be providing the stimulating signal for the device under test (DUT) in real time. It can thus be presumed that the frequency of the signal presented to the analyzer will be the same as that of the internal generator. "Special Function 37" has been provided to allow the measurement interval to synchronize to the internal generator. (Note that phase shift through the DUT does not invalidate this synchronization.)

When making THD type measurements, the system normally synchronizes to the signal present at the output of the first gain stage (PGA), prior to filtering. Setting "Special Function 37.1" will provide ideal sync for this case as well.

Measurement of IMD will synchronize to the recovered low or difference frequency present in the input signal, unless "Special Function 37.1" is in effect. In this case it will sync to the internal low or difference frequency oscillator.

The frequency display will reflect the effective frequency of the synchronizing signal in all cases except IMD measurements. In this case, if "Special Function 37.0" is in effect (the default case), another measurement will be taken to show the high frequency component of the waveform. This will cause a significant time penalty.

It can thus be recommended that the instrument be set to "Special Function 37.1" whenever the internal generator is providing the stimulus for the DUT in real time. Note that erroneous amplitude readings may be encountered if the frequency of the measured signal is different from that of the internal generator, when 37.1 is in effect, and that the frequency displayed will not reflect the frequency of the input signal.

4.3 DETECTOR SELECTION

The technique used for ripple cancellation in the Model 5500 allows amplitude measurements to be taken without consideration for post filtering the detected signals. It should be realized that certain detector characteristics have internal time constants that cannot be eliminated by this technique. The algorithm inherent in the RMS detector, for example, requires the averaging of the exponentially weighted value of the input signal. Although the time constant chosen is the shortest possible consistent with the accuracy required, it will give rise to a perceptible settling time.

The quasi-peak detector, by CCIR definition, also has a time constant which is considerably longer than a measurement cycle. Any measurement using this detector has to account for the decay rate to provide properly settled values.

The average value detector, on the other hand, has no inherent settling time and, where the measured values may be expressed in these dimensions, provides the fastest possible results. Any apparent settling time observed when using this detector is due to such effects as base line shift caused by the AC coupling time constants in the amplifiers or other similar effects.

In general, settling effects can be minimized by using the 400 Hz high pass filter where the errors introduced will not invalidate the measurement results.

Note that the software will try to set the time constant of the RMS detector to the minimum required for the measured frequency, but because the frequency is determined by zero crossings, certain waveforms (e.g. noise, multi-frequency signals or suppressed carrier modulated waveforms) may give rise to errors in the measured value. For these cases, a means is provided to fix the RMS time constant using "Special Function 29"; see the section in the manual entitled "Detector Speed and Operating Mode". Not found in the manual are the ranges of frequencies covered by each range. These ranges are defined such that the computation errors in the RMS detector will not contribute more than 0.1% to the total error budget. Where accuracy requirements are more relaxed, it is reasonable to fix the RMS detector speed faster than the conservative values chosen by the automatic software speed selection.

These are the ranges available:

RANGE	SPECIAL FUNCTION
10 - 30 Hz	29.2
30 - 100 Hz	29.3
100 - 400 Hz	29.4
400 Hz and up	29.5

It will generally be found that the average detector is the fastest and that, at frequencies above approximately 1 kHz, speed will be enhanced by inserting the 400 Hz high pass filter.

4.4 GPIB USAGE

The IEEE-488 bus or GPIB has become the communications medium of choice for the control of instrumentation and small ATE systems. Many users are confronted by a bewildering array of equipment on their benches that should all work together but find themselves stuck with strange messages like "Error - no listeners detected" or "Bus time out error". This application note will attempt to clarify some of the more rudimentary aspects of implementing a test system that communicates via the GPIB.

The IEEE has published a document, "IEEE Std 488-1978", which is a definitive work that leaves relatively little room for ambiguity but the precision of the document, in a manner similar to that of many legal documents, can seem quite arcane to those unfamiliar with the terminology and practice described. None the less, it is recommended that anyone intending to make serious use of the GPIB obtain a copy for reference; as one becomes more familiar with the bus and its operation, the standard will provide answers to many questions.

We will not attempt here to describe the mechanics of the operation of the bus or some of the more elegant techniques used by people who have become expert in its application. The intent is only to provide some hints on actually getting the 5500 to respond to commands and return data to the controller in a reasonably efficient manner.

4.4.1 BUS TRANSFERS

Most operations involving the 5500 on the bus involve the transfer of strings or groups of characters over the bus, much like the transfers of characters between a computer and a serial terminal. There are some points to keep in mind, however, that are somewhat unique to the GPIB.

Getting down to how it is that characters are actually transferred over the bus, we must quickly clarify a few terms that you will encounter in every description of bus operation. Every information transfer in any system requires that there be a transmitter of information and one or more receivers of this information. For normal character type transfers, the GPIB documents will refer to them as the talker and listeners, respectively. If there is a talker transmitting information to the bus and a listener is listening on the bus, the data transfer will probably take place. The talker does not have to know who is listening and the listener does not have to know who is the talker.

Instruments such as the 5500 are advertised as having certain talker and listener **capabilities**. The 5500 has the capability to both talk and listen, for example. This does not mean that it will somehow automatically both talk and listen if connected to a GPIB cable! Except for a little used mode, talkers and listeners will sit idly on the bus unless they are instructed as to their respective roles. This generally requires the services of a controller, the third type of main element on the bus.

4.4.2 CONTROLLER

The primary role of a controller is to instruct a device with talker capability to present its data to the bus and to instruct one or more listeners to accept the data. For any other talker to transmit data to the bus will require the intervention of the controller who must instruct the new talker that it has the exclusive right to transmit data to the bus. As soon as any talker is given transmission rights on the bus, any other talker must cease talking. Devices with listen capability do not automatically listen to data on the bus, they must be instructed by the controller to do so. Once a device is instructed to listen, it will continue to do so until the controller tells it to stop.

For the controller to instruct a particular device to do something, it must have a means of uniquely identifying each device on the bus. This is achieved by setting some information in the device which will be the "device address" that the device will be known by. Most instruments provide switches on the rear panel for setting the device address although some, such as the 5500, allow the user to specify the address via the front panel.

The only information that all devices always accept are instructions from the controller, which are cleverly encoded on the bus to avoid being mistaken for data. How this is done is not generally of concern to the users as it is handled by the interfaces provided by the manufacturers of the devices.

4.4.3 SRQ

Because a talker cannot just grab the bus to send information, a means is provided in the standard to allow a device with information to transmit, or in need of some service from the controller, to request service without disturbing the orderly progress of bus transactions. This capability is known as the service request function or SRQ and is used by a device with talker capabilities to attract the services of the controller, which must (and generally will) be capable of responding. The controller will normally conduct what is known as a "Serial Poll" of the devices on the bus to see which one(s) are requesting service. The serial poll will return a status byte that will provide some information to help the controller determine what action is required. The serial poll will also cause the requesting device to release the SRQ.

It can be seen that for one device to send information to another will generally require a data producer with the capability to be instructed to become the active talker, a data consumer capable of being instructed to listen, and a controller to do the instructing. This may not always seem clear in a typical instrumentation setup because manufacturers of controllers almost invariably build talk and listen capabilities into their systems. The software documentation may not clearly differentiate between the commands that relate to operation of the functions.

4.4.4 ELEMENTS OF A SYSTEM

To make meaningful use of the 5500 in an automated system will generally require a dedicated controller or a "personal" computer with a GPIB interface. It is assumed that the user is reasonably familiar with the operating system and use of the unit which will be used as the system controller and that for the sake of simplicity, the controller and the 5500 are the only units on the bus. It is also assumed that if the controller is a personal computer with an add-on interface, that the interface has been installed correctly. Amber provides an example of the installation of a National Instruments interface board in an IBM PC; we have found this to be an economical and functional combination.

Although the requirements for programming various GPIB controllers vary from model to model and among manufacturers, there are some guidelines that can be followed to ease the pain of getting a system up and running.

4.4.5 GETTING STARTED

With the 5500 connected to the controller via the appropriate GPIB cable, power up both machines. It is assumed that the default addressing mode and address have not been changed in the 5500. This can be verified on the front panel by using the shift of the "GPIB LCL" key which should show "28-1" on the left display. This means that the 5500 device address is 28 and that the talk and listen capabilities are enabled. See the 5500 manual for explanation.

If the controller software provides a monitor mode, this will assist in getting things going, otherwise you will have to write small programs to exercise the 5500. The controller must put the 5500 in the "remote" state before any data will be accepted. Some controllers require that you do this explicitly by executing some kind of "Remote" command with the device address as an argument, while others automatically assume that this must be done when you attempt to communicate with the device. The next step is to get the 5500 to listen to some command string. Because the 5500 ignores line terminator sequences such as carriage returns and line feeds, almost any output or print type command should work. Note that you must tell the controller to send the string to the 5500's address. Now try to print the string "0.1RC" to address 28 on the bus. The 5500 should click and flash and reset itself to its default settings (all except for the GPIB address and operating mode). If nothing happens at all, things are going to get a little tough. Check in the controller manual for the meaning of any error messages that it reports and prepare for some hours of manual flipping. The 5500 remote light should be on. If not, check the means that the controller uses to put the device into remote. The remote state will usually be referred to as "REMS" or "RWLS" in the controller documentation. Note that the controller has had to instruct its own talker to become active and also had to instruct the 5500 to listen. This will generally be quite transparent to the user.

If you are still with us you probably have the 5500 accepting instructions from the controller and have it listening to the talker that is associated with the controller. The next step is to get the listener associated with the controller to accept information from the 5500. This can usually be accomplished by inputting a string from the 5500 address on the bus and then printing the string on the controller's console. The string should be in scientific notation and represent the value seen on the left display of the 5500. Again, if you get errors or strange results, the problem is probably in your use of the controller software.

If the 5500 will accept strings from the controller's talker and send strings to the controller's listener, you are half way there. At this point you can write small programs to set up a measurement and to collect the measurement results. We will now move on to the subject of getting the system to do this reasonably efficiently.

4.4.6 TYPICAL COMMAND STRUCTURE

We will describe what we think is the most efficient way to set up the controller and the 5500. The functions used will generally be present in all controllers. The data in parentheses and double quotes implies literal strings to be sent as data message; without quotes implies bus commands or states.

1. Place the 5500 in local lockout state (LWLS).
2. Place the 5500 in the remote state (RWLS).
3. Recall the default machine state ("0.1RC", SDC or DCL).
4. Place the 5500 in hold mode ("T1").
5. Flush the 5500 output buffer by reading from it until a timeout condition occurs in the controller.
6. Enable the 5500 SRQ on any condition of output ready ("22.2SP").
7. Send a command string to the 5500 that describes the desired measurement configuration (e.g. "AP 1.5VL IO 01 FR 1000 HZ M1").
8. Trigger a measurement attempt (GET or "CL").
9. Wait for SRQ, either using the interrupt processing of the controller or by periodically conducting serial polls. This is not required but allows other processing to occur instead of waiting on a read.
10. Read the data from the 5500. Note that in the triggered modes of operation, the data **must** be taken, or the the output buffer will fill up and themeasurement process will be put to sleep untilroom is available.
11. Check if the reading is an error or exception by comparing the returned value to 90000E5. If the value is greater than this it is an error or exception. The fourth and fifth digits of the mantissa represent the error code. A measurement exception is usually handled by triggering a new measurement but repeated errors will require some corrective action and would usually require some interactive operator input to continue.
12. If the value is valid it may be used immediately or stored for later processing.
13. If there are more tests to run, send some new command string to the 5500 and go back to step 8, otherwise proceed to step 14.
14. If control is to be returned to the 5500 front panel, take it out of the remote state. The 5500 software will automatically restore the free running mode of measurement ("T0").

It is often important to wait until the measured value converges on a final value before further processing. The 5500 does not presume that it knows how you define a "settled" measurement but produces results as quickly as practical. You may wish to develop some algorithms for qualifying readings. Commonly used routines will require that several readings be within a certain percentage of each other before they are accepted as settled. For amplitude measurements, it may sometimes impose less of a math burden on the host software if dB units are used to output the data and then simple subtractions and compares will define the settling window. Improvements in the execution speed of the algorithm will have a noticeable effect on performance because it will probably be called quite often.

It is possible to have an organic computer perform the settling algorithm. Have the controller's program wait for some specific keyboard input before triggering a measurement. The operator can observe the monitor signal on an oscilloscope and trigger a measurement when it has settled. It is possible to use the "CLEAR" key on the 5500 front panel for this purpose if local lockout has not been set.

4.4.7 ADDITIONAL POINTS

There are some points that may be of interest to you as you become more familiar with the use of the bus. First of all, the 5500 does not support the "END" message. This is often used to indicate the end of a data transmission by asserting the "End or Identify" (EDI) interface line when sending the last byte of data but a peculiarity of the Motorola GPIA chip (as used in the 5500) discourages its use. This is generally of little consequence as the 5500 uses a carriage return line feed sequence to delimit data messages. It does no harm if the host talker asserts END but it should not require it to be used. Instead the host should have line feed specified as its "End of String" (EOS) byte.

Although the 5500 does not use DMA to effect bus transfers, it does use a high priority, buffered interrupt driven routine. This means that it will not hold up the bus with NDAC while it processes previous commands. If the input buffer, which has room for approximately 100 characters, ever becomes full however, it will hold off further input by asserting NRFD until room is available in the buffer. If information is not taken from the output buffer in the triggered modes of operations and data is still input to the input buffer, a deadlock condition can be created. The best way out of a deadlock may involve the big red switch.

It is possible to get into a confusing condition if the 5500 is powered down while in one of the triggered modes of operation or if the machine state is stored while in this mode. If the entire machine state is later recalled from the front panel, the trigger mode will also be recalled but cannot be changed from the front panel. If you find yourself in this situation, recall 0.1 and store it in the offending memories.

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4.5 HP/AMBER GPIB CODE COMPARISON

Hewlett Packard 8903B Audio Analyzer
and
Amber model 5500 Audio Measurement System

GPIB and Special Function Code Comparison Chart

The following tables show the GPIB code correspondence between the HP8903B and the Amber 5500 instruments. The table is presented two ways: first sorted alphabetically by Amber code and secondly, alphabetically by HP code. Both versions contain identical information.

Note that four types of codes are presented here:

COMMANDS:	usually operate independently
PREFIXES:	expect data and a terminator
TERMINATOR:	concludes a data string
SPECIAL FUNCTION:	used to set up a condition

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HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by AMBER code

Command or Function	Type	Amber code	HP code	Remarks
SELECT SIGNAL TO NOISE MODE	COMMAND		S2	Amber requires command sequence
SELECT OUTPUT 600 OHMS QUASI-FLOAT	COMMAND	--	47.0SP	Similiar to Amber P0 Command
SELECT OUTPUT 50 OHMS QUASI-FLOAT	COMMAND	--	47.1SP	Similiar to Amber P2 Command
All Plug-in Filters OFF	COMMAND	--	H0	Similiar to Amber code H0 and L0
Left plug-in Filter ON	COMMAND	--	H1	Similiar to Amber code H1
ENABLE LEFT OPTIONAL FILTER	COMMAND	--	H1	Similiar to Amber code H1
Right Plug-in Filter ON	COMMAND	--	H2	Similiar to other Amber codes
DISABLE ALL LOW PASS FILTERS	COMMAND	--	L0	
SELECT SINAD MODE	COMMAND	--	M2	Amber uses command sequence for SINAD
Automatic Notch Tuning	COMMAND	--	N0	Similiar to Amber code 37.1SP
Notch Hold	COMMAND	--	N1	Similiar to Amber code 37.0SP
SET TO AUTOMATIC	COMMAND	AU	AU	SAME
SELECT DBM DISPLAY UNITS	COMMAND	BM	NOT SUPPORTED	
SELECT INPUT TO B OUTPUT	COMMAND	BO	NOT SUPPORTED	
SELECT DBV DISPLAY UNITS	COMMAND	BV	NOT SUPPORTED	
SELECT SOURCE TO A ONLY	COMMAND	C0	NOT SUPPORTED	
SELECT SOURCE TO B ONLY	COMMAND	C1	NOT SUPPORTED	
SELECT SOURCE TO A + B	COMMAND	C2	NOT SUPPORTED	
SELECT SOURCE TO A - B	COMMAND	C3	NOT SUPPORTED	
CLEAR DISPLAY	COMMAND	CL	CL	SAME
TRIGGER MEASUREMENT (TRIG MODE)	COMMAND	CL	CL	SAME
SELECT RMS DETECTOR	COMMAND	D0	A0	SAME
SELECT AVERAGE DETECTOR	COMMAND	D1	A1	SAME
SELECT QUASI-PEAK DETECTOR	COMMAND	D2	5.7SP	Recent HP serial numbers only
SELECT DC LEVEL MODE	COMMAND	DC		REQUIRES OPTION 008 on 5500
DC LEVEL	COMMAND	DC	S1	Similiar
STEP DOWN/DECREMENT	COMMAND	DN	DN	SAME
INPUT FREQ MEASURE & DETECTOR	COMMAND	F1	NOT SUPPORTED	HP always measures INPUT
Measure OSC Frequency	COMMAND	F0		Similiar to HP code N1
DISABLE HIGH PASS FILTER	COMMAND	H0		HP uses plug-in filters
ENABLE HP FILTER	COMMAND	H1		SAME
SELECT INPUT A	COMMAND	IA	NOT SUPPORTED	
SELECT INPUT B	COMMAND	IB	NOT SUPPORTED	
SELECT INPUT TO A OUTPUT	COMMAND	IO	NOT SUPPORTED	
DISABLE ALL WEIGHTING FILTERS	COMMAND	L0		HP depends on plug-in filters installed
ENABLE 30KHZ LP FILTER	COMMAND	L1	L1	SAME
ENABLE 80KHZ LP FILTER	COMMAND	L2	L2	SAME
ENABLE SPCL FILTER	COMMAND	L3		HP depends on plug-in filters installed
ENABLE PSOPHOMETRIC FILTER	COMMAND	L3		HP depends on plug-in filters installed
ENABLE AUX FILTER 1	COMMAND	L4	NOT SUPPORTED	HP has 4 filters maximum
ENABLE AUX FILTER 2	COMMAND	L5	NOT SUPPORTED	HP has 4 filters maximum
ENABLE AUX FILTER 3	COMMAND	L6	NOT SUPPORTED	HP has 4 filters maximum
ENABLE AUX FILTER 4	COMMAND	L7	NOT SUPPORTED	HP has 4 filters maximum
SELECT LOG DISPLAY UNITS	COMMAND	LG	LG	SAME
SELECT LINEAR DISPLAY UNITS	COMMAND	LN	LN	SAME
SELECT WIDE BAND AC LEVEL MODE	COMMAND	M1	M1	SAME
SELECT WATTS LEVEL MODE	COMMAND	M1WA	19.0	
SELECT THD + N LEVEL MODE	COMMAND	M3	S3	CODES INTERCHANGED
SELECT BP LEVEL VERY WIDE	COMMAND	M4	NOT SUPPORTED	HP does not have narrow band mode
SELECT BP LEVEL WIDE	COMMAND	M5	NOT SUPPORTED	HP does not have narrow band mode
SELECT BP LEVEL MEDIUM	COMMAND	M6	NOT SUPPORTED	HP does not have narrow band mode
SELECT BP LEVEL NARROW	COMMAND	M7	NOT SUPPORTED	HP does not have narrow band mode
SELECT HP LEVEL MODE	COMMAND	M8	NOT SUPPORTED	HP does not have narrow band mode
SELECT LP LEVEL MODE	COMMAND	M9	NOT SUPPORTED	HP does not have narrow band mode
RAPID FREQUENCY COUNT MODE	COMMAND	NOT SUPPORTED	RF	
RAPID SOURCE MODE	COMMAND	NOT SUPPORTED	RS	
SWEEP OFF	COMMAND	NOT SUPPORTED	W0	See Amber option 054
SWEEP ON	COMMAND	NOT SUPPORTED	W1	See Amber option 054
SELECT OUTPUT OFF	COMMAND	O0	NOT SUPPORTED	
SELECT OUTPUT ON	COMMAND	O1	NOT SUPPORTED	

HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by AMBER code

Command or Function	Type	Amber code	HP code	Remarks
SELECT OUTPUT FLOAT MODE	COMMAND	OF	NOT SUPPORTED	
SELECT OUTPUT GND REF MODE	COMMAND	OG	NOT SUPPORTED	
SELECT OUTPUT 600 OHMS BALANCED	COMMAND	P0	NOT SUPPORTED	Similiar to HP 47.0SP (not bal)
SELECT OUTPUT 150 OHMS BALANCED	COMMAND	P1	NOT SUPPORTED	
SELECT OUTPUT 50 OHMS UNBALANCED	COMMAND	P2	--	Similiar to HP code 47.1SP
SELECT PHASE MEASUREMENT MODE	COMMAND	PZ	NOT SUPPORTED	REQUIRES OPTION 009
DISABLE RATIO/RELATIVE	COMMAND	R0	R0	SAME
ENABLE RATIO/RELATIVE	COMMAND	R1	R1	SAME
READ LEFT DISPLAY	COMMAND	RL	RL	SAME
READ MEASURED AMPLITUDE	COMMAND	RL	RR	DISPLAYS REVERSED
READ MEASURED FREQUENCY	COMMAND	RR	RL	DISPLAYS REVERSED
READ RIGHT DISPLAY	COMMAND	RR	RR	SAME
SELECT THD + N RATIO MODE	COMMAND	S3	M3	CODES INTERCHANGED
SELECT CCIF IMD MODE	COMMAND	S4	NOT SUPPORTED	HP does not maesure IMD
SELECT SMPTE IMD MODE	COMMAND	S5	NOT SUPPORTED	HP does not measure IMD
SELECT FREE RUN MODE	COMMAND	T0	T0	SAME
SELECT HOLD MODE	COMMAND	T1	T1	SAME
SELECT TRIGGER IMMEDIATE MODE	COMMAND	T2	T2	SAME
SELECT TRIGGER WITH SETTLING	COMMAND	T3	T3	SAME
STEP UP/INCREMENT	COMMAND	UP	UP	SAME
SELECT VOLTS DISPLAY UNITS	COMMAND	VO	LN	HP may require additional commands
SELECT WATTS UNITS (LEVEL MODE)	COMMAND	WA	--	HP USES SPCL FNCT 19
SELECT 100K OHM INPUT	COMMAND	Z0	--	HP ALWAYS 100K OHM
SELECT 150 OHM INPUT	COMMAND	Z1	NOT SUPPORTED	HP is always 100k ohms
SELECT 600 OHM INPUT	COMMAND	Z2	NOT SUPPORTED	HP is always 100k ohms
SET SOURCE AMPLITUDE INCREMENT	PREFIX	AN	AN	SAME
SET SOURCE AMPLITUDE	PREFIX	AP	AP	SAME
SET SOURCE FREQUENCY INCREMENT	PREFIX	FN	FN	SAME
SET SOURCE FREQUENCY	PREFIX	FR	FR	SAME
SET IMD OFFSET FREQ	PREFIX	IF	NOT SUPPORTED	
SELECT SWEEP START FREQ	PREFIX	NOT SUPPORTED	FA	
SELECT SWEEP STOP FREQ	PREFIX	NOT SUPPORTED	FB	
SET PLOT LIMIT	PREFIX	NOT SUPPORTED	PL	
SET RELATIVE MODE REFERENCE	PREFIX	RE	NOT SUPPORTED	
SET FILTER FREQUENCY	PREFIX	SF	NOT SUPPORTED	
SET FILTER FREQUENCY INCREMENT	PREFIX	SN	NOT SUPPORTED	
Input Level Range 4.76V	SPCL FNCT	--	1.10SP	Ranges are different
Input Level Range 3.00V	SPCL FNCT	--	1.11SP	Ranges are different
Input Level Range 1.89V	SPCL FNCT	--	1.12SP	Ranges are different
Input Level Range 1.19V	SPCL FNCT	--	1.13SP	Ranges are different
Input Level Range 0.754V	SPCL FNCT	--	1.14SP	Ranges are different
Input Level Range 0.476V	SPCL FNCT	--	1.15SP	Ranges are different
Input Level Range 0.300V	SPCL FNCT	--	1.16SP	Ranges are different
Input Level Range 0.189V	SPCL FNCT	--	1.17SP	Ranges are different
Input Level Range 0.119V	SPCL FNCT	--	1.18SP	Ranges are different
Input Level Range 0.0754V	SPCL FNCT	--	1.19SP	Ranges are different
Input Level Range 300V	SPCL FNCT	--	1.1SP	Ranges are different
Input Level Range 189V	SPCL FNCT	--	1.2SP	Ranges are different
Input Level Range 119V	SPCL FNCT	--	1.3SP	Ranges are different
Input Level Range 75.4V	SPCL FNCT	--	1.4SP	Ranges are different
Input Level Range 47.6V	SPCL FNCT	--	1.5SP	Ranges are different
Input Level Range 30.0V	SPCL FNCT	--	1.6SP	Ranges are different
Input Level Range 18.9V	SPCL FNCT	--	1.7SP	Ranges are different
Input Level Range 11.9V	SPCL FNCT	--	1.8SP	Ranges are different
Input Level Range 7.54V	SPCL FNCT	--	1.9SP	Ranges are different
SINAD & SNR display resolution 0.5dB	SPCL FNCT	--	16.0SP	Amber is always 0.01dB resolution

HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by AMBER code

Command or Function	Type	Amber code	HP code	Remarks
SINAD & SNR display resolution 0.01dB	SPCL FNCT	--	16.1SP	Amber is always 0.01dB resolution
DC INPUT RANGE 300V	SPCL FNCT	--	2.1SP	Ranges are different
DC INPUT RANGE 64V	SPCL FNCT	--	2.2SP	Ranges are different
DC INPUT RANGE 16V	SPCL FNCT	--	2.3SP	Ranges are different
DC INPUT RANGE 4V	SPCL FNCT	--	2.4SP	Ranges are different
Display GPIB address in binary	SPCL FNCT	--	21.0SP	See spcl fnct 21.1
Display decimal point DD.DDmV	SPCL FNCT	--	4.6SP	Similiar to Amber 5500 code 30.3
Display decimal point D.DDDmV	SPCL FNCT	--	4.7SP	Similiar to Amber 5500 code 30.3
Display decimal point 0.DDDDmV	SPCL FNCT	--	4.8SP	Similiar to Amber 5500 code 30.3
Detector response Fast RMS	SPCL FNCT	--	5.0SP	Amber code D0 and 29.5SP
Detector response Slow RMS	SPCL FNCT	--	5.1SP	Amber code D0 and 29.3SP
Detector response Fast average	SPCL FNCT	--	5.2SP	Amber code D1 and 29.5SP
Detector response Slow average	SPCL FNCT	--	5.3SP	Amber code D1 and 29.3SP
Notch Tune HOLD	SPCL FNCT	--	6.1SP	Similiar to Amber code 6.1SP
All errors enabled	SPCL FNCT	--	8.0SP	
Disable analyzer errors 12-17, 31 & 96	SPCL FNCT	--	8.1SP	
Disable source errors 18 and 19	SPCL FNCT	--	8.2SP	
Disable both source and analyzer errors	SPCL FNCT	--	8.3SP	
Input Level Range AUTO	SPCL FNCT	1.0SP	1.0SP	SAME
Input Level Range 0dBm	SPCL FNCT	1.10SP	--	Ranges are different
Input Level Range -5dBm	SPCL FNCT	1.11SP	--	Ranges are different
Input Level Range -10dBm	SPCL FNCT	1.12SP	--	Ranges are different
Input Level Range -15dBm	SPCL FNCT	1.13SP	--	Ranges are different
Input Level Range -20dBm	SPCL FNCT	1.14SP	--	Ranges are different
Input Level Range -25dBm	SPCL FNCT	1.15SP	--	Ranges are different
Input Level Range HOLD	SPCL FNCT	1.1SP	NOT SUPPORTED	
Input Level Range +40dBm	SPCL FNCT	1.2SP	--	Ranges are different
Input Level Range +35dBm	SPCL FNCT	1.3SP	--	Ranges are different
Input Level Range +30dBm	SPCL FNCT	1.4SP	--	Ranges are different
Input Level Range +25dBm	SPCL FNCT	1.5SP	--	Ranges are different
Input Level Range +20dBm	SPCL FNCT	1.6SP	--	Ranges are different
Input Level Range +15dBm	SPCL FNCT	1.7SP	--	Ranges are different
Input Level Range +10dBm	SPCL FNCT	1.8SP	--	Ranges are different
Input Level Range +5dBm	SPCL FNCT	1.9SP	--	Ranges are different
Display source settings	SPCL FNCT	10SP	10.0SP	Amber code 10.0SP also accepted
Disable RELATIVE mode	SPCL FNCT	11.0SP	NOT SUPPORTED	Minor differences in RELATIVE modes
Display LEVEL relative reference	SPCL FNCT	11.1SP	--	Similiar to HP code 11.1SP
Display RATIO/RELATIVE reference	SPCL FNCT	11.1SP	11.1SP	Minor differences in RELATIVE modes
Display DISTORTION relative reference	SPCL FNCT	11.2SP	NOT SUPPORTED	
Enter RATIO/RELATIVE mode	SPCL FNCT	11.3SP	11.0SP	
Enable RELATIVE mode using stored reference	SPCL FNCT	11.3SP	11.0SP	
Enable RELATIVE mode using current value	SPCL FNCT	11.4SP	NOT SUPPORTED	
Select OSC as output	SPCL FNCT	12.0SP	NOT SUPPORTED	
Select EXT IN as output	SPCL FNCT	12.1SP	NOT SUPPORTED	
Signal source DEFAULT	SPCL FNCT	14.1SP	NOT SUPPORTED	
Signal source IMD composite	SPCL FNCT	14.2SP	NOT SUPPORTED	
Signal source swept sine	SPCL FNCT	14.3SP	NOT SUPPORTED	
Signal source external input	SPCL FNCT	14.4SP	NOT SUPPORTED	
DC INPUT RANGE 100V	SPCL FNCT	2.0SP	--	
DC INPUT RANGE 10V	SPCL FNCT	2.1SP	--	
DC INPUT RANGE 1V	SPCL FNCT	2.2SP	--	
Left display to GPIB port	SPCL FNCT	20.0SP	--	Similiar to RL command
Right display to GPIB port	SPCL FNCT	20.1SP	--	Similiar to RR command
Display GPIB address in decimal	SPCL FNCT	21.0SP	21.1SP	
GPIB Service request	SPCL FNCT	22.nSP	22.nSP	See manuals for SRQ conditions
Power up in DEFAULT state	SPCL FNCT	23.0SP	NOT SUPPORTED	
Power up in last power down state	SPCL FNCT	23.1SP	NOT SUPPORTED	
Start AUTO CAL sequence	SPCL FNCT	24SP	NOT SUPPORTED	
Display WATTS impedance reference	SPCL FNCT	25.0SP	NOT SUPPORTED	
Display level as WATTS into "nnn" ohms	SPCL FNCT	25.nnnSP	19.NNNSP	

HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by AMBER code

Command or Function	Type	Amber code	HP code	Remarks
Display dBm impedance reference	SPCL FNCT	26.0SP	NOT SUPPORTED	
dBm measurement impedance nnn ohms	SPCL FNCT	26.nnnSP	NOT SUPPORTED	
Post Wght Filter gain AUTO	SPCL FNCT	27.0SP	NOT SUPPORTED	
Post Wght Filter gain HOLD	SPCL FNCT	27.1SP	NOT SUPPORTED	
Post Wght Filter gain 0dB	SPCL FNCT	27.2SP	NOT SUPPORTED	
Post Wght Filter gain +10dB	SPCL FNCT	27.3SP	NOT SUPPORTED	
Post Wght Filter gain +20dB	SPCL FNCT	27.4SP	NOT SUPPORTED	
Narrow band tune to OSC	SPCL FNCT	28.0SP	NOT SUPPORTED	
Narrow band tune to INPUT	SPCL FNCT	28.1SP	NOT SUPPORTED	
Detector speed AUTO	SPCL FNCT	29.0SP	--	Similiar to HP spcl fnct 5
Detector speed HOLD	SPCL FNCT	29.1SP	--	Similiar to HP spcl fnct 5
Detector speed very slow	SPCL FNCT	29.2SP	--	Similiar to HP spcl fnct 5
Detector speed slow	SPCL FNCT	29.3SP	--	Similiar to HP spcl fnct 5
Detector speed fast	SPCL FNCT	29.4SP	--	Similiar to HP spcl fnct 5
Detector speed very fast	SPCL FNCT	29.5SP	--	Similiar to HP spcl fnct 5
Post Notch Gain AUTO	SPCL FNCT	3.0SP	3.0SP	Same
Post Notch Gain HOLD	SPCL FNCT	3.1SP	NOT SUPPORTED	
Post Notch Gain 0dB	SPCL FNCT	3.2SP	3.1SP	
Post Notch Gain +20dB	SPCL FNCT	3.3SP	3.2SP	
Post Notch Gain +40dB	SPCL FNCT	3.4SP	3.3SP	
POST NOTCH GAIN +60dB	SPCL FNCT	3.5SP	3.4SP	
POST NOTCH GAIN +80dB	SPCL FNCT	3.6SP	NOT SUPPORTED	
Amplitude units AUTO	SPCL FNCT	30.0SP	NOT SUPPORTED	
Amplitude units HOLD	SPCL FNCT	30.1SP	NOT SUPPORTED	
Amplitude units Volts	SPCL FNCT	30.2SP	NOT SUPPORTED	
Amplitude units mVolts	SPCL FNCT	30.3SP	NOT SUPPORTED	
Amplitude units µV	SPCL FNCT	30.4SP	NOT SUPPORTED	
Amplitude units Watts	SPCL FNCT	30.5SP	NOT SUPPORTED	
Amplitude units mW	SPCL FNCT	30.6SP	NOT SUPPORTED	
Amplitude units µW	SPCL FNCT	30.7SP	NOT SUPPORTED	
Display decimal point AUTO	SPCL FNCT	31.0SP	4.0SP	
Display decimal point HOLD	SPCL FNCT	31.1SP	NOT SUPPORTED	
Display decimal point DDDD.	SPCL FNCT	31.2SP	4.1SP	Amber 5500 is DDDDD.
Display decimal point DDD.D	SPCL FNCT	31.3SP	4.2SP	Amber 5500 is DDDD.D
Display decimal point DD.DD	SPCL FNCT	31.4SP	4.3SP	Amber 5500 is DDD.DD
Display decimal point D.DDD	SPCL FNCT	31.5SP	4.4SP	Amber 5500 is DD.DDD
Display decimal point 0.DDDD	SPCL FNCT	31.6SP	4.5SP	Amber 5500 is D.DDDD
Frequency display FLOATING	SPCL FNCT	32.0SP	NOT SUPPORTED	
Frequency display HOLD	SPCL FNCT	32.1SP	NOT SUPPORTED	
Frequency display DDDDD.	SPCL FNCT	32.2SP	NOT SUPPORTED	
Frequency display DDDD.D	SPCL FNCT	32.3SP	NOT SUPPORTED	
Frequency display DDD.DD	SPCL FNCT	32.4SP	NOT SUPPORTED	
Frequency display DD.DDD	SPCL FNCT	32.5SP	NOT SUPPORTED	
Frequency display D.DDDD	SPCL FNCT	32.6SP	NOT SUPPORTED	
Frequency display 0.DDDDD	SPCL FNCT	32.7SP	NOT SUPPORTED	
Set instrument GPIB address	SPCL FNCT	33.nnSP	NOT SUPPORTED	"nn" is any valid address
GPIB to TALK and LISTEN	SPCL FNCT	34.0SP	NOT SUPPORTED	
GPIB to LISTEN only	SPCL FNCT	34.1SP	NOT SUPPORTED	
GPIB to TALK only	SPCL FNCT	34.2SP	NOT SUPPORTED	
Display SMPTE IMD ampl mix ratio	SPCL FNCT	35.0SP	NOT SUPPORTED	
SMPTE IMD Ampl ratio 1:1	SPCL FNCT	35.1SP	NOT SUPPORTED	
SMPTE IMD Ampl ratio 1:2	SPCL FNCT	35.2SP	NOT SUPPORTED	
SMPTE IMD Ampl ratio 1:4	SPCL FNCT	35.3SP	NOT SUPPORTED	
SMPTE IMD Ampl ratio 1:10	SPCL FNCT	35.4SP	NOT SUPPORTED	
Frequency tuning sync to INPUT	SPCL FNCT	37.0SP	NOT SUPPORTED	
Frequency tuning sync to OSC	SPCL FNCT	37.1SP	NOT SUPPORTED	
Disable serial interface	SPCL FNCT	38.0SP	NOT SUPPORTED	
Enable serial interface	SPCL FNCT	38.1SP	NOT SUPPORTED	
Display VOLTS load impedance	SPCL FNCT	4.0SP	NOT SUPPORTED	
Set Volts load impedance to "nnn" ohms	SPCL FNCT	4.nnnSP	NOT SUPPORTED	

HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by AMBER code

Command or Function	Type	Amber code	HP code	Remarks
Display dBm load impedance	SPCL FNCT	5.0SP	NOT SUPPORTED	
Set dBm load impedance to "nnn" ohms	SPCL FNCT	5.nnnSP	NOT SUPPORTED	
Notch Tune AUTO	SPCL FNCT	6.0SP	6.0SP	
Notch Tune follow OSC	SPCL FNCT	6.1SP	--	
Phase range ±180°	SPCL FNCT	8.0SP	NOT SUPPORTED	
Phase range 0 to 360°	SPCL FNCT	8.1SP	NOT SUPPORTED	
Hold settings	SPCL FNCT	9.0SP	9.0SP	
Detector response Quasi Peak	SPCL FNCT	D2	5.7SP	
Signal-to-Noise AUTO	SPCL FNCT	NOT SUPPORTED	12.0SP	
Signal-to-Noise 200mS delay	SPCL FNCT	NOT SUPPORTED	12.1SP	
Signal-to-Noise 400mS delay	SPCL FNCT	NOT SUPPORTED	12.2SP	
Signal-to-Noise 600mS delay	SPCL FNCT	NOT SUPPORTED	12.3SP	
Signal-to-Noise 800mS delay	SPCL FNCT	NOT SUPPORTED	12.4SP	
Signal-to-Noise 1.0 S delay	SPCL FNCT	NOT SUPPORTED	12.5SP	
Signal-to-Noise 1.2 S delay	SPCL FNCT	NOT SUPPORTED	12.6SP	
Signal-to-Noise 1.4 S delay	SPCL FNCT	NOT SUPPORTED	12.7SP	
Signal-to-Noise 1.6 S delay	SPCL FNCT	NOT SUPPORTED	12.8SP	
Signal-to-Noise 1.8 S delay	SPCL FNCT	NOT SUPPORTED	12.9SP	
XY Recorder ENABLE plot	SPCL FNCT	NOT SUPPORTED	13.0SP	
XY Recorder DISABLE plot	SPCL FNCT	NOT SUPPORTED	13.1SP	
Minimum time between measurements	SPCL FNCT	NOT SUPPORTED	14.0SP	
Add 1 second between measurements	SPCL FNCT	NOT SUPPORTED	14.1SP	
Sweep resolution 10 points/decade	SPCL FNCT	NOT SUPPORTED	17.0SP	
Sweep resolution 1 point /decade	SPCL FNCT	NOT SUPPORTED	17.1SP	
Sweep resolution 2 points/decade	SPCL FNCT	NOT SUPPORTED	17.2SP	
Sweep resolution 5 points/decade	SPCL FNCT	NOT SUPPORTED	17.3SP	
Sweep resolution 10 points/decade	SPCL FNCT	NOT SUPPORTED	17.4SP	
Sweep resolution 20 points/decade	SPCL FNCT	NOT SUPPORTED	17.5SP	
Sweep resolution 50 points/decade	SPCL FNCT	NOT SUPPORTED	17.6SP	
Sweep resolution 100 points/decade	SPCL FNCT	NOT SUPPORTED	17.7SP	
Sweep resolution 200 points/decade	SPCL FNCT	NOT SUPPORTED	17.8SP	
Sweep resolution 500 points/decade	SPCL FNCT	NOT SUPPORTED	17.9SP	
DC INPUT RANGE AUTO	SPCL FNCT	NOT SUPPORTED	2.0SP	
SINAD range 0 to 18dB	SPCL FNCT	NOT SUPPORTED	7.0SP	
SINAD range 0 to 24dB	SPCL FNCT	NOT SUPPORTED	7.1SP	
Output source impedance 600 ohms	SPCL FNCT	P0	47.0SP	
Output source impedance 50 ohms	SPCL FNCT	P2	47.1SP	
Read LEFT display to GPIB port	SPCL FNCT	RL	20.1SP	
Read RIGHT display to GPIB port	SPCL FNCT	RR	20.0SP	
Display level as WATTS into 8 ohms	SPCL FNCT	WA	19.0SP	
DB UNITS	TERMINATOR	DB	DB	SAME
DBM UNITS	TERMINATOR	DM	DV	Means dBu or dBre on 8903B (ref 0.775V)
DBV UNITS	TERMINATOR	DV	NOT SUPPORTED	
HERTZ UNITS	TERMINATOR	HZ	HZ	SAME
KHZ UNITS	TERMINATOR	KH	KH	SAME
KHZ UNITS	TERMINATOR	KH	KZ	
MILLIVOLTS UNITS	TERMINATOR	MV	MV	SAME
MILLIWATTS UNITS	TERMINATOR	MW	NOT SUPPORTED	
PLOT LOWER LIMIT	TERMINATOR	NOT SUPPORTED	LL	
SPCL SPCL	TERMINATOR	NOT SUPPORTED	SS	
PLOT UPPER LIMIT	TERMINATOR	NOT SUPPORTED	UL	
OHMS UNITS	TERMINATOR	OH	NOT SUPPORTED	
PERCENT UNITS	TERMINATOR	PE	NOT SUPPORTED	
RECALL SET UP	TERMINATOR	RC	NOT SUPPORTED	
SPECIAL FUNCTION (SPCL)	TERMINATOR	SP	SP	
STORE SET UP	TERMINATOR	ST	NOT SUPPORTED	
MICROVOLTS UNITS	TERMINATOR	UV	NOT SUPPORTED	
MICROWATTS UNITS	TERMINATOR	UW	NOT SUPPORTED	
VOLTS UNITS	TERMINATOR	VL	VL	

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HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by HP code

Command or Function	Type	HP code	Amber code	Remarks
SELECT DC LEVEL MODE	COMMAND		DC	REQUIRES OPTION 008 on 5500
Measure OSC Frequency	COMMAND		FO.	Similiar to HP code N1
DISABLE HIGH PASS FILTER	COMMAND		H0	HP uses plug-in filters
ENABLE HP FILTER	COMMAND		H1	SAME
DISABLE ALL WEIGHTING FILTERS	COMMAND		L0	HP depends on plug-in filters installed
ENABLE SPCL FILTER	COMMAND		L3	HP depends on plug-in filters installed
ENABLE PSOPHOMETRIC FILTER	COMMAND		L3	HP depends on plug-in filters installed
SELECT OUTPUT 50 OHMS UNBALANCED	COMMAND	--	P2	Similiar to HP code 47.1SP
SELECT WATTS UNITS (LEVEL MODE)	COMMAND	--	WA	HP USES SPCL FNCT 19
SELECT 100K OHM INPUT	COMMAND	--	Z0	HP ALWAYS 100K OHM
SELECT WATTS LEVEL MODE	COMMAND	19.0	M1WA	
SELECT OUTPUT 600 OHMS QUASI-FLOAT	COMMAND	47.0SP	--	Similiar to Amber P0 Command
SELECT OUTPUT 50 OHMS QUASI-FLOAT	COMMAND	47.1SP	--	Similiar to Amber P2 Command
SELECT QUASI-PEAK DETECTOR	COMMAND	5.7SP	D2	Recent HP serial numbers only
SELECT RMS DETECTOR	COMMAND	A0	D0	SAME
SELECT AVERAGE DETECTOR	COMMAND	A1	D1	SAME
SET TO AUTOMATIC	COMMAND	AU	AU	SAME
TRIGGER MEASUREMENT (TRIG MODE)	COMMAND	CL	CL	SAME
CLEAR DISPLAY	COMMAND	CL	CL	SAME
STEP DOWN/DECREMENT	COMMAND	DN	DN	SAME
All Plug-in Filters OFF	COMMAND	H0	--	Similiar to Amber code H0 and L0
Left plug-in Filter ON	COMMAND	H1	--	Similiar to Amber code H1
ENABLE LEFT OPTIONAL FILTER	COMMAND	H1	--	Similiar to Amber code H1
Right Plug-in Filter ON	COMMAND	H2	--	Similiar to other Amber codes
DISABLE ALL LOW PASS FILTERS	COMMAND	L0	--	
ENABLE 30KHZ LP FILTER	COMMAND	L1	L1	SAME
ENABLE 80KHZ LP FILTER	COMMAND	L2	L2	SAME
SELECT LOG DISPLAY UNITS	COMMAND	LG	LG	SAME
SELECT LINEAR DISPLAY UNITS	COMMAND	LN	LN	SAME
SELECT VOLTS DISPLAY UNITS	COMMAND	LN	VO	HP may require additional commands
SELECT WIDE BAND AC LEVEL MODE	COMMAND	M1	M1	SAME
SELECT SINAD MODE	COMMAND	M2	--	Amber uses command sequence for SINAD
SELECT THD + N RATIO MODE	COMMAND	M3	S3	CODES INTERCHANGED
Automatic Notch Tuning	COMMAND	N0	--	Similiar to Amber code 37.1SP
Notch Hold	COMMAND	N1	--	Similiar to Amber code 37.0SP
SELECT DBM DISPLAY UNITS	COMMAND	NOT SUPPORTED	BM	
SELECT INPUT TO B OUTPUT	COMMAND	NOT SUPPORTED	BO	
SELECT DBV DISPLAY UNITS	COMMAND	NOT SUPPORTED	BV	
SELECT SOURCE TO A ONLY	COMMAND	NOT SUPPORTED	C0	
SELECT SOURCE TO B ONLY	COMMAND	NOT SUPPORTED	C1	
SELECT SOURCE TO A + B	COMMAND	NOT SUPPORTED	C2	
SELECT SOURCE TO A - B	COMMAND	NOT SUPPORTED	C3	
INPUT FREQ MEASURE & DETECTOR	COMMAND	NOT SUPPORTED	F1	HP always measures INPUT
SELECT INPUT A	COMMAND	NOT SUPPORTED	IA	
SELECT INPUT B	COMMAND	NOT SUPPORTED	IB	
SELECT INPUT TO A OUTPUT	COMMAND	NOT SUPPORTED	IO	
ENABLE AUX FILTER 1	COMMAND	NOT SUPPORTED	L4	HP has 4 filters maximum
ENABLE AUX FILTER 2	COMMAND	NOT SUPPORTED	L5	HP has 4 filters maximum
ENABLE AUX FILTER 3	COMMAND	NOT SUPPORTED	L6	HP has 4 filters maximum
ENABLE AUX FILTER 4	COMMAND	NOT SUPPORTED	L7	HP has 4 filters maximum
SELECT BP LEVEL VERY WIDE	COMMAND	NOT SUPPORTED	M4	HP does not have narrow band mode
SELECT BP LEVEL WIDE	COMMAND	NOT SUPPORTED	M5	HP does not have narrow band mode
SELECT BP LEVEL MEDIUM	COMMAND	NOT SUPPORTED	M6	HP does not have narrow band mode
SELECT BP LEVEL NARROW	COMMAND	NOT SUPPORTED	M7	HP does not have narrow band mode
SELECT HP LEVEL MODE	COMMAND	NOT SUPPORTED	M8	HP does not have narrow band mode
SELECT LP LEVEL MODE	COMMAND	NOT SUPPORTED	M9	HP does not have narrow band mode
SELECT OUTPUT OFF	COMMAND	NOT SUPPORTED	O0	
SELECT OUTPUT ON	COMMAND	NOT SUPPORTED	O1	
SELECT OUTPUT FLOAT MODE	COMMAND	NOT SUPPORTED	OF	
SELECT OUTPUT GND REF MODE	COMMAND	NOT SUPPORTED	OG	

HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by HP code

Command or Function	Type	HP code	Amber code	Remarks
SELECT OUTPUT 600 OHMS BALANCED	COMMAND	NOT SUPPORTED	P0	Similiar to HP 47.0SP (not bal)
SELECT OUTPUT 150 OHMS BALANCED	COMMAND	NOT SUPPORTED	P1	
SELECT PHASE MEASUREMENT MODE	COMMAND	NOT SUPPORTED	PZ	REQUIRES OPTION 009
SELECT CCIF IMD MODE	COMMAND	NOT SUPPORTED	S4	HP does not maesure IMD
SELECT SMPTE IMD MODE	COMMAND	NOT SUPPORTED	S5	HP does not measure IMD
SELECT 150 OHM INPUT	COMMAND	NOT SUPPORTED	Z1	HP is always 100k ohms
SELECT 600 OHM INPUT	COMMAND	NOT SUPPORTED	Z2	HP is always 100k ohms
DISABLE RATIO/RELATIVE	COMMAND	R0	R0	SAME
ENABLE RATIO/RELATIVE	COMMAND	R1	R1	SAME
RAPID FREQUENCY COUNT MODE	COMMAND	RF	NOT SUPPORTED	
READ LEFT DISPLAY	COMMAND	RL	RL	SAME
READ MEASURED FREQUENCY	COMMAND	RL	RR	DISPLAYS REVERSED
READ MEASURED AMPLITUDE	COMMAND	RR	RL	DISPLAYS REVERSED
READ RIGHT DISPLAY	COMMAND	RR	RR	SAME
RAPID SOURCE MODE	COMMAND	RS	NOT SUPPORTED	
DC LEVEL	COMMAND	S1	DC	Similiar
SELECT SIGNAL TO NOISE MODE	COMMAND	S2		Amber requires command sequence
SELECT THD + N LEVEL MODE	COMMAND	S3	M3	CODES INTERCHANGED
SELECT FREE RUN MODE	COMMAND	T0	T0	SAME
SELECT HOLD MODE	COMMAND	T1	T1	SAME
SELECT TRIGGER IMMEDIATE MODE	COMMAND	T2	T2	SAME
SELECT TRIGGER WITH SETTLING	COMMAND	T3	T3	SAME
STEP UP/INCREMENT	COMMAND	UP	UP	SAME
SWEEP OFF	COMMAND	W0	NOT SUPPORTED	See Amber option 054
SWEEP ON	COMMAND	W1	NOT SUPPORTED	See Amber option 054
SET SOURCE AMPLITUDE INCREMENT	PREFIX	AN	AN	SAME
SET SOURCE AMPLITUDE	PREFIX	AP	AP	SAME
SELECT SWEEP START FREQ	PREFIX	FA	NOT SUPPORTED	
SELECT SWEEP STOP FREQ	PREFIX	FB	NOT SUPPORTED	
SET SOURCE FREQUENCY INCREMENT	PREFIX	FN	FN	SAME
SET SOURCE FREQUENCY	PREFIX	FR	FR	SAME
SET IMD OFFSET FREQ	PREFIX	NOT SUPPORTED	IF	
SET RELATIVE MODE REFERENCE	PREFIX	NOT SUPPORTED	RE	
SET FILTER FREQUENCY	PREFIX	NOT SUPPORTED	SF	
SET FILTER FREQUENCY INCREMENT	PREFIX	NOT SUPPORTED	SN	
SET PLOT LIMIT	PREFIX	PL	NOT SUPPORTED	
Input Level Range 0dBm	SPCL FNCT	--	1.10SP	Ranges are different
Input Level Range -5dBm	SPCL FNCT	--	1.11SP	Ranges are different
Input Level Range -10dBm	SPCL FNCT	--	1.12SP	Ranges are different
Input Level Range -15dBm	SPCL FNCT	--	1.13SP	Ranges are different
Input Level Range -20dBm	SPCL FNCT	--	1.14SP	Ranges are different
Input Level Range -25dBm	SPCL FNCT	--	1.15SP	Ranges are different
Input Level Range +40dBm	SPCL FNCT	--	1.2SP	Ranges are different
Input Level Range +35dBm	SPCL FNCT	--	1.3SP	Ranges are different
Input Level Range +30dBm	SPCL FNCT	--	1.4SP	Ranges are different
Input Level Range +25dBm	SPCL FNCT	--	1.5SP	Ranges are different
Input Level Range +20dBm	SPCL FNCT	--	1.6SP	Ranges are different
Input Level Range +15dBm	SPCL FNCT	--	1.7SP	Ranges are different
Input Level Range +10dBm	SPCL FNCT	--	1.8SP	Ranges are different
Input Level Range +5dBm	SPCL FNCT	--	1.9SP	Ranges are different
Display LEVEL relative reference	SPCL FNCT	--	11.1SP	Similiar to HP code 11.1SP
DC INPUT RANGE 100V	SPCL FNCT	--	2.0SP	
DC INPUT RANGE 10V	SPCL FNCT	--	2.1SP	
DC INPUT RANGE 1V	SPCL FNCT	--	2.2SP	
Left display to GPIB port	SPCL FNCT	--	20.0SP	Similiar to RL command
Right display to GPIB port	SPCL FNCT	--	20.1SP	Similiar to RR command
Detector speed AUTO	SPCL FNCT	--	29.0SP	Similiar to HP spcl fnct 5
Detector speed HOLD	SPCL FNCT	--	29.1SP	Similiar to HP spcl fnct 5

HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by HP code

Command or Function	Type	HP code	Amber code	Remarks
Detector speed very slow	SPCL FNCT	--	29.2SP	Similiar to HP spcl fnct 5
Detector speed slow	SPCL FNCT	--	29.3SP	Similiar to HP spcl fnct 5
Detector speed fast	SPCL FNCT	--	29.4SP	Similiar to HP spcl fnct 5
Detector speed very fast	SPCL FNCT	--	29.5SP	Similiar to HP spcl fnct 5
Notch Tune follow OSC	SPCL FNCT	--	6.1SP	
Input Level Range AUTO	SPCL FNCT	1.0SP	1.0SP	SAME
Input Level Range 4.76V	SPCL FNCT	1.10SP	--	Ranges are different
Input Level Range 3.00V	SPCL FNCT	1.11SP	--	Ranges are different
Input Level Range 1.89V	SPCL FNCT	1.12SP	--	Ranges are different
Input Level Range 1.19V	SPCL FNCT	1.13SP	--	Ranges are different
Input Level Range 0.754V	SPCL FNCT	1.14SP	--	Ranges are different
Input Level Range 0.476V	SPCL FNCT	1.15SP	--	Ranges are different
Input Level Range 0.300V	SPCL FNCT	1.16SP	--	Ranges are different
Input Level Range 0.189V	SPCL FNCT	1.17SP	--	Ranges are different
Input Level Range 0.119V	SPCL FNCT	1.18SP	--	Ranges are different
Input Level Range 0.0754V	SPCL FNCT	1.19SP	--	Ranges are different
Input Level Range 300V	SPCL FNCT	1.1SP	--	Ranges are different
Input Level Range 189V	SPCL FNCT	1.2SP	--	Ranges are different
Input Level Range 119V	SPCL FNCT	1.3SP	--	Ranges are different
Input Level Range 75.4V	SPCL FNCT	1.4SP	--	Ranges are different
Input Level Range 47.6V	SPCL FNCT	1.5SP	--	Ranges are different
Input Level Range 30.0V	SPCL FNCT	1.6SP	--	Ranges are different
Input Level Range 18.9V	SPCL FNCT	1.7SP	--	Ranges are different
Input Level Range 11.9V	SPCL FNCT	1.8SP	--	Ranges are different
Input Level Range 7.54V	SPCL FNCT	1.9SP	--	Ranges are different
Display source settings	SPCL FNCT	10.0SP	10SP	Amber code 10.0SP also accepted
Enter RATIO/RELATIVE mode	SPCL FNCT	11.0SP	11.3SP	
Enable RELATIVE mode using stored reference	SPCL FNCT	11.0SP	11.3SP	
Display RATIO/RELATIVE reference	SPCL FNCT	11.1SP	11.1SP	Minor differences in RELATIVE modes
Signal-to-Noise AUTO	SPCL FNCT	12.0SP	NOT SUPPORTED	
Signal-to-Noise 200mS delay	SPCL FNCT	12.1SP	NOT SUPPORTED	
Signal-to-Noise 400mS delay	SPCL FNCT	12.2SP	NOT SUPPORTED	
Signal-to-Noise 600mS delay	SPCL FNCT	12.3SP	NOT SUPPORTED	
Signal-to-Noise 800mS delay	SPCL FNCT	12.4SP	NOT SUPPORTED	
Signal-to-Noise 1.0 S delay	SPCL FNCT	12.5SP	NOT SUPPORTED	
Signal-to-Noise 1.2 S delay	SPCL FNCT	12.6SP	NOT SUPPORTED	
Signal-to-Noise 1.4 S delay	SPCL FNCT	12.7SP	NOT SUPPORTED	
Signal-to-Noise 1.6 S delay	SPCL FNCT	12.8SP	NOT SUPPORTED	
Signal-to-Noise 1.8 S delay	SPCL FNCT	12.9SP	NOT SUPPORTED	
XY Recorder ENABLE plot	SPCL FNCT	13.0SP	NOT SUPPORTED	
XY Recorder DISABLE plot	SPCL FNCT	13.1SP	NOT SUPPORTED	
Minimum time between measurements	SPCL FNCT	14.0SP	NOT SUPPORTED	
Add 1 second between measurements	SPCL FNCT	14.1SP	NOT SUPPORTED	
SINAD & SNR display resolution 0.5dB	SPCL FNCT	16.0SP	--	Amber is always 0.01dB resolution
SINAD & SNR display resolution 0.01dB	SPCL FNCT	16.1SP	--	Amber is always 0.01dB resolution
Sweep resolution 10 points/decade	SPCL FNCT	17.0SP	NOT SUPPORTED	
Sweep resolution 1 point /decade	SPCL FNCT	17.1SP	NOT SUPPORTED	
Sweep resolution 2 points/decade	SPCL FNCT	17.2SP	NOT SUPPORTED	
Sweep resolution 5 points/decade	SPCL FNCT	17.3SP	NOT SUPPORTED	
Sweep resolution 10 points/decade	SPCL FNCT	17.4SP	NOT SUPPORTED	
Sweep resolution 20 points/decade	SPCL FNCT	17.5SP	NOT SUPPORTED	
Sweep resolution 50 points/decade	SPCL FNCT	17.6SP	NOT SUPPORTED	
Sweep resolution 100 points/decade	SPCL FNCT	17.7SP	NOT SUPPORTED	
Sweep resolution 200 points/decade	SPCL FNCT	17.8SP	NOT SUPPORTED	
Sweep resolution 500 points/decade	SPCL FNCT	17.9SP	NOT SUPPORTED	
Display level as WATTS into 8 ohms	SPCL FNCT	19.0SP	WA	
Display level as WATTS into "nnn" ohms	SPCL FNCT	19.NNNSP	25.nnnSP	
DC INPUT RANGE AUTO	SPCL FNCT	2.0SP	NOT SUPPORTED	
DC INPUT RANGE 300V	SPCL FNCT	2.1SP	--	Ranges are different
DC INPUT RANGE 64V	SPCL FNCT	2.2SP	--	Ranges are different

HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by HP code

Command or Function	Type	HP code	Amber code	Remarks
DC INPUT RANGE 16V	SPCL FNCT	2.3SP	--	Ranges are different
DC INPUT RANGE 4V	SPCL FNCT	2.4SP	--	Ranges are different
Read RIGHT display to GPIB port	SPCL FNCT	20.0SP	RR	
Read LEFT display to GPIB port	SPCL FNCT	20.1SP	RL	
Display GPIB address in binary	SPCL FNCT	21.0SP	--	See spcl fnct 21.1
Display GPIB address in decimal	SPCL FNCT	21.1SP	21.0SP	
GPIB Service request	SPCL FNCT	22.nSP	22.nSP	See manuals for SRQ conditions
Post Notch Gain AUTO	SPCL FNCT	3.0SP	3.0SP	Same
Post Notch Gain 0dB	SPCL FNCT	3.1SP	3.2SP	
Post Notch Gain +20dB	SPCL FNCT	3.2SP	3.3SP	
Post Notch Gain +40dB	SPCL FNCT	3.3SP	3.4SP	
POST NOTCH GAIN +60dB	SPCL FNCT	3.4SP	3.5SP	
Display decimal point AUTO	SPCL FNCT	4.0SP	31.0SP	
Display decimal point DDDD.	SPCL FNCT	4.1SP	31.2SP	Amber 5500 is DDDDD.
Display decimal point DDD.D	SPCL FNCT	4.2SP	31.3SP	Amber 5500 is DDDD.D
Display decimal point DD.DD	SPCL FNCT	4.3SP	31.4SP	Amber 5500 is DDD.DD
Display decimal point D.DDD	SPCL FNCT	4.4SP	31.5SP	Amber 5500 is DD.DDD
Display decimal point 0.DDDD	SPCL FNCT	4.5SP	31.6SP	Amber 5500 is D.DDDD
Display decimal point DD.DDmV	SPCL FNCT	4.6SP	--	Similiar to Amber 5500 code 30.3
Display decimal point D.DDDmV	SPCL FNCT	4.7SP	--	Similiar to Amber 5500 code 30.3
Display decimal point 0.DDDDmV	SPCL FNCT	4.8SP	--	Similiar to Amber 5500 code 30.3
Output source impedance 600 ohms	SPCL FNCT	47.0SP	P0	
Output source impedance 50 ohms	SPCL FNCT	47.1SP	P2	
Detector response Fast RMS	SPCL FNCT	5.0SP	--	Amber code D0 and 29.5SP
Detector response Slow RMS	SPCL FNCT	5.1SP	--	Amber code D0 and 29.3SP
Detector response Fast average	SPCL FNCT	5.2SP	--	Amber code D1 and 29.5SP
Detector response Slow average	SPCL FNCT	5.3SP	--	Amber code D1 and 29.3SP
Detector response Quasi Peak	SPCL FNCT	5.7SP	D2	
Notch Tune AUTO	SPCL FNCT	6.0SP	6.0SP	
Notch Tune HOLD	SPCL FNCT	6.1SP	--	Similiar to Amber code 6.1SP
SINAD range 0 to 18dB	SPCL FNCT	7.0SP	NOT SUPPORTED	
SINAD range 0 to 24dB	SPCL FNCT	7.1SP	NOT SUPPORTED	
All errors enabled	SPCL FNCT	8.0SP	--	
Disable analyzer errors 12-17, 31 & 96	SPCL FNCT	8.1SP	--	
Disable source errors 18 and 19	SPCL FNCT	8.2SP	--	
Disable both source and analyzer errors	SPCL FNCT	8.3SP	--	
Hold settings	SPCL FNCT	9.0SP	9.0SP	
Input Level Range HOLD	SPCL FNCT	NOT SUPPORTED	1.1SP	
Disable RELATIVE mode	SPCL FNCT	NOT SUPPORTED	11.0SP	Minor differences in RELATIVE modes
Display DISTORTION relative reference	SPCL FNCT	NOT SUPPORTED	11.2SP	
Enable RELATIVE mode using current value	SPCL FNCT	NOT SUPPORTED	11.4SP	
Select OSC as output	SPCL FNCT	NOT SUPPORTED	12.0SP	
Select EXT IN as output	SPCL FNCT	NOT SUPPORTED	12.1SP	
Signal source DEFAULT	SPCL FNCT	NOT SUPPORTED	14.1SP	
Signal source IMD composite	SPCL FNCT	NOT SUPPORTED	14.2SP	
Signal source swept sine	SPCL FNCT	NOT SUPPORTED	14.3SP	
Signal source external input	SPCL FNCT	NOT SUPPORTED	14.4SP	
Power up in DEFAULT state	SPCL FNCT	NOT SUPPORTED	23.0SP	
Power up in last power down state	SPCL FNCT	NOT SUPPORTED	23.1SP	
Start AUTO CAL sequence	SPCL FNCT	NOT SUPPORTED	24SP	
Display WATTS impedance reference	SPCL FNCT	NOT SUPPORTED	25.0SP	
Display dBm impedance reference	SPCL FNCT	NOT SUPPORTED	26.0SP	
dBm measurement impedance nnn ohms	SPCL FNCT	NOT SUPPORTED	26.nnnSP	
Post Wght Filter gain AUTO	SPCL FNCT	NOT SUPPORTED	27.0SP	
Post Wght Filter gain HOLD	SPCL FNCT	NOT SUPPORTED	27.1SP	
Post Wght Filter gain 0dB	SPCL FNCT	NOT SUPPORTED	27.2SP	
Post Wght Filter gain +10dB	SPCL FNCT	NOT SUPPORTED	27.3SP	
Post Wght Filter gain +20dB	SPCL FNCT	NOT SUPPORTED	27.4SP	
Narrow band tune to OSC	SPCL FNCT	NOT SUPPORTED	28.0SP	
Narrow band tune to INPUT	SPCL FNCT	NOT SUPPORTED	28.1SP	

HP 8903B and Amber 5500 GPIB Code Comparison
Sorted by HP code

Command or Function	Type	HP code	Amber code	Remarks
Post Notch Gain HOLD	SPCL FNCT	NOT SUPPORTED	3.1SP	
POST NOTCH GAIN +80dB	SPCL FNCT	NOT SUPPORTED	3.6SP	
Amplitude units AUTO	SPCL FNCT	NOT SUPPORTED	30.0SP	
Amplitude units HOLD	SPCL FNCT	NOT SUPPORTED	30.1SP	
Amplitude units Volts	SPCL FNCT	NOT SUPPORTED	30.2SP	
Amplitude units mVolts	SPCL FNCT	NOT SUPPORTED	30.3SP	
Amplitude units µV	SPCL FNCT	NOT SUPPORTED	30.4SP	
Amplitude units Watts	SPCL FNCT	NOT SUPPORTED	30.5SP	
Amplitude units mW	SPCL FNCT	NOT SUPPORTED	30.6SP	
Amplitude units µW	SPCL FNCT	NOT SUPPORTED	30.7SP	
Display decimal point HOLD	SPCL FNCT	NOT SUPPORTED	31.1SP	
Frequency display FLOATING	SPCL FNCT	NOT SUPPORTED	32.0SP	
Frequency display HOLD	SPCL FNCT	NOT SUPPORTED	32.1SP	
Frequency display DDDDD.	SPCL FNCT	NOT SUPPORTED	32.2SP	
Frequency display DDDD.D	SPCL FNCT	NOT SUPPORTED	32.3SP	
Frequency display DDD.DD	SPCL FNCT	NOT SUPPORTED	32.4SP	
Frequency display DD.DDD	SPCL FNCT	NOT SUPPORTED	32.5SP	
Frequency display D.DDDD	SPCL FNCT	NOT SUPPORTED	32.6SP	
Frequency display 0.DDDDD	SPCL FNCT	NOT SUPPORTED	32.7SP	
Set instrument GPIB address	SPCL FNCT	NOT SUPPORTED	33.nnSP	"nn" is any valid address
GPIB to TALK and LISTEN	SPCL FNCT	NOT SUPPORTED	34.0SP	
GPIB to LISTEN only	SPCL FNCT	NOT SUPPORTED	34.1SP	
GPIB to TALK only	SPCL FNCT	NOT SUPPORTED	34.2SP	
Display SMPTE IMD ampl mix ratio	SPCL FNCT	NOT SUPPORTED	35.0SP	
SMPTE IMD Ampl ratio 1:1	SPCL FNCT	NOT SUPPORTED	35.1SP	
SMPTE IMD Ampl ratio 1:2	SPCL FNCT	NOT SUPPORTED	35.2SP	
SMPTE IMD Ampl ratio 1:4	SPCL FNCT	NOT SUPPORTED	35.3SP	
SMPTE IMD Ampl ratio 1:10	SPCL FNCT	NOT SUPPORTED	35.4SP	
Frequency tuning sync to INPUT	SPCL FNCT	NOT SUPPORTED	37.0SP	
Frequency tuning sync to OSC	SPCL FNCT	NOT SUPPORTED	37.1SP	
Disable serial interface	SPCL FNCT	NOT SUPPORTED	38.0SP	
Enable serial interface	SPCL FNCT	NOT SUPPORTED	38.1SP	
Display VOLTS load impedance	SPCL FNCT	NOT SUPPORTED	4.0SP	
Set Volts load impedance to "nnn" ohms	SPCL FNCT	NOT SUPPORTED	4.nnnSP	
Display dBm load impedance	SPCL FNCT	NOT SUPPORTED	5.0SP	
Set dBm load impedance to "nnn" ohms	SPCL FNCT	NOT SUPPORTED	5.nnnSP	
Phase range ±180°	SPCL FNCT	NOT SUPPORTED	8.0SP	
Phase range 0 to 360°	SPCL FNCT	NOT SUPPORTED	8.1SP	
DB UNITS	TERMINATOR	DB	DB	SAME
DBM UNITS	TERMINATOR	DV	DM	Means dBu or dBre on 8903B (ref 0.775V)
HERTZ UNITS	TERMINATOR	HZ	HZ	SAME
KHZ UNITS	TERMINATOR	KH	KH	SAME
KHZ UNITS	TERMINATOR	KZ	KH	
PLOT LOWER LIMIT	TERMINATOR	LL	NOT SUPPORTED	
MILLIVOLTS UNITS	TERMINATOR	MV	MV	SAME
DBV UNITS	TERMINATOR	NOT SUPPORTED	DV	
MILLIWATTS UNITS	TERMINATOR	NOT SUPPORTED	MW	
OHMS UNITS	TERMINATOR	NOT SUPPORTED	OH	
PERCENT UNITS	TERMINATOR	NOT SUPPORTED	PE	
RECALL SET UP	TERMINATOR	NOT SUPPORTED	RC	
STORE SET UP	TERMINATOR	NOT SUPPORTED	ST	
MICROVOLTS UNITS	TERMINATOR	NOT SUPPORTED	UV	
MICROWATTS UNITS	TERMINATOR	NOT SUPPORTED	UW	
SPECIAL FUNCTION (SPCL)	TERMINATOR	SP	SP	
SPCL SPCL	TERMINATOR	SS	NOT SUPPORTED	
PLOT UPPER LIMIT	TERMINATOR	UL	NOT SUPPORTED	
VOLTS UNITS	TERMINATOR	VL	VL	

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4.6 SAMPLE CONTROLLER PROGRAM for an AMBER 5500 PROGRAMMABLE DISTORTION & NOISE MEASUREMENT SYSTEM with an IBM PC

Issue 01: May 1985

This program is offered to purchasers of an Amber 5500 Programmable Distortion & Noise Measurement System to assist the user in writing specific application programs. It is offered on a no charge basis, as is, and without support or warranties.

The program is designed to run on an IBM-PC/XT or equivalent equipped with a National Instruments GPIB-PC interface board and at least 256 k of memory. It assumes the user has the National Instruments documentation and BASICA interpreter and is familiar with BASIC programming.

The program allows the user to set up as many as 100 separate tests, each involving several commands to the 5500 and processing of the measured results. It can test the results for certain limit criteria and provide summarized reports to screen or printer.

The program could be used, for example, to run a complete checkout of a device under test with up to 100 parameters evaluated according to user defined limits.

It is suggested that the user list the source code which is well remarked for examples of command and data retrieval syntax. Also illustrated is error processing and GPIB protocol.

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4.6.1 AMBER 5500 SYSTEM EVALUATION PACKAGE FOR THE PC

Issue 2.0: June 6, 1985

This package allows the user to define a series of 5500 instrument tests, execute them under the control of the BASICA interpreter with the National Instruments GPIB-PC BASICA Language Interface and have an Evaluation Report, consisting of measurement results and test analyses, displayed to the screen or printer.

PREREQUISITES

BASICA Interpreter

National Instruments GPIB-PC Interface with 5500 GPIB device, "A5500", and GPIB-PC interface board, "GPIB0", configured and installed. Refer to the National Instruments manual and to the IBCONF listings of the GPIB0 board and the A5500 device configuration enclosed with this document.

PACKAGE COMPONENTS

The following files are all included on the disk. Note that this program uses version B of the National Instruments software. Some difficulties have been reported with the latest version C of this software.

README.DOC is a general description and instruction text. Recommended reading.

T5500.BAS is a BASICA program which accepts a series of test configurations (up to 100), sets up the 5500, executes the specified tests and reports the results to the screen or printer. To run T5500 from DOS, enter BASICA T5500; to run it from BASICA, first LOAD "T5500" then enter RUN. T5500 prompts the user for the name of a Test Series Configuration data file. If no file name is entered, data must be entered via the keyboard, otherwise data will be read from the named file. Refer to Test Series Configuration below for a detailed description of the input data required. Data files must be unformatted ASCII text files, should be included in the GP5500 directory and suffixed .DAT.

MKDATA.BAS is a BASICA program which creates test data files for T5500. To run MKDATA from DOS, enter BASICA MKDATA; to run it from BASICA, first load "MKDATA" then enter RUN. MKDATA prompts the user for the name of the file to be created which should be suffixed .DAT.

After acquiring Test Series Identification data, it will prompt the user for Test Specification data starting with Command String Sequence. If no data is entered, the data file is closed and MKDATA terminates. Refer to Test Series Configuration below for a more detailed description of input data.

4.6.2 TEST SERIES CONFIGURATION

Test configuration data may be entered via the keyboard or read from a data file at T5500 run-time. Data files may be created using MKDATA or with any word processor. All data files must be ASCII text files of the form:

Test Identification record

Instrument Identification record

Report Format & Destination record

General remarks record

Test Specification blocks - where Test Specification block refers to the following set of records:

Command String Sequence record

Reference Specification record

Reference (Measurement) Units Display record

Criteria Specification record

Criteria (Deviation) Units Display record

Comments record

All records are ASCII strings delimited by quotes and there the number of Test Specification blocks must be between 1 and 100. Record types are described below. SAMPL.DAT, below, is an example of a valid test data file. When entering data on the keyboard from T5500 or MKDATA, the quotes are omitted.

4.6.3 TEST SERIES IDENTIFICATION RECORDS

Test Identification is the label associated with the test series that is used in the Evaluation Report header. This string is limited to 60 characters.

Instrument Identification is a label associated with the particular instrument under test, i.e. serial number that is used in the Evaluation Report header. This string is limited to 60 characters.

Report Format and Destination designates the printer or the screen as the output device and selects long or short report formats. Choices include "PA", "PF", "SA", and "SF" where "P" selects the printer, "S" the screen, "A" indicates that all individual test results should be displayed, and "F" that only the results of those tests which failed should be displayed.

