Farnell Instruments

Automatic Modulation Meter
Model 257

Farnell Instruments Limited. Durban Road, Bognor Regis, West Sussex, PO22 9RL
Tel +44(0)1243 825811 Fax +44(0)1243 861232

257 AUTOMATIC MODULATION METER

CONTENTS

1. INTRODUCTION

The Automatic Modulation Meter model 257 has been designed to simplify the task of measuring amplitude and frequency modulation on signals in the range 1.5MHz to 2GHz. By eliminating the need to tune a local oscillator and make level adjustments the 257 speeds up measurements and reduces errors. Patented circuitry ensures that the meter always locks to the highest signal available ignoring spurious signals and harmonics.

AM and FM measurements can be made at full accuracy over the frequency range 1.5MHz to 2GHz and with reduced accuracy and sensitivity to 4GHz. On FM, five ranges are provided with full scale readings of 1, 3, 10, 30, and 100kHz deviation. Peak positive, peak negative or mean deviation can be displayed. On AM five ranges give full scale readings of 1, 3, 10, 30, and 100%. Peak, trough or mean of percentage modulation can be displayed.

For ease of measurement, three bandpass filters with nominal upper cut-off frequencies of 60kHz, 15kHz and 3.5kHz, a psophometric filter or a 750 μs de-emphasis network can be selected to filter the recovered modulation.

The different ranges and functions are selected by front panel push buttons with LEDs providing positive indication of function.

The unit is small and lightweight, so making it ideal for field work, especially with the battery option installed, which will give at least 8 hours of continuous use before needing a recharge.

For automatic test facilities a GPIB option is available which provides remote control and interrogation of all functions. N.B. The GPIB interface is not available if the battery option is fitted.

Available models of Automatic Modulation Meters :-

255/01	3½ Digit Display. Mains operation.
255/03	3½ Digit Display. Mains/Batt operation.
255/05	3½ Digit Display. Mains operation, GPIB option fitted.
257/01	Analogue Display. Mains operation.
257/03	Analogue Display. Mains/Batt operation.
257/05	Analogue Display. Mains operation, GPIB option fitted.
/F	A 150Hz notch filter fitted to the 3.5kHz filter can be ordered with any of the above models.

2. SPECIFICATION

2.1 RF Input

Freq Range	1.5MHz to 2.0GHz and a useful response, with reduced sensitivity, to at least 4GHz.
Impedance	50 Ω nominal.
Level	2mV to 1V rms Full specification for noise, accuracy etc applies over the input range 10mV to 1V.
Max Input	0.5W continuous.
Tuning	Automatic tuning selects the largest available signal. Correct operation requires spurious signals to be >10dB below the wanted signal.
Acquisition	Typically < 100ms. Settling time for the AF circuits is additional and is typically 1s for a reading > 75% of meter range.
Local Oscillator	Feedout -60dBm typically.

2.2 FM Measurement

FSD Ranges	Five ranges with full scale deviations of 1kHz, 3kHz, 10kHz, 30kHz and 100kHz.
Modes	Peak Positive, Peak Negative and Mean deviation.
Accuracy	± 2% of Full scale ± 1% of reading with a 1kHz tone. See audio filter specification for additional error due to AF response. Residual FM is additional.
Residual FM	<20Hz at 100MHz <100Hz at 500MHz <200Hz at 1000MHz Measured with 3.5kHz AF bandwidth.
Distortion	<1% at 100kHz deviation with a 1kHz tone.

2.3 AM Measurement

FSD Ranges	Five ranges with full scale indications of 1%, 3%, 10%, 30%, 100%.
Modes	Peak, Trough and Mean of peak and trough.
Accuracy	± 2% of Full scale ± 2% of reading with a 1kHz tone. See audio filter specification for additional error due to AF response. Residual AM is additional.
Residual AM	<0.5% (15kHz bandwidth selected)
Distortion	<1% for 80% AM with a 1kHz tone.

2.4 Audio Filters

60kHz Filter	250Hz - 60kHz ± 0.5 dB 12Hz - 72kHz ± 3 dB typically. HF roll off at 80 dB/decade.
15kHz Filter	250Hz - 15kHz ± 0.5 dB 12Hz - 19.5kHz ± 3 dB typically. HF roll off at 60 dB/decade.
3.5kHz Filter	250Hz - 3.5kHz ± 0.5 dB 12Hz - 4.0kHz ± 3 dB typically. HF roll off at 100 dB/decade.
Psophometric	Complies with CCITT Volume V P53
De-emphasis	750µs de-emphasis. 3 dB bandwidth typically 12Hz - 212Hz. HF roll off at 12dB/decade.

2.5 Front Panel

AF OUTPUT	Front panel BNC.
Level	0dBm approx. for FSD.
Impedance	600 Ω nominal.
DISPLAY	
Type	Moving coil meter with 60mm mirror scale.
Overload	Fully protected against overranging.

2.6 Power Requirements

AC Line	Internal selection
115V	102V to 130V
230V	205V to 265V
Power	6VA Approx.
Frequency	48 to 60Hz.
Fuse	100mA fast blow on rear panel.

2.7 Environmental

TEMPERATURE	
Operating	0°C to 55°C. Full specification over the range 5°C to 45°C.
Storage	-20°C to 55°C.
Humidity	Max 95% RH at 30°C.
MECHANICAL	
Size	H105, W215, D305 mm
Weight	Approx 1.7kg. Approx. 2.6kg with battery option.

2.8 150Hz Notch Filter (Option)

Notch	150Hz ± 3Hz >40dB on 3.5kHz filter range
3.5kHz Filter	250Hz - 3.5kHz ± 0.5 dB HF roll off at 100 dB/decade.

2.9 Battery Facility (Option)

Discharge Time	>8 hours. Typically 10 hours for a fully charged battery.
Recharge Time	14 hours.
Battery Test	Pressing the Bat Chk push button displays the battery condition on the display. A reading of between 8 and 10 is required for normal operation.
Fuse	1A slow blow on rear panel.

2.10 GPIB Interface (Option)

Address	0 to 15 Selectable by rear panel DIL switches.
Interface	Remote control and interrogation of all functions via a GPIB interface. This interface complies to the ANSI/IEEE 488-1978 standard with message formats compliant with ANSI/IEEE 728-1982 standard.
Subsets	SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0.

3. OPERATING INSTRUCTIONS

3.1 Power Requirements

AC MAINS OPERATION

Two AC power ranges are available, 102V - 130V and 205V - 260V. Select the appropriate range on the mains selector switch. This is located adjacent to the mains transformer on the bottom PCB inside the instrument and is identified as W1.

WARNING

INCORRECT SUPPLY RANGE SELECTION COULD CAUSE SERIOUS DAMAGE TO THE INSTRUMENT.

Connect the power lead to the local AC supply socket. The instrument is switched on by switching the front panel rotary switch to 'ON'. The instrument is immediately ready for use; no warm-up time is required. At power on the 257 defaults to the FM 100kHz range with the mean detector and the 3.5kHz filter selected.

3.2 Input Signal

Connect the signal source to the 'INPUT' socket, the 'LOCK' LED should immediately illuminate if the signal is within the range 2mV to 1V. The 'LOCK' LED shows that the instrument is correctly tuned to the incoming signal. The measuring circuits are inhibited when the 'LOCK' indicator is not lit.

The instrument locks to the highest level signal applied to the input. It will not lock to a harmonic or other spurious signal provided that the intended carrier has the highest level signal and that it is within the specified frequency range. The tuning mechanism provides a continuous dynamic frequency lock that permits accurate modulation measurements to be taken even on a slowly sweeping carrier.

In general, the instrument provides good selectivity against interference from spurious signals. However, the broadband nature of the input circuit implies that the possibility of such interference cannot be completely eliminated. If it is suspected that a reading is being affected by high level interfering signals, make a check by disconnecting and reconnecting the signal source several times; any change in the modulation reading implies interference. Normal harmonic levels, even in the worst case, are unlikely to have any effect on measurements.

3.3 FM Measurement

Proceed as follows :-

1. Press the 'MODE FM' pushbutton.

2. Select the appropriate 'RANGE' with the < > pushbuttons. Five ranges are available with full scale deviations of 1, 3, 10, 30 and 100kHz.

3. Select the required 'AF FILTER' with the < > pushbuttons. Five filter functions are available; three bandpass filters with nominal upper cut-off frequencies of 60kHz, 15kHz and 3.5kHz; a psophometric filter complying to the CCITT standard and a 750 μs de-emphasis network.

4. Select the required 'DETECTOR' mode with the '+', 'MEAN' and '-' pushbuttons. '+' gives peak positive deviation, '-' gives peak negative deviation and 'MEAN' gives the average of peak positive and peak negative deviations.

3.4 AM Measurement

Proceed as follows :-

1. Press the 'MODE AM' pushbutton.

2. Select the appropriate 'RANGE' with the < > pushbuttons. Two ranges are available with full scale modulation percentages of 10.00% and 100.0%. The demodulator is highly linear and allows accurate AM readings up to 100%.

3. Select the required 'AF FILTER' with the < > pushbuttons. Five filter functions are available; three bandpass filters with nominal upper cut-off frequencies at 60kHz, 15kHz and 3.5kHz; a psophometric filter complying to the CCITT standard and a 750 µs de-emphasis network.

4. Select the required 'DETECTOR' with the '+', 'MEAN' or '-' pushbuttons. '+' gives peak percentage modulation, '-' gives trough percentage modulation and 'MEAN' gives the average between the peak and trough modulation.

3.5 Battery Operation (Option)

To operate from the internal battery, switch the front panel rotary switch to 'Bat'. This will give at least 8 hours of continuous use from a fully charged battery. The battery state during mains or battery operation can be determined by pressing the 'Bat Chk' pushbutton. A reading between 8 and 10 on the scale is required for normal operation. To charge the battery, switch the front panel rotary switch to 'Chge'. Allow 14 hours for a complete charge. A yellow LED shows that the battery is on charge. During normal mains operation the battery is trickle charged.

4. TECHNICAL DESCRIPTION

4.1 Introduction

The 257 technical description comprises a system description followed by a circuit description of each sub-assembly. The circuit description shows how the particular system functions are achieved.

4.2 System Description

RF System

The RF input is applied to a sampling mixer. This mixer allows a wide range of RF carrier frequencies to be covered with a single local oscillator of modest tuning range. The mixer is tolerant to overloading and is very linear. The lowest RF carrier frequency is determined by the fundamental frequency range of the local oscillator (L.O.). The highest RF carrier frequency is determined by the harmonics in the very narrow (250 picoseconds) sampling pulse. An incoming signal causes the L.O. frequency to change until the mixer output is at IF (420kHz), when the L.O. is locked.

The mixer output is fed via a buffer, a 1.5MHz low pass filter (to remove L.O. and RF carrier frequencies), and an a.g.c. stage to the IF amplifier.

The L.O. is controlled by a broadband phase sensitive detector which locks the oscillator to the highest amplitude signal in the IF passband via an integrator system.

AM Demodulation

The IF output is fed via a band pass filter which allows all relevant modulation side bands to pass to the AM demodulator.

The AM demodulator is an active mean detector and is highly linear. The demodulated AF signal is fed to the AF Board and is also used to control the a.g.c. system.

FM Demodulation

The FM demodulator is of the pulse integrating type and is highly linear. The output consists of twin current sources of opposite polarity.

The effective L.O. frequency (particular L.O. harmonic) may be above or below the RF carrier frequency, and this affects the sense of the IF deviations. A phase switch selects the output from the demodulator which is appropriate for the particular L.O. frequency.

Frequency Locking System

An output from the IF amplifier is limited to remove any AM. Normal and inverted outputs from the limiter are applied to a phase shifting network. An output from the centre of the network plus one of the inputs is fed to a phase sensitive detector. The detector is balanced when the two inputs are in quadrature, i.e. when the phase shifting network is at resonance (420kHz).

When the IF deviates from 420kHz, the phase sensitive detector is driven off balance, in a direction determined by the state of the phase switch. This causes the integrator voltage to rise or fall, as appropriate to adjust the L.O. frequency to bring back the IF to 420kHz.

To prevent the integrator saturating, a comparator circuit detects when the oscillator tuning voltage has exceeded the desired range. The comparator output triggers a monostable which resets the integrator to within the control range.

If the phase of the feedback is incorrect, the local oscillator will be moved away from the required frequency. The comparator will then operate and the monostable will clock a bistable; this reverses the phase of the reference signal into the phase discriminator, and also selects the appropriate FM demodulator output.

Lock Indication

A comparator inhibits the lock action if the a.g.c. voltage goes out of the proper operating range. A detector and comparator combination measures the signal level at the phase shifting network and inhibits the lock indication if an IF signal at 420kHz is not present. Besides controlling the lock indicator, the lock signal also inhibits the input to the AF system and disables the peak and trough detectors.

AF System

The required AM or FM audio signal is selected by a switch and fed through a 60kHz LPF which feeds a 15kHz LPF which feeds a 3.5kHz LPF which feeds into a pshophometric filter. The 60kHz LPF also feeds into a de-emphasis circuit. The outputs from these filters are selected by a switch and fed into a switched gain stage with gains of x1 or x10 and x1, x3.3 or x10.

The switched gain stage output is fed through a 25Hz high pass filter (to remove any sub-audio components) to the audio detectors.

The peak and trough of the AF signal are separately detected. Switches at the output select the measurement mode:peak, trough and the mean between peak and trough. This drives the meter.

4.3 Circuit Description

The following descriptions should be read in conjunction with the circuit diagrams which are located in section 8 of this manual.

RF Circuit

The sampling mixer D4 to D7 is fed from the L.O. T63, L7, D1, D2 via the driver amplifier T64 to T68, and the pulse generator using step recovery diode D3 and L9.

The FET buffer stage T1 prevents loading of the mixer. Inductor L2 with C5 to C7 form the 1.5MHz low pass filter and T2 is the gain control stage.

The IF amplifier comprises the FET input stage T3, emitter-coupled pairs T4, T5 and T6, T7 and tuned stage T10 driven by T8. The output to the limiter of the L.O. control system is provided by T9.

The filter (L3, C18, L4, L5 and C19) feeds the detectors and the driver (T11) for the IF socket. VR5 adjusts the filter shape for minimum AM on FM.

The AM demodulation is performed by transistors T12 and T14, with bias control provided by T13. The demodulator outputs appear as currents of opposite polarity. One is converted to a voltage by VR3 with T15 and is fed to the AF Board; VR3 sets the AM output amplitude. The other output is applied to C22, which is backed off by the a.g.c. reference current source (T17 to T19); VR6 sets the a.g.c. threshold. The potential on C22 is applied to the a.g.c. control FET T2. If the level of the IF signal applied to the demodulator is not correct the current into C22 will be greater or less than the back off current, and the signal level into the IF amplifier will be controlled accordingly.

The signal at T13 collector is a clipped version of the IF and feeds the limiting amplifier T25 to T27. C25,T28,T29 form a monostable with emitter current controlled by T32. VR4 controls the clipping level, which thus sets the FM demodulator output amplitude.

The pulse outputs at the collectors of T28,T29, are of opposite phase. When T31 is on, the output is fed via D19 and when T31 is off, the output is fed via D20.

Transistor T41 with associated diodes clips the IF signal to remove any AM and the clipped signal is applied to C33 of the series tuned circuit C33,L6. T42 provides an anti-phase signal which is applied to the other end of the tuned circuit (L6). Bistable IC1 via T43 selects at TP3 either the in-phase or the anti-phase signal (at D27,D28) to be applied to the phase detector, with the quadrature signal at TP4 from the centre of the tuned circuit (C33/L6).

The phase detector consists of two series current switches, T44 controlled by T56, and T57 controlled by T55. The output current feeds the 'current mirror' circuit T51 and T52. Preset controls VR1 and VR2 set the gain and

offset respectively. The current output is fed through the composite amplifier T58, T60, T61, T62, to the integrator capacitor C45 and via L12, L8, L7 to the varicap diodes D1, D2, causing the L.O. frequency to change.

The tuning voltage is monitored at the dual comparator T59, T54, T53. When the voltage is outside the normal range, monostable T47, T46 is triggered which, in turn, clocks the ICI. Also, the reset circuit T48 to T50 operates to reset the integrator at T58 base.

Transistors T20, T21 act as a dual comparator to detect if the a.g.c. voltage is within the working voltage range. Diodes D14,D21 detect the presence of a 420kHz IFsignal at the tuned circuit C33/L6. This is combined with the a.g.c. detector output through D13, and is converted to a logic signal by T22, T23 to switch the Lock line and Lock LED.

AF Circuit

The audio inputs are fed via analogue switch U1a which selects AM or FM into the active filter U2a,b. This is a 3 pole 60kHz low pass filter with a gain of approximately 2.5. Trimmer CV1 is adjusted to give the 60kHz filter a flat response (within 0.5dB) to 60kHz. The output is fed into the analogue 8 input switch U4 and to the input of a 15kHz low pass filter U2c. The output of this filter is fed to the switch U4 and the input of a 3.5kHz low pass filter U2d and U3a. The output of the second stage (U3a) is fed to the analogue switch U4 and both first and second stage outputs feed the psophometric filter U3b and U3c. Potentiometer RV2 is used to adjust the gain of the psophometric filter to unity at 800Hz. The output of this filter is also fed into the analogue switch U4. The 60kHz filter output is also used to feed into de-emphasis filter R6,C9 to give 750µS de-emphasis. This along with three test points at various points along these filters is fed into the analogue switch U4.

Control of the analogue switch U4 is from U18 which has inputs from the front panel controls.

The analogue switch output U4 feeds an amplifier U3d which is selectable x1/x10. This feeds an amplifier U5a which has a gain of x1. These two gains are used to give the 10 and 100 ranges; driven by U15a,b,c which has inputs from the front panel as before. The output of this series of amplifiers is fed through a 25Hz active high pass filter U5b. The signal is then further amplified (U5c) to provide a 0dBm AF output from 600ohms (R33,R34 in parallel).

The output of U5c is then attenuated by R35 and R36 to be an equal in amplitude but inverted, version of the output of U5b. Potentiometer RV4 sets the amplitude to be indentical. These two outputs feed the two peak detectors U6d/U16a/U6a and U6b/U16b/U6c. They are both the same: but since the output from U5c is an inverted version of U5b the upper one is in the peak mode and the lower one is the trough mode. If the input on U6 pin 10 exeeds the output voltage on U6 pin 9, then comparator U6d charges up C28 through R39 and D2. The voltage across R39 and C28 is buffered by voltage follower U6a, which feeds the output to switch U7 and the comparator U5d. This is speeded up by D1 and R40.

The long discharge time constant is provided by R41. Analogue switch U16a quickly discharges the hold capacitor C28 when the RF board is unlocked. A small negative offset voltage is provided by R47/R48 to override the op-amp U6a offset, and the overall offset is trimmed out by potentiometer RV5.

Analogue switch U7 selects either peak/trough/mean (via R42,R50) or the battery test voltage (adjusted with potentiomenter RV10). The switch output is buffered to drive the meter.