General Remarks refers to any comments which should be part of the Evaluation Report Summary. This string is limited to 256 characters.

4.6.4 TEST SPECIFICATIONS REPORTS

Command String Sequence is a string of valid 5500 GPIB commands used to configure the instrument to a known state prior to executing any measurements. T5500 initializes the instrument to its default state by issuing a DCL bus command before it begins the test series; it, however, does not re-initialize the instrument after each test. This string is limited to 256 characters. A null command string sequence will cause T5500 to output the Evaluation Report and quit. A "/" command string sequence will cause T5500 to start executing measurements without reconfiguring the instrument.

Reference Specification is the numeric string which represents the actual value, regardless of units, to which measurement results will be compared. It is up to the user to make sure that the implied reference units correspond to the currently selected units in which measurement data is being returned by the 5500. If "/" is entered as the reference specification, the reference specification and reference (measurement) units display are carried over from the last test specification or a default of 0.1 and V.

Reference (Measurement) Units Display indicates the units display which is to accompany the Evaluation Reports measurement and reference data displays. Data is not converted to fit the units display. Again, it is up to the user to make sure that the implied reference units correspond to the currently selected units in which measurement data is being returned by the 5500. If "/" is entered as reference specification, this record must be omitted.

Criteria Specification is a numeric string which represents the actual value to which the deviation between measurement and reference is to be compared, regardless of units. This string must be delimited by the test type specification which indicates under what circumstances the test will fail. There are currently 6 types of tests available:

"R"	fail if abs ((measurement / reference) - 1)) criteria
"R+"	fail if (measurement / reference) - 1) criteria
"R-"	fail if (measurement / reference) - 1) criteria
"D"	fail if abs ((measurement - reference) criteria
"D+"	fail if (measurement - reference) criteria
"D-"	fail if (measurement - reference) criteria

where measurement is the data returned by the instrument after triggering measurement if it is not an error. If "/" is entered as the criteria specification, the criteria specification and criteria (deviation) units display are carried over from the last test specification.

Criteria (Deviation) Units Display indicates the units which will accompany the Evaluation Report's criteria and deviation displays. If "%" units are selected, criteria and deviation will be displayed 100 times the actual value specified and used in calculation. If "/" is entered as criteria specification, this record must be omitted.

Comments is a string of up to 256 characters which is used in the Evaluation Report at the top of the test results display.

4.6.5 SAMPLE TEST DATA FILE

File Name: SAMPL.DAT

"Sample Test"	Test Identification
"SN # 000000"	Instrument Identification
"SA"	Report Destination & Format
"This is an example"	General Remarks
"io o1 1.5vl"	Command String Sequence
"1.5"	Reference Specification
"V"	Reference (Measurement) Display
".01R+"	Criteria Specification
"%"	Criteria (Deviation) Display
"Test # 1"	Comments
"1.8vl"	Command String Sequence
"/"	Reference Specification Reference (Measurement) Display
"/"	Criteria Specification Criteria (Deviation) Display
"Test # 2"	Comments

Following is the Evaluation Report produced by T5500.BAS SAMPL.DAT.

4.6.6 5500 SYSTEM EVALUATION REPORT

Test ID : Sample
Test Instrument ID : SN # 000000
Date : 10-10-1984

Test # 1

Command Sequence: io o1 1.5vl

Measurement : 1.5 V

Reference : 1.5 V

Fail Criteria : (measurement/reference - 1 >1%

Analysis : Passed with a deviation of 0%

Start Time : 14:51:21

Stop Time : 14:51:25

Readings :

1. Error 12
2. Error 12
3. Error 12
4 Error 22
5. Error 11
6. Error 11
7. 1.56 V
8. 1.51 V
10. 1.5 V
11. 1.5 V

4.6.7 5500 SYSTEM EVALUATION REPORT

Test ID : Sample Test
Instrument ID : SN # 000000
Date : 10-10-1984

Test # 2

Command Sequence: 1.8vl

Measurement : 1.79 V

Reference : 1.5 V

Fail Criteria : (measurement/reference - 1 >1%

Analysis : Failed with a deviation of 19.33333%

Start Time : 14:51:26

Stop Time : 14:51:35

Readings :

1. 1.79 V
2. 1.8 V
3. 1.8 V
4. 1.8 V
5. 1.79 V
6. 1.79 V
7. 1.79 V
8. 1.79 V
9. 1.79 V
10. 1.79 V
11. 1.79 V
12. 1.79 V
13. 1.79 V
14. 1.79 V
15. 1.79 V
16. 1.79 V
17. 1.79 V
18. 1.79 V
19. 1.79 V
20. 1.79 V

4.6.8 5500 SYSTEM EVALUATION REPORT

Test ID	: Sample Test
Instrument ID	: SN # 000000
Date	: 10-10-1984

SUMMARY

Start Time	: 14:51:20
Stop Time	: 14:51:35
Execution Status	: 2 measurement(s) attempted Test completed with no errors generated
Analysis	: Of 2 measurement test(s) performed , 1 failed and 1 passed
Remarks	: This is an example

4.6.9 IBCONF LISTINGS

CONFIGURED BEFORE PROCEEDING WITH THIS PROGRAM

Press RETURN to begin.

>>>>

Scanning file GPIB.COM . . . reading data . . .completed.

2 Board(s) 16 Device(s)

==

DEFINE SYSTEM WIDE PARAMETERS (effective for all boards)

==

PARAMETER	DEFAULT	NEW VALUE

Reference Clock Frequency? (decimal) . . . . [8 MHz] . . . .>

Disable Automatic Serial Polling? . . . . [no] . . . . . .>

==

You may now proceed with board and device level configurations.

If you need help, type HELP.

cmd>

==

NAME: GPIB0 **NUMBER: B 0**

==

(1) Primary GPIB Address.. 00H
(2) Secondary GPIB Address.. 0:none
(3) Timeout setting.. 13
(4) EOS byte.. 00H
(5) EOS modes.. none
(6) Board Options.. (SC EOT)
(7) Port Address.. 02B8H
(8) DMA channel.. 1
(9) High-speed timing.. OFF

Footnotes:

SC	Board is System Controller.
EOT	Send EOI w/last byte of write.
REOS	Terminate read on EOS.
XEOS	Send EOI with EOS byte.
BIN	Use 8-bit compare on EOS.
nnH	Hexadecimal number.

==

cmd>

==

NAME: A5500 ACCESS: GPIB0 NUMBER: D 0

==

(1) Primary GPIB Address..	1CH
(2) Secondary GPIB Address...	0:none
(3) Timeout setting..	13
(4) EOS byte..	0AH
(5) EOS modes...	(REOS)
(6) Device Options...	(EOT)

Footnotes:

EOT Send EOI w/last byte of write.
REOS Terminate read on EOS.
XEOS Send EOI with EOS byte.
BIN Use 8-bit compare on EOS.
nnH Hexadecimal number.

==

cmd >

```
10 REM ****************************************************************
20 REM Make T5500 Data File - MKDATA - Version #40 - Oct 10'84
30 REM ****************************************************************
40 INPUT "Enter T5500 data file name "; FLNM$
50 REM If null string entered, exit
60 IF FLNM$ = "" THEN GOTO 320
70 REM Create & open file for output
80 OPEN "O",1,FLNM$
90 INPUT "Enter Test Identification";T$
100 INPUT "Enter Instrument Identification";I$
110 INPUT "Enter Report Destination & Format: SA/SF/PA/PF";R$
120 INPUT "Enter General Remarks";C$
130 PRINT #1,CHR$(34);T$;CHR$(34);CHR$(34);I$;CHR$(34);CHR$(34);R$;CHR$(34);CHR$
(34);C$;CHR$(34)
140 INPUT "Enter 5500 GPIB Command String Sequence";CS$
150 IF CS$ = "" THEN GOTO 310 ELSE PRINT #1,CHR$(34);CS$;CHR$(34)
160 INPUT "Enter Reference Specification (default is /)";RF$
170 IF (RF$ <> "/") AND (RF$ <> "") THEN GOTO 200
180 PRINT #1,CHR$(34);"/";CHR$(34)
190 GOTO 220
200 INPUT "Enter Reference (Measurement) Units Display";RU$
210 PRINT #1,CHR$(34);RF$;CHR$(34);CHR$(34);RU$;CHR$(34)
220 INPUT "Enter Criteria Specification (default is /)";CR$
230 IF (CR$ <> "/") AND (CR$ <> "") THEN GOTO 260
240 PRINT #1,CHR$(34);"/";CHR$(34)
250 GOTO 280
260 INPUT "Enter Criteria (Deviation) Units Display";CU$
270 PRINT #1,CHR$(34);CR$;CHR$(34);CHR$(34);CU$;CHR$(34)
280 INPUT "Enter Comments";CM$
290 PRINT #1,CHR$(34);CM$;CHR$(34)
300 GOTO 140
310 CLOSE #1
320 END
```

```
10 REM   ********************************************************************
20 REM   5500 Evaluation Test - T5500 - Version #60 - Oct 10'84
30 REM   ********************************************************************
40 REM   ********************************************************************
50 REM   GPIB controller initialization sequence
60 REM   ********************************************************************
70        CLEAR   ,58000!           ' GPIB-PC Rev. B.1
80        IBINIT1 = 58000!          ' BASICA Declaration File
90        IBINIT2 = IBINIT1 + 3     '
100        BLOAD "bib.m",IBINIT1
110        CALL IBINIT1(IBFIND,IBTRG,IBCLR,IBPCT,IBSIC,IBLOC,IBPPC,IBBNA,IBONL,I
BRSC,IBSRE,IBRSV,IBPAD,IBSAD,IBIST,IBDMA,IBEOS,IBTMO,IBEOT)
120        CALL IBINIT2(IBGTS,IBCAC,IBWAIT,IBPOKE,IBWRT,IBWRTA,IBCMD,IBCMDA,IBRD
,IBRDA,IBSTOP,IBRPP,IBRSP,IBDIAG,IBXTRC,IBSTA%,IBERR%,IBCNT%)
130  REM  ********************************************************************
140  REM  Main initialization sequence
150  REM  ********************************************************************
160 REM  Test declarations & initialization sequence
170 GOSUB 1270
180 REM  Find device (A5500) & board (GPIB0) identifiers
190 REM  Define GPIB read termination criteria & timeout
200 GOSUB 810
210 REM  If error generated, report & quit
220 IF ECODE <> 0 THEN GOTO 590
230 REM  Clear interface & instrument ( to default state)
240 REM  Put instrument into RWLS state, HOLD mode & select all SRQ conditions
250 GOSUB 1020
260 REM  If error generated, report & quit
270 IF ECODE <> 0 THEN GOTO 590
280 REM  Clear 5500 GPIB input buffer
290 GOSUB 6010
300 IF ECODE <> 0 THEN GOTO 590
310 REM  Start time
320 SSTRT$ = TIME$
330 REM  ********************************************************************
340 REM  Main loop: execute command sequences & measure
350 REM  ********************************************************************
360 REM  Get configuration data: command string, reference & test criteria
370 REM  Initialize test variables
380 GOSUB 1760
390 REM  If no more data, report & quit
400 IF NOMORE THEN GOTO 590
410 REM  If error generated, report & quit
420 IF ECODE <> 0 THEN GOTO 590
430 REM  Start time
440 TSTRT$(TCNT) = TIME$
450 REM  Trigger measurement, collect & evaluate results
```

```
460 GOSUB 2480
470 REM   If error generated, report & quit
480 IF ECODE <> 0 THEN GOTO 520
490 REM   If settling criteria satisfied, then next test, else try again
500 IF SETTLED = 0 THEN GOTO 460
510 IF MSTATS(TCNT) = 0 THEN FCNT = FCNT + 1 ELSE PCNT = PCNT + 1
520 REM   Stop time
530 TSTOP$(TCNT) = TIME$
540 REM   Next test
550 IF ECODE = 0 THEN GOTO 360
560 REM   **********************************************************************
570 REM   Report & exit
580 REM   **********************************************************************
590 SSTOP$ = TIME$
600 IF IMODE = 2 THEN CLOSE #1
610 REM   If reported error = Device Find, Board Find, IFC, Remote
620 REM  Enable, Remote Disable, Sending Listen Address, Invalid Test Data
630 REM  do not attempt to clear instrument or return to LOCS state
640 IF (ECODE <> 0) AND (ECODE <= 6) THEN GOTO 740
650 REM   If reported error = SDC, LLO
660 REM  do not attempt to clear instrument
670 IF (ECODE = 7) OR (ECODE = 8) THEN GOTO 720
680 REM   Clear instrument to default machine status
690  CALL IBCLR(DVM%)
700 REM   Clear instrument to default machine status
710  CALL IBCLR(DVM%)
720 REM   Return instrument to LOCS state
730 V% = 0 : CALL IBSRE(BRD0%,V%)
740 REM   Report measurement test results on screen or printer
750 GOSUB 2700
760 END
770 REM   **********************SUBROUTINES**********************************
780 REM   *********************************************************************
790 REM   Find device (A5500) & board (GPIB0) identifiers
800 REM   **********************************************************************
810 DEV$ = "A5500" : BDNAME$ = "GPIB0"
820 REM   Set ECODE to Device Find Failed error
830 ECODE = 1
840 CALL IBFIND(DEV$,DVM%)
850 REM   Trap Device Find Failed error
860 IF DVM% < 0 THEN GOTO 980
870 REM   Set ECODE to Board Find Failed error
880 ECODE = 2
890 CALL IBFIND(BDNAME$,BRD0%)
900 REM   Trap Board Find Failed error
910 IF BRD0% < 0 THEN GOTO 980
920 REM Set timeout to 10 sec
```

```
930 V% = 13 : CALL IBTMO(DVM%,V%)
940 REM Set read termination criteria to EOS & EOS to <LF>
950 V% = &H400 + &HA : CALL IBEOS (DVM%,V%)
960 REM   Clear ECODE
970 ECODE = 0
980 RETURN
990 REM   *********************************************************************
1000 REM   Board IFC, LLO, SDC, put instrument in HOLD & select all SRQ
1010 REM   *********************************************************************
1020 REM   Execute IFC
1030 ECODE = 3
1040 CALL IBSIC(BRD0%)
1050 IF IBSTA% < 0 THEN GOTO 1230
1060 REM   Put instrument in REMS state: Remote enable
1070 ECODE = 4
1080 V% = 1 : CALL IBSRE(BRD0%,V%)
1090 IF IBSTA% < 0 THEN GOTO 1230
1100 REM   Put instrument in RWLS state: assert LLO
1110 ECODE = 8
1120 CMD$ = CHR$(&H11) : CALL IBCMD(BRD0%,CMD$)
1130 IF IBSTA% < 0 THEN GOTO 1230
1140 REM   Clear instrument to default state: assert SDC
1150 ECODE = 7
1160 CALL IBCLR(DVM%)
1170 IF IBSTA% < 0 THEN GOTO 1230
1180 REM   Put instrument in 'Hold Mode' & select all SRQ conditions
1190 ECODE = 10
1200 WRT$ = "T122.2SP" : CALL IBWRT(DVM%,WRT$)
1210 IF IBSTA% < 0 THEN GOTO 1230
1220 ECODE = 0
1230 RETURN
1240 REM   ********************************************************************
1250 REM   Declarations & initialization
1260 REM   ********************************************************************
1270 DIM BUFR$(100,20)     'instrument message buffer
1280 DIM CMDSTR$(100)      'command string buffer
1290 DIM REF!(100)         'reference buffer
1300 DIM RUNITS$(100)       'measurement & reference units
1310 DIM CRTRIA!(100)      'fail criteria buffer
1320 DIM TTYP(100)         'test type buffer
1330 DIM MSTATS(100)       'measurement status
1340 DIM MARGIN!(100)       'PASS/FAIL MARGIN
1350 DIM CUNITS$(100)       'criteria units
1360 DIM MCNT(100)         'measurement counter buffer
1370 DIM TSTRT$(100)       'measurement start time buffer
1380 DIM TSTOP$(100)       'measurement stop time buffer
```

```
1390 DIM NOTES$(100)         'comments
1400 REM  Test constants:
1410 SETLCNT = 3             '# of consecutive in range measurements re: settling
1420 MAXTRIG = 20            '# of measurement attempts before test fails
1430 SRNGE! = .1             'settling range
1440 SPMAX = 100              '# of serial polls before test fails
1450 REM  Test variables initialization:
1460 TCNT = 0                'test counter
1470 NOMORE = 0              'no more test data flag
1480 ECODE = 0
1490 FCNT = 0 : PCNT = 0      'pass/fail counters
1500 REM  Test data input initialization
1510 REM  Collect data file name
1520 INPUT "Test data file "; INNAME$
1530 REM  If user response is null, data entered via keyboard
1540 IF INNAME$ = "" THEN IMODE = 1 ELSE IMODE = 2
1550 ON IMODE GOSUB 1640,1570
1560 RETURN
1570 OPEN "I",1,INNAME$
1580 REM  Get test identification from input file
1590 INPUT #1,TESTNM$,INSTRNM$,RMODE$
1600 REM  Get comments
1610 GOSUB 4810
1620 SNOTES$ = ANOTE$
1630 RETURN
1640 REM  Get test identification from keyboard
1650 INPUT "Test identification"; TESTNM$
1660 REM  Get instrument identification
1670 INPUT "Instrument identification";INSTRNM$
1680 REM  Report destination
1690 INPUT "Report to screen (S) or printer (P)"; RMODE$
1700 REM  General comments
1710 INPUT "General remarks";SNOTES$
1720 RETURN
1730 REM  **********************************************************************
1740 REM  Initialize test, get configuration data & send command string
1750 REM  **********************************************************************
1760 TCNT = TCNT + 1
1770 MCNT(TCNT) = 0  'total # of attempted measurements
1780 MSTATS(TCNT) = 0  'initial status = failed
1790 SFLAG = 0        '# consecutive in range measurements
1800 SETTLED = 0      'settled measurement flag
1810 REM  Read commands, reference & criteria from keyboard or data file
1820 ON IMODE GOSUB 5020,4900
1830 IF NOMORE = 0 THEN GOTO 1850
1840 TCNT = TCNT - 1 : RETURN
1850 IF CMDSTR$(TCNT) = "/" THEN GOTO 1890
```

```
1860 ECODE = 10
1870 CALL IBWRT(DVM%,CMDSTR$(TCNT))
1880 IF IBSTA% < 0 THEN GOTO 2180
1890 REM  Convert reference & save it
1900 IF REFSTR$ <> "/" THEN GOTO 1960
1910 IF TCNT <= 1 THEN GOTO 1940
1920 REF!(TCNT) = REF!(TCNT-1) : RUNITS$(TCNT) = RUNITS$(TCNT-1)
1930 GOTO 1970
1940 REF!(TCNT) = .1 : RUNITS$(TCNT) = "V"
1950 GOTO 1970
1960 REF!(TCNT) = VAL(REFSTR$)
1970 REM  Check whether criteria valid & save value
1980 IF CRTSTR$ <> "/" THEN GOTO 2040
1990 IF TCNT <= 1 THEN GOTO 2020
2000 CRTRIA!(TCNT) = CRTRIA!(TCNT-1) : TTYP(TCNT) = TTYP(TCNT-1)
2010 CUNITS$(TCNT) = CUNITS$(TCNT-1) : GOTO 2170
2020 CRTRIA!(TCNT) = .1 : TTYP(TCNT) = 1
2030 CUNITS$(TCNT) = "%" : GOTO 2170
2040 REM  Determine type of evaluation to be done on data
2050 TTYP(TCNT) = 1 : ECODE = 12
2060 CRTRIA!(TCNT) = VAL(CRTSTR$)
2070 I = 1 : L = LEN (CRTSTR$)
2080 M$ = MID$(CRTSTR$,I,1)
2090 IF (M$ = "R") OR (M$ = "r") OR (M$ = "D") OR (M$ = "d") THEN GOTO 2120
2100 I = I + 1
2110 IF I > L THEN GOTO 2180 ELSE GOTO 2080
2120 IF (M$ = "D") OR (M$ = "d")  THEN TTYP(TCNT) = 4
2130 IF I = L THEN GOTO 2170
2140 M$ = MID$(CRTSTR$,I+1,1) : TTYP(TCNT) = TTYP(TCNT) + 1
2150 IF (M$ <> "-") AND (M$ <> "+") THEN GOTO 2180
2160 IF M$ = "-" THEN TTYP(TCNT) = TTYP(TCNT) + 1
2170 IF (TTYP(TCNT) <= 3) AND (REF!(TCNT) = 0) THEN ECODE = 11 ELSE ECODE = 0
2180 RETURN
2190 REM  ******************************************************************
2200 REM  Read instrument messages & report read error if it occurs
2210 REM  ******************************************************************
2220 ECODE = 9
2230 RD$ = SPACE$(12) : CALL IBRD(DVM%,RD$)
2240 REM  If read error detected then return Read Failed error
2250 IF (IBSTA% AND &H8000) <> 0 THEN GOTO 2270
2260 ECODE = 0
2270 RETURN
2280 REM  ****************************************************************
2290 REM  Serial poll
2300 REM  ****************************************************************
2310 ECODE = 15
2320 SPCNTR = 0
```

```
2330 SPR% = 0
2340 CALL IBRSP(DVM%,SPR%)
2350 REM  If B6 of SPR not set, device not requesting service
2360 IF (SPR% AND &H40) <> 0 THEN GOTO 2410
2370 REM  If device not requesting service, try again ( upto 20 times)
2380 SPCNTR = SPCNTR + 1
2390 IF SPCNTR < SPMAX THEN GOTO 2330
2400 RETURN
2410 REM  If device requesting service, only B2..B0 relevant
2420 SPR% = SPR% AND &H7
2430 ECODE = 0
2440 RETURN
2450 REM   **********************************************************************
2460 REM  Trigger measurement & read results
2470 REM   **********************************************************************
2480 ECODE = 13
2490 CALL IBTRG(DVM%)
2500 IF IBSTA < 0 GOTO 2660
2510 REM   Serial poll device
2520 GOSUB 2310
2530 REM   If serial poll failed, exit
2540 IF ECODE <> 0 THEN GOTO 2660
2550 REM   Read instrument message
2560 GOSUB 2200
2570 IF ECODE <> 0 THEN GOTO 2660
2580 REM   If fatal instrument error returned, then exit
2590 ECODE = 14
2600 IF (SPR% AND &H4) <> 0 THEN GOTO 2660
2610 ECODE = 0
2620 MCNT(TCNT) = MCNT(TCNT) + 1
2630 BUFR$(TCNT,MCNT(TCNT)) = RD$
2640 REM   Evaluate results
2650 GOSUB 4170
2660 RETURN
2670 REM   **********************************************************************
2680 REM   Report test results on screen or printer
2690 REM   **********************************************************************
2700 RFLAG = 1 : AFLAG = 1          'intialize report flags to screen/all
2710 R1$ = MID$(RMODE$,1,1) : R2$ = MID$(RMODE$,2,1)
2720 IF (R1$ = "p") OR (R1$ = "P") THEN RFLAG = 2
2730 IF (R2$ = "f") OR (R2$ = "F") THEN AFLAG = 2
2740 LASTP = 0                          'last page flag
2750 REM   Build page header
2760 DIM HDR$(11) : DIM EVAL$(25)
2770 IF TESTNM$ = "/" THEN TESTNM$ = ""
2780 IF INSTRNM$ = "/" THEN INSTRNM$ = ""
```

```
2790 ON RFLAG GOSUB 5240,5340
2800 REM   Report individual test results
2810 IF TCNT = 0 THEN 3200
2820 FOR I = 1 TO TCNT STEP 1
2830 REM   Measurement evaluation
2840 IF (AFLAG = 2) AND (MSTATS(I) = 1) THEN GOTO 3190
2850 GOSUB 3250
2860 IF CMDSTR$(I) = "/" THEN CMDSTR$(I) = ""
2870 CMTSTR$ = "Command Sequence:    " + CMDSTR$(I)
2880 GOSUB 5790
2890 EL = 5
2900 FOR J = 1 TO 4 STEP 1
2910 EVAL$(EL) = CSTR$(J)
2920 EL = EL + 1
2930 NEXT J
2940 EVAL$(9) = "Measurement:" + SPACE$(7) + MSMSTR$
2950 EVAL$(10) = "Reference:" + SPACE$(9) + REFSTR$
2960 EVAL$(11) = "Fail Criteria:" + SPACE$(6) + CRTSTR$
2970 EVAL$(12) = "Analysis:" + SPACE$(11) + ANLYS$
2980 EVAL$(13) = "Start Time:" + SPACE$(9) + TSTRT$(I)
2990 EVAL$(14) = "Stop Time:" + SPACE$(10) + TSTOP$(I)
3000 EVAL$(15) = "Readings:"
3010 EL = 16 : J = 1 : JMAX = CINT(CSNG(MCNT(I))/2!)
3020 IF MCNT(I) => 10 THEN JMAX = 10 ELSE JMAX = MCNT(I)
3030 IF J > JMAX THEN GOTO 3100
3040 GOSUB 4430
3050 S1$ = SPACE$(10-LEN(NUM1$)) : S2$ = SPACE$(30-LEN(RDNG1$))
3060 S3$ = SPACE$(10-LEN(NUM2$))
3070 EVAL$(EL) = NUM1$ + S1$ + RDNG1$ + S2$ + NUM2$ + S3$ + RDNG2$
3080 EL = EL + 1 : J = J + 1
3090 GOTO 3030
3100 IF EL = 26 THEN GOTO 3130
3110 EVAL$(EL) = ""
3120 EL = EL + 1 : GOTO 3100
3130 CMTSTR$ = NOTES$(I)
3140 GOSUB 5790
3150 FOR J = 1 TO 4 STEP 1
3160 EVAL$(J) = CSTR$(J)
3170 NEXT J
3180 ON RFLAG GOSUB 3930,3800
3190 NEXT I
3200 REM   Display overall evaluation
3210 LASTP = 1
3220 GOSUB 5530
3230 RETURN
3240 REM   *****************************************************************
3250 REM   Evaluate test results
```

```
3260 REM   *****************************************************************
3270 IF (I <> TCNT) OR (ECODE < 9) THEN GOTO 3310
3280 MSMSTR$ = "Not Available" : ANLYS$ = STATUS$
3290 IF ECODE <> 12 THEN GOTO 3380
3300 CRTSTR$ = "Invalid" : GOTO 3440
3310 REM   Build measurement display string
3320 MSMSTR$ = STR$(VAL(BUFR$(I,MCNT(I)))) + " " + RUNITS$(I)
3330 REM   Build analysis string
3340 IF MSTATS(I) = 0 THEN A$ = "Failed" ELSE A$ = "Passed"
3350 IF CUNITS$(I) = "%" THEN C! = MARGIN!(I) * 100! ELSE C! = MARGIN!(I)
3360 ANLYS$ = A$ + " with a deviation of " + STR$(ABS(C!)) + " " + CUNITS$(I)
3370 REM   Build ctriteria string
3380 IF TTYP(I) > 3 THEN A$ = "(measurement - reference)" ELSE A$ = "(measuremen
t/reference - 1)"
3390 IF CUNITS$(I) = "%" THEN C! = CRTRIA!(I) * 100! ELSE C! = CRTRIA!(I)
3400 B$ = STR$(C!) + " " + CUNITS$(I)
3410 IF (TTYP(I) = 1) OR (TTYP(I) = 4) THEN CRTSTR$ = "abs" + A$ + " > " + B$
3420 IF (TTYP(I) = 2) OR (TTYP(I) = 5) THEN CRTSTR$ = A$ + " > " + B$
3430 IF (TTYP(I) = 3) OR (TTYP(I) = 6) THEN CRTSTR$ = A$ + " < " + B$
3440 IF ECODE = 11 THEN REFSTR$ = "Invalid" ELSE REFSTR$ = STR$(REF!(I)) + " " +
 RUNITS$(I)
3450 RETURN
3460 REM   *****************************************************************
3470 REM   Set DEVTN! to the difference between measurement & reference
3480 REM   *****************************************************************
3490 DEVTN! = MSMNT! - REF!(TCNT)
3500 RETURN
3510 REM   *****************************************************************
3520 REM   Set DEVTN! to the ratio of deviation measurement to reference
3530 REM   *****************************************************************
3540 DEVTN! = (MSMNT! / REF!(TCNT)) - 1
3550 RETURN
3560 REM   *****************************************************************
3570 REM   Fail if measurement result not in range
3580 REM   *****************************************************************
3590 MRGN! = ABS(DEVTN!) - CRTRIA!(TCNT)
3600 MARGIN!(TCNT) = ABS(DEVTN!)
3610 IF MRGN! > 0! THEN MSTATS(TCNT) = 0 ELSE MSTATS(TCNT) = 1
3620 RETURN
3630 REM   *****************************************************************
3640 REM   Fail if measurment result too large
3650 REM   *****************************************************************
3660 MRGN! = DEVTN! - CRTRIA!(TCNT)
3670 MARGIN!(TCNT) = ABS(DEVTN!)
3680 IF MRGN! > 0 THEN MSTATS(TCNT) = 0 ELSE MSTATS(TCNT) = 1
3690 RETURN
```

```
3700 REM    ****************************************************************
3710 REM    Fail if measurement result too small
3720 REM    ****************************************************************
3730 MRGN! = DEVTN! - CRTRIA!(TCNT)
3740 MARGIN!(TCNT) = ABS(DEVTN!)
3750 IF MRGN! < 0 THEN MSTATS(TCNT) =0 ELSE MSTATS(TCNT) = 1
3760 RETURN
3770 REM    ****************************************************************
3780 REM    Print test evaluation
3790 REM    ****************************************************************
3800 LPRINT CHR$(12)
3810 MID$(HDR$(2),PPNTR,2) = STR$(PNUM)
3820 FOR IJ = 1 TO 11 STEP 1
3830 LPRINT HDR$(IJ)
3840 NEXT IJ
3850 FOR IJ = 1 TO 25 STEP 1
3860 LPRINT SPACE$(5) + EVAL$(IJ)
3870 NEXT IJ
3880 IF PNUM = PMAX THEN LPRINT CHR$(12) ELSE PNUM = PNUM + 1
3890 RETURN
3900 REM    ****************************************************************
3910 REM     Write test evaluation to screen
3920 REM    ****************************************************************
3930 LN1 = 1                                        'first display line
3940 IF PNUM = PMAX THEN LN2 = 19 ELSE LN2 = 14     'last display line
3950 MID$(HDR$(1),PPNTR,2) = STR$(PNUM)
3960 PNUM = PNUM + 1
3970 FOR IJ = 1 TO 3 STEP 1
3980 PRINT HDR$(IJ)
3990 NEXT IJ
4000 FOR IJ = LN1 TO LN2 STEP 1
4010 PRINT EVAL$(IJ)
4020 NEXT IJ
4030 IF PNUM > PMAX THEN GOTO 4130
4040 FOR IJ = 1 TO (20 - ((LN2 - LN1) + 1)) STEP 1
4050 PRINT " "
4060 NEXT IJ
4070 INPUT "Continue";SCRQ$
4080 IF (SCRQ$ = "n") OR (SCRQ$ = "N") THEN GOTO 4120
4090 IF LN2 = 25 THEN GOTO 4130
4100 LN1 = 15 : LN2 = 25
4110 GOTO 3950
4120 END
4130 RETURN
4140 REM    ****************************************************************
4150 REM     Check for valid measurement results
4160 REM    ****************************************************************
```

```
4170 REM   Check whether data returned is an error
4180 IF (MID$(RD$,1,4) = "+900") AND (MID$(RD$,7,4) = "E+05") THEN GOTO 4370
4190 MSMNT! = VAL(RD$)
4200 REM   Check for settled measurement results
4210 IF TTYP(TCNT) <= 3 THEN TTYP1 = 1 ELSE TTYP1 = 2
4220 IF TTYP(TCNT) <= 3 THEN TTYP2 = TTYP(TCNT) ELSE TTYP2 = TTYP(TCNT) - 3
4230 REM   Calclate deviance
4240 ON TTYP1 GOSUB 3520,3470
4250 REM   Calculate analysis
4260 REM   Measurement relative to reference must be
4270 REM   Within specified range to pass, in the case of TTYP1 = 0
4280 REM   Below specified range to pass, in the case of TTYP1 = 1
4290 REM   Above specified range to pass, in the case of TTYP1 = 2
4300 ON TTYP2 GOSUB 3570,3640,3710
4310 IF MSTATS(TCNT) = 0 THEN GOTO 4370
4320 SFLAG = SFLAG + 1
4330 IF SFLAG < SETLCNT THEN GOTO 4380
4340 REM   Case of valid measurement reported & settling criteria passed
4350 SETTLED = 1
4360 RETURN
4370 SFLAG = 0
4380 IF MCNT(TCNT) => MAXTRIG THEN SETTLED = 1
4390 RETURN
4400 REM   ******************************************************************
4410 REM   Create "Readings:" display
4420 REM   ******************************************************************
4430 NUM1$ = STR$(J) + "." : R$ = BUFR$(I,J)
4440 GOSUB 4510 : RDNG1$ = R$
4450 IF MCNT(I) => (J+10) THEN GOTO 4480
4460 NUM2$ = "" : RDNG2$ = ""
4470 RETURN
4480 NUM2$ = STR$(J+10) + "." : R$ = BUFR$(I,J+10)
4490 GOSUB 4510 : RDNG2$ = R$
4500 RETURN
4510 IF (MID$(R$,1,4) = "+900") AND (MID$(R$,7,4) = "E+05") THEN GOTO 4540
4520 R$ = STR$(VAL(R$)) + " " + RUNITS$(I)
4530 RETURN
4540 R$ = "Error " + MID$(R$,5,2)
4550 RETURN
4560 REM   ******************************************************************
4570 REM   Create test status display
4580 REM   ******************************************************************
4590 IF ECODE <> 0 THEN GOTO 4610
4600 STATUS$ = "no errors generated" : RETURN
4610 ON ECODE GOTO 4620,4630,4640,4650,4660,4670,4680,4690,4700,4710,4720,4730,4
740,4750,4760,4770
4620 STATUS$ = "device find failure" : RETURN
```

```
4630 STATUS$ = "board find failure" : RETURN
4640 STATUS$ = "IFC failure" : RETURN
4650 STATUS$ = "remote enable failure" : RETURN
4660 STATUS$ = "listen address failure" : RETURN
4670 STATUS$ = "remote disable failure" : RETURN
4680 STATUS$ = "SDC failure" : RETURN
4690 STATUS$ = "LLO failure" : RETURN
4700 STATUS$ = "read failure" : RETURN
4710 STATUS$ = "write failure" : RETURN
4720 STATUS$ = "invalid reference" : RETURN
4730 STATUS$ = "invalid criteria" : RETURN
4740 STATUS$ = "trigger failure" : RETURN
4750 STATUS$ = "fatal instrument error " + MID$(BUFR$(TCNT,MCNT(TCNT)),5,2) : RE
TURN
4760 STATUS$ = "instrument not resquesting service" : RETURN
4770 STATUS$ = "measurement settling failure" : RETURN
4780 REM   ******************************************************************
4790 REM   Get comments from input file # 1
4800 REM   ******************************************************************
4810 INPUT #1,ANOTE$
4820 IF RIGHT$(ANOTE$,1) <> "'" THEN GOTO 4860
4830 INPUT #1,BNOTE$
4840 ANOTE$ = MID$(ANOTE$,1,LEN(ANOTE$)-1) + " " + BNOTE$
4850 GOTO 4820
4860 RETURN
4870 REM   ******************************************************************
4880 REM   Get configuration data from input file # 1
4890 REM   ******************************************************************
4900 IF EOF(1) THEN GOTO 4980
4910 INPUT #1,CMDSTR$(TCNT),REFSTR$
4920 IF REFSTR$ <> "/" THEN INPUT #1,RUNITS$(TCNT)
4930 INPUT #1,CRTSTR$
4940 IF CRTSTR$ <> "/" THEN INPUT #1,CUNITS$(TCNT)
4950 GOSUB 4810
4960 NOTES$(TCNT) = ANOTE$
4970 RETURN
4980 NOMORE = 1 : RETURN
4990 REM   ******************************************************************
5000 REM   Get configuration data from keyboard
5010 REM   ******************************************************************
5020 INPUT "Enter command string";CMDSTR$(TCNT)
5030 IF CMDSTR$(TCNT) = "" THEN GOTO 5230
5040 INPUT "Enter reference";REFSTR$
5050 INPUT "Enter criteria";CRTSTR$
5060 INPUT "Enter comments";NOTES$(TCNT)
5070 REM   Extract reference units from REFSTR if not /
5080 IF REFSTR$ = "/" THEN GOTO 5140
```

```
5090 RI = 1 : RL = LEN(REFSTR$)
5100 IF MID$(REFSTR$,RI,1) = " " THEN GOTO 5130
5110 RI = RI + 1
5120 IF RI < RL THEN GOTO 5100
5130 IF RI <> RL THEN RUNITS$(TCNT) = MID$(REFSTR$,RI+1,RL-RI)
5140 REM   Extract criteria units from CRTSTR if not /
5150 IF CRTSTR$ = "/" THEN GOTO 5220
5160 CI = 1 : CL = LEN(CRTSTR$)
5170 IF MID$(CRTSTR$,CI,1) = " " THEN GOTO 5200
5180 CI = CI + 1
5190 IF CI < CL THEN GOTO 5170
5200 IF CI <> CL THEN CUNITS$(TCNT) = MID$(CRTSTR$,CI+1,CL-CI)
5210 IF CI < CL THEN CRTSTR$ = MID$(CRTSTR$,1,CI-1)
5220 RETURN
5230 NOMORE = 1 : RETURN
5240 REM   *****************************************************************
5250 REM   Build screen header & initialize screen variables
5260 REM   *****************************************************************
5270 PMAX = (2 * TCNT) + 1            'total pages
5280 PNUM = 1                   'current page
5290 PPNTR = 65                 'page number position
5300 HDR$(1) = SPACE$(60) + "page 1  / " + STR$(PMAX)
5310 HDR$(2) = "Test ID:" + SPACE$(12) + TESTNM$
5320 HDR$(3) = "Instrument ID:" + SPACE$(6) + INSTRNM$
5330 RETURN
5340 REM   *****************************************************************
5350 REM   Build print header & initialize print variables
5360 REM   *****************************************************************
5370 PMAX = TCNT + 1                  'total pages
5380 PNUM = 1                         'current page
5390 PPNTR = 65                       'page number position
5400 HDR$(1) = ""
5410 HDR$(2) = SPACE$(60) + "page 1 of" + STR$(PMAX)
5420 HDR$(3) = ""
5430 HDR$(4) = SPACE$(25) + "5500 SYSTEM EVALUATION REPORT"
5440 HDR$(5) = ""  : HDR$(6) = ""
5450 HDR$(7) = SPACE$(5) + "Test ID:" + SPACE$(12) + TESTNM$
5460 HDR$(8) = SPACE$(5) + "Instrument ID:" + SPACE$(6) + INSTRNM$
5470 HDR$(9) = SPACE$(5) + "Date:" + SPACE$(15) + DATE$
5480 HDR$(10) = "" : HDR$(11) = ""
5490 RETURN
5500 REM   *****************************************************************
5510 REM   Display overall evaluation
5520 REM   *****************************************************************
5530 EVAL$(1) = "" : EVAL$(2) = ""
5540 EVAL$(3) = SPACE$(35) + "SUMMARY"
5550 EVAL$(4) = ""
```

```
5560 EVAL$(5) = "Start Time: " + SPACE$(8) + SSTRT$ : EVAL$(6) = ""
5570 EVAL$(7) = "Stop Time: " + SPACE$(9) + SSTOP$ : EVAL$(8) = ""
5580 EVAL$(9) = "Execution Status:  " + STR$(TCNT) + " measurement(s) attempted"
5590 STATS$ = SPACE$(20)
5600 IF ECODE = 0 THEN STATS$ = STATS$ + "Test completed with " ELSE STATS$ = ST
ATS$ + "Test aborted due to "
5610 GOSUB 4570
5620 EVAL$(10) = STATS$ + STATUS$ : EVAL$(11) = ""
5630 EVAL$(12) = "Analysis:" + SPACE$(11) + "Of" + STR$(FCNT+PCNT) + " measureme
nt test(s) performed"
5640 EVAL$(13) = SPACE$(19) + STR$(FCNT) + " failed and" + STR$(PCNT) + " passed
"
5650 EVAL$(14) = "" : EVAL$(15) = "Remarks:"
5660 CMTSTR$ = "  " + SNOTES$
5670 GOSUB 5790 : CL = 1
5680 FOR EL = 16 TO 19 STEP 1
5690 EVAL$(EL) = CSTR$(CL) : CL = CL + 1
5700 NEXT EL
5710 FOR EL = 20 TO 25 STEP 1
5720 EVAL$(EL) = ""
5730 NEXT EL
5740 ON RFLAG GOSUB 3910,3780
5750 RETURN
5760 REM   *****************************************************************
5770 REM   Process comments
5780 REM   *****************************************************************
5790 CI = 1
5800 IF RIGHT$(CMTSTR$,1) = "/" THEN CMTSTR$ = MID$(CMTSTR$,1,LEN(CMTSTR$)-1)
5810 IF LEN(CMTSTR$) < 75 THEN GOTO 5930
5820 CL = 75
5830 CS$ = MID$(CMTSTR$,1,CL)
5840 IF RIGHT$(CS$,1) = " " THEN GOTO 5900
5850 CL = CL - 1
5860 IF CL > 0 THEN GOTO 5830
5870 CSTR$(CI) = MID$(CMTSTR$,1,74)
5880 CMTSTR$ = MID$(CMTSTR$,75,LEN(CMTSTR$)-74)
5890 GOTO 5920
5900 CSTR$(CI) = MID$(CMTSTR$,1,CL-1)
5910 CMTSTR$ = MID$(CMTSTR$,CL+1,LEN(CMTSTR$)-CL)
5920 CI = CI + 1 : GOTO 5810
5930 CSTR$(CI) = CMTSTR$
5940 FOR CJ = CI+1 TO 4 STEP 1
5950 CSTR$(CJ) = ""
5960 NEXT CJ
5970 RETURN
```

```
5980 REM   ******************************************************************
5990 REM   Clear 5500 GPIB input buffer
6000 REM   ******************************************************************
6010 REM   Clear status byte
6020 SPR% = 0
6030 CALL IBRSP(DVM%,SPR%)
6040 REM   Read instrument messages
6050 GOSUB 2220
6060 REM  If message returned, continue to read until no more messages
6070 IF ECODE = 0 THEN GOTO 6050
6080 IF (IBSTA% AND &H4000) = 0 THEN GOTO 6100
6090 ECODE = 0
6100 RETURN
```

AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

OWNER'S MANUAL

SECTION 5

THEORY of OPERATION

Issue 07 January 1989

THEORY OF OPERATION

5.0.0 INTRODUCTION

This section describes the various circuits used in the 5500 as a guide to circuit operation and to assist in troubleshooting. Reference should be made to Section 8, Schematic Diagrams. The second digit of each subsection in this Theory of Operation identifies the schematic being described. For example, Subsection 5.4, Detectors, describes Schematic 4.

Additional relevant details are provided in Section 6, Maintenance and Calibration and Section 7, Parts List.

5.1.0 FILTER & NOTCH (Schematic 1a, 1b)

5.1.1 GENERAL DESCRIPTION

This circuit forms a programmable notch filter used for fundamental rejection in the THD mode of operation. Additionally provided are High Pass, Band Pass, and Low Pass outputs for selective, narrow band or noise measurements. Constructed on a plug-in circuit board labelled (1) FILTER, it follows the PROMAG™ format.

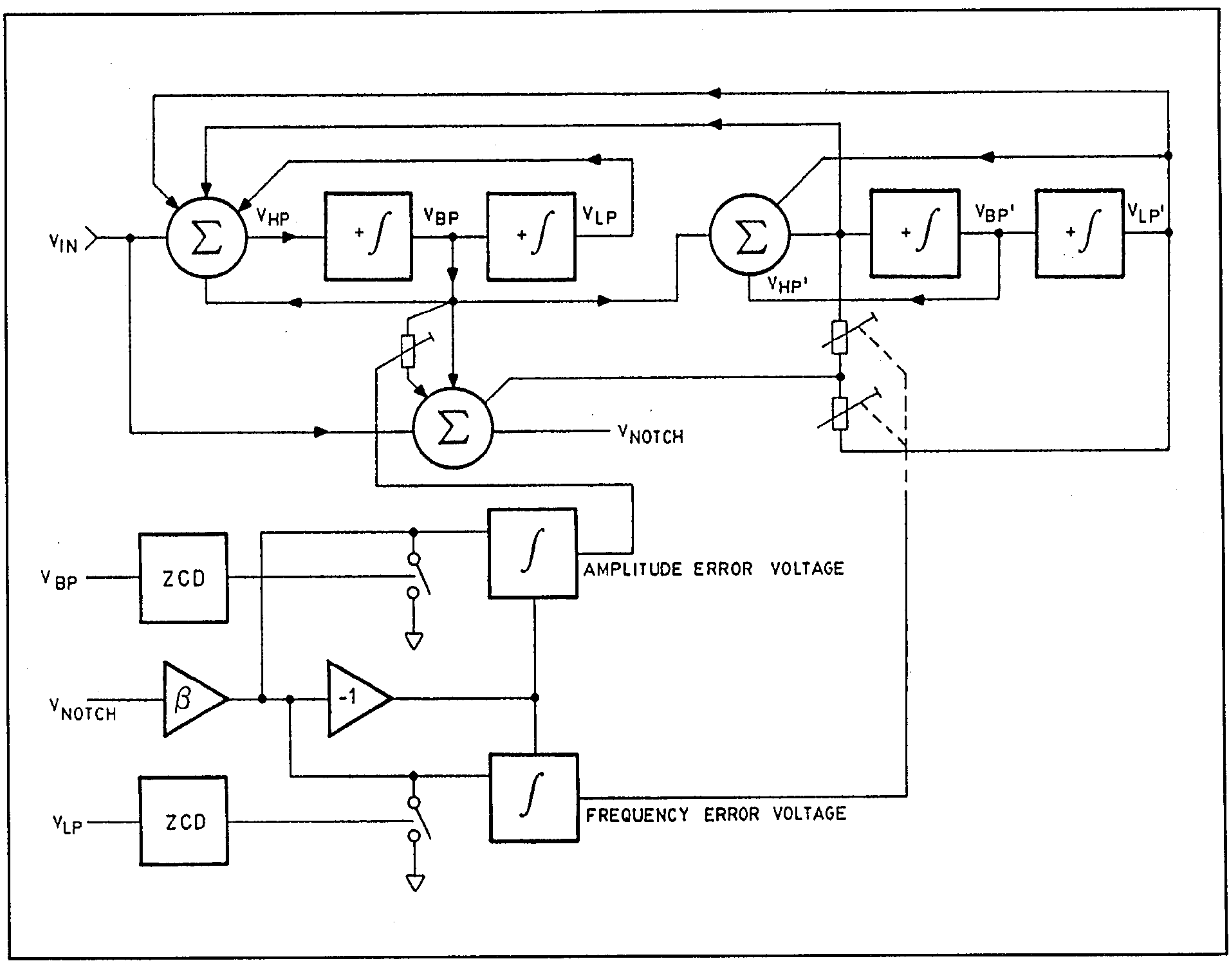
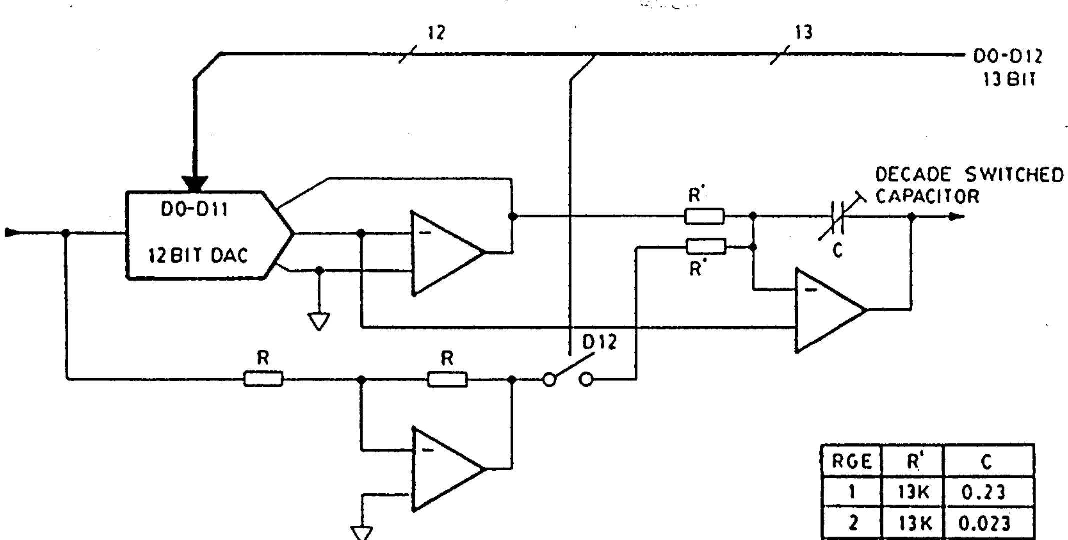


Fig. 5.1.2 Notch Filter & Servo

5.1.2 NOTCH FILTER

The notch filter is used to remove fundamental frequency in the THD measurement mode. It is variable from 10 Hz to 100 kHz. The filter also provides six additional outputs for narrow band measurements: four band pass modes with switchable "Q", one high pass output and one low pass output.

The main state variable loop consists of two coupled 2nd order state variable filters, each containing two non-inverting integrators and a differential summing amplifier. In the THD mode, an internal servo is enabled to auto-null the notch filter by an appropriate amount of phase and amplitude error correction.



RGE	R'	C
1	13K	0.23
2	13K	0.023
3	13K	2220P
4	13K	220P

$$V_{out} = \frac{1}{R'C} \int V_{in} \, dt. \left(\frac{\text{CODE IN DECIMAL}}{4096} \right)$$

$$f_o = \frac{1}{2\pi R'C} \left(\frac{\text{CODE IN DECIMAL}}{4096} \right)$$

Fig. 5.1.3
Non-inverting integrator with feed forward compensation

5.1.3 FILTER INTEGRATORS

Center frequency of the notch filter is changed by relay switching four decade spaced capacitors in each respective integrator. A 13-bit multiplying DAC (Digital-to-Analog converter) is used to change the effective value of the integrator resistor providing fine frequency tuning within each decade. The 13-bit DAC is the combination of a monolithic 12-bit DAC plus a discrete 13th bit switched as the most significant bit. This 13th bit is used to reduce the effective noise gain of the integrator as frequency is switched towards the lower portion of a decade range.

Phase shifts in the cascaded amplifiers making up this integrator can cause undesirable "Q" enhancements at high filter frequencies. To counter this, a feed forward path is used to the Miller integrator to achieve a 3-fold increase in "Q" factor compared to an uncompensated integrator. This results in the total phase shift being equal to a simple Miller integrator alone.

5.1.4 NOTCH AMP AND SERVO

Notch or fundamental rejection is achieved by the summation of the filter input signal with the phase inverted Band Pass output of a State Variable Filter. At resonance, the band pass output of this filter will be exactly 180° out-of-phase with the input and thereby achieve fundamental rejection.

Due to component tolerances in the state variable loop, fundamental rejection of the notch filter alone is typically only about 40 dB, while over 100 dB is desired. To achieve this, a notch servo circuit is used to automatically trim the phase and gain to produce complete rejection.

The notch amplifier (U1021) output is amplified 40 dB by a residual gain amplifier, U1016A and U1016B. This signal is chopped at a rate synchronous with the fundamental signal by switches Q1004 and Q1005 such that the presence of fundamental in the signal will produce a non-zero average value at the output of the switch. Both normal and quadrature switches are used to accommodate any phase angle of error signal.

The frequency (or phase) servo correction circuit uses the filter low pass output to generate the chopping signal. The integrator following the chopper smooths the signal and produces a DC error voltage proportional to the amount of fundamental present in the signal. The integrator gain is also switched with frequency to optimize loop gain and decrease settling time at low frequencies. Capacitors are switched in four one decade steps from 10 Hz to 100 kHz.

The derived DC error voltage is used for phase correction of the filter loop by injecting some lead/lag quadrature phase signal to the notch amp.

5.1.5 FILTER AMPLITUDE SERVO

The same amplified residual error signal used in the previously described phase servo is fed to another chopper switch controlled by a square wave representing phase 2 (band pass output) of the state variable filter. At the amplitude servo, an equivalent full wave rectified error signal is presented to an integrator by summing the chopped signal and the inverse distortion signal. Thus any fundamental component synchronous with V_{BP} will create an error DC voltage at the integrator output. This error voltage represents the amplitude imbalance between V_{IN} and V_{BP} and is used to control an amplitude LDR (light dependent resistor - LED), Q1010, adjusting the amount of V_{BP} amplitude required for total cancellation.

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THEORY OF OPERATION

5.2.0 LOW DISTORTION STATE VARIABLE OSCILLATOR (Schematic 2a, 2b)

5.2.1 GENERAL DESCRIPTION

The oscillator is used as a primary signal source to generate low distortion sine waves, with four decades of frequency span from 10 Hz to 100 kHz. It also contains a square wave generator derived from the sine output. The oscillator may also be switched to a filter mode providing a second order low pass and band pass outputs with Q = 1.0. The oscillator consists of two non-inverting integrators and differential summing amplifier connected in a loop. An analog multiplier provides a variable level alternate feedback path around the summing amplifier for level control and is referred to as the AGC circuit.

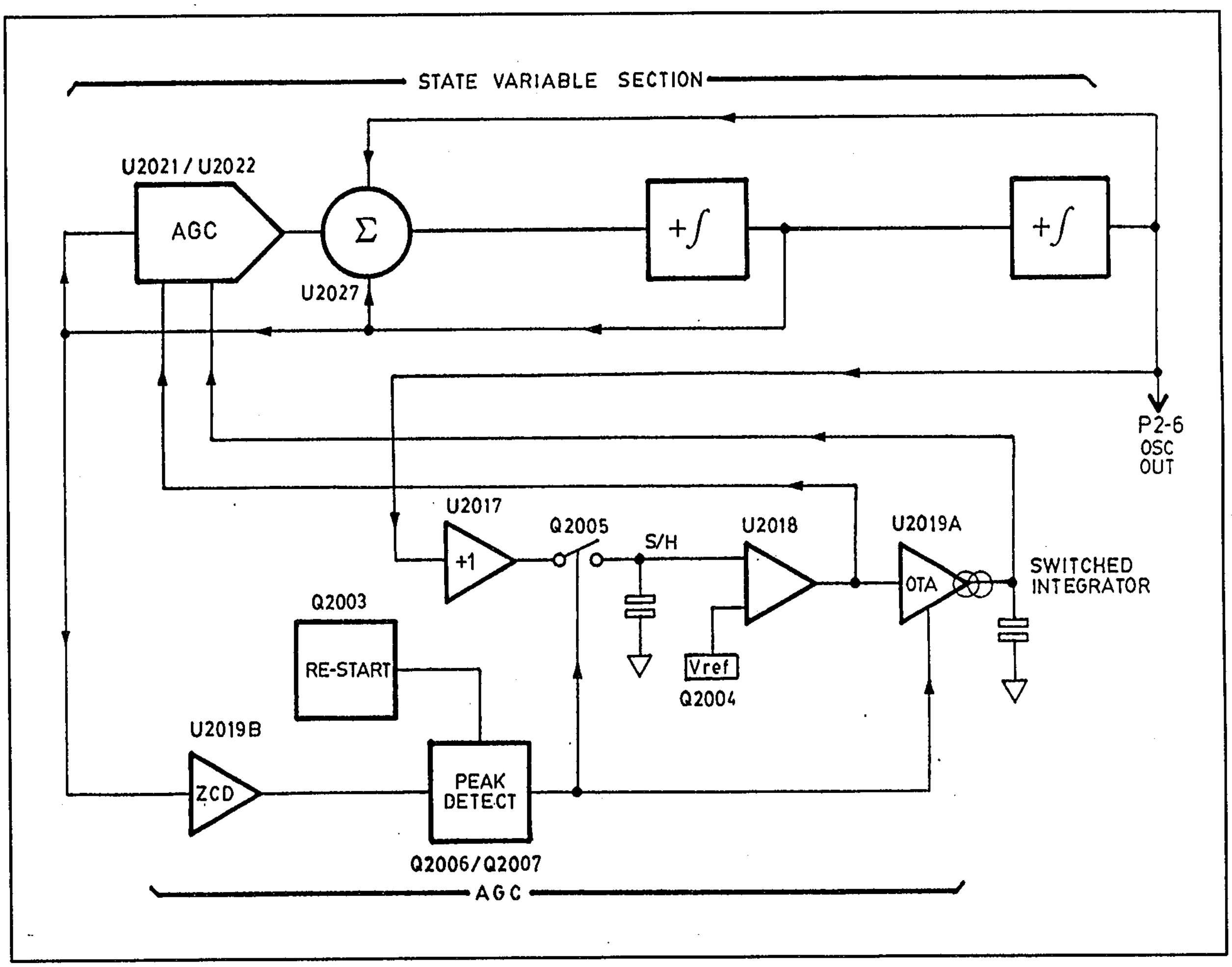
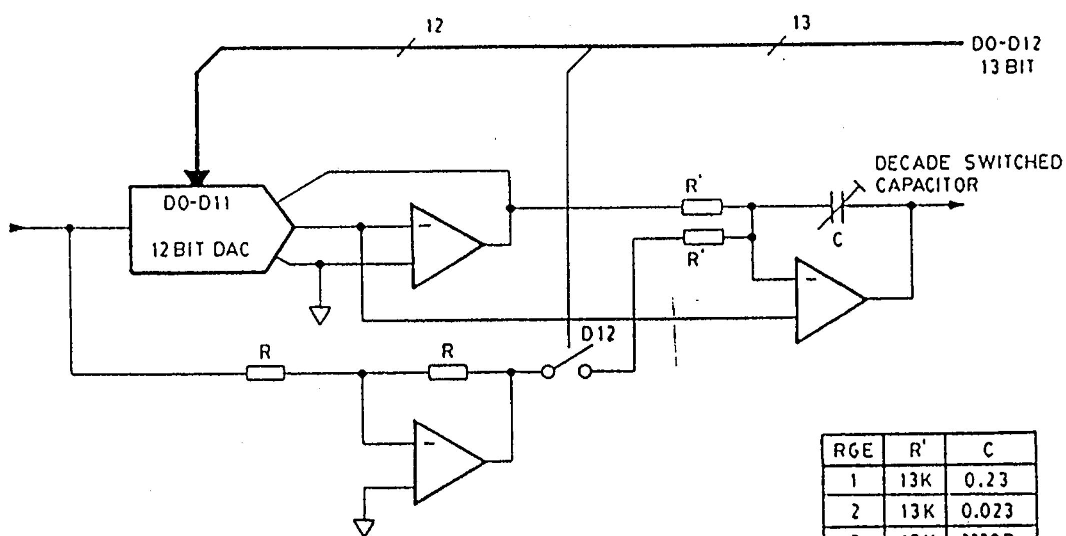


Fig. 5.2.1 Oscillator & AGC circuits simplified

5.2.2 INTEGRATOR

The oscillator frequency is changed by relay switching four decade spaced capacitors across the integrator and a 13-bit CMOS multiplying DAC is used to change the effective value of the integrator resistor providing the fine frequency resolution within each decade of frequency. The 13-bit DAC is the combination of a monolithic 12-bit DAC plus a discrete 13th bit switched as the most significant bit. This 13th bit is used to reduce the effective noise gain of the integrator as the frequency is switched towards the lower portion within the decade range.

Phase shifts in the cascading amplifiers making up this integrator can cause undesirable "Q" enhancements at high filter frequencies. To counter this, a feed forward path is used to the Miller integrator to achieve a 3-fold increase in "Q" factor compared to an uncompensated integrator. This results in a total phase shift being equal to a simple Miller integrator alone.



RGE	R'	C
1	13K	0.23
2	13K	0.023
3	13K	2220P
4	13K	220P

$$V_{out} = \frac{1}{R'C} \int V_{in} \; dt. \left(\frac{\text{CODE IN DECIMAL}}{4096} \right)$$

$$f_o = \frac{1}{2\pi R'C} \left(\frac{\text{CODE IN DECIMAL}}{4096} \right)$$

Fig. 5.2.2
Non-inverting integrator with feed forward compensation

5.2.3 OSCILLATOR AGC LOOP

The purpose of the AGC loop is to measure the oscillator output amplitude, compare it to a reference voltage corresponding to the desired level and generate an error voltage which when delivered to the multiplier, forces the oscillator output amplitude to equal the desired level.

A sample and hold circuit is used to measure the oscillator output level by driving the FET Q2005 on at each peak of the sine wave over a 13 μs window. The potential at the hold capacitor is compared with a reference voltage (V-Ref) and outputs an error voltage cycle by cycle. This error voltage is converted to a control voltage by a switched integrator whose gain is proportional to frequency. This control voltage is then used to drive the multiplier completing the loop. In the oscillator mode, the multiplier is used to supply a controlled amount of positive feedback to counter the damping resistor R2077. In the filter mode, the multiplier is disconnected from the filter loop and filter "Q" is set at 1.

5.2.4 SQUARE WAVE OUTPUT

Either sine wave or square wave outputs can be switched to output bus. The square wave generator is disabled when sine wave is selected to avoid the switching noise that would otherwise be generated. The sine wave output is used to feed a zero crossing detector "squaring" the output to a peak-to-peak voltage of approximately ±V Ref (+3.1623 V) supplied through P1-36. This squared-up voltage then drives a CMOS inverter as a buffer and swings the output within millivolts of V-Ref. This is then followed by an inverting op-amp to control the slew rate of the square wave so that succeeding stages are not over-driven.

Both duty cycle and gain trims are provided for calibration of the square wave.

A separate utility square wave output is provided on P1-10 for frequency measurement; this output is TTL compatible.

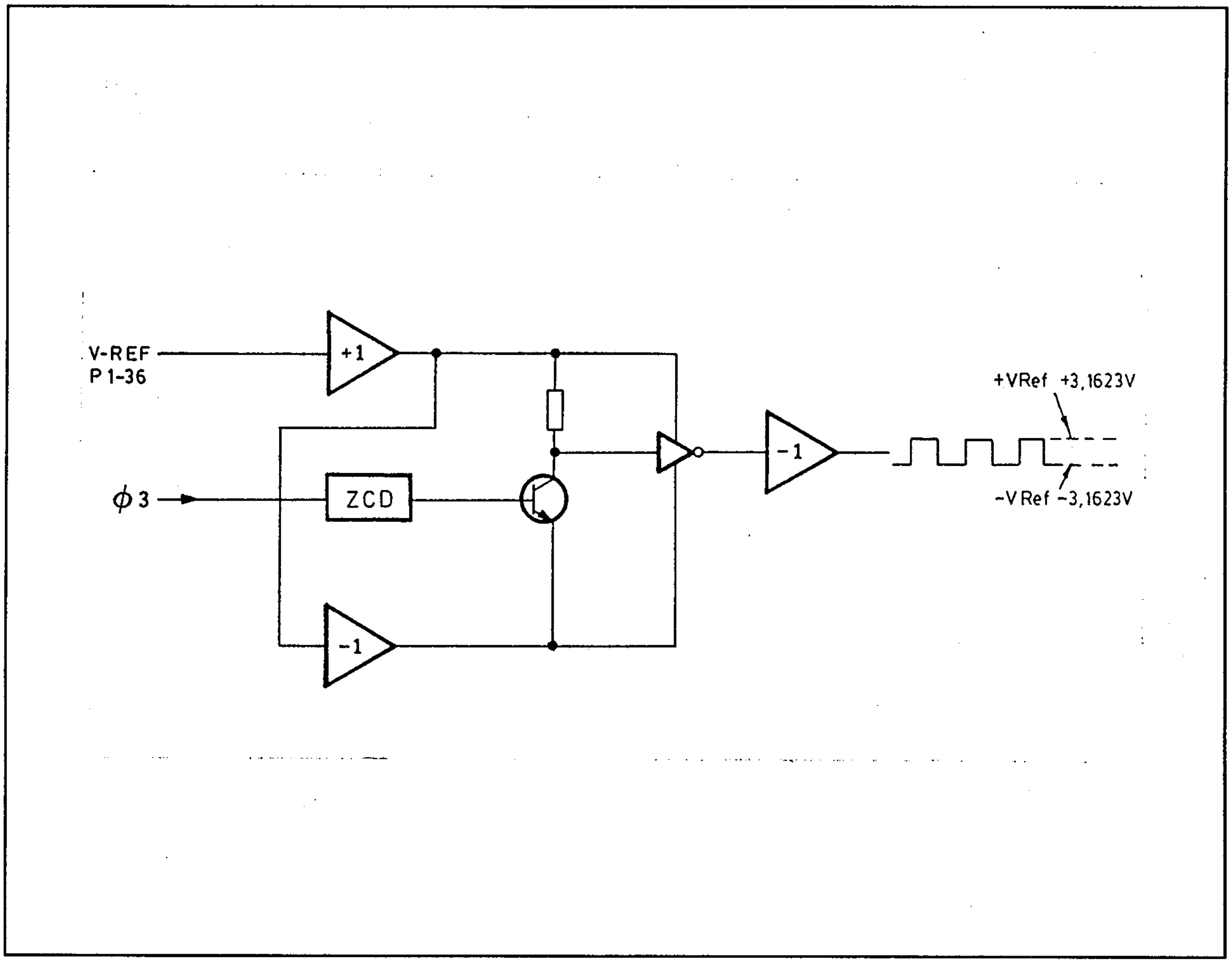


Fig. 5.2.4 Square wave generator

5.3.0 INPUT ATTENUATOR & PREAMPLIFIER

5.3.1 GENERAL DESCRIPTION

This circuit serves to normalize signal levels presented to the INPUT of the 5500 system. Also referred to as PGA (Programmable Gain A), it is constructed on a plug-in PROMAG™ circuit board labelled (3) PREAMP. Its circuit appears on Schematic 3a, 3b.

5.3.2 INPUT TERMINATION

Two input resistors are provided for switchable input termination, 150 ohm and 600 ohm, 2 Watt for both A and B inputs. Termination is not provided for internal oscillator receive. These resistors switch across high and low inputs of a balanced input and across high and ground of an unbalanced input. They are selectable by a front panel control or GPIB command.

5.3.3 INPUT COUPLING CAPACITORS

Input signal is AC coupled via two 1 μf, 400 Volt film capacitors. These are matched to within 0.5% to achieve good low frequency CMRR.

5.3.4 INPUT ATTENUATOR

Following the AC coupling, the signal then appears across two 100 k ohm input attenuators used to normalize high input signal levels to +10 dBV. These are relay switched in 10 dB steps giving attenuations of 0 dB, -10 dB, -20 dB and -30dB. Input compensation capacitors are used to counter stray capacitances which would effect high frequency response.

5.3.5 PROTECTION

At -10, -20 and -30 attenuation settings, input circuitry is protected by the current limiting of the attenuator resistors. However, when set to unity gain and suddenly presented with a high voltage, further input protection is necessary until auto-ranging attenuates the signal to a safe level. Under these overload conditions a light bulb, which has a cold resistance of approximately 600 ohms, will illuminate presenting a high impedance and serve as a current limiter. A 0.01 μf capacitor is connected across the light bulb to compensate for its inductance. Referring to Figure 5-3, diodes D1 through D6 complete the protection circuit.

5.3.6 CASCODE PREAMP

Two hybrid preamps are used for front-end gain. A cascode configuration is used for low input capacitance and wide bandwidth. The FETs used are biased at 2 mA each by an active current source. Cascode clamp limits V_{DG} to less than 2 diode drops for all voltage excursion levels and removes the effect of C_{GD} (Miller capacitance) increasing the bandwidth of the input stage. This coupled with its active drain load has ample current to charge C_c of the following operational amplifier, raising the dominant pole of the composite operational amplifier. The operational amplifiers, U3005 and U3012, are unity gain stable. As they have a slow input stage, it is shutdown by tying pins 2 and 3 to ground and replaced by the FET cascode stage. Some over-compensation is used (C3016, C3042) to ensure stability.

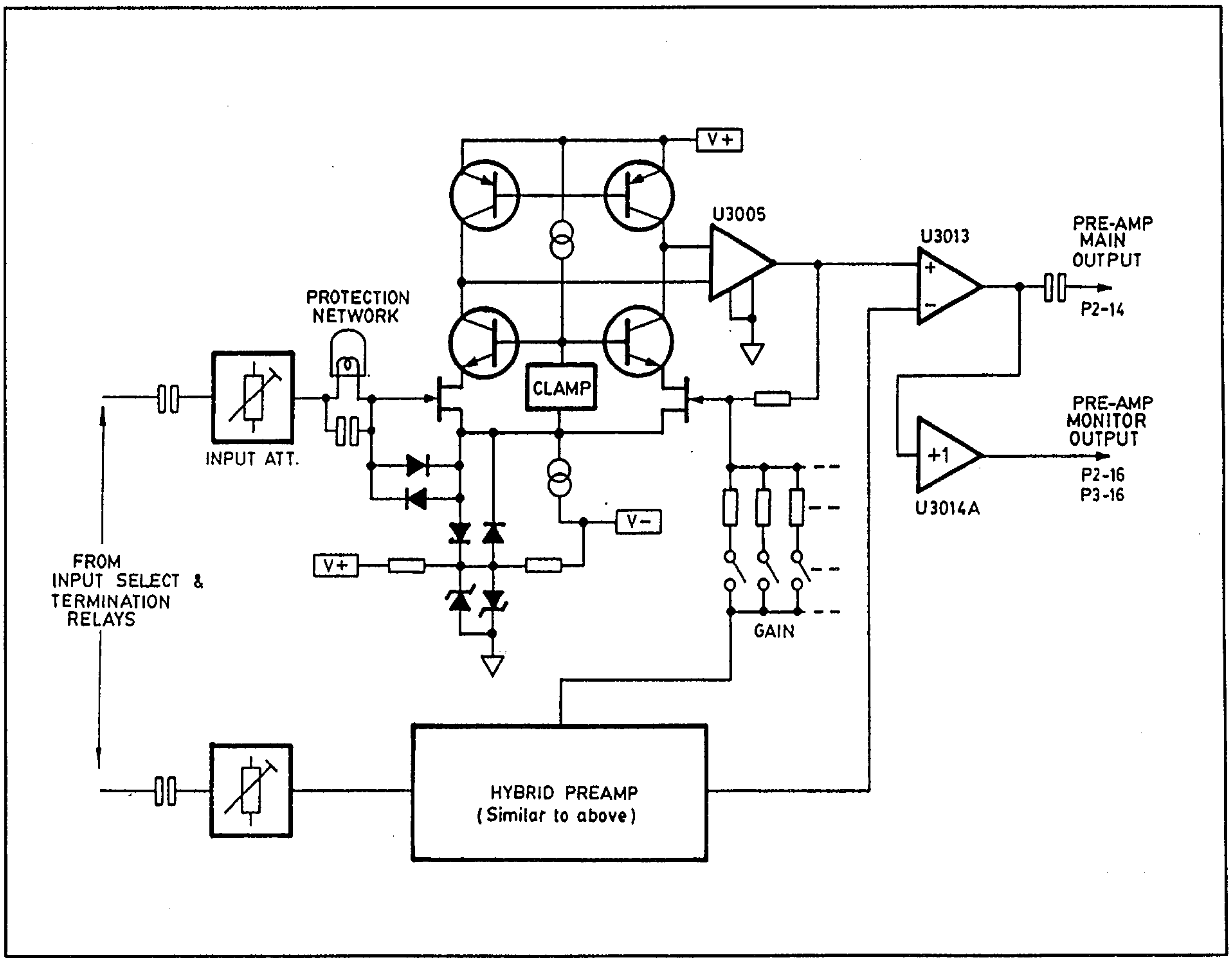


Fig. 5.3 Programmable Gain A simplified

5.3.7 OUTPUT DIFFERENTIAL AMPLIFIER

Outputs of the cascode preamps are combined through a classic differential amplifier (U3013) coupled with a DC feedback integrator (U3014B) to null out DC offsets. Broad band and high frequency common mode rejection trims are provided at this stage followed by a unity gain buffer (U3014A) to provide a monitor output for general utility use.

Table 5-3 Preamp Gain/loss

LEVEL MODE			DISTORTION MODE		
NOMINAL INPUT SIGNAL RANGE dBV	ATTENUATOR LOSS dB	PREAMP GAIN dB	NOMINAL INPUT SIGNAL RANGE dBV	ATTENUATOR LOSS dB	PREAMP GAIN dB
+40 to +30	-30	0	+40 to +35	-30	0
+30 to +20	-20	0	+35 to +30	-30	+5
+20 to +10	-10	0	+30 to +25	-20	0
+10 to 0	0	0	+25 to +20	-20	+5
0 to -10	0	+10	+20 to +15	-10	0
-10 to -20	0	+20	+15 to +10	-10	+5
-20 to -30	0	+30	+10 to +5	0	0
			+5 to 0	0	+5
			0 to -5	0	+10
			-5 to -10	0	+15
			-10 to -15	0	+20
			-15 to -20	0	+25

NOTE: 1) Auto-ranging hysteresis will cause a variation of approximately +0, -2 dB of nominal input range level.

2) Gains and attenuations are set by 0.1% tolerance resistors achieving a gain/loss accuracy of 0.01 dB.

5.3.8 CONTROL LOGIC

The preamp board analog circuitry is controlled by the host CPU through the digital interface resident on the board. The circuit design follows the PROMAG™ Digital Interface standards. Address and data descriptions are in hexadecimal notation.

5.3.9 DECODING LOGIC

With reference to schematic #3, address decoding is by U3011 (74LS85, 4-bit magnitude comparator) and U3010 (74LS138, 1-to-8 decoder). Using the decoding links CL0, CL1, CL2, and CL3, U3011 decodes the address block between 80 and 87 inclusive. This then qualifies U3010 where, when in a write cycle, only address 80 and 81 are used to control all functions on the preamp board. The data bus is routed to U3006 (74LS273, octal D flip-flop) and in reduced form, i.e. D0 - D5, to U3016 (74LS174, hex D flip-flop). Both flip-flops have their master reset inputs connected to the QUIET STATIC BUS reset line so that on power-up the flip-flops are set to logic low outputs. Data is latched into U3006 at address 80 and into U3016 at address 81.

5.3.10 FUNCTIONAL & GAIN CONTROL

The preamp functions are controlled by individual or groups of data bits through three ULN2003 transistor arrays (U3015, U3004, U3008). Four functional groups are implemented by the interface design. U3003 (74LS259) decodes three data bits to control the positive gain relays. U3007 decodes two bits for controlling the attenuator relays. And U3009 decodes two bits for input selection control. The input termination select control is by two data bits latched by U3016.

5.4.0 DETECTOR BOARD (Schematics 4a, 4b)

The analog circuitry of the detector board selects various AC signal sources from the 5500, conditions them and, through digitally controlled switching circuits under CPU control, sends two signals to the CPU for amplitude and frequency readings respectively. Both signals are logic level pulses whose frequencies have a direct relationship to the amplitude and frequency of the corresponding analyzer signals. The CPU, by selecting the sources for these two signals, determines all automated system settings and operations.

5.4.1 PGC (PROGRAMMABLE GAIN "C")

The PGB and weighting filter output is fed on P2-48 to a FET buffered operational amplifier with a high input impedance and low bias current (Q4003 and U4020). The input signal is DC coupled through a 2k2Ω resistor. The FETs are biased at 5 mA by an active current source (Q4004 and Q4005) and feed the second stage of a 5534 (U4020) with its front end shut down. One of three gains is selected by a DG211 CMOS analog switch (U4021) under control of the CPU through the interface logic. The PGC stage gains are 0, +10, and +20 dB and its output is buffered by half of a LF412 operational amplifier (U4005).

The PGC output is fed to various circuits on the detector board. PGC is buffered by half of a TL072 (U4017) and is connected to the MEASURED FUNCTION MONITOR BNC on the front panel. The output is protected by a series resistance and zener diode clamps. PGC also feeds P1-34.

5.4.2 RMS CONVERTER

PGC is also fed to an AD536A rms-to-DC converter IC (U4009). This device computes the true rms value of a complex input waveform. Using a CPU controlled method of changing the effective value of the external capacitor, which sets the averaging time constant, a performance balance is achieved between output ripple and settling time. A 4053 CMOS switch (U4010) adds capacitance to the fixed capacitor C4032 to optimize performance. Output ripple is further reduced by a single pole post filter (C4033). An internal buffer amp provides the rms output to one input of the level multiplexer.

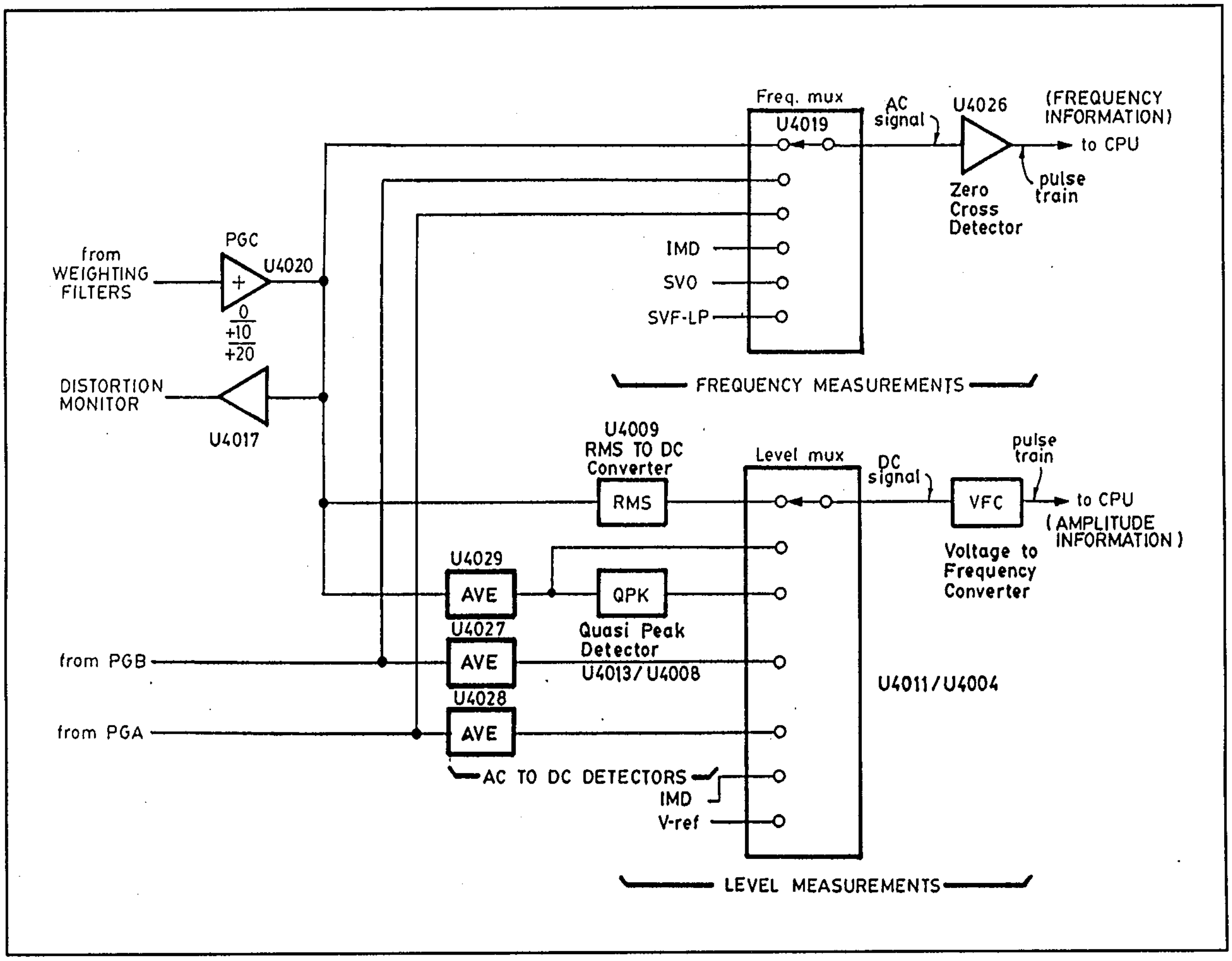


Fig. 5.4 Detectors and switching simplified

5.4.3 ABSOLUTE VALUE AVERAGING

PGC is additionally fed to a precision absolute value circuit (U4029) used as an average response detector for level measurement. Gain matching to the rms detector is provided by the software AUTOCAL routines.

5.4.4 LEVEL DETECTION

The host CPU selects, by means of U4004 (DG508, CMOS analog multiplexer), the source signal for amplitude detection. All sources to the level multiplexer are normalized and the output is buffered by U4007. Zener diode clamps on the input prevent extreme out-of-range conditions at later stages. The output of the buffer goes to a DG211 switch (U4003) where the CPU can select the output or one reduced by 6 dB. This is now further buffered by the second half of U4007 (TL072). The buffer output is sent to P1-38 and to the input of the voltage-to-frequency converter (U4006 - VFC 32). With the input and offset trims (VR4002 & VR4001), the voltage-to-frequency converter is calibrated so that a normalized signal will be between 0 V and 3.162 V producing a "within range" frequency output. This is a pulse train and, by referencing this against a master clock, the CPU is able to determine the represented amplitudes.

As stated previously, the host CPU selects the source to the voltage- to-frequency converter by the eight channel multiplexer, U4004. In normal operation, the CPU scans different points in the 5500 system to maintain gain stages at their proper settings.

5.4.5 QUASI-PEAK DETECTOR

The third source to the multiplexer is the Quasi-peak detector which meets CCIR 468-3 specifications for attack/decay time constants.

The output of the average detector is tapped at U4029, pin 7 and brought through a trimmable voltage divider for level matching. U4013B is an absolute value buffer. The input and output RC networks around U4013A provide specific charge/discharge time constants. The circuit formed by U4008, Q4002 and associated components form the peak hold with preset decay circuit. This output is fed to the level multiplexer.

5.4.6 PGA-PGB DETECTORS

Gains are monitored and set by the host CPU, by use of average responding amplitude detectors, whose inputs are from the preamp and PGB board respectively. The detectors are identical to the average detector for PGC. They are formed by U4028 and U4027 and feed the next two inputs to the level multiplexer.

5.4.7 IMD DETECTOR (Requires option 002)

Input to the level multiplexer is via P2-42. An average detector on the IMD PROMAG™ board provides the normalized DC level send to the detector board. A simple RC network formed by a low pass single pole filter provides signal conditioning at the multiplexer input. When the IMD option is installed, the CPU monitors distortion reference levels through this detector.

5.4.8 V-REF

V-REF is a precision voltage source of 3.162 V generated by Q4001 (TL431, precision voltage regulator) and buffered by U4005A. This is fed to the last input of the level multiplexer, to the P1 bus and as bias to the summing node of the VFC32. It is also fed through a switch in the DG211 (U4003) to the summing node of U4005B (PGC input buffer) as a method of controller calibration.

5.4.9 FREQUENCY DETECTOR

PGC, PGB, and PGA are also fed, while they are normalized bipolar waveforms, to the frequency multiplexer formed by a DG508 (U4019). This multiplexer's output is AC coupled to a TL311 (U4026) high speed comparator to produce a square wave representing the signal frequency which is fed to the CPU. The remaining five inputs of the frequency multiplexer are assigned to the P2 and P3 bus. Certain inputs have been assigned to the IMD option to read recovered LF and HF and to the internal oscillator to read generator frequency directly.

5.4.10 LOGIC CIRCUITS

The logic circuitry on the detector board is divided into two sections. The QUIET STATIC BUS LOGIC provides an additional set of bus transceivers for address, data, and control signals buffering to other PROMAG™ modules (which only become active when the PROMAG™ modules are accessed). This in effect keeps the activity on the P1 bus on the motherboard to a minimum to reduce the possibility of polluting any analyzer functions or measurements. The second section is the digital interface to the detector board functions. All addresses and data are in hexadecimal notation.

5.4.11 STATIC BUS INTERFACE

With reference to Schematic #4b, the STATIC BUS buffers of the CPU connect to the detector board on J4002 by a 50-wire ribbon cable. The QUIET STATIC BUS interface logic forms the CPU signal buffering to the 5500 system P1 bus. All PROMAG™ module's logic interface is via the motherboard P1 bus. The STATIC BUS address lines are 8 bits which sets STATIC BUS I/O to a 256 byte address block.

The address lines buffer (U4015) is enabled by any STATIC BUS address between 80 and FF because A7, through inverter U4018, is used to enable U4015. Pull-up resistors for A0 - A6 and R/W keep the QUIET STATIC BUS in a non-floating mode when not accessed. Address line A7 on the QUIET STATIC BUS is continually a logic high by being connected only to a pull-up.

In a write cycle to the QUIET STATIC BUS, the R/W line will set the direction of the data bus transceiver U4022. The logic low of the R/W line also, through gate U4025 and U4018, immediately enables U4022. A7 being high on the STATIC BUS also qualifies the EN* signal to be sent through to the QUIET STATIC BUS by gate U4025. Pull-ups are also used on the data bus and EN* signal to keep them in a non-floating state when not accessed.

In a read cycle, the R/W line again sets the direction of the data bus driver but the driver will only be enabled when EN* is true thus preventing erroneous data from being on the data bus.

All other pins on J4002 (STATIC BUS) and P1 (QUIET STATIC BUS) are connected together 1-to-1.

5.4.12 DETECTOR INTERFACE

The detector board analog circuitry is controlled by the CPU through the digital interface resident on the board. The interface follows the PROMAG™ digital interface standards to hardware usage. Address decoding is by U4016 (74LS85, 4-bit magnitude comparator) and U4014 (74LS138, 1-of-8 decoder). Using links CL1 and CL3, U4016 decodes the address block of 28 to 2F. The first two addresses in this block are selected for use from U4014 (28 & 29) and only in write mode by using the R/W line as a qualifier.

Two 74LS273 octal D flip-flops are used to latch data from the CPU when either of them is addressed by tying their clock inputs to decoder outputs. U4024 is clocked by address 28 and U4023 by address 29. The MASTER RESET pins are connected to the system RESET* on the QUIET STATIC BUS to ensure known states whenever the instrument is powered up.

The latched outputs are used as individual bits or in groups as coded controls. The level and frequency multiplexers use binary codes and enable information from U4024 while the information in U4023 is further adapted to the hardware that is controlled. U4012 (DG508) is used as an active high 1-of-8 decoder with the high level being set to +15 V.

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5.5.0 POWER AMPLIFIER (Option 001)

5.5.1 GENERAL DESCRIPTION

This circuit, constructed on a plug-in PROMAG™ circuit board labelled (5) POWER AMP, serves to amplify the fixed level oscillator output and provides coarse (-20 dB steps) and fine attenuation for precision level setting. The circuit card occupies two PROMAG™ slots and contains a plug-in daughter board which is shielded within its own metal enclosure. The main circuit card follows the PROMAG™ board convention with its associated P1, P2 and P3 plug-in tongues. Attached to the metal shield box is a heat sink required for thermal dissipation of the output transistors. (Though heat sinking is provided, this board is not intended to operate in free air but requires the air currents generated within the 5500 frame to assist in thermal dissipation.) An isolation transformer is also attached to the shield box and is itself contained in a mumetal shield.

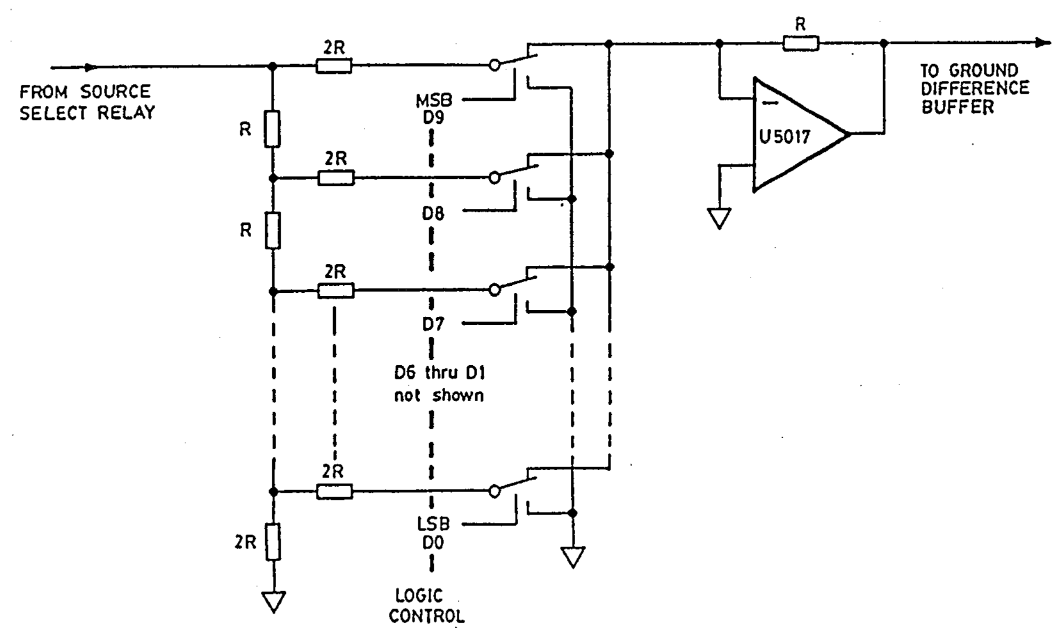

Fig. 5.5.1 10-BIT DAC, fine level control

5.5.2 10 BIT DAC FINE LEVEL CONTROL (Referring to Figure 5-5.1 and Schematic 5)

The main or auxiliary signal source bus is selectable with a relay to the input of a 10-bit discrete MDAC (multiplying digital to analog convertor). The R-2R resistor ladder is comprised of a combination of 10 k and 20 k R-nets and discrete resistors. The switches are 4053 "form C" CMOS switches. This allows the fine level control of 0.03 dB or better over a 10 dB range.

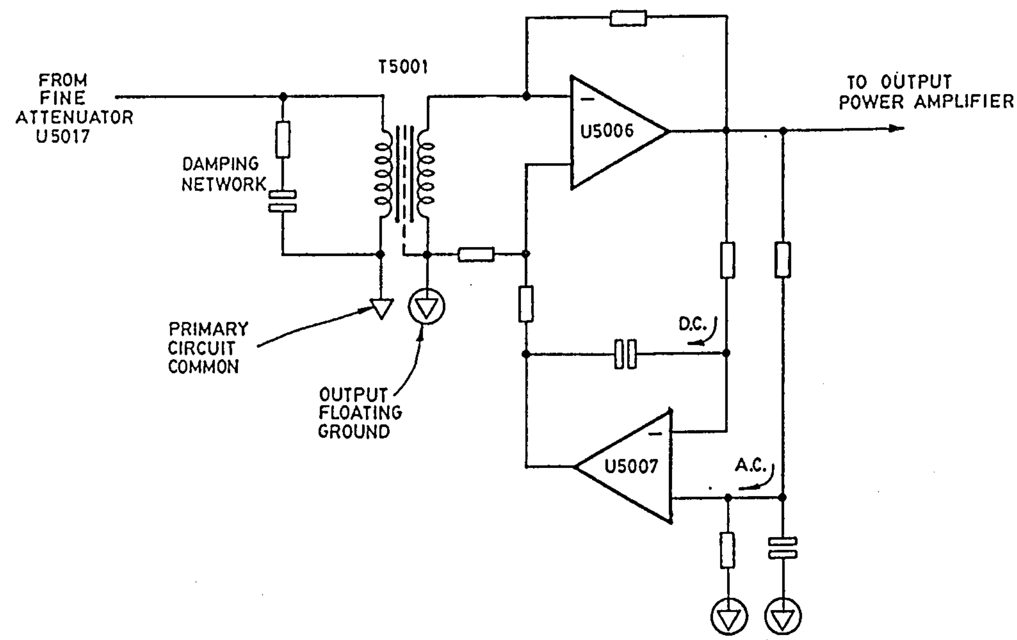

Fig. 5.5.2 Ground difference buffer

5.5.3 GROUND DIFFERENTIAL BUFFER (Figure 5-6)

A transformer is used to couple the ground referred input to the floating power amplifier (Figure 5-5.2). A combination of DC negative feedback and AC positive feedback provide linearization and DC stability to the negative impedance coupled transformer used in a current mode. The two primary and secondary windings are paralleled in a 1:1 transfer ratio. Since I1/I2 = N2/N1, the voltage gain of this stage is unity. Damping is provided at the primary winding for best square wave response. The low frequency distortion reduction is directly proportional to the positive feedback factor and set by R5004. This is chosen to cancel R_{sec} of the transformer. The floating buffer amplifiers are powered from bipolar 15 Volts derived from the ±35 Volt via discrete voltage regulators. (Q-5001, Q-5020)

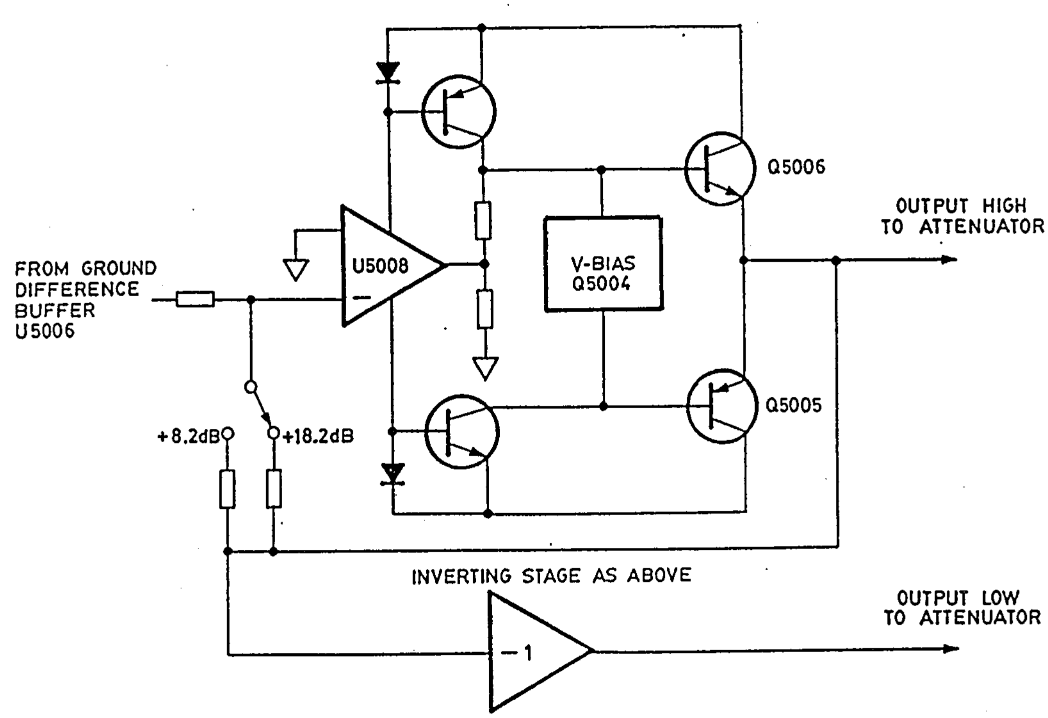

Fig. 5.5.3 Output power amplifier simplified

5.5.4 FLOATING POWER AMPLIFIERS (Figure 5-5.3)

Output from the transformer buffer is fed to an inverting power amplifier with switchable gains of 8.2 dB and 18.2 dB. This amplifies the oscillator output to the maximum 33 V rms (open circuit) required. The power amplifiers use a pair of zener diodes to limit voltage at ±15 Volts to U5008. Current through the upper and lower transdiode Q- 5013, Q-5015 is mirrored to the level shifters at unity current gain but large voltage gain with a V_{BE} multiplier connected at its mid- point. Interstage series voltage feedback is provided from this node to pin 6 of U5008. The bias transistor is thermally connected to the output transistors on the heat sink block to provide thermal feedback and prevent thermal runaway. The output transistors provide the necessary current gain to drive both A and B outputs loaded to full level at low distortion.

Current limiting is implemented by sensing current through output emitter resistors and clamping the output drive when the 200 mA threshold is exceeded. Output from the upper power amp is followed by an identical power amp but configured as a unity inverter to provide push/pull operation. ± 0.1% resistors are used where gains or attenuations are affected to preserve longitudinal balance (>60dB). Current mode operation is used to eliminate common mode distortion caused by the input stage when used in a non-inverting mode.

5.5.5 OUTPUT COARSE ATTENUATOR

A constant output impedance attenuator is used following the power amplifiers to provide attenuations in 20 dB steps from unity to -80 dB and an output impedance of 50 ohm. Switchable resistors are used in series to increase the source impedance proving 150 ohm and 600 ohm outputs. The top most resistors are high power type (2 Watts & 1 Watt) to sustain the maximum current if the outputs are shorted or driving an extremely low impedance.

Table 5-5 Power amp/attenuator gain chart

POWER AMPLIFIER GAIN	COARSE ATTENUATOR LOSS dB	BALANCED OUTPUT LEVEL (150 Ω source, 600 load) dBm	UNBALANCED OUTPUT LEVEL (open circuit) V rms
+18.2dB	0	+32dBm	16.5V
+8.2dB	0	+22dBm	5.22V
+18.2dB	-20	+12dBm	1.65V
+8.2dB	-20	+2dBm	522 mV
+18.2dB	-40	-8dBm	165 mV
+8.2dB	-40	-18dBm	51.2 mV
+18.2dB	-60	-28dBm	16.5 mV
+8.2dB	-60	-38dBm	5.12 mV
+18.2dB	-80	-48dBm	1.65 mV
+8.2dB	-80	-58dBm	512 μV

5.5.6 OUTPUT IMPEDANCE SWITCHING

A 50 ohm impedance attenuator is used for each power amplifier. The front panel BNC unbalanced output is available, with a 50 ohm source impedance, from the upper power amplifier. In the balanced mode, 150 ohm and 600 ohm source impedances are available. These impedances are achieved by the addition of 25 ohm resistors in series for 150 source and 250 ohm resistors in series for the 600 ohm source.

A zero source impedance power amp output is routed through P3 to drive the optional B output attenuator. The attenuator output is also relay switched as a send signal to the analyzer INPUT for internal level check.

5.5.7 GROUND/FLOAT SWITCHING

Power amp floating common and analog signal common are not electrically connected in the FLOAT mode.

In the relay switched GROUND mode, analyzer and oscillator commons are connected through a light bulb F-5001 which exhibits a cold DC resistance of approximately 500 ohm. Its inductive reactance is countered with a shunt capacitor of 0.068 μf which results in an impedance of approximately 24 ohm at 100 kHz when in the ground mode.

5.5.8 CONTROL LOGIC

The power amp board's analog circuitry is controlled by the host CPU through the digital interface resident on the board. The circuit design follows the PROMAG™ digital interface standards. All information in this circuit description treats the power amp main board and daughter board as one since only analog considerations define the daughter board requirements. Addresses and data descriptions are in hexadecimal notation.

5.5.9 DECODING LOGIC

With reference to schematic #5, address decoding is by U5016 (74LS85, 4-bit magnitude comparator) and U5015 (74LS138, 1-of-8 decoder). Using the decoding links CL1, CL2, and CL3, U5016 decodes the address block of C0 to C7. This then qualifies U5015 where, when in a write cycle, address C0, C1 and C2 are used to control the power amp functions.

The data bus is routed to U5010 (74LS273, octal D flip-flop) and to U5011 and U5012 (74LS174, hex D flip-flop). U5011 and U5012 use a six bit data bus, D0 - D5. The master reset pin of each flip-flop is connected to the QUIET STATIC BUS reset line so that all outputs are set logic low on power-up.

5.5.10 POWER AMP INTERFACE

U5012 and four bits of U5011 are used to latch data for the 10-bit DAC attenuator circuit. These are addressed at C2 and C1 respectively. The circuit requires 10k pull-up resistors to +7.5 V for the correct logic high level.

The remaining controls are relay drives. ULN2003, darlington transistor arrays (U5004 and U5005), are used as the drivers with the flip-flop outputs as controls. Data bit D4 and D5 from flip-flop U5011 control the GND/FLOAT relay and the input main/aux relay respectively; they are at address C1. Address C0 has the remaining controls defined as follows: one bit for the output enable relay, 3 bits for the output termination selection and 4 bits for the output attenuator control. Three of these 4 bits for output attenuator control are used in an encoded format and feed U5003 (74LS259) which is used as 1-of-8 logic high decoder.

5.6.0 IMD OSCILLATOR AND ANALYZER (Option 002) (Schematic 6a, 6b)

5.6.1 GENERAL DESCRIPTION

The IMD section, an option to the 5500 system, is constructed on a plug-in PROMAG™ circuit board labelled (6) IMD, containing both low frequency oscillator and IMD analyzer. It uses the normal system oscillator for high frequency generation and performs both popular IMD tests, SMPTE and CCIF. In the SMPTE mode, selectable mix ratio permits choice of 1:1, 2:1, 4:1, and 10:1 amplitude ratios. In the SMPTE mode, the HF signal may be between 3 kHz and 100 kHz while the LF component has a choice of one of eight frequencies between 40 Hz and 500 Hz. In the CCIF mode, difference frequency is selectable to be 1-of-8 choices and mean frequency can be 4 kHz to 100 kHz.

5.6.2 LOW FREQUENCY OSCILLATOR

This circuit is based on the state variable filter comprised of a summing amplifier (U-6013A) followed by two integrators in cascade (U- 6012). R6044 supplies positive feedback around the loop and an AGC circuit (U-6013B) controls the amount of negative feedback to just sustain oscillation. Full wave rectified current is compared with a reference current derived from a precision voltage reference, Q-6005. This is made variable to adjust the level of oscillation. The sum of both currents are fed to a summing integrator whose output is an error voltage used to drive a FET feedback control element, Q-6004. Drain- source resistance of the FET is dependent on the applied gate source error voltage, which will control the amount of feedback to sustain oscillation. Output is taken from the low pass integrator (U-6012B) which, through double integration, has the lowest harmonic distortion.

Frequency of oscillation is controlled by switch selection of both integrator resistors and follows the time constant of $F_O=1/2RC$. One of eight of the following frequencies is available: 40 Hz, 50 Hz, 60 Hz, 80 Hz, 100 Hz, 125 Hz, 250 Hz, 500 Hz.

5.6.3 SMPTE GENERATOR

SMPTE IM source has the following characteristics:

Low frequency limits are 40 Hz to 500 Hz
High frequency limits are 3 kHz to 100 kHz
Amplitude ratios are 1:1, 2:1, 4:1, 10:1, LF to HF

A mixing amplifier (U-6017) is used on the IMD board to select one of four amplitude mix ratios. The mixed output, regardless of ratio, has the same peak-to-peak amplitude as the equivalent THD mode oscillator sine wave.

5.6.4 CCIF GENERATOR

The CCIF generator produces a twin tone high frequency signal mixed at a 1:1 amplitude ratio whose difference frequency does not exceed 1 kHz and mean frequency is between 4 kHz and 100 kHz. This is achieved on the IMD board by a discrete balanced modulator using matched FET Q-6003 as variable resistive elements. The balanced modulator converts its two input signals to two new signals with frequencies equal to the sum and difference of the input signals. The internal 5500 oscillator is used as the modulation frequency and the IMD low frequency oscillator is used as the carrier frequency. Thus, the resulting composite signal will consist of a twin-tone signal whose mean frequency is the same as the HF oscillator and whose difference frequency is twice the LF oscillator (i.e., the "offset" frequency). A trim adjustment is provided for carrier suppression and another provided for gain calibration. This adjustment is made to obtain the same peak-to-peak output as the THD mode oscillator sine wave at P2-6. Output from the balanced modulator is fed to a 4-pole elliptical filter U-6007, U-6016 with a 500 Hz notch for further carrier suppression, and also provides additional gain for signal level normalization.

5.6.5 OUTPUT SELECT

Mode selection is via relay switching providing IMD on/off select and SMPTE/CCIF select. The balanced modulator for CCIF twin tone generation is switched off when not in the CCIF mode to prevent signal leak through and contamination of IM residual.

5.6.6. ANALYZER

SMPTE IMD

The composite input signal in the SMPTE distortion mode, which appears at preamp out, is presented to the input of the 8 pole, 2 kHz, High Pass Butterworth filter. This filter removes virtually all of the low frequency component leaving only the high frequency carrier with the IMD components. Depending on the composite input amplitude ratio, 1 of 4 succeeding gains will be selected to normalize the high frequency level.

GAIN	LF TO HF RATIO
0dB	1:1
+6dB	2:1
+12dB	4:1
+20dB	10:1

This normalized HF level is demodulated by an AM detector formed by a precision absolute value circuit. The output, which appears at P2-24, will be a detected version of the HF carrier signal used to ratio against the distortion signal for distortion level calculations. This output is then AC coupled into a 10 pole 1 kHz Butterworth 10 dB gain low pass filter whose AM product output is the intermodulation distortion.

5.6.7 CCIF IMD

When the instrument is switched to the CCIF IMD mode, the preamp output is connected directly to the 10 pole 1 kHz low pass filter with 10 dB of gain. This filter then removes the twin tone high frequency signal and leaves only the difference frequency signal for analysis.

5.6.8 IMD RECOVERED FREQUENCY

Frequency display in the 5500 normally shows the frequency of an incoming signal. In the IMD mode, where two mixed tones are used, frequency separation circuits are used in order to obtain a meaningful frequency display.

In the SMPTE IM mode, input signal is passed through a 3 pole 1 kHz low pass filter to remove its high frequency component allowing the resultant low frequency to be measured. The HF component is available as an output of the 2 kHz high Pass Filter.

In the CCIF mode, both the twin-tone mean frequency and difference frequency must be measured. The mean frequency is approximated by using a log compression amplifier to amplify the dead zone near zero crossing. Because near complete carrier suppression exists, this recovered mean frequency can only be measured to within a few percent. The difference frequency is recovered by first taking the absolute value of the composite twin-tone signal. A low pass filter will then remove the high frequency signal and leave only a low frequency envelope. As full wave detection is used, the frequency of this envelope is actually twice the difference frequency. This is then level shifted to a CMOS flip-flop configured as a divide by 2 circuit. The output square wave is low pass filtered to slow down the fast rising edges and minimize interference to other circuits.

5.6.9 LOGIC INTERFACE

All IM functions are controlled by the host CPU through the digital interface resident on the board. The interface circuit design follows the PROMAG™ digital interface standards. Address and data descriptions are in hexadecimal notation.

5.6.10 ADDRESS DECODING

With reference to Schematic #6b, address decoding is by U6002 (74LS85, 4-bit magnitude comparator) and by U6004 (74LS138, 1-of-8 decoder). Using links CL2 and CL4, U6004 decodes the address block between D0 and D7. U6004's outputs for addresses D0 and D1, during write cycles, are the only addresses used for all functions.

The data bus is routed to U6005 (74LS273, octal D flip-flop) and to U6006 (74LS174, hex D flip-flop); only data bits D0 - D5 are used with U6006. Both ICs' master reset control is connected to the QUIET STATIC BUS's reset control to ensure the flip-flops are in a known state after power-up.

5.6.11 IMD CONTROL

U6005, addressed at D0, has different functions under control by different groups of data bits. Data D1, D2 and D3 are used as a binary code to select eight LF oscillator frequencies. Data D4 and D5 go to U6003 (74LS139, dual 1-of-4 decoder). The binary coded data of D4 and D5 select, through U6003, one of four IM HF gain settings in the analog section. Data D6 is routed to U6001 (ULN2003, darlington transistor array). It goes to two of the transistor circuits at pin 1 and pin 5. The output at pin 16 is used as a relay driver and the output at pin 12 with the pull-up resistor is used as a logic level control. Data D7 in similar fashion connects to pins 2 and 3 of U6001. The output at pin 15 is used as a relay drive and the output at pin 14 with the pull-up is a logic level control. At the same time pin 14 goes to pin 4 whose output, pin

13 with its pull-up resistor, is an inverted logic control.

U6006, which is addressed at D1, has 3 bits used as controls. Data D0 and D1 are used as binary code for selection of 1-of-4 IMD ratios. Data bit D2 controls circuitry for selection of the sync send signals.

5.7.0 PROGRAMMABLE GAIN B (PGB)

5.7.1 GENERAL DESCRIPTION

This module is a wide band gain stage used to amplify low level signals (preamp output in wide band level mode, band pass, low pass or high pass in Narrow Band modes, notch filter out in distortion mode or IMD detector out in IMD mode). This circuit and its companion weighting filters are constructed on a plug-in PROMAG™ circuit board labelled (7) PGB/MUX.

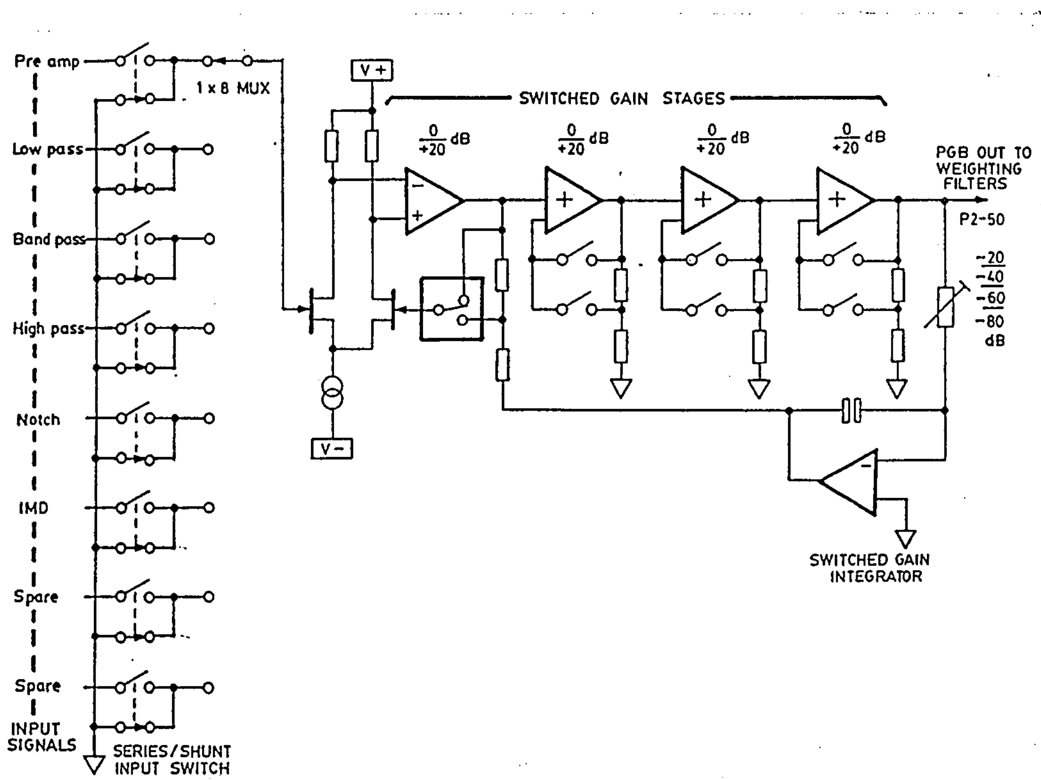

Fig. 5.7 MUX/PGB/Switched integrator simplified

5.7.2 INPUT MULTIPLEXER

PGB input is selectable from 1 of 8 sources. CMOS switches are used in a "T" (series/shunt/series) configuration to minimize crosstalk.

5.7.3 PGB

The programmable gain stages can be divided into 5 circuits: 4 x 20 dB gain stages in cascade and an overall DC feedback switched integrator. The first 20 dB gain stage, identified as +20 dB A, is a FET buffered operational amplifier and has low bias current. Its input is AC coupled and has an input impedance of 2.2 MΩ . Input FETs are biased at 2 mA with an active current source which feeds the second stage of U7003; its own front end is shut down. Gain is selected by U-7004A CMOS switches. The following gain stages labelled +20B, +20C, and +20D are identical using MA332 operational amplifiers which are high F_t and unity gain stable.

The total cascaded gain is non-inverting and is selected in the order of +20A, +20B, +20C and +20D so switching transient propagation is minimized.

5.7.4 SWITCHED INTEGRATOR

Because the 80 dB cascaded gain stages are DC coupled, millivolts of input offset could saturate the gain chain. Therefore an integrator with switchable gain is provided for offset correction. Unity and +20 dB of PGB gain sets the first step of integrator gain and each addition of 20 dB PGB gain corresponds to 20 dB of gain reduction in the integrator.

Table 5-4

	INDIVIDUAL STAGE GAIN				
TOTAL PGB GAIN	**+20A**	**+20B**	**+20C**	**+20D**	**DC INTEGRATOR GAIN**
0dB	0dB	0dB	0dB	0dB	-20dB
+20dB	+20dB	0dB	0dB	0dB	-20dB
+40dB	+20dB	+20dB	0dB	0dB	-40dB
+60dB	+20dB	+20dB	+20dB	0dB	-60dB
+80dB	+20dB	+20dB	+20dB	+20dB	-80dB

5.7.5 WEIGHTING FILTERS

Four standard filters are provided in the weighting filter section:

1) 400 Hz High-Pass 3rd-order Butterworth. This filter is in series with any one of the remaining filters. Its input and output appear both on P2 and P3 to allow special loop through insertion between preamp out and notch filter in.

2) 30 kHz Low-Pass 3rd-order Butterworth.

3) 80 kHz Low-Pass 3rd-order Butterworth.

4) "A" weighting filter or optionally, CCIR or Psophometric.

Filters 2, 3 and 4 are selected by a DG508 MUX using its first four inputs. The other four inputs appear on P3 to allow expansion of the filters.

5.7.6 LOGIC INTERFACE

The PGB board's analog circuitry is divided into three sections. The input multiplexer, PGB gain stages, and the weighting filter section. All functions are controlled by the host CPU through the digital interface resident on the board. The circuit design follows the PROMAG™ digital interface standards. Addresses and data descriptions are in hexadecimal notation.

5.7.7 ADDRESS DECODING

With reference to Schematic 7b, address decoding is by U7016 (74LS138, 4-bit magnitude comparator) and U7025 (74LS138, 1-of-8 decoder). Using decoding links CL0, CL2, and CL3, U7016 decodes the address block of A0 to A7. This qualifies U7025 where, in a write cycle only, decoded address A0 and A1 are used.

5.7.8 SYSTEM CONTROL

The data bus is routed (in reduced form, D0 - D5) to U7026 and U7027 (74LS174, hex D flip-flop). Address A0 clocks data into U7026. The first four bits D0 - D3 are used to control the weighting filter multiplexer. D0 - D2 are used in binary code to select 1-of-8 filters while D3 is the multiplexer enable control. D4 controls the 400 Hz HP filter enable. The logical invert of this is generated by an inverter in U7014 and is also fed to the P1 bus where it is used by the detector board.

D5 of U7026 and D0 - D2 of U7027 which are addressed at A1 control the PGB gain stages. Each control line also goes to an inverter because the gain circuitry requires each control line with its logical complement.

D3 - D5 of U7027 are used as the input selection controls. They are used in binary coded format and also routed to U7017 (74LS138) to be decoded. The logical invert of the decoded controls is also required and U7028 and U7015 are used for this.

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5.8.0 AUXILIARY WEIGHTING FILTERS (OPTION 005 or 006) (Reference : Schematic #8)

5.8.1 FEATURES

The optional auxiliary filter board may be provided in two standard versions or in a custom version. All versions are achieved using the same basic board but with different component populations. Schematic 8 shows all seven possible filters although typically only four would be provided. Note that the circuitry of the CCIR and Program filters are the same - only the component values change.

5.8.2 FILTER TYPES

AUDIO FILTER OPTION:

1) 20 Hz to 20 kHz Audio band pass filter or 22.4 Hz to 22.4 kHz Audio band pass filter
2) IEEE receiver filter with 19.0 kHz notch
3) "A" weighting filter
4) CCIR filter, 1 kHz or 2 kHz reference

TELECOMMUNICATION FILTER OPTION:

1) 2 kHz Flat filter
2) 15 kHz Flat filter
3) C message with 1010 Hz notch
4) Program filter

These filters are fed from the 400 Hz High Pass filter output of the PGB module and are selected by a 1-of-8 multiplexer, U8109.

5.8.3 LOGIC CONTROL

The AUXILIARY FILTERS board is an extension of the PGB board providing four additional weighting filters. The board has its own on-board digital interface, as per the PROMAG™ standards, which responds to the PGB addressing and data corresponding to the four auxiliary weighting filters. Address and data descriptions are in hexadecimal notation.

5.8.4 ADDRESS DECODING

U8003 (74LS85) and U8004 (74LS138) provide decoding with the decoded address "A0" output of U8004 controlling U8005 (74LS174). This latches data from the QUIET STATIC BUS as required for filter selection. U8005's master reset line is connected to the system reset on the P1 bus to clear the D flip-flop at power-on.

The digital control of 3 binary coded bits plus an enable bit go to a CMOS multiplexer which is identical and in-parallel to one on the PGB board. The filter mux on the PGB has filter inputs for the first four positions, the mux on the auxiliary filter board has filters connected to the last four positions. Therefore the outputs of the two multiplexers which are wired together form an eight filter selector.

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5.9.0 5500 POWER AMP EXPANSION BOARD (B-OUTPUT) (Option 007)

The B-output board option provides the 5500 system with a second signal source output. The output level and impedance will be identical as the A-output with the additional feature of being able to reverse its phase relative to A-output. The circuit board is labelled (9) B-OUTPUT and follows the PROMAG™ format. Refer to Schematic #9.

5.9.1 SIGNAL PATH

Input to the B-output attenuator is taken from the pre-attenuator signal of the power amp board.

The B-output attenuator and output impedance circuit is identical to the Power Amp and its circuit description and gain chart is valid for B-output.

B-output's independent phase and output "ON" switching is by a two Form-C relay in the signal path before the output attenuator.

A metal shield box provides the floating and shielded isolation similar to that on the main power amplifier.

5.9.2 CONTROL LOGIC

The B-output's control logic codes are identical to the power amp's for output attenuation and impedance. Additional codes provide control over the independent functions. B-output has its digital interface circuitry resident on the board and the circuit design follows the PROMAG™ digital interface standards. Address and data descriptions are in hexadecimal notation.

5.9.3 LOGIC INTERFACE

The additional logic codes required are latched in a 74LS174 Hex D- Flip-Flop address at C3 and drive relays through U5907 (ULN2003).

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5.11.0 POWER SUPPLY SUBSECTIONS OVERVIEW
Ref: Schematic #11A & 11B
Simplified Block Diagram Figure 5-9

The 5500 Power Supply module provides several regulated and monitored supply rails. Each rail contains short circuit protection, over and under voltage monitoring and over-current protection.

The power transformer is of toroidal construction to reduce radiated interference. Several primary taps are provided to permit operation from any common international mains supplies.

Heat sink mounting is included for high power rails and forced air cooling ensures proper thermal management.

The following supply rails are provided:

+5 V 5 A CPU and logic
±12 V power supply
±12 V 250 mA Serial communication
±19 V 2 A Analog pre-regulated rails
±35 V 400 mA Isolated power amplifier

5.11.0.1 5 VOLT SUPPLY

This section supplies the voltage requirements of the 5500 CPU board and the digital interfacing logic resident on each PROMAG™ board. The circuit is implemented by a Unitrode UC3834 voltage regulator with crowbar over-voltage protection.

5.11.0.2 V-STBY GENERATOR

Provides the supply voltage requirements of the non-volatile memory located on the CPU board. The V-STBY generator is not switched by the 5500 power-on button but remains operational unless the 5500 is not connected to AC mains. It also has the function of trickle charging three NICAD batteries which automatically provide V-STBY to the non- volatile memory when no AC mains is connected.

5.11.0.3 ±12 VOLT UNSWITCHED SUPPLY

This section provides the bi-polar voltage requirements of the power supply control circuitry. This section remains powered as long as AC mains remains connected and is implemented by low power 3-terminal regulators.

5.11.0.4 ±12 VOLT SUPPLY

This section provides the bi-polar voltage requirements for the two RS232 communication ports that can be installed. The circuit is implemented by two Unitrode UC3834 voltage regulators with crowbar over-voltage protection.

5.11.0.5 ±19 VOLT SUPPLY

This section provides the bi-polar voltage requirements for the analog circuitry resident on each PROMAG™ board in the 5500 system. Each PROMAG™ board provides post regulation to ±15V using three terminal regulators. This method has the benefit of reducing power dissipation both in the supply and on each PROMAG™ board while also providing greater isolation between boards.

5.11.0.6 ±35 VOLT SUPPLY

This section provides the bi-polar requirements of the output section of the Power Amp board. The circuit is designed so that the Unitrode UC3834 voltage regulators can operate properly in a requirement that normally would exceed their maximum input supply rating.

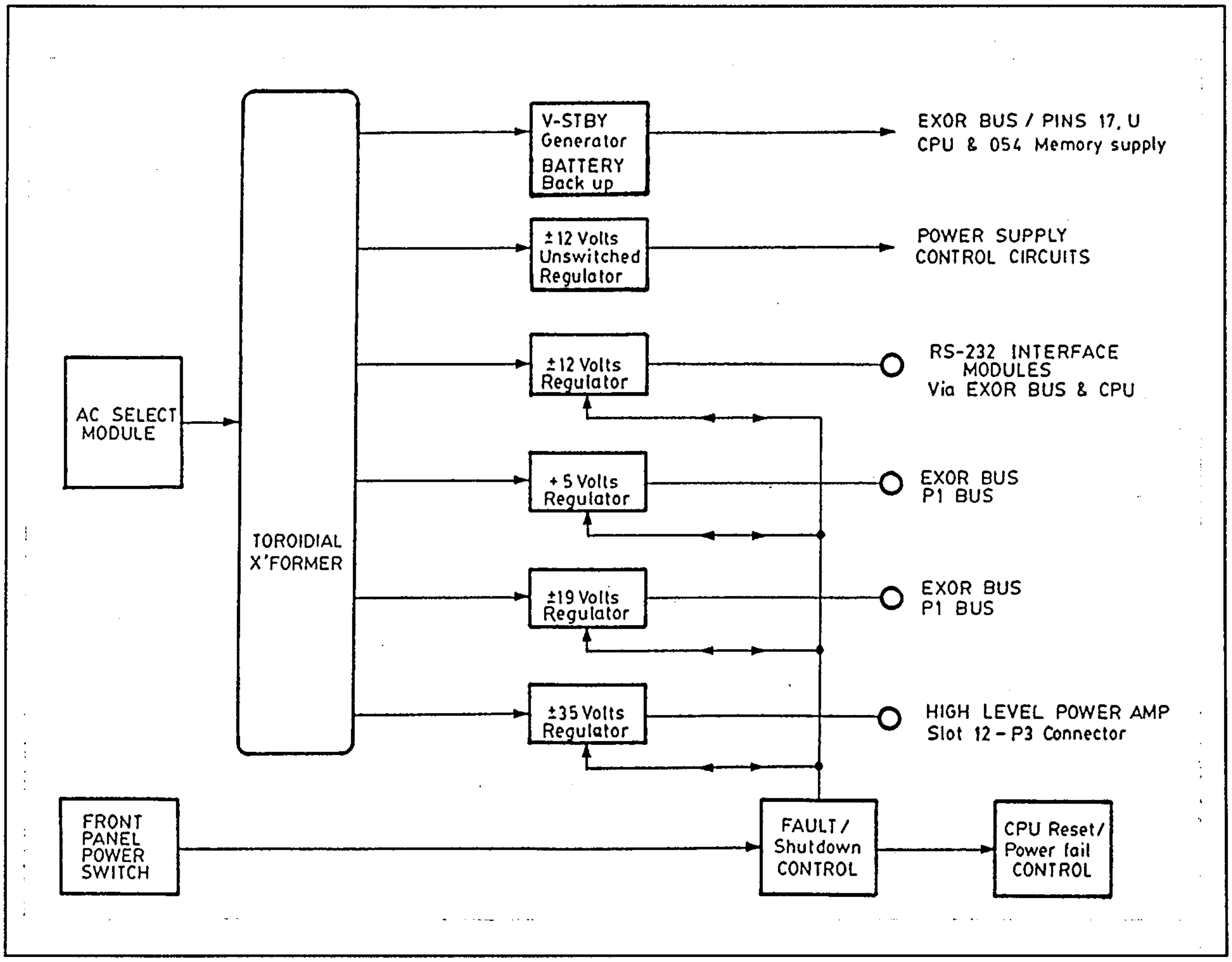

Fig. 5.11 Power supply and control simplified

5.11.1 POWER SUPPLY CONTROL CIRCUITRY

The power supply system control circuitry is designed to be able to shut the complete supply off when any subsection sends a fault condition signal on a common wired-OR input. Details of controlling the subsection's regulators and their implementation is described in a later section.

The 5500 system power switch is a special case of the fault/shutdown circuitry. The power supply's AC and pre-regulated DC circuits are not switched but remain active if AC mains is connected.

The control circuit operation can best be described starting with the system being in the "ON" state with no subsystem faults.

The power-on front panel switch being closed keeps Q8034 (IVN5001AND - MOSFET) in a non-conducting condition. Through pull-up resistors the common FAULT line is kept high and through R8063 this level is connected to the negative input of a comparator (U8006, pin 10). This is a higher voltage than V-ref (generated by Q8022, TL431) at the positive input, causing the output to be at circuit common level. This is fed to the negative input of another comparator (U8006, pin 6) whose positive input has a voltage level set by a divider network. This causes the output (U8006, pin 1) to be at a high level by a 4k7 pull-up. This output called SHUTDOWN is the control input to the UC3834 regulators where a high level is normal operation.

With the power-on switch open (system OFF) or, if a subsection pulls the fault line low, the comparator output (U8006, pin 13) will go high. But since the comparator is an open collector type, the output will go high at a rate set by the time constant formed by R8059 and C8029. This allows a delay before the second comparator pulls the SHUTDOWN signal low. This delay of approximately 1/4 second allows any transient fault conditions to pass without shutting down the system.

5.11.2 VOLTAGE REGULATION

As previously mentioned, the main voltage regulator used in most of the power supply subsystems is the Unitrode UC3834 linear regulator. Its main features are a low input/output differential voltage, usable for positive or negative supplies, adjustable current sense, and over/under voltage alerts with programmable delay.

Using the Unitrode data sheet and the positive 19 Volt subsection schematic for reference, the general implementation can be described.

Q8031 is used as the external pass device with the driver sink current control from pin 12. Pin 9 is one input of the regulator error amp which senses the output voltage through the divider network formed by R8089 and R8088. The other error amp input is pin 8 which is connected to an internal reference voltage generator at pin 3.

The resistor network formed by R8100, R8101, and R8102 provides the current sense amp at pin 6 and 7 a voltage representation of the output current. The resistors are chosen to program the maximum output current required under worst case conditions for each subsection.

The internal fault monitoring circuit, after a programmed delay set by C8046 connected to pin 11, will provide a fault alert output on pin 10. This is connected to the common fault line of the control circuit.

The SHUTDOWN control is connected back to the UC3834 through a comparator IC to pins 14 and 15. Any fault in the system causes SHUTDOWN to go low and turn each subsection off.

The negative rail implementation is quite similar except for a few simple additions.

The internal reference voltage is a negative source at pin 2 connected to pin 9 of the error amp and both the fault output and the shutdown control input use extra circuitry to level shift the controls.

LEDs connected to both rails provide a visual indication of voltage being present. These LEDs, as on the other subsystems, are mounted on the PCB. A problem on a subsystem may be spotted because a LED will not light during the 1/4 second fault delay interval before system shutdown.

5.11.3 REGULATOR MODIFICATIONS

There are special additions to the UC3834 subsections to provide extra functions.

On the ±19 Volt subsection, TRANSORBS are installed across the filter caps. The transformer windings for this section have a very large VA capacity. If a large mains over-voltage condition exists, these transorbs will short causing a large mains current and blow the AC mains fuse. The system will require repair but catastrophic damage will have been prevented.

The ±12 Volt and the 5 V subsections utilize the crowbar output of the Unitrode UC3834 regulator. This control output is activated following a sustained over-voltage condition such as if the pass transistor shorted out.

Using the 5 Volt regulator as an example, Q8028 (TIC126, SCR) is installed across the output rails. In an over-voltage condition, the crowbar output at pin 16 will turn on the SCR. This accomplishes two things. First, the large current flow because of the SCR shorting the output will blow the fuse in series before the pass transistor. Second, the now shorted output will force the UC3834 into a fault condition which will shutdown the 5500 supply. As with the transorbs, damage will be limited if a fault develops.

The ±35 Volt subsection required additional circuitry to allow the Unitrode UC3834 regulators to be used where the unregulated DC voltage exceeds the maximum input supply voltage rating of the chip.

Using the +35 Volt circuit as an example, D8007, a 15 Volt zener diode, drops the supply voltage to the UC3834. And D8010 performs the level shifting required for the pass transistor driver output. Over- current sensing is level shifted by the circuit made up by Q8010, R8020, R8024 and R8021. The voltage across R8021 will reflect the output current.

An additional requirement of the ±35 Volt supply is that it be floating with respect to all other supply voltages. This requires a method of isolating the fault alert outputs and the input shutdown controls. Opto-isolators U8008, U8009 and U8010 interface the system control circuitry.

The two transformer windings that supply the ±35 Volt supply have an additional electrostatic shield which is connected to ±35 Volt supply common. This serves to shield these two windings from the other primary and secondary windings.

5.11.4 CONTROL CIRCUITRY

Support control circuitry for the CPU board is installed on the power supply board. It provides the CPU with an indication of a stable power rail with an early indication of a failing supply, and the power-on reset control. Additionally, the 5 Volt supply is adjustable as is the V-stby generator which supplies the non-volatile memory supply.

The power fail circuit is designed to give the CPU an early indication of a problem so that the programming has the chance to store the 5500 operating state for later recall.

Two comparators in the U8005 package (output pins 2 and 1) along with Q8016 form the multifunction sense circuit.

Comparator input pin 5 will sense a power supply system fault or the front panel switch going to the OFF position. Comparator input pin 6 will sense the failure of AC power or low line condition.

The CPU reset control signal is generated by two comparators (output pins 13 and 14 of U8005) with their associated circuitry. When the power supply is turned on, U8005 pin 13 switches low (comparators negative supply). This shuts off Q8019 allowing C8028 to charge through R8051. This RC sets the delay time for the reset control after power-up allowing the 5 Volt supply time to stabilize before the CPU is allowed to begin operating.

An external connection has been allowed for at this point for an external reset control by shorting C8028 to 5 Volt common.

The voltage on C8028 will switch U8005 pin 14 low. This switches U8018 off and the reset control line is pulled to nearly 5 Volts by R8053 and Q8017 with the associated circuitry.

The 5 Volt supply is the only major section with allowance for adjusting the output voltage. Trimpot VR8002 allows adjustment from 4.8 to 5.3 Volts. This is set to 5.10 Volts measured on the power supply output connector.

The V-stby generator provides the supply voltage to the non-volatile memory resident on the CPU board and also keeps the NICAD batteries charged. This circuit is not switched and remains operational as long as the unit is connected to mains. When not connected to an AC source, the NICAD batteries maintain the supply voltage to the memory.

Input to the LM317 adjustable regulator (Q8027) is from a high unregulated DC voltage to provide operation even under low line conditions. VR8001 with associated components provide adjustment of the output voltage. Q8025 is implemented as a base-collector forward biased diode which, when the regulator is not operating, provides a low leakage blocking diode from the battery circuit. Q8026 with its associated circuitry provides a dynamic load to the LM317. This is done because the very low current requirements of the memory, especially when the 5500 is off, would not be enough to ensure regulation. R8069 provides the battery charging rate and, again because of the memory's low current needs, causes minor voltage loss when the 5500 is disconnected from mains.

5.11.5 AC MAINS

The AC circuit is comprised of the transformer along with the mains voltage selection switching and the switched fan used for internal cooling.

Input AC voltage selection is provided for by a combination connector/tap selector/fuse/filter. The voltage select drum along with the four transformer primary windings provide nominal AC voltage selection of 100 V, 120 V, 220 V, and 240 V.

The transformer secondaries are rated to provide approximately 300 VA of rated secondary current. As the system is designed to operate at 50 Hz and there are temperature rise limitations, the toroid transformer uses a 500 VA core. An electrostatic shield is provided to isolate primary and secondary windings.

The 5500 fan, used to cool the power supply pass transistor heatsink assembly and to maintain an even heat distribution throughout the internal area of the 5500, is powered from a 100 V AC secondary winding. It is switched by a solid state relay controlled by the 5 Volt supply.

5.11.6.0 TYPICAL PERFORMANCE SPECIFICATIONS

5.11.6.1 5 VOLT SUPPLY

Output ripple and noise at rated current and 10% low AC line: less than 5 mV (0.1%) typical.

Output impedance at midband frequencies: less than 0.2 ohm typical.

5.11.6.2 ±12 VOLT SUPPLY

Output ripple and noise at rated current and 10% low AC line: less than 6 mV (0.05%) typical.

Output impedance at midband frequencies: less than 0.5 ohm typical.

5.11.6.3 ±19 VOLT SUPPLY

Output ripple and noise at rated current and 10% low AC line: less than 20 mV (0.1%) typical.

Output impedance at midband frequencies: less than 0.6 ohm typical.

5.11.6.4 ±35 VOLT SUPPLY

Output ripple and noise at rated current and 10% low AC line: less than 30 mV (0.1%) typical.

Output impedance at midband frequencies: less than 3 ohms typical.

5.12.0 CPU BOARD FUNCTIONAL DESCRIPTION

The CPU board (Drawing #12 - CPU) serves a number of functions in the PROMAG™ system. Not only does it contain the microprocessor and its support logic, but it also supports a total of five distinct communications channels to allow it to be controlled by or to control other systems or subsystems. In addition, it provides the digital support logic for the system's data acquisition.

5.12.1 PHYSICAL & ELECTRICAL CHARACTERISTICS

The board is designed to conform closely with the physical and electrical characteristics of Motorola's Exorbus. In the active mode, the board draws approximately 750 ma from the 5 volt logic supply and 100 ma from the 5 volt standby logic supply. In the quiescent state the board draws only a few microamps from the standby supply to retain the contents of its non-volatile RAM. For systems not providing a standby supply, provision is made to install a lithium type primary cell on-board for memory retention through power down. The 5 volt logic rails are provided with transient voltage and supply reversal protection while diode D6 guarantees that the logic supply cannot exceed Vstandby by more than 0.6 volts. Extensive power supply decoupling is provided by a combination of distributed capacitance bus bars, ceramic decoupling caps and large value bulk electrolytic.

5.12.2 MICROPROCESSOR

The MPU used is a 6809 type processor provided with an internal clock oscillator which is disabled and driven by the main system timebase as described below. The design of the MPU support logic is such that it is possible to use this MPU as the main Exorbus system processor, or to remove the MPU from its socket and treat the CPU board as a peripheral board to another MPU.

5.12.3 SYSTEM TIMING LOGIC

The low drift 8 MHz oscillator U1 provides the signal from which two important timebases for the system are derived. The MPU clock may be taken directly from U1 or may be divided by U2 to provide operation at 0.5 or 1 usec cycle time, respectively. U2 is also used to provide the 2 MHz REF clock used by various system timers for delay measurements and data acquisition. A programmable delay circuit is implemented using U25 and its associated gates to provide a means for MRDY stretching the MPU E clock during Static Bus accesses, allowing relaxed timing requirements for Static Bus devices. Note that E is not used for any real time measurements.

5.12.4 ADDRESS DECODING LOGIC

A bipolar prom, U28, provides the highest level of address decoding for the system, producing a four bit output code as a function of the address bus which is connected to its eight lowest address inputs, giving a decoding resolution of 256 locations. The highest address input to U28 is available for use in map switching in a debugger environment and all the outputs are qualified by a signal that can be derived from Exorbus signals VXA, VUA or VMA. The three lowest order outputs of U28 provide the select inputs for one of eight decoder U20 which directly drives the active low chip select inputs of the five available memory sockets, U3, U8, U13, U21 and U29. The MPU bus peripherals and the PROMAG™ Static Bus are enabled by two of the remaining outputs. The outputs of U20 are further qualified by RESET and a locally generated signal VMA*. Another one of eight decoder, U16, is qualified by U20 and decodes A4 to A6 to give a decoding resolution for the MPU bus peripherals of 16 locations.

5.12.5 MEMORY SUPPORT LOGIC

The five memory sockets can be configured in a number of ways to support virtually any useful combination of JEDEC pinout ROM and RAM. One device, U29, is expected to be an 8K to 32K EPROM or ROM type device, while U21 and U13 may be configured as 8K to 16K EPROMs or ROMs or 8K RAMs. U8 and U3 may be configured as 8K to 16K EPROMs or ROM or as 2K or 8K RAMs. Standby power is provided on U3 and optionally on U8 and U13 when these devices are specified as non- volatile RAMs. Two gates of U19 provide read and write signals qualified by E for driving the WE* and RE* inputs to the memory devices. When U3 is an 8K RAM device, pin 26(CS) is brought to the unbuffered Exorbus RESET signal through a current limiting resistor R4 to guarantee the integrity of the RAM data through power fail. A high impedance pull down resistor, R3, provides a low logic level on this pin if the board is removed from the Exorbus connector. See below for the requirements of the off board reset generator.

5.12.6 EXORBUS SUPPORT LOGIC

The CPU board interfaces to the Motorola Exorbus via P5. Comprehensive support for operation with other Exorbus boards is provided and allowance made for the data acquisition board to be either an Exor master or slave. Several unique signals not normally provided on the bus can be disabled for operation with other boards which may themselves make use of these unassigned pins. The two most of concern are EXVMA* on pin H of the bus, which can be used to qualify DMA transfers and the SYNC instruction, and EXHF on pin 26 which can be used as an accurate timebase for other subsystems on the bus. The EXVMA* signal is derived from the on-board VMA produced by clocking the state of BA on the falling edge of E. This provides a necessary qualifying signal to be used with DMA, HALT or the SYNCH instruction.

The direction of the Exorbus data buffer is controlled by a signal produced by the highest output line of address decoder PROM U28, which provides a logic low level whenever an on-board device is decoded. This signal may be modified by the BA line going high, indicating that either a DMA transfer is in progress or that U12 (the MPU) is not present.

No provision is made on-board for reset generation as this is a complex function that is expected to be handled by the power supply. It is required that the Exorbus RESET line be taken to a logic low level before the power supply has fallen below that required for proper functioning of the logic circuits and that it not be allowed to rise to a logic high level until at least 200 msecs after the power supply has risen to a valid level. In addition, the level present on the Exorbus RESET line should be maintained at a value between -0.1 volt and 0.3 volts while the system is in its standby state to minimize power consumption from the standby supply or the on-board battery. If these requirements are met, the validity of the data in the RAM can be guaranteed through power fail. An input is provided on U11 to receive a "impending power fail" signal from the Exorbus power supply and this signal may be connected to NMI to asynchronously alert the processor.

5.12.7 STATIC BUS CONTROL LOGIC

The PROMAG™ system uses a relatively straightforward synchronous bus structure to allow the CPU to communicate with measurement hardware and certain types of front panels. The basic bus is organized as an eight bit address bus and an eight bit data bus, with signals provided that are properly timed to allow the orderly transfer of data to Static Bus data consumers and from Static Bus data producers. No provision is made to allow more than one Static Bus master on the bus.The Static Bus is accessed via P1 on the board.

The CPU board treats the devices on the Static Bus as memory mapped peripherals and allows both the writing of data to peripherals and the reading of data from them. Attempts to write to non-existent consumers or read from non-existent producers will not cause any bus contention. U14 is used to buffer the address lines from the MPU to the Static Bus and because the Static Bus is memory mapped, it merely latches the lowest eight bits of the MPU address bus at the start of any valid Static Bus transfer. The outputs of U14 are always enabled, imposing the restriction of a single Static Bus master. The data presented by the MPU on a Static Bus write cycle is clocked into U9 after the data bus has stabilized, providing latched data to be taken by any Static Bus data consumers, while U4 is used as an input buffer to allow the MPU to read any data presented by an Static Bus data producer. The direction of data traffic on the bus is determined by the SBRD line which is derived by latching the state of the MPU R/W* line during Static Bus accesses using gates from U19 and U22.

A critical timing signal named SBODV* is generated on the falling edge of Q during valid Static Bus transfer cycles and remains in its active low state until the falling edge of E. As mentioned above, the Static Bus transfer timing is stretched by U25 and its associated gates, giving a worst case address or SBRD to SBODV fall of 125 nsec and 500 nsec data valid to SBODV rise specification. It is expected that Static Bus data consumers will transfer data on the low level of SBODV or on its rising edge. Data, address and SBRD hold times are in excess of 250 nsec, as they are latched until the start of the next valid Static Bus transfer. Static Bus data producers are expected to have an address access time of less than 500 nsec and a chip select access time of less than 350 nsec.

5.12.8 DATA ACQUISITION LOGIC

Hardware is provided to count the negative transitions of two signals that are presented by the Static Bus and to simultaneously count transitions of the REF signal generated by U2. This may be used to measure the frequencies of the signals which are typically used to represent the frequency and amplitude of some test signal. Gating logic is provided by a flip-flop in U18 with gates from U15 to allow the accumulation of counts to be synchronized to one of the two signals. This is extremely useful for the classical "frequency measurement by period inversion" technique and provides the necessary synchronizing signal for the synchronous integration method of amplitude measurement when one of the signals represents the output of a voltage to frequency converter.

A total of six counters, provided by U5 and U10, are available in the system. One of the counters in U5 can be used by the executive software as a real time clock or as a tick generator for time slicing. The remaining two counters of U5, pre-scaled by the two four bit counters of U17, are used in conjunction with one counter of U10 to form the synchronously gated counter set. The remaining two counters of U10 are available as software gated counters for counting the reference clock and one of the two inputs. The prescale counters in U17 may be read by U11 and may be reset by its CA2 output.

5.12.9 ASYNCHRONOUS SERIAL COMMUNICATIONS

Comprehensive support for two async serial ports is provided by U6 with baud rate generator crystal X2. The 2681 device provides flexible control of such parameters as baud rate, stop bits and handshaking. No buffers are provided on-board to interface to the transmission medium, although standard accessory boards can provide RS 232 interfaces via connectors P2 and P3. Five volt logic supply and bipolar twelve volt communications power are brought to these connectors from the Exorbus interface, with the twelve volt supplies diode isolated as per manufacturers' recommendations for EIA drivers.

5.12.10 IEEE 488 (GPIB) INTERFACE

Hardware is provided to interface the board to the GPIB via U7. The 68488 device provides talker and listener capability for the system. Bus drivers are not provided onboard but are supplied on a standard accessory board. Five volt logic power to drive the buffers is supplied to the interface connector P4 from the Exorbus logic supply.

5.13.0 5500 KEYBOARD AND DISPLAY BOARD
Ref: 5500 Keyboard and display Schematic #13

The keyboard and display board provides the primary mode of interfacing between an operator and the instrument. GPIB and RS232 communication ports provide alternate modes of control.

The PCB is comprised of all push buttons required to operate the 5500, all seven segment displays and LED tallies for instrument readings and status information and all the digital hardware to provide bi-directional interfacing to the 5500 CPU controller. Communication to the CPU is via a 50-wire ribbon cable connected to the CPU's "STATIC BUS" which is the first of two levels of the buffered parallel port used by the CPU to communicate with subsystems within the instrument. Only the "Power ON" button is directly wired to the hardware based power supply control circuitry using a four-pin Molex connector.

A second 4-pin connector provides +5V and GND in addition to power being present on the ribbon cable. This provides all power for the logic circuits and displays except for the button scanning circuit which requires a -12V source. This is derived from -19V available on the 50 wire ribbon.

5.13.1 ADDRESS DECODING

Address decoding is by a bi-polar PROM (U901) and a dual 1-of-4 decoder (U902) which provide device selection of all sections on the board. The 3 LSB address lines (A0 - A2) are buffered from the static bus (U904) because of the multipoint routing and CMOS level pull-ups required.

Three ICM7218E CMOS universal 8 digit LED driver chips are used for all display functions (U901, U911, U912). They each have on chip an 8k x 8 static memory array providing storage for each segment and LED in the output matrix. The host CPU needs only to write data via the 8 bit data bus to the memory locations corresponding to the displays being turned on or off. The chip independently maintains its multiplex scan circuitry and has on-board all the required high power digit and segment drivers. All three ICM7218 chips are used in the NO DECODE mode which means that input data is not in a coded format. In addition, the shutdown control (pin 10) of each ICM7218 is connected to the STATIC BUS RESET signal so that all displays are off when the host CPU is in its initialization mode during the first few seconds of instrument turn on. This prevents the random data that would be displayed before the host CPU has had time to set up displayed information.

5.13.2 KEYBOARD ENCODING

The front panel buttons are scanned by the KR-9600 PRO keyboard encoder IC (U908). It contains a 3600 bit read only memory and all the logic necessary to encode SPST keyboard closures into a 10 bit code with switch debouncing.

When a key is depressed, a signal pulse from the DATA READY output (pin 16) sets the SERVRQ* (service request) line on the STATIC BUS through latches U905 and gate U903B. The host CPU in the process of reading the ANY KEY OUTPUT line (pin 5) buffered by U904, will reset the SERVRQ latch for the next switch closure. The host CPU then reads the encoded data through the data bus buffer (U907).

The SHIFT key is debounced by U920A and B and latched by U921A. If U921A is set (i.e. SHIFT is active) when a key is pressed, it is reset by U921B clocked by the DATA READY output of U908.

5.14 5500 GPIB INTERFACE
Ref: Schematic #14

The 5500 GPIB interface board is located at the back of the unit. Through a 26-wire ribbon cable to the 5500 CPU, the board provides the interface to the IEEE Standard Instrumentation bus (488-1978).

Two MC3447 octal bi-directional bus transceiver ICs are located on the board providing direct connection to the GPIB bus. Transceiver direction is controlled by the host CPU and there are no other required components located here since the MC3447 provides the bus standard termination internally.

+5V and GND is provided through the 26-wire ribbon cable by the host CPU.

5.15.0 5500 RS232 INTERFACE BOARD
Ref: Schematic #15

The 5500 RS232 interface is located at the back of the unit and connects to the host CPU via a 24-wire ribbon cable. Located on the board is a MC1488 quad line driver and a MC1489 quad line receiver IC providing bi-directional interfacing to equipment in conformance with the specifications of EIA Standard RS-232C.

A configuration header on the board allows setting up the RS232 interface so that the host CPU may be either DCE or DTE standard.

Power to the board is provided by the host CPU and includes +5 and GND, ±12 and 12V com.

AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

OWNER'S MANUAL

SECTION 6

MAINTENANCE & CALIBRATION

Issue 07 January 1989

6. CALIBRATION PROCEDURE

CAUTION : This instrument contains CMOS and other types of semiconductors that are sensitive to electrostatic discharge. These parts can be permanently damaged or their reliability diminished unless proper handling procedures are followed.

Before removing the cover of this instrument, study these procedures carefully and follow them rigorously to avoid damaging your instrument.

USE A STATIC-FREE WORK STATION

This includes an antistatic work surface grounded via a high value resistor (330k ohm, for example) to a hard ground. Avoid all plastics, vinyl and styrofoam including styrofoam cups, plastic coffee cups, plastic coffee cup holders, cigarette packages with cellophane wrappers, plastic combs, vinyl books or folders, plastic covers on work sheets, plastic bottles, plastic bags, potato chip bags, plastic purses, plastic solder suckers and plastic ashtrays.

ENSURE THAT YOUR BODY IS GROUNDED BEFORE TOUCHING ANY STATIC SENSITIVE DEVICE

Develop habits to prevent discharging your body into static sensitive devices. When approaching a test bench touch a ground first. When working on equipment, wear a metallic wrist strap connected via a 330k ohm resistor to hard ground. If not wearing a grounding strap, hold on to a ground while touching any semiconductor (un-powered, of course).

USE GROUNDED TEST EQUIPMENT

This includes soldering irons, oscilloscopes, and other instrumentation.

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The model 5500 contains a number of internal calibrations and adjustments. These fall into two categories: Those requiring calibration to an external reference standard and those that are calibrated for best performance.

The 5500 contains a software controlled automatic calibration feature which greatly simplifies the calibration procedure. It can perform most of the AC reference calibrations without the use of an external AC calibrator. This procedure references all AC gains and level measurements to an internal precision DC reference which has a typical accuracy of over an order of magnitude better than the specified AC accuracy of the instrument.