The lock detector indicator input is on P4 pin 6. This is buffered and inverted and used to disable switches U1 and U4 when not locked.

Front panel lock LED drive is provided by U10a,b. The filter LEDs are driven from U12a and U10c which are decoded from the control lines. The range LEDs are driven from U12b and U10d which are decoded from the control lines. The AM and FM LEDs are driven from U13a and the peak/ trough/mean LEDs are driven from U13b.

Front panel switch decoding for the filters is done in the form of up/down buttons by U14,18 and 25. The ranges are done in the same way by U14,25 and U20. U20 also decodes the FM/AM and peak/mean/trough switches.

The mains transformer has two secondaries feeding a bridge rectifier, to generate positive and negative rails. On battery versions the positive regulator U21 is switched by W2 between 12.0 and 14.0V (in the charge mode). The potentiometer RV8 sets the actual voltages. The charge current is limited to about 150mA by R76.

When the unit is run from the battery the +12V rail is fed directly from the battery (i.e. unregulated) via W2c. The -15V rail is generated by an inverter T1 and T2 with L1. This is switched via W2a into the -12V regulator U22. The rails also feed regulators U23 and U24 to generate +5V and -5V respectively.

On mains only and GPIB versions U21 is replaced with a LM2940 regulator which is a low drop out voltage +12V regulator. R76 is replaced with a link.

Tables follow to show decoding for R1,2,3; F1,2,3; D1,2.

RANGE CONTROL LINES					
R3	R2	R1	FSD	U3d Gain	U5a Gain
0	0	0	1kHz	x10	x10
0	0	1	3kHz	x10	x3.3
0	1	0	10kHz	x1	x10
0	1	1	30kHz	x1	x3.3
1	0	0	100kHz	x1	x1

FILTER CONTROL LINES			
F3	F2	F1	Filter
0	0	0	60kHz Bandpass
0	0	1	15kHz Bandpass
0	1	0	3.5kHz Bandpass
0	1	1	Psophometric Filter
1	0	0	750µs De-emphasis
1	0	1	Test Point (15kHz)
1	1	0	Test Point (3.5kHz)
1	1	1	Test Point (Psophometric)

DETECTOR CONTROL LINES		
D2	D1	Detector Mode
0	0	Mean (of peak and trough or positive and negative)
0	1	Trough or negative deviation
1	0	Peak or positive deviation
1	1	Battery volts (Option)

150Hz Notch Filter (Option)

A third order Butterworth notch filter implemented in three Tow Thomas biquadratic sections is inserted into the 3.5kHz filter on the AF board. Each section consists of 3 op-amp stages with adjustment of null and natural frequencies.

5. CALIBRATION

5.1 Test Equipment Required

1. Digital Voltmeter (DVM); ≥ 10M ohms input impedance.
2. 30MHz Oscilloscope with x10 probe.
3. 10MHz Counter.
4. Signal Generator, 1 - 2GHz (AM/CW).
5. Signal Generator, 1 - 100MHz,AM/FM.
   Variable modulation frequency, 10Hz - 100kHz.
   FM 0 - 100kHz peak. AM 0 - 100%.
6. AF Level Meter and distortion analyser.
7. Frequency Difference Meter and Reference Oscillator
   (Frequency Difference Method) or:
8. Spectrum Analyser (Bessel Zero Method).
9. Ammeter, 0 to 500mA (Battery version only).

5.2 AF Board Test

IMPORTANT. This board has mains voltages on it.
Be careful.

PSU Test

Set mains selector to 230V input. Monitor P5 pin 11 with oscilloscope or DVM, earth end to pin 16 of P5. Connect variac, set to zero output, to mains input. Switch unit on. Slowly increase the variac output and check that the voltage measured regulates at between +11.5V to +12.5V.

Check	pin 12 of P5	+5V
	pin 13 of P5	- 5V
	pin 14 of P5	-12V

Front Panel Interface Tests.

Connect front panel board and check for normal response of switches and LEDs. Switch power off and then back on. Unit should power on set to FM, 100kHz range, 3.5kHz filter and Mean detector.

Adjustment of Notch Filter (Option)

Monitor the AF o/p with a dB meter. Set level of audio at 1kHz to read 9 on the model 257. Zero the relative mode on the dB meter.

Adjust RV1 and RV3 fully anticlockwise. Set the AF to 150Hz. Monitor the AF o/p (pin 8 U3) with a oscilloscope and adjust RV5 for a minimum on the oscilloscope.

Monitor H2 with oscilloscope and adjust RV3 for min 150Hz.

Monitor H1 with oscilloscope and adjust RV1 for min 150Hz.

Set AF to 180Hz. Monitor H1 with oscilloscope, Note level on oscilloscope or meter reading. Set AF to 125Hz. Adjust RV2 for level to be the same as at 180Hz.

Set the AF to 200Hz. Adjust RV4 for -2% from Ref on the model 257. Set the AF to 113Hz. Adjust RV6 for -2% from Ref on the model 257. Repeat until no adjustment required.

Select the 15kHz filter. Set the AF to 1kHz and note the reading on the model 257 meter or AF o/p. Select the 3.5kHz filter and adjust RV7 for the same reading.

Set Potentiometers on AF Board

Select FM, range 100kHz, 3.5kHz filter, Mean detector and disconnect the RF Board at P4.

Monitor U7 pin 3 with DVM. Select "peak" (+) and adjust RV5 for 0.000V. Select "trough" (-) and adjust RV6 for 0.000V. Select "mean" and check reading is 0.000V.

Feed audio signal into P4 pin 1 at 800Hz. Select trough (-) and adjust AF level to read 1.000V on the DVM. Select peak and adjust RV4 to read the same. Select mean and check for 1.000V. Adjust RV7 for a reading of 10 on meter.

Connect the RF board to P4. Connect signal generator (Item 5) to 257 RF I/P. Adjust the FM modulation to 100kHz at 800Hz AF. Attenuate the audio input until the DVM reads 0.300V. Select the 30 range and adjust RV11 for the DVM to read 1.000V

Attenuate the audio input until the DVM reads 0.333V. Select the 10 range and adjust RV10 for 1.000V

Attenuate the audio input until the DVM reads 0.300V. Select the 3 range and adjust RV3 for 1.000V on the DVM.

Attenuate the audio input until the DVM reads 0.333V. Select the 1 range and check for 1.00V ± 20mV

Select 100 range and adjust the AF input so that the DVM reads 1.000V. Select the psophometric filter and adjust RV2 for 1.000V on the DVM.

FM 60kHz Bandpass

Select ranges as follows:

FM	100kHz	Mean	60kHz filter

Use the signal generator (item 5) to inject into the unit an RF signal deviated 80kHz at a 1kHz rate. Swing the AF from 20Hz to 70kHz and check that the reading on the meter remains within ± 0.5dB over the range 25Hz to 60kHz. Adjust CV1 to achieve this.

NOTE. 0.5dB = 2.5 divisions or 5% of reading

FM 15kHz Bandpass

Select 15kHz filter. Swing the AF from 20Hz to 20kHz and check that the reading remains within ± 0.5dB over the range 25Hz to 15kHz. The reading must fall by more than 0.5dB at 20kHz.

FM 3.5kHz Bandpass

Select 3.5kHz filter. Swing the AF from 20Hz to 4kHz and check that the reading remains within ± 0.5dB over the range 25Hz to 3.5kHz. The reading must fall by more than 0.5dB at 4kHz.

AM 60kHz Bandpass

Select ranges as follows:

AM	100%	Mean	60kHz filter

Use the signal generator (item 5) to inject into the unit an RF signal amplitude modulated 80% with 1kHz audio. Swing the AF from 20Hz to 70kHz and check that the reading on the meter remains within ± 0.5dB over the range 25Hz to 60kHz. Adjust CV1 to achieve this.

AM 15kHz Bandpass

Select 15kHz filter. Swing the AF from 20Hz to 20kHz and check that the reading remains within ± 0.5dB over the range 25Hz to 15kHz. The reading must fall by more than 0.5dB at 20kHz.

FM 3.5kHz Bandpass

Select 3.5kHz filter. Swing the AF from 20Hz to 4kHz and check that the reading remains within ± 0.5dB over the range 25Hz to 3.5kHz. The reading must fall by more than 0.5dB at 4kHz.

Psophometric Filter

Select psophometric filter and set the AF to 800Hz. Monitor the AF output socket with an AF level meter (Item 6) set to ac dB, or use the DVM (Item 1) set to dB measurement. Select relative mode on AF meter or dvm to zero reading.

Check the AF response against the following table.

Freq Hz	Level dB Min	Level dB Max
800	-0.1	+0.1
600	-3.0	-1.0
500	-4.6	-2.6
400	-7.3	-5.3
300	-12.6	-8.6
200	-23.0	-19.0
150	-31.0	-27.0
100	-43.0	-39.0
1000	0.0	+2.0
1200	-1.0	+1.0
1500	-2.3	-0.3
2000	-4.0	-2.0
2500	-5.1	-3.1
3000	-7.6	-3.6
3500	-11.5	-5.5
4000	-18.0	-12.0
5000	-39.0	-32.0

De-Emphasis

Select 3.5kHz filter. Set AF to 1kHz. Select relative mode to zero AF meter or DVM reading. Select de-emphasis filter and check reading falls by between 13 and 14dB.

5.3 RF Board Test

Discriminator

Connect the signal generator, set to 1.5MHz at 0dBm level, to the INPUT socket. Connect the oscilloscope (item 2) using the x10 probe to TP5 (RF Board). Set the oscilloscope to 5V/cm d.c. and increase the signal generator frequency to obtain the first lowest d.c. level on the oscilloscope (2.3MHz approx.). Remove the oscilloscope probe. Connect the counter (item 3) to the IF OUTPUT socket and record the frequency.