Adjustments for best performance will require an external low distortion generator and external low distortion analyzer. If the instrument contains option 201, High Performance Group, specialized procedures are required to measure the extremely low levels of residual distortion produced. However, if this external equipment is not available, a slightly reduced level of performance can be achieved using only the internal facilities.

All calibrations and adjustments should be done with instrument in a normal temperature and humidity environment (25°C ±3°, 25% ±15%) and nominal AC mains voltage (+5, -10%). The instrument should be powered up with its covers on for at least thirty minutes prior to calibration to ensure that it has reached its normal operating temperature.

6.1 CALIBRATION INTERVAL

The adjustments and calibration procedures described here should be performed every 2000 hours of use or at one year intervals, whichever occurs sooner.

For best performance, it is recommended that the front panel accessed automatic calibration be run as a routine at a frequency comfortable to the user, for example, once per week or prior to sensitive measurements.

6.2 AUTO CAL

The accuracy of all level measurements is a function of the gain accuracy of several programmable gain and attenuation stages, the transfer accuracy of several detectors and the linearity of the analog to digital convertor.

Programmable gain stages and attenuators have inherent accuracy by design to support the system accuracy performance requirements. They use fixed high precision components and do not require calibration.

The other factors that affect system accuracy are calibrated by the AUTO CAL feature. This is done by using a precision internal DC Voltage source as a reference, measuring the transfer gain of the detectors and A to D convertor and storing correction factors in non- volatile memory.

The frequency of the generator is also calibrated at eight points (top and bottom of each decade) against the internal crystal based frequency counter.

The AUTO CAL procedure can be run as often and whenever desired. It is recommended that it be done after the instrument has reached thermal equilibrium (after thirty minutes of powered operation).

To run AUTO CAL, disconnect any cables connected to the OUTPUT A or OUTPUT B (other cables on INPUT, MONITOR, rear panel, etc. can be left in place). Then key in:

[2] [4] [SPCL]

You will hear some clicks and the front panel will show

| CAL | 1 |

to

| CAL | 7 |

as it goes through its multi-step process. The entire sequence takes approximately thirty seconds.

Note: If any hardware failure occurs during the sequence, the display will show:

| Error | 60 |

This is a fatal error indicating that some element of the sequence has experienced a major hardware failure. As almost all of the Generator and Analyzer components are used, the failure could be in several possible locations. Perform diagnostic trouble shooting to locate the failure.

6.3 REQUIRED EQUIPMENT

a) General purpose dual trace, single time base oscilloscope. Bandwidth of 10 MHz or greater.

b) Low distortion generator. Frequency range 10 Hz to 100 kHz. THD + N of generator should be at least 10 dB below (i.e. one third of) the specified distortion of the 5500. Recommended choice: Amber model 3501.

c) Low distortion THD + N analyzer. Frequency range 10 Hz to 100 kHz. THD + N of the analyzer should be at least 10 dB below the specified distortion of the 5500. Recommended choice: Amber model 3501.

OPTIONAL:

d) PROMAG™ extender card. This allows easy access to circuit points on the various analog sub-modules plugged into the 5500 frame. It is available from Amber as 5500 option 701.

e) Digital DC Voltmeter with a resolution of 4.5 digits and an accuracy at 3 V of ±0.06% or better. (Example, Fluke 8050A)

f) Precision Digital AC Voltmeter with a resolution of 4.5 digits and an accuracy at 1 kHz at 16 V of ±0.2% (±0.02 dB). Instruments of this caliber are generally only found in calibration laboratories. In lieu of this, the 5500 instrument's own AC level meter should provide acceptable performance after an AUTO CAL cycle. (Typical accuracy of the above mentioned points will be ±0.3% (±0.03dB).)

6.4 INTERNAL ACCESS

Removal of the bottom cover gains access to the power supply board and the connections to the motherboard. Removal of the top cover gains access to all PROMAG™ boards.

In general, calibration of the PROMAG™ boards can be done using an insulated adjustment tool through the labelled holes in the PROMAG™ top brackets which are accessible when the 5500's top cover is removed. Certain calibration steps may require a PROMAG™ extender board (option 701 available from Amber).

6.5 ADJUSTMENT SEQUENCE

In general, the sequence described in the following pages should be strictly followed. Each calibration or adjustment procedure assumes the previous procedures have been completed.

Following is a summary of the categories of adjustments and calibrations, the modules affected and the section numbers of this manual. They are shown in the order to be performed.

TABLE 6.5

ADJUSTMENT & CALIBRATION SUMMARY

SUB-MODULE	PROCEDURE	MANUAL SECTION
Power supply	Vstandby adjustment Vref adjustment +5V adjustment	6.6.1 6.6.2 6.6.2
Oscillator	Frequency calibration THD calibration Level calibration	6.7.2 6.7.3 6.7.4 6.7.5
Detector	Vref calibration	6.8
Preamp (PGA)	CMRR adjustment	6.9
Filter & Notch	Fundamental rejection	6.10.2
PGB & MUX	Weighting filter calibration	6.11
IMD (Option 002)	Level calibration Oscillator IMD adjustment	6.12.1 6.12.2
Auxiliary filters	Audio filter calibration (Option 005)	6.13
Auxiliary filters	Telecom filter calibration (Option 006)	6.14

6.6 POWER SUPPLY

Reference: Power Supply Schematic #11
Motherboard Schematic #16

The 5500 power supply calibration procedure is minimized by virtue of a circuit design which eliminates most trim components. Calibration of the three trimming potentiometers requires an oscilloscope and a precision DC Volt meter.

6.6.1 V-STDBY

The V-STDBY generator provides the supply voltage for the non-volatile RAM resident on the CPU and the charging current for the NICAD batteries.

On the motherboard screw terminal, measure V-STDBY referenced to 0 V (i.e. ground).

Adjust VR8001 to set voltage to 5.00 V DC.

6.6.2 5 VOLTS V-REF ADJUSTMENT

The V-REF trimmer (VR8003) in conjunction with the 5 Volts adjust trimmer (VR8002) sets the switching point of the CPU reset control signal. When V-REF is set, the 5 Volt supply is set to its final value.

Monitor the 5 Volt supply by connecting the voltmeter across D8021 which is located next to the output connector J8008 (cathode of diode is +5 Volts, anode is 0 V). It is important to monitor the 5 Volts directly on the power supply board.

Monitor CPU reset at the connector J416, pin 1 on the motherboard, with the oscilloscope.

Adjust VR8002 (5 V) to 4.85 V.

Adjust VR8003 (V-ref) to minimum (counter clockwise). CPU reset signal should be logic HI (+5 V).

Adjust VR8003 slowly clockwise just until the CPU reset goes to logic LO.

Adjust VR8002 to 5.10 Volts.

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6.7.0 5500 OSCILLATOR BOARD (SVO) CALIBRATION (Systems without option 201)

The following procedure should be used to calibrate the oscillator board in the system. It assumes that the 5500 system is fully functional and that the 5500 power amp board meets all of its specifications.

This procedure requires an external precision audio analyzer and optionally a precision AC volt meter as described in Section 6.3.

One half hour must be allowed for system warm-up with the cover on so that the system reaches thermal equilibrium. All adjustments are made through numbered holes in the PROMAG™ bracket with the board remaining in its slot. Due to the SVO board's sensitivity to thermal disturbances, all external air currents must be minimized. One effective way to do the following calibration procedure is to replace the 5500 top cover with a cardboard cover that has a slot cut out over the SVO board. This allows adjustment of the trim pots while closely simulating the normal thermal state of the 5500.

6.7.1 SYSTEM SET-UP

Recall machine state 0.1 to initialize the 5500 to a known state.

Enter a source amplitude of 16 Volts and enable output A in 50 ohm unbalanced mode. Enter special function 37.1 for internal source sync. Enter a source frequency of first 100 Hz and then 1 kHz to force the SVO into its range 2 mode.

Connect the 5500 output to the external THD + N analyzer and connect the analyzer's monitors to the oscilloscope.

6.7.2 FREQUENCY SETTING

One frequency adjustment is provided on this module to calibrate the discrete 13th BIT DAC. To make this adjustment, select 500 Hz as the generator frequency. Note the actual reading on the 5500 front panel display then select 1 kHz and adjust #9 for precisely twice the frequency reading as 500 Hz. Example:

SELECT	FREQUENCY DISPLAY
	(example)
500 Hz	500.6 Hz
1 kHz	Adjust for 1001.2 Hz

6.7.3 THD ADJUSTMENT

Step 1 Enter a source frequency of 100 Hz and then 1.0 kHz (oscillator range is now in internal range 2 mode).

Step 2 Adjust #6 and #7 for minimum second harmonic distortion as measured on the external analyzer and oscilloscope.

Step 3 Select a source frequency of 70 kHz. Adjust #4 and #5 to minimize second harmonic distortion.

6.7.4 LEVEL CALIBRATION

Enter a source frequency of 100 Hz and then 1.0 kHz. Select a 50 Ω output source impedance. Connect the 5500 unbalanced output to the precision AC volt meter. With a source amplitude entry of 16.0 Volts, adjust #3 for a reading of exactly 16.000 Volts.

The oscillator is now calibrated and should not be readjusted in the system to compensate any additive system errors.

6.7.5 SQUARE WAVE LEVEL

Select SPCL Function 14.7 to obtain a square wave output. Set generator to +10 dBV, adjust #1 for a 50% duty cycle (equal mark/space ratio) then adjust #2 for a level reading which is the same as the sine wave mode (14.1 SPCL Function).

6.8 DETECTOR

The detector module contains several detectors (rms, average, quasi- peak), a switched gain stage, an analog-to-digital convertor and other circuits. Parameters of all of these circuits affect level measurement accuracy. They are all calibrated using the internal software based automatic calibration sequence (see Section 6.2).

The only external calibration required on this module is the DC Vref precision source used as a reference for all of the AUTO CAL procedures.

The Vref source is factory adjusted and normally will not require calibration by the user. If the AC level measuring accuracy subsequent to an AUTO CAL sequence is suspect, Vref may be measured and, if necessary, adjusted. A DC Voltmeter as described in Section 6.3 should be used.

6.8.1 Vref CALIBRATION

This calibration requires access to circuit board test points thus necessitating the use of the PROMAG™ extender card (Amber 5500 option 701).

Monitor Vref at U4005 pin 1 or P1 pin 36 on the detector module or back plane board.

If the measured DC level is not +3.162 V ± 2mV, adjust VR4003 to the correct value. See Schematic 4E in Section 8.

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6.9 PREAMP CALIBRATION

The preamp is adjusted to optimize CMRR. The following procedure adjusts two trimmers at two frequencies to accurately calibrate the preamp as a system subsection.

It is assumed that the preamp board will be calibrated in a complete and functional 5500. No special instrumentation is required for the procedure. An oscilloscope connected to the input monitor will aid in the procedure to simultaneously observe the common mode waveform while following the calibration steps.

The procedure involves feeding a common mode signal to the differential input of the instrument and adjusting for minimum signal (that is, best CMRR).

To connect a common mode signal, it will be necessary to feed both the tip and ring of the input connector.

Using a telephone type phone plug (WE310 or PJ051), prepare a cable with tip and ring connected together as the "hot" lead from the generator and sleeve as ground. Alternatively, use an Amber banana/binding post to phone plug adapter (Part number 13005).

Step 1 Recall machine state 0.1 to initialize the 5500 to a known state.

Step 2 Set special function 1.8. (This holds the PGA in unity gain.)

Step 3 Set the source amplitude to +10 dBV. Select 50 ohm source impedance, 1 kHz source frequency, select level display in dBV and enable the output.

Step 4 Install the adapter cable into the A input. Jumper the ring- and-tip connections.

Step 5 Connect the source output from the unbalanced BNC connector to the adapter by connecting the commons together and the signal source to the jumpered ring and tip. This presents a common mode signal to the preamplifier.

Step 6 Adjust VR3001, through hole #2, for a minimum reading on the left (level) display.

Step 7 Enter a source frequency of 20 kHz and adjust C3009, through hole #1, for a minimum reading on the left display.

Step 8 Reenter a source frequency of 1 kHz. Repeat both adjustments until no further optimization can be achieved. The level readings at both frequencies will typically be between -70 and -80 dBV.

The preamp is now calibrated and no attempt should be made to adjust it under differing conditions.

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6.10 FILTER & NOTCH (SVF) CALIBRATION

The following procedure should be used to calibrate the filter board in the system. A precision external oscillator with at least 10 dB lower distortion then the 5500 analyzer, such as the Amber model 3501, should be used as the test signal source (see Section 6.3).

6.10.1 SYSTEM SET-UP

Recall machine state 0.1 to initialize the 5500 to a known state and disconnect any inputs or outputs.

Set up the external oscillator to approximately 1.0 kHz and to 3.0 Volts rms level. Connect to the 5500 system INPUT A (unbalanced or balanced input).

Connect the two 5500 front panel monitors to an oscilloscope and display both traces. Select 400 Hz and 30 kHz filters. Enter special function 1.8 (to hold the preamp gain at unity) and select THD mode. You should see the fundamental signal on one trace and the residual distortion on the second trace of the oscilloscope.

6.10.2 ADJUSTMENT

Step 1 Enter a 5500 source frequency of 1000 Hz. Adjust #1 and #2 (VR1001, VR1002) for maximum fundamental rejection.

The filter and notch board is now calibrated.

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6.11 PGB MUX CALIBRATION PROCEDURE

The following calibration procedure applies to the weighting filters located on the PGB board. The PGB circuitry itself does not have adjustments. And only one of the three trimmers in the weighting filters group is adjusted, depending on which filter has been installed (ANSI/IEC A is standard, CCIR [option 101] or Psophometric [option 102] is optional).

It is assumed that the following adjustments are done in a complete and otherwise functional and calibrated 5500.

6.11.1 INSTRUMENT SET-UP

Recall machine state 0.1 to initialize the 5500 to a known state.

Request a generator source amplitude of 0 dBV (1 V), enable OUTPUT A and select OSCA as the INPUT. Select log units (i.e. dBV or dBm) and set a relative level of 0.0 dB by pushing SHIFT and RELATIVE. This is the reference level with no filters selected. Also select 37.1 SPCL FNCT for oscillator sync since certain levels during the course of this procedure may be below that required for proper frequency measurement.

All adjustments can be made without removing the PGB board from its slot. Each adjustment is accessible through labelled holes in the PGB PROMAG™ bracket. The 5500 level display (left display) along with an oscilloscope connected to the input and measured function monitors is all that is required. Allow several minutes for system warm-up with the cover on.

The following procedure adjusts the gain of the weighting filter to conform to the reference standard. This is done by setting the gain to unity at a particular frequency. Unity gain is verified by turning the filter off and on and noting no level change when the test generator is at the reference frequency.

6.11.2 PGB WITH "A" WEIGHTING FILTER (standard)

Observe the measured level. Select A-WTG filter and observe the measured function monitor for any problems.

Adjust R7001 through hole #1 to match the reference level (0.0dB) at a source frequency of 1kHz (unity gain).

6.11.3 PGB WITH CCIR FILTER (option 101)

Set source frequency to 1 kHz for the original CCIR specification or to 2 kHz for the Dolby specification. Observe the measured level.

Select CCIR, observe the measured function monitor for any problems and adjust VR7002 through hole #2 for unity gain (0.0 dB).

6.11.4 PGB WITH PSOPHOMETRIC (option 102)

Set source frequency to 800 Hz and observe the measured level. Select psophometric, observe the measured function monitor for any problems and adjust VR7003 through hole #3 for unity gain (0.0 dB).

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6.12.0 IMD CALIBRATION (if option 002 is installed)

The following procedure should be used to calibrate the IMD board. This requires a complete and functional 5500 system where the standard (non-optional) subsections of a 5500 system have been factory calibrated or user calibrated in the correct sequence as described in Section 6.0.6.

The three adjustments on the IMD pertain to the oscillator section and are adjusted using only an oscilloscope. There are no adjustments in the analyzer section.

Allow one half hour for system warm-up with the cover on. The adjustments should be done through the holes in the PROMAG™ bracket instead of on the extender card. This will keep the board temperature more stable. Note that the CCIF adjustments are the most temperature dependent and may require readjustment after replacing the cover on the 5500 for five minutes.

6.12.1 LEVEL CALIBRATION

Step 1 Recall machine state 0.1 to initialize the 5500 to a known state. Disconnect any inputs or outputs.

Step 2 Set special function 1.8. (This holds the PGA in unity gain.)

Step 3 Select source amplitude to 3.00 V rms. Select 50 ohm source impedance, enable the output and select oscillator A send on the input select. Connect the unbalanced 50 ohm output to an oscilloscope.

Step 4 While in level mode, adjust the variable gain of the oscilloscope to have the sine wave signal displayed occupy six vertical divisions peak-to-peak. This sets a reference displayed amplitude.

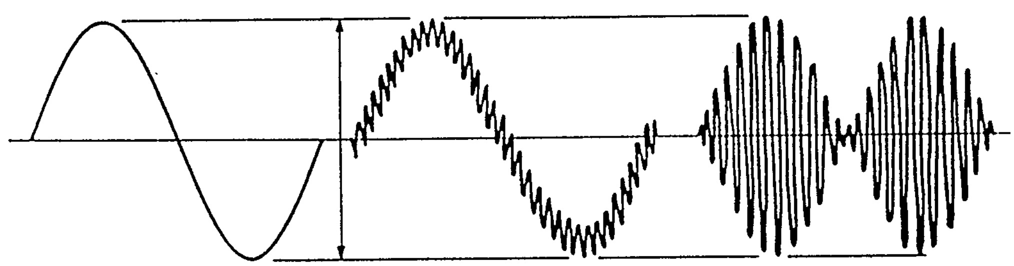
Step 5 Select SMPTE IMD mode. Adjust VR6003, through hole #3, so that the SMPTE signal is also six vertical divisions peak-to-peak on the oscilloscope.

Step 6 Select CCIF IMD mode. Adjust VR6002, through hole #2, so that the CCIF signal is also six vertical divisions peak-to-peak on the oscilloscope.

6.12.2 DISTORTION ADJUSTMENT

While in CCIF mode, select a LF frequency of 500 Hz and a HF frequency of 100 kHz. Connect the oscilloscope to the measured function monitor of the 5500. Adjust VR6001, through hole #1, for minimum IM distortion.

Replace the cover on the system and verify the adjustments after five minutes. This completes the IMD calibration.



Normal Sine Wave

SMPTE IMD Wave Form

CCIF IMD Wave Form

Both IMD Waveforms are adjusted for same peak-to-peak amplitude as sine wave.

Fig. 6.12 IMD Test waveforms

6.13 AUDIO WEIGHTING FILTER (Option 005)

This module provides four audio noise weighting filters meeting various international standards. Two of the four filters have a unity gain adjustment. One filter has a notch frequency adjustment and one filter has no adjustment.

6.13.1 5500 SET UP

Recall machine state 0.1 to initialize the 5500 to a known state.

Request a generator source amplitude of 0 dBV (1 V), enable OUTPUT A and select OSCA as the INPUT. Select log units (i.e. dBV or dBm) and set a relative level of 0.0 dB by pushing SHIFT and RELATIVE. This is the reference level with no filters selected. Also select 37.1 SPCL FNCT for oscillator sync since certain levels during the course of this procedure may be below that required for proper frequency measurement.

6.13.2 CALIBRATION OF CCIR FILTER

Enter a source frequency of 2 kHz if the Dolby specification is used or enter a source frequency of 1 kHz if the original CCIR 468-3 specification is used.

Observe the level reading and then select CCIR filter. Adjust VR8003, through hole #4, to match the level reading observed before (0.0 dB).

6.13.3 CALIBRATION OF ANSI/IEC A WEIGHTING FILTER

Deselect CCIR and enter a source frequency of 1 kHz. Observe level reading. Select the "A" weighting filter. Adjust VR8002, through hole #3 for the reference reading (0.0 dB).

6.13.4 CALIBRATION OF IHF WEIGHTING FILTER

Enter a source frequency of 19 kHz. Using the modify up/down buttons and using a suitable frequency increment value, set the source frequency to 19.000 kHz, ±9 Hz. Select the IHF filter. Repeatedly adjust both C8062 and VR8001, through holes #1 and #2, for the maximum attenuation possible in the 19 kHz notch circuit. Note that the notch may require further trimming after the board achieves a stable temperature when the 5500 cover is replaced.

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6.14 TELECOMMUNICATIONS WEIGHTING FILTERS (Option 006)

This module contains four noise weighting filters, two band pass and two low pass. The low pass filters have unity pass band gain by design and precision frequency determining components. They have no adjustments. The two band pass filters have gain adjustments and the C-Message also has notch frequency adjustment.

6.14.1 5500 SET-UP

Recall machine state 0.1 to initialize the 5500 to a known state.

Select source amplitude of 0 dBV, enable output A, select oscillator send A on the input selector and select dBV units for the level display. Also enter special function 37.1 to set internal sync.

6.14.2 PROGRAM FILTER CALIBRATION

With source frequency at 1 kHz, set a relative level of 0.0 dB by pushing SHIFT and RELATIVE while in the log units. Select the Program filter. Adjust VR8003, through hole #4, for the same 0.0 dB level.

6.14.3 C-MESSAGE FILTER

The C-Message filter consists of a multi-pole band pass section and a nominal 1 kHz notch (band reject) section. Adjustments to the filter require bypassing specific sections as described below.

The notch facility is implemented by cascading three separate notches at 995 Hz, 1010 Hz and 1025 Hz to achieve broad frequency width and deep notch depth. Each notch filter has a center frequency adjustment and each must be set independently.

The band pass section has a gain adjustment that must be set for unity gain at 1 kHz. To allow this adjustment to be set, the three notch filters must be bypassed.

The input and output of each notch filter appears on a PCB post. these are arranged in such a manner that 0.1 inch jumper plugs are used to connect each filter in the path in the normal mode. The filters can be easily bypassed or reconfigured by removing these jumpers and using miniature clip leads or jumper wires with post sockets.

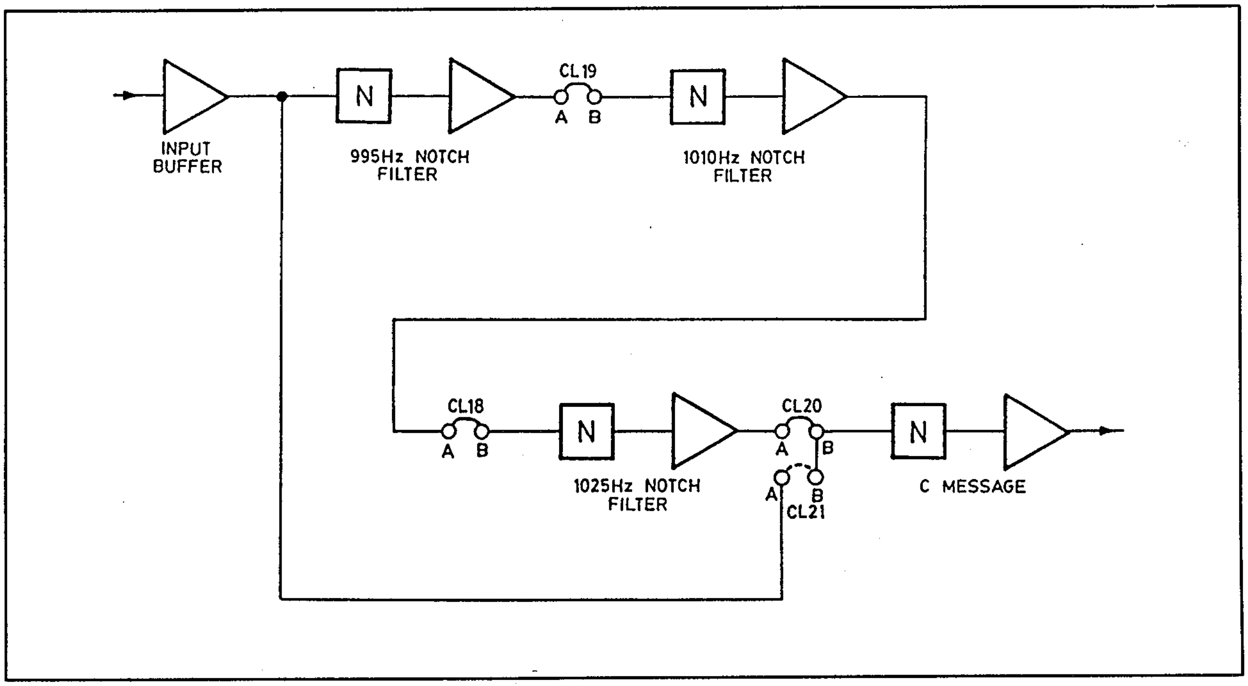


Fig. 6.14.1 Notch filter functional path

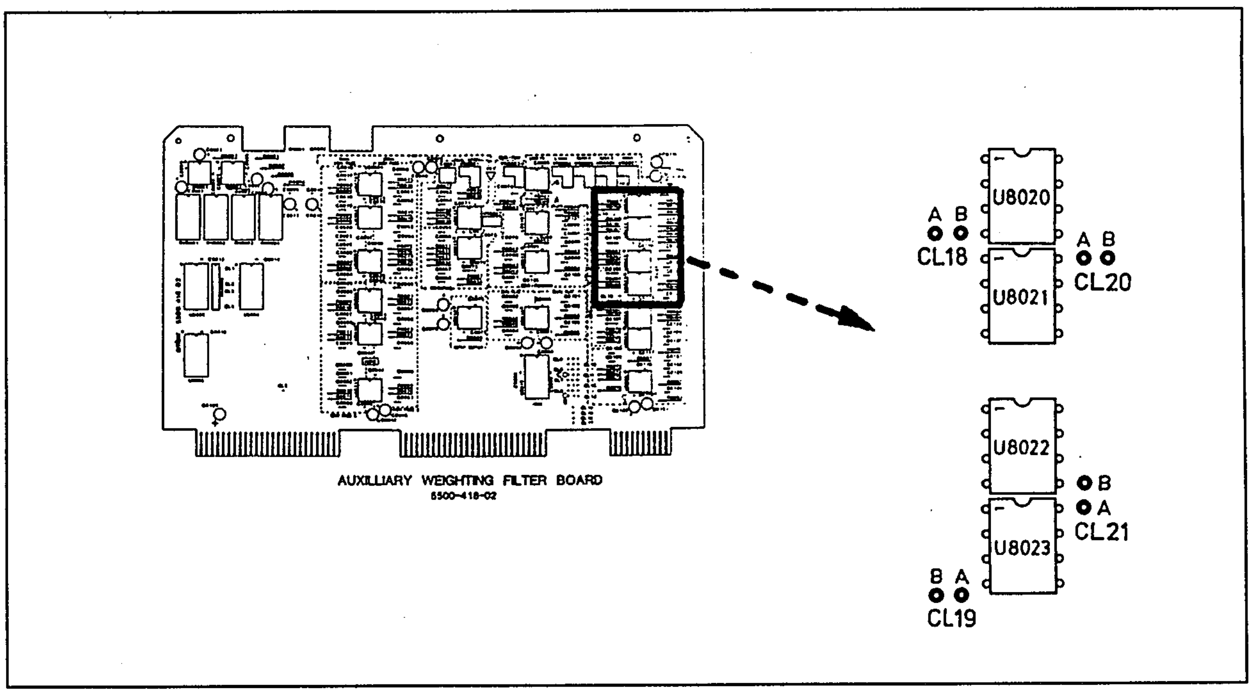


Fig. 6.14.2 Notch filter jumper locations

TABLE 6.14.1
NOTCH FILTER JUMPERS

FILTER	INPUT	OUTPUT
995Hz	Internal	CL19-A
1010Hz	CL19-B	CL18-A
1025Hz	CL18-B	CL20-A
C-Message	CL20-B Internal	CL21-B
Input signal	CL21-A	——

TABLE 6.14.2
JUMPER CONFIGURATIONS

DESIRED PATH	INSTALL JUMPER
C-Message ONLY	CL21-A to CL21-B
995Hz Notch	CL19-A to CL21-B
1010Hz Notch	CL21-A to CL19-B and CL18-A to CL20-B
1025Hz Notch	CL21-A to CL18-B and CL20-A to CL20-B
NORMAL OPERATION	CL19-A to CL19-B CL18-A to CL18-B CL20-A to CL20-B

6.14.4 C-MESSAGE GAIN

Bypass the three notch filters by removing all jumpers and connecting CL21-A to CL21-B (see Table 6.14.2).

Step 1 Recall machine state 0.1 to initialize the 5500 to a known state.

Select source amplitude of 0 dBV, enable output A, select oscillator send A on the input selector and select dBV units for the level display. Also enter special function 37.1 to set internal sync.

Step 2 With a source frequency of 1 kHz, set a relative level of 0.0 dB by pushing SHIFT RELATIVE while in the log units mode. Select the C-Message filter and adjust VR8004 through hole #5 for the same 0.0 dB level.

6.14. NOTCH FREQUENCY TUNE

Each of the three notch filters will be fine tuned for its nominal center frequency. Each is connected in the path one at a time while the other two are bypassed. (Note that the C-Message filter remains in the path for these adjustments.)

Connect an oscilloscope to the MEASURED FUNCTION MONITOR output. This will allow the observation of the filter tune null described below. The level meter on the 5500 will under-range near null making accurate tuning difficult but the external oscilloscope (or an external level meter) will facilitate this adjustment.

Step 1 Install the 995 Hz notch filter in the path by connecting jumpers CL19-A to CL21-B (see Table 6.14.2).

Step 2 Select a source frequency of 995 Hz ± 1 Hz (use the increment mode to fine tune the oscillator).

Step 3 Adjust VR8005 through hole #6 for maximum attenuation (i.e. minimum signal).

Step 4 Install the 1010 notch filter in the path by connecting CL21-A to CL19-B and CL18-A to CL20-B.

Step 5 Select a source frequency of 1010 Hz ± 1 Hz.

Step 6 Adjust VR8006 through hole #7 for maximum attenuation.

Step 7 Install the 1025 Hz notch filter in the path by connecting jumpers CL21-A to CL18-B and CL20-A to CL20-B.

Step 8 Select a source frequency of 1025 Hz ± 1 Hz.

Step 9 Adjust VR8007 through hole #8 for maximum attenuation.

Step 10 Reconnect the filter path to normal operation by connecting jumpers CL19-A to CL19-B, CL18-A to CL18-B and CL20-A to CL20-B.

This completes the C-Message and notch adjustments.

AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

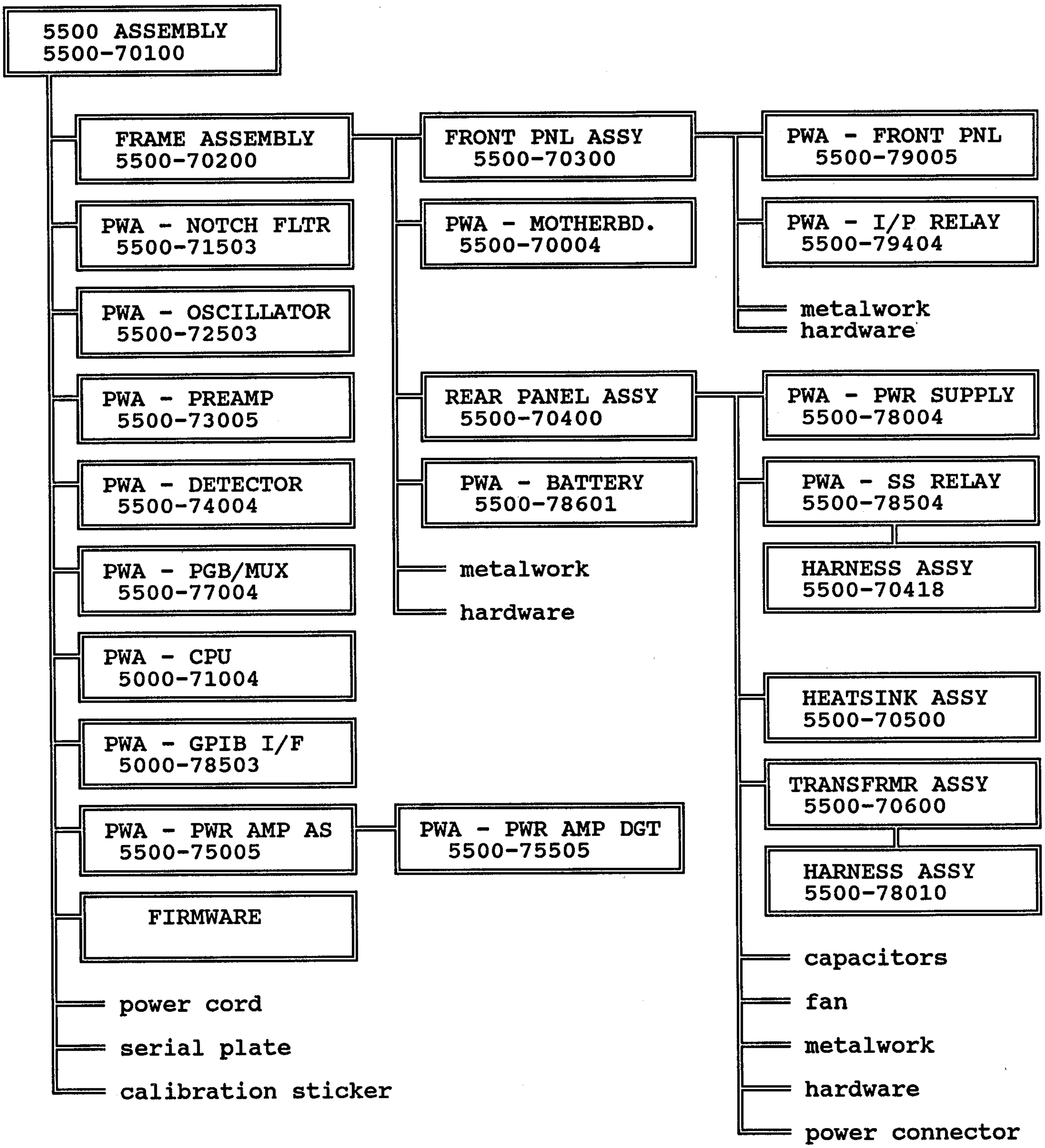
OWNER'S MANUAL

SECTION 7

PARTS LISTS

Issue 07 January 1989

DWG. 5500-10100 ISS.04 BASIC 5500 ASSEMBLY TREE 15 FEB 89



5500 ASSEMBLY 15500-70100

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	SERIAL PLATE	11000-40011			AMBER	11000-40011	1
	CALIBRATION STICKER	11000-40021			AMBER	11000-40021	1
	CPU PCB ASSY	5000-71004			AMBER	5000-71004	2
	FIRMWARE	5500-			AMBER	5500-	1
	FRAME ASSY	5500-70200			AMBER	5500-70200	1
	NOTCH FILTER PCB ASSY	5500-71503			AMBER	5500-71503	1
	OSCILLATOR PCB ASSY	5500-72503			AMBER	5500-72503	1
	PREAMP PCB ASSY	5500-73005			AMBER	5500-73005	1
	DETECTOR PCB ASSY	5500-74004			AMBER	5500-74004	1
	POWER AMP PCB ASSY	5500-75004			AMBER	5500-75004	1
	PGB/MUX PCB ASSY	5500-77004			AMBER	5500-77004	1
	GPIB I/F PCB ASSY	5500-78503			AMBER	5500-78503	1
	POWER CORD	589-05310			ALPHA	531	1

5500 FRAME ASSEMBLY 5500-70200

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	HARNESS FLAT CABLE	5500-30001	50PIN		AMBER	5500-30001	1
	TOP COVER	5500-62002			AMBER	5500-62002	1
	BOTTOM COVER	5500-62103			AMBER	5500-62103	1
	CARD CAGE	5500-63005			AMBER	5500-63005	1
	EXOR HOLD DOWN BRACKET	5500-63402			AMBER	5500-63402	1
	SHIELD PLATE	5500-63504			AMBER	5500-63504	12
	SIDE BRACKET	5500-65007			AMBER	5500-65007	2
	HANDLE CLIPS	5500-65501			AMBER	5500-65501	4
	DRESS STRIPS	5500-68002			AMBER	5500-68002	4
	MOTHERBOARD ASSY	5500-70004			AMBER	5500-70004	1
	FRONT PANEL ASSEMBLY	5500-70300			AMBER	5500-70300	1
	REAR PANEL ASSY	5500-70400			AMBER	5500-70400	1
	BATTERY PCB ASSEMBLY	5500-78601			AMBER	5500-78601	1
	MACHINE SCREW FLAT 6-32	61113-16025	1/4			AN507-632-R4	40
	MACHINE SCREW FLAT BLACK 6-32	61113-16031	5/16		VARIOUS	AN507-632-R5	32
	MACHINE SCREW PAN 6-32	61114-16037	3/8		VARIOUS	MS35206-228	37
	MACHINE SCREW PAN 6-32	61114-16050	1/2			MS35206-230	12
	MACHINE SCREW PAN 6-32	61114-16075	3/4			MS35206-232	2
	SCREW FLAT BLACK 10-32	61129-21600			SPAE NAUR	HX-216	4
	MACHINE SPEED NUT	61240-54000	6-32		EATON YALE	DC-1887-632-24	48
	WASHER FLAT #6	61510-16400			VARIOUS	AN 960-6	14
	WASHER INTERNAL TOOTH #6	61520-93660			VARIOUS	AN 936-A6	10
	SPACER	61699-10000			SPAE NAUR	SPA-22	4
	RUBBER BUMPER	65100-50180			3M	SJ5018/6227	5
	HANDLE	65200-78400	10"		PHC	7840	2
	CASE FEET REAR	65300-40801			BUCKEYE	MP 40008-01B	2
	CASE FOOT LEFT	65300-40802			BUCKEYE	MP 40008-01B	1
	CASE FOOT RIGHT	65300-40803			BUCKEYE	MP 40008-01B	1
	CASE TILT BAIL KIT	65300-40810	14"		BUCKEYE	MP 40008 10	1
	CARD GUIDES	67001-29011			VERO	2901126	36
	SCREW LUG	67101-34115	3/8		AMP	34115	6

5500 FRONT PANEL ASSEMBLY 15500-70300

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	HARNESS 403	15500-30403	9.5"		AMBER	15500-30403	1
	HARNESS 410	15500-30410	12.5"		AMBER	15500-30410	1
	HARNESS 412	15500-30412	11.5"		AMBER	15500-30412	1
	HARNESS 413	15500-30413	15.5"		AMBER	15500-30413	1
	FRONT PANEL UNDERLAY	15500-61005			AMBER	15500-61005	1
	OUTPUT CONNECTOR SHIELD	15500-61601			AMBER	15500-61601	1
	PCB SHIELD PLATE	15500-61901	5X9		AMBER	15500-61901	1
	FRONT PANEL OVERLAY	15500-69202			AMBER	15500-49003	1
	KEYBOARD/DISPLAY PCB ASSEMBLY	15500-79005			AMBER	15500-79005	1
	INPUT PCB ASSEMBLY	15500-79404			AMBER	15500-79404	1
	MACHINE SCREW PHIL PH 6-32	61111-16031	5/16		VARIOUS	MS35206-227	11
	MACHINE KNURLED DRESS NUT	61250-19700	BLACK		SWITCHCRAFT	P-1970	4
	WASHER BNC STEP	61500-56046			SEASTROM	5604-66	10
	WASHER NYLON	61502-56107			SEASTROM	5610-76-M30	4
	MACHINE WASHER IT	61520-36400	#6		VARIOUS	AN936-A4	11
	SCREW LUG	67101-34115	3/8		AMP	34115	8
	CONNECTOR, BANNANA JACK	740-28545	GREEN		ITT	2854-5	1
	CONNECTOR R-T-S CHASSIS	76103-11420			SWITCHCRAFT	M114B	2
	CONNECTOR BNC	77001-79106	GOLD		KINGS	KC79-106-MA9	6

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	PRINTED CIRCUIT BOARD	15500-49004			AMBER	5500-490-04	1
	KNOB CAP BROWN	63803-90114			LICON	803901140000	15
	KNOB CAP BEIGE	63803-90115			LICON	803901150000	15
	KNOB CAP OLIVE	63803-90116			LICON	803901160000	1
	KNOB CAP BROWN LED	63803-90117			LICON	803901170000	20
	CONNECTOR SOCKET 14PIN	71014-21439				214-AG39D	2
	CONNECTOR SOCKET 16PIN	71016-21639				216-AG39D	2
	CONNECTOR SOCKET 40PIN	71040-24039				240-AG39D	4
	CONNECTOR SOCKET 18PIN WW	71718-31800				18-8685-610C	7
	CONNECTOR HEADER 50P R ANG EJ	78003-20000			RN	IDH-50LP-SR3-TG	1
	CONNECTOR HEADER 4PIN LATCHING	78007-20410			MOLEX	22-29-2041	2
	SWITCH LIGHT PIPES	84211-22110			LICON	80-3901	20
C901	CAPACITOR MONOLYTIC	42031-41000	0.1				12
C902	CAPACITOR ELECT 100/25	48030-10000	100				1
C903	CAPACITOR MONOLYTIC	42031-41000	0.1				
C904	CAPACITOR MONOLYTIC	42031-41000	0.1				
C905	CAPACITOR MONOLYTIC	42031-41000	0.1				
C906	CAPACITOR MONOLYTIC	42031-41000	0.1				
C907	CAPACITOR MONOLYTIC	42031-41000	0.1				
C908	CAPACITOR MONOLYTIC	42031-41000	0.1				
C909	NOT USED						
C910	NOT USED						
C911	NOT USED						
C912	CAPACITOR CERAMIC DISC	41033-04700	47P				1
C913	CAPACITOR FILM	45042-32201	0.022	20%		MKS3 0.022/100/20W	1
C914	CAPACITOR MONOLYTIC	42031-41000	0.1				
C915	CAPACITOR MONOLYTIC	42031-41000	0.1				
C916	CAPACITOR MONOLYTIC	42031-41000	0.1				
C917	NOT USED						
C918	CAPACITOR FILM	45042-42200	0.22	5%	WIMA	MKS3 0.22 63 5	1
C919	CAPACITOR MONOLYTIC	42031-41000	0.1				
C920	CAPACITOR MONOLYTIC	42031-41000	0.1				
D901	SEMICON LED RECT RED	21531-57124			GI	MV57124	43
D902	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D903	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D904	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D905	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D906	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D907	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D908	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D909	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D910	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D911	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D912	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D913	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D914	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D915	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D916	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D917	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D918	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D919	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D920	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D921	NOT USED						

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
D922	NOT USED						
	CONNECTOR SOCKET 20PIN	71020-22039			AUGAT	220-AG39D	3
D923	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	18
D924	SEMICON LED RECT RED	21531-57124				MV57124	
D925	SEMICON LED RECT RED	21531-57124				MV57124	
D926	NOT USED						
D927	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D928	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D929	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D930	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D931	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D934	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D937	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D939	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D940	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D941	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D942	NOT USED						
D943	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D944	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D945	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D946	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D947	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D948	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D949	NOT USED						
D950	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D951	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D952	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D953	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D954	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D955	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D956	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D957	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D958	SEMICON LED SUPER BRIGHT	21541-39010			GI	ESBR3901	
D959	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D960	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D961	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D962	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D963	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	15
D964	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D965	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D966	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D967	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D968	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D969	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D970	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D971	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D972	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D973	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D974	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D975	NOT USED						
D976	NOT USED						
D977	NOT USED						
D978	NOT USED						

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
D979	NOT USED						
D980	NOT USED						
D981	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D982	NOT USED						
D983	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D985	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D986	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D987	SEMICON LED SUPER BRIGHT	21541-39010			STANLEY	ESBR3901	
D988	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D989	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D990	SEMICON LED SUPER BRIGHT GREEN	21541-39010			GI	ESBR3901	
D991	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D992	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D993	SEMICON LED RECT GREEN	21531-52124			GI	MV52124	
D994	NOT USED						
D995	SEMICON LED RECT RED	21531-57124			GI	MV57124	
R901	RESISTOR CF 1/4W	32033-10030	100K	5%			2
R902	RESISTOR CF 1/4W	32033-33010	3K3	5%			6
R903	RESISTOR CF 1/4W	32033-33010	3K3	5%			
R904	RESISTOR CF 1/4W	32033-33010	3K3	5%			
R905	RESISTOR CF 1/4W	32033-33010	3K3	5%			
R906	RESISTOR CF 1/4W	32033-33010	3K3	5%			
R907	RESISTOR CF 1/4W	32033-33010	3K3	5%			
R908	RESISTOR CF 1/4W	32033-47010	47K	5%			1
R909	RESISTOR CF 1/4W	32033-10030	100K	5%			
R910	RESISTOR CF 1/4W	32033-30000	300	5%			1
RN901	RESISTOR NET 8PIN SIP	39087-33010	3K3X7			4608X-101-332	2
RN902	RESISTOR NET 8PIN SIP	39087-33010	3K3X7			4608X-101-332	
S901	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	30
S902	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S903	NOT USED						
S904	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	16
S905	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S906	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S907	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S908	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S909	NOT USED						
S910	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S911	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S912	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S913	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S914	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S915	SWITCH PUSHBUTTON MAIN. W/LED	84111-23100			ITW	39-23100	1
S916	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S917	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S918	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S919	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S920	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S921	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S922	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S923	NOT USED						
S924	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S925	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
S926	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S927	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S928	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S929	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S930	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S931	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S932	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S933	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S934	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S935	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S936	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S937	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S938	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S939	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S940	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S941	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S942	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S943	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S944	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S945	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S946	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S947	SWITCH PUSHBUTTON MOM. W/LED	84111-22102			ITW	39-22100	
S948	NOT USED						
S949	NOT USED						
S950	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S951	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
S952	SWITCH PUSHBUTTON MOMENTARY	84111-22100			ITW	39-22500	
U901	SEMICON MEMORY BIPOLAR PROM	26022-27130			ADV MICRO DEV	AM27S13APC	1
U902	SEMICON DUAL 2/4 DECODER	27743-74139				74LS139	1
U903	SEMICON QUAD 2 IN NAND OC	27743-74003				74LS03	1
U904	SEMICON OCT DRIVER TRISTATE	27743-74244				74LS244	3
U905	SEMICON DUAL D TYPE FF	27743-74074				74LS74	1
U906	SEMICON OCT DRIVER TRISTATE	27743-74244				74LS244	
U907	SEMICON OCT DRIVER TRISTATE	27743-74244				74LS244	
U908	SEMICON KEYBOARD ENCODER	29004-96000			SMC	KR9600 PRO	1
U909	NOT USED						
U910	SEMICON 8 DIGIT LED DRIVER	29200-72181			INTERSIL	ICM 7218EIJL	3
U911	SEMICON 8 DIGIT LED DRIVER	29200-72181			INTERSIL	ICM 7218EIJL	
U912	SEMICON 8 DIGIT LED DRIVER	29200-72181			INTERSIL	ICM 7218EIJL	
U913	SEMICON LED DISPLAY	21551-66300				MAN6630G	2
U914	SEMICON LED DISPLAY	21551-66100				MAN6610G	4
U915	SEMICON LED DISPLAY	21551-66100				MAN6610G	
U916	SEMICON LED DISPLAY	21551-66300				MAN6630G	
U917	SEMICON LED DISPLAY	21551-66100				MAN6610G	
U918	SEMICON LED DISPLAY	21551-66100				MAN6610G	
U919	NOT USED						
U920	SEMICON	27742-74132				MC74HC132N	1
U921	SEMICON	27742-74074				SN74HC74N	1
U922	SEMICON POWER MOS FET	22318-10000				VN10KM	1

5500 INPUT ASSEMBLY 15500-79404

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	COAX, YEL		4"				1
	COAX, RED		4"				1
	SIDE INSULATOR	15500-			AMBER	15500-	1
	REAR SHIELD				AMBER	15500-	1
	HARNESS 401	15500-30401	11.5"		AMBER	15500-30401	1
	HARNESS 402	15500-30402	6.5"		AMBER	15500-30402	1
	HARNESS 404	15500-30404	6.0"		AMBER	15500-30404	1
	PRINTED CIRCUIT BOARD	15500-49404			AMBER	15500-49404	1
	INPUT CONNECTOR SHIELD	15500-69401			AMBER	15500-69401	1
	SEPARATOR SHIELD	15500-69501			AMBER	15500-69501	1
	CAPACITOR ELECTROLYTIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	2
	CONNECTOR R-T-S CHASSIS	76103-11420			SWITCHCRAFT	M114B	2
	RELAY 2 FORM C	84801-18000	18V		ITT	RY-18-WK	2

5500 MOTHER BOARD ASSEMBLY 15500-70004

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	PRINTED CIRCUIT BOARD	15500-40004			AMBER	5500-400-04	1
	SEMICON TRANSORB	29001-15680	6.8		GS	1.5KE6.8A	2
	MACHINE SCREW PHIL PH 4-40	61111-14050	1/2		VARIOUS	MS35206-217	26
	MACHINE SCREW PHIL PH 6-32	61113-16031	5/16		VARIOUS	AN507-632-R5	15
	MACHINE NUT HEX	61222-44000	#4		VARIOUS	MS35649-242	26
	MACHINE NUT PC-MOUNT	61260-63240	6-32		PEM	KFE-632-ET	15
	MACHINE LOCK WASHER IT	61520-36400	#4		VARIOUS	AN936-A4	26
	MACHINE LOCK WASHER IT	61520-93660	#6		VARIOUS	AN936-A6	15
J401	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	14
J402	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J403	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J404	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J405	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J406	NOT USED						
J407	NOT USED						
J408	NOT USED						
J409	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J410	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J411	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J412	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J413	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J414	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J415	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J416	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J417	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
J418	CONNECTOR HEADER LATCH	78007-20410	4 PIN		MOLEX	22-29-2041	
P1-01	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-02	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-03	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-04	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-05	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-06	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-07	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-08	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-09	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-10	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-11	NOT USED						
P1-12	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P1-13	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-01	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	25
P2-02	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-03	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-04	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-05	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-06	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-07	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-08	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-09	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-10	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-11	NOT USED						
P2-12	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P2-13	CONNECTOR CARD EDGE	71517-34250	50PIN		EDAC	342-050-524-202	
P3-01	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-020-524-202	12

5500 MOTHER BOARD ASSEMBLY 15500-70004

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
P3-02	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-020-524-202	
P3-03	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P3-04	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P3-05	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P3-06	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P3-07	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P3-08	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P3-09	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P3-10	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P3-11	NOT USED						
P3-12	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P3-13	CONNECTOR CARD EDGE	71517-34220	20PIN		EDAC	342-050-524-202	
P4-14	CONNECTOR CARD EDGE	71517-86524	86PIN		EDAC	307-086-524-202	5
P4-15	CONNECTOR CARD EDGE	71517-86524	86PIN		EDAC	307-086-524-202	
P4-16	CONNECTOR CARD EDGE	71517-86524	86PIN		EDAC	307-086-524-202	
P4-17	CONNECTOR CARD EDGE	71517-86524	86PIN		EDAC	307-086-524-202	
P4-18	CONNECTOR CARD EDGE	71517-86524	86PIN		EDAC	307-086-524-202	

5500 REAR PANEL ASSEMBLY 15500-70400

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	HARNESS 7	15400-30007			AMBER	15400-30007	1
	HARNESS 11	15400-30011			AMBER	15400-30011	1
	HARNESS 409	15500-30409			AMBER	15500-30409	1
	HARNESS 411	15500-30411			AMBER	15500-30411	1
	HARNESS,DIODE BRIDGE	15500-38000			AMBER	15500-38000	
	HARNESS, FAN	15500-38010			AMBER	15500-38010	1
	POWER SUPPLY CHASSIS	15500-64006			AMBER	5500-640-03	1
	CAPACITOR BRACKET	15500-64102			AMBER	15500-64102	1
	REAR PANEL	15500-67002			AMBER	15500-67002	1
	PLATE 1.0X3.5	15500-67401			AMBER	15500-67401	2
	HEATSINK ASSY	15500-70500			AMBER	15500-70500	1
	TRANSFORMER ASSY	15500-70600			AMBER	15500-70600	1
	POWER SUPPLY PCB ASSY	15500-78004			AMBER	15500-78004	1
	SSR ASSY	15500-78504			AMBER	15500-78504	1
	SEMICON BRIDGE RECTIFIER	29006-98020			MOTOROLA	MDA980-2	2
	RESISTOR MF 1%	32035-66500	665	1%	CORNING	SMA4-665R-1	2
	STEP WASHER	61500-56046			SEASTROM	5604-66	6
	NYLON WASHER	61502-25170			SMITH	2517	6
	FAN GUARD	65500-18203			HOWARD	6-182-033UL	1
	FAN	65500-52470			HOWARD	3-15-2470	1
	CONNECTOR LUG	67100-32000			SPAE-NAUR	WT-32	7
	CONNECTOR LUG	67100-37000			SPAE NAUR	WT-37	5
	CONNECTOR LUG	67100-39000			SPAE-NAUR	WT-39	3
	TERMINAL LUG	67101-34115	3/8		AMP	34115	6
	PLUG (PLASTIC) BUTTON	67200-00000			SPAE NAUR	245-049	1
	CONNECTOR AC FILTER	71000-37000			SCHAFNER	FN370-4/22	1
	CONNECTOR BNC	77001-79106	GOLD		KINGS	KC79-106-MA9	6

5500 POWER SUPPLY PCB ASSEMBLY 15500-78004

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	HARNESS	15500-38011			AMBER	15500-38011	1
	HARNESS	15500-38012			AMBER	15500-38012	1
	HARNESS	15500-38014			AMBER	15500-38014	1
	PRINTED CIRCUIT BOARD	15500-48003			AMBER	15500-48003	1
	HEAT SINK PC MOUNTED	61800-60300			THERMALLOY	6030B	3
	CONNECTOR SOCKET PCB DIP 8PIN	71008-20839			AUGAT	208-AG39D	1
	CONNECTOR SOCKET PCB DIP 14PIN	71014-21439			AUGAT	214-AG39D	4
	CONNECTOR SOCKET PCB DIP 16PIN	71016-21639			AUGAT	216-AG39D	7
	CONNECTOR HEADER LATCH 4PIN	78007-20410			MOLEX	22-29-2041	5
	FUSE CLIP	85314-10206			LITTLEFUSE	1020710:102068	6
C8001	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8002	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8003	CAPACITOR ELECT 2200/25	48030-22010	2200	20%	SIEMENS	85200 2200 UF 25V	2
C8004	CAPACITOR ELECT 2200/25	48030-22010	2200	20%	SIEMENS	85200 2200 UF 25V	
C8005	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8006	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8007	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8008	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8009	CAPACITOR FILM	45042-44701	0.47	20%	WIMA	MKS3 0.47/63/20W	5
C8010	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8011	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8013	CAPACITOR FILM	45042-44701	0.47	20%	WIMA	MKS3 0.47/63/20W	
C8014	CAPACITOR FILM	45042-24700	4700P	5%	WIMA	FKC3 4700/160/5W	
C8015	CAPACITOR FILM	45042-24700	4700P	5%	WIMA	FKC3 4700/160/5W	
C8016	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8017	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	21
C8018	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8019	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8020	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8021	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8022	CAPACITOR TANTALUM 4.7/25V	47031-04790	4.7	20%	WIMA		2
C8023	CAPACITOR TANTALUM 4.7/25V	47031-04790	4.7	20%			
C8024	CAPACITOR FILM	45042-31002	0.01	20%	WIMA	MKS3 0.01/100/20W	2
C8025	CAPACITOR FILM	45042-31002	0.01	20%	WIMA	MKS3 0.01/100/20W	
C8026	CAPACITOR FILM	45041-31000	0.01	20%	WIMA	MKS3 0.01/100/20W	1
C8027	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%		TCD-103Z	
C8028	CAPACITOR FILM	45042-42200	0.22		WIMA		
C8029	CAPACITOR FILM	45042-42200	0.22		WIMA		
C8030	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%		TCD-103Z	7
C8031	CAPACITOR FILM	45042-24700	4700P	5%	WIMA	FKC3 4700/160/5W	3
C8032	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8033	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	16
C8034	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8035	CAPACITOR ELECT 1000/40 RADIAL	48050-10010	1000	20%	SIEMENS	85200/1000/40	1
C8036	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8037	CAPACITOR FILM	45042-44701	0.47	20%	WIMA	MKS3 0.47/63/20W	
C8038	CAPACITOR FILM	45042-22200	2200P	5%	WIMA	FKC3 2200/160/5W	1
C8039	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8040	CAPACITOR ELECT 470/16	48020-47000	470	20%	SIEMENS	81000/470/16	1
C8041	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8042	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C8043	CAPACITOR FILM	45042-21001	1000P	5%	WIMA	FKC3/1000/160/5W	
C8044	CAPACITOR FILM	45042-21001	1000P	5%	WIMA	FKC3/1000/160/5W	2

5500 POWER SUPPLY PCB ASSEMBLY 15500-78004

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
C8045	CAPACITOR FILM	45042-44701	0.47	20%	WIMA	MKS3 0.47/63/20W	
C8046	CAPACITOR FILM	45042-44701	0.47	20%	WIMA	MKS3 0.47/63/20W	
C8047	CAPACITOR ELECT 100/25	48030-10000	100	20%	SIEMENS	85200/100/25	2
C8048	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8049	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8050	CAPACITOR ELECT 100/25	48030-10000	100	20%	SIEMENS	85200/100/25	
C8051	CAPACITOR FILM	45042-42200	0.22		WIMA		3
C8052	CAPACITOR ELECT 65000/25	48080-00000	65000		MALLORY	CGS653U025W4C	1
C8053	CAPACITOR ELECT 40000/40	48080-40000	40000		MALLORY	CGS403U040W4C	2
C8054	CAPACITOR ELECT 40000/40	48080-00001	40000		MALLORY	CGS403U040W4C	
C8055	CAPACITOR ELECT 4200/75	48080-42000	4200		MALLORY	CGS422U075R4C	2
C8056	CAPACITOR ELECT 4200/75	48080-00004	4200		MALLORY	CGS422U075R4C	
C8057	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8058	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8059	CAPACITOR ELECT 220/40	48050-22000	220	20%	SIEMENS	81000 220UF 40V	2
C8060	CAPACITOR ELECT 220/40	48050-22000	220	20%	SIEMENS	81000 220UF 40V	
C8061	CAPACITOR CERAMIC DISC	41033-24700	4700P				2
C8062	CAPACITOR CERAMIC DISC	41033-24700	4700P				
C8063	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%		TCD-103Z	
C8064	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%		TCD-103Z	
C8065	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%		TCD-103Z	
C8066	CAPACITOR FILM	45042-34701	0.047	10%	WIMA	MKS3 0.047/100/10W	1
C8067	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%		TCD-103Z	
C8068	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8069	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8070	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8071	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8072	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8073	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8074	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8075	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8076	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%		TCD-103Z	
C8077	CAPACITOR MONOLYTIC	41031-41000	0.1	20%	AVX	SR205E104MAA	
C8078	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8079	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C8081	CAPACITOR MONOLITHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
CL8001	JUMPER						
CL8002	JUMPER						
CL8003	JUMPER						6
CL8004	JUMPER						
D8001	SEMICON FULL WAVE BRIDGE RECT	29006-06000			GI	KBL06	2
D8002	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D8003	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D8004	SEMICON DIODE GEN PURPOSE	21136-41500				1N4150TR	
D8005	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	8
D8006	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D8007	SEMICON ZENER DIODE	21207-53520				1N5352B	
D8008	SEMICON ZENER DIODE	21207-53520				1N5352B	
D8009	SEMICON FULL WAVE BRIDGE RECT	29006-06000			GI	KBL06	
D8010	SEMICON ZENER DIODE	21207-53520				1N5352B	4
D8011	SEMICON DIODE GEN PURPOSE	21136-41500				1N4150TR	
D8012	SEMICON ZENER DIODE	21207-53520				1N5352B	
D8013	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
D8014	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D8015	SEMICON ZENER DIODE	21207-07511				1N751A	1
D8016	SEMICON DIODE GEN PURPOSE	21136-41500				1N4150TR	
D8017	SEMICON DIODE GEN PURPOSE	21136-41500				1N4150TR	
D8018	NOT USED						
D8019	SEMICON DIODE ZENER	21207-07501	4.7V			1N750A	1
D8020	SEMICON RECTIFIER	21135-54040				1N5404	
D8021	SEMICON RECTIFIER	21135-54040				1N5404	
D8022	SEMICON RECTIFIER	21135-54040				1N5404	
D8023	SEMICON RECTIFIER	21135-54040				1N5404	4
D8024	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D8025	SEMICON DIODE GEN PURPOSE	21136-41500				1N4150TR	5
D8026	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D8027	SEMICON LED RECT RED	21531-57124			GI	MV57124	7
D8028	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D8029	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D8030	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D8031	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D8032	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D8033	SEMICON LED RECT RED	21531-57124			GI	MV57124	
D8034	SEMICON TRANSORB	29001-15390	39V			1.5KE39A	2
D8035	SEMICON TRANSORB	29001-15390	39V			1.5KE39A	
F8001	FUSE 1/2 AMP FAST	85313-00500	1/2A			312.500	2
F8002	FUSE 1/2 AMP FAST	85313-05000	1/2A			312.500	
F8003	FUSE 10A FAST	85313-00010	10A			312-010	1
J8001	CONNECTOR HEADER	78011-95055	5 PIN		MOLEX	09-18-5055	1
J8006	CONNECTOR HEADER	78011-95058	5 PIN		MOLEX	09-18-5058	1
J8008	CONNECTOR HEADER	78011-95051	5 PIN		MOLEX	09-18-5051	1
Q8001	SEMICON NEG REGULATOR 12V	25922-79120	12V		MOTOROLA	79L12AWC	1
Q8002	SEMICON POS REGULATOR 12V	25922-78120	12V			78L12	1
Q8003	SEMICON TRANSISTOR PNP GP	22622-44030				2N4403	4
Q8004	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q8005	SEMICON TRANSISTOR PNP PWR	22622-03200			TI	TIP32A	1
Q8006	SEMICON SCR TRANSISTOR	22622-11260				TIC-126B	3
Q8007	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	8
Q8008	SEMICON TRANSISTOR NPN	22622-31000				TIP31A	1
Q8009	SEMICON SCR TRANSISTOR	22622-11260				TIC-126B	
Q8010	SEMICON TRANSISTOR PNP	22622-50870				2N5087	1
Q8011	SEMICON TRANSISTOR	22622-52100				2N5210	1
Q8013	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q8014	SEMICON TRANSISTOR PNP GP	22622-44030				2N4403	
Q8016	SEMICON VMOS POWER FET	23401-06060			SILICONIX	VN0606M	4
Q8017	SEMICON TRANSISTOR PNP GP	22622-44030				2N4403	
Q8018	SEMICON VMOS POWER FET	23401-06060			SILICONIX	VN0606M	
Q8019	SEMICON FET N CHANNEL	22392-09200			SILICONIX	J111	2
Q8020	SEMICON FET N CHANNEL	22392-09200			SILICONIX	J111	
Q8021	SEMICON TRANSISTOR PNP GP	22622-44030				2N4403	
Q8022	SEMICON SHUNT REGULATOR	25922-43100			TEXAS INSTRUM	TL431CLP	1
Q8023	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q8024	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q8025	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q8026	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q8027	SEMICON ADJ REGULATOR	25922-31700				LM317T	1

5500 POWER SUPPLY PCB ASSEMBLY 15500-78004

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
Q8028	SEMICON SCR TRANSISTOR	22622-11260				TIC-126B	
Q8030	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q8033	SEMICON VMOS POWER FET	22401-06060			SILICONIX	VN0606M	
Q8034	SEMICON VMOS POWER FET	23401-06060			SILICONIX	VN0606M	
R8001	RESISTOR CF 1/2W	32052-00220	2.2	5%		22037-02290	2
R8002	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8003	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	15
R8004	RESISTOR CF 1/2W	32052-00220	2.2	5%		22037-02290	
R8005	RESISTOR CF 1/4W	32033-62000	620	5%	ALLEN BRADLEY	CB 5	
R8006	RESISTOR CF 1/4W	32033-62000	620	5%	ALLEN BRADLEY	CB 5	7
R8007	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	10
R8008	RESISTOR CF 1/4W	32033-01000	10	5%	ALLEN BRADLEY	CB 5	4
R8009	RESISTOR CF 1/4W	32033-01000	10	5%	ALLEN BRADLEY	CB 5	
R8010	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R8011	RESISTOR MF 1/4W	32035-34810	3K48	1%	CORNING	SMA4- -1	1
R8012	RESISTOR MF 1/4W	32035-49900	499	1%	CORNING	SMA4- -1	7
R8013	RESISTOR MF 1/4W	32035-49900	499	1%	CORNING	SMA4- -1	
R8014	RESISTOR MF 1/4W	32035-24910	2K49	1%	CORNING	SMA4- -1	1
R8015	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB 5	5
R8016	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8017	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8018	RESISTOR CF 1/4W	32033-30020	30K	5%	ALLEN BRADLEY	CB 5	2
R8019	RESISTOR CF 1/4W	32033-30020	30K	5%	ALLEN BRADLEY	CB 5	
R8020	RESISTOR CF 1/4W	32033-30000	300	5%	ALLEN BRADLEY	CB 5	
R8021	RESISTOR CF 1/4W	32033-08200	82	5%	ALLEN BRADLEY	CB 5	2
R8022	RESISTOR CF 1/4W	32033-08200	82	5%	ALLEN BRADLEY	CB 5	
R8023	RESISTOR CF 1/4W	32033-30000	300	5%	ALLEN BRADLEY	CB 5	
R8024	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8025	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8026	RESISTOR 1/2W	32062-00220	2.2	5%			2
R8027	RESISTOR 1/2W	32062-00220	2.2	5%			
R8028	RESISTOR CF 1/4W	32033-62000	620	5%	ALLEN BRADLEY	CB 5	
R8029	RESISTOR CF 1/4W	32033-01000	10	5%	ALLEN BRADLEY	CB 5	
R8030	RESISTOR CF 1/4W	32033-01000	10	5%	ALLEN BRADLEY	CB 5	
R8031	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R8032	RESISTOR CF 1/4W	32033-10040	1M0	5%	ALLEN BRADLEY	CB 5	
R8033	RESISTOR CF 1/4W	32033-10040	1M0	5%	ALLEN BRADLEY	CB 5	
R8034	RESISTOR CF 1/4W	32033-62000	620	5%	ALLEN BRADLEY	CB 5	
R8035	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8036	RESISTOR CF 1/4W	32033-33020	33K	5%	ALLEN BRADLEY	CB 5	1
R8037	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R8038	RESISTOR MF 1/4W	32035-49900	499	1%	CORNING	SMA4- -1	
R8039	RESISTOR MF 1/4W	32035-49900	499	1%	CORNING	SMA4- -1	
R8040	RESISTOR MF 1/4W	32035-11320	11K3	1%	CORNING	SMA4- -1	1
R8041	RESISTOR MF 1/4W	32035-82510	8K25	1%	CORNING	SMA4- -1	1
R8042	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB 5	
R8043	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB 5	2
R8044	RESISTOR CF 1/4W	32033-10040	1M0	5%	ALLEN BRADLEY	CB 5	
R8045	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8046	RESISTOR CF 1/4W	32033-10040	1M0	5%	ALLEN BRADLEY	CB 5	6
R8047	RESISTOR CF 1/4W	32033-22040	2M2	5%	ALLEN BRADLEY	CB 5	
R8048	RESISTOR MF 1/4W	32035-18720	18K7	1%	CORNING	SMA4- -1	1
R8049	RESISTOR MF 1/4W	32035-16220	16K2	1%	CORNING	SMA4- -1	1

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DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
R8050	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB 5	
R8051	RESISTOR CF 1/4W	32033-10040	1M0	5%	ALLEN BRADLEY	CB 5	
R8052	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB 5	
R8053	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB 5	
R8054	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4- -1	2
R8055	RESISTOR CF 1/4W	32033-15020	15K	5%	ALLEN BRADLEY	CB 5	1
R8056	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8057	RESISTOR CF 1/4W	32033-10030	100K	5%	ALLEN BRADLEY	CB 5	
R8058	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R8059	RESISTOR CF 1/4W	32033-22040	2M2	5%	ALLEN BRADLEY	CB 5	2
R8060	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8061	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R8062	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8063	RESISTOR CF 1/4W	32033-10030	100K	5%	ALLEN BRADLEY	CB 5	2
R8064	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8065	RESISTOR CF 1/4W	32033-68010	6K8	5%	ALLEN BRADLEY	CB 5	
R8066	RESISTOR MF 1/4W	32035-33210	3K32	1%	CORNING	SMA4- -1	1
R8067	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8068	RESISTOR CF 1/4W	32033-47000	470	5%	ALLEN BRADLEY	CB 5	1
R8069	JUMPER						
R8070	RESISTOR CF 1/4W	32033-27000	270	5%	ALLEN BRADLEY	CB 5	1
R8072	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8073	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R8074	RESISTOR MF 1/4W	32035-26700	267	1%	CORNING	SMA4- -1	1
R8075	RESISTOR MF 1/4W	32035-12100	121	1%	CORNING	SMA4- -1	1
R8076	RESISTOR MF 1/4W	32035-49900	499	1%	CORNING	SMA4- -1	
R8077	RESISTOR MF 1/4W	32035-12110	1K21	1%	CORNING	SMA4- -1	1
R8078	RESISTOR CF 1/4W	32033-12020	12K	5%	ALLEN BRADLEY	CB 5	1
R8079	RESISTOR 1W	34062-01500	15	5%			1
R8080	RESISTOR CF 1/4W	32033-62000	620	5%	ALLEN BRADLEY	CB 5	
R8081	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R8082	RESISTOR CF 1/4W	32033-05100	51	5%	ALLEN BRADLEY	CB 5	
R8083	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CB 5	1
R8084	RESISTOR 3W	34073-01080	0.1	3%			3
R8085	RESISTOR 3W	34073-01080	0.1	3%			
R8086	RESISTOR MF 1/4W	32035-42210	4K22	1%	CORNING	SMA4- -1	1
R8087	RESISTOR MF 1/4W	32035-49900	499	1%	CORNING	SMA4- -1	
R8088	RESISTOR MF 1/4W	32035-49900	499	1%	CORNING	SMA4- -1	
R8089	RESISTOR MF 1/4W	32035-59010	5K90	1%	CORNING	SMA4- -1	1
R8090	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R8091	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB 5	
R8092	RESISTOR CF 1/4W	32033-62000	620	5%	ALLEN BRADLEY	CB 5	
R8093	RESISTOR CF 1/4W	32033-62000	620	5%	ALLEN BRADLEY	CB 5	
R8094	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R8095	RESISTOR 1/2W	32052-01000	10	5%			2
R8096	RESISTOR 1/2W	32052-01000	10	5%			
R8097	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R8098	RESISTOR CF 1/4W	32033-05100	51	5%	ALLEN BRADLEY	CB 5	5
R8099	RESISTOR CF 1/4W	32033-05100	51	5%	ALLEN BRADLEY	CB 5	
R8100	RESISTOR CF 1/4W	32033-05100	51		ALLEN BRADLEY	CB 5	
R8101	RESISTOR CF 1/4W	32033-05100	51	5%	ALLEN BRADLEY	CB 5	
R8102	RESISTOR 3W	34073-01080	0.1	3%			
R8103	JUMPER						

5500 POWER SUPPLY PCB ASSEMBLY 15500-78004

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
R8104	RESISTOR CF 1/4W	32033-20010	2K	5%	ALLEN BRADLEY	CB 5	2
R8105	RESISTOR CF 1/4W	32033-20010	2K	5%	ALLEN BRADLEY	CB 5	
R8106	RESISTOR CF 1/4W	32033-68010	6K8	5%	ALLEN BRADLEY	CB 5	2
R8107	RESISTOR CF 1/4W	32033-33010	3K3	5%	ALLEN BRADLEY	CB 5	3
R8108	RESISTOR CF 1/4W	32033-33010	3K3	5%	ALLEN BRADLEY	CB 5	
R8109	RESISTOR CF 1/4W	32033-51000	510	5%	ALLEN BRADLEY	CB 5	1
R8110	NOT USED	32033-10040	1M0	5%	ALLEN BRADLEY	CB 5	
R8111	RESISTOR CF 1/4W	32033-06800	68	5%	ALLEN BRADLEY	CB 5	2
R8112	RESISTOR CF 1/4W	32033-30000	300	5%	ALLEN BRADLEY	CB 5	4
R8113	RESISTOR CF 1/4W	32033-06800	68	5%	ALLEN BRADLEY	CB 5	
R8114	RESISTOR CF 1/4W	32033-30000	300	5%	ALLEN BRADLEY	CB 5	
R8115	RESISTOR CF 1/4W	32033-10040	1M0	5%	ALLEN BRADLEY	CB 5	
R8116	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4- -1	
R8117	RESISTOR CF 1/4W	32033-33010	3K3	5%	ALLEN BRADLEY	CB 5	
RN8001	RESISTOR NET 8PIN 4RES SIP	39085-10020	10K			4608X-102-103	2
RN8002	RESISTOR NET 8PIN 4RES SIP	39085-10020	10K			4608X-102-103	
RN8003	RESISTOR NET 8PIN 4RES SIP	39085-47010	4K7			4308X-102-472	1
U8001	SEMICON VOLTAGE REGULATOR	25922-38340			UNITRODE	UC3834N	7
U8002	SEMICON VOLTAGE REGULATOR	25922-38340			UNITRODE	UC3834N	
U8003	SEMICON VOLTAGE REGULATOR	25922-38340			UNITRODE	UC3834N	
U8004	SEMICON VOLTAGE REGULATOR	25922-38340			UNITRODE	UC3834N	
U8005	SEMICON COMPARATOR	25308-33900				LM339J	
U8006	SEMICON COMPARATOR	25308-33900				LM339J	
U8007	SEMICON COMPARATOR	25308-33900				LM339J	3
U8008	SEMICON OPTO COUPLER	21634-43500				4N35	3
U8009	SEMICON OPTO COUPLER	21634-43500				4N35	
U8010	SEMICON OPTO COUPLER	21634-43500				4N35	
U8011	SEMICON VOLTAGE REGULATOR	25922-38340			UNITRODE	UC3834N	
U8012	SEMICON VOLTAGE REGULATOR	25922-38340			UNITRODE	UC3834N	
U8013	SEMICON VOLTAGE REGULATOR	25922-38340			UNITRODE	UC3834N	
VR8001	RESISTOR TRIM CONTROL ST TA	51416-10000	100		BOURNS	3386P-1-101	1
VR8002	RESISTOR TRIM CONTROL ST TA	51416-20200	2K		BEK	3386P-1-202	1
VR8003	RESISTOR TRIM CONTROL ST TA	51416-10010	1K		VRN INT	3386P-1-102	1

SOLID STATE RELAY ASSEMBLY 5500-78504

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	EPOXY						1
	RESISTOR CF 1/2W	32052-04700	47	5%	ALLEN BRADLEY		1
	CAPACITOR FILM AC LINE	45042-34700			WIMA	MP-3	1
	HARNESS	5500-38010			AMBER	5500-38010	1
	PRINTED CIRCUIT BOARD	5500-48504			AMBER	5500-48504	1
	PLASTIC HOUSING PHENOLIC	66000-00001			PMC	R-1-802	1
	CONNECTOR HOUSING	78010-39252			MOLEX	03-09-2052	1
	CONNECTOR PINS MALE PCB	78012-92133			MOLEX	02-09-2133	4
	RELAY,SOLID STATE	84801-64502			TELEDYNE	645-2	1

5500 HEATSINK ASSEMBLY 15500-70500

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	MACHINE SCREW 6-32 PH		5/8				10
	MACHINE NUT 6-32						8
	INTERNAL LOCK WASHER #6						18
	FLAT WASHER #6						8
	TUBING, CLEAR						
	MACHINE SCREW 6-32 PH		1/4				8
	HARNESS	15500-38013			AMBER	15500-38013	1
	HEATSINK A	15500-64602	641K		AMBER	15500-64602	1
	HEATSINK B	15500-64702	641K		AMBER	15500-64702	1
	HEAT SINK	15500-64802			AMBER	15500-64802	1
	HEAT SINK BRACKET	15500-64904			AMBER	15500-64904	1
	MACHINE SCREW 4-40	61111-14070	5/8		BANCROFT	AN507-440-R10	5
	MACHINE NUT 4-40	61222-44000			BANCROFT	MS35649-242	5
	WASHER INTERNAL TOOTH #4	61520-36400			BANCROFT	AN936-A4	5
	MICA WASHER TO-3	61530-43032			THERMALLOY	43-03-2	5
	TRANSISTOR SOCKETS	71001-80800	TO-3		ACTIVE	8080-1G1	5
Q8012	SEMICON TRANSISTOR PNP	22622-58790			MOTOROLA	2N5879	3
Q8015	SEMICON TRANSISTOR NPN	22622-58810			MOTOROLA	2N5881	2
Q8029	SEMICON TRANSISTOR PNP	22622-58790			MOTOROLA	2N5879	
Q8031	SEMICON TRANSISTOR PNP	22622-58790			MOTOROLA	2N5879	
Q8032	SEMICON TRANSISTOR NPN	22622-58810			MOTOROLA	2N5881	

5500 TRANSFORMER ASSEMBLY 15500-70600

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	TRANSFORMER BRACKET	15500-67101			AMBER	15500-67101	1
	TRANSFORMER	53608-31740			TOROID	3174	1
	TRANSFORMER BRACKET ROUND	53700-30771			TOROID	3077	1
	TRANSFORMER INSULATOR	53700-30772			TOROID	3077	2
	HEX NUT #14	61500-					1
	HEX BOLT 5/16-18	61500-00000	2.75IN		SPAE-NAUR	HC-34	1
	LOCK NUT 5/16-18	61500-00001			SPAE-NAUR	165-162	1
	FLAT TERMINAL LUG	67100-24000			SPAE NAUR	WT-24	1
	CONNECTOR LUG	67100-39000			SPAE-NAUR	WT-39	1
	CONNECTOR LUG	67100-42000			SPAE NAUR	WT-42	2
	CONNECTOR CRIMP TERMINAL	78009-61103	.062		MOLEX	02-06-1103	8
	CRIMP TERMINAL, FEM.	78009-91103	.093		MOLEX	02-09-1103	2
	CONNECTOR HOUSING FEM 4PIN	78010-61041	4PIN		MOLEX	03-06-1041	2

BATTERY PACK ASSEMBLY 5000-78601

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	RESISTOR CF 1/4W (FUSE)	32033-18000	180	5%	ALLEN BRADLEY	CB1815	1
	PRINTED CIRCUIT BOARD	5000-48601			AMBER	5000-48601	1
	HARNESS 8007	5500-38007			AMBER	5500-38007	1
	BATTERY NICAD	59500-15200	1.2V		MALORY	AA NC-15	3
	BATTERY HOLDER	59501-22280	AA		KEYSTONE	2228	3

LOW DISTORTION NOTCH PCB ASSEMBLY 5500-71503

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	PRINTED CIRCUIT BOARD	5500-41503			AMBER	5500-41503	1
	PROMAG BRACKET	5500-60104	1a		AMBER	5500-60104	1
	MACHINE SCREW FH 4-40	61111-14031	5/16		BANCROFT	AN507-440-R5	2
	MACHINE SCREW FH 6-32	61113-16025	1/4		BANCROFT	AN507-632-R4	3
	MACHINE NUT HEX	61222-44000	4-40		BANCROFT	MS35649-242	2
	MACHINE NUT PC MOUNT	61260-63200	6-32		PEM	KF2-632-ET	3
	MACHINE FLAT WASHER	61510-14300	#4		BANCROFT	AN 960-4	2
	MACHINE LOCK WASHER	61520-36400	#4		BANCROFT	AN936-A4	2
	INSULATOR STEP WASHER	61540-77210	TO-220		THERMALLOY	7721-7PPS	2
	INSULATOR MICA SHEET	61600-43779	TO-220		THERMALLOY	43-77-9	2
	EJECTOR LATCH	65299-20810	BROWN		SCANBE	S208-1	2
	CONNECTOR, SOCKET DIL	71008-20839	8 PIN		AUGAT	208-AG39D	11
	CONNECTOR, SOCKET DIL	71014-21439	14PIN		AUGAT	214-AG39D	2
	CONNECTOR, SOCKET DIL	71016-21639	16PIN		AUGAT	216-AG39D	19
	CONNECTOR, SOCKET DIL	71018-21839	18PIN		AUGAT	218-AG39D	4
	CONNECTOR, SOCKET DIL	71020-22039	20PIN		AUGAT	220-AG39D	4
C1001	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%	MURATA/ERIE		1
C1002	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1003	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1004	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1005	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1006	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1007	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1008	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1009	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1010	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1011	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1012	CAPACITOR ELECTROLYTHIC	48050-02200	22/40	20%	SIEMENS	85200/22/40V	1
C1013	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1014	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	10
C1015	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	
C1016	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1017	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	
C1018	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	
C1019	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1020	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1021	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1022	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1023	CAPACITOR FILM	45042-42202	0.22	20%	WIMA	MKS3 0.22/63/20W	
C1024	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1025	CAPACITOR FILM	45042-22202	2200P	20%	WIMA	FKC3 2200/160/5W	3
C1026	CAPACITOR FILM	45042-32201	0.022	20%	WIMA	MKS3 0.022/100/20W	
C1027	CAPACITOR FILM	45042-32201	0.022	20%	WIMA	MKS3 0.022/100/20W	3
C1028	CAPACITOR FILM	45042-42202	0.22	20%	WIMA	MKS3 0.22/63/20W	3
C1029	CAPACITOR FILM	45042-22202	2200P	20%	WIMA	FKC3 2200/160/5W	
C1030	CAPACITOR FILM	45042-32201	0.022	20%	WIMA	MKS3 0.022/100/20W	
C1031	CAPACITOR FILM	45042-42202	0.22	20%	WIMA	MKS3 0.22/63/20W	
C1032	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1033	CAPACITOR FILM	45042-22202	2200P	20%	WIMA	FKC3 2200/160/20W	
C1034	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C1035	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1036	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1037	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
C1038	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	57
C1039	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1040	CAPACITOR FILM	45042-51002	1.0	10%	WIMA	MKS3 1.0/63/10W	2
C1041	CAPACITOR FILM	45042-51002	1.0	10%	WIMA	MKS3 1.0/63/10W	
C1042	CAPACITOR FILM	45042-12201	220P	20%	WIMA	FKC3 220/160/20W	
C1043	CAPACITOR FILM	45042-12201	220P	20%	WIMA	FKC3 220/160/20W	3
C1044	CAPACITOR FILM	45042-12201	220P	20%	WIMA	FKC3 220/160/20W	
C1045	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1046	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1047	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1048	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1049	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1050	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1051	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C1052	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1053	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	
C1054	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	
C1055	CAPACITOR CERAMIC DISC	41033-04700	47P	20%	MURATA/ERIE	DD05B10N750470J500V	2
C1056	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C1057	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C1058	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1059	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1060	CAPACITOR FILM	45042-00000	*	SEL	WIMA	MATCH w/C1061=0.230	1
C1061	CAPACITOR FILM	45042-42200	0.220	SEL	WIMA	MKS3 0.22/63/5W	4
C1062	CAPACITOR FILM	45042-00000	*	SEL	WIMA	MATCH w/C1063=0.0230	1
C1063	CAPACITOR FILM	45042-32200	0.0220	SEL	WIMA	MKS3 0.022/100/5W	4
C1064	CAPACITOR NPO	41535-22200	2000P	1%	VITRAMON	VP12BA202FB	4
C1065	CAPACITOR NPO	41535-12200	220P	1%	VITRAMON	VP32BA221FB	
C1066	CAPACITOR FILM	45042-00000	*	SEL	WIMA	MATCH w/C1067=0.230	1
C1067	CAPACITOR FILM	45042-42200	0.220	SEL	WIMA	MKS3 0.22/63/5W	
C1068	CAPACITOR FILM	45042-00000	*	SEL	WIMA	MATCH w/C1069=0.0230	1
C1069	CAPACITOR FILM	45042-32200	0.0220	SEL	WIMA	MKS3 0.022/100/5W	
C1070	CAPACITOR NPO	41535-22000	2000P	1%	VITRAMON	VP12BA202FB	
C1071	CAPACITOR NPO	41535-12200	220P	1%	VITRAMON	VP32BA221FB	
C1072	CAPACITOR FILM	45042-00000	*	SEL	WIMA	MATCH w/C1073=0.230	1
C1073	CAPACITOR FILM	45042-42200	0.220	SEL	WIMA	MKS3 0.22/63/5W	
C1074	CAPACITOR FILM	45042-00000	*	SEL	WIMA	MATCH w/C1075=0.0230	1
C1075	CAPACITOR FILM	45042-32200	0.0220	SEL	WIMA	MKS3 0.022/100/5W	
C1076	CAPACITOR NPO	41535-22000	2000P	1%	VITRAMON	VP12BA202FB	
C1077	CAPACITOR NPO	41535-12200	220P	1%	VITRAMON	VP32BA221FB	4
C1078	CAPACITOR FILM	45042-00000	*	SEL	WIMA	MATCH w/C1079=0.230	1
C1079	CAPACITOR FILM	45042-42200	0.220	SEL	WIMA	MKS3 0.22/63/5W	
C1080	CAPACITOR FILM	45042-00000	*	SEL	WIMA	MATCH w/C1081=0.0230	1
C1081	CAPACITOR FILM	45042-32200	0.0220	SEL	WIMA	MKS3 0.022/100/5W	
C1082	CAPACITOR NPO	41535-22000	2000P	1%	VITRAMON	VP12BA202FB	
C1083	CAPACITOR NPO	41535-12200	220P	1%	VITRAMON	VP32BA221FB	
C1084	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1085	CAPACITOR CERAMIC DISC	41033-10000	100P	20%	MURATA/ERIE	DD08B10N750101500V	
C1086	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C1087	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1088	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1089	CAPACITOR CERAMIC DISC	41033-02200	22P	20%	MURATA/ERIE	DD05B10N750220J500V	
C1090	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	

LOW DISTORTION NOTCH PCB ASSEMBLY 5500-71503

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
C1091	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	
C1092	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1093	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1094	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1095	CAPACITOR CERAMIC DISC	41033-11000	100P	20%	MURATA/ERIE	DD08B10N750101500V	
C1096	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1097	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C1098	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1099	CAPACITOR CERAMIC DISC	41033-02200	22P	20%	MURATA/ERIE	DD05B10N750220J500V	4
C1100	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1101	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C1102	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1103	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1104	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1105	CAPACITOR CERAMIC DISC	41033-11000	100P	20%	MURATA/ERIE	DD08B10N750101500V	
C1106	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1107	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C1108	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1109	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1110	CAPACITOR CERAMIC DISC	41033-02200	22P	20%	MURATA/ERIE	DD05B10N750220J500V	
C1111	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1112	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	11
C1113	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1114	CAPACITOR CERAMIC DISC	41033-04700	47P	20%	MURATA/ERIE	DD05B10N750470J500V	
C1115	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1116	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1117	CAPACITOR CERAMIC DISC	41033-11000	100P	20%	MURATA/ERIE	DD08B10N750101500V	4
C1118	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1119	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C1120	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1121	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	
C1122	CAPACITOR ELECTROLYTHIC	48050-01000	10/40	20%	SIEMENS	85200/10/40	
C1123	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1124	CAPACITOR CERAMIC DISC	41033-02200	22P	20%	MURATA/ERIE	DD05B10N750220J500V	
C1125	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1126	CAPACITOR CERAMIC DISC	41033-06800	68P	20%	MURATA/ERIE	DD07B10N750680J500V	1
C1127	CAPACITOR, TRIM CONTROL TA	49000-53801	7-25P		MURATA/ERIE	DV11PS25B	1
C1128	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1129	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1130	CAPACITOR CERAMIC DISC	41033-01000	10P	20%	MURATA/ERIE	10PF100V:DC1-100J	
D1001	SEMICON DIODE ZENER 1W	21207-47480	22V		MOTOROLA	1N4748ATR	1
D1002	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D1003	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D1004	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D1005	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	4
D1006	SEMICON DIODE ZENER	21207-07521			MOTOROLA	1N752A	
D1007	SEMICON DIODE ZENER	21207-07521			MOTOROLA	1N752A	2
D1008	SEMICON DIODE GP	21136-41500			MOTOROLA	1N4150TR	2
D1009	SEMICON DIODE GP	21136-41500			MOTOROLA	1N4150TR	
D1010	SEMICON DIODE ZENER	21207-07461	3.3V		MOTOROLA	1N746A	1
K1001	RELAY, REED DUAL FORM A	84801-26531	12V		COTO	2653-12-300	
K1002	RELAY, REED DUAL FORM A	84801-26531	12V		COTO	2653-12-300	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
K1003	RELAY, REED DUAL FORM A	84801-26531	12V		COTO	2653-12-300	
K1004	RELAY, REED DUAL FORM A	84801-26531	12V		COTO	2653-12-300	
K1005	RELAY, REED DUAL FORM A	84801-26531	12V		COTO	2653-12-300	
K1006	RELAY, REED DUAL FORM A	84801-26531	12V		COTO	2653-12-300	
K1007	RELAY, REED DUAL FORM A	84801-26531	12V		COTO	2653-12-300	8
K1008	RELAY, REED DUAL FORM A	84801-26531	12V		COTO	2653-12-300	
Q1001	SEMICON REGULATOR POSITIVE	25922-78152	15V		MOTOROLA	78M15UC	1
Q1002	SEMICON REGULATOR NEGATIVE	25922-79152	15V		MOTOROLA	79M15UC	1
Q1003	NOT USED						
Q1004	SEMICON N-CH DMOS FET	22318-21500			SILICONIX	2SD215DE	2
Q1005	SEMICON N-CH DMOS FET	22318-21500			SILICONIX	2SD215DE	
Q1006	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	1
Q1007	NOT USED						
Q1008	SEMICON LED/LDR	21511-85000			CLAIREX	CLM8500	
Q1009	SEMICON LED/LDR	21511-85000			CLAIREX	CLM8500	
Q1010	SEMICON LED/LDR	21511-85000			CLAIREX	CLM8500	3
R1001	RESISTOR CF 1/4W	32033-33010	3K3	5%	A BRADLEY	CB3325	
R1002	RESISTOR CF 1/4W	32033-33010	3K3	5%	A BRADLEY	CB3325	
R1003	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	
R1004	RESISTOR CF 1/4W	32033-20010	2K	5%	A BRADLEY	CB2025	2
R1005	RESISTOR MF 1/4W	32035-20020	20K0	1%	CORNING	SMA4-20K-1	
R1006	RESISTOR CF 1/4W	32033-10000	100	5%	A BRADLEY	CB1015	5
R1007	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	
R1008	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	
R1009	RESISTOR MF 1/4W	32035-20020	20K0	1%	CORNING	SMA4-20K-1	2
R1010	RESISTOR MF 1/4W	32035-46410	4K64	1%	CORNING	SMA4-4.64K-1	1
R1011	RESISTOR MF 1/4W	32035-68120	68K1	1%	CORNING	SMA4-68.1K-1	1
R1012	RESISTOR CF 1/4W	32033-10000	100	5%	A BRADLEY	CB1015	
R1013	RESISTOR CF 1/4W	32033-10010	1K	5%	A BRADLEY	CB1025	3
R1014	RESISTOR CF 1/4W	32033-22010	2K2	5%	A BRADLEY	CB2225	1
R1015	RESISTOR MF 1/4W	32035-49910	4K99	1%	CORNING	SMA4-4.99K-1	1
R1016	RESISTOR MF 1/4W	32035-15820	15K8	1%	CORNING	SMA4-15.8K-1	1
R1017	RESISTOR CF 1/4W	32033-75000	750	5%	A BRADLEY	CB7515	1
R1018	RESISTOR MF 1/4W	32035-75010	7K50	1%	CORNING	SMA4-7.5K-1	2
R1019	RESISTOR CF 1/4W	32033-10000	100	5%	A BRADLEY	CB1015	
R1020	RESISTOR CF 1/4W	32033-10000	100	5%	A BRADLEY	CB1015	
R1021	RESISTOR CF 1/4W	32033-10030	100K	5%	A BRADLEY	CB1045	2
R1022	RESISTOR CF 1/4W	32033-02200	22	5%	A BRADLEY	CB2205	
R1023	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	
R1024	RESISTOR CF 1/4W	32033-33000	330	5%	A BRADLEY	CB3315	1
R1025	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	10
R1026	RESISTOR CF 1/4W	32033-10010	1K	5%	A BRADLEY	CB1025	
R1027	RESISTOR CF 1/4W	32033-22040	2M2	5%	A BRADLEY	CB2255	2
R1028	RESISTOR CF 1/4W	32033-22040	2M2	5%	A BRADLEY	CB2255	
R1029	RESISTOR CF 1/4W	32033-10030	100K	5%	A BRADLEY	CB1045	
R1030	RESISTOR CF 1/4W	32033-02200	22	5%	A BRADLEY	CB2205	2
R1031	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	
R1032	RESISTOR CF 1/4W	32033-10040	1M	5%	A BRADLEY	CB1055	2
R1033	RESISTOR CF 1/4W	32033-10040	1M	5%	A BRADLEY	CB1055	
R1034	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	
R1035	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	
R1036	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R1037	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	

LOW DISTORTION NOTCH PCB ASSEMBLY 5500-71503

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
R1038	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1039	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1040	RESISTOR MF 1/4W	32035-10030	100K0	1%	CORNING	SMA4-100K-1	1
R1041	RESISTOR MF 1/4W	32035-49920	49K9	1%	CORNING	SMA4-49.9K-1	1
R1042	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1043	RESISTOR MF 1/4W	32035-10010	1K0	1%	CORNING	SMA4-1K-1	2
R1044	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1045	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R1046	RESISTOR MF 1/4W	32035-10010	1K0	1%	CORNING	SMA4-1K-1	
R1047	JUMPER						2
R1048	JUMPER						
R1049	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1050	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1051	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R1052	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1053	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1054	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1055	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1056	RESISTOR CF 1/4W	32033-82000	820	5%	A BRADLEY	CB8215	2
R1057	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1058	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1059	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	7
R1060	RESISTOR CF 1/4W	32033-20010	2K	5%	A BRADLEY	CB2025	
R1061	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1062	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1063	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R1064	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1065	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1066	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1067	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R1068	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1069	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1070	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	25
R1071	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1072	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1073	RESISTOR MF 1/4W	32035-75010	7K50	1%	CORNING	SMA4-7.5K-1	
R1074	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1075	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R1076	RESISTOR CF 1/4W	32033-82000	820	5%	A BRADLEY	CB8215	
R1077	RESISTOR MF 1/4W	32035-12420	12K4	1%	CORNING	SMA4-12.4K-1	1
R1078	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R1079	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	
R1080	RESISTOR CF 1/4W	32033-10020	10K	5%	A BRADLEY	CB1035	
R1081	RESISTOR CF 1/4W	32033-10050	10M	5%	A BRADLEY	CB1065	1
R1082	RESISTOR CF 1/4W	32033-33010	3k3	5%	A BRADLEY	CB3325	
R1083	RESISTOR CF 1/4W	32033-33010	3K3	5%	A BRADLEY	CB3325	
R1084	RESISTOR CF 1/4W	32033-33010	3k3	5%	A BRADLEY	CB3325	5
R1085	RESISTOR CF 1/4W	32033-10010	1K	5%	A BRADLEY	CB1025	
R1086	RESISTOR CF 1/4W	32033-10000	100	5%	A BRADLEY	CB1015	
RN1001	RESISTOR NET 8 PIN 7 RES SIP	39087-33010	3K3X7	5%	BOURNS	4608R-101-332	
RN1002	RESISTOR NET 8 PIN 7 RES SIP	39087-33010	3K3x7	5%	BOURNS	4608R-101-332	2
RN1003	RESISTOR NET 16 PIN 15 RES DIP	38167-10020	10Kx15	5%	BOURNS	4116R-002-103	1
U1001	SEMICON DRIVER	29200-20030			MOTOROLA	ULN2003AN	1

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
U1002	SEMICON LSTTL HEX D FF	27743-74174			MOTOROLA	SN74LS174N	3
U1003	SEMICON LSTTL HEX INVERTER	27743-74004			MOTOROLA	74LS04PC	1
U1004	SEMICON CMOS SWITCH QUAD ANALOG	24021-21100			SILICONIX	DG211CJ	
U1005	SEMICON LSTTL HEX D FF	27743-74174			MOTOROLA	SN74LS174N	
U1006	SEMICON LSTTL OCTAL D TYP FLFL	27743-74273			MOTOROLA	SN74LS273N	
U1007	SEMICON LSTTL OCTAL D TYP FLFL	27743-74273			MOTOROLA	SN74LS273N	2
U1008	SEMICON LSTTL OCTAL BUS TRANS	27743-74245			MOTOROLA	SN74LS245N	1
U1009	SEMICON LSTTL 4 BIT MAG COMP	27743-74085			MOTOROLA	SN74LS85N	2
U1010	SEMICON LSTTL 3 TO 8 DECODER	27743-74138			MOTOROLA	SN74LS138N	2
U1011	SEMICON LSTTL QUAD 2-IN NAND	27743-74008			MOTOROLA	SN74LS08N	1
U1012	SEMICON BIPOLAR EPROM	26022-27130			AMD	AMD27S13APC	1
U1013	SEMICON CMOS SWITCH QUAD ANALOG	24021-21100			SILICONIX	DG211CJ	4
U1014	SEMICON CMOS SWITCH QUAD ANALOG	24021-21100			SILICONIX	DG211CJ	
U1015	SEMICON LSTTL 3 TO 8 DECODER	27743-74138			MOTOROLA	SN74LS138N	
U1016	SEMICON DUAL OP AMP LO NOISE	25311-55320			SIGNETICS	NE5532AN	
U1017	SEMICON OP AMP LO-OFFSET FET	25312-41200			NATIONAL	LF412N	2
U1018	SEMICON OP AMP LO-OFFSET FET	25312-41200			NATIONAL	LF412N	
U1019	SEMICON CMOS CONV DUA 8BIT DAC	25000-75280			ANALOG DEVICES	AD7528JN	1
U1020	SEMICON LINEAR DUAL OTA	25430-32800			RCA	CA3280	1
U1021	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U1022	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U1023	SEMICON CMOS 12 BIT DAC	25000-75410			ANALOG DEVICES	AD7541AJN	
U1024	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	
U1025	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	
U1026	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	10
U1027	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U1028	SEMICON CMOS 12 BIT DAC	25000-75410			ANALOG DEVICES	AD7541AJN	
U1029	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	
U1030	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U1031	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U1032	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U1033	SEMICON CMOS 12 BIT DAC	25000-75410			ANALOG DEVICES	AD7541AJN	4
U1034	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	
U1035	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	
U1036	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U1037	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	7
U1038	SEMICON CMOS 12 BIT DAC	25000-75410			ANALOG DEVICES	AD7541AJN	
U1039	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	
U1040	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U1041	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U1042	SEMICON CMOS SWITCH QUAD ANALOG	24021-21100			SILICONIX	DG211CJ	
U1043	SEMICON LSTTL HEX D FF	27743-74174			MOTOROLA	SN74LS174N	
U1044	SEMICON LSTTL 4 BIT MAG COMP	27743-74085			MOTOROLA	SN74LS85N	
U1045	SEMICON DUAL OP AMP LO NOISE	25311-55320			SIGNETICS	NE5532AN	2
VR1001	RESISTOR TRIM CONTROL ST SA	51415-50020	50K		BOURNS	3386W-1-503	2
VR1002	RESISTOR TRIM CONTROL ST SA	51415-50020	50K		BOURNS	3386W-1-503	
VR1003	RESISTOR TRIM CONTROL MT SA	51515-10010	1K		BOURNS	3299X-1-102	1

LOW DISTORTION OSCILLATOR PCB ASSEMBLY 5500-72503

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	PRINTED CIRCUIT BOARD	5500-42503			AMBER	5500-42503	1
	PROMAG BRACKET	5500-60204	2a		AMBER	5500-60204	1
	MACHINE SCREW FH 4-40	61111-14031	5/16		BANCROFT	AN507-440-R5	2
	MACHINE SCREW FH 6-32	61113-16025	1/4		SPAE NAUR	AN507-632R4	3
	MACHINE NUT - HEX	61222-44000	4-40		BANCROFT	MS35649-242	2
	MACHINE NUT PC MOUNT	61260-63200	6-32		PEM	KF2-632-ET	3
	MACHINE FLAT WASHER	61510-14300	#4		BANCROFT	AN 960-4	2
	MACHINE LOCK WASHER #4	61520-36400	#4		BANCROFT	AN936-A4	2
	INSULATOR STEP WASHER	61540-77210	TO-220		THERMALLOY	7721-7PPS	2
	INSULATOR MICA SHEET	61600-43779	TO-220		THERMALLOY	43-77-9	2
	PCB EJECTORS	65299-20810	RED		SCANBE	S208-1	2
	CONNECTOR SOCKET PCB DIL	71008-20839	8 PIN		AUGAT	208-AG39D	12
	CONNECTOR SOCKET PCB DIL	71014-21439	14 PIN		AUGAT	214-AG39D	2
	CONNECTOR SOCKET PCB DIL	71016-21639	16 PIN		AUGAT	216-AG39D	9
	CONNECTOR SOCKET PCB DIL	71018-21839	18 PIN		AUGAT	218-AG39D	2
	CONNECTOR SOCKET PCB DIL	71020-22039	20 PIN		AUGAT	220-AG39D	4
C2001	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%		SR205E104MAA	46
C2002	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2003	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2004	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2005	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2006	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2007	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2008	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2009	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2010	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2011	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2012	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2013	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2014	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2015	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%	M/E		1
C2016	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2017	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	17
C2018	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2019	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2020	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2021	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2022	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2023	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2024	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2025	CAPACITOR CERAMIC DISC	41033-03300	33P	20%	MURATA/ERIE		1
C2026	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	4
C2027	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C2028	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2029	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2030	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2031	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2032	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2033	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2034	CAPACITOR FILM	45042-42200	0.22	20%	WIMA	MKS3 0.22/100/20W	1
C2035	CAPACITOR FILM	45042-24700	4700P	5%	WIMA	FKC3 4700/160/5W	1
C2036	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2037	CAPACITOR ELECT 100/25	48030-10000	100	20%		25V100:NRE100M25V	2

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
C2038	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2039	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2040	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C2041	CAPACITOR CERAMIC DISC	41033-12200	220P	20%	MURATA/ERIE		1
C2042	CAPACITOR ELECT 100/25	48030-10000	100	20%	SIEMENS	25V100:NRE100M25V	
C2043	CAPACITOR CERAMIC DISC	41033-03000	30P	20%	MURATA/ERIE		1
C2044	CAPACITOR CERAMIC DISC	41033-00330	3P3	20%	MURATA/ERIE		2
C2045	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2046	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	9
C2047	CAPACITOR CERAMIC DISC	41033-01000	10P	20%	MURATA/ERIE		
C2048	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2049	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2050	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2051	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2052	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C2053	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2054	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2055	CAPACITOR FILM	45042-00000	*	SEL	WIMA	match w/C2056=0.230	1
C2056	CAPACITOR FILM	45042-42200	0.22	SEL	WIMA		2
C2057	CAPACITOR FILM	45042-00000	*	SEL	WIMA	match w/C2058=0.0230	1
C2058	CAPACITOR FILM	45042-32200	0.022	SEL	WIMA		2
C2059	CAPACITOR NPO	41535-22200	2000P	1%	VITRAMON		2
C2060	CAPACITOR NPO	41535-12200	220P	1%	VITRAMON	VP32BA221FB	2
C2061	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2062	CAPACITOR CERAMIC DISC	41033-11000	100P	20%	MURATA/ERIE		2
C2063	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2064	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2065	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2066	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C2067	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2068	CAPACITOR CERAMIC DISC	41033-02200	22P	20%	MURATA/ERIE		2
C2069	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C2070	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2071	CAPACITOR FILM	45042-00000	*	SEL	WIMA	match w/C2072=0.230	1
C2072	CAPACITOR FILM	45042-42200	0.22	SEL	WIMA		
C2073	CAPACITOR FILM	45042-00000	*	SEL	WIMA	match w/C2074=0.0230	
C2074	CAPACITOR FILM	45042-32200	0.022	SEL	WIMA		
C2075	CAPACITOR NPO	41535-22200	2000P	1%	VITRAMON		
C2076	CAPACITOR NPO	41535-12200	220P	1%	VITRAMON	VP32BA221FB	
C2077	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2078	CAPACITOR CERAMIC DISC	41033-11000	100P	20%	MURATA/ERIE		
C2079	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2080	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2081	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2082	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C2083	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2084	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2085	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2086	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2087	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2088	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%	SIEMENS	85200 10/40	
C2089	CAPACITOR CERAMIC DISC	41033-01000	10P	5%		DD05B10N750100J500V	
C2090	CAPACITOR CERAMIC DISC	41033-01000	10P	5%		DD05B10N750100J500V	

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DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
C2091	CAPACITOR CERAMIC DISC	41033-00330	3P3	20%	MURATA/ERIE		
C2092	CAPACITOR ELECT 22/40 RADIAL	48050-02200	22	20%		85200/22/40V	1
C2093	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C2094	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C2095	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2096	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2097	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2098	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2099	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%			
C2100	CAPACITOR ELECT 10/40 RADIAL	48050-01000	10	20%			
C2101	CAPACITOR CERAMIC DISC	41033-02200	22P	20%			
C2103	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2104	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C2105	CAPACITOR TRIM CONTROL TA	49000-53801	7-25		MURATA	DV11PS25B	1
D2001	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	4
D2002	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D2003	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D2004	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D2005	SEMICON DIODE ZENER 1W	21207-47480	22V		MOTOROLA	1N4748ATR	1
D2006	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	6
D2007	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D2008	SEMICON DIODE SHOTTKY	21107-62630			MOTOROLA	1N6263TR	1
D2009	SEMICON DIODE ZENER	21207-07461	3.3V		MOTOROLA	1N746A	
D2010	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D2011	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D2012	SEMICON DIODE ZENER	21207-07531	6.2V		MOTOROLA	1N753ATR	2
D2013	SEMICON DIODE ZENER	21207-07531	6.2V		MOTOROLA	1N753ATR	
D2014	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D2015	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D2016	SEMICON DIODE ZENER	21207-07461	3.3V		MOTOROLA	1N746A	3
D2019	SEMICON DIODE ZENER	21207-07461	3.3V	5%	MOTOROLA	1N746A	
K2001	RELAY, 2C 18V	84801-18000	18V		ITT	RY-18-WK	1
K2002	RELAY, REED 2A	84801-26531	12V		COTO	2653-12-300	5
K2003	RELAY, REED 1A	84801-26041	12V		COTO	2604-12-300	2
K2004	RELAY, REED 2A	84801-26531	12V		COTO	2653-12-300	
K2005	RELAY, REED 2A	84801-26531	12V		COTO	2653-12-300	
K2006	RELAY, REED 2A	84801-26531	12V		COTO	2653-12-300	
K2007	RELAY, REED 2A	84801-26531	12V		COTO	2653-12-300	
K2008	RELAY, REED 1A	84801-26041	12V		COTO	2604-12-300	
Q2001	SEMICON POSITIVE REGULATOR	25922-78151	15V		MOTOROLA	78M15AUC	1
Q2002	SEMICON NEGATIVE REGULATOR	25922-79152	15V		MOTOROLA	79M15AUC	1
Q2003	SEMICON TRANSISTOR PNP GP	22192-44030			MOTOROLA	2N4403	1
Q2004	SEMICON SHUNT REGULATOR	25922-43100			MOTOROLA	TL431CLP	1
Q2005	SEMICON FET N CHANNEL	22392-48610			MOTOROLA	2N4861A	1
Q2006	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	3
Q2007	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q2008	NOT USED						
Q2009	SEMICON TRANSISTOR PNP GP	22522-44010			MOTOROLA	2N4401	
Q2010	SEMICON POWER MOS FET	23401-06060			SILICONIX	VN0606M	1
R2001	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	8
R2002	RESISTOR CF 1/4W	32033-10040	1M	5%	ALLEN BRADLEY	CB1055	4
R2003	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	4
R2004	RESISTOR CF 1/4W	32033-10030	100K	5%	ALLEN BRADLEY	CB1045	3

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
R2005	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	15
R2006	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2007	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2008	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R2009	RESISTOR CF 1/4W	32033-10040	1M	5%	ALLEN BRADLEY	CB1055	
R2010	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2011	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2012	RESISTOR CF 1/4W	32033-20010	2K	5%	ALLEN BRADLEY		3
R2013	RESISTOR CF 1/4W	32033-20010	2K	5%	ALLEN BRADLEY		
R2014	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	3
R2015	RESISTOR CF 1/4W	32033-10000	100	5%	ALLEN BRADLEY	CB1015	
R2016	RESISTOR CF 1/4W	32033-27010	2K7	5%	ALLEN BRADLEY		1
R2017	RESISTOR CF 1/4W	32033-10030	100K	5%	ALLEN BRADLEY	CB1045	
R2018	RESISTOR CF 1/4W	32033-20010	2K	5%	ALLEN BRADLEY		
R2019	RESISTOR CF 1/4W	32033-30010	3K	5%	ALLEN BRADLEY		1
R2020	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R2021	RESISTOR CF 1/4W	32033-39010	3K9	5%	ALLEN BRADLEY		1
R2022	RESISTOR CF 1/4W	32033-86010	8K6	5%	ALLEN BRADLEY		1
R2023	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB2225	
R2024	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R2025	RESISTOR CF 1/4W	32033-56020	56K	5%	ALLEN BRADLEY		1
R2026	RESISTOR CF 1/4W	32033-56010	5K6	5%	ALLEN BRADLEY	CB5625	
R2027	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB2225	
R2028	RESISTOR CF 1/4W	32033-68010	6K8	5%	ALLEN BRADLEY		1
R2029	RESISTOR MF 1/4W	32035-60410	6K04	1%	CORNING		1
R2030	JUMPER						1
R2031	RESISTOR CF 1/4W	32033-06200	62	5%	ALLEN BRADLEY		1
R2032	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY		2
R2033	RESISTOR CF 1/4W	32033-56010	5K6	5%	ALLEN BRADLEY	CB5625	5
R2034	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY		
R2035	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R2036	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB2225	
R2037	RESISTOR CF 1/4W	32033-10040	1M	5%	ALLEN BRADLEY	CB1055	
R2038	RESISTOR CF 1/4W	32033-22020	22K	5%	ALLEN BRADLEY		2
R2039	RESISTOR CF 1/4W	32033-15040	1M5	5%	ALLEN BRADLEY		2
R2040	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R2041	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R2042	RESISTOR CF 1/4W	32033-02400	24	5%	ALLEN BRADLEY		2
R2043	RESISTOR CF 1/4W	32033-33010	3K3	5%	ALLEN BRADLEY	CB3325	1
R2044	RESISTOR MF 1/4W	32035-68110	6K81	1%	CORNING		2
R2045	RESISTOR CF 1/4W	32033-13010	1K3	5%	ALLEN BRADLEY		1
R2046	RESISTOR CF 1/4W	32033-11010	1K1	5%	ALLEN BRADLEY		1
R2047	RESISTOR MF 1/4W	32035-68110	6K81	1%	CORNING		
R2048	RESISTOR CF 1/4W	32033-56010	5K6	5%	ALLEN BRADLEY	CB5625	
R2049	RESISTOR CF 1/4W	32033-22020	22K	5%	ALLEN BRADLEY		
R2050	RESISTOR CF 1/4W	32033-10040	1M	5%	ALLEN BRADLEY	CB1055	
R2051	RESISTOR CF 1/4W	32033-56010	5K6	5%	ALLEN BRADLEY	CB5625	
R2052	RESISTOR CF 1/4W	32033-10000	100	5%	ALLEN BRADLEY	CB1015	
R2053	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R2054	RESISTOR CF 1/4W	32033-10000	100	5%	ALLEN BRADLEY	CB1015	
R2055	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R2056	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB2225	5
R2057	RESISTOR CF 1/4W	32033-15040	1M5	5%	ALLEN BRADLEY		

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
R2058	RESISTOR CF 1/4W	32033-02400	24	5%	ALLEN BRADLEY		
R2059	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	5
R2060	RESISTOR CF 1/4W	32033-01000	10	5%	ALLEN BRADLEY		2
R2061	RESISTOR CF 1/4W	32033-01000	10	5%	ALLEN BRADLEY		
R2062	RESISTOR MF 1/4W	32035-11520	11K5	1%	CORNING		1
R2063	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2064	RESISTOR MF 1/4W	32035-10010	1K0	1%	CORNING		1
R2065	RESISTOR MF 1/4W	32035-75010	7K50	1%	CORNING		1
R2066	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2067	RESISTOR MF 1/4W	32035-12420	12K4	1%	CORNING		1
R2068	RESISTOR CF 1/4W	32033-39030	390K	5%	ALLEN BRADLEY		1
R2069	RESISTOR CF 1/4W	32033-10030	100K	5%	ALLEN BRADLEY	CB1045	
R2070	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R2071	RESISTOR CF 1/4W	32033-56010	5K6	5%	ALLEN BRADLEY	CB5625	
R2072	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R2073	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R2074	NOT USED						
R2075	NOT USED						
R2076	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2077	RESISTOR MF 1/4W	32035-24930	249K	1%	CORNING		1
R2078	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R2079	NOT USED						
R2080	RESISTOR MF 1/4W	32035-13020	13K0	1%	CORNING	SMA4-13K-1	
R2081	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2082	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2083	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2084	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R2085	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R2086	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING		
R2087	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING		
RN2001	RESISTOR NET 8PIN 7 RES SIP	39087-33010	3K3X7		BOURNS	4608R-101-332	2
RN2002	RESISTOR NET 8PIN 7 RES SIP	39087-33010	3K3X7		BOURNS	4608R-101-332	
RN2003	RESISTOR NET 16PIN 15 RES DIP	38167-10020	10KX15		BOURNS	4116R-002-103	1
U2001	SEMICON OP AMP BI-FET DUAL	25111-07200				TL-072CP	2
U2002	SEMICON CMOS CONV DUA 8BIT DAC	25000-75280			ANALOG DEVICES	AD7528JN	1
U2003	SEMICON	27743-74008				74LS08	1
U2004	SEMICON LSTTL OCTAL D TYP FLFL	27743-74273				SN74LS273N	2
U2005	SEMICON	27743-74245				74LS245	1
U2006	SEMICON LSTTL HEX INVERTER	27743-74004				74LS04	1
U2007	SEMICON LSTTL HEX D FF	27743-74174				74LS174	
U2008	SEMICON LSTTL 4BIT MAG COMP	27743-74085				SN74LS85N	1
U2009	SEMICON LSTTL HEX D FF	27743-74174				74LS174	2
U2010	SEMICON LSTTL OCTAL D TYP FLFL	27743-74273				SN74LS273N	
U2011	SEMICON LSTTL 3 TO 8 DECODER	27743-74138				SN74LS138N	1
U2012	SEMICON BI-FET OP AMP	25111-07100				TL-071CP	2
U2013	SEMICON OP AMP LO NOISE	25311-55320			SIGNETICS	NE5532AN	1
U2014	SEMICON LIN COMPARATOR	25308-31100				LM311P	2
U2015	SEMICON DRIVER	29200-20030				ULN2003AN	1
U2016	SEMICON CMOS HEX INVERTER	24021-40490				4049BPC	1
U2017	SEMICON BI-FET OP AMP	25111-07100				TL-071CP	
U2018	SEMICON OP AMP LO-OFFSET FET	25312-41200				LF412N	1
U2019	SEMICON LINEAR DUAL OTA	25430-32800			RCA	CA3280	1
U2020	SEMICON LIN COMPARATOR	25308-31100				LM311P	

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DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
U2021	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	9
U2022	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U2023	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U2024	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U2025	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U2026	SEMICON CMOS 12 BIT DAC	25000-75410			ANALOG DEVICES	AD7541AJN	2
U2027	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U2028	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U2029	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U2030	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U2031	SEMICON CMOS 12 BIT DAC	25000-75410			ANALOG DEVICES	AD7541AJN	
U2032	SEMICON OP AMP BI-FET DUAL	25111-07200				TL-072CP	
VR2001	RESISTOR TRIM CONTROL ST SA	51415-50020	50K		BOURNS	3386W-1-503	5
VR2002	RESISTOR TRIM CONTROL MT SA	51515-10010	1K		BOURNS	3299X-1-102	3
VR2003	RESISTOR TRIM CONTROL MT SA	51515-10010	1K		BOURNS	3299X-1-102	
VR2004	RESISTOR TRIM CONTROL ST SA	51415-50020	50K		BOURNS	3386W-1-503	
VR2005	RESISTOR TRIM CONTROL ST SA	51415-50020	50K		BOURNS	3386W-1-503	
VR2006	RESISTOR TRIM CONTROL ST SA	51415-50020	50K		BOURNS	3386W-1-503	
VR2007	RESISTOR TRIM CONTROL ST SA	51415-50020	50K		BOURNS	3386W-1-503	
VR2008	RESISTOR TRIM CONTROL MT SA	51515-10010	1K		BOURNS	3299X-1-102	
W2001	SEMICON VCA	29007-10100			VALLEY PEOPLE	TA-101	1

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	PRINTED CIRCUIT BOARD	5500-43005			AMBER	5500-43005	1
	HANDLE BRACKET	5500-60302			AMBER	5500-60302	1
	EJECTOR LATCHES ORANGE	65299-50052			THERMALLOY	5005-20N	2
	CONNECTOR SOCKET 8PIN	71008-20839			AUGAT	208-AG39D	4
	CONNECTOR SOCKET 16PIN	71016-21639			AUGAT	216-AG39D	11
	CONNECTOR SOCKET 20PIN	71020-22039			AUGAT	220-AG39D	1
	FUSE CLIPS	85314-10206			LITTLEFUSE	102071:102068	2
C3001	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	22
C3002	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 10V	8
C3003	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 10V	
C3004	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 10V	
C3005	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 10V	
C3006	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3007	CAPACITOR CERAMIC DISC	41033-11000	100P	20%	ERIE	831-000-COGO-100D	
C3008	CAPACITOR TRIM CONTROL TA	49000-53801	7-25P		MURATA/ERIE	DV11PS25B	2
C3009	CAPACITOR TRIM CONTROL TA	49000-53801	7-25P		MURATA	DV11PS25B	
C3010	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3011	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3012	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 10V	
C3013	CAPACITOR FILM	45042-13302	330P	20%	WIMA	FKC3 330/160/20W	2
C3014	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3015	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 10V	
C3016	CAPACITOR CERAMIC DISC	41033-01000	10P	20%		10PF100V:DC1-100J	4
C3017	CAPACITOR CERAMIC DISC	41033-01000	10P	20%		10PF100V:DC1-100J	
C3018	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%		TCD-103Z	3
C3019	CAPACITOR CERAMIC DISC	41033-03300	33P	10%		33PF100V	4
C3020	CAPACITOR FILM	45042-10000	100P	5%	WIMA	4KC3 100\160\5	2
C3021	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3023	CAPACITOR MONOLYTIC	42031-41000	0.1		AVX	SR205E104MAA	
C3024	NOT INSTALLED						
C3025	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3026	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3027	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%			
C3028	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3029	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 10V	
C3030	CAPACITOR CERAMIC DISC	41033-11000	100P	20%	ERIE	831-000-COGO-100D	
C3031	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3032	CAPACITOR FILM	45042-11000	100P	5%	WIMA	4KC3 100\160\5	
C3033	CAPACITOR CERAMIC DISC	41033-03300	33P	10%		33PF100V	
C3034	CAPACITOR FILM	45042-12201	220P	5%	WIMA		2
C3035	CAPACITOR CERAMIC DISK	41033-04700	47P	10%			1
C3036	NOT INSTALLED						
C3037	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3038	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3039	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3040	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3041	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 10V	
C3042	CAPACITOR CERAMIC DISC	41033-01000	10P	20%		10PF100V:DC1-100J	
C3043	CAPACITOR CERAMIC DISC	41033-01000	10P	20%		10PF100V:DC1-100J	
C3044	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%		TCD-103Z	
C3045	CAPACITOR FILM HIGH VOLT AXIAL	45052-51000	1.0	10%	SIEMENS	1/10/400/5200	2
C3046	CAPACITOR FILM HIGH VOLT AXIAL	45052-51000	1.0	10%	SIEMENS	1/10/400/5200	
C3047	CAPACITOR FILM	45042-22202	2200P	20%	WIMA	FKC3 2200/160/20W	2

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
C3048	CAPACITOR CERAMIC DISC	41033-11000	100P	20%	ERIE	831-000-COGO-100D	3
C3049	CAPACITOR FILM	45042-12201	220P	5%	WIMA		
C3050	CAPACITOR CERAMIC DISC	41033-03900	39P	20%			1
C3051	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3052	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3053	CAPACITOR CERAMIC DISC	41033-14700	470P	20%			1
C3054	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3055	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3056	CAPACITOR ELECT 22/40	48050-02200	22	20%	SIEMENS	85200/22/40V	1
C3057	CAPACITOR FILM	45042-22202	2200P	20%	WIMA	FKC3 2200/160/20W	
C3058	CAPACITOR FILM	45042-13302	330P	20%	WIMA	FKC3 330/160/20W	
C3059	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3060	CAPACITOR FILM	45042-41000	0.1	5%	WIMA	MKS 0.1/100/5W	1
C3061	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3062	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C3063	CAPACITOR CERAMIC DISK	41033-03300	33P	10%			
C3064	CAPACITOR CERAMIC DISK	41033-03300	33P	10%			
D3001	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D3002	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D3003	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D3004	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	4
D3006	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	19
D3007	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3008	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3009	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3010	SEMICON TRANSORB 12V	29001-15120			MOTOROLA	1.5KE12A	2
D3011	SEMICON DIODE ZENER 3.3V	21207-07461			MOTOROLA	1N746A	3
D3012	SEMICON TRANSORB 36V	29001-63600			MOTOROLA	P6KE36	1
D3013	SEMICON DIODE ZENER 3.3V	21207-07461			MOTOROLA	1N746A	
D3015	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3016	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3017	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3018	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3019	SEMICON TRANSORB 12V	29001-15120			MOTOROLA	1.5KE12A	
D3020	SEMICON DIODE ZENER 3.3V	21207-07581			MOTOROLA	1N758	2
D3021	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3022	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3023	SEMICON DIODE ZENER 3.3V	21207-07581			MOTOROLA	1N758	
D3024	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3025	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3026	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3027	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3028	INSTALL JUMPER						1
D3029	SEMICON DIODE ZENER 3.3V	21207-07461			MOTOROLA	1N746A	
D3030	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3031	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3032	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3033	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D3034	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
F3001	LIGHT BULB MINIATURE 120V	91000-12000	120V		GI/CHIGAGO	120PS	2
F3002	LIGHT BULB MINIATURE 120V	91000-12000	120V		GI/CHIGAGO	120PS	
K3001	RELAY, REED 1A	84801-26041	12V		COTO	2604-12-300	7
K3002	RELAY, REED 1A	84801-26041	12V		COTO	2604-12-300	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
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K3003	RELAY, REED 1A	84801-26041	12V		COTO	2604-12-300	
K3004	RELAY, REED 1A	84801-26041	12V		COTO	2604-12-300	
K3005	RELAY, REED 1A	84801-26041	12V		COTO	2604-12-300	
K3006	RELAY, REED 1A	84801-26041	12V		COTO	2604-12-300	
K3007	RELAY, REED 1A	84801-26041	12V		COTO	2604-12-300	
K3008	RELAY, REED 2A	84801-42301			COTO	4230-12-3001	4
K3009	RELAY, REED 2A	84801-26531			COTO	2653-12-300	
K3010	RELAY, REED 2A	84801-26531			COTO	2653-12-300	
K3011	RELAY, REED 2A	84801-26531			COTO	2653-12-300	5
K3012	RELAY, 2C 18V	84801-18000	18V		ITT	RY18W-K	5
K3013	RELAY, 2C 18V	84801-18000	18V		ITT	RY18W-K	
K3014	RELAY, 2C 18V	84801-18000	18V		ITT	RY18W-K	
K3015	RELAY, 2C 18V	84801-18000	18V		ITT	RY18W-K	
K3016	RELAY, 2C 18V	84801-18000	18V		ITT	RY18W-K	
K3017	RELAY, REED 2A	84801-26531	12V		COTO	2653-12-300	
K3018	RELAY, REED 2A	84801-42301	12V		COTO	4230-12-3001	
K3019	RELAY, REED 2A	84801-42301	12V		COTO	4230-12-3001	
K3020	RELAY, REED 2A	84801-42301	12V		COTO	4230-12-3001	
K3021	RELAY, REED 2A	84801-26531	12V		COTO	2653-12-300	
N3001	RESISTOR NETWORK PRECISION	38935-17769	Custom	0.1%	CADDOCK	1776-91	2
N3002	RESISTOR NETWORK PRECISION	38935-17769	Custom	0.1%	CADDOCK	1776-91	
N3003	RESISTOR NET 8 PIN 7RES SIP	39087-33010	3K3X7		BOURNS	4608R-101-332	2
N3004	RESISTOR NET 8 PIN 7RES SIP	39087-33010	3K3X7		BOURNS	4608R-101-332	
Q3001	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	10
Q3002	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q3003	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q3004	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3005	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3006	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q3007	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q3008	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	12
Q3009	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3010	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3011	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3012	SEMICON DUAL N CH FET	22318-25146			MOTOROLA	2SK146GR	2
Q3013	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q3014	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q3015	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q3016	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3017	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3018	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q3019	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q3020	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3021	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3022	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3023	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q3024	SEMICON DUAL N CH FET	22318-25146			TOSHIBA	2SK146GR	
R3001	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	6
R3002	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	
R3003	RESISTOR CF 1/4W	32033-33000	330	5%	ALLEN BRADLEY	CB3315	
R3004	RESISTOR CF 1/4W	32033-33000	330	5%	ALLEN BRADLEY	CB3315	4
R3005	RESISTOR CF 1/4W	32033-36000	360	5%	ALLEN BRADLEY	CB3615	2
R3006	RESISTOR CF 1/4W	32033-47000	470	5%	ALLEN BRADLEY	CB4715	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
R3007	RESISTOR CF 1/4W	32033-82010	8K2	5%	ALLEN BRADLEY	CB8225	2
R3008	RESISTOR CF 1/4W	32033-47000	470	5%	ALLEN BRADLEY	CB4715	4
R3009	RESISTOR CF 1/4W	32033-04700	47	5%	ALLEN BRADLEY	CB4705	
R3010	RESISTOR CF 1/4W	32033-13000	130	5%	ALLEN BRADLEY	CB1315	2
R3011	RESISTOR CF 1/4W	32033-33010	3K3	5%	ALLEN BRADLEY		1
R3013	RESISTOR CF 1/4W	32033-06200	62	5%	ALLEN BRADLEY	CB6205	4
R3014	RESISTOR CF 1/4W	32033-06200	62	5%	ALLEN BRADLEY	CB6205	
R3015	RESISTOR MF 1/4W	32040-24910	2K49	0.1%			5
R3016	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	2
R3017	RESISTOR MF 1/4W	32035-49900	499	1%	CORNING	SMA4-499R-1	2
R3019	RESISTOR MF 1/4W	32035-24310	2K43	1%	CORNING	SMA4-2.43K-1	1
R3020	RESISTOR CF 1/4W	32033-12030	120K	5%	ALLEN BRADLEY	CB1245	1
R3021	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	
R3022	RESISTOR MF 1/4W	32040-68420	68K38	0.1%			2
R3023	RESISTOR MF 1/4W	32040-21620	21K62	0.1%			2
R3024	RESISTOR MF 1/4W	32040-68410	6K838	0.1%			2
R3025	RESISTOR MF 1/4W	32040-31610	3K162	0.1%			2
R3027	RESISTOR MF 1/4W	32040-63910	6K399	0.1%			1
R3028	RESISTOR MF 1/4W	32040-23010	2K303	0.1%			1
R3029	RESISTOR MF 1/4W	32040-107710	1K077	0.1%			1
R3030	RESISTOR MF 1/4W	32040-55300	553.3	0.1%			1
R3031	RESISTOR MF 1/4W	32040-29700	296.7	0.1%			1
R3032	RESISTOR MF 1/4W	32040-16300	162.6	0.1%			1
R3033	RESISTOR MF 1/4W	32040-09000	90.16	0.1%			1
R3034	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	
R3035	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	
R3036	RESISTOR CF 1/4W	32033-33000	330	5%	ALLEN BRADLEY	CB3315	
R3037	RESISTOR CF 1/4W	32033-33000	330	5%	ALLEN BRADLEY	CB3315	
R3038	RESISTOR CF 1/4W	32033-36000	360	5%	ALLEN BRADLEY	CB3615	
R3039	RESISTOR CF 1/4W	32033-47000	470	5%	ALLEN BRADLEY	CB4715	
R3040	RESISTOR CF 1/4W	32033-82010	8K2	5%	ALLEN BRADLEY	CB8225	
R3041	RESISTOR CF 1/4W	32033-47000	470	5%	ALLEN BRADLEY	CB4715	
R3042	RESISTOR CF 1/4W	32033-04700	47	5%	ALLEN BRADLEY	CB4705	2
R3043	RESISTOR CF 1/4W	32033-13000	130	5%	ALLEN BRADLEY	CB1315	
R3044	RESISTOR MF 1/4W	32040-68420	68K38	0.1%			
R3045	RESISTOR MF 1/4W	32040-21620	21K62	0.1%			
R3046	RESISTOR MF 1/4W	32040-31610	3K162	0.1%			
R3047	RESISTOR MF 1/4W	32040-68410	6K838	0.1%			
R3048	RESISTOR MF 1/4W	32035-49900	499	1%	CORNING	SMA4-499R-1	
R3052	RESISTOR CF 1/4W	32033-06200	62	5%	ALLEN BRADLEY	CB6205	
R3053	RESISTOR CF 1/4W	32033-06200	62	5%	ALLEN BRADLEY	CB6205	
R3054	RESISTOR MF 1/4W	32040-24910	2K49	0.1%			
R3056	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	
R3057	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R3058	RESISTOR MF 1/4W	32040-24910	2K49	0.1%			
R3059	RESISTOR MF 1/4W	32040-24910	2K49	0.1%			
R3060	RESISTOR MF 1/4W	32040-24910	2K49	0.1%			
R3061	RESISTOR CF 1/4W	32033-10000	100	5%	ALLEN BRADLEY	CB1015	1
R3062	RESISTOR CF 1/4W	32033-02700	27	5%	ALLEN BRADLEY	CB2705	1
R3065	RESISTOR MF 1/4W	32035-60410	6K04	1%	CORNING	SMA4-6.04K-1	1
R3066	RESISTOR MF 1/4W	32035-66500	665	1%	CORNING	SMA4-665R-1	1
R3067	RESISTOR MF 2W	34065-15000	150	1%			2
R3068	RESISTOR MF 2W	34065-60000	600	1%			2

PREAMP PCB ASSEMBLY 5500-73005

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
R3069	RESISTOR MF 2W	34065-60000	600	1%			
R3070	RESISTOR MF 2W	34065-15000	150	1%			
R3071	RESISTOR CF 1/4W	32033-15040	1M5	5%	ALLEN BRADLEY	CB1555	1
U3001	SEMICON LINEAR POS REG 15V	25922-78152	15V		MOTOROLA	78M15AUC	1
U3002	SEMICON LINEAR NEG REG 15V	25922-79152	15V		MOTOROLA	79M15AUC	1
U3003	SEMICON LSTTL 8 BIT ADD LATCH	27743-74259			MOTOROLA	74LS259	3
U3004	SEMICON 7 TRANSISTOR ARRAY	29200-20030			MOTOROLA	ULN2003A	3
U3005	SEMICON AUDIO OP AMP	25211-33200			ANALOG DEVICES	MA332CP	2
U3006	SEMICON OCTAL D FLIP FLOP	27743-74273			MOTOROLA	74LS273	1
U3007	SEMICON LSTTL 8 BIT ADD LATCH	27743-74259			MOTOROLA	74LS259	
U3008	SEMICON 7 TRANSISTOR ARRAY	29200-20030			MOTOROLA	ULN2003A	
U3009	SEMICON LSTTL 8 BIT ADD LATCH	27743-74259			MOTOROLA	74LS259	
U3010	SEMICON LSTTL 3 TO 8 DECODER	27743-74138			MOTOROLA	74LS138	3
U3011	SEMICON 4 BIT MAG COMP	27743-74085			MOTOROLA	74LS85	3
U3012	SEMICON AUDIO OP AMP	25211-33200			ANALOG DEVICES	MA332CP	
U3013	SEMICON OP AMP LO NOIS LIN	25311-55340			SIGNETICS	NE5534AN	1
U3014	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	1
U3015	SEMICON 7 TRANSISTOR ARRAY	29200-20030			MOTOROLA	ULN2003A	
U3016	SEMICON LSTTL HEX D FF	27743-74174			MOTOROLA	74LS174	1
U3017	SEMICON LSTTL DUAL D FF	27743-74074			MOTOROLA	SN74LS74N	1
U3018	SEMICON LSTTL 3 TO 8 DECODER	27743-74138			MOTOROLA	74LS138	
U3019	SEMICON 4 BIT MAG COMP	27743-74085			MOTOROLA	74LS85	
U3020	SEMICON 4 BIT MAG COMP	27743-74085			MOTOROLA	74LS85	
U3021	SEMICON LSTTL 3 TO 8 DECODER	27743-74138			MOTOROLA	74LS138	
V3001	RESISTOR TRIM CONTROL MT TA	51516-20000	200		BOURNS	3299W-1-201	1

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	PRINTED CIRCUIT BOARD	5500-44004			AMBER	5500-44004	1
	PROMAG BRACKET	5500-60402	4		AMBER	5500-60402	1
	MACHINE SCREW FH 4-40	61111-14031	5/16		VARIOUS	AN507-440-R5	2
	MACHINE SCREW FH 6-32	61113-16025	1/4		VARIOUS	AN507-632-R4	3
	MACHINE NUT HEX	61222-44000	4-40		VARIOUS	MS35649-242	2
	MACHINE NUT PC MOUNT	61260-63200	6-32		PEM	KF2-632-ET	3
	MACHINE FLAT WASHER	61510-14300	#4		VARIOUS	AN 960-4	2
	MACHINE LOCK WASHER	61520-36400	#4		VARIOUS	AN936-A4	2
	INSULATOR STEP WASHER	61540-77210	TO-220		THERMALLOY	7721-7PPS	2
	INSULATOR MICA SHEET	61600-43779	TO-220		THERMALLOY	43-77-9	2
	EJECTOR LATCH	65299-00020	BLK		RN	EL-2K	2
	EJECTOR LATCH	65299-20810	YEL		SCANBE	S208-1	2
	CONNECTOR SOCKET IC DIL	71008-20839	8 PIN		AUGAT	208-AG39D	10
	CONNECTOR SOCKET IC DIL	71014-21439	14PIN		AUGAT	214-AG39D	2
	CONNECTOR SOCKET IC DIL	71016-21639	16PIN		AUGAT	216-AG39D	11
	CONNECTOR SOCKET IC DIL	71020-22039	20PIN		AUGAT	220-AG39D	4
C4001	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	4
C4002	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C4003	CAPACITOR FILM	45042-21001	1000P	5%	WIMA	FKC3/1000/160/5W	1
C4004	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	8
C4005	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	45
C4006	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4007	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4008	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4009	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4010	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4011	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C4012	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4013	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4014	CAPACITOR NPO	41535-22000	220P	1%	VITRAMON	VP32BA221FB	1
C4015	CAPACITOR CERAMIC DISC	41033-14700	470P	5%	MURATA/ERIE	DD14F10N750471J500V	1
C4016	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4017	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4018	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4019	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4020	CAPACITOR TANTALUM 1.5/25V	47031-01590	1.5	10%	SIEMENS	TAG 1.5UF 25V	1
C4021	CAPACITOR CERAMIC DISC	41033-11500	150P	20%	MURATA/ERIE	DD09B10N750151J500V	1
C4022	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4023	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4024	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4025	NOT USED						
C4026	CAPACITOR TANTALUM 4.7/25V	47031-04790	4.7		ITT	TAG 4.7M25	2
C4027	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4028	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4029	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4030	CAPACITOR TANTALUM 10/25V	47031-10000	10	20%	ITT	COM TAG 10UF 25V	1
C4031	CAPACITOR FILM	45042-51002	1.0	20%	WIMA	MKS3 1.0/63/20W	1
C4032	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C4033	CAPACITOR FILM	45042-41000	0.1	10%	WIMA	MKS3 0.1/100/10W	1
C4034	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C4035	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4036	CAPACITOR TANTALUM 4.7/25V	47031-04790	4.7		ITT	TAG 4.7M25	
C4037	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
C4038	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4039	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4040	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C4041	CAPACITOR FILM	45042-31000	0.01	20%	WIMA	MKS3 0.01/100/20W	2
C4042	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4043	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4044	CAPACITOR FILM	45042-44700	0.47	5%	WIMA	MKS3 0.47/63/5W	1
C4045	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4046	CAPACITOR FILM	45042-31000	0.01	20%	WIMA	MKS3 0.01/100/20W	
C4047	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4048	CAPACITOR FILM	45042-42200	0.22	5%	SIEMENS	B32561 .22UF 100V	1
C4049	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C4050	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4051	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C4052	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C4053	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	
C4054	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4055	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4056	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4057	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4058	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4059	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C4060	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C4061	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C4062	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4063	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4064	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4065	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4066	CAPACITOR CERAMIC DISC	41033-13300	330P	20%	MP	GB331K	1
C4067	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C4068	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4069	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4070	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4071	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4072	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	5
C4073	CAPACITOR CERAMIC DISC	41033-01000	10P	5%	MURATA/ERIE	DD05B10N750100J500V	
C4074	NOT USED						
C4075	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4076	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4077	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4078	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4079	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C4080	NOT USED						
C4081	CAPACITOR ELECT 22/40V	48050-02200	22	20%	SIEMENS	85200/22/40V	1
C4082	CAPACITOR FILM	45042-44701	0.47	20%	WIMA	MKS3 0.47/63/20W	1
D4001	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	4
D4002	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D4003	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D4004	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D4005	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4006	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4007	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4008	SEMICON DIODE GEN PURPOSE	21207-47450			MOTOROLA	1N4745	2

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
D4009	SEMICON DIODE GEN PURPOSE	21207-47450			MOTOROLA	1N4745	
D4012	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	12
D4013	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4014	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4015	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4016	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4017	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4018	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4019	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4020	SEMICON DIODE GEN PURPOSE	21136-41500			MOTOROLA	1N4150TR	
D4021	SEMICON DIODE ZENER	21207-07551	7.5V		MOTOROLA	1N755A	
D4022	SEMICON DIODE ZENER	21207-07551	7.5V		MOTOROLA	1N755A	2
J4001	JUMPER						1
J4002	CONNECTOR LATCH RT ANGLE 50PIN	78003-20000			RN	IDH-50K-SR3-TG	1
J4003	NOT USED						
J4004	NOT USED						
Q4001	SEMICON SHUNT REGULATOR	25922-43100			TI	TL431CLP	1
Q4002	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q4003	SEMICON DUAL N CH FET	22318-25146			TOSHIBA	2SK146GR	1
Q4004	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	3
Q4005	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
R4001	RESISTOR CF 1/4W	32033-20010	2K0	5%	ALLEN BRADLEY	CB2025	1
R4002	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	3
R4003	RESISTOR CF 1/4W	32033-47020	47K	5%	ALLEN BRADLEY	CB4735	2
R4004	RESISTOR MF 1/4W	32035-24910	2K49	1%	CORNING	SMA4-2.49K-1	1
R4005	RESISTOR CF 1/4W	32033-51010	5K1	5%	ALLEN BRADLEY	CB5125	4
R4006	RESISTOR CF 1/4W	32033-51010	5K1	5%	ALLEN BRADLEY	CB5125	
R4007	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R4008	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	SMA4-10K-1	
R4009	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB2225	
R4010	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R4011	RESISTOR CF 1/4W	32033-30010	3K	5%	ALLEN BRADLEY	CB3025	1
R4012	RESISTOR CF 1/4W	32033-10000	100	5%	ALLEN BRADLEY	CB1015	1
R4013	NOT USED						
R4014	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	7
R4015	NOT USED						
R4016	RESISTOR CF 1/4W	32033-47030	470K	5%	ALLEN BRADLEY	CB4745	1
R4017	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R4018	RESISTOR MF 1/4W	32035-24930	249K	1%	CORNING	SMA4-249K-1	1
R4019	NOT USED						
R4020	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R4021	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R4022	NOT USED						
R4023	NOT USED						
R4024	RESISTOR MF 1/4W	32035-30100	301	1%	CORNING	SMA4-301R-1	1
R4025	RESISTOR MF 1/4W	32035-60410	6K04	1%	CORNING	SMA4-6.04K-1	3
R4026	NOT USED						
R4027	NOT USED						
R4028	NOT USED						
R4029	RESISTOR MF 1/4W	32035-33230	332K	1%	CORNING	SMA4-332K-1	1
R4030	NOT USED						
R4031	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	1
R4032	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	

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R4033	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB2225	4
R4034	RESISTOR MF 1/4W	32040-10020	10K00	0.1%	CORNING		1
R4035	RESISTOR MF 1/4W	32040-31612	3K162	0.1%	CORNING		1
R4036	RESISTOR CF 1/4W	32033-51010	5K1	5%	ALLEN BRADLEY	CB5125	
R4037	RESISTOR CF 1/4W	32033-51010	5K1	5%	ALLEN BRADLEY	CB5125	
R4038	RESISTOR MF 1/4W	32035-49910	4K99	1%	CORNING	SMA4-4.9K-1	1
R4039	RESISTOR MF 1/4W	32040-14612	1K462	0.1%	CORNING		1
R4040	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB2225	
R4041	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R4042	RESISTOR CF 1/4W	32033-22020	22K	5%	ALLEN BRADLEY	CB2235	1
R4043	RESISTOR CF 1/4W	32033-12000	120	5%	ALLEN BRADLEY	CB1215	1
R4044	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	3
R4045	RESISTOR CF 1/4W	32033-82000	820	5%	ALLEN BRADLEY	CB8215	2
R4046	RESISTOR CF 1/4W	32033-82000	820	5%	ALLEN BRADLEY	CB8215	
R4047	RESISTOR CF 1/4W	32033-22040	2M2	5%	ALLEN BRADLEY	CB2255	
R4048	RESISTOR MF 1/4W	32035-15020	15K0	1%	CORNING	SMA4-15K-1	1
R4049	RESISTOR CF 1/4W	32033-10050	10M	5%	ALLEN BRADLEY	CB1065	1
R4050	RESISTOR MF 1/4W	32035-16520	16K5	1%	CORNING	SMA4-16.5K-1	1
R4051	RESISTOR CF 1/4W	32033-15040	1M5	5%	ALLEN BRADLEY	CB1555	1
R4052	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY	CB1035	
R4053	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CB1025	
R4054	RESISTOR CF 1/4W	32033-22040	2M2	5%	ALLEN BRADLEY	CB2255	2
R4055	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB2225	
R4056	RESISTOR CF 1/4W	32033-47020	47K	5%	ALLEN BRADLEY	CB4735	
R4057	RESISTOR MF 1/4W	32035-49920	49K9	1%	CORNING	SMA4-49.9K-1	1
R4058	NOT USED						
R4059	RESISTOR CF 1/4W	32033-10040	1M	5%	ALLEN BRADLEY	CB1055	1
R5056	RESISTOR MF 1/4W	32035-60410	6K04	1%	CORNING	SMA4-6.04K-1	
R5057	RESISTOR MF 1/4W	32035-60410	6K04	1%	CORNING	SMA4-6.04K-1	
RN4001	RESISTOR NET 8 PIN 7 RES SIP	39087-10020	10KX7		BOURNS	4608R-101-103	1
RN4002	RESISTOR NET 8 PIN 7 RES SIP	39087-47010	4K7X7	5%	BOURNS	4608R-101-472	3
RN4003	RESISTOR NET 8 PIN 7 RES SIP	39087-47010	4K7X7	5%	BOURNS	4608R-101-472	
RN4004	RESISTOR NET 8 PIN 4 RES SIP	39087-33010	3K3X4	5%	BOURNS	4608R-102-332	1
RN4005	RESISTOR NET 16 PIN 8 RES DIP	38165-20020	20KX8	5%	BOURNS	4116R-001-203	3
RN4006	RESISTOR NET 16 PIN 8 RES DIP	38165-20020	20KX8	5%	BOURNS	4116R-001-203	
RN4007	RESISTOR NET 16 PIN 8 RES DIP	38165-20020	20KX8	5%	BOURNS	4116R-001-203	
RN4008	NOT USED						
RN4009	RESISTOR NET 8 PIN 7 RES SIP	39087-47010	4K7X7	5%	BOURNS	4608R-101-472	
U4001	SEMICON POSITIVE REGULATOR	25922-78152	15V		MOTOROLA	78M15UC	1
U4002	SEMICON NEGATIVE REGULATOR	25922-79152	15V		MOTOROLA	79M15UC	1
U4003	SEMICON QUAD SWITCH	24021-21100			SILICONIX	DG211CJ	
U4004	SEMICON CMOS 8-CH ANALOG MUX	24021-50800			SILICONIX	DG508ACJ	4
U4005	SEMICON DUAL FET OP AMP	25312-34082			MOTOROLA	MC34082P	1
U4006	SEMICON VOLT TO FREQ CONVERTER	25000-32000			ANALOG DEVICES	VFC 32 KP	1
U4007	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	
U4008	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	
U4009	SEMICON RMS TO DC CONVERTER	25000-53600			ANALOG DEVICES	AD536AJD	1
U4010	SEMICON CMOS SWITCH	24021-40530			RCA	CD4053B	1
U4011	SEMICON CMOS 8-CH ANALOG MUX	24021-50800			SILICONIX	DG508ACJ	
U4012	SEMICON CMOS 8-CH ANALOG MUX	24021-50800			SILICONIX	DG508ACJ	
U4013	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	
U4014	SEMICON LSTTL 3 TO 8 DECODER	27743-74138			MOTOROLA	74LS138	1
U4015	SEMICON OCTAL BUS TRANSCIEVER	27743-74245			MOTOROLA	74LS245	2