Replace the x10 probe and increase the signal generator frequency until a second low is found (3.2MHz approx.). Again remove the probe and record the frequency at the IF output using the counter.

Subtract the counter readings obtained in (a) and (b) and divide the difference by 2. Adjust RV2 (RF Board) to alter the IF by the amount just calculated so that both the low points produce the same IF

Reduce the signal generator frequency to 2MHz, reconnect the oscilloscope to TP5, and then adjust to find the first highest d.c. level (2.3MHz approx.). Disconnect probe and measure IF with counter. Reconnect probe and then look for the second highest d.c. level (3.2MHz approx.).

Calculate the difference between the highest readings and divide by 2. Adjust RV1 (RF Board) to alter the IF by the amount just calculated so that both the high points produce the same IF

If necessary, repeat the settings of (a) to (e) four or five times until both upper points are the same and both lower points are the same. The IF should then be between 400 and 440 kHz with a maximum of 1kHz difference between the two upper points and between the two lower points; and a maximum of 10kHz between the upper and lower points.

Lock Indicator

Connect the oscilloscope to TP1 (RF Board). Connect the signal generator, set to give 50mV at 5MHz, to the INPUT socket. Reduce output of signal generator until the a.g.c. at TP1 falls. Increase the level slightly until the voltage just rises, this should occur between 1mV and 2mV. Adjust RV6 (RF Board) until the Lock indicator extinguishes and then bring it back slightly so that the indicator just glows. Note that the Lock indicator should come on as the a.g.c. rises.

Set the signal generator to 1MHz and then increase the frequency until the Lock indicator is fully illuminated; this should occur at a frequency of less than 5MHz.

Connect the oscilloscope to the junction of R1, R2 (input). Set the signal generator to 5MHz and then increase the signal level until the Lock indicator extinguishes; this should not occur until 2.8V p-p is reached on the oscilloscope. If 2.8V p-p is not reached increase the value of R7 and recheck.

AM Demodulator

Connect the calibrated signal generator* to the INPUT socket and set it to give 90% AM at a 1kHz rate. Adjust RV3 (RF Board) for a meter reading of 9 on the upper scale (mean mode still selected).

Tuned Circuit Adjustments

Fit the test lid on the RF Board and connect the signal generator to the INPUT socket, set to give 100kHz deviation at a 1kHz rate. Connect the oscilloscope to the AF OUTPUT socket and set it to 0.1V/cm. Press the AM and 10 pushbuttons. Adjust RV5, L3 and L6 for a minimum reading on the oscilloscope or on the meter. Remove the lid.

Connect calibrated signal generator to the INPUT socket and set it to give 100kHz deviation at a 1kHz rate. Adjust RV4 (RF Board) for 100kHz on meter.

*If an accurately calibrated standard signal generator is not available,the following procedures should be used.

5.4 AM Calibration

The most accurate method of AM calibration is to set up 100% AM at 1kHz rate in the RF source by using the oscilloscope to set the AM trough to exactly zero. This setting is not dependent on the oscilloscope linearity. Note that it is valid to perform this setting operation by observing the IF output (420kHz). Set the AM Cal.Pot. (RV3 on RF Board 710.162) for 100% AM reading (Mean). If the modulation on the RF source is linear there will be no significant difference between Peak and Trough (less than 0.5%). Modulation depths of less than 100% may be used for calibration but achieving an accurately known depth of AM is more prone to error.

5.5 FM Calibration

Setting up a known FM deviation on the RF source may be achieved in several ways. Two simple methods are as follows:

Bessel Zero Method

This method involves the use of a selective receiver (preferably a spectrum analyser) to observe the nulling of the carrier or sidebands that occurs at known ratios of peak deviation to modulation rate. Suggested conditions are, set the modulation rate to exactly 1kHz (± 1Hz). Observe the level of the carrier frequency with the deviation at zero: Increase deviation until the third null of the carrier is reached and set the deviation to achieve a carrier null of 50dB or better. This setting corresponds to a deviation of 8.65kHz. Set the FM Cal.Pot. (RV4 on RF Board 710.162) to this reading on the 10kHz range, with Mean selected. Note that it is valid to observe the IF spectrum as well as the RF spectrum.

Frequency Difference Method

Connect the RF source and a reference oscillator of the same nominal carrier frequency to the inputs of the Frequency Difference Meter. With the deviation at zero, tune the reference oscillator for minimum reading on the meter (no greater than a few kHz). With a 1kHz modulation rate, increase deviation, which will cause the difference reading to rise. The difference reading corresponds to the average frequency deviation and for sinusoidal modulation is related to the peak deviation by a factor of $\Pi / 2 = 1/0.636$. Hence a frequency difference of 63.6kHz corresponds to a peak deviation of 100kHz. The calibrated RF source is now applied to the 257 and the FM Cal.Pot. adjusted for correct reading on the appropriate range. A frequency counter driven from the filtered output of a mixer may be substituted for the Frequency Difference Meter, the RF source and reference being connected to the mixer input.

5.6 Additional Checks

Test and check to the instrument against the following table :-

MONITOR	TEST ITEM	INPUT	NOTES
AF Output	Distortion Analyser	40MHz, 80kHz FM at 1kHz	With all covers fitted, check distortion <1%
AF Output	Distortion Analyser	40MHz, 80% AM at 1kHz	With all covers fitted, check distortion <1%
AF Output	AC Voltmeter	40MHz, 100% AM at 1kHz	Switch off modulaion. Check reading falls >50dB
AF Output	AC Voltmeter	40MHz, 100kHz FM at 1kHz	Switch off modulaion. Check reading falls >50dB
-	-	2GHz unmodulated <1mV	Increase level until the lock LED lightsThis should be <2mV
-	-	1GHz clean unmodulated signal	Check residual FM on meter <200Hz

5.7 GPIB Calibration (Option)

Use a calibrated FM signal of 100kHz deviation as for calibration of the overall unit as stated above. Using a GPIB controller continuously read back the talk string and display the modulation on the screen. Adjust RV1 on the GPIB board (900.136) for 100kHz on the controller display.

5.8 Battery Tests (Option)

NOTE: DISCONNECT BATTERY IF FITTED

Connect a DVM and a dummy battery, a 2200uF capacitor with a 1K resistor shunted across it, across the output connections from the PCB to the battery. Switch the unit to 'charge' and set RV8 for 14.0V on the DVM. Check the yellow charge LED illuminates.

Switch unit to 'use mains' and connect an ammeter across the output connections to the battery on the p.c.b. Check the measured current is 15mA approx. Switch unit to 'charge' and check current is 180mA approx. NOTE: Do not leave in this mode for more than a few seconds as heatsink will get hot.

Connect a variable psu set to +12.0V to the battery pins on the p.c.b. Switch unit to 'use battery' and check that the unit operates.

Measure	P5 pin 11	check +12V
	P5 pin 12	check + 5V
	P5 pin 13	check - 5V
	P5 pin 14	check + 5V

Check the unit will operate correctly over the range + 11.0V to + 14.0V.

6. GPIB OPERATION (Option)

6.1 General

The GPIB option provides control and interrogation of all functions of the 257. The GPIB address of the instrument is set up by rear panel DIL switches. Any address in the range 0 to 15 can be selected. The switch settings required for these addresses are shown in following table. Note these switches are only read during power on or IFC.

GPIB Adress Switch Settings.

GPIB Address	SW1	SW2	SW3	SW4
0	ON	ON	ON	ON
1	ON	ON	ON	OFF
2	ON	ON	OFF	ON
3	ON	ON	OFF	OFF
4	ON	OFF	ON	ON
5	ON	OFF	ON	OFF
6	ON	OFF	OFF	ON
7	ON	OFF	OFF	OFF
8	OFF	ON	ON	ON
9	OFF	ON	ON	OFF
10	OFF	ON	OFF	ON
11	OFF	ON	OFF	OFF
12	OFF	OFF	ON	ON
13	OFF	OFF	ON	OFF
14	OFF	OFF	OFF	ON
15	OFF	OFF	OFF	OFF

The instrument will power up in the local state with the front panel switches operative. When the instrument is addressed to listen the front panel will become locked out and the GPIB LED will illuminate. The instrument is returned to local state either by receiving an appropriate command over the GPIB or by pressing the GPIB pushbutton on the front panel. Note if LLO is in operation pressing the GPIB pushbutton will have no effect. The following table shows the effect of the primary command group messages on the 257.

Primary Command Group Messages.

Message	Effect
GTL	Returns instrument to local state.
SDC, DCL	Terminates any current talk string and sets the instrument to the power on settings
PPE, PPU	No effect, parallel poll not implemented
GET	No effect, device trigger not implemented
TCT	No effect, Instrument never controller
LLO	Enter local lockout state
SPE	Enable sending of status byte
SPD	Disable sending of status byte
MLA	Enables receiving listen commands
UNL	Disable listener function
MTA	Enable transmission of talk strings. If serial poll is enabled the status byte will be transmitted.
UNT	Disable talker functions.

6.2 Listen Commands

The command strings recognized by the 257 are shown in the following table. Command strings may be upper or lower case and be concatenated at will. Any characters between command strings are ignored. Each command is implemented immediately after receiving the required characters, not at the end of the complete concatenated list.

For example the command string :- 'FM5FL1DT2'

sets the 257 to the 100kHz FM range, the 60kHz AF filter and the mean detector.