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
U4016	SEMICON 4 BIT MAG COMP	27743-74085			MOTOROLA	74LS85	1
U4017	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	6
U4018	SEMICON LSTTL HEX INVERTER	27743-74004			MOTOROLA	74LS04	1
U4019	SEMICON CMOS 8-CH ANALOG MUX	24021-50800			SILICONIX	DG508ACJ	
U4020	SEMICON OP AMP LO NOISE	25311-55340			SIGNETICS	NE5534AN	1
U4021	SEMICON QUAD SWITCH	24021-21100			SILICONIX	DG211CJ	2
U4022	SEMICON OCTAL BUS TRANSCIEVER	27743-74245			MOTOROLA	74LS245	
U4023	SEMICON OCTAL D FLIP FLOP	27743-74273			MOTOROLA	74LS273	2
U4024	SEMICON OCTAL D FLIP FLOP	27743-74273			MOTOROLA	74LS273	
U4025	SEMICON QUAD 2 IN NAND	27743-74000			MOTOROLA	74LS00	1
U4026	SEMICON BI FET COMPARATOR	25308-31100			TI	TL311P	1
U4027	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	
U4028	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	
U4029	SEMICON OP AMP LO-OFFSET FET	25312-41200			NATIONAL	LF412N	1
VR4001	RESISTOR TRIM CONTROL ST SA	51415-50020	50K		BOURNS	3386W-1-503	1
VR4002	RESISTOR TRIM CONTROL MT SA	51515-50010	5K	10%		3299X-1-502	1
VR4003	RESISTOR TRIM CONTROL ST SA	51415-10020	10K		BOURNS	3386W-1-103	1
VR4004	RESISTOR TRIM CONTROL ST SA	51415-50010	5K		BOURNS	3386W-1-502	2
VR4005	RESISTOR TRIM CONTROL ST SA	51415-50010	5K		BOURNS	3386W-1-502	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	PRINTED CIRCUIT BOARD	5500-47004			AMBER	5500-47004	1
	HANDLE BRACKET	5500-60702	7		AMBER	500-60702	1
	MACHINE SCREW FH 4-40	61111-14031	5/16		VARIOUS	AN507-440-R5	2
	MACHINE SCREW FH 6-32	61113-16025	1/4		VARIOUS	AN507-632-R4	3
	MACHINE NUT HEX	61222-44000	4-40		VARIOUS	MS35649-242	2
	MACHINE NUT PC MOUNT	61260-63200	6-32		PEM	KF2-632-ET	3
	MACHINE FLAT WASHER	61510-14300	#4		VARIOUS	AN960-4	2
	MACHINE LOCK WASHER	61520-36400	#4		VARIOUS	AN936-A4	2
	INSULATOR STEP WASHER	61540-77210	TO-220		THERMALLOY	7721-7PPS	2
	INSULATOR MICA SHEET	61600-43779	TO-220		THERMALLOY	43-77-9	2
	EJECTOR LATCH	65299-20810	VIO		SCANBE	S208-1	2
	CONNECTOR SOCKET IC DIL	71008-20839	8 PIN		AUGAT	208-AG39D	8
	CONNECTOR SOCKET IC DIL	71014-21439	14PIN		AUGAT	214-AG39D	3
	CONNECTOR SOCKET IC DIL	71016-21639	16PIN		AUGAT	216-AG39D	15
C7001	CAPACITOR CERAMIC DISC	41033-02200	22P	20%		10PF100V:DC1-100J	1
C7002	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7003	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	60
C7004	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7005	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7006	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7007	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7008	CAPACITOR CERAMIC DISC	41033-33000	330P	20%	MP	GB331K	
C7009	CAPACITOR CERAMIC DISC	41033-01000	10P	20%		10PF100V:DC1-100J	
C7010	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7011	CAPACITOR FILM	0.047					
C7012	CAPACITOR FILM	45042-18200	820P	5%	WIMA		1
C7013	CAPACITOR FILM	45042-42200	0.22	5%	SIEMENS	B32561.22UF100V	
C7014	CAPACITOR FILM	45042-42200	0.22	5%	SIEMENS	B32561.22UF100V	
C7015	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7016	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7020	JUMPER						1
C7025	CAPACITOR CERAMIC DISC	41033-01000	10P	20%		10PF100V:DC1-100J	5
C7026	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	16
C7027	CAPACITOR FILM	45042-42200	0.22	5%	SIEMENS	B32561.22UF 100V	3
C7028	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7029	CAPACITOR CERAMIC DISC	41033-13300	330P	20%	MP	GB331K	4
C7030	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7031	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7032	CAPACITOR CERAMIC DISC	41033-01000	10P	20%		10PF100V:DC1-100J	
C7033	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1		AVX	SR205E104MAA	
C7034	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7035	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7036	NOT USED						
C7037	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7038	CAPACITOR CERAMIC DISC	41033-33000	330P	20%	MP	GB331K	
C7039	CAPACITOR CERAMIC DISC	41033-01000	10P	20%		10PF100V:DC1-100J	
C7040	CAPACITOR CERAMIC DISC	41033-33000	330P	20%	MP	GB331K	
C7042	NOT USED						
C7044	NOT USED						
C7050	NOT USED						
C7054	NOT USED						
C7055	NOT USED						
C7059	NOT USED						

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
C7060	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7061	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7066	NOT USED						
C7073	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7074	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7075	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7076	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7077	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7078	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7079	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7080	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7081	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7084	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7086	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7087	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7088	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7089	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7090	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7091	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7092	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7093	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7094	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7095	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7096	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7097	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7098	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7099	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7100	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7101	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7102	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7103	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7104	CAPACITOR FILM	45042-31000	0.01	5%	WIMA	MKS3 0.01/100/5W	
C7105	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7106	CAPACITOR FILM	45042-22200	2200P	5%	WIMA	FKC3 2200/160/5W	
C7107	CAPACITOR FILM	45042-22200	2200P	5%	WIMA	FKC3 2200/160/5W	2
C7108	CAPACITOR FILM	45042-31000	0.01	5%	WIMA	MKS3 0.01/100/5W	3
C7109	NOT USED						
C7110	CAPACITOR FILM	45042-25600	5600P	5%	WIMA	FKC3 5600/160/5W	
C7111	CAPACITOR FILM	45042-25600	5600P	5%	WIMA	FKC3 5600/160/5W	2
C7113	CAPACITOR FILM	45042-31000	0.01	5%	WIMA	MKS3 0.01/100/5W	
C7114	CAPACITOR FILM	45042-31002	0.01	20%	WIMA	MKS3 0.01/100/20W	1
C7115	CAPACITOR FILM	45042-13300	330P	5%	WIMA		
C7116	CAPACITOR FILM	45042-13300	330P	5%	WIMA		2
C7117	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7118	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7119	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7120	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7121	NOT USED						
C7122	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7123	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7124	CAPACITOR CERAMIC DISC	41033-01000	10P	20%		10PF100V:DC1-100J	
C7125	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7126	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
C7127	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7128	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7129	CAPACITOR FILM	45042-41002	0.1	20%	WIMA	MKS3 0.1/100/20W	1
C7130	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7131	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7132	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7133	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7134	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7135	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7136	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7137	CAPACITOR FILM	45042-21001	1000P	5%	WIMA	FKC3 1000/160/5W	1
C7138	CAPACITOR MONOLYTHIC CEDRAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C7140	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200/10/40V	
C7141	CAPACITOR FILM	45042-51002	1.0	20%	WIMA	MKS3 1.0/63/20W	1
C7142	CAPACITOR MONOLYTHIC CERAMIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
D7001	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	4
D7002	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D7003	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D7004	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
Q7001	SEMICON TRANSISTOR NPN GP	22522-44010				2N4401	2
Q7002	SEMICON TRANSISTOR NPN GP	22522-44010				2N4401	
Q7005	SEMICON DUAL N CH FET	22318-25146			TOSHIBA	2SK146GR	1
R7004	RESISTOR CF 1/4W	32033-30010	3K	5%	CORNING		1
R7005	RESISTOR MF 1/4W	32035-49910	4K99	1%	CORNING	RN55D 4.99KD	1
R7007	RESISTOR CF 1/4W	32033-20010	2K	5%	CORNING		1
R7008	RESISTOR CF 1/4W	32033-10020	10K	5%	CORNING		4
R7009	RESISTOR CF 1/4W	32033-22040	2M2	5%	CORNING		1
R7010	RESISTOR MF 1/4W	32035-82520	82K5			8252F	1
R7011	RESISTOR CF 1/4W	32033-12000	120	5%	CORNING		1
R7012	RESISTOR MF 1/4W	32040-10020	10K00	0.1%	CORNING		
R7013	RESISTOR CF 1/4W	32033-10010	1K	5%	CORNING	CF1/4 1KR	
R7014	RESISTOR MF 1/4W	32035-33200	33K2			3322F	1
R7015	RESISTOR MF 1/4W	32035-34010	3K4	1%	CORNING	RN55D 3.4KD	1
R7016	RESISTOR MF 1/4W	32040-10020	10K00	0.1%	CORNING		4
R7017	RESISTOR MF 1/4W	32040-11110	1K111	0.1%	CORNING		4
R7018	RESISTOR CF 1/4W	32033-10010	1K	5%	CORNING	CF1/4 1KR	
R7019	RESISTOR MF 1/4W	32040-10020	10K00	0.1%	CORNING		
R7020	RESISTOR CF 1/4W	32033-10010	1K	5%	CORNING	CF1/4 1KR	
R7021	RESISTOR MF 1/4W	32040-11110	1K111	0.1%	CORNING		
R7022	RESISTOR MF 1/4W	32035-22110	2K21	1%	CORNING	RN55D 2.21KD	1
R7026	RESISTOR MF 1/4W	32035-82000	820	1%	CORNING		2
R7027	RESISTOR MF 1/4W	32035-82000	820	1%	CORNING		
R7033	RESISTOR CF 1/4W	32033-10010	1K	5%	CORNING	CF1/4 1KR	
R7034	RESISTOR CF 1/4W	32033-10010	1K	5%	CORNING	CF1/4 1KR	
R7035	RESISTOR CF 1/4W	32033-10020	10K	5%	CORNING		
R7055	RESISTOR CF 1/4W	32033-10010	1K	5%	CORNING	CF1/4 1KR	7
R7060	RESISTOR CF 1/4W	32033-51020	51K	5%	CORNING		1
R7061	RESISTOR MF 1/4W	32040-11110	1K111	0.1%	CORNING		
R7062	RESISTOR MF 1/4W	32040-11110	1K111	0.1%	CORNING		
R7063	RESISTOR MF 1/4W	32040-10020	10K00	0.1%	CORNING		
R7064	RESISTOR CF 1/4W	32033-10020	10K	5%	CORNING		
R7065	RESISTOR MF 1/4W	32035-12410	1K24	1%	CORNING	1241F	3
R7066	RESISTOR MF 1/4W	32035-33210	3K32	1%	CORNING	RN55D 3.32KD	3

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
R7067	RESISTOR MF 1/4W	32035-28720	28K7	1%	CORNING	2872F	1
R7068	RESISTOR MF 1/4W	32035-12410	1K24	1%	CORNING	1241F	
R7069	RESISTOR MF 1/4W	32035-33210	3K32	1%	CORNING	RN55D 3.32KD	
R7070	RESISTOR MF 1/4W	32035-11320	11K3	1%	CORNING		1
R7071	RESISTOR MF 1/4W	32035-12410	1K24	1%	CORNING	1241F	
R7072	RESISTOR MF 1/4W	32035-33210	3K32	1%	CORNING	RN55D 3.32KD	
R7073	RESISTOR MF 1/4W	32035-19630	196K	1%	CORNING	1963F	1
R7074	RESISTOR CF 1/4W	32033-10040	1M0	5%	CORNING		1
R7075	RESISTOR CF 1/4W	32033-10010	1K	5%	CORNING	CF1/4 IKR	
R7076	RESISTOR CF 1/4W	32033-47030	470K	5%	CORNING		1
R7077	RESISTOR CF 1/4W	32033-10020	10K	5%	CORNING		
R7078	RESISTOR CF 1/4W	32033-10030	100K	5%	CORNING		
R7079	RESISTOR CF 1/4W	32033-15040	1M5	5%	CORNING		1
R7080	RESISTOR CF 1/4W	32033-10030	100K	5%	CORNING		2
RN7001	RESISTOR NETWORK 8PIN/7RES SIP	39087-33010	3K3 X 7		MURATA	4608X-101-332	1
U7001	SEMICON POS REG	25922-78152	15V		TI	78M15UC	1
U7002	SEMICON NEG REG	25922-79152			MO	79M15AUC	1
U7003	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	1
U7004	SEMICON COS QUAD ANALOG SWITCH	24021-21100			SILICONIX	DG211CJ	
U7005	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	
U7006	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	3
U7007	SEMICON AUDIO OP AMP	25211-33200			ANALOG SYSTEMS	MA332CP	
U7008	NOT USED						
U7008	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	4
U7009	NOT USED						
U7010	NOT USED						
U7011	NOT USED						
U7012	NOT USED						
U7014	SEMICON LSTTL HEX INVERTER	27743-74004				74LS04	2
U7015	SEMICON LSTTL QUAD NAND	27743-74000				74LS00	1
U7016	SEMICON LSTTL 4 BIT COMPARATOR	27743-74085				74LS85	1
U7017	SEMICON LSTTL 3 TO 8 DECODER	27743-74138				74LS138	
U7018	SEMICON CMOS 8-CH ANAL MULTIPL	24021-50800				DG508ACJ	
U7019	SEMICON CMOS QUAD ANAL SWITCH	24021-21100			SILICONIX	DG211CJ	
U7020	SEMICON CMOS QUAD ANAL SWITCH	24021-21100			SILICONIX	DG211CJ	
U7021	SEMICON CMOS 8-CH ANAL MULTIPL	24021-50800				DG508ACJ	2
U7022	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	
U7023	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	
U7024	SEMICON CMOS QUAD ANAL SWITCH	24021-21100			SILICONIX	DG211CJ	8
U7025	SEMICON LSTTL 3 TO 8 DECODER	27743-74138				74LS138	2
U7026	SEMICON LSTTL HEX D FF	27743-74174				74LS174	
U7027	SEMICON LSTTL HEX D FF	27743-74174				74LS174	2
U7028	SEMICON LSTTL HEX INVERTER	27743-74004				74LS04	
U7029	SEMICON CMOS QUAD ANAL SWITCH	24021-21100			SILICONIX	DG211CJ	
U7030	SEMICON CMOS QUAD ANAL SWITCH	24021-21100			SILICONIX	DG211CJ	
U7031	SEMICON CMOS QUAD ANAL SWITCH	24021-21100			SILICONIX	DG211CJ	
U7032	SEMICON OP AMP BI-FET DUAL	25111-07200			TI	TL-072CP	
U7033	SEMICON CMOS QUAD ANAL SWITCH	24021-21100			SILICONIX	DG211CJ	
VR7001	RESISTOR TRIM CONTROL ST SA	51515-10010	1K		BOURNS	3299X-1-102	1

CPU PCB ASSEMBLY . 5000-71004

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	CAPACITOR BUS BAR	49000-71170	0.33P		ROGERS	QV2-7.11.7.33	5
	PRINTED CIRCUIT BOARD	5000-41004			AMBER	5000-41004	1
	EJECTOR LATCH WHITE	65299-50052			THERMALLOY	5005-20N	1
	CONNECTOR SOCKET IC DIL	71008-20839	8 PIN		AUGAT	208-AG39D	1
	CONNECTOR SOCKET IC DIL	71014-21439	14PIN		AUGAT	214-AG39D	10
	CONNECTOR SOCKET IC DIL	71016-21639	16PIN		AUGAT	216-AG39D	7
	CONNECTOR SOCKET IC DIL	71020-22039	20PIN		AUGAT	220-AG39D	3
	CONNECTOR SOCKET IC DIL	71028-22839	28PIN		AUGAT	228-AG39D	7
	CONNECTOR SOCKET IC DIL	71040-24039	40PIN		AUGAT	240-AG39D	4
B1001	NOT USED						
C1001	CAPACITOR ELECT 100/25	48030-10000	100		SIEMENS	81000 100UF 25V	2
C1002	CAPACITOR CERAMIC DISC	41033-01800	18P		MURATA/ERIE		1
C1003	CAPACITOR TRIM CONTROL TOP ADJ	49000-53801	7-25		MURATA/ERIE	538011B725	1
C1004	CAPACITOR ELECT 100/25	48030-10000	100		SIEMENS	81000 100UF 25V	
C1005	CAPACITOR TANTALUM 4.7/25	47031-04790	4.7				1
C1006	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	10
C1007	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	
C1008	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	
C1009	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	
C1010	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	
C1011	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	
C1012	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	
C1013	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	
C1014	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	
C1015	CAPACITOR TANTALUM 10/25	47031-10000	10	20%	ITT	TAP 10M25	
C1016	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	22
C1017	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1018	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1019	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1020	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1021	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1022	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1023	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1024	CAPACITOR CERAMIC DISC	41033-00330	3.3P	20%	MURATA/ERIE		1
C1025	CAPACITOR CERAMIC DISC	41033-01000	10P		MURATA/ERIE		1
C1026	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1027	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1028	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1029	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1030	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1031	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1032	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1033	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1034	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1035	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1036	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1037	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1038	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C1039	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
D1001	SEMICON RECTIFIER	21135-40040			MOTOROLA	1N4004	5
D1002	SEMICON RECTIFIER	21135-40040			MOTOROLA	1N4004	
D1003	NOT USED	21135-40040			MOTOROLA	1N4004	
D1004	NOT USED	21135-40040			MOTOROLA	1N4004	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
D1005	SEMICON DIODE	21207-50000			MOTOROLA	MPTE 5	1
D1006	SEMICON RECTIFIER	21135-40040			MOTOROLA	1N4004	
L45	JUMPER						2
L50	JUMPER						
N1001	RESISTOR NETWORK 8 PIN 7RES SIP	39087-33010	3K3X7	5%	BOURNS	4608R-101-332	3
N1002	RESISTOR NETWORK 8 PIN 7RES SIP	39087-33010	3K3X7	5%	BOURNS	4608R-101-332	
N1003	RESISTOR NETWORK 8 PIN 7RES SIP	39087-33010	3K3X7	5%	BOURNS	4608R-101-332	
P1	CONNECTOR HEADER LP RT ANG	78006-52125	50PIN		RN	IDH-50LP-SR3-TG	1
P2	CONNECTOR HEADER LP RT ANG	78006-52122	20PIN		RN	IDH-20LP-SR3-TG	2
P3	NOT USED	78006-52122	20PIN		RN	IDH-20LP-SR3-TG	
P4	CONNECTOR HEADER LP RT ANG	78006-26000	26PIN		RN	IDH-26LP-SR3-TG	1
Q1001	NOT USED						
R1001	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	5
R1002	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	
R1003	RESISTOR CF 1/4W	32033-10030	100K	5%	ALLEN BRADLEY	CB1045	1
R1004	RESISTOR CF 1/4W	32033-27010	2K7	5%	ALLEN BRADLEY	CB2725	1
R1005	RESISTOR CF 1/4W	32033-33010	3K3	5%	ALLEN BRADLEY	CB3325	1
R1006	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	
R1007	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	
R1008	RESISTOR CF 1/4W	32033-22010	2K2	5%	ALLEN BRADLEY	CB2225	1
R1009	RESISTOR CF 1/4W	32033-47010	4K7	5%	ALLEN BRADLEY	CB4725	
U1001	SEMICON CMOS CLOCK GENERATOR	29003-72091			INTERSIL	ICM7209IPA	1
U1002	SEMICON SYCH 4 BIT COUNTER	27743-74161			MOTOROLA	SN74LS161AN	2
U1003	SEMICON CMOS MEMORY RAM 8KX8	26022-62641			HITACHI	HM6264P-12	2
U1004	SEMICON OCT BUS TRANS NON INVER	27743-74245			MOTOROLA	74LS245N	3
U1005	SEMICON PROG TIMER	29002-68400			MOTOROLA	MC68B40P	2
U1006	SEMICON DUART	29240-26810			SIGNETICS	SCN2681A	1
U1007	SEMICON IEEE 488 INTERFACE	29200-68488			MOTOROLA	MC68B488P	1
U1008	SEMICON CMOS MEMORY RAM 8KX8	26022-62641			HITACHI	HM6264P-12	
U1009	SEMICON OCT FLIP FLOP TRI	27743-74374			MOTOROLA	SN74LS374N	2
U1010	SEMICON PROG TIMER	29002-68400			MOTOROLA	MC68B40P	
U1011	SEMICON PERIF INTERFACE ADAPT	29200-68210			MOTOROLA	MC68B21P	1
U1012	SEMICON CPU	29002-68090			MOTOROLA	MC68B09	1
U1013	SEMICON MEMORY EPROM 27128	26022-27128			FUJ	27128G-25	2
U1014	SEMICON OCT FLIP FLOP TRI	27743-74374			MOTOROLA	SN74LS374N	
U1015	SEMICON QUAD 2 INPUT OR GATE	27741-74032			MOTOROLA	74F32N	1
U1016	SEMICON LSTTL 3 TO 8 DECODER	27743-74138			MOTOROLA	74LS138N	1
U1017	SEMICON DUAL 4BIT BIN COUNTER	27743-74393			MOTOROLA	SN74LS393N	1
U1018	SEMICON TTL DUAL D FLIP-FLOP	27743-74074			MOTOROLA	74LS74AN	1
U1019	SEMICON QUAD 2 INPUT NAND GATE	27743-74000			MOTOROLA	74LS00N	3
U1020	SEMICON CMO HI SPEED 3-8 DECOD	27741-74138			MOTOROLA	74F138N	1
U1021	SEMICON MEMORY EPROM 27128	26022-27128			FUJ	27128G-25	
U1022	SEMICON QUAD 2 INPUT NAND GATE	27743-74000			MOTOROLA	74LS00N	
U1023	SEMICON LSTTL HEX INVERTER	27741-74004			MOTOROLA	74F04N	1
U1024	SEMICON LSTTL HEX INVERTER OC	27743-74005			MOTOROLA	SN74LS05N	1
U1025	SEMICON SYCHRON 4BIT COUNTER	27743-74161			MOTOROLA	SN74LS161AN	
U1026	SEMICON QUAD 2 INPUT NAND GATE	27743-74000			MOTOROLA	74LS00N	
U1027	SEMICON LSTTL HEX INVERTER	27743-74004			MOTOROLA	74LS04N	1
U1028	SEMICON MEMORY BIPOLAR PROM	26022-27130			AMD	AM27S13APC	1
U1029	SEMICON MEMORY EPROM 250NS	26022-27256	256K			27256-25	1
U1030	SEMICON DUAL JK EDGE TRIG FLIP	27743-74112			MOTOROLA	SN74LS112AN	1
U1031	SEMICON LSTTL HEX BUS DRIVER	27743-74367			MOTOROLA	SN74LS367AN	2
U1032	NOT USED	27743-74367			MOTOROLA	SN74LS367AN	

CPU PCB ASSEMBLY 5000-71004

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
U1033	SEMICON QUAD 2 INPUT EX-OR	27743-74086			MOTOROLA	SN74LS86N	1
U1034	NOT USED	27743-74640			MOTOROLA	74LS640N	1
U1035	NOT USED	27743-74245			MOTOROLA	74LS245N	
U1036	NOT USED	27743-74245			MOTOROLA	74LS245N	
X1001	CRYSTAL	52001-80000	8MHZ		LAPTECH	AMBER-5500	1
X1002	CRYSTAL	52001-36864	3.686		SFE	3.6864MHZ-HC18	1

GPIB INTERFACE PCB ASSEMBLY 5000-78503

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CB2215	1
	HARNESS FLAT CABLE	5500-30002	26PIN		AMBER	5500-30002	1
	PRINTED CIRCUIT BOARD	5500-48503			AMBER	5500-48503	1
	INTERFACE BRACKET GPIB	5500-67602			AMBER	5500-67602	1
	MACHINE SCREW PHIL PH 6-32	61111-16032	5/16		VARIOUS	MS35206-227	2
	MACHINE LOCK WASHER IT	61520-93660	#6		VARIOUS	AN936-A6	2
	EJECTOR LATCH	65299-20000			R NUGENT	EL-2K	2
	CONNECTOR ACCESS KIT	71002-00000			AMP	552633-4	1
	CONNECTOR SOCKET IC DIL	71024-22439	24PIN		AUGAT	224-AG39D	2
C801	CAPACITOR ELECT 220/16	48020-22000	220	20%	SIEMENS		1
C802	CAPACITOR MONOLYTIC	42031-41000	0.1	20%	AVX	SR205E104MAA	2
C803	CAPACITOR MONOLYTIC	42031-41000	0.1		AVX	SR205E104MAA	
P801	HEADER RT ANG MALE	78006-26000	26PIN		R NUGENT	IDH-26K-SR3-TG	1
P802	CONNECTOR RT ANG FEMALE	76002-55279	24PIN		AMP	552791-1	1
U801	SEMICON BUS TRANSCIEVER	29200-34470			MOTOROLA	MC3447P	2
U802	SEMICON BUS TRANSCIEVER	29200-34470			MOTOROLA	MC3447P	

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	HARNESS	5500-30501	P5001		AMBER	5500-30501	1
	PRINTED CIRCUIT BOARD (MOTHER)	5500-45003			AMBER	5500-45003	1
	POWER AMP BRACKET	5500-60505			AMBER	5500-60505	1
	POWER AMP SHIELD	5500-65105			AMBER	5500-65105	1
	HEAT SINK STRIP	5500-65402			AMBER	5500-65402	1
	DAUGHTER PCB ASSY	5500-75505			AMBER	5500-75505	1
	MACHINE SCREW FH 4-40	61111-14031	5/16		VARIOUS	AN507-440-R5	2
	MACHINE SCREW FH 6-32	61113-16025	1/4		VARIOUS	AN507-632-R4	3
	MACHINE NUT HEX	61222-44000	4-40		VARIOUS	MS35649-242	2
	MACHINE NUT PC MOUNT	61260-63200	6-32		PEM	KF2-632-ET	3
	MACHINE FLAT WASHER	61510-14300	#4		VARIOUS	AN960-4	2
	MACHINE LOCK WASHER	61520-36400	#4		VARIOUS	AN936-A4	2
	INSULATOR STEP WASHER	61540-77210	TO-220		THERMALLOY	7721-7PPS	2
	INSULATOR MICA SHEET	61600-43779	TO-220		THERMALLOY	43-77-9	
	EJECTOR LATCH	65299-20810	GREEN		SCANBE	S208-1	2
	CONNECTOR SOCKET IC DIL	71008-20839	8 PIN		AUGAT	208-AG39D	
	CONNECTOR SOCKET IC DIL	71016-21639	16PIN		AUGAT	216-AG39D	11
	CONNECTOR SOCKET IC DIL	71020-22039	20PIN		AUGAT	220-AG39D	1
	CONNECTOR HEADER	78004-20410	4 PIN		MOLEX	22-10-2041	8
	FUSE CLIPS	85314-10206			LITTLEFUSE	102071:102068	1
C5002	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5003	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5004	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5005	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5006	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5015	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5036	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5037	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5038	CAPACITOR CERAMIC DISC	41033-31000	0.01	20%	MURATA/ERIE	TCD-103Z	1
C5039	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5040	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5041	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5042	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5043	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5049	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5050	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5051	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5052	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5053	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5054	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5055	CAPACITOR CERAMIC DISC	41033-02200	22P	20%	MURATA/ERIE	22PF100V	1
C5056	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5057	CAPACITOR ELECT 22/40	48050-02200	22	20%	SIEMENS	86200/22/40V	1
C5058	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5059	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5060	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
D5001	JUMPER INSTALLED						
D5002	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D5003	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D5004	SEMICON DIODE ZENER	21207-07551	7.5V			1N755A	
D5005	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	
D5006	SEMICON DIODE RECTIFIER	21135-40020			MOTOROLA	1N4002	4
D5007	SEMICON DIODE ZENER	21207-07551	7.5V			1N755A	2

POWER AMP PCB ASSEMBLY 5500-75005

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
D5013	SEMICON DIODE ZENER 1W	21207-47480	22V		MOT	1N4748ATR	1
D5026	JUMPER INSTALLED						
K5001	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	2
K5004	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
R5001	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CF1/4 1KR	2
R5002	RESISTOR CF 1/4W	32033-10010	1K	5%	ALLEN BRADLEY	CF1/4 1KR	
R5047	RESISTOR CF 1/4W	32033-10030	100K	5%	ALLEN BRADLEY		
R5048	RESISTOR MF 1/4W	32035-20020	20K0	1%	CORNING		
R5059	RESISTOR MF 1/4W	32035-20020	20K0	1%	CORNING		3
R5060	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING		2
R5063	RESISTOR MF 1/4W	32035-10020	10K0	1%	CORNING	RN55D 10KR	
R5064	RESISTOR MF 1/4W	32035-20020	20K0	1%	CORNING		
R5065	RESISTOR CF 1/4W	32033-10030	100K	5%	ALLEN BRADLEY		
RN5001	RESISTOR NET 8 PIN 7 RES SIP	39087-10020	10K X 7			4608X-101-103	2
RN5002	RESISTOR NET 8 PIN 7 RES SIP	39087-10020	10K X 7			4608X-101-103	
RN5003	RESISTOR NET 16 PIN 8 RES DIP	38165-10030	100K X8			4116R-001-104	1
RN5006	RESISTOR NET 16 PIN 8 RES DIP	38165-10020	10KX8			4116R-001-103	1
RN5007	RESISTOR NET 16 PIN 8 RES DIP	38165-20020	20KX8			4116R-001-203	1
T5001	TRANSFORMER AUDIO	53508-58510			HAMMOND	585G	1
U5001	SEMICON POS REGULATOR 15V	25922-78152	15V		TI	78M15UC	1
U5002	SEMICON NEG REG 15V	25922-79152	15V		MO	79M15AUC	1
U5003	SEMICON LSTTL 8BIT ADD LATCH	27743-74259			TI	SN74LS259N	1
U5004	SEMICON TRANSISTOR 7 ARRAY	29200-20030				ULN2003AN	2
U5005	SEMICON TRANSISTOR 7 ARRAY	29200-20030				ULN2003AN	
U5010	SEMICON LSTTL OCTAL D FF	27743-74273				74LS273	1
U5011	SEMICON LSTTL HEX D FF	27743-74174				74LS174	2
U5012	SEMICON LSTTL HEX D FF	27743-74174				74LS174	
U5013	SEMICON CMOS SWITCH	24021-40530			SIGNETICS	CD4053B	
U5014	SEMICON CMOS SWITCH	24021-40530			SIGNETICS	CD4053B	
U5015	SEMICON LSTTL 3 TO 8 DECODER	27743-74138				74LS138	1
U5016	SEMICON 4BIT COMPARATOR	27743-74085				74LS85	1
U5017	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	4
U5018	SEMICON CMOS SWITCH	24021-40530			SIGNETICS	CD4053B	
U5019	SEMICON CMOS SWITCH	24021-40530			SIGNETICS	CD4053B	4

POWER AMP DAUGHTER PCB ASSEMBLY 5500-75505

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
	PRINTED CIRCUIT BOARD	5500-45504			AMBER	5500-45504	1
	POWER AMP HEAT SINK BLOCK	5500-65203			AMBER	5500-65203	1
	POWER AMP DB POWER SHIELD	5500-65303			AMBER	5500-65303	1
	HARDWARE PEM NUT	61260-44000	4-40		PEM	KF2 440 ET	4
	HEAT SINK CUP	61800-26041	TO-92			2604SH18E	1
	CONNECTOR SOCKET IC DIL	71008-20839	8 PIN		AUGAT	208-AG39D	6
	CONNECTOR SOCKET PC BOTTOM ENT	78005-20420	4 PIN		MOLEX	22-17-2042	
	CONNECTOR HOUSING LATCH	78010-20450	4 PIN		MOLEX	20-01-2045	1
C5007	CAPACITOR CERAMIC DISC	41033-04700	47P	20%	MURATA/ERIE	GH470K	1
C5008	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5009	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	12
C5010	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5011	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5012	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5013	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5014	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5016	CAPACITOR CERAMIC DISC	41033-03300	33P	20%	MURATA/ERIE		1
C5017	CAPACITOR FILM	45042-44701	0.47	20%	WIMA	MKS3 0.47/63/20W	1
C5018	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	34
C5019	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5020	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5021	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5022	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5023	CAPACITOR CERAMIC DISC	41033-11500	150P	20%	MURATA/ERIE	DB201-Z5P150PF	2
C5024	CAPACITOR CERAMIC DISC	41033-00330	3P3	20%	MURATA/ERIE		1
C5025	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5026	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5027	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5028	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5029	CAPACITOR CERAMIC DISC	41033-01000	10P	20%	MURATA/ERIE	22PF100V	1
C5030	CAPACITOR CERAMIC DISC	41033-11500	150P	20%	MURATA/ERIE	DB201-Z5P150PF	
C5031	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5032	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5044	CAPACITOR FILM	45042-21500	1500P	10%	WIMA	FKC3 1500/160/10W	1
C5045	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5046	CAPACITOR MONOLYTHIC	42031-41000	0.1	20%	AVX	SR205E104MAA	
C5047	CAPACITOR ELECT 10/40	48050-01000	10	20%	SIEMENS	85200 10UF 40V	
C5048	CAPACITOR CERAMIC DISC	41033-01000	10P	20%	MURATA/ERIE	10PF100V:DC1-100J	1
C5067	CAPACITOR FILM	45042-42200	0.22	20%		MKS3 0.22 63 20	1
C5068	NOT USED						
C5069	NOT USED						
D5008	SEMICON DIODE ZENER	21207-09660				1N966BTR	
D5009	SEMICON DIODE RECTIFIER	21135-40010			MOTOROLA	1N4001	4
D5010	SEMICON DIODE RECTIFIER	21135-40010			MOTOROLA	1N4001	
D5011	SEMICON DIODE	21135-40010			MOTOROLA	1N4001	
D5012	SEMICON DIODE	21135-40010			MOTOROLA	1N4001	
D5014	SEMICON DIODE ZENER	21207-09660				1N966BTR	2
D5015	SEMICON DIODE ZENER	21207-47460				1N4746A	4
D5016	SEMICON DIODE ZENER	21207-47460	-			1N4746A	
D5017	SEMICON DIODE ZENER	21207-47460				1N4746A	
D5018	SEMICON DIODE ZENER	21207-47460				1N4746A	
J5001	CONNECTOR HEADER LATCH	78007-20410	4PIN		MOLEX	22-29-2041	1
J5002	CONNECTOR SOCKET PC BOT. ENTRY	78005-20420	4PIN		MOLEX	22-17-2042	

POWER AMP DAUGHTER PCB ASSEMBLY 5500-75505

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
J5003	CONNECTOR SOCKET PC BOT. ENTRY	78005-20420	4PIN		MOLEX	22-17-2042	8
J5004	CONNECTOR SOCKET PC BOT. ENTRY	78005-20420	4PIN		MOLEX	22-17-2042	
J5005	CONNECTOR SOCKET PC BOT. ENTRY	78005-20420	4PIN		MOLEX	22-17-2042	
J5006	CONNECTOR SOCKET PC BOT. ENTRY	78005-20420	4PIN		MOLEX	22-17-2042	
J5007	CONNECTOR SOCKET PC BOT. ENTRY	78005-20420	4PIN		MOLEX	22-17-2042	
K5002	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	10
K5003	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
K5005	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
K5006	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
K5007	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
K5008	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
K5009	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
K5010	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
K5011	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
K5012	RELAY 2 FORM C 18V	84801-18000			ITT	RY18W-K	
Q5001	SEMICON TRANSISTOR POWER NPN	22522-00700			MOTOROLA	MPSU07	3
Q5002	SEMICON TRANSISTOR NPN POWER	22622-15028			MOTOROLA	MJE15028	2
Q5003	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q5004	SEMICON TRANSISTOR NPN	22622-71800				2N718A	2
Q5005	SEMICON TRANSISTOR PNP POWER	22622-15029				MJE15029	2
Q5006	SEMICON TRANSISTOR PNP GP	22622-15029			MOTOROLA	MJE15029	
Q5007	SEMICON TRANSISTOR PNP POWER	22622-15029				2N4403	
Q5008	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	4
Q5009	SEMICON TRANSISTOR NPN	22622-71800				2N718A	
Q5010	SEMICON TRANSISTOR NPN POWER	22622-15028				MJE15028	
Q5011	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	4
Q5012	SEMICON TRANSISTOR PNP POWER	22622-05000			MOTOROLA	MPSU57	
Q5013	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q5014	SEMICON TRANSISTOR NPN POWER	22522-00700			MOTOROLA	MPSU07	
Q5015	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q5016	SEMICON TRANSISTOR NPN POWER	22522-00700			MOTOROLA	MPSU07	
Q5017	SEMICON TRANSISTOR NPN GP	22522-44010			MOTOROLA	2N4401	
Q5018	SEMICON TRANSISTOR PNP POWER	22622-05000			MOTOROLA	MPSU57	3
Q5019	SEMICON TRANSISTOR PNP GP	22622-44030			MOTOROLA	2N4403	
Q5020	SEMICON TRANSISTOR NPN POWER	22622-05000			MOTOROLA	MPSU57	
R5003	RESISTOR MF 1/4W	32035-30110	3K01	1%	CORNING	3011F	2
R5004	RESISTOR CF 1/4W	32033-12000	120	5%	ALLEN BRADLEY		1
R5005	RESISTOR CF 1/4W	32033-04970	4.7	5%	ALLEN BRADLEY		4
R5006	RESISTOR CF 1/4W	32033-04970	4.7	5%	ALLEN BRADLEY		
R5007	RESISTOR CF 1/4W	32033-04970	4.7	5%	ALLEN BRADLEY		
R5008	RESISTOR CF 1/4W	32033-04970	4.7	5%	ALLEN BRADLEY		
R5010	RESISTOR CF 1/4W	32033-10050	10M	5%	ALLEN BRADLEY		1
R5011	RESISTOR CF 1/4W	32033-10030	100K	5%	ALLEN BRADLEY	CF1/4 100KR	3
R5012	RESISTOR CF 1/4W	32033-10020	10K	5%	ALLEN BRADLEY		1
R5013	RESISTOR CF 1/4W	32033-20010	2K	5%	ALLEN BRADLEY		2
R5014	RESISTOR CF 1/4W	32033-02200	22	5%	ALLEN BRADLEY	CF1/4 22R	8
R5015	RESISTOR CF 1/4W	32033-12010	1K2	5%	ALLEN BRADLEY	CF1/4 1.2KR	2
R5016	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CF1/4 220R	8
R5017	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CF1/4 220R	
R5018	RESISTOR CF 1/4W	32033-02200	22	5%	ALLEN BRADLEY	CF1/4 22R	
R5019	RESISTOR CF 1/4W	32033-62000	620	5%	ALLEN BRADLEY		
R5020	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CF1/4 220R	
R5021	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CF1/4 220R	

POWER AMP DAUGHTER PCB ASSEMBLY 5500-75505

DESIG	DESCRIPTION	AMBER PART NUMBER	ELECT VALUE	TOL	MANUFACTURER	MANUFACTURER PART NUMBER	QTY USED
R5022	RESISTOR CF 1/4W	32033-02200	22	5%	ALLEN BRADLEY	CF1/4 22R	
R5023	RESISTOR CF 1/4W	32033-02200	22	5%	ALLEN BRADLEY	CF1/4 22R	1
R5024	RESISTOR CF 1/4W	32033-02200	22	5%	ALLEN BRADLEY	CF1/4 22R	
R5025	RESISTOR CF 1/4W	32033-62000	620	5%	ALLEN BRADLEY		2
R5026	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CF1/4 220R	
R5027	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CF1/4 220R	
R5028	RESISTOR CF 1/4W	32033-02200	22	5%	ALLEN BRADLEY	CF1/4 22R	
R5029	RESISTOR CF 1/4W	32033-12010	1K2	5%	ALLEN BRADLEY	CF1/4 1.2KR	
R5030	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CF1/4 220R	
R5031	RESISTOR CF 1/4W	32033-22000	220	5%	ALLEN BRADLEY	CF1/4 220R	
R5032	RESISTOR CF 1/4W	32033-02200	22	5%	ALLEN BRADLEY	CF1/4 22R	
R5033	RESISTOR CF 1/4W	32033-02200	22	5%	ALLEN BRADLEY	CF1/4 22R	
R5035	RESISTOR CF 1/4W	32033-15040	1M5	5%	ALLEN BRADLEY		1
R5036	RESISTOR CF 1/4W	32033-20010	2K	5%	ALLEN BRADLEY		
R5037	RESISTOR CF 1/4W	32033-82010	8K2	5%	ALLEN BRADLEY		
R5038	RESISTOR MF 1/4W	32040-81120	81K28	0.1%	CORNING		1
R5039	RESISTOR CF 1/4W	32033-15000	150	5%	ALLEN BRADLEY		
R5040	RESISTOR MF 1/4W	32040-25720	25K71	0.1%	CORNING		1
R5041	RESISTOR CF 1/4W	32033-15000	150	5%	ALLEN BRADLEY		2
R5042	RESISTOR MF 1/4W	32040-10020	10K00	0.1%	CORNING		2
R5043	RESISTOR MF 1/4W	32040-10020	10K00	0.1%	CORNING		
R5044	RESISTOR CF 1/4W	32033-82010	8K2	5%	ALLEN BRADLEY		2
R5046	RESISTOR MF 1/4W	32035-10020	10K00	1%	CORNING		1
R5049	RESISTOR MF 2W	34065-05000	50.00	0.1%			
R5050	RESISTOR MF 1/2W	32050-50000	500.0	0.1%			
R5051	RESISTOR MF 1/4W	32040-06200	62.00	0.1%	CORNING		
R5052	RESISTOR MF 1/4W	32040-49400	494.0	0.1%	CORNING		6
R5053	RESISTOR MF 1/4W	32040-06100	61.13	0.1%	CORNING		
R5054	RESISTOR MF 1/4W	32040-06100	61.13	0.1%	CORNING		
R5055	RESISTOR MF 1/4W	32040-49400	494.0	0.1%	CORNING		
R5056	RESISTOR MF 1/4W	32040-05500	55.00	0.1%	CORNING		
R5057	RESISTOR MF 1/4W	32040-49400	494.0	0.1%	CORNING		
R5058	RESISTOR MF 1W	32050-25000	250.0	0.1%	CONSTANTA		2
R5061	RESISTOR MF 1W	32060-02500	25.00	0.1%	CONSTANTA		2
R5062	RESISTOR MF 1W	32060-02500	25.0	0.1%	CONSTANTA		
R5066	RESISTOR MF 1/2W	32050-50000	500.0	0.1%			2
R5067	RESISTOR MF 2W	34065-05000	50.00	0.1%			2
R5068	RESISTOR MF 1/4W	32040-06200	62.00	0.1%	CORNING		2
R5069	RESISTOR MF 1/4W	32040-49400	494.0	0.1%	CORNING		
R5070	RESISTOR MF 1/4W	32040-49400	494.0	0.1%	CORNING		
R5071	RESISTOR MF 1/4W	32040-06100	61.13	0.1%	CORNING		
R5072	RESISTOR MF 1/4W	32040-06100	61.13	0.1%	CORNING		4
R5073	RESISTOR MF 1W	32050-25000	250.0	0.1%	CONTANTA		
R5074	RESISTOR MF 1/4W	32040-49400	494.0	0.1%	CORNING		
R5075	RESISTOR MF 1/4W	32040-05500	55.00	0.1%	CORNING		2
U5006	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U5007	SEMICON BI-FET OP AMP	25111-07100				TL-071CP	1
U5008	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
U5009	SEMICON OP AMP LO NOISE LIN	25311-55340			SIGNETICS	NE5534AN	
VR5001	RESISTOR TRIM CONTROL MT TA	51516-20000	200			3299W-1-201	1

AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

OWNER'S MANUAL

SECTION 8

TECHNICAL DOCUMENTATION

Issue 08 January 1989

TECHNICAL DOCUMENTS

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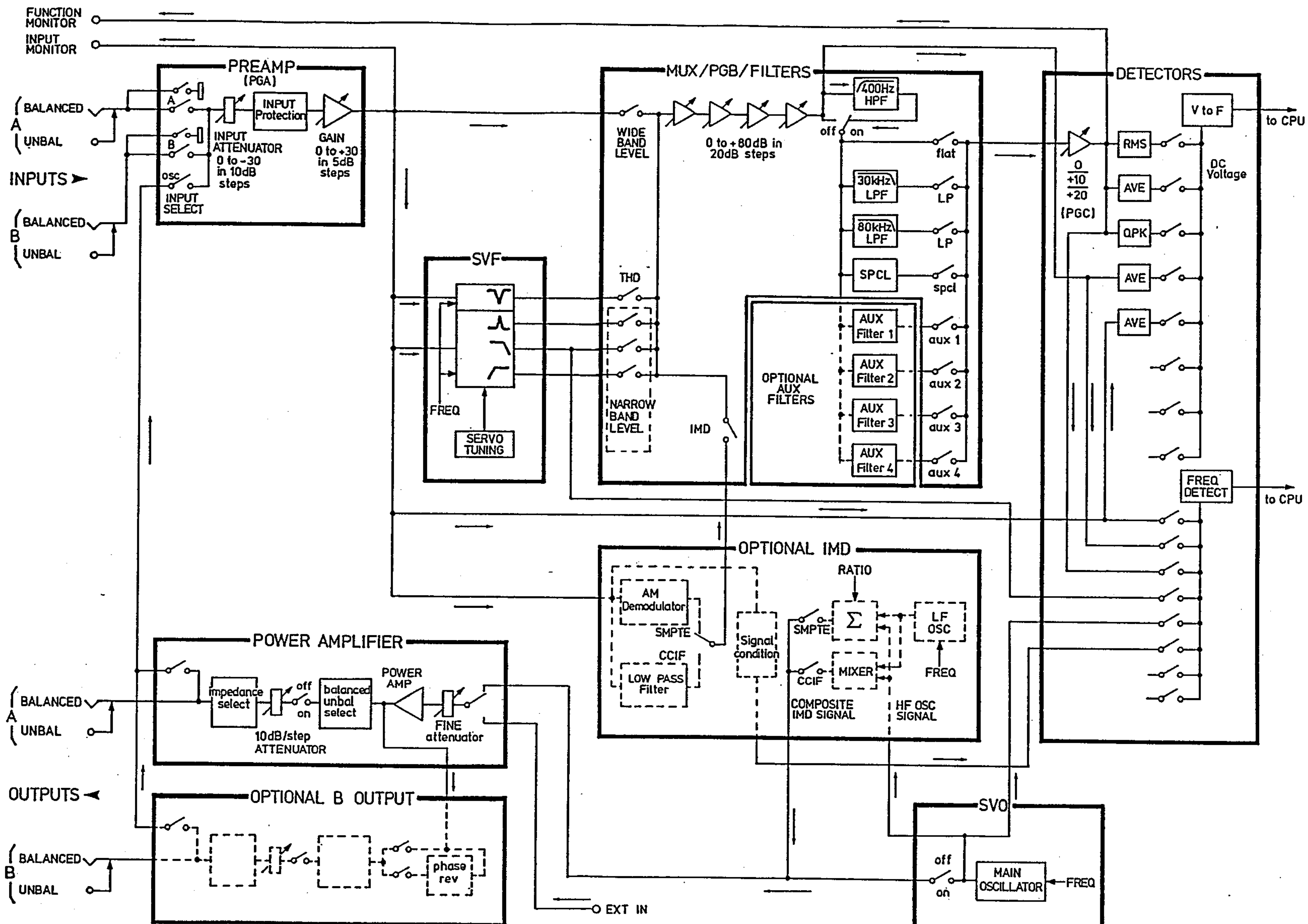
BOARDS



Amber model 5500
Programmable Distortion & Noise Measuring System
FUNCTIONAL BLOCK DIAGRAM

8.1 GLOSSARY

ADDR Addressed. Indicates that the 5500 has been addressed over the GPIB interface. (An IEEE-488 mnemonic)

ASCII American Standard Convention for Information Interchange. Defines an 7-bit code for each of up to 128 characters to facilitate data exchange between devices.

AVE Average. A measurement of the time weighted average of the absolute value of an AC signal. Most older analog meters yield the average detected, rms calibrated value of AC signals and this 5500 detector has been included to allow correlation of these measurements.

BNC Bayonet Connector. A coaxial 2-terminal connector used to connect single ended (unbalanced) signals between the 5500 and external devices.

BP Band Pass (filter). Usually refers to the band pass filter mode of the Narrow Band Level function of the 5500 or the actual filter (SVF) that achieves the function.

CCIF Comite Consultatif International Telephonique. An organization that has defined a method for IMD measurement that uses two frequencies of equal amplitude and closely spaced as the test signal. The 5500 measures the even order products (or difference frequency) and expresses this as a ratio of the amplitude of either of the two test signals. Also called DIFFERENCE FREQUENCY DISTORTION (DFD).

CCITT Comite Consultatif International Telephonique et Telegraphique. A European based standards organization that specifies a number of methods of audio measurement. The related specifications here are P-53A Psophometric and P-53B Program that are used in telecommunications and communications applications.

CCIR International Radio Consultation Committee. A European based standards organization that specifies a number of methods of audio measurement. The relative specification here is 468-3 which specifies a noise weighting curve, detection characteristic and measurement method.

CLR Clear. May either be the GPIB SDC or DCL command or the front panel Clear key. (An IEEE-488 mnemonic)

CPU Central Processing Unit. Usually refers to the heart of a computer system. In the case of the 5500, refers to the particular integrated circuit and support circuits that form the internal computer.

CR Carriage Return. A code generally used to conclude a series of characters in a data transmission.

CRT Cathode Ray Tube. Generally refers to a computer terminal or display device connected to the serial (RS232) interface.

dBm Decibels referenced to 1 milliWatt. The ratio in dB of a measured signal level to a reference signal that produces 1 mW of power. Strictly speaking, a power measurement, but the 5500, like all voltmeters or signal level meters, measures signal level in Volts and, using an impedance reference, calculates an implied power and expresses this power as a dB ratio to 1 mW. If the reference impedance is 600 ohms, the voltage for 0 dBm is 775 mV. Sometimes called dBu.

dBV Decibels referred to 1 Volt. The ratio in dB of a measured signal level to a reference signal level of 1 Volt. Numerically the same as dBm if the reference impedance is 1000 ohms.

DCE Data Communications Equipment. One of the two configurations that the RS232 interface may take. Usually the controlling equipment (e.g. modem or CPU) assumes the role of DCE. The 5500 may be set to the DCE configuration. See also DTE.

DF Difference Frequency. The numeric difference between the two high frequency components of the CCIF IMD composite test signal. See also OF.

DIN Deutsches Institut fur Normung. An organization that specifies a number of methods of audio measurements. The particular reference here is an IMD method, similar to the SMPTE method, but using frequencies of 50 Hz and 8 kHz.

DTE Data Terminal Equipment. One of two configurations that the RS232 interface may take. Usually the peripheral equipment assumes the role of DTE. The 5500 may be set to the DTE configuration. See also DCE.

GND Ground. The low or reference terminal of a signal connector. The 5500 has several separate grounds: chassis/mains ground, analyzer ground, oscillator ground, digital ground, communications ground.

GPIB General Purpose Interface Bus. An industry standard method for communications between instruments and computers. Techniques, protocol, and physical implementation are defined in the IEEE-488 standard.

HF High Frequency. Refers to the higher frequency component of the SMPTE or DIN IMD composite test signal. (Example : 7 kHz)

HPF High Pass Filter. A band limiting or noise weighting filter that has a flat unity gain response above a defined cutoff frequency with a constant slope (i.e. constant dB per octave) roll-off with decreasing frequency below the cutoff.

IEEE-488 Institute of Electrical and Electronic Engineers Standard no. 488. A definition of the GPIB interface. See GPIB.

I/O Input and/or Output. Generally used to define ports.

IMD Intermodulation Distortion. Distortion produced by the non- linearities in a device under test shown by the interaction of a composite two-frequency test signal. The output of the device under test contains, in addition to the original composite twin tone test signal, additional distortion components at frequencies mathematically related to the frequencies of the test signal (example, distortion products will appear at the sum and difference of the original test signal).

INCR Increment. The amount the frequency or amplitude is changed when the UP or DOWN button is pushed.

LCL (Return to Local). A GPIB command. When the 5500 LCL button is pushed, the front panel is again reactivated (if the instrument is not in local lockout state).

LF Low Frequency. Refers to the lower frequency component of the SMPTE or DIN IMD composite test signal. (Example : 60 Hz)

LF Linefeed. A code use to advance a printer or other device after completion of a series of characters in a data transmission.

LIN Linear. Refers to a certain class of measurement units used in the 5500: Volts, Watts, percent.

LLO Local Lock Out. A GPIB command. When the 5500 is in the LLO + REM mode, the front panel is inoperative. Control is then via the GPIB interface.

LPF Low Pass Filter. A band limiting or noise weighting filter that has a flat unity gain response up to the cutoff frequency then a constant slope (i.e. constant dB per octave) roll-off with increasing frequency.

LOG Logarithmic. Refers to a certain class of measurement units used in the 5500: dB, dBm, dBV.

NBL Narrow Band Level. Signal level in a limited bandwidth. The band width is defined by the Band Pass, Low Pass or High Pass filter in the 5500 with center or cutoff frequency defined by the user.

OF Offset Frequency. One half the difference between the two test frequencies of the CCIF IMD composite signal or the offset from the mean of the two frequencies. Example, if the two frequencies are 14 kHz and 15 kHz, the mean is 14.5 kHz. The offset is 500 Hz and the difference is 1 kHz.

OSC Oscillator. Refers to the sine wave signal source in the 5500. May also be called the generator although generator usually comprises both the oscillator and the output power amplifier and attenuator.

PGA Programmable Gain A. The input section of the 5500 receiver or analyzer. The gain (or loss) of this stage is programmed by the computer in the 5500. See the block diagram in the technical section.

PGB Programmable Gain B. An intermediate gain stage in the 5500 analyzer. PGB follows PGA and the SVF, if selected. It provides signal gain to boost low signal levels to an appropriate level for the detectors.

PGC Programmable Gain C. In the same path as PGB. PGB feeds any weighting filters that may be selected and PGC follows the weighting filters to make up any signal level lost in the filters before presentation to the detectors.

QPK Quasi-Peak. A signal level detector that measures the highest peak level of a time varying signal but with a finite attack time and slow release time to give some averaging to the measurement. Quasi- peak time constants are defined by the CCIR-468-3 standard.

RAM Random Access Memory. Computer accessed memory that may be periodically read and modified by the computer when necessary.

RCL Recall. The process of recalling a previously stored state of the 5500 from non-volatile memory.

REM Remote. A GPIB command. When the REM indication is illuminated in the front panel GPIB area, the 5500 is able to receive and accept commands via its GPIB interface. The front panel is inoperative except for the LCL and CLR keys (unless LWLS).

rms Root Mean Square. A measurement of the effective value of a time varying (i.e. AC) signal. The 5500 uses a "true rms" detector to measure signal level.

RS232 Serial Interface Standard (EIA). Defines certain characteristics for industry standard communications interface. The 5500 can be set to implement most of the variations of the standard.

RTS Ring-tip-sleeve. A telephone style 3-conductor connector used to connect differential (balanced) signals between the 5500 and external devices. Also, related to RS232 "request to send" mnemonic.

SMPTE Society of Motion Picture and Television Engineers. An organization that has, among other activities, defined a particular IMD measurement technique and test frequencies: 7 kHz and 60 Hz mixed in a 1 to 4 amplitude ratio.

SPCL Special. Usually refers to the Special Functions on the 5500. These are set-up or seldom used parameters and configurations inside the 5500 that are changed by entering a SPCL FNCT code. May also refer to a not defined noise weighting filter (SPCL FIL).

SRQ Service Request or Request for Service. A GPIB command.

STO Store. The process of placing the status of the 5500 in a non- volatile memory.

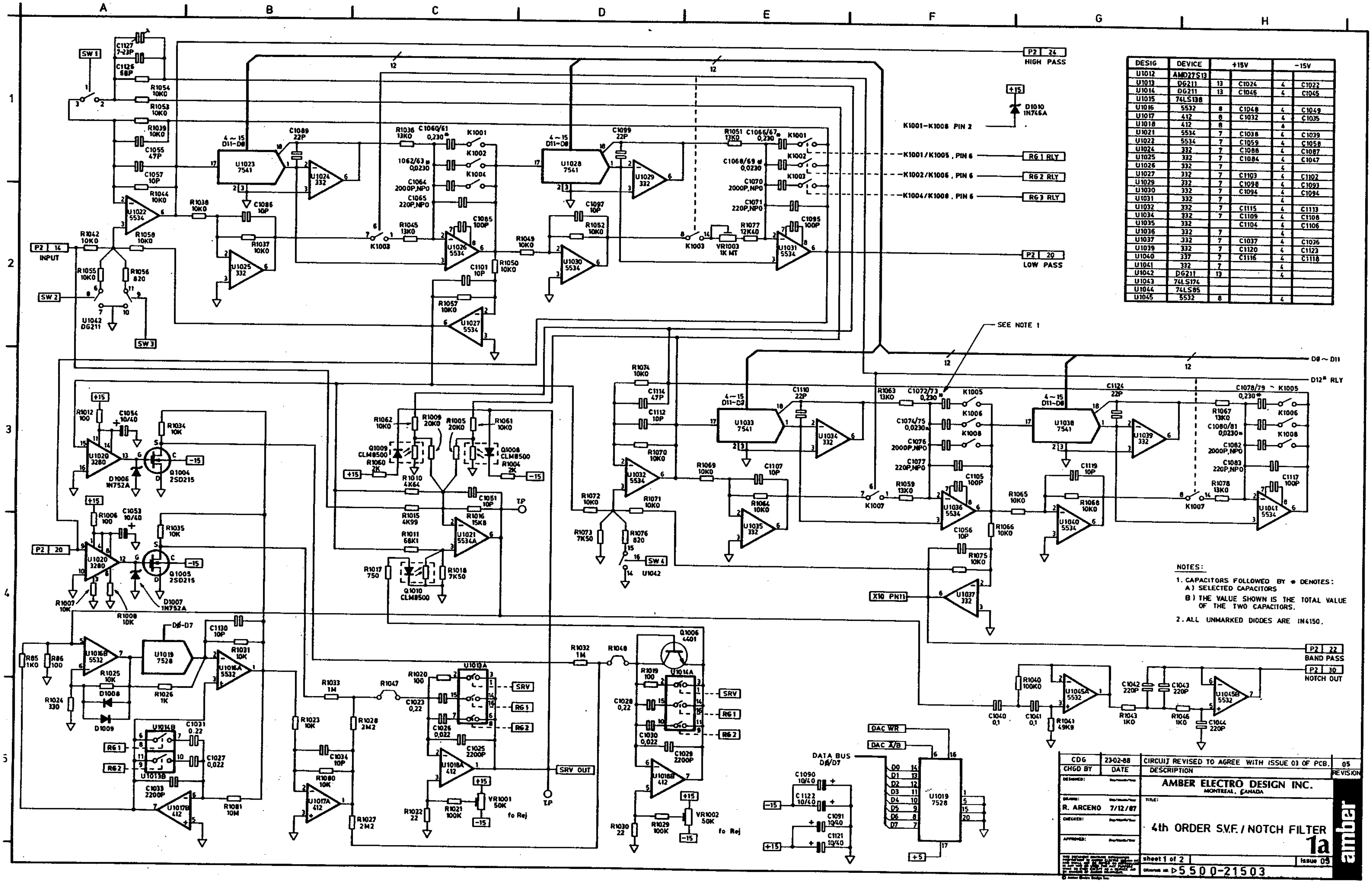
SVF State Variable Filter. Programmable filter in the 5500 analyzer used for the notch function in THD and the band pass, low pass, and high pass functions in Narrow Band Level.

SVO State Variable Oscillator. Primary programmable oscillator in the 5500 generator section.

THD Total Harmonic Distortion. A measurement of the rms sum of all harmonics of a signal as a ratio of the fundamental.

THD+N Total Harmonic Distortion plus Noise. A measurement of the rms sum of all harmonics and noise of a signal within the measurement bandwidth as a ratio of the fundamental.

SCHEMATICS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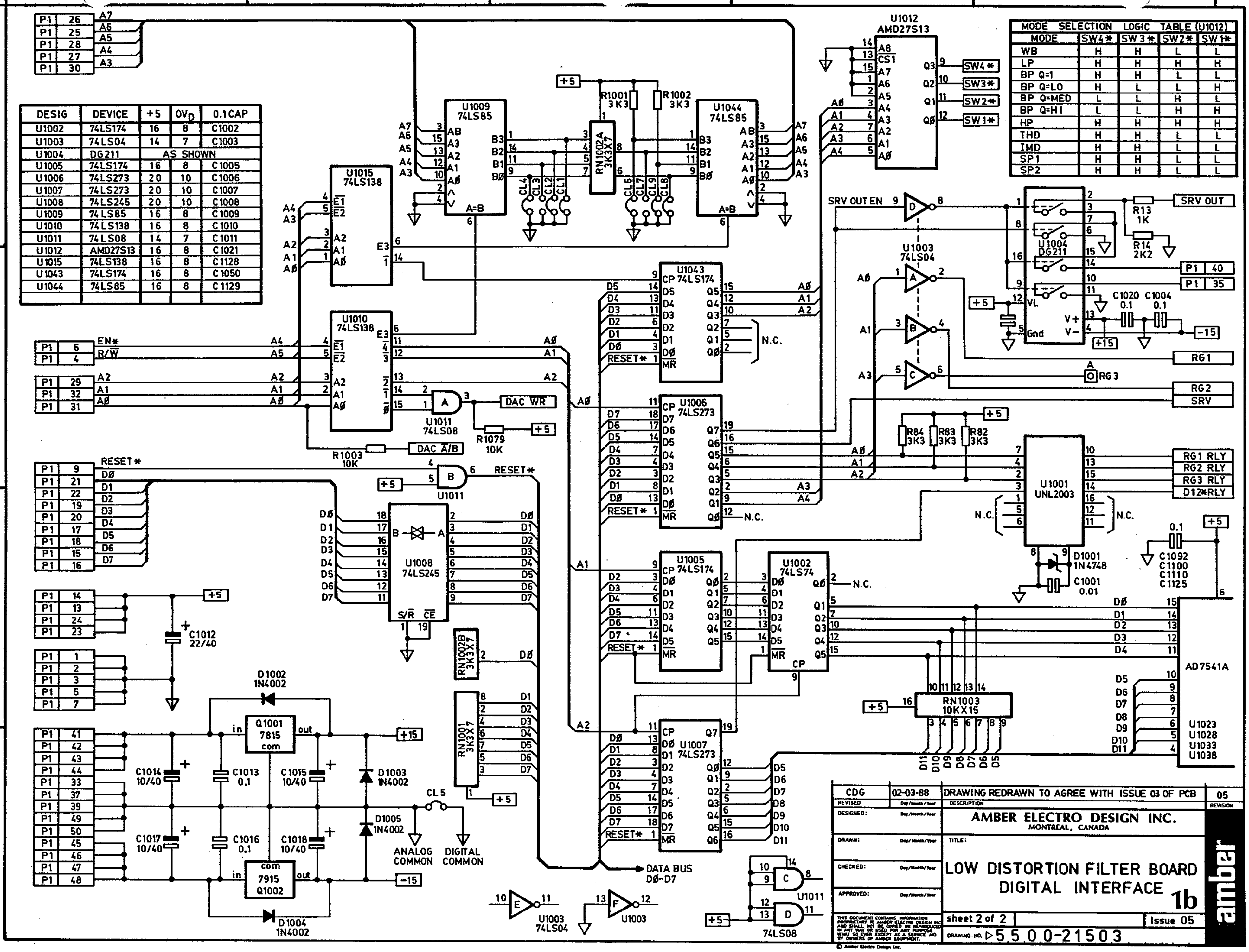
P2 20 LOW PASS
P2 14 INPUT
P2 22 BAND PASS
P2 30 NOTCH OUT
R61 RLY
R62 RLY
R63 RLY
K1001–K1008 PIN 2
K1001/K1005 , PIN 6
K1002/K1006 , PIN 6
K1004/K1008 , PIN 6
SEE NOTE 1
D0 ~ D11
D12* RLY
DATA BUS D0/D7
DAC WR
DAC A/B
SRV OUT
NOTES:
1. CAPACITORS FOLLOWED BY * DENOTES:
A) SELECTED CAPACITORS
B) THE VALUE SHOWN IS THE TOTAL VALUE OF THE TWO CAPACITORS.
2. ALL UNMARKED DIODES ARE IN4150.
CDG 23-02-88 CIRCUIT REVISED TO AGREE WITH ISSUE 03 OF PCB. 05
CHGD BY DATE DESCRIPTION REVISION
AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA
R. ARCENO 7/12/87
4th ORDER S.V.F. / NOTCH FILTER
1a
amber
sheet 1 of 2
Issue 05
5500-21503



MODE	SW4*	SW3*	SW2*	SW1*
WB	H	H	L	L
LP	H	H	H	H
BP Q=1	H	H	L	L
BP Q=LO	H	L	L	H
BP Q=MED	L	L	H	L
BP Q=HI	L	L	H	H
HP	H	H	H	H
THD	H	H	L	L
IMD	H	H	L	L
SP1	H	H	L	L
SP2	H	H	L	L

MODE SELECTION LOGIC TABLE (U1012)

DESIG	DEVICE	+5	$0V_D$	0.1 CAP
U1002	74LS174	16	8	C1002
U1003	74LS04	14	7	C1003
U1004	DG211	AS SHOWN		
U1005	74LS174	16	8	C1005
U1006	74LS273	20	10	C1006
U1007	74LS273	20	10	C1007
U1008	74LS245	20	10	C1008
U1009	74LS85	16	8	C1009
U1010	74LS138	16	8	C1010
U1011	74LS08	14	7	C1011
U1012	AMD27S13	16	8	C1021
U1015	74LS138	16	8	C1128
U1043	74LS174	16	8	C1050
U1044	74LS85	16	8	C1129

REVISED	Day/Month/Year	DESCRIPTION	REVISION
CDG	02-03-88	DRAWING REDRAWN TO AGREE WITH ISSUE 03 OF PCB	05

DESIGNED: Day/Month/Year

DRAWN: Day/Month/Year

CHECKED: Day/Month/Year

APPROVED: Day/Month/Year

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

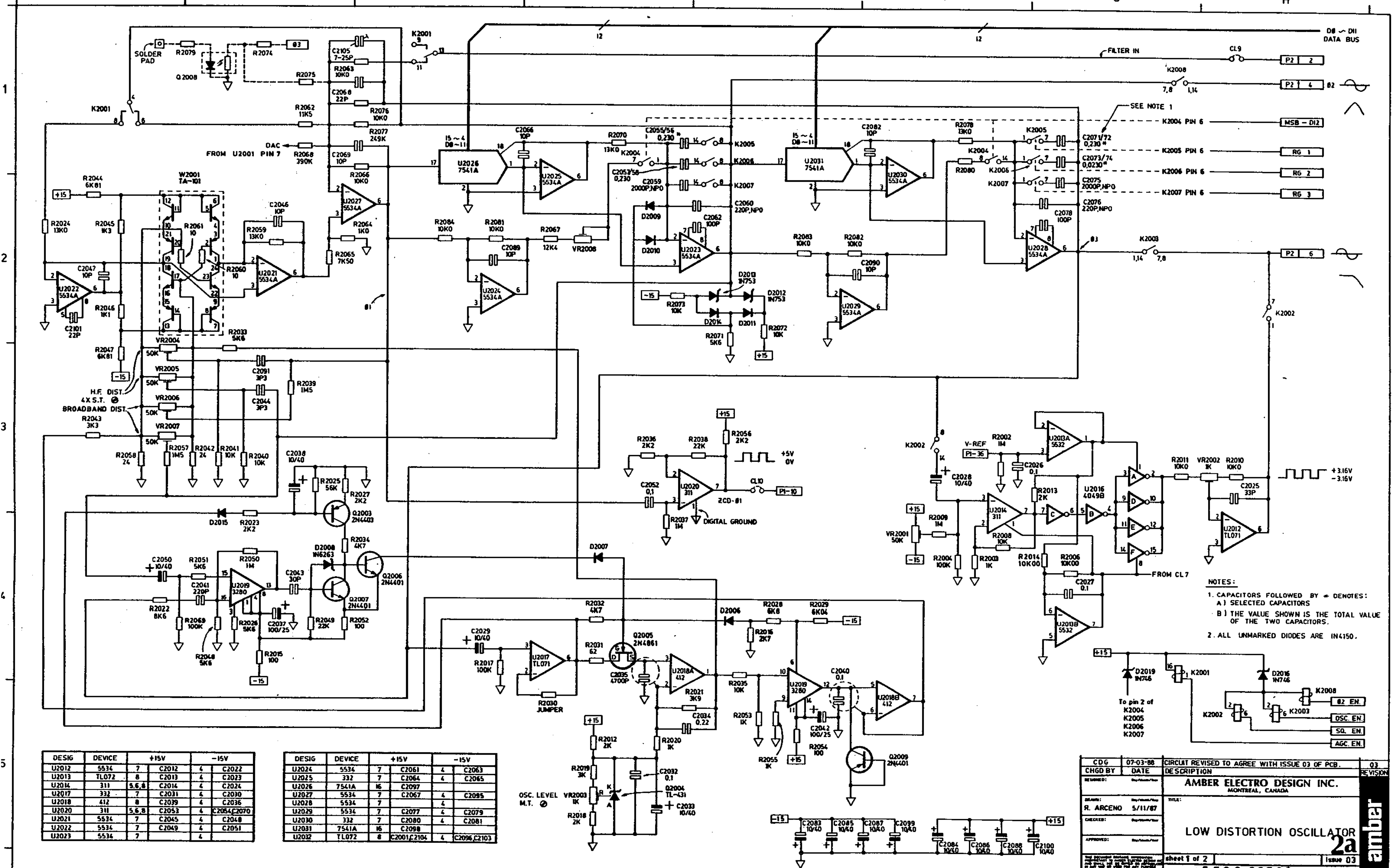
TITLE:

LOW DISTORTION FILTER BOARD DIGITAL INTERFACE 1b

sheet 2 of 2 | Issue 05

DRAWING NO. ▷ 5500-21503

amber



NOTES:

1. CAPACITORS FOLLOWED BY * DENOTES:
   A) SELECTED CAPACITORS
   B) THE VALUE SHOWN IS THE TOTAL VALUE OF THE TWO CAPACITORS.
2. ALL UNMARKED DIODES ARE IN4150.

DESIG	DEVICE	+15V		-15V	
U2012	5534	7	C2012	4	C2022
U2013	TL072	8	C2013	4	C2023
U2014	311	5,6,8	C2014	4	C2024
U2017	332	7	C2031	4	C2030
U2018	412	8	C2039	4	C2036
U2020	311	5,6,8	C2053	4	C2054,C2070
U2021	5534	7	C2045	4	C2048
U2022	5534	7	C2049	4	C2051
U2023	5534	7		4	

DESIG	DEVICE	+15V		-15V	
U2024	5534	7	C2061	4	C2063
U2025	332	7	C2064	4	C2065
U2026	7541A	16	C2097		
U2027	5534	7	C2067	4	C2095
U2028	5534	7		4	
U2029	5534	7	C2077	4	C2079
U2030	332	7	C2080	4	C2081
U2031	7541A	16	C2098		
U2032	TL072	8	C2001,C2104	4	C2096,C2103

CDG	07-03-88	CIRCUIT REVISED TO AGREE WITH ISSUE 03 OF PCB.	03
CHGD BY	DATE	DESCRIPTION	REVISION

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

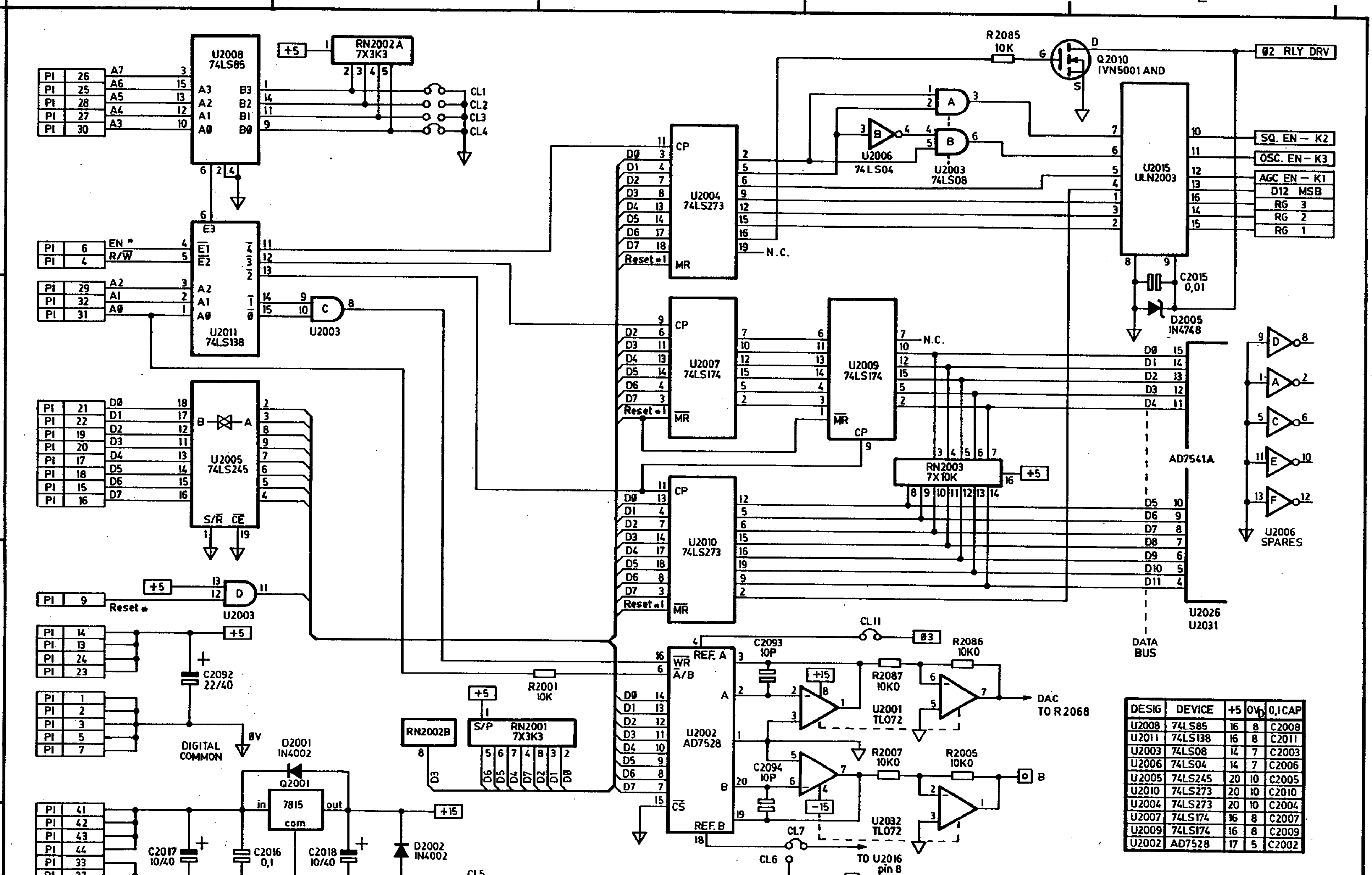
DRAWN: R. ARCENO 5/11/87

TITLE: LOW DISTORTION OSCILLATOR 2a

sheet 1 of 2 — Issue 03

DRAWING NO. ▷5 500-22503

amber



DESIG	DEVICE	+5	ØV	0,1 CAP
U2008	74LS85	16	8	C2008
U2011	74LS138	16	8	C2011
U2003	74LS08	14	7	C2003
U2006	74LS04	14	7	C2006
U2005	74LS245	20	10	C2005
U2010	74LS273	20	10	C2010
U2004	74LS273	20	10	C2004
U2007	74LS174	16	8	C2007
U2009	74LS174	16	8	C2009
U2002	AD7528	17	5	C2002

CHGD BY	DATE	DESCRIPTION	REVISION
CDG	07-03-88	CKT RVSD TO AGREE WITH ISS. 03 OF PCB	03

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

DESIGNED: Day/Month/Year
DRAWN: R. ARCENO 5/11/87
CHECKED: Day/Month/Year
APPROVED: Day/Month/Year

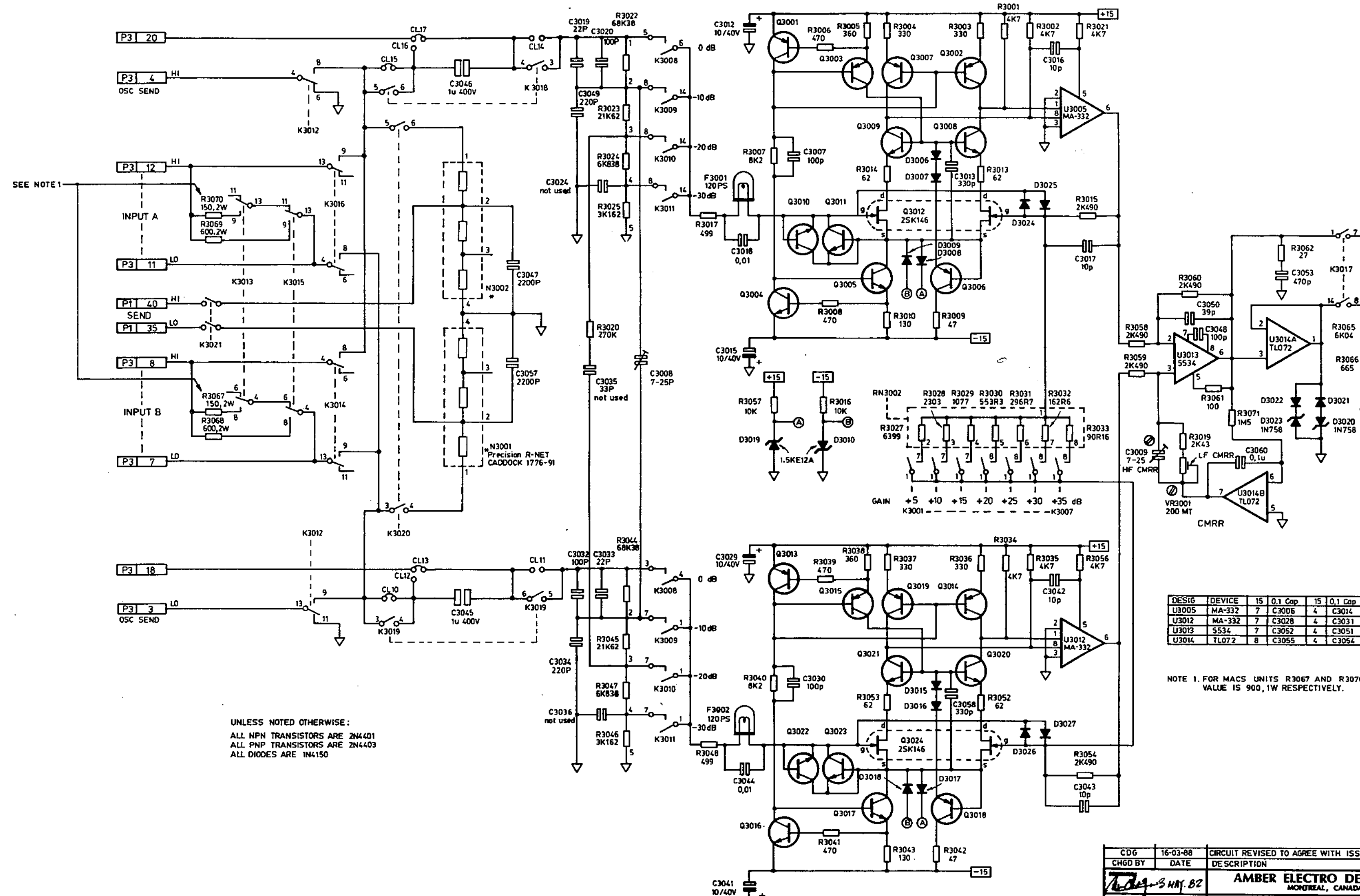
TITLE: LOW DISTORTION OSCILLATOR DIGITAL INTERFACE

2b

sheet 2 of 2 — Issue 03

DRAWING NO. ▷5 500-22503

amber



DESIG	DEVICE	15	0,1 Cap	15	0,1 Cap
U3005	MA-332	7	C3006	4	C3014
U3012	MA-332	7	C3028	4	C3031
U3013	5534	7	C3052	4	C3051
U3014	TL072	8	C3055	4	C3054

NOTE 1. FOR MACS UNITS R3067 AND R3070 VALUE IS 900, 1W RESPECTIVELY.