257 Commands

Commands	Functions
AM1	1% AM Range
AM2	3% AM Range
AM3	10% AM Range
AM4	30% AM Range
AM5	100% AM Range
DT1	Peak/positive detector
DT2	Mean detector
DT3	Trough/negative detector
FL1	60kHz AF Filter
FL2	15kHz AF Filter
FL3	3.5kHz AF Filter
FL4	Psophometric Filter
FL5	750µs De-emphasis network
FM1	1kHz Range
FM2	3kHz Range
FM3	10kHz Range
FM4	30kHz Range
FM5	100kHz Range
ID	Send identity string
SR0	Service request disabled
SR1	Service request enabled
TR1	Use CR,LF as string terminator(default)
TR2	Use LF as talk string terminator
TR3	Use EOI as talk string terminator

6.3 Talk Strings

When requested by the controller the 257 will send a talk string. This consists either of a measurement result string or, after an ID command, an indentity string. The strings are terminated in one of three ways; after a TR1 command or after power on a 'CR' 'LF' terminator is used; after a TR2 command a 'LF' terminator is used and after a TR3 command EOI is asserted coincident with the last character.

The format of the measurement result string is shown in the following table. It consists of a 26 character string plus 2,1 or 0 characters as terminators.

For example the talk string:- S0 FM3 FL3 DT1 8.23E03 HZ

shows a stable reading of 8.23kHz mean deviation with a 3.5kHz AF filter.

The identity string consists of 16 characters plus terminator.

For example:- AMM 257 VERS 1.1

Measurement Result String

POSITION	FUNCTION	VALUE	
1..2	Status	'S0'	Stable reading
		'S1'	Valid reading not fully stabilised
		'S2'	Valid reading after service request
		'S3'	Reading overranged
		'S4'	Out of lock
3	Separator	' '	Space
4..5	Mode	'AM'	AM ranges
		'FM'	FM ranges
6	Range	'1'	1% / 1kHz range
		'2'	3% / 3kHz range
		'3'	10% / 10kHz range
		'4'	30% / 30kHz range
		'5'	100% / 100kHz range
7	Separator	' '	Space
8..10	Filter	'FL1'	60kHz LP filter selected
		'FL2'	15kHz LP filter selected
		'FL3'	3.5kHz LP filter selected
		'FL4'	Psophometric filter selected
		'FL5'	De-emphasis network selected
11	Separator	' '	Space
12..14	Detector	'DT1'	Peak / positive deviation detector
		'DT2'	Mean detector
		'DT3'	Trough / negative deviation detector
15	Separator	' '	Space
16..23	Result	Floating point (NR3) notation of result	
		Eg.	'1.023E03'
			'87.12E00'
24	Separator	' '	Space
25..26	Unit	'HZ'	On FM ranges
		'% '	On AM ranges.
27..28	Terminator	CR,LF	After power on or TR1
		LF	After TR2
		None	After TR3

6.4 Service Request

When requested by the controller during serial poll the 257 returns a status byte. The format is shown in following table.

257 Status Byte

BIT	FUNCTION	VALUE			
8	Unused	0			
7	SRQ	0	No service request		
6	Valid Measurement	0 1	Unstable reading Stable reading		
5	Unused	0			
4	Unused	0			
3..1	Status	Bit3	Bit2	Bit1	
		0	0	0	Stable reading
		0	0	1	Unstable but valid
		0	1	1	Overrange
		1	1	0	Unlocked

After a SR1 command the 257 will generate a service request on the next occurrence of a stable reading. The resultant measurement string is stored until read. Note the string will start with 'S2' to indicate that the measurement string resulted from a service request.

7. PARTS LISTS

7.1 Complete Unit 257-01

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
A1	1096	255/7 Rear Panel Drg.890.520	1	A10	900.115	255/7 RF Board	1
A2	1089	12mm Flush Head Studs	6	A11	610.103	M3x8 Pan Hd. Pozi B.Z.P. Screw	10
A3	1099	255/7 Rear Panel Graphic Label	1	A12	1007	No4x1/4" Selftap 'B'Pan Hd BZP	6
A4	610.111	M3 B.Z.P. Nut	6	A13	1080	255/7 RF PCB Cover Drg.890.506	1
A5	620.122	Spire Clip for No6 UNC screws	4	A14	1101	No6x3/8" CSK Pozi	8
A6	1039	Instrument End Moulding	1	A15	1193	257 Handbook	1
A7	900.302	257-01/05 AF Board (Complete)	1	A16	1196	Carton + End Mouldings	1
A8	900.308	255/7 Chassis Module	1	A17	520.135	6A 250V Cord set BLACK	1
A9	900.304	257-F01/F05 Front Panel Module	1				

7.2 Chassis 900.308

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
A1	1081	257 Centre Tray Drg.890.503	1	A8	1007	No4x1/4" Selftap 'B'Pan Hd BZP	1
A2	1090	8mm Standoff	10	A9	610.112	Solder Tag M3	1
A3	640.110	Handle (Carrying)	1	A10	1087	255/257 Top Cover Drg.890.508	1
A4	1213	No4x1/2 Csk AB S/Tapper Nickel	2	A11	1088	255/257 Bottom Cover 890.509	1
A5	1085	255/257/267 Side Member R/H	1	A12	1194	5/32 X 3/8 Rivet	4
A6	1086	255/257/267 Side Member L/H	1	A13	640.142	Folding Feet Type A	2
A7	620.121	Rivet 1/8"	6	A14	640.143	Feet Type A	2

7.3 Front Panel Module 900.304

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
A1	900.132	257 Front Panel Board	1	A9	1002	1mA Meter	1
A2	330.141	255/7-01-05 Version Switch	1	A10	610.111	M3 B.Z.P. Nut	6
A3	330.142	255/7 RF Input Lead	1	A11	610.112	Solder Tag M3	2
A4	1079	255/7 Front Panel Drg.890.501	1	A12	620.122	Spire Clip for No6 UNC screws	4
A5	1089	12mm Flush Head Studs	6	A13	640.112	Sifam collet knob,15mm	1
A6	1191	257 Farnell Graphic Label	1	A14	1100	Sifam cap,lined,black	1
A7	530.106	BNC Bulkhead Socket 50ohm	1	A15	660.141	Wire Green/Yellow 24/0.2mm	1
A8	1039	Instrument End Moulding	1				

7.4 RF Board 900.115

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
A1	710.162	255/257 RF PCB	1	C29	210.130	820pF Ceramic Plate 10% 100V	1
A2	1188	Link (Sleeve+tcw)	8	C30	250.102	47nF Polyester 5% 250V	1
A3	620.101	PIN Solder Terminal	17	C31	250.102	47nF Polyester 5% 250V	1
A4	650.103	TO18 Transistor Pad (White)	1	C32	250.102	47nF Polyester 5% 250V	1
A5	650.102	TO5 Transistor Pad (White)	1	C33	220.107	330pF Polystyrene 5% 160V	1
A6	720.199	Copper Screening Can	1	C34	260.104	22uF 16V Tantalum	1
C1	240.101	10nF ceramic disc,-20+80%,50V	1	C35	260.103	1uF 35V Tantalum	1
C2	210.124	1p8F Ceramic Plate 2% 100V	1	C36	240.101	10nF ceramic disc,-20+80%,50V	1
C3	210.129	2p7F Ceramic Plate 2% 100V	1	C37	260.103	1uF 35V Tantalum	1
C4	240.101	10nF ceramic disc,-20+80%,50V	1	C38	250.102	47nF Polyester 5% 250V	1
C5	210.104	22pF Ceramic Plate 2% 100V	1	C39	250.102	47nF Polyester 5% 250V	1
C6	210.107	33pF Ceramic Plate 2% 100V	1	C40	250.102	47nF Polyester 5% 250V	1
C7	220.114	33pF Polystyrene 5% 160V	1	C41	240.101	10nF ceramic disc,-20+80%,50V	1
C8	240.101	10nF ceramic disc,-20+80%,50V	1	C42	1187	1.0uF Z5U Multilayer Ceramic	1
C9	240.101	10nF ceramic disc,-20+80%,50V	1	C43	240.101	10nF ceramic disc,-20+80%,50V	1
C10	240.101	10nF ceramic disc,-20+80%,50V	1	C44	240.101	10nF ceramic disc,-20+80%,50V	1
C11	240.101	10nF ceramic disc,-20+80%,50V	1	C45	260.101	10uF 25V Tantalum	1
C12	260.103	1uF 35V Tantalum	1	C46	260.104	22uF 16V Tantalum	1
C13	250.102	47nF Polyester 5% 250V	1	C47	1137	100p NPO 0805 Ceramic Cap	1
C14	210.129	2p7F Ceramic Plate 2% 100V	1	C48	220.116	100pF Polystyrene 5% 160V	1
C15	260.101	10uF 25V Tantalum	1	C49	210.106	100pF Ceramic Plate 2% 100V	1
C16	210.119	470pF Ceramic Plate 10% 100V	1	C50	210.106	100pF Ceramic Plate 2% 100V	1
C17	260.103	1uF 35V Tantalum	1	C51	240.101	10nF ceramic disc,-20+80%,50V	1
C18	210.126	180pF Ceramic Plate 2% 100V	1	C52	210.119	470pF Ceramic Plate 10% 100V	1
C19	220.105	180pF Polystyrene 5% 160V	1	C53	240.101	10nF ceramic disc,-20+80%,50V	1
C20	240.101	10nF ceramic disc,-20+80%,50V	1	C54	260.103	1uF 35V Tantalum	1
C21	250.102	47nF Polyester 5% 250V	1	C55	260.101	10uF 25V Tantalum	1
C22	260.107	47uF 6.3V Tantalum	1	C56	260.104	22uF 16V Tantalum	1
C23	240.101	10nF ceramic disc,-20+80%,50V	1	C58	260.101	10uF 25V Tantalum	1
C24	240.101	10nF ceramic disc,-20+80%,50V	1	C59	260.103	1uF 35V Tantalum	1
C25	220.115	150pF Polystyrene 5% 160V	1	C60	260.103	1uF 35V Tantalum	1
C26	260.107	47uF 6.3V Tantalum	1	D1	410.120	MSI Varactor Diode	1
C27	240.101	10nF ceramic disc,-20+80%,50V	1	D2	410.120	MSI Varactor Diode	1
C28	260.104	22uF 16V Tantalum	1	D3	410.121	5082-0180 Step Recovery Diode	1

Cir Ref	Stock Ref	Description	Qty
D4	410.105	5082-2811 Schottky Diode	1
D5	410.105	5082-2811 Schottky Diode	1
D6	410.105	5082-2811 Schottky Diode	1
D7	410.105	5082-2811 Schottky Diode	1
D8	410.102	1N4148 G.P.Diode	1
D9	410.102	1N4148 G.P.Diode	1
D10	410.102	1N4148 G.P.Diode	1
D11	410.102	1N4148 G.P.Diode	1
D12	410.102	1N4148 G.P.Diode	1
D13	410.102	1N4148 G.P.Diode	1
D14	410.102	1N4148 G.P.Diode	1
D16	410.102	1N4148 G.P.Diode	1
D17	410.102	1N4148 G.P.Diode	1
D18	410.102	1N4148 G.P.Diode	1
D19	410.102	1N4148 G.P.Diode	1
D20	410.102	1N4148 G.P.Diode	1
D21	410.102	1N4148 G.P.Diode	1
D24	410.102	1N4148 G.P.Diode	1
D25	410.102	1N4148 G.P.Diode	1
D26	410.102	1N4148 G.P.Diode	1
D27	410.102	1N4148 G.P.Diode	1
D28	410.102	1N4148 G.P.Diode	1
D29	410.102	1N4148 G.P.Diode	1
D30	410.102	1N4148 G.P.Diode	1
D31	410.102	1N4148 G.P.Diode	1
D32	410.102	1N4148 G.P.Diode	1
D33	410.102	1N4148 G.P.Diode	1
L1	340.103	Ferrite Core FX1898	1
L2	310.118	220uH SC10 Choke 10% 0.2W	1
L3	1238	I.F.Transformer YHCS11100AC2	1
L4	310.101	1mH SC10 Choke 10% 0.2W	1
L5	310.101	1mH SC10 Choke 10% 0.2W	1
L6	1238	I.F.Transformer YHCS11100AC2	1
L7	1332	7P 7mm Variable Coil 39uH	1
L8	340.102	Ferrite Bead FX1115	1
L10	340.103	Ferrite Core FX1898	1
L11	340.102	Ferrite Bead FX1115	1
L12	340.102	Ferrite Bead FX1115	1
P1	1004	Special Lead Assembly (257)	1
R1	130.123	100R Metal Film 250mW	1
R2	130.123	100R Metal Film 250mW	1
R3	130.116	2K2 Metal Film 250mW	1
R4	130.106	10K Metal Film 250mW	1
R5	150.105	1K5 Metal Film 1% 250mW	1
R6	130.125	100K Metal Film 250mW	1
R8	130.125	100K Metal Film 250mW	1
R9	130.106	10K Metal Film 250mW	1
R10	130.118	22K Metal Film 250mW	1
R11	130.120	1K0 Metal Film 250mW	1
R12	130.141	8K2 Metal Film 250mW	1
R13	130.106	10K Metal Film 250mW	1
R14	130.138	1K8 Metal Film 250mW	1
R15	130.106	10K Metal Film 250mW	1
R16	130.101	3K3 Metal Film 250mW	1
R17	130.134	6K8 Metal Film 250mW	1
R18	130.123	100R Metal Film 250mW	1
R19	130.118	22K Metal Film 250mW	1
R20	130.132	560R Metal Film 250mW	1
R21	130.106	10K Metal Film 250mW	1
R22	130.123	100R Metal Film 250mW	1
R23	130.110	330R Metal Film 250mW	1
R24	130.101	3K3 Metal Film 250mW	1
R25	130.104	390R Metal Film 250mW	1
R26	130.124	33R Metal Film 250mW	1
R27	150.105	1K5 Metal Film 1% 250mW	1
R28	150.105	1K5 Metal Film 1% 250mW	1
R29	130.120	1K0 Metal Film 250mW	1
R30	130.122	15K Metal Film 250mW	1
R31	140.107	10M Metal Film 5% 250mW	1
R32	130.137	1K2 Metal Film 250mW	1
R33	130.125	100K Metal Film 250mW	1
R34	130.129	4K7 Metal Film 250mW	1
R35	130.106	10K Metal Film 250mW	1
R36	130.129	4K7 Metal Film 250mW	1
R37	130.130	47K Metal Film 250mW	1
R38	130.141	8K2 Metal Film 250mW	1
R39	150.101	10K Metal Film 1% 250mW	1
R40	150.104	2K7 Metal Film 1% 250mW	1
R41	130.137	1K2 Metal Film 250mW	1
R42	150.122	1K2 Metal Film 1% 250mW	1
R43	150.121	750R Metal Film 1% 250mW	1
R44	130.125	100K Metal Film 250mW	1
R45	150.123	5K6 Metal Film 1% 250mW	1
R46	130.122	15K Metal Film 250mW	1
R47	130.125	100K Metal Film 250mW	1
R48	130.133	5K6 Metal Film 250mW	1
R49	130.118	22K Metal Film 250mW	1
R50	130.118	22K Metal Film 250mW	1
R51	130.129	4K7 Metal Film 250mW	1
R52	130.129	4K7 Metal Film 250mW	1
R53	150.105	1K5 Metal Film 1% 250mW	1
R54	150.105	1K5 Metal Film 1% 250mW	1
R55	130.114	220K Metal Film 250mW	1
R56	130.118	22K Metal Film 250mW	1
R57	140.107	10M Metal Film 5% 250mW	1
R58	130.103	1MO Metal Film 250mW	1
R59	130.135	150K Metal Film 250mW	1
R60	140.105	2M2 Metal Film 5% 250mW	1
R61	130.125	100K Metal Film 250mW	1
R62	130.106	10K Metal Film 250mW	1
R63	130.125	100K Metal Film 250mW	1
R64	130.130	47K Metal Film 250mW	1
R65	130.116	2K2 Metal Film 250mW	1
R66	130.116	2K2 Metal Film 250mW	1
R67	130.130	47K Metal Film 250mW	1
R68	130.130	47K Metal Film 250mW	1
R69	130.129	4K7 Metal Film 250mW	1
R70	130.129	4K7 Metal Film 250mW	1
R71	130.130	47K Metal Film 250mW	1
R72	130.130	47K Metal Film 250mW	1
R73	130.125	100K Metal Film 250mW	1
R75	130.129	4K7 Metal Film 250mW	1
R76	130.101	3K3 Metal Film 250mW	1
R77	130.129	4K7 Metal Film 250mW	1
R78	130.134	6K8 Metal Film 250mW	1
R79	130.120	1K0 Metal Film 250mW	1
R80	150.103	680R Metal Film 1% 250mW	1
R81	130.106	10K Metal Film 250mW	1
R82	130.104	390R Metal Film 250mW	1
R83	130.130	47K Metal Film 250mW	1
R84	130.118	22K Metal Film 250mW	1
R85	130.101	3K3 Metal Film 250mW	1
R86	130.154	390K Metal Film 250mW	1
R87	130.125	100K Metal Film 250mW	1
R88	130.154	390K Metal Film 250mW	1
R89	130.154	390K Metal Film 250mW	1
R90	1197	3M9 Metal Film 5%	1
R91	130.118	22K Metal Film 250mW	1
R92	130.154	390K Metal Film 250mW	1
R93	130.120	1K0 Metal Film 250mW	1
R94	130.115	33K Metal Film 250mW	1
R95	130.116	2K2 Metal Film 250mW	1
R96	130.129	4K7 Metal Film 250mW	1
R97	130.133	5K6 Metal Film 250mW	1
R98	130.118	22K Metal Film 250mW	1
R99	130.133	5K6 Metal Film 250mW	1
R100	130.129	4K7 Metal Film 250mW	1
R101	130.120	1K0 Metal Film 250mW	1
R102	130.116	2K2 Metal Film 250mW	1
R103	130.123	100R Metal Film 250mW	1
R104	130.123	100R Metal Film 250mW	1
R105	150.103	680R Metal Film 1% 250mW	1
R106	130.101	3K3 Metal Film 250mW	1
R107	130.145	180K Metal Film 250mW	1
R108	130.123	100R Metal Film 250mW	1
R109	130.106	10K Metal Film 250mW	1
RV1	170.101	220R 500mW Open Cer.Pot VA05H	1
RV2	170.101	220R 500mW Open Cer.Pot VA05H	1
RV3	170.101	220R 500mW Open Cer.Pot VA05H	1
RV4	170.111	2K2 500mW Open Cer.Pot.VAO5H	1
RV5	170.112	470R 500mW Open Cer.Pot.VAO5H	1
RV6	170.111	2K2 500mW Open Cer.Pot.VAO5H	1
S0	1104	82 MCX PCB Receptacle	1
T1	430.108	J304 Nch JFET	1
T2	430.109	J111 Nch JFET	1
T3	430.108	J304 Nch JFET	1
T4	430.103	BC547B NPN G.P. Transistor	1
T5	430.103	BC547B NPN G.P. Transistor	1
T6	430.102	BC557B PNP G.P. Transistor	1
T7	430.102	BC557B PNP G.P. Transistor	1
T8	430.103	BC547B NPN G.P. Transistor	1
T9	430.103	BC547B NPN G.P. Transistor	1
T10	430.103	BC547B NPN G.P. Transistor	1
T11	430.102	BC557B PNP G.P. Transistor	1
T12	430.102	BC557B PNP G.P. Transistor	1
T13	430.103	BC547B NPN G.P. Transistor	1
T14	430.103	BC547B NPN G.P. Transistor	1
T15	430.102	BC557B PNP G.P. Transistor	1
T17	430.103	BC547B NPN G.P. Transistor	1
T18	430.103	BC547B NPN G.P. Transistor	1