UNLESS NOTED OTHERWISE:
ALL NPN TRANSISTORS ARE 2N4401
ALL PNP TRANSISTORS ARE 2N4403
ALL DIODES ARE 1N4150

CHGD BY	DATE	DESCRIPTION	REVISION
CDG	16-03-88	CIRCUIT REVISED TO AGREE WITH ISSUE 05 OF P.C.B.	04

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

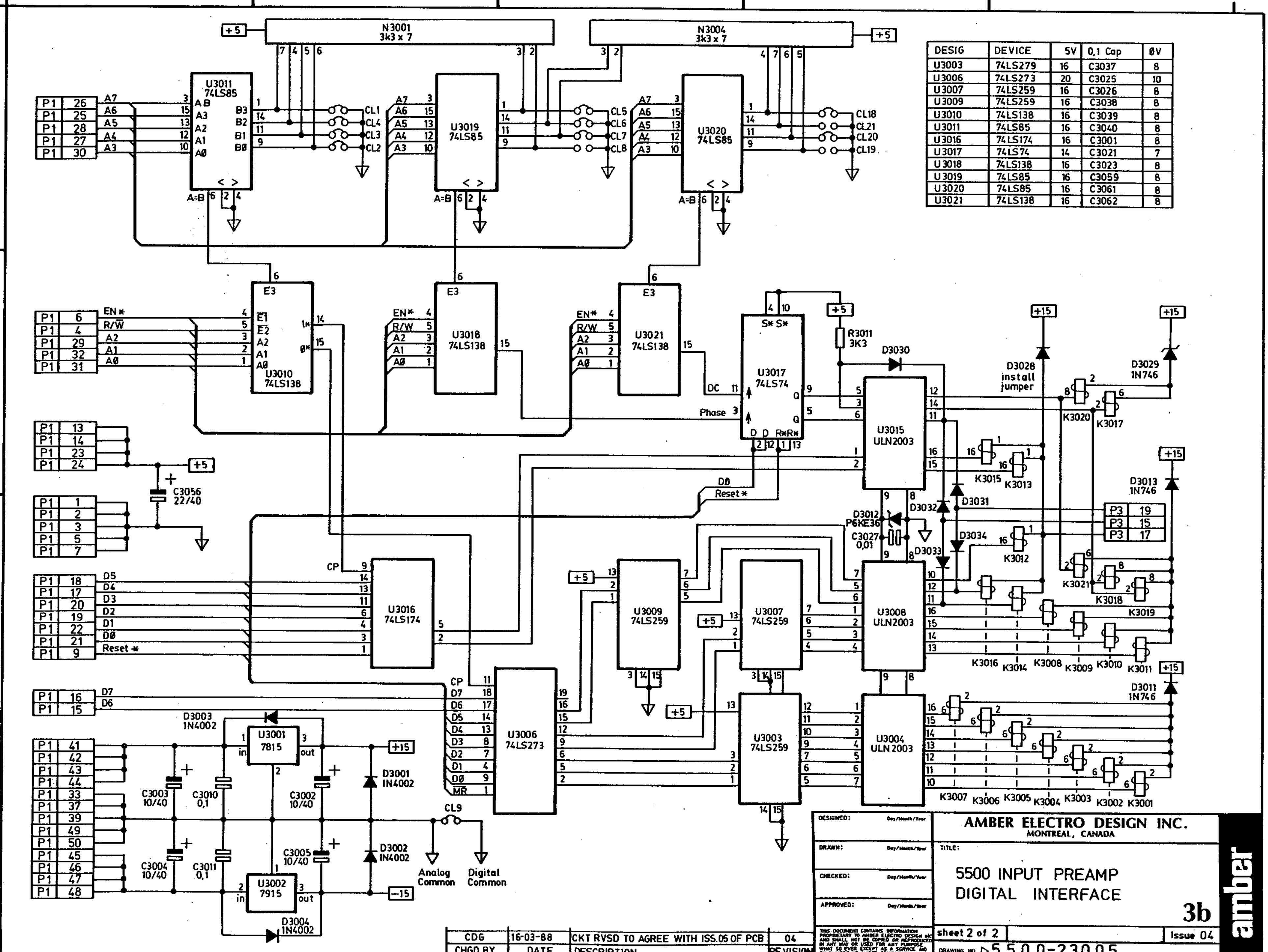
3 MAY 82
V. GOBUYAN 17/07/85
12/10/85

TITLE: 5500 INPUT ATTENUATOR AND PREAMPLIFIER

3a

amber

sheet 1 of 2
Issue 04
5500-23005



DESIG	DEVICE	5V	0,1 Cap	0V
U3003	74LS279	16	C3037	8
U3006	74LS273	20	C3025	10
U3007	74LS259	16	C3026	8
U3009	74LS259	16	C3038	8
U3010	74LS138	16	C3039	8
U3011	74LS85	16	C3040	8
U3016	74LS174	16	C3001	8
U3017	74LS74	14	C3021	7
U3018	74LS138	16	C3023	8
U3019	74LS85	16	C3059	8
U3020	74LS85	16	C3061	8
U3021	74LS138	16	C3062	8

CDG	16-03-88	CKT RVSD TO AGREE WITH ISS.05 OF PCB	04
CHGD BY	DATE	DESCRIPTION	REVISION

DESIGNED: Day/Month/Year
DRAWN: Day/Month/Year
CHECKED: Day/Month/Year
APPROVED: Day/Month/Year

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

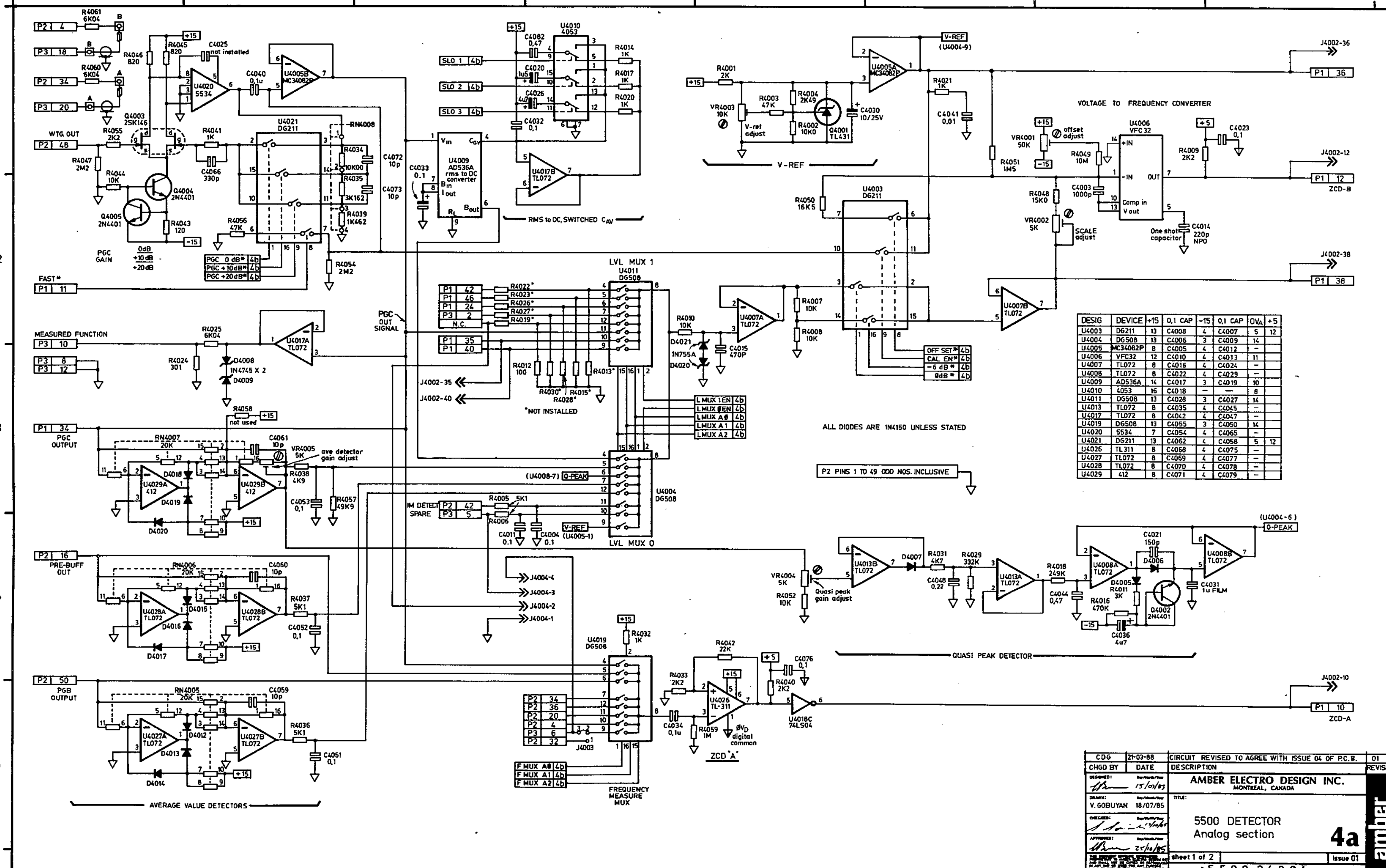
TITLE:
5500 INPUT PREAMP
DIGITAL INTERFACE

3b

sheet 2 of 2 | Issue 04

DRAWING NO. ▷5500-23005

amber



DESIG	DEVICE	+15	0,1 CAP	-15	0,1 CAP	OV_A	+5
U4003	DG211	13	C4008	4	C4007	5	12
U4004	DG508	13	C4006	3	C4009	14	
U4005	MC34082P	8	C4005	4	C4012	–	
U4006	VFC32	12	C4010	4	C4013	11	
U4007	TL072	8	C4016	4	C4024	–	
U4008	TL072	8	C4022	4	C4029	–	
U4009	AD536A	14	C4017	3	C4019	10	
U4010	4053	16	C4018	–	—	8	
U4011	DG508	13	C4028	3	C4027	14	
U4013	TL072	8	C4035	4	C4045	–	
U4017	TL072	8	C4042	4	C4047	–	
U4019	DG508	13	C4055	3	C4050	14	
U4020	5534	7	C4054	4	C4065	–	
U4021	DG211	13	C4062	4	C4058	5	12
U4026	TL311	8	C4068	4	C4075	–	
U4027	TL072	8	C4069	4	C4077	–	
U4028	TL072	8	C4070	4	C4078	–	
U4029	412	8	C4071	4	C4079	–	

CHGD BY	DATE	DESCRIPTION	REVISION
CDG	21-03-88	CIRCUIT REVISED TO AGREE WITH ISSUE 04 OF P.C.B.	01

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

DESIGNED: 15/01/85
DRAWN: V. GOBUYAN 18/07/85
CHECKED:
APPROVED: 25/10/85

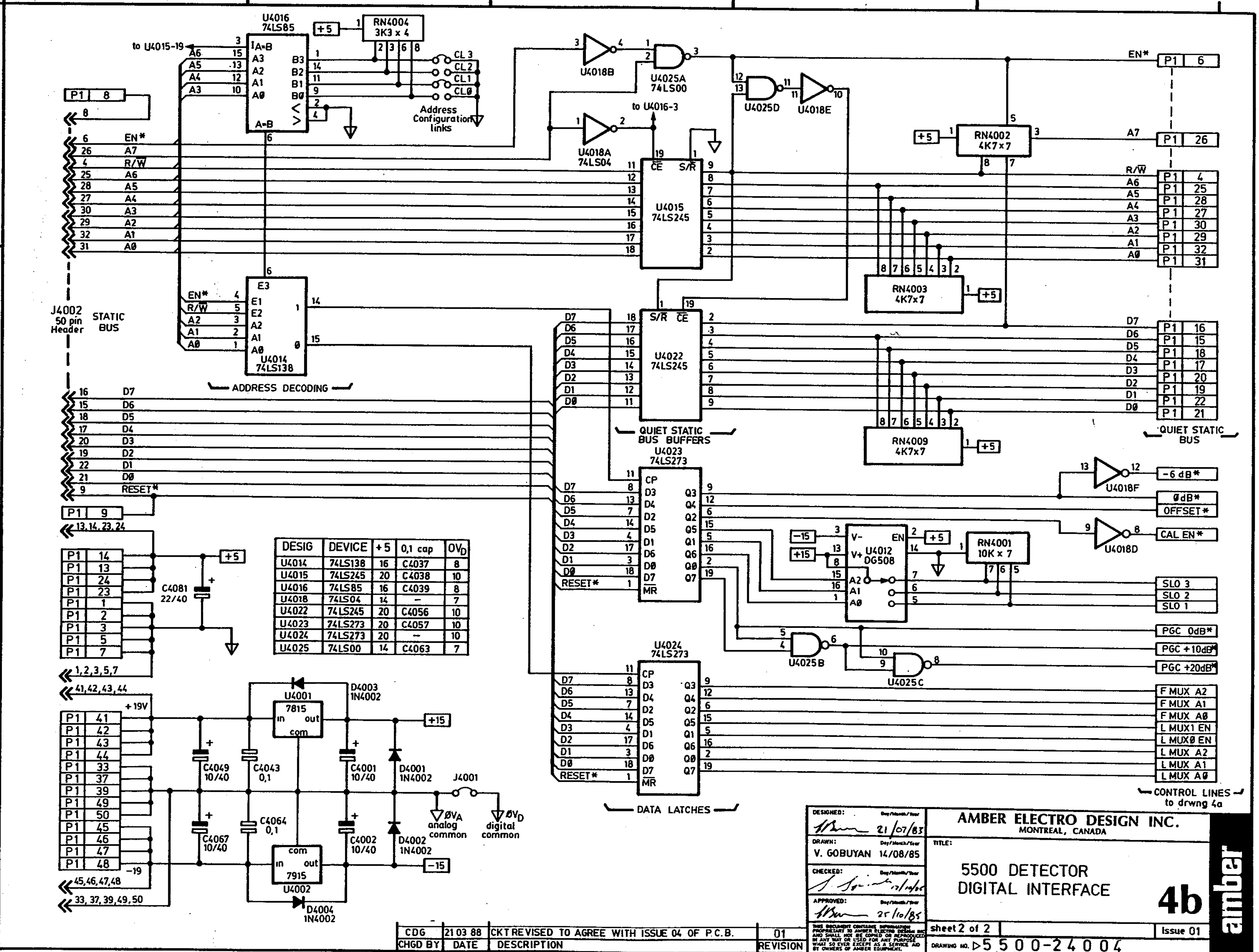
TITLE: 5500 DETECTOR
Analog section

4a

sheet 1 of 2 — issue 01

DRAWING NO. D5500-24004

amber



DESIG	DEVICE	+5	0,1 cap	$0V_D$
U4014	74LS138	16	C4037	8
U4015	74LS245	20	C4038	10
U4016	74LS85	16	C4039	8
U4018	74LS04	14	–	7
U4022	74LS245	20	C4056	10
U4023	74LS273	20	C4057	10
U4024	74LS273	20	–	10
U4025	74LS00	14	C4063	7

CHGD BY	DATE	DESCRIPTION	REVISION
CDG	21 03 88	CKT REVISED TO AGREE WITH ISSUE 04 OF P.C.B.	01

DESIGNED: 21/07/83
DRAWN: V. GOBUYAN 14/08/85
CHECKED:
APPROVED: 25/10/85

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MONTREAL, CANADA

TITLE: 5500 DETECTOR DIGITAL INTERFACE

4b

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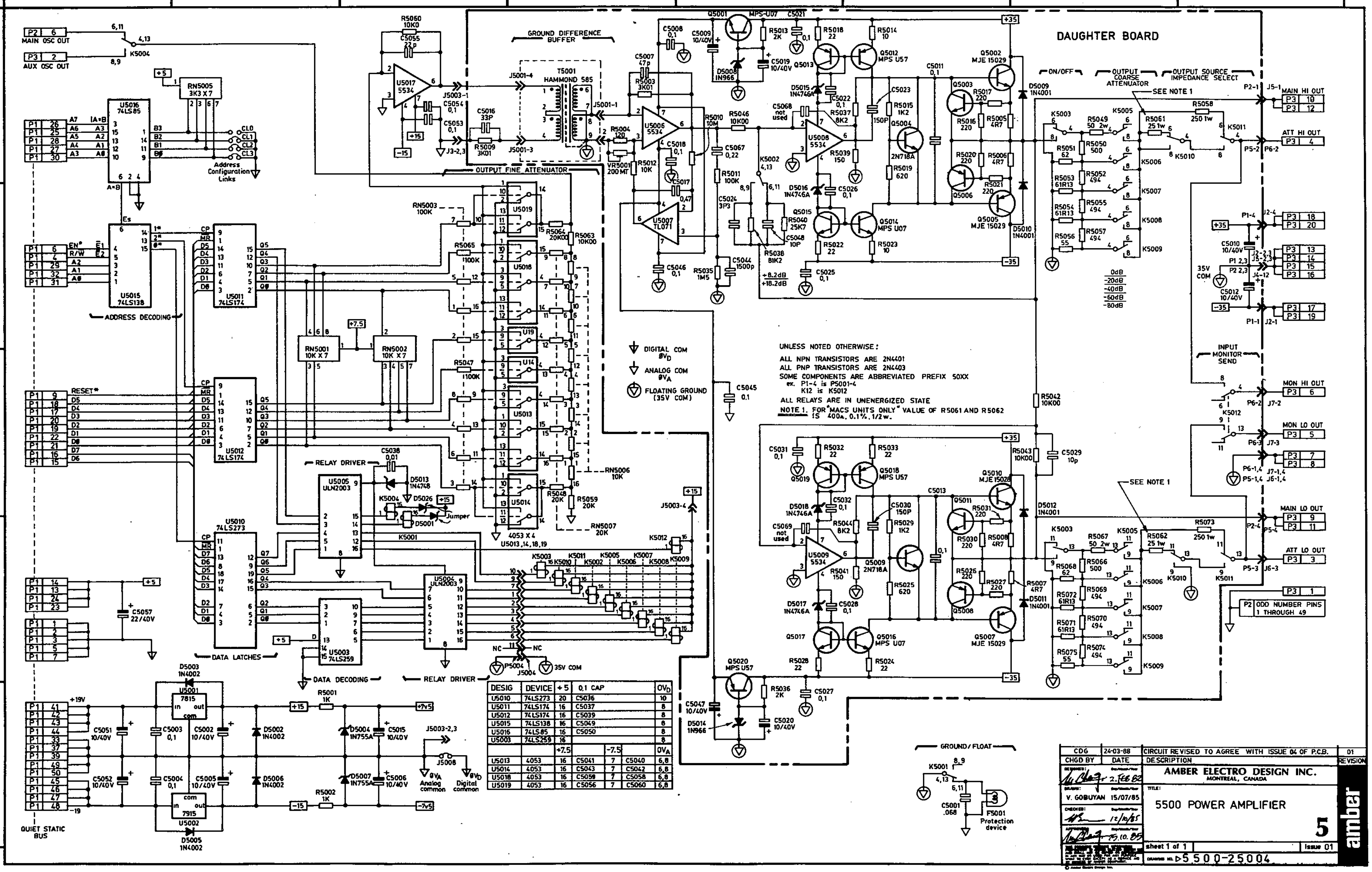
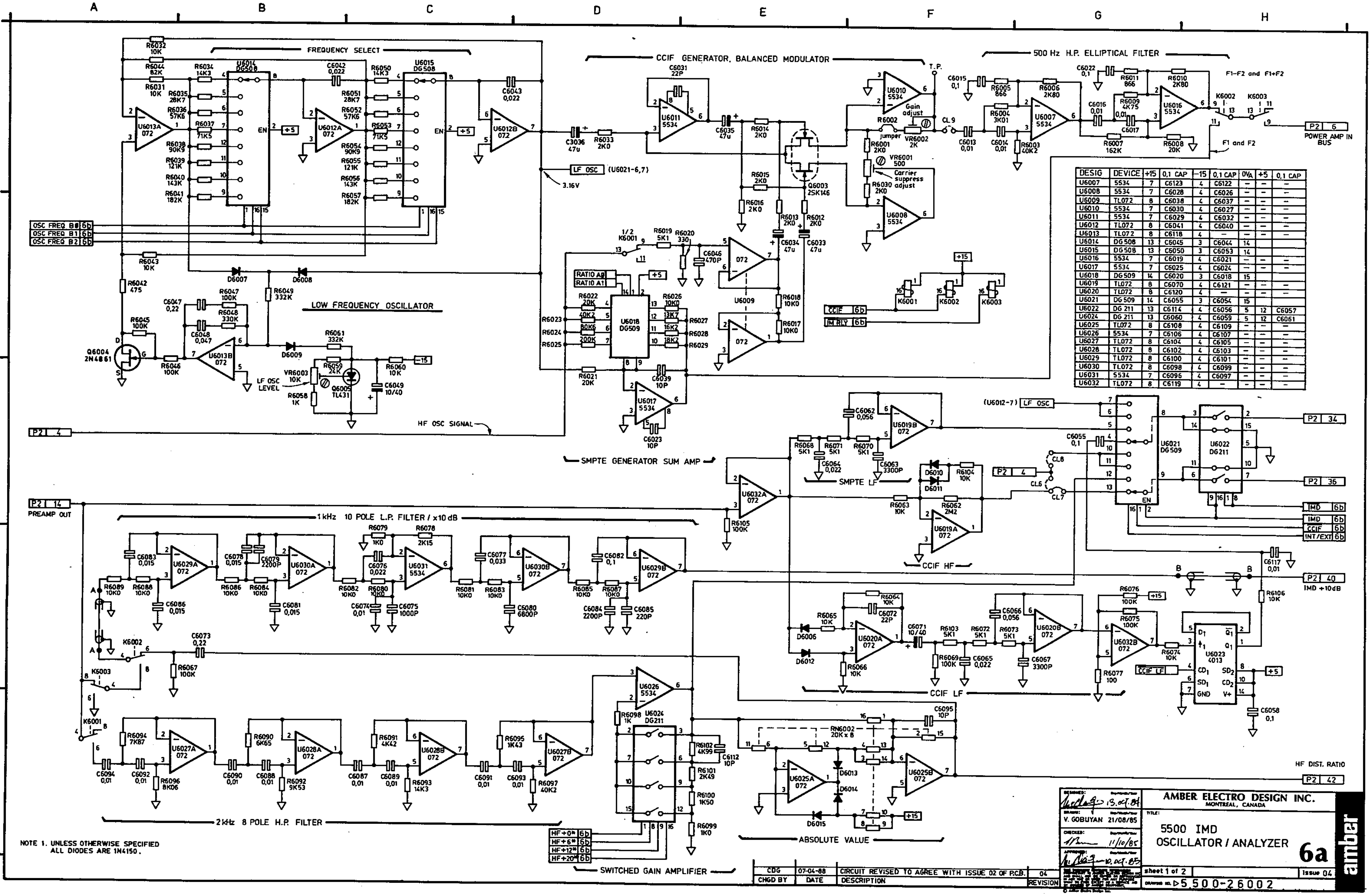
sheet 2 of 2

Issue 01

DRAWING NO. ▷5500-24004



DESIG	DEVICE	+5	0.1 CAP			ØV_D
U5010	74LS273	20	C5036			10
U5011	74LS174	16	C5037			8
U5012	74LS174	16	C5039			8
U5015	74LS138	16	C5049			8
U5016	74LS85	16	C5050			8
U5003	74LS259	16				8
		+7.5		-7.5		ØV_A
U5013	4053	16	C5041	7	C5040	6,8
U5014	4053	16	C5043	7	C5042	6,8
U5018	4053	16	C5059	7	C5058	6,8
U5019	4053	16	C5056	7	C5060	6,8



DESIG	DEVICE	+15	0,1 CAP	−15	0,1 CAP	0VA	+5	0,1 CAP
U6007	5534	7	C6123	4	C6122	–	–	–
U6008	5534	7	C6028	4	C6026	–	–	–
U6009	TL072	8	C6038	4	C6037	–	–	–
U6010	5534	7	C6030	4	C6027	–	–	–
U6011	5534	7	C6029	4	C6032	–	–	–
U6012	TL072	8	C6041	4	C6040	–	–	–
U6013	TL072	8	C6118	4	–	–	–	–
U6014	DG508	13	C6045	3	C6044	14		
U6015	DG508	13	C6050	3	C6053	14		
U6016	5534	7	C6019	4	C6021	–	–	–
U6017	5534	7	C6025	4	C6024	–	–	–
U6018	DG509	14	C6020	3	C6018	15		
U6019	TL072	8	C6070	4	C6121	–	–	–
U6020	TL072	8	C6120	4	–	–	–	–
U6021	DG509	14	C6055	3	C6054	15		
U6022	DG211	13	C6114	4	C6056	5	12	C6057
U6024	DG211	13	C6060	4	C6059	5	12	C6061
U6025	TL072	8	C6108	4	C6109	–	–	–
U6026	5534	7	C6106	4	C6107	–	–	–
U6027	TL072	8	C6104	4	C6105	–	–	–
U6028	TL072	8	C6102	4	C6103	–	–	–
U6029	TL072	8	C6100	4	C6101	–	–	–
U6030	TL072	8	C6098	4	C6099	–	–	–
U6031	5534	7	C6096	4	C6097	–	–	–
U6032	TL072	8	C6119	4	–	–	–	–

CDG	07-04-88	CIRCUIT REVISED TO AGREE WITH ISSUE 02 OF P.C.B.	04
CHGD BY	DATE	DESCRIPTION	REVISION

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

DRAWN: V. GOBUYAN 21/08/85

TITLE: 5500 IMD OSCILLATOR / ANALYZER

6a

sheet 1 of 2 — Issue 04

DRAWING NO. D5500-26002

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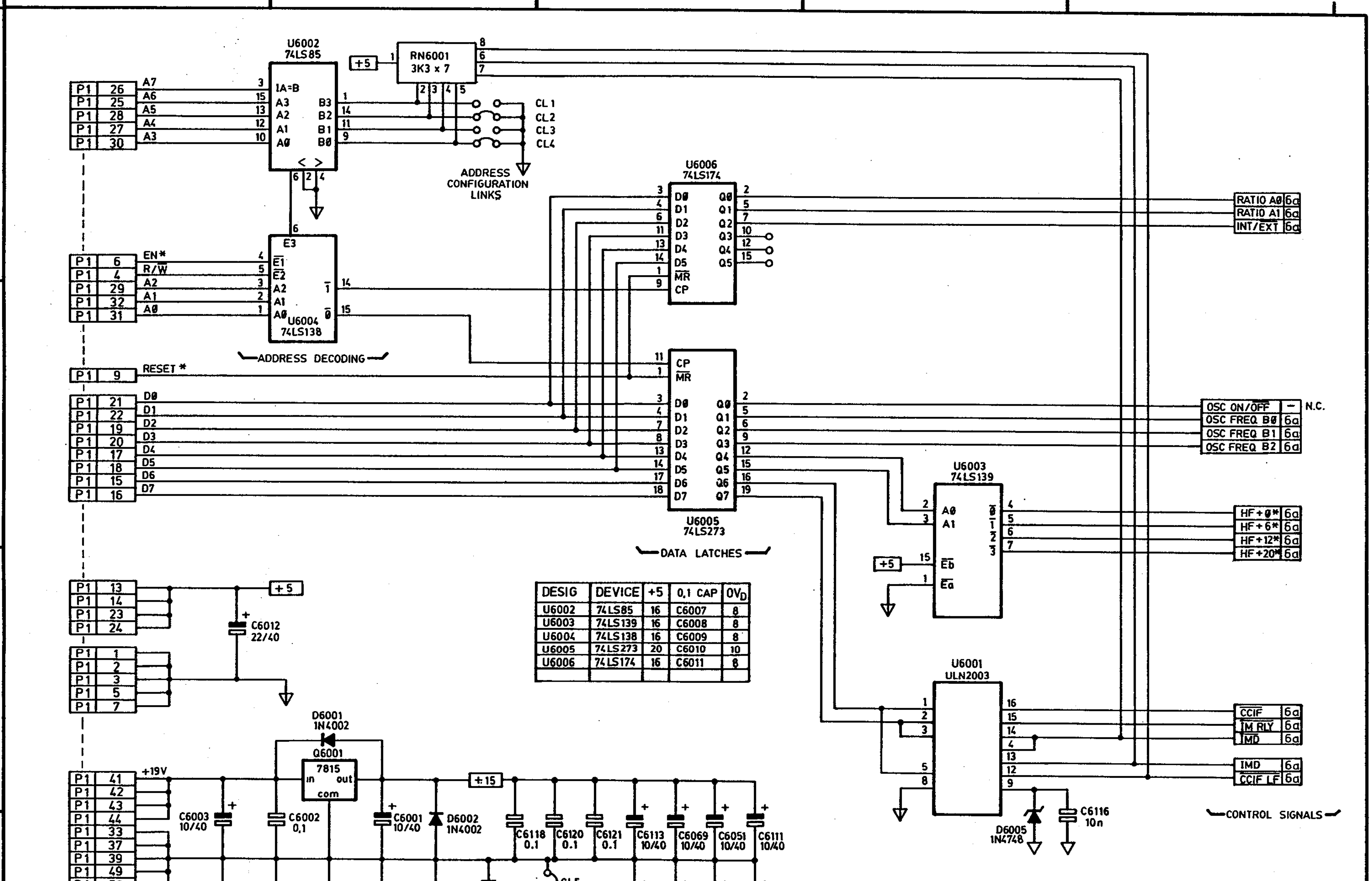

DESIG	DEVICE	+5	0,1 CAP	$0V_D$
U6002	74LS85	16	C6007	8
U6003	74LS139	16	C6008	8
U6004	74LS138	16	C6009	8
U6005	74LS273	20	C6010	10
U6006	74LS174	16	C6011	8

CHGD BY	DATE	DESCRIPTION	REVISION
CDG	08-04-88	CIRCUIT REVISED TO AGREE WITH ISSUE 02 OF P.C.B.	04

DESIGNED: 15/1/85
DRAWN: V. GOBUYAN 22/08/85
CHECKED: 17/10/85
APPROVED: 25/10/85

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

TITLE: 5500 IMD DIGITAL INTERFACE

6b

sheet 2 of 2 | Issue 04

DRAWING NO. ▷5500-26002

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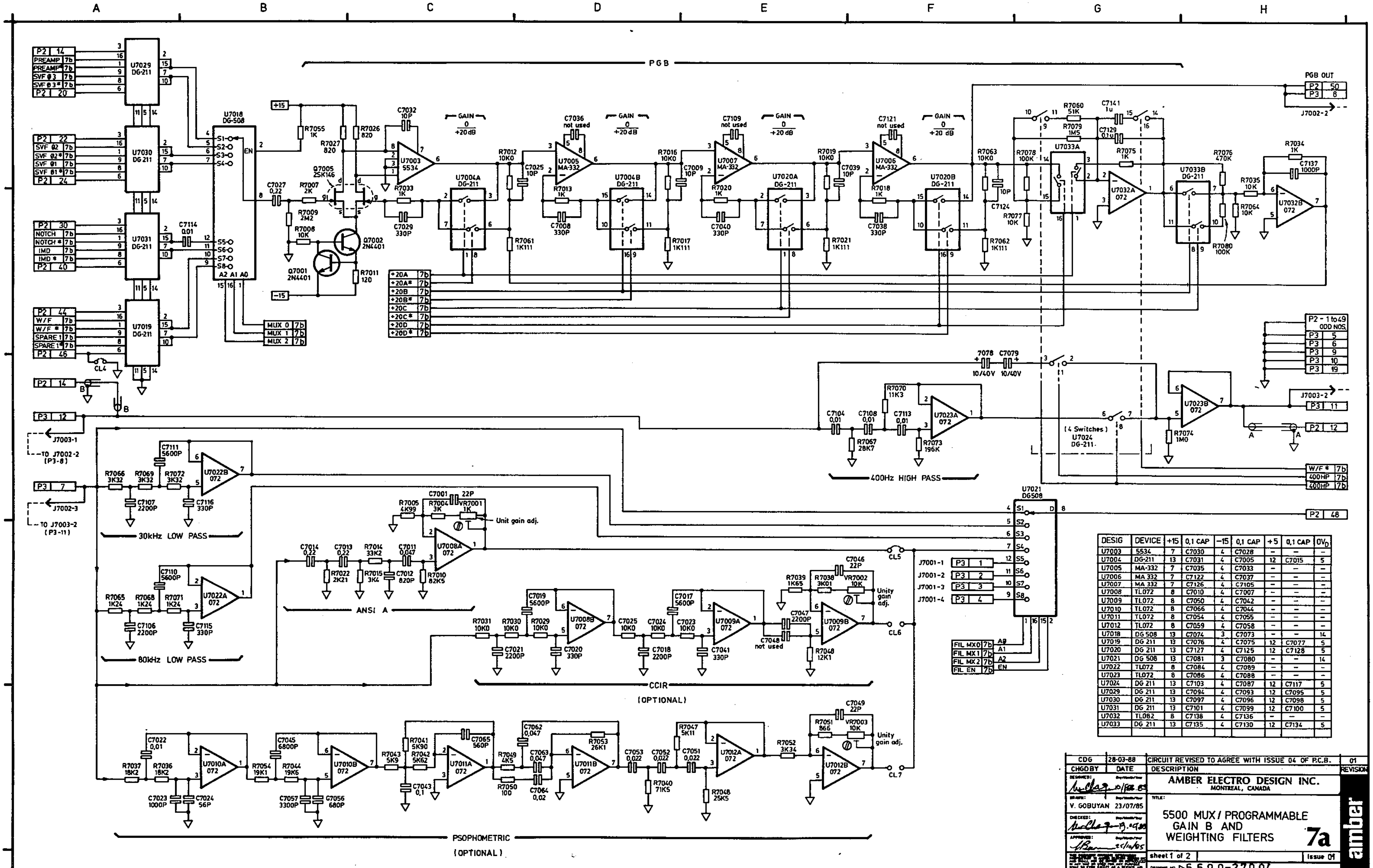


DESIG	DEVICE	+15	0,1 CAP	−15	0,1 CAP	+5	0,1 CAP	$0V_D$
U7003	5534	7	C7030	4	C7028	–	–	–
U7004	DG-211	13	C7031	4	C7005	12	C7015	5
U7005	MA-332	7	C7035	4	C7033	–	–	–
U7006	MA 332	7	C7122	4	C7037	–	–	–
U7007	MA 332	7	C7126	4	C7105	–	–	–
U7008	TL072	8	C7010	4	C7007	–	–	–
U7009	TL072	8	C7050	4	C7042	–	–	–
U7010	TL072	8	C7066	4	C7044	–	–	–
U7011	TL072	8	C7054	4	C7055	–	–	–
U7012	TL072	8	C7059	4	C7058	–	–	–
U7018	DG 508	13	C7074	3	C7073	–	–	14
U7019	DG 211	13	C7076	4	C7075	12	C7077	5
U7020	DG 211	13	C7127	4	C7125	12	C7128	5
U7021	DG 508	13	C7081	3	C7080	–	–	14
U7022	TL072	8	C7084	4	C7089	–	–	–
U7023	TL072	8	C7086	4	C7088	–	–	–
U7024	DG 211	13	C7103	4	C7087	12	C7117	5
U7029	DG 211	13	C7094	4	C7093	12	C7095	5
U7030	DG 211	13	C7097	4	C7096	12	C7098	5
U7031	DG 211	13	C7101	4	C7099	12	C7100	5
U7032	TL082	8	C7138	4	C7136	–	–	–
U7033	DG 211	13	C7135	4	C7130	12	C7134	5

CHGD BY	DATE	DESCRIPTION	REVISION
CDG	28-03-88	CIRCUIT REVISED TO AGREE WITH ISSUE 04 OF P.C.B.	01

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

DRAWN: V. GOBUYAN 23/07/85

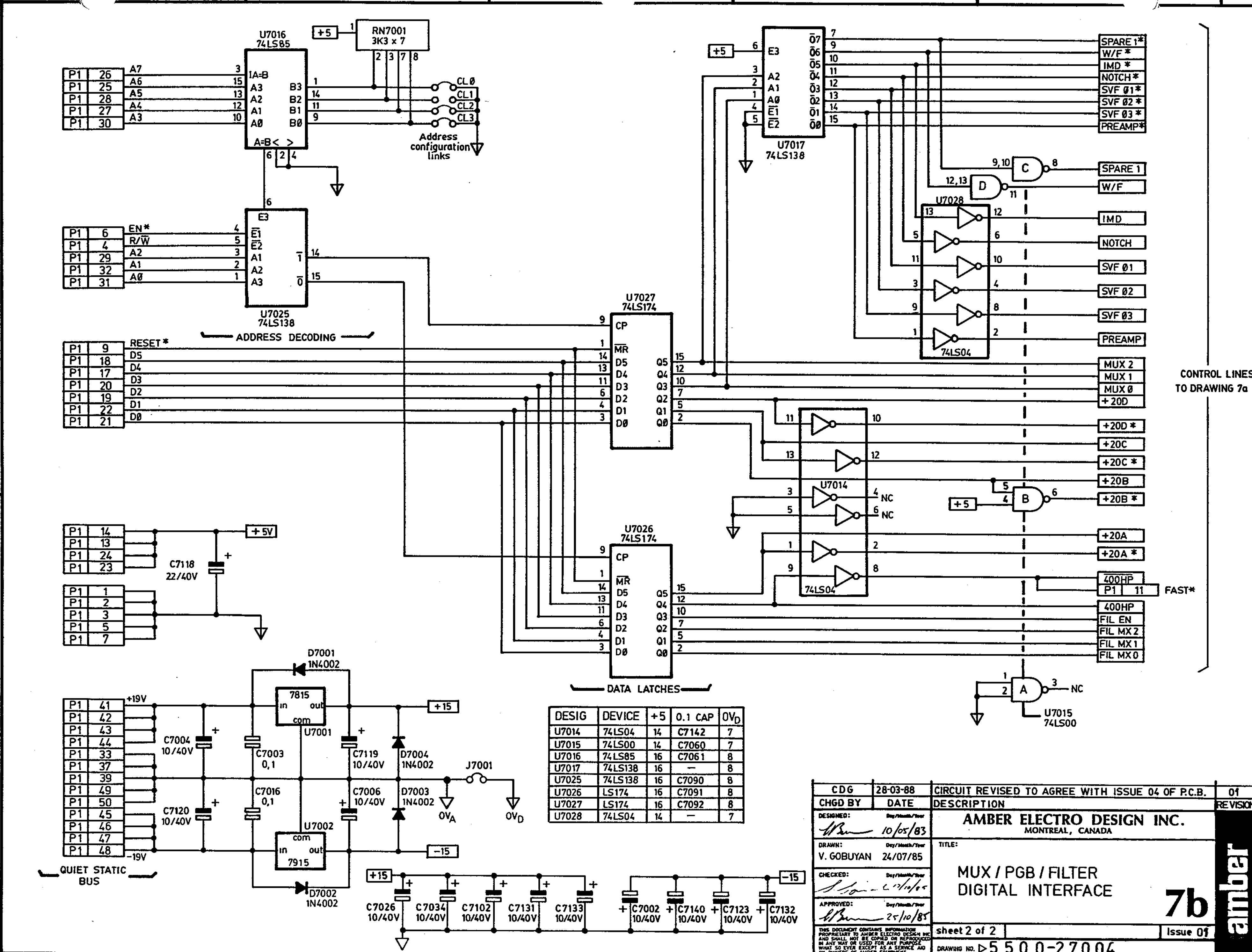
TITLE: 5500 MUX / PROGRAMMABLE GAIN B AND WEIGHTING FILTERS

7a

sheet 1 of 2 — Issue 01

DRAWING NO. ▷5500-27004

amber



DESIG	DEVICE	+5	0.1 CAP	$0V_D$
U7014	74LS04	14	C7142	7
U7015	74LS00	14	C7060	7
U7016	74LS85	16	C7061	8
U7017	74LS138	16	—	8
U7025	74LS138	16	C7090	8
U7026	LS174	16	C7091	8
U7027	LS174	16	C7092	8
U7028	74LS04	14	—	7

CHGD BY	DATE	DESCRIPTION	REVISION
CDG	28-03-88	CIRCUIT REVISED TO AGREE WITH ISSUE 04 OF P.C.B.	01

DESIGNED: 10/05/83
DRAWN: V. GOBUYAN 24/07/85
CHECKED:
APPROVED: 25/10/85

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

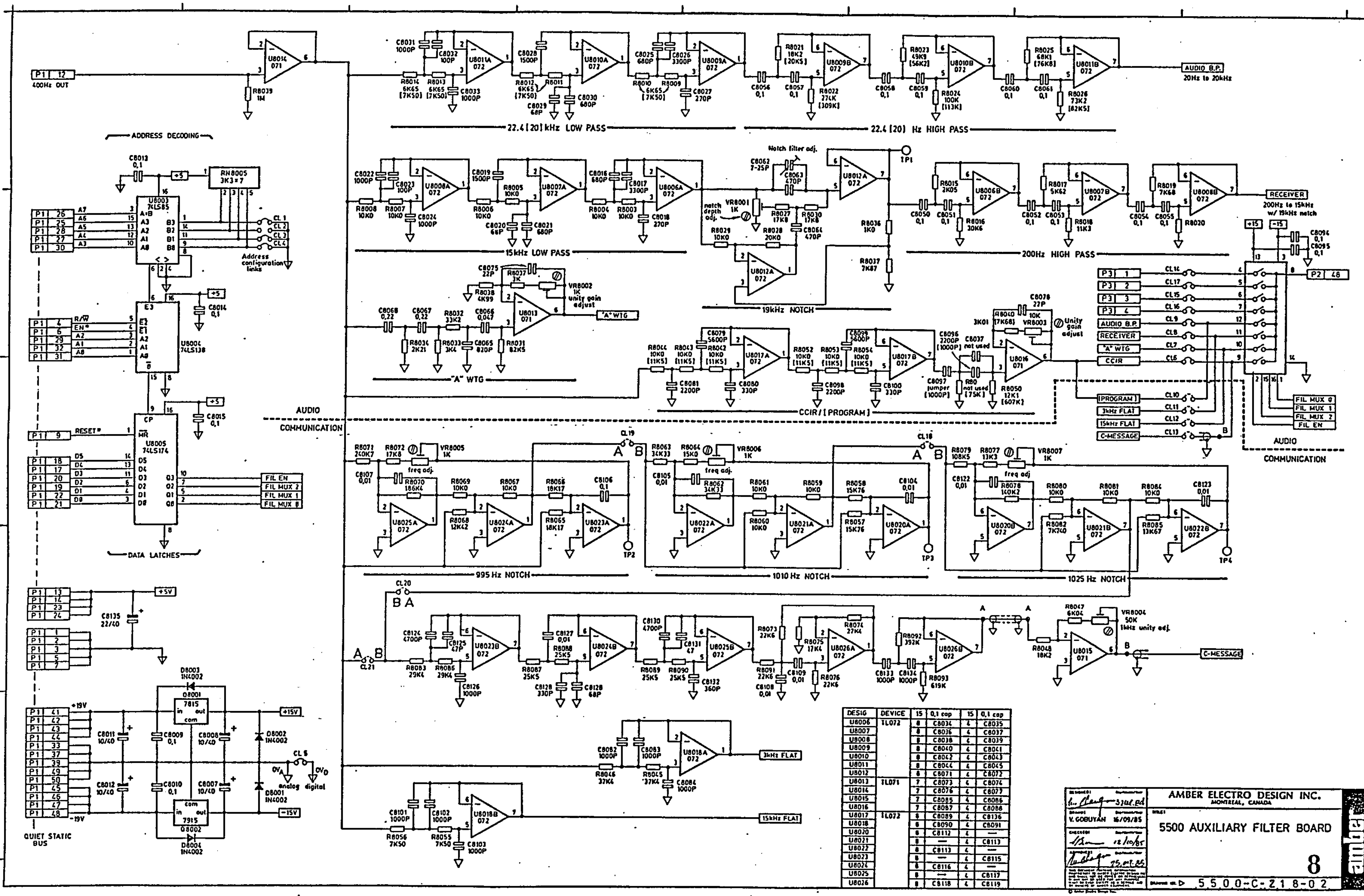
TITLE:
MUX / PGB / FILTER DIGITAL INTERFACE

7b

sheet 2 of 2 — Issue 01

DRAWING NO. ▷5500-27004

amber



DESIG	DEVICE	15	0,1 cap	15	0,1 cap
U8006	TL072	8	C8034	4	C8035
U8007		8	C8036	4	C8037
U8008		8	C8038	4	C8039
U8009		8	C8040	4	C8041
U8010		8	C8042	4	C8043
U8011		8	C8044	4	C8045
U8012		8	C8071	4	C8072
U8013	TL071	7	C8073	4	C8074
U8014		7	C8076	4	C8077
U8015		7	C8085	4	C8086
U8016		7	C8087	4	C8088
U8017	TL072	8	C8089	4	C8136
U8018		8	C8090	4	C8091
U8020		8	C8112	4	—
U8021		8	—	4	C8113
U8022		8	C8113	4	—
U8023		8	—	4	C8115
U8024		8	C8116	4	—
U8025		8	—	4	C8117
U8026		8	C8118	4	C8119

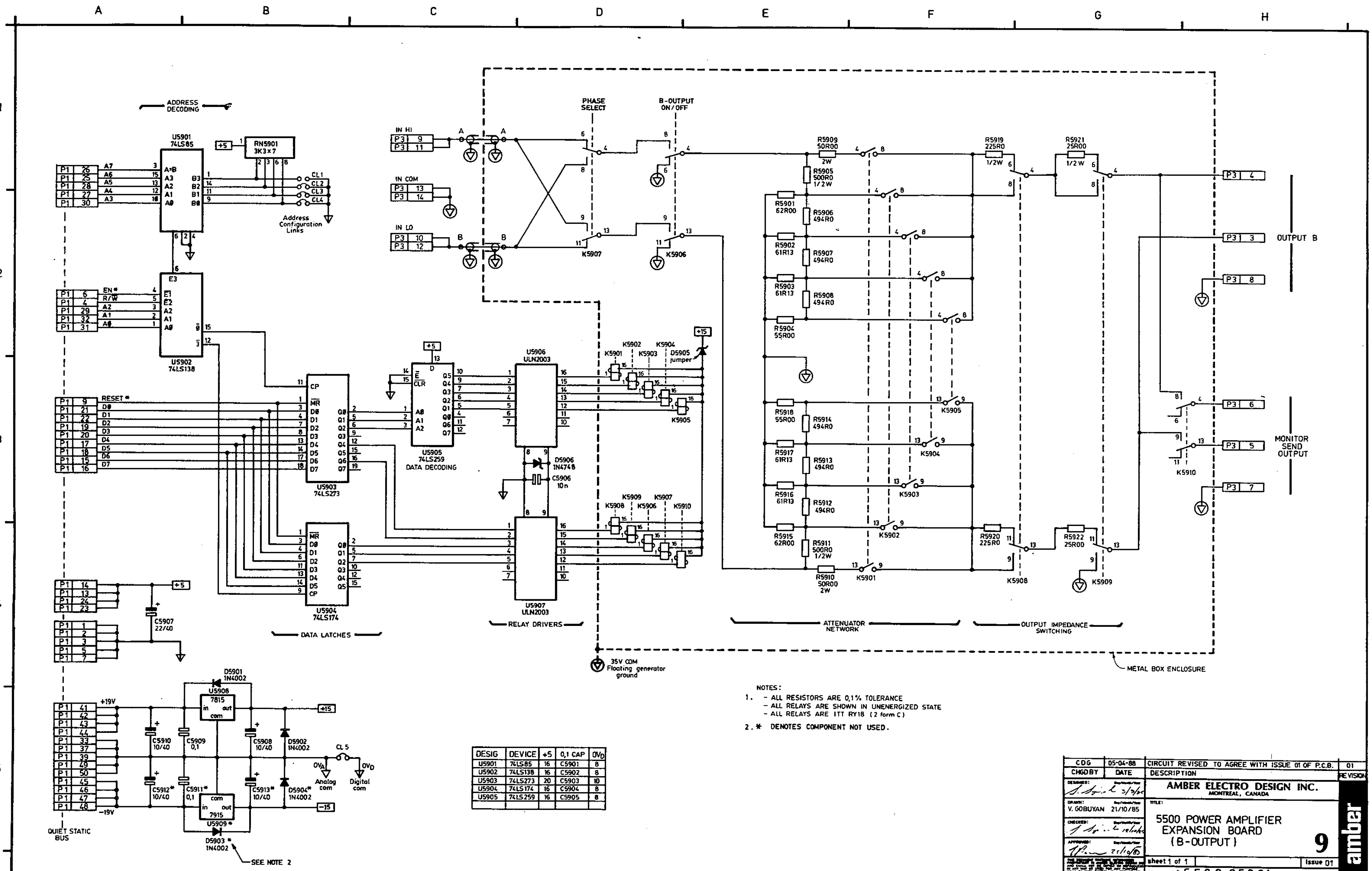
AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

5500 AUXILIARY FILTER BOARD

V. GOBUYAN 16/09/85

8

5500-C-218-02



NOTES:

1. - ALL RESISTORS ARE 0,1% TOLERANCE
   - ALL RELAYS ARE SHOWN IN UNENERGIZED STATE
   - ALL RELAYS ARE ITT RY18 (2 form C)
2. * DENOTES COMPONENT NOT USED.

DESIG	DEVICE	+5	0,1 CAP	0VD
U5901	74LS85	16	C5901	8
U5902	74LS138	16	C5902	8
U5903	74LS273	20	C5903	10
U5904	74LS174	16	C5904	8
U5905	74LS259	16	C5905	8

CDG	05-04-88	CIRCUIT REVISED TO AGREE WITH ISSUE 01 OF P.C.B.	01
CHGD BY	DATE	DESCRIPTION	REVISION

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

DRAWN: V. GOBUYAN 21/10/85

TITLE: 5500 POWER AMPLIFIER EXPANSION BOARD (B-OUTPUT)

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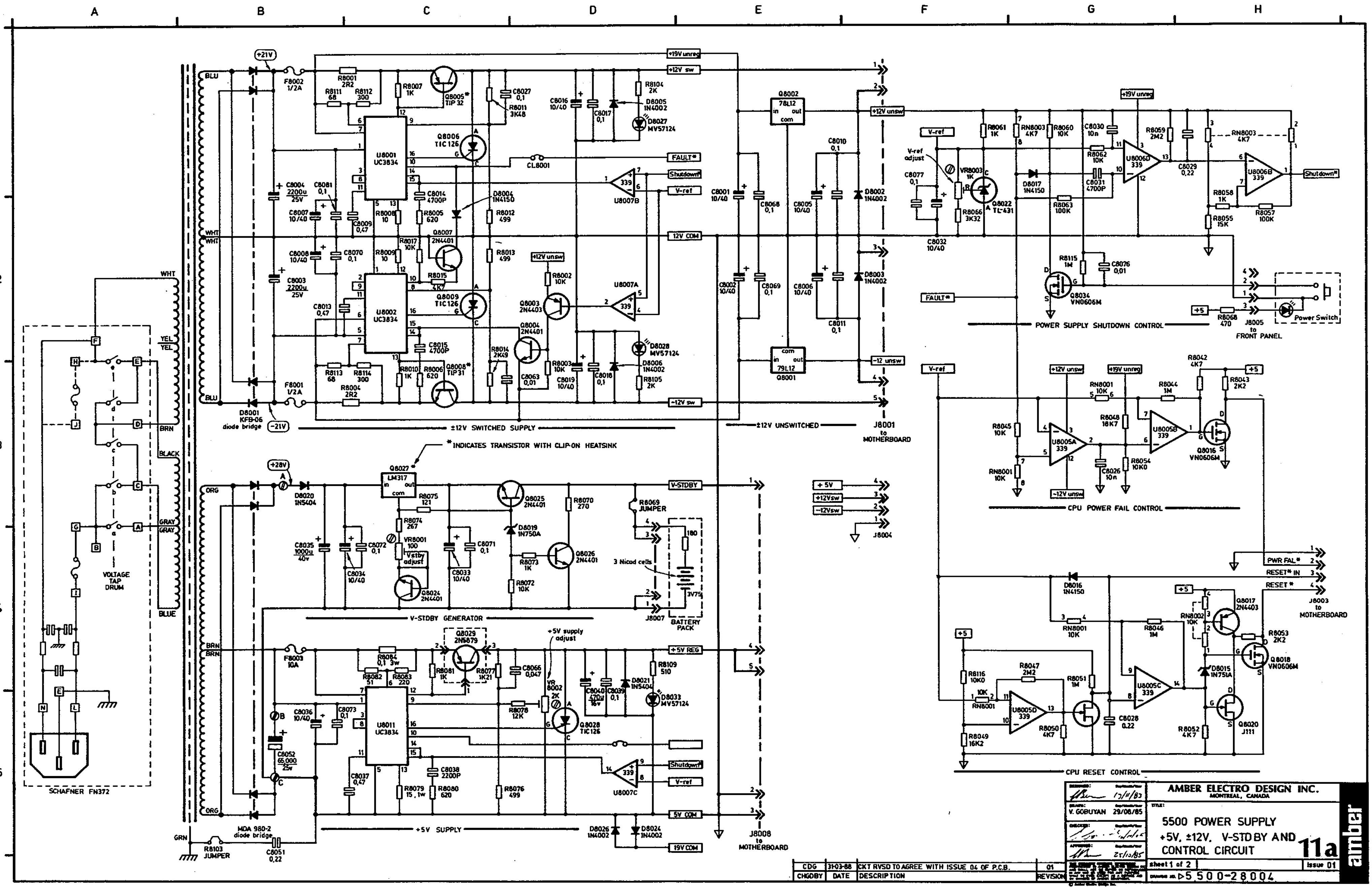
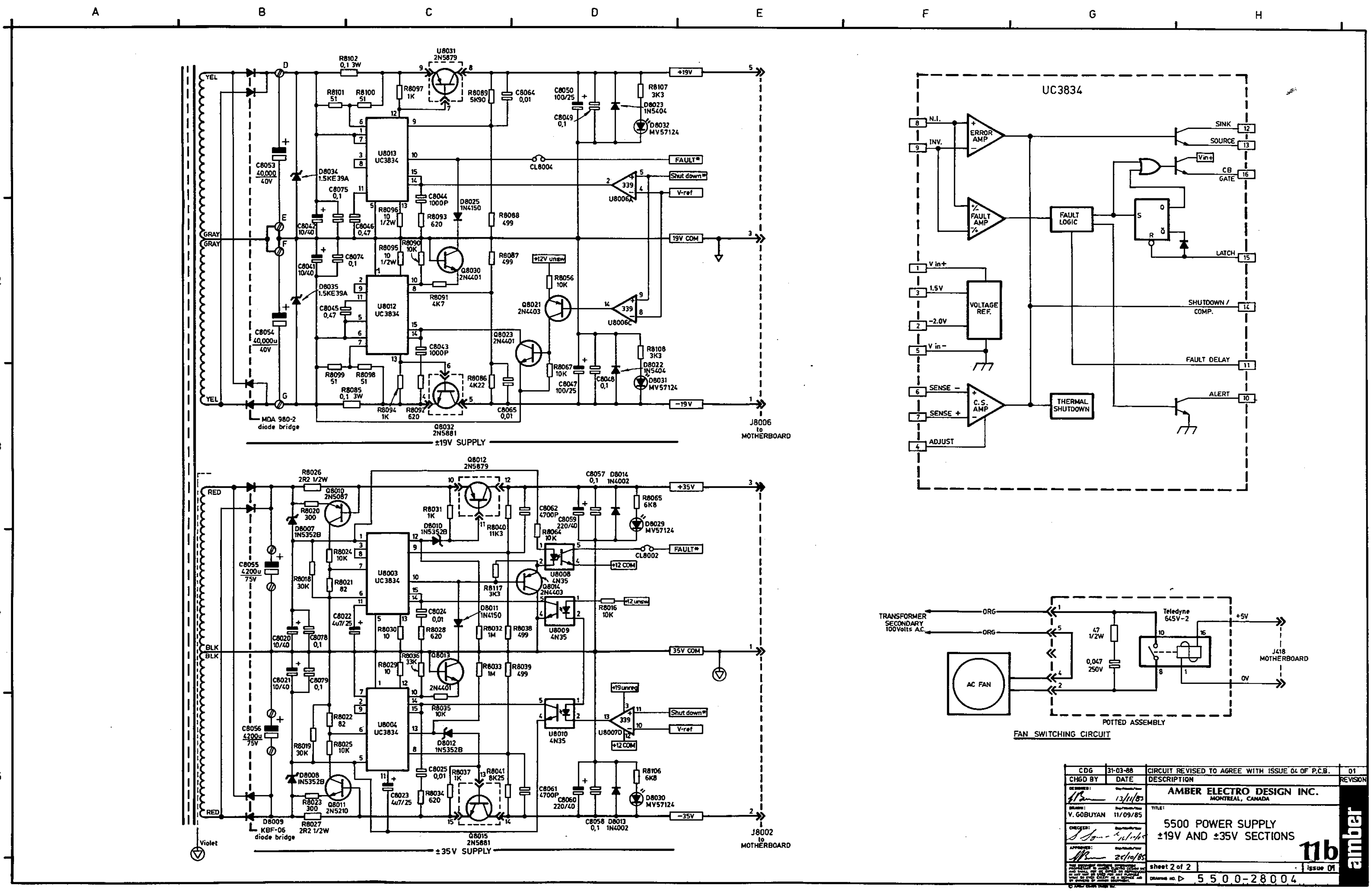
sheet 1 of 1 — Issue 01

DRAWING NO. D5500-25901

amber


±12V SWITCHED SUPPLY
±12V UNSWITCHED
*INDICATES TRANSISTOR WITH CLIP-ON HEATSINK
V-STDBY GENERATOR
+5V SUPPLY
POWER SUPPLY SHUTDOWN CONTROL
CPU POWER FAIL CONTROL
CPU RESET CONTROL
J8001 to MOTHERBOARD
J8003 to MOTHERBOARD
J8005 to FRONT PANEL
J8008 to MOTHERBOARD
SCHAFNER FN372
VOLTAGE TAP DRUM
BATTERY PACK
AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA
5500 POWER SUPPLY
+5V, ±12V, V-STD BY AND CONTROL CIRCUIT
11a
V. GOBUYAN 29/06/85
sheet 1 of 2
issue 01
D5 500-28004
CDG 31-03-88 CKT RVSD TO AGREE WITH ISSUE 04 OF P.C.B. 01
CHGDBY DATE DESCRIPTION REVISION
amber



CDG	31-03-88	CIRCUIT REVISED TO AGREE WITH ISSUE 04 OF P.C.B.	01
CHGD BY	DATE	DESCRIPTION	REVISION

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

DRAWN: V. GOBUYAN 11/09/85

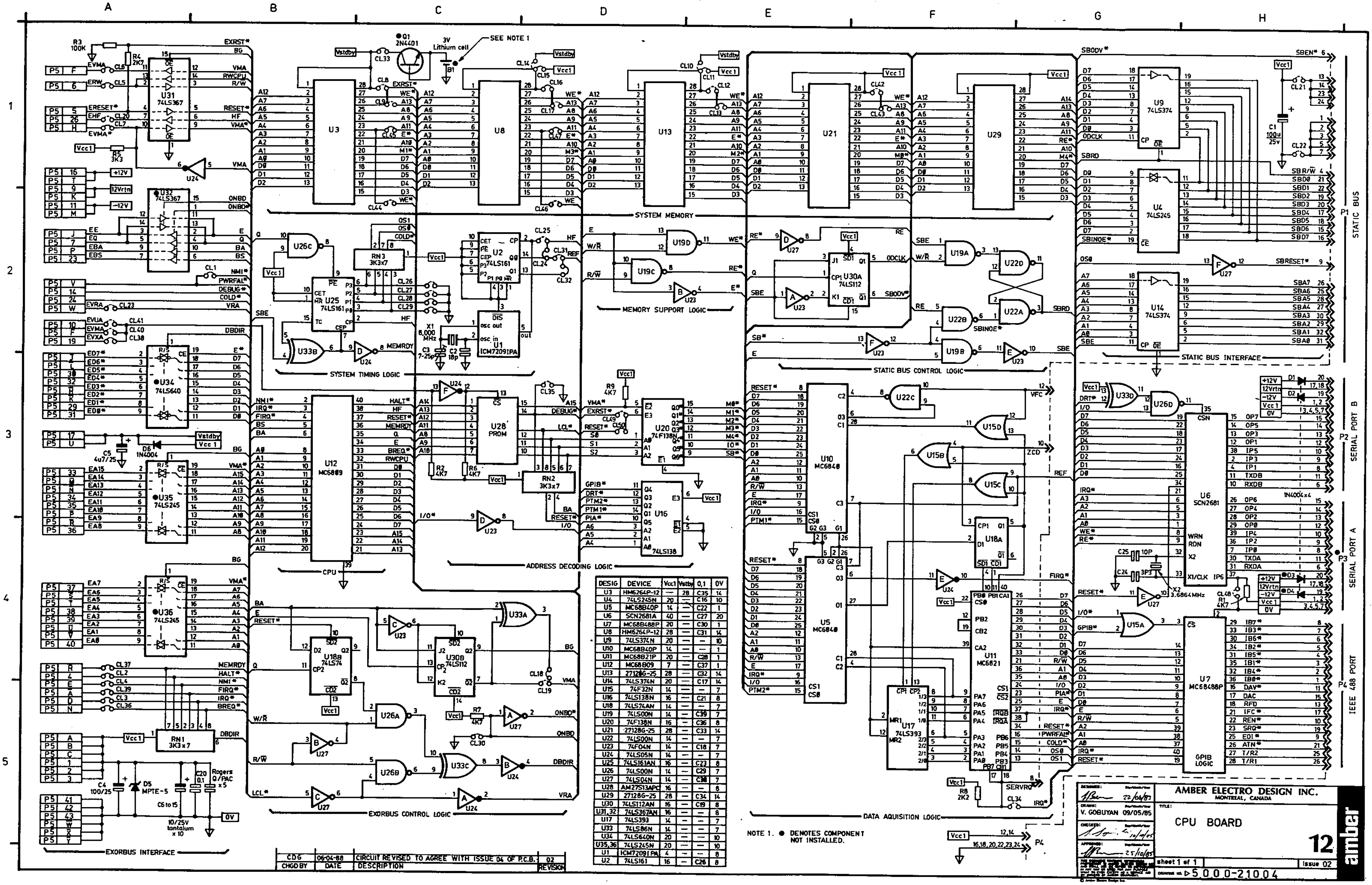
TITLE: 5500 POWER SUPPLY ±19V AND ±35V SECTIONS

11b

sheet 2 of 2 — issue 01

DRAWING NO. 5500-28004

amber



DESIG	DEVICE	Vcc1	Vstby	0,1	0V
U3	HM6264P-12	—	28	C35	14
U4	74LS245N	20	—	C16	10
U5	MC68B40P	14	—	C22	1
U6	SCN2681A	40	—	C27	20
U7	MC68B488P	20	—	C30	1
U8	HM6264P-12	28	—	C31	14
U9	74LS374N	20	—	—	10
U10	MC68B40P	14	—	—	1
U11	MC68B21P	20	—	C28	1
U12	MC68B09	7	—	C37	1
U13	27128G-25	28	—	C32	14
U14	74LS374N	20	—	C17	14
U15	74F32N	14	—	—	7
U16	74LS138N	16	—	C21	8
U18	74LS74AN	14	—	—	7
U19	74LS00N	14	—	C39	7
U20	74F138N	16	—	C36	8
U21	27128G-25	28	—	C33	14
U22	74LS00N	14	—	—	7
U23	74F04N	14	—	C18	7
U24	74LS05N	14	—	—	7
U25	74LS161AN	16	—	C23	8
U26	74LS00N	14	—	C29	7
U27	74LS04N	14	—	C38	7
U28	AM27S13APC	16	—	—	8
U29	27128G-25	28	—	C34	14
U30	74LS112AN	16	—	C19	8
U31, 32	74LS367AN	16	—	—	8
U17	74LS393	14	—	—	7
U33	74LS86N	14	—	—	7
U34	74LS640N	20	—	—	10
U35, 36	74LS245N	20	—	—	10
U1	ICM7209IPA	4	—	—	8
U2	74LS161	16	—	C26	8

CHGD BY	DATE	DESCRIPTION	REVISION
CDG	06-04-88	CIRCUIT REVISED TO AGREE WITH ISSUE 04 OF P.C.B.	02

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

DESIGNED: 22/04/85
DRAWN: V. GOBUYAN 09/05/85
CHECKED: 10/10/85
APPROVED: 25/10/85

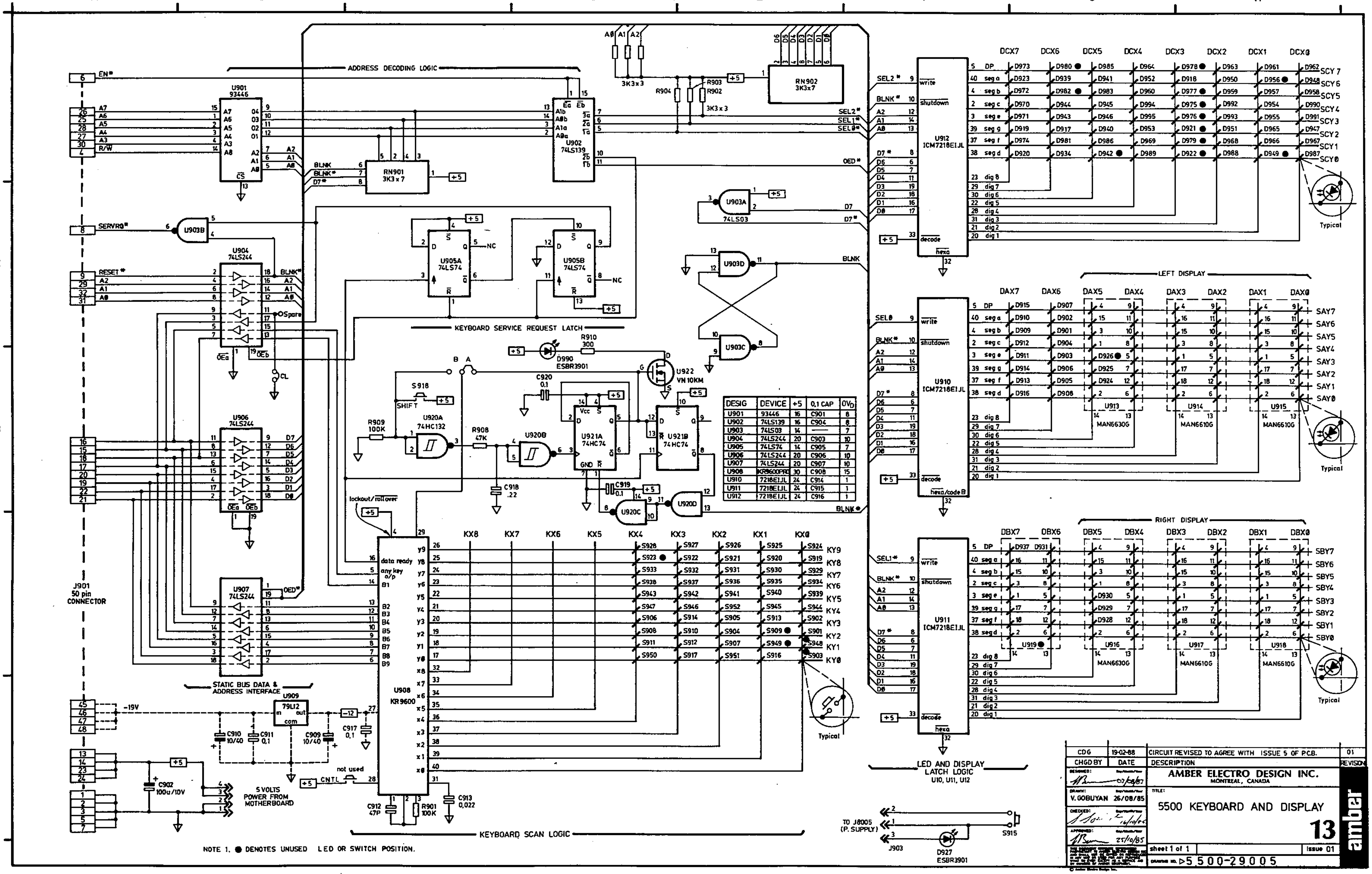
TITLE: CPU BOARD

12

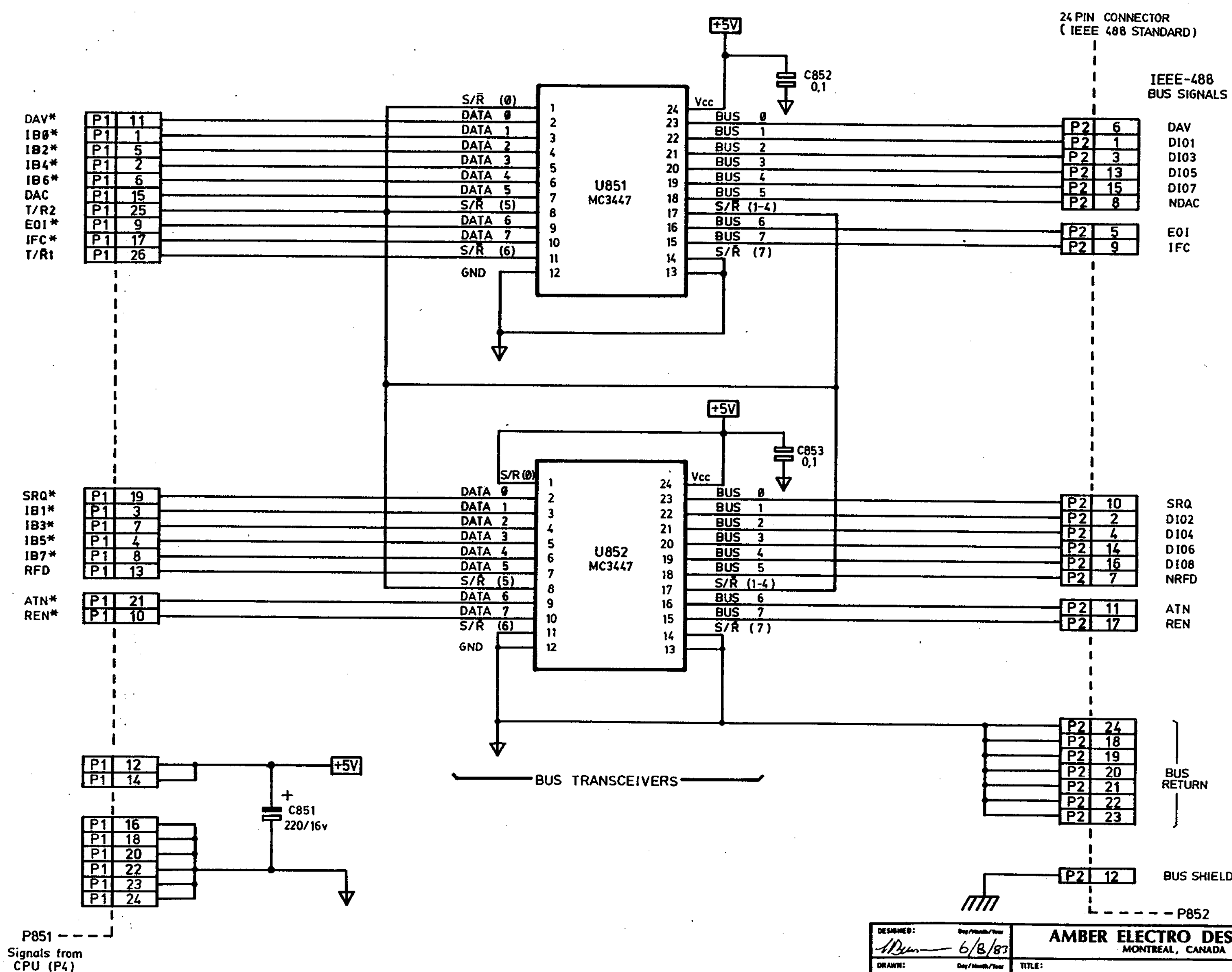
sheet 1 of 1 | issue 02

DRAWING NO. ▷5000-21004

amber



DESIG	DEVICE	+5	0,1 CAP	0V
U901	93446	16	C901	8
U902	74LS139	16	C904	8
U903	74LS03	14	—	7
U904	74LS244	20	C903	10
U905	74LS74	14	C905	7
U906	74LS244	20	C906	10
U907	74LS244	20	C907	10
U908	KR9600PRO	30	C908	15
U910	7218EIJL	24	C914	1
U911	7218EIJL	24	C915	1
U912	7218EIJL	24	C916	1