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
T19	430.103	BC547B NPN G.P. Transistor	1	T49	430.102	BC557B PNP G.P. Transistor	1
T20	430.103	BC547B NPN G.P. Transistor	1	T50	430.102	BC557B PNP G.P. Transistor	1
T21	430.102	BC557B PNP G.P. Transistor	1	T51	430.102	BC557B PNP G.P. Transistor	1
T22	430.102	BC557B PNP G.P. Transistor	1	T52	430.102	BC557B PNP G.P. Transistor	1
T23	430.103	BC547B NPN G.P. Transistor	1	T53	430.102	BC557B PNP G.P. Transistor	1
T25	430.103	BC547B NPN G.P. Transistor	1	T54	430.102	BC557B PNP G.P. Transistor	1
T26	430.103	BC547B NPN G.P. Transistor	1	T55	430.103	BC547B NPN G.P. Transistor	1
T27	430.102	BC557B PNP G.P. Transistor	1	T56	430.103	BC547B NPN G.P. Transistor	1
T28	430.103	BC547B NPN G.P. Transistor	1	T57	430.103	BC547B NPN G.P. Transistor	1
T29	430.103	BC547B NPN G.P. Transistor	1	T58	430.103	BC547B NPN G.P. Transistor	1
T30	430.102	BC557B PNP G.P. Transistor	1	T59	430.103	BC547B NPN G.P. Transistor	1
T31	430.102	BC557B PNP G.P. Transistor	1	T60	430.103	BC547B NPN G.P. Transistor	1
T32	430.103	BC547B NPN G.P. Transistor	1	T61	430.103	BC547B NPN G.P. Transistor	1
T41	430.102	BC557B PNP G.P. Transistor	1	T62	430.102	BC557B PNP G.P. Transistor	1
T42	430.103	BC547B NPN G.P. Transistor	1	T63	430.108	J304 Nch JFET	1
T43	430.103	BC547B NPN G.P. Transistor	1	T64	430.103	BC547B NPN G.P. Transistor	1
T44	430.103	BC547B NPN G.P. Transistor	1	T65	430.103	BC547B NPN G.P. Transistor	1
T45	430.103	BC547B NPN G.P. Transistor	1	T66	430.102	BC557B PNP G.P. Transistor	1
T46	430.103	BC547B NPN G.P. Transistor	1	T67	430.110	2N2369A NPN Switching	1
T47	430.103	BC547B NPN G.P. Transistor	1	T68	430.106	2N3866 NPN RF Transistor	1
T48	430.103	BC547B NPN G.P. Transistor	1	U1	460.110	SN5472J JK Flip Flop	1

7.5 AF Board 900.302

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
A1	710.160	255/257 AF PCB	1	C50	250.108	22nF Polyester 5% 250V	1
A2	540.101	100mA Quick Blow 20mm Fuse	1	C52	260.104	22uF 16V Tantalum	1
A3	610.120	M3x10 Pan HD Pozi B.Z.P. Screw	3	C53	240.107	100nF X7R MCL 50V	1
A4	610.111	M3 B.Z.P. Nut	3	C54	240.107	100nF X7R MCL 50V	1
A5	610.118	M3 Crinkle B.Z.P. Washer	3	C55	240.107	100nF X7R MCL 50V	1
A6	650.126	Heatsink (Redpoint TV1505)	1	C56	240.107	100nF X7R MCL 50V	1
A7	650.112	TO-220 Insulating Kit	1	C57	240.107	100nF X7R MCL 50V	1
A8	1189	Cardboard Shield	1	C58	240.107	100nF X7R MCL 50V	1
A9	1006	No6x5/16"Selftap 'B'Pan Hd BZP	4	C59	240.107	100nF X7R MCL 50V	1
A10	610.112	Solder Tag M3	1	C60	240.107	100nF X7R MCL 50V	1
A11	660.116	Wire 7/0.2mm PVC 1.2mm Yellow	1	C63	240.107	100nF X7R MCL 50V	1
A12	660.141	Wire Green/Yellow 24/0.2mm	1	C64	240.107	100nF X7R MCL 50V	1
C1	210.128	560pF Ceramic Plate 2% 100V	1	C65	240.107	100nF X7R MCL 50V	1
C2	250.102	47nF Polyester 5% 250V	1	C66	240.107	100nF X7R MCL 50V	1
C3	210.128	560pF Ceramic Plate 2% 100V	1	C67	240.107	100nF X7R MCL 50V	1
C4	250.102	47nF Polyester 5% 250V	1	C68	240.107	100nF X7R MCL 50V	1
C5	220.123	1n2F Polystyrene 5% 160V	1	C69	240.107	100nF X7R MCL 50V	1
C6	210.106	100pF Ceramic Plate 2% 100V	1	C70	240.107	100nF X7R MCL 50V	1
C7	210.106	100pF Ceramic Plate 2% 100V	1	C71	240.107	100nF X7R MCL 50V	1
C8	210.126	180pF Ceramic Plate 2% 100V	1	C72	240.107	100nF X7R MCL 50V	1
C9	250.101	100nF Polyester 5% 100V	1	C73	240.107	100nF X7R MCL 50V	1
C10	250.122	1n5F Polyester 5% 400V	1	C75	240.107	100nF X7R MCL 50V	1
C11	250.110	6n8F Polyester 5% 400V	1	C76	240.107	100nF X7R MCL 50V	1
C12	210.109	120pF Ceramic Plate 2% 100V	1	C77	240.107	100nF X7R MCL 50V	1
C13	250.105	10nF Polyester 5% 400V	1	C78	240.107	100nF X7R MCL 50V	1
C14	250.124	18nF Polyester 5% 250V	1	C79	240.107	100nF X7R MCL 50V	1
C15	250.122	1n5F Polyester 5% 400V	1	C80	240.107	100nF X7R MCL 50V	1
C16	250.128	27nF Polyester 5% 250V	1	C81	240.107	100nF X7R MCL 50V	1
C17	210.119	470pF Ceramic Plate 10% 100V	1	C82	240.107	100nF X7R MCL 50V	1
C18	210.118	220pF Ceramic Plate 2% 100V	1	C84	210.108	150pF Ceramic Plate 2% 100V	1
C19	250.101	100nF Polyester 5% 100V	1	C85	210.106	100pF Ceramic Plate 2% 100V	1
C20	250.105	10nF Polyester 5% 400V	1	C100	260.104	22uF 16V Tantalum	1
C21	250.101	100nF Polyester 5% 100V	1	CV1	1001	5.5-50pF Ceramic Trimmer	1
C22	250.108	22nF Polyester 5% 250V	1	D1	410.102	1N4148 G.P.Diode	1
C23	250.105	10nF Polyester 5% 400V	1	D2	410.102	1N4148 G.P.Diode	1
C24	250.105	10nF Polyester 5% 400V	1	D3	410.102	1N4148 G.P.Diode	1
C25	250.102	47nF Polyester 5% 250V	1	D4	410.102	1N4148 G.P.Diode	1
C26	250.102	47nF Polyester 5% 250V	1	D5	410.102	1N4148 G.P.Diode	1
C27	260.103	1uF 35V Tantalum	1	D6	410.102	1N4148 G.P.Diode	1
C28	260.103	1uF 35V Tantalum	1	D7	410.115	1N4001 1A 50V Rectifier	1
C29	260.103	1uF 35V Tantalum	1	D8	1028	11DQ04 1A 40V Schottky Diode	1
C30	260.103	1uF 35V Tantalum	1	D9	410.115	1N4001 1A 50V Rectifier	1
C31	240.107	100nF X7R MCL 50V	1	D10	1028	11DQ04 1A 40V Schottky Diode	1
C32	240.107	100nF X7R MCL 50V	1	D15	410.102	1N4148 G.P.Diode	1
C33	240.107	100nF X7R MCL 50V	1	D16	410.102	1N4148 G.P.Diode	1
C34	240.107	100nF X7R MCL 50V	1	L3	1188	Link (Sleeve+tcw)	1
C35	240.107	100nF X7R MCL 50V	1	P2	520.177	Fixed Main Inlet P.C.B. Type	1
C36	250.105	10nF Polyester 5% 400V	1	P3	520.202	40way Low Profile Box Header	1
C37	1063	1000uF 35V Radial Electrolytic	1	P4	1011	6Way Header Harwin M20 Series	1
C38	250.103	220nF Polyester 5% 100V	1	R1	130.103	1MO Metal Film 250mW	1
C39	270.102	47uF 35V Axial Electrolytic	1	R2	130.134	6K8 Metal Film 250mW	1
C40	270.121	470uF 35V Radial Electrolytic	1	R3	130.134	6K8 Metal Film 250mW	1
C41	250.103	220nF Polyester 5% 100V	1	R4	130.141	8K2 Metal Film 250mW	1
C42	260.101	10uF 25V Tantalum	1	R5	130.141	8K2 Metal Film 250mW	1
C45	240.107	100nF X7R MCL 50V	1	R6	150.143	7K5 Metal Film 1% 250mW	1
C48	260.101	10uF 25V Tantalum	1	R7	150.142	9K1 Metal Film 1% 250mW	1
C49	260.101	10uF 25V Tantalum	1	R8	150.143	7K5 Metal Film 1% 250mW	1

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
R9	150.143	7K5 Metal Film 1% 250mW	1	R100	150.143	7K5 Metal Film 1% 250mW	1
R10	130.103	1MO Metal Film 250mW	1	R101	150.131	8K2 Metal Film 1% 250mW	1
R11	130.106	10K Metal Film 250mW	1	R102	150.131	8K2 Metal Film 1% 250mW	1
R12	130.106	10K Metal Film 250mW	1	RN2	190.118	8x100K 2% SIL Resistor Network	1
R13	130.106	10K Metal Film 250mW	1	RV2	170.119	10K 200mW Sealed Pot.	1
R14	130.106	10K Metal Film 250mW	1	RV3	170.123	500R 200mW Sealed Pot.	1
R15	130.106	10K Metal Film 250mW	1	RV4	170.120	1K0 200mW Sealed Pot.	1
R16	130.106	10K Metal Film 250mW	1	RV5	170.122	1M0 200mW Sealed Pot.	1
R17	150.133	22K Metal Film 1% 250mW	1	RV6	170.122	1M0 200mW Sealed Pot.	1
R18	130.130	47K Metal Film 250mW	1	RV7	170.123	500R 200mW Sealed Pot.	1
R19	130.134	6K8 Metal Film 250mW	1	RV9	170.122	1M0 200mW Sealed Pot.	1
R20	130.159	3K9 Metal Film 250mW	1	RV10	170.123	500R 200mW Sealed Pot.	1
R21	130.130	47K Metal Film 250mW	1	RV11	170.126	5K0 200mW Sealed Pot.	1
R22	130.130	47K Metal Film 250mW	1	U1	470.167	74HC4053 Triple 2 Channel MUX	1
R23	130.130	47K Metal Film 250mW	1	U2	450.102	TL084 Quad Op Amp	1
R24	130.122	15K Metal Film 250mW	1	U3	450.102	TL084 Quad Op Amp	1
R25	130.128	1K5 Metal Film 250mW	1	U4	470.174	74HC4051 8 Channel MUX	1
R26	130.103	1MO Metal Film 250mW	1	U5	450.102	TL084 Quad Op Amp	1
R27	130.144	27K Metal Film 250mW	1	U6	450.102	TL084 Quad Op Amp	1
R28	130.134	6K8 Metal Film 250mW	1	U7	470.174	74HC4051 8 Channel MUX	1
R29	130.145	180K Metal Film 250mW	1	U9	470.152	74HCU04 Hex Inverter	1
R30	130.154	390K Metal Film 250mW	1	U10	470.152	74HCU04 Hex Inverter	1
R31	130.129	4K7 Metal Film 250mW	1	U11	470.175	74HC132 Quad 2I/P NAND Schmitt	1
R32	130.106	10K Metal Film 250mW	1	U12	470.176	74HC139 Dual 2 to 4 Decoder	1
R33	130.137	1K2 Metal Film 250mW	1	U13	470.176	74HC139 Dual 2 to 4 Decoder	1
R34	130.137	1K2 Metal Film 250mW	1	U14	470.154	74HC32N Quad 2 I/P or Gate	1
R35	130.137	1K2 Metal Film 250mW	1	U15	470.167	74HC4053 Triple 2 Channel MUX	1
R36	130.120	1K0 Metal Film 250mW	1	U16	470.177	74HC4016 Quad Analog Switch	1
R37	140.107	10M Metal Film 5% 250mW	1	U18	470.164	74HC193 4 bit up/down Counter	1
R38	130.125	100K Metal Film 250mW	1	U19	470.164	74HC193 4 bit up/down Counter	1
R39	130.129	4K7 Metal Film 250mW	1	U20	470.165	4044 Quad R S Latch	1
R40	130.106	10K Metal Film 250mW	1	U21	1062	LM2940 12V Regulator	1
R41	130.103	1MO Metal Film 250mW	1	U22	440.103	7912 -12V 1A Regulator	1
R42	130.120	1K0 Metal Film 250mW	1	U23	440.106	78L05 +5V 100mA Regulator	1
R43	140.107	10M Metal Film 5% 250mW	1	U24	440.111	79L05 -5V 100mA Regulator	1
R44	130.125	100K Metal Film 250mW	1	U25	470.175	74HC132 Quad 2I/P NAND Schmitt	1
R45	130.129	4K7 Metal Film 250mW	1	U26	470.175	74HC132 Quad 2I/P NAND Schmitt	1
R46	130.103	1MO Metal Film 250mW	1	US1	520.148	16 Way Low Profile D.I.L.	1
R47	130.120	1K0 Metal Film 250mW	1	US2	520.147	14 Way Low Profile D.I.L.	1
R48	130.114	220K Metal Film 250mW	1	US3	520.147	14 Way Low Profile D.I.L.	1
R49	130.106	10K Metal Film 250mW	1	US4	520.148	16 Way Low Profile D.I.L.	1
R50	130.120	1K0 Metal Film 250mW	1	US5	520.147	14 Way Low Profile D.I.L.	1
R51	130.125	100K Metal Film 250mW	1	US6	520.147	14 Way Low Profile D.I.L.	1
R52	130.127	680R Metal Film 250mW	1	US7	520.148	16 Way Low Profile D.I.L.	1
R53	130.106	10K Metal Film 250mW	1	US9	520.147	14 Way Low Profile D.I.L.	1
R54	140.107	10M Metal Film 5% 250mW	1	US10	520.147	14 Way Low Profile D.I.L.	1
R55	130.103	1MO Metal Film 250mW	1	US11	520.147	14 Way Low Profile D.I.L.	1
R56	130.125	100K Metal Film 250mW	1	US12	520.148	16 Way Low Profile D.I.L.	1
R57	130.111	2K7 Metal Film 250mW	1	US13	520.148	16 Way Low Profile D.I.L.	1
R58	130.106	10K Metal Film 250mW	1	US14	520.147	14 Way Low Profile D.I.L.	1
R59	130.103	1MO Metal Film 250mW	1	US15	520.148	16 Way Low Profile D.I.L.	1
R60	130.125	100K Metal Film 250mW	1	US16	520.147	14 Way Low Profile D.I.L.	1
R61	130.103	1MO Metal Film 250mW	1	US18	520.148	16 Way Low Profile D.I.L.	1
R62	130.103	1MO Metal Film 250mW	1	US19	520.148	16 Way Low Profile D.I.L.	1
R63	130.125	100K Metal Film 250mW	1	US20	520.148	16 Way Low Profile D.I.L.	1
R70	130.106	10K Metal Film 250mW	1	US25	520.147	14 Way Low Profile D.I.L.	1
R72	130.106	10K Metal Film 250mW	1	US26	520.147	14 Way Low Profile D.I.L.	1
R76	1188	Link (Sleeve+tcw)	1	W1	510.128	Slide Mains Selector	1
R93	130.125	100K Metal Film 250mW	1	W2	1011	6Way Header Harwin M20 Series	1
R95	140.105	2M2 Metal Film 5% 250mW	1	X1	370.109	Mains Transformer	1
R99	130.129	4K7 Metal Film 250mW	1	Y1	550.104	Fuse Holder PCB Type Panel	1

7.6 Front Panel Board 900.132

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
A1	710.164	257 Front Panel PCB	1	D15	420.102	L.E.D. HE Red 3mm	1
A2	660.112	Wire 7/0.2mm PVC 1.2mm Black	10	D16	420.102	L.E.D. HE Red 3mm	1
A3	660.114	Wire 7/0.2mm PVC 1.2mm Red	10	D17	420.102	L.E.D. HE Red 3mm	1
A4	1209	Spade Terminal Crimp	2	D18	420.102	L.E.D. HE Red 3mm	1
D1	420.107	L.E.D. Yellow 3mm	1	D19	420.102	L.E.D. HE Red 3mm	1
D3	420.102	L.E.D. HE Red 3mm	1	R1	130.127	680R Metal Film 250mW	1
D4	420.102	L.E.D. HE Red 3mm	1	R2	130.107	820R Metal Film 250mW	1
D5	420.102	L.E.D. HE Red 3mm	1	R3	130.107	820R Metal Film 250mW	1
D6	420.102	L.E.D. HE Red 3mm	1	R4	130.107	820R Metal Film 250mW	1
D7	420.102	L.E.D. HE Red 3mm	1	R5	130.107	820R Metal Film 250mW	1
D8	420.102	L.E.D. HE Red 3mm	1	R6	130.107	820R Metal Film 250mW	1
D9	420.102	L.E.D. HE Red 3mm	1	R7	130.107	820R Metal Film 250mW	1
D10	420.102	L.E.D. HE Red 3mm	1	S1	330.149	255/7 40 Way F.P. Lead	1
D11	420.102	L.E.D. HE Red 3mm	1	W1	1003	Switch MPS 0 Lorlin	1
D12	420.102	L.E.D. HE Red 3mm	1	W2	1003	Switch MPS 0 Lorlin	1
D13	420.102	L.E.D. HE Red 3mm	1	W3	1003	Switch MPS 0 Lorlin	1
D14	420.102	L.E.D. HE Red 3mm	1	W4	1003	Switch MPS 0 Lorlin	1

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
W5	1003	Switch MPS