CDG	21-04-88	CIRCUIT AGREES WITH ISSUE 02 OF PCB	01
CHGD BY	DATE	DECRIPTION	REVISION

DESIGNED: 6/8/83
DRAWN: V. GOBUYAN 09/09/85
CHECKED:
APPROVED: 25/10/85

AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA

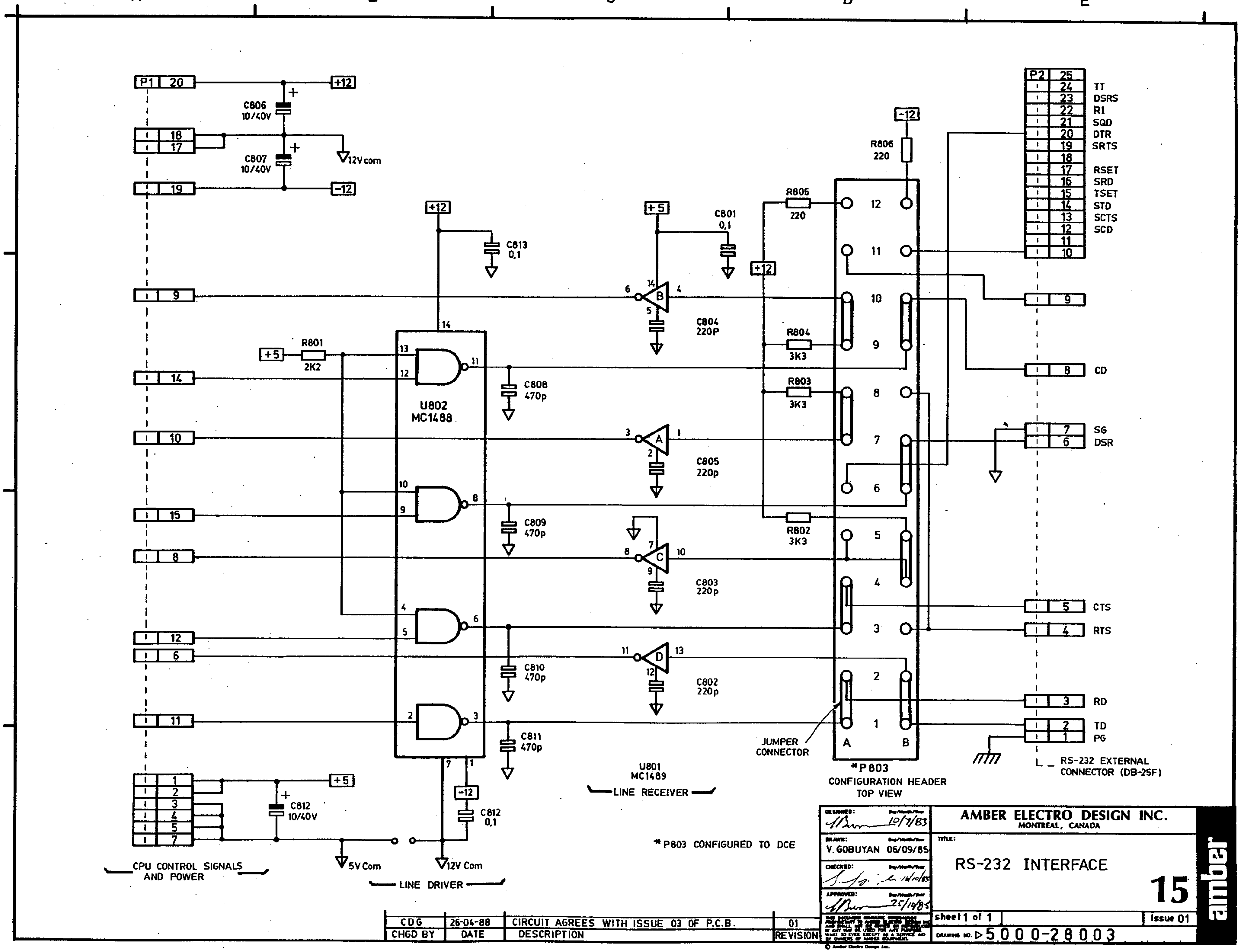
TITLE: GPIB INTERFACE BOARD

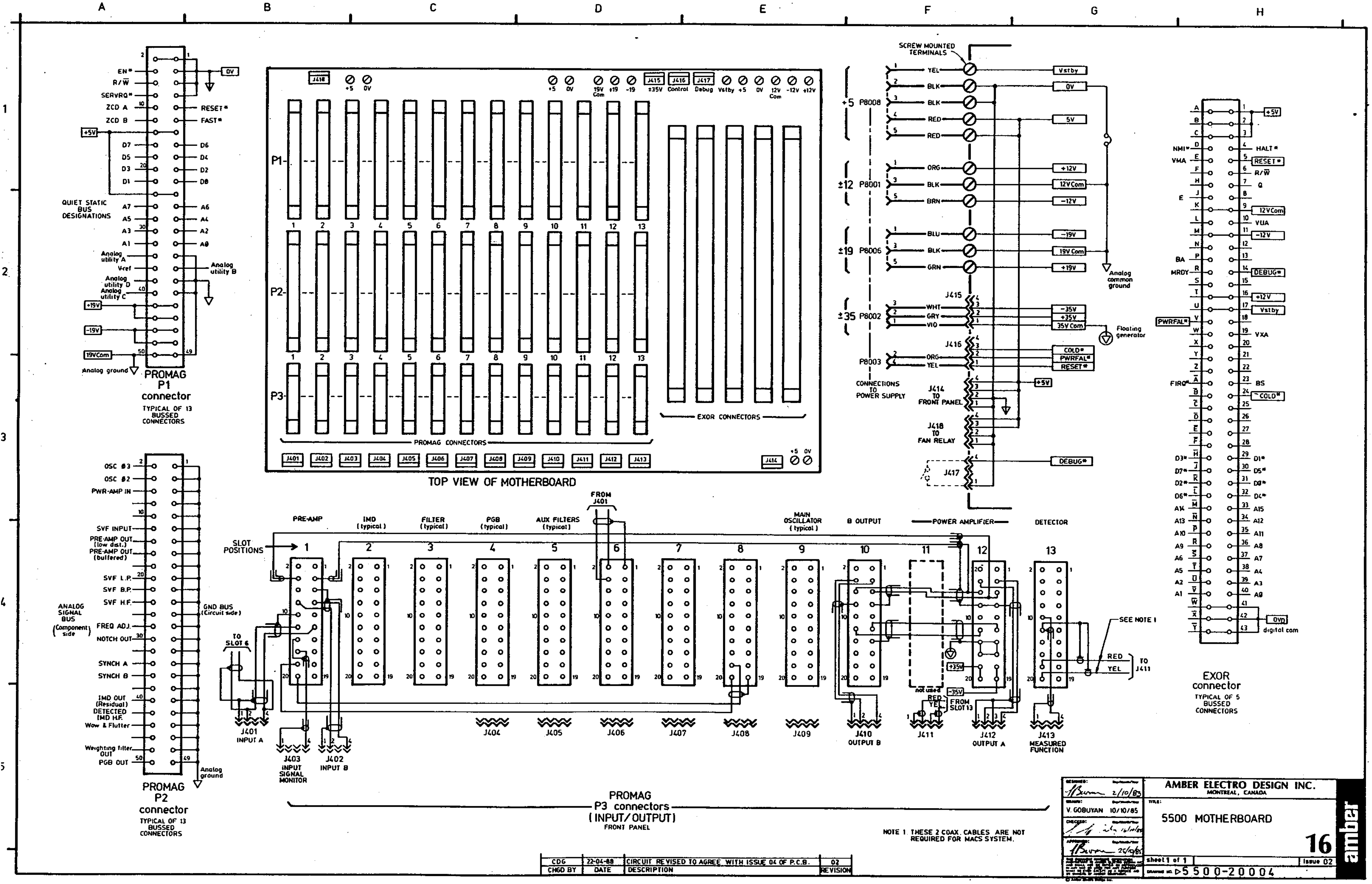
14

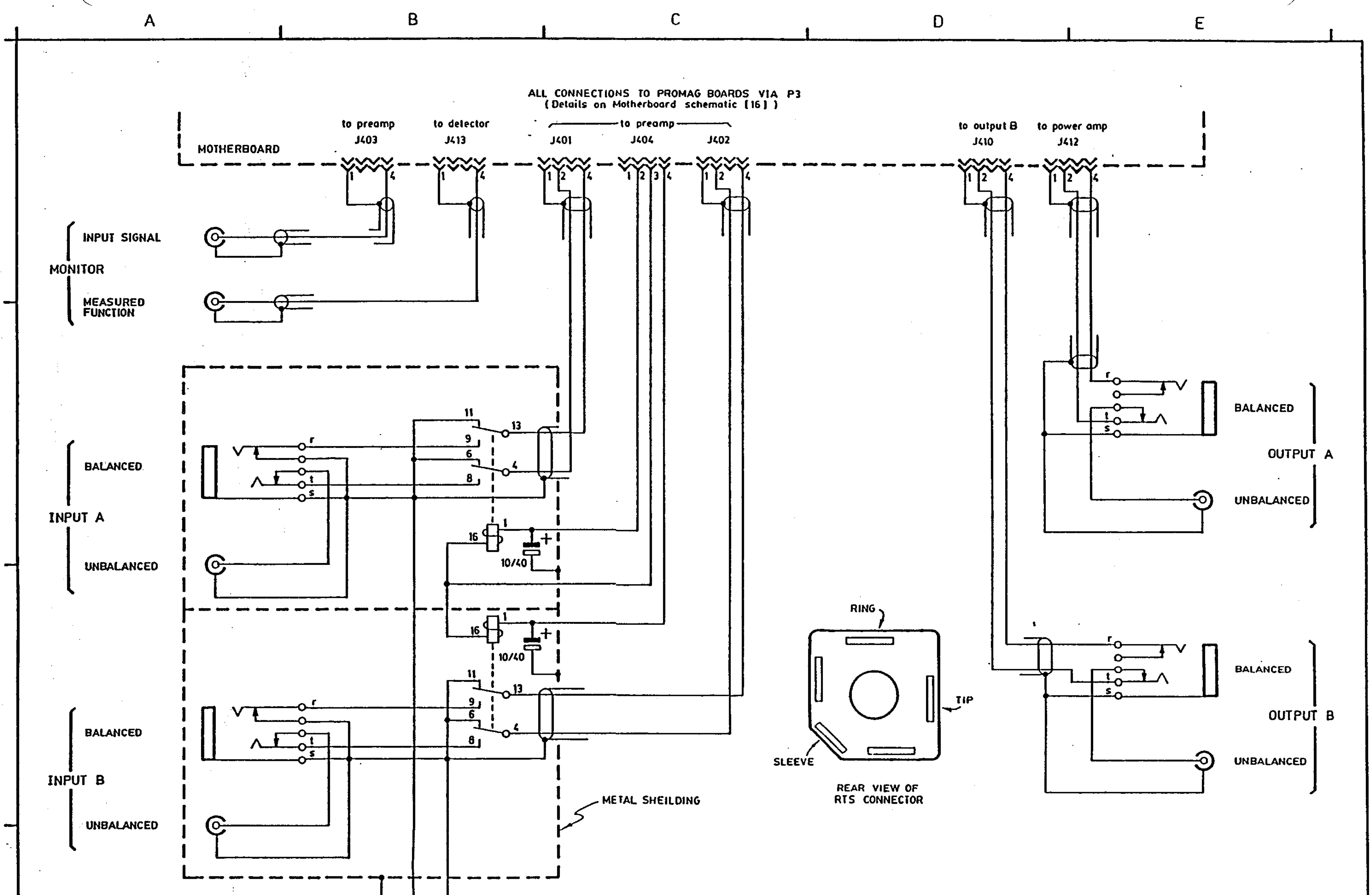
sheet 1 of 1 | Issue 01

DRAWING NO. ▷ 5000-28503

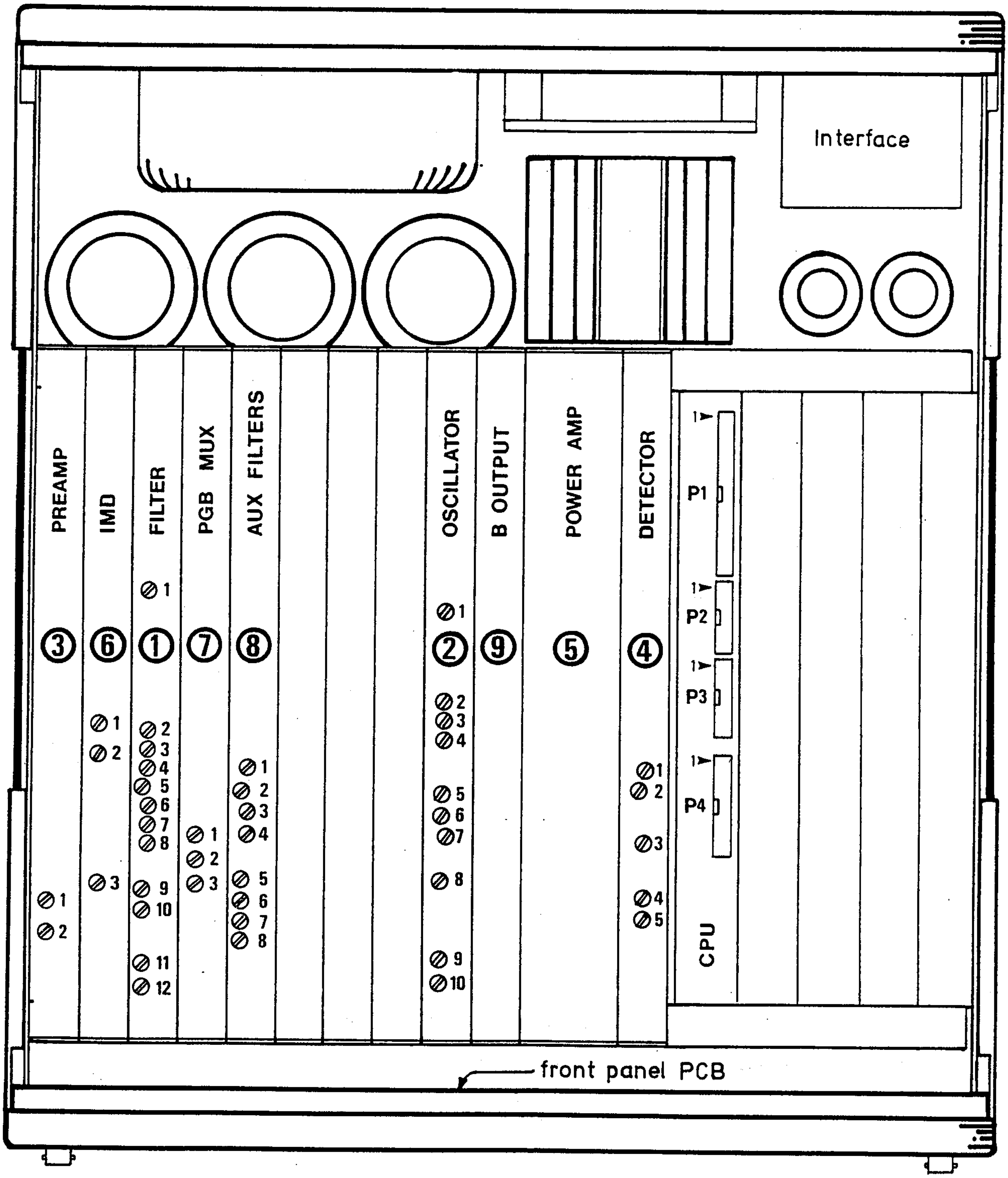
amber


A
B
C
D
E
1
2
3
4
P1
20
18
17
19
9
14
10
15
8
12
6
11
1
2
3
4
5
7
+12
-12
+5
C806
10/40V
C807
10/40V
12V com
C813
0,1
R801
2K2
U802
MC1488
C808
470p
C809
470p
C810
470p
C811
470p
C812
0,1
C812
10/40V
5V Com
12V Com
CPU CONTROL SIGNALS AND POWER
LINE DRIVER
C801
0,1
C804
220P
C805
220p
C803
220p
C802
220p
U801
MC1489
LINE RECEIVER
R805
220
R806
220
R804
3K3
R803
3K3
R802
3K3
JUMPER CONNECTOR
*P803
CONFIGURATION HEADER
TOP VIEW
*P803 CONFIGURED TO DCE
P2
TT
DSRS
RI
SQD
DTR
SRTS
RSET
SRD
TSET
STD
SCTS
SCD
CD
SG
DSR
CTS
RTS
RD
TD
PG
RS-232 EXTERNAL CONNECTOR (DB-25F)
DESIGNED: 10/7/83
DRAWN: V. GOBUYAN 06/09/85
CHECKED: 16/10/85
APPROVED: 25/10/85
AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA
TITLE:
RS-232 INTERFACE
15
amber
sheet 1 of 1
Issue 01
DRAWING NO. ▷5000-28003
CDG
26-04-88
CIRCUIT AGREES WITH ISSUE 03 OF P.C.B.
01
CHGD BY
DATE
DESCRIPTION
REVISION
© Amber Electro Design Inc.


TOP VIEW OF MOTHERBOARD
PROMAG CONNECTORS
EXOR CONNECTORS
PROMAG P1 connector
TYPICAL OF 13 BUSSED CONNECTORS
QUIET STATIC BUS DESIGNATIONS
PROMAG P2 connector
TYPICAL OF 13 BUSSED CONNECTORS
ANALOG SIGNAL BUS (Component side)
GND BUS (Circuit side)
PROMAG P3 connectors (INPUT/OUTPUT)
FRONT PANEL
SLOT POSITIONS
PRE-AMP
IMD (typical)
FILTER (typical)
PGB (typical)
AUX FILTERS (typical)
MAIN OSCILLATOR (typical)
B OUTPUT
POWER AMPLIFIER
DETECTOR
J401 INPUT A
J402 INPUT B
J403 INPUT SIGNAL MONITOR
J410 OUTPUT B
J412 OUTPUT A
J413 MEASURED FUNCTION
SCREW MOUNTED TERMINALS
CONNECTIONS TO POWER SUPPLY
J414 TO FRONT PANEL
J418 TO FAN RELAY
Analog common ground
Floating generator
EXOR connector
TYPICAL OF 5 BUSSED CONNECTORS
NOTE 1 THESE 2 COAX. CABLES ARE NOT REQUIRED FOR MACS SYSTEM.
CDG | 22-04-88 | CIRCUIT REVISED TO AGREE WITH ISSUE 04 OF P.C.B. | 02
CHGD BY | DATE | DESCRIPTION | REVISION
AMBER ELECTRO DESIGN INC.
MONTREAL, CANADA
5500 MOTHERBOARD
V. GOBUYAN 10/10/85
sheet 1 of 1
Issue 02
D5500-20004
16
amber

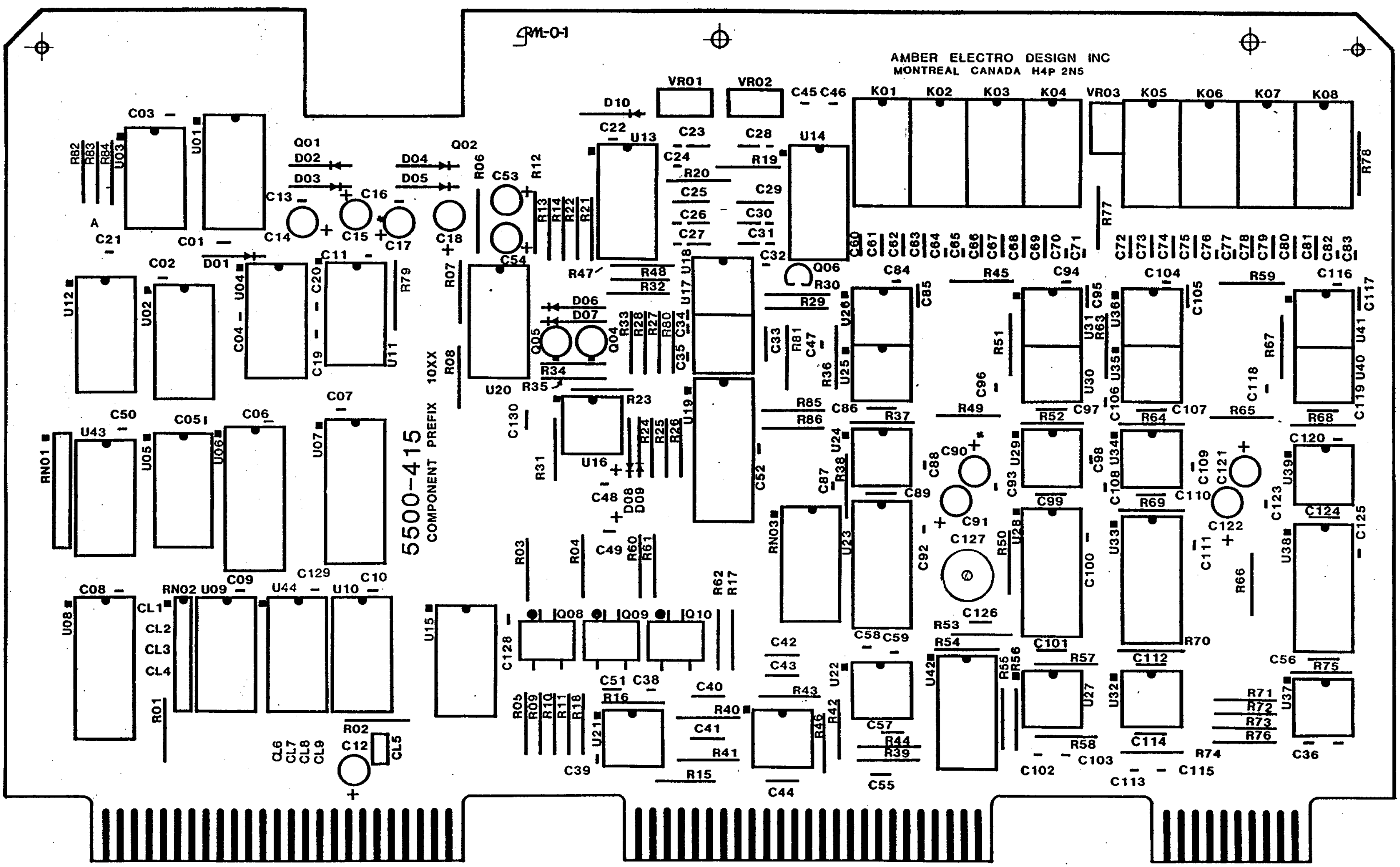


DESIGNED:	AMBER ELECTRO DESIGN INC. MONTREAL, CANADA
DRAWN: V. GOBUYAN 28/08/86	TITLE: FRONT PANEL CONNECTIONS
CHECKED:	17
APPROVED:	DRAWING NO ▷ 5500-C-295-01



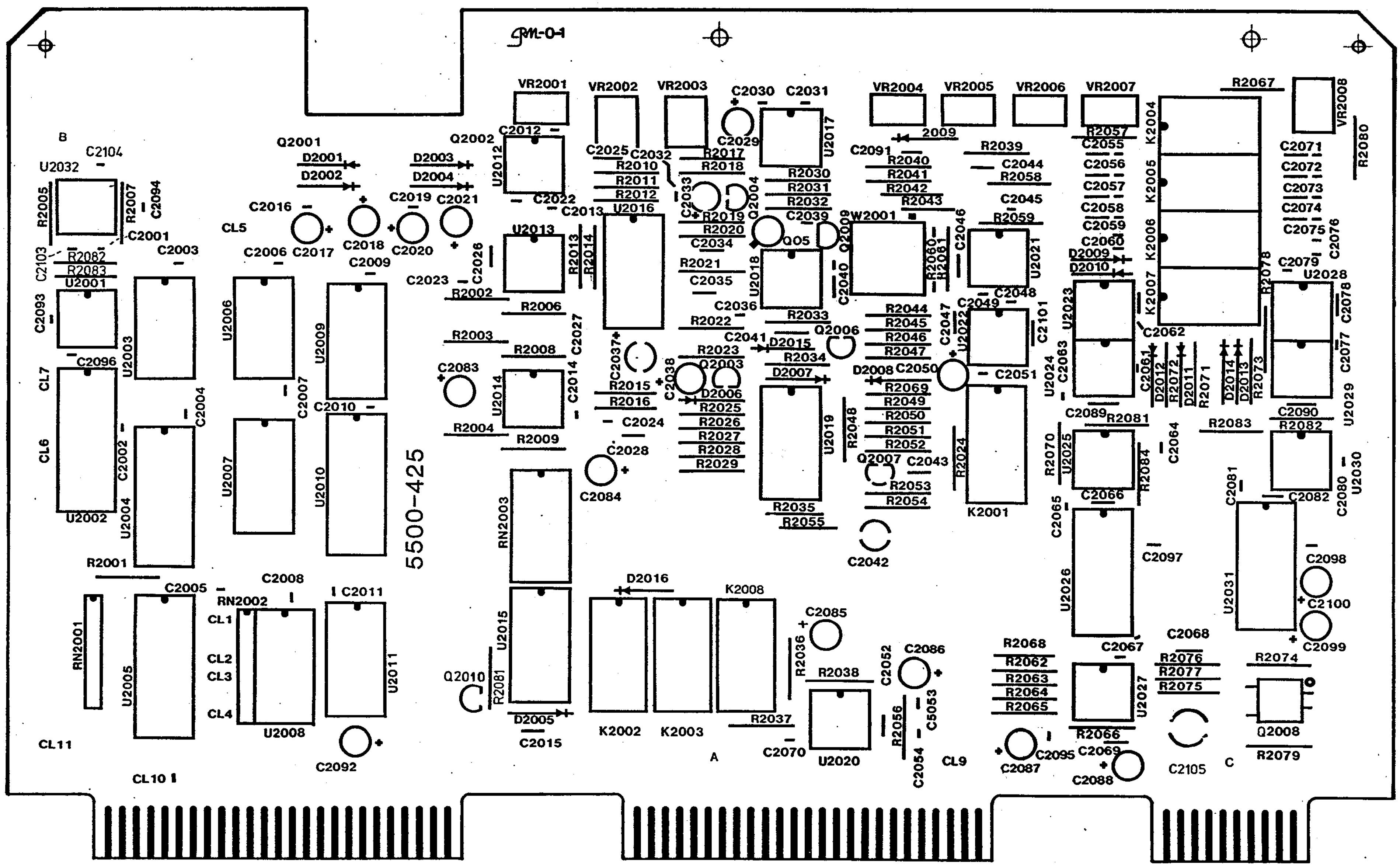
TOP VIEW OF 5500
COVER REMOVED

BOARDS



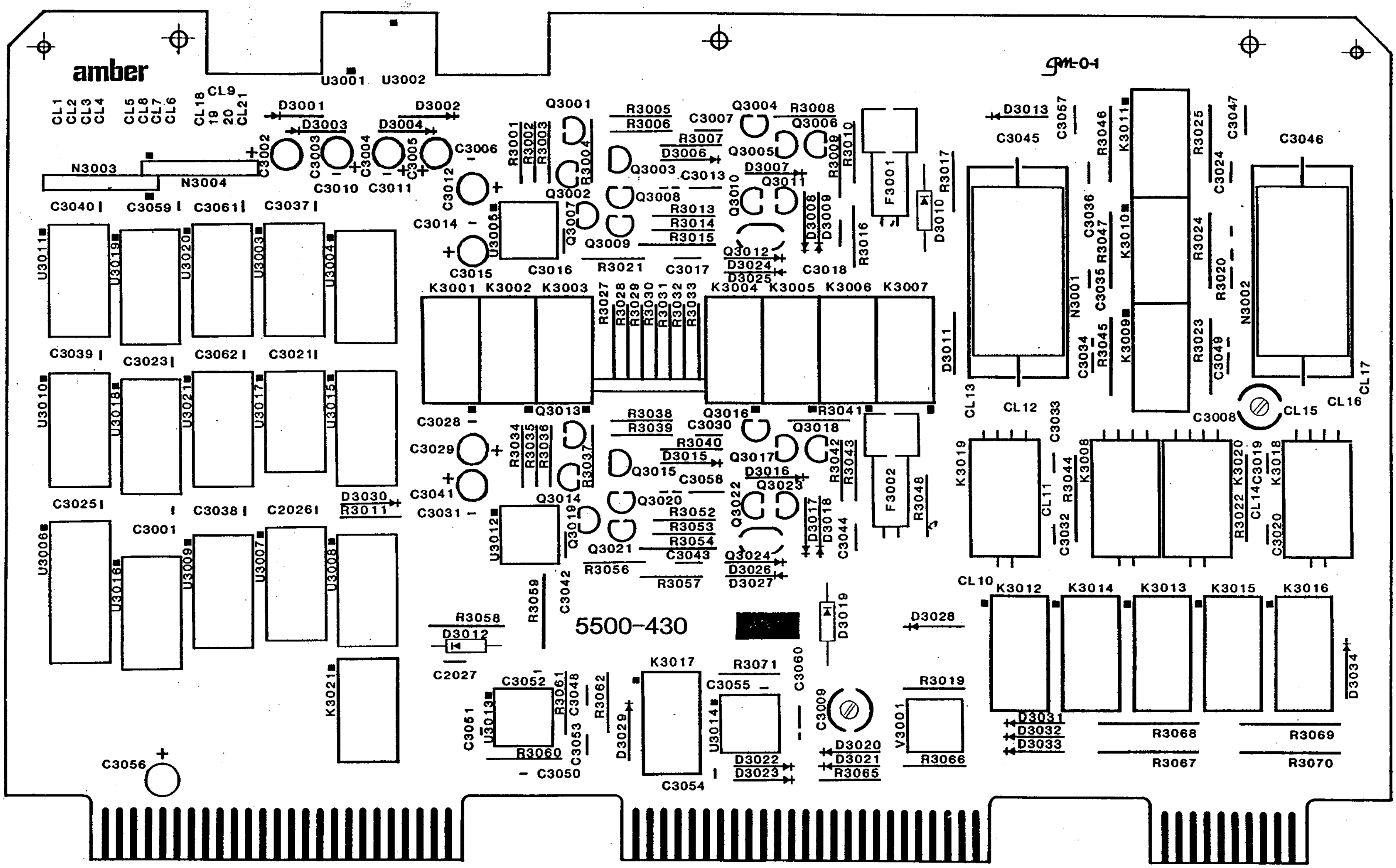
LOW DISTORTION FILTER

5500-71503



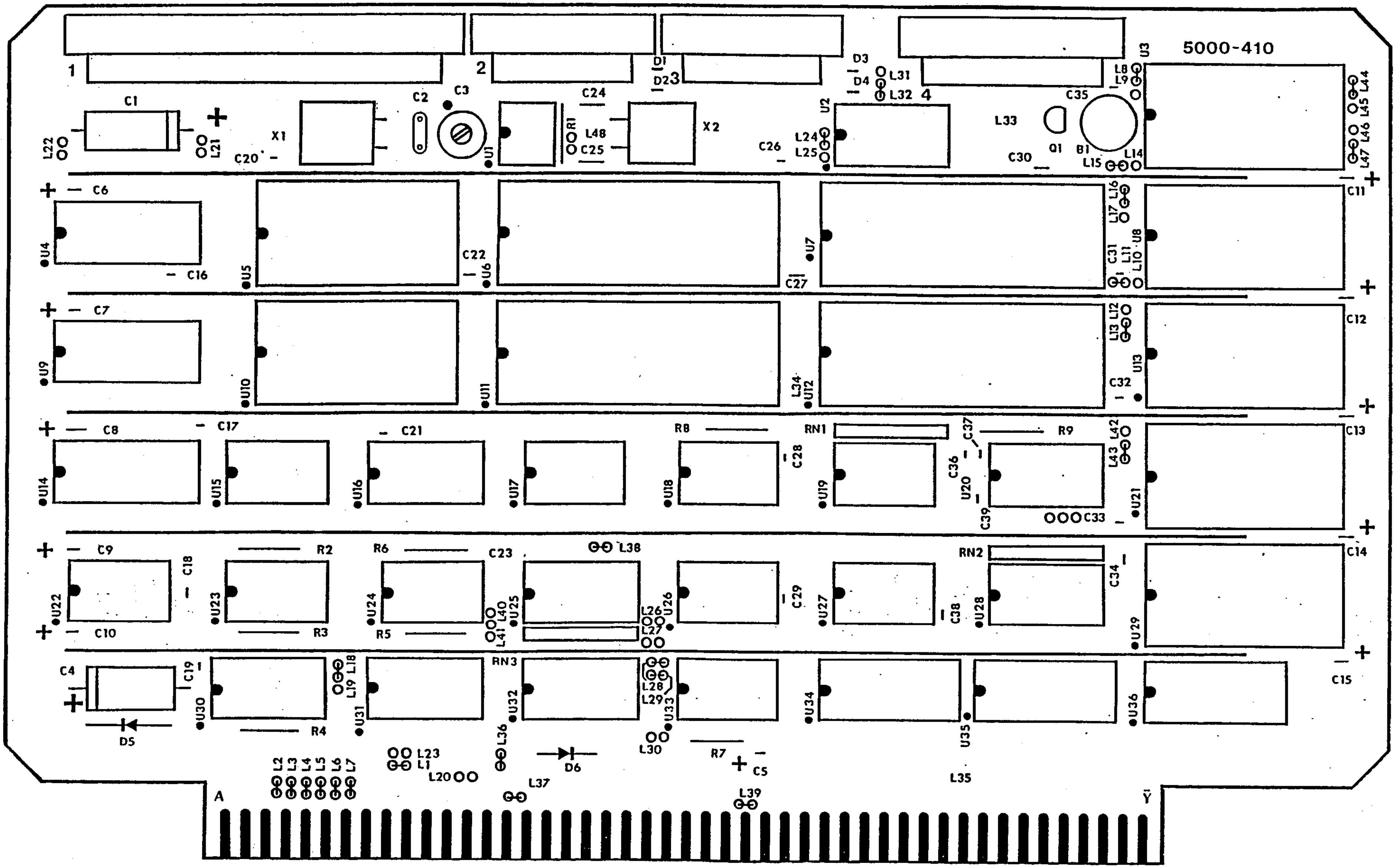
LOW DISTORTION OSCILLATOR

5500-72503



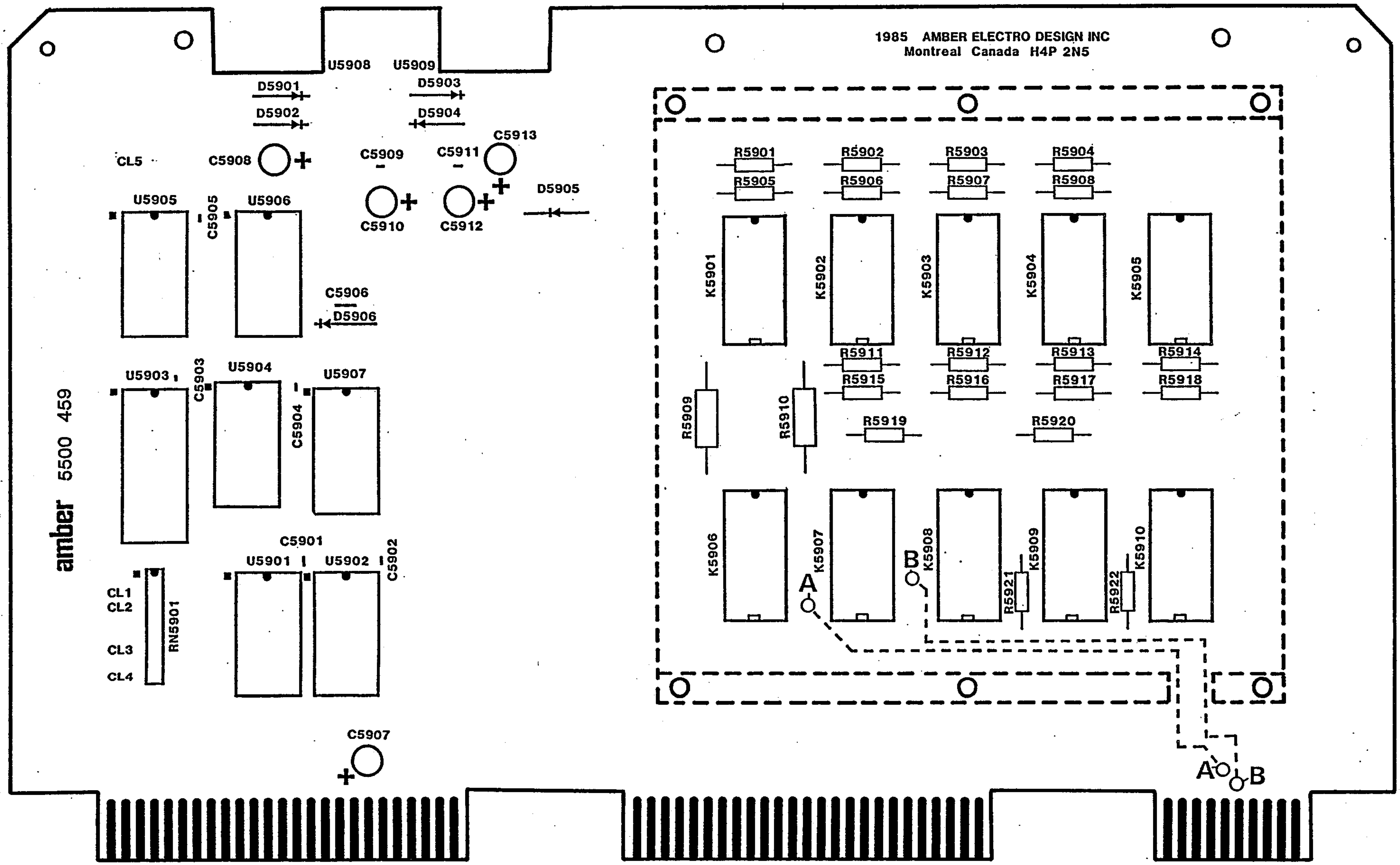
PREAMP BOARD

5500-73005



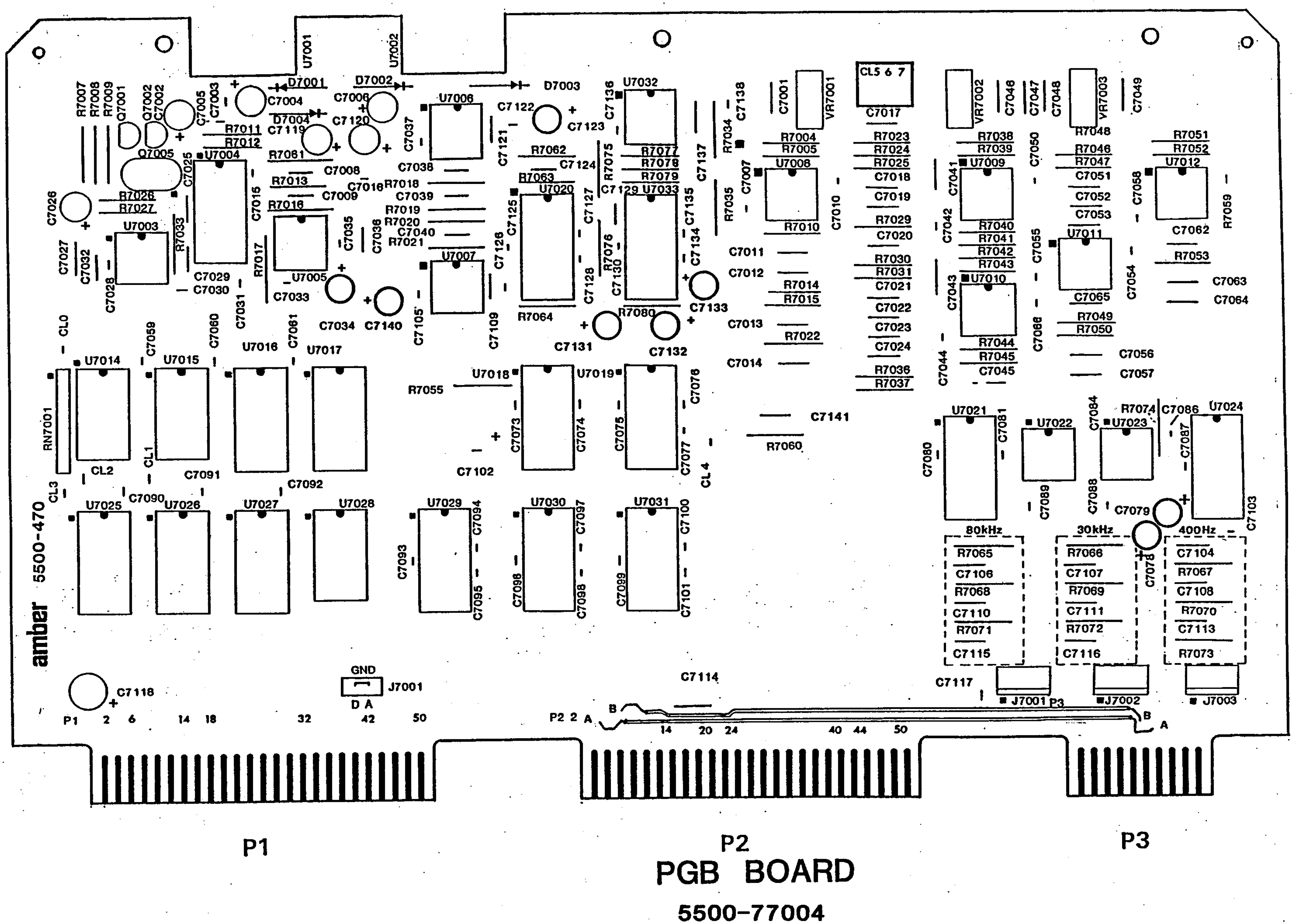
CPU BOARD

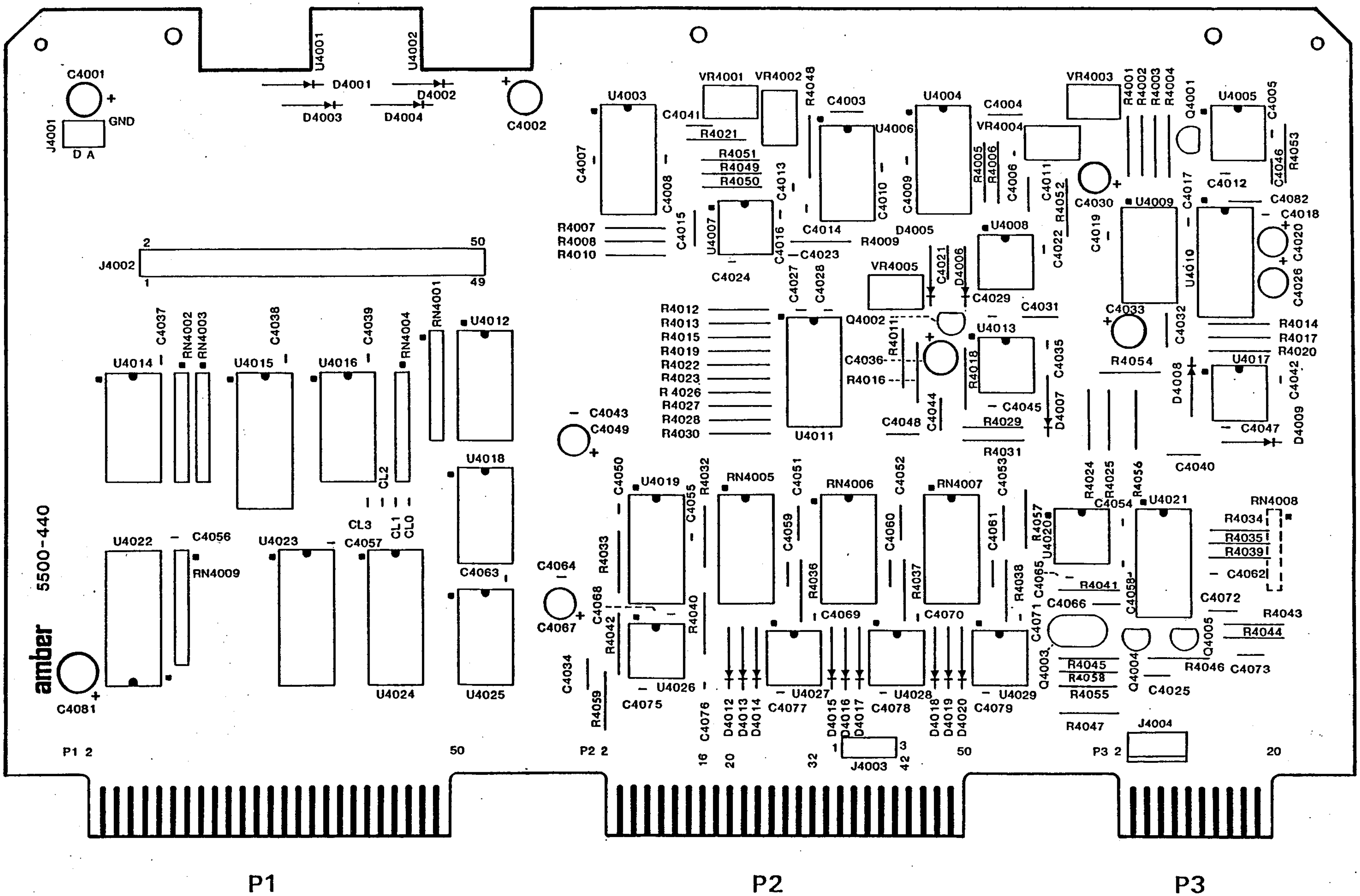
5500-71004



POWER AMP EXPANSION BOARD

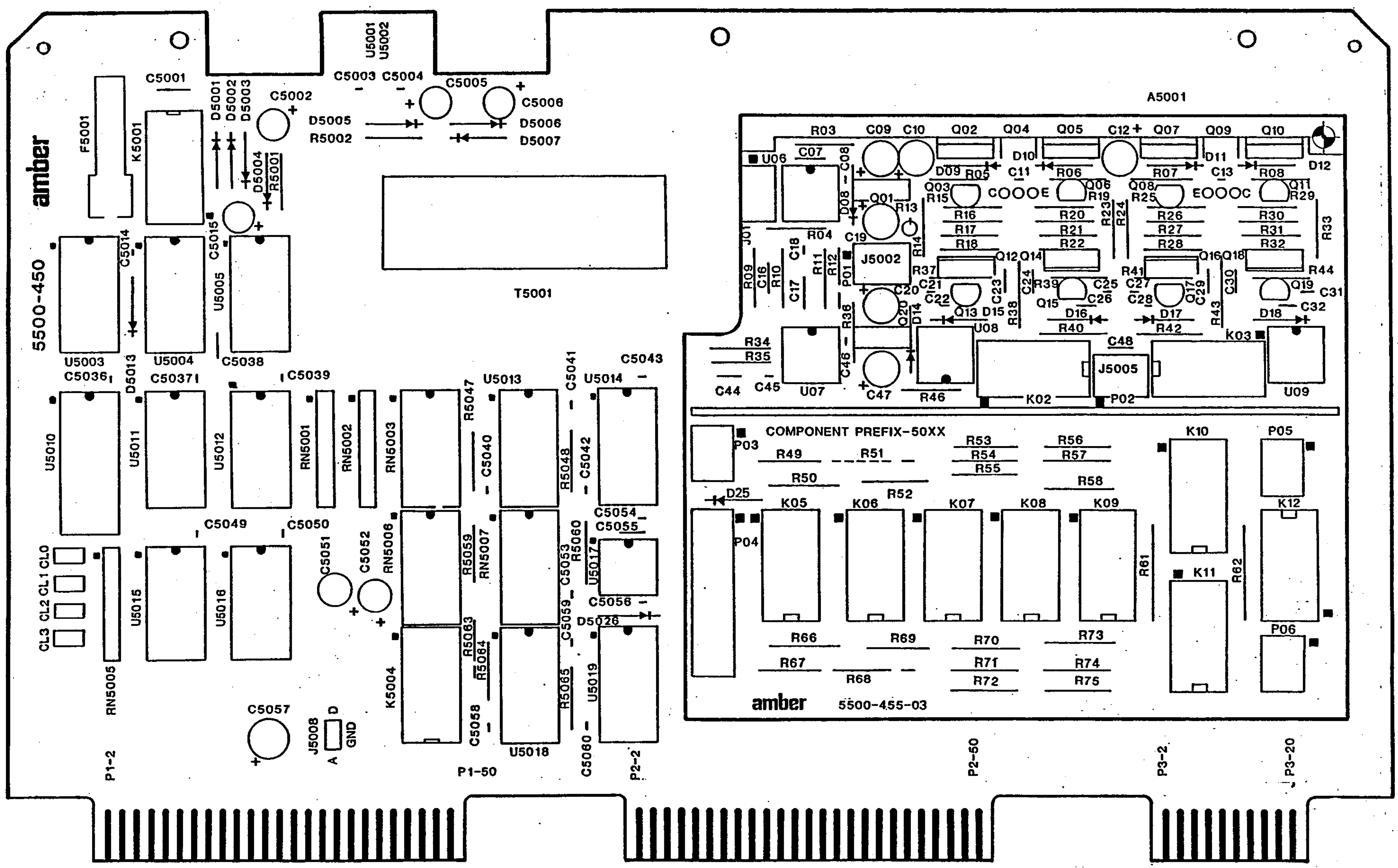
5500-75901


amber 5500-470
P1
P2
P3
PGB BOARD
5500-77004



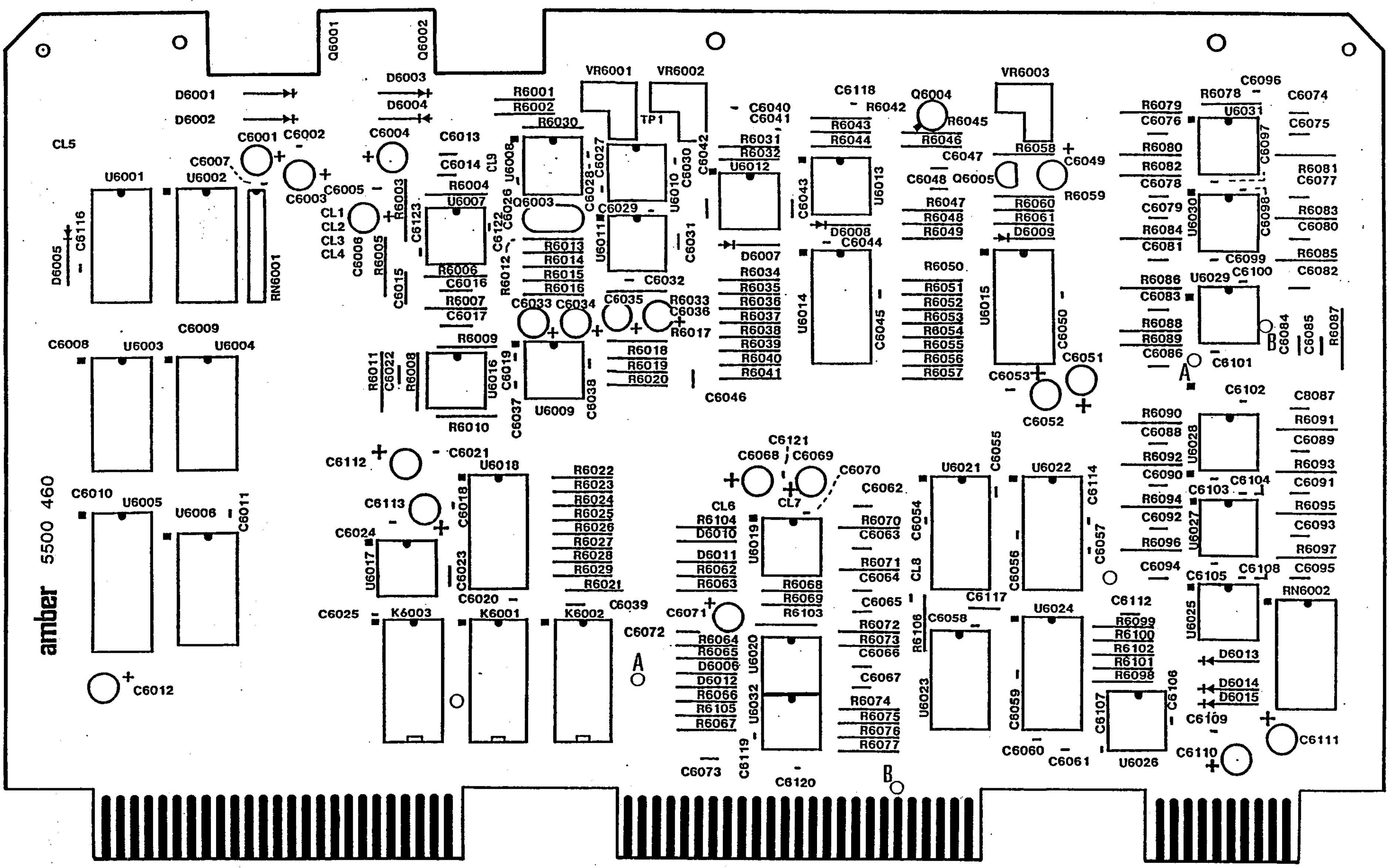
DETECTOR BOARD

5500-74004



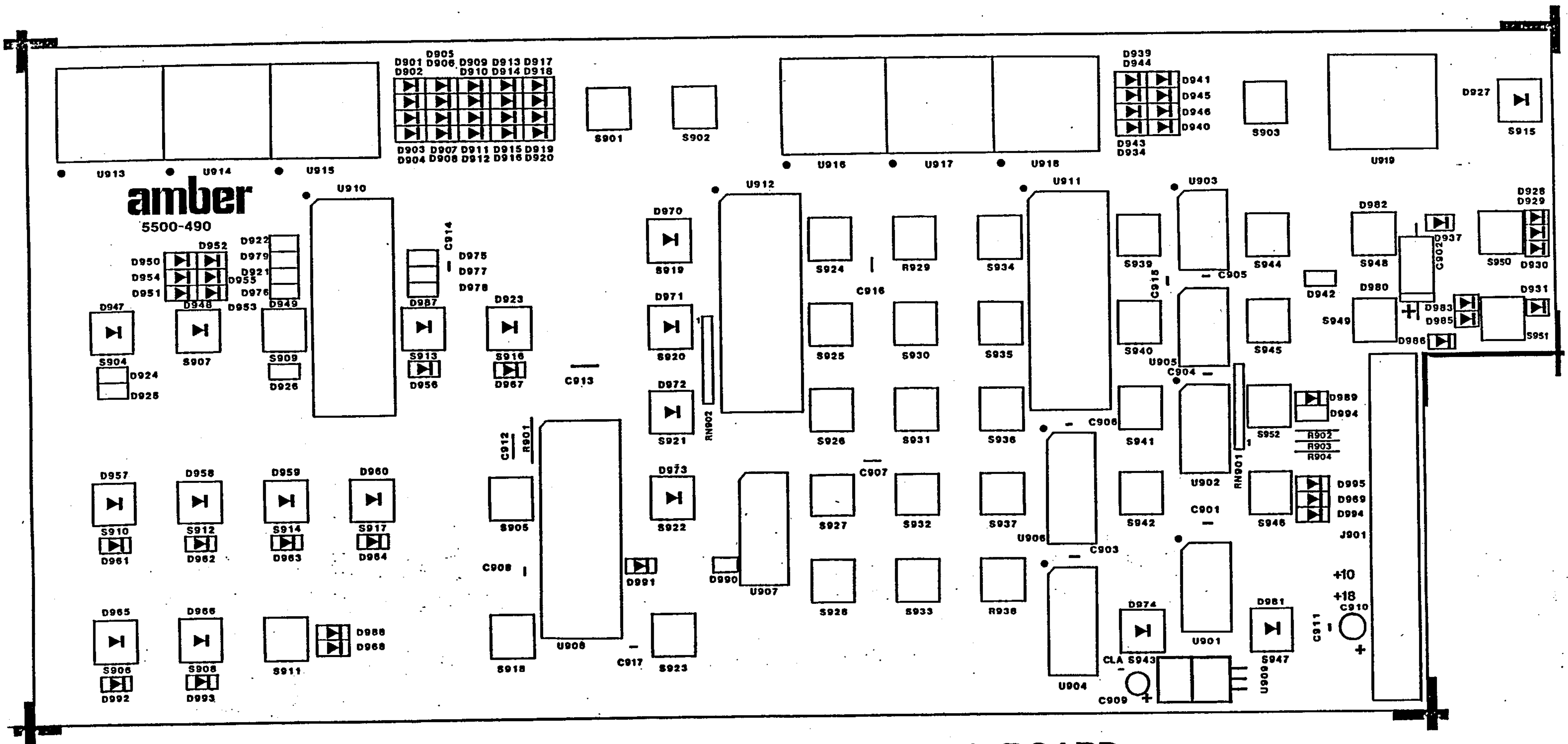
POWER AMP BOARD

5500-75005



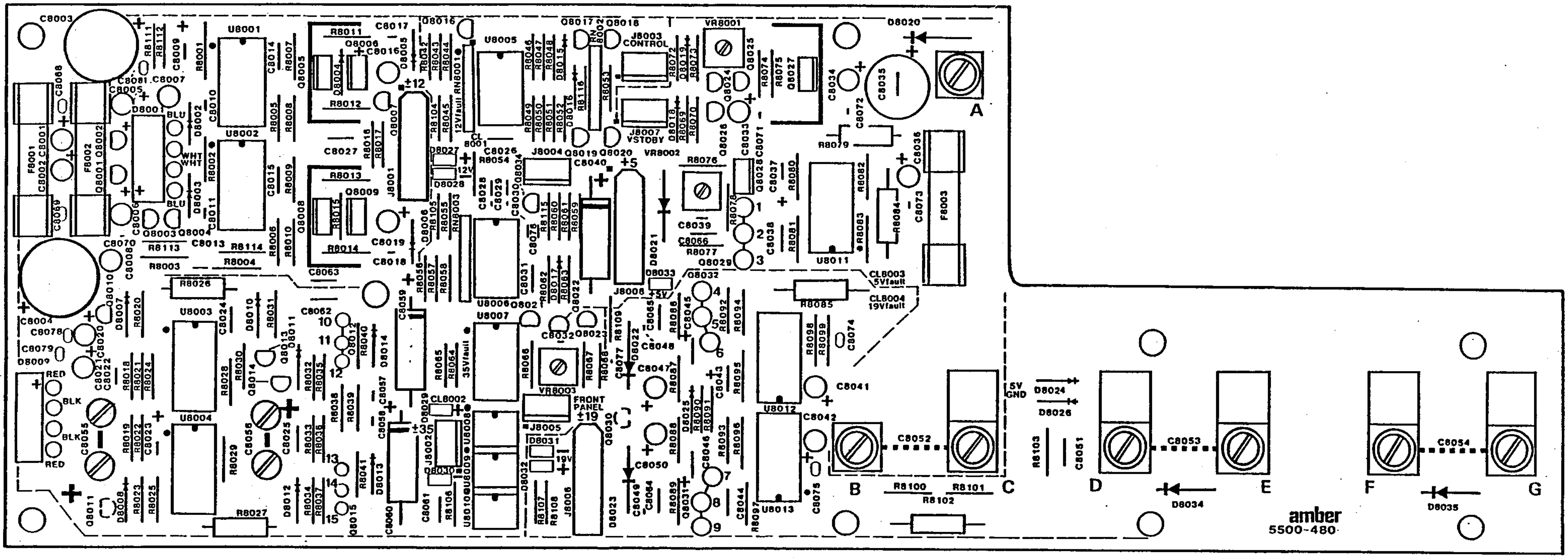
IMD BOARD

5500-76002



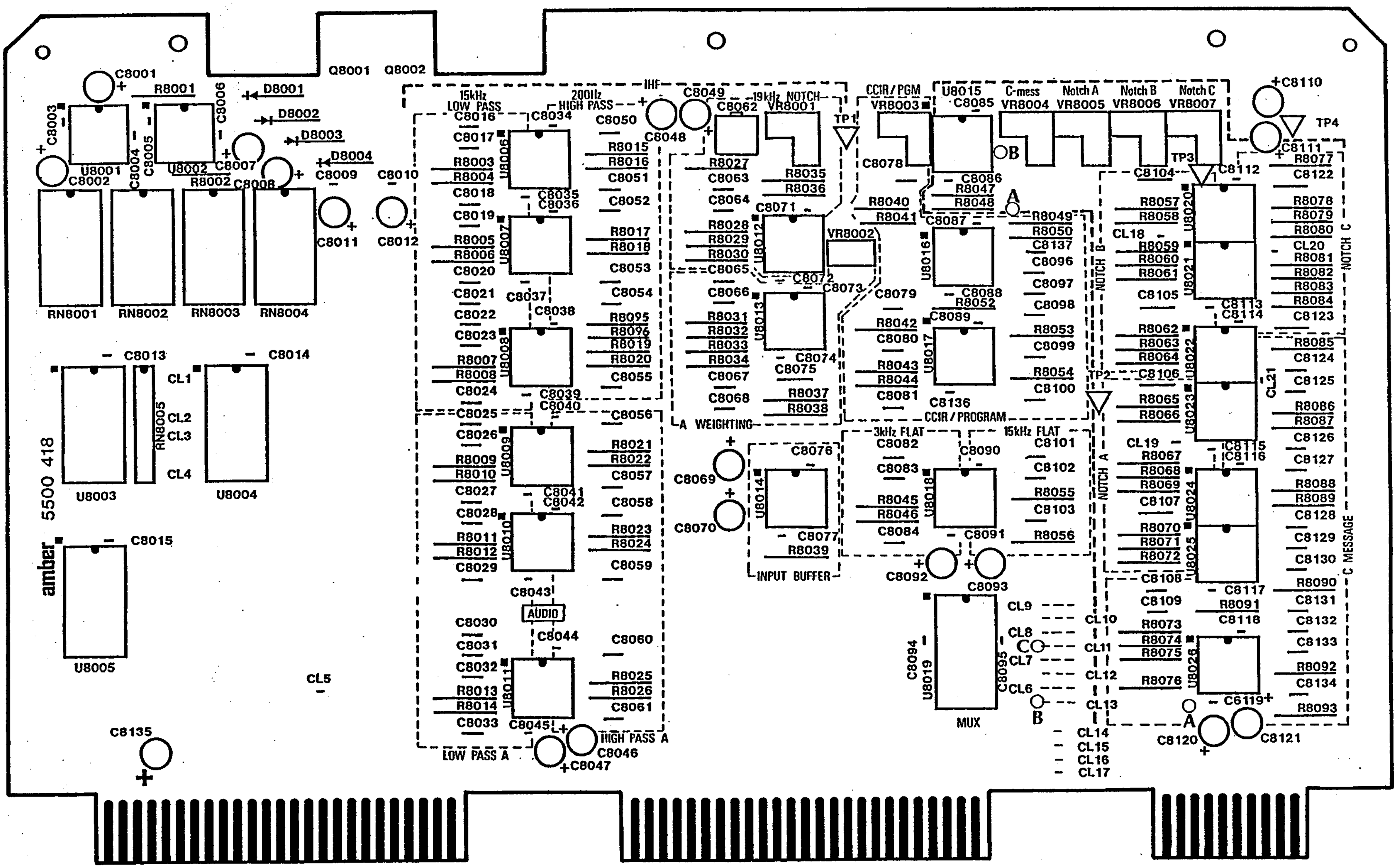
5500 KEYBOARD & DISPLAY BOARD

5500-79005



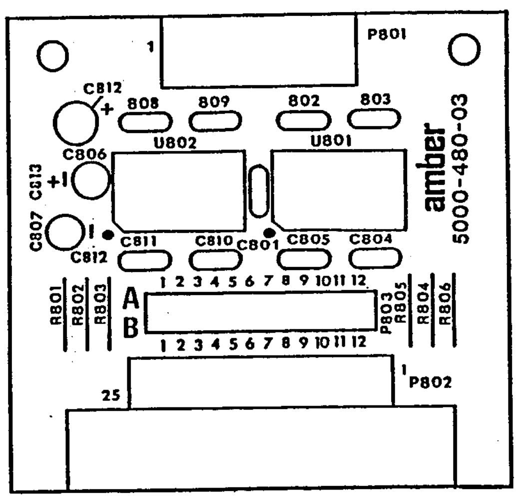
5500 POWER SUPPLY BOARD

5500-78003



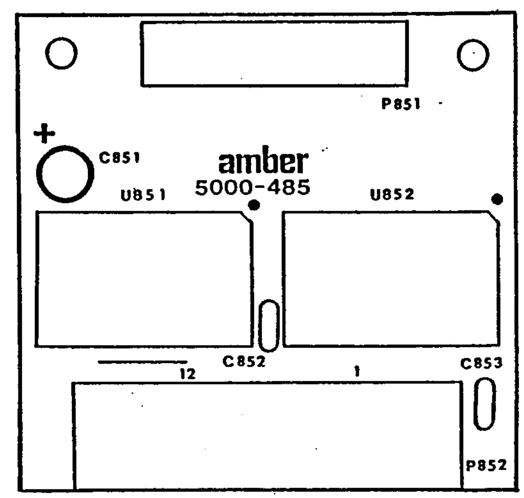
AUXILLIARY WEIGHTING FILTER BOARD

5500-71803



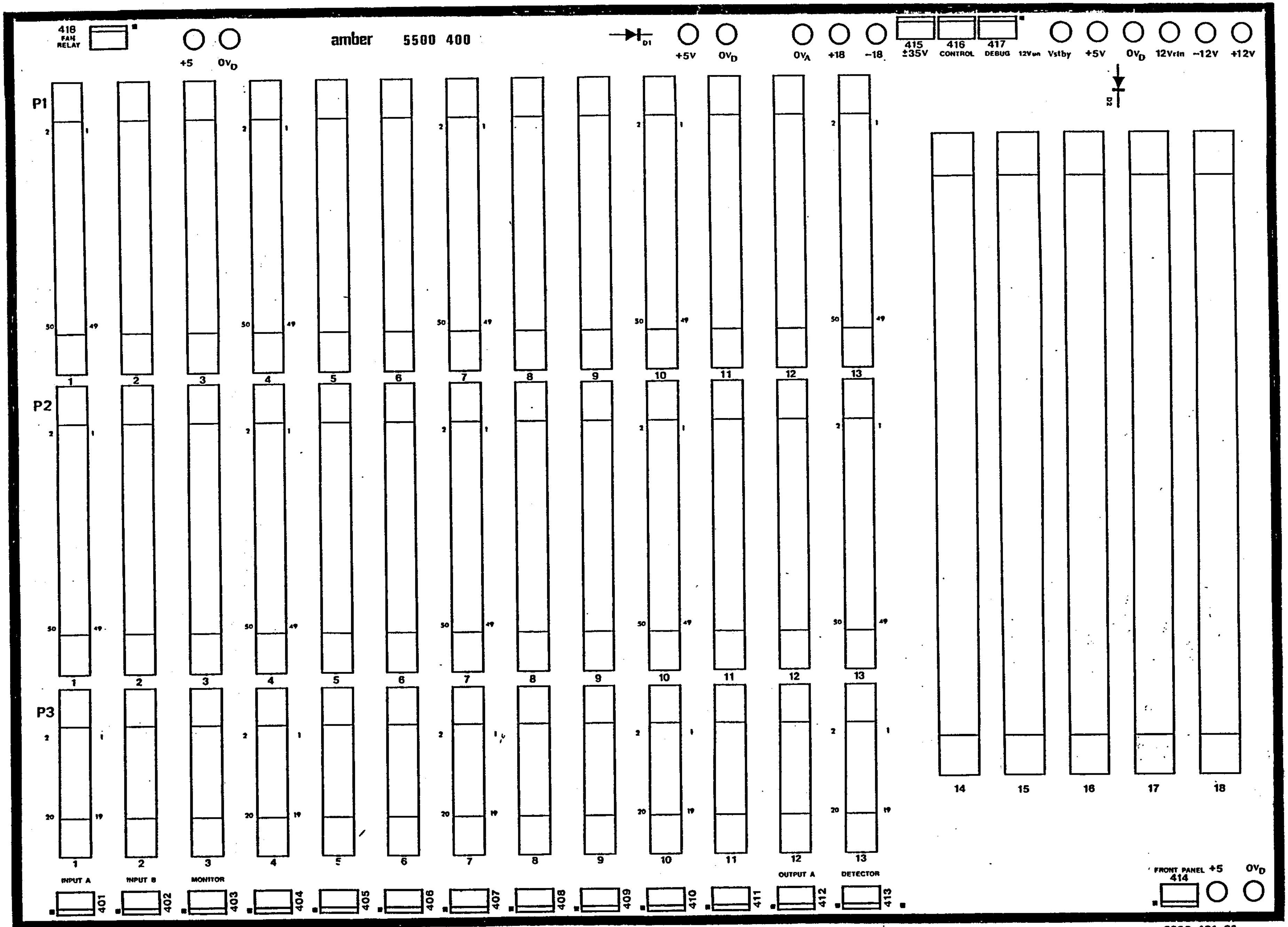
RS-232 INTERFACE BOARD

5500-78004



GPIB INTERFACE BOARD

5500-78503



5500 MOTHERBOARD

5500-70002

MOTHERBOARD P1 BUS ASSIGNMENTS				
Digital Gnd	2		1	Digital Gnd
Write* (SGR/W)	4		3	Digital Gnd
Enable* (SBEN*)	6		5	Digital Gnd
Service Request*	8		7	Digital Gnd
Frequency A (ZCD-A)	10		9	Reset* (SBRESET*)
Frequency B (ZCD-B)	12		11	Fast*
+5V Digital Power	14		13	+5V Digital Power
Data 7	16		15	Data 6
Data 5	18		17	Data 4
Data 3	20		19	Data 2
Data 1	22		21	Data 0
+5V Digital Power	24		23	+5V Digital Power
Address 7	26		25	Address 6
Address 5	28		27	Address 4
Address 3	30		29	Address 2
Address 1	32		31	Address 0
PGC Out	34		33	Analog Gnd
V Ref (+3.1623V)	36		35	Util. Analog Low
D.C. Signal Bus	38		37	Analog Gnd
Util. Analog High	40		39	Analog Gnd
+18V Analog Power	42		41	+18V Analog Power
+18V Analog Power	44		43	+18V Analog Power
-18V Analog Power	46		45	-18V Analog Power
-18V Analog Power	48		47	-18V Analog Power
Analog Gnd	50		50	Analog Gnd

Note: Connector viewed from insertion side
Even numbers: PROMAG™ component side
Odd numbers : PROMAG™ circuit side
* Denotes an active low logic signal

MOTHERBOARD P2 BUS ASSIGNMENTS

Main Osc Source	2		1	Analog Common
Auxiliary Osc Source	4		3	Analog Common
Processed Source	6		5	Analog Common
Not Assigned	8		7	Analog Common
Not Assigned	10		9	Analog Common
Notch In	12		11	Analog Common
PGA Out	14		13	Analog Common
PGA Auxiliary Out	16		15	Analog Common
Not Assigned	18		17	Analog Common
Low Pass Out	20		19	Analog Common
Band Pass Out	22		21	Analog Common
High Pass Out	24		23	Analog Common
Not Assigned	26		25	Analog Common
Frequency Fine Tune	28		27	Analog Common
Notch Out (THD)	30		29	Analog Common
Freq. MUX Spare In	32		31	Analog Common
Recovered LF	34		33	Analog Common
Recovered HF	36		35	Analog Common
Not Assigned	38		37	Analog Common
IMD Distortion	40		39	Analog Common
IMD HF	42		41	Analog Common
PGB MUX Aux In	44		43	Analog Common
PGB MUX Spare In	46		45	Analog Common
Wght Fil Out (PGC In)	48		47	Analog Common
PGB Out	50		50	Analog Common

Note: Connector viewed from insertion side
Even numbers: PROMAG™ component side
Odd numbers : PROMAG™ circuit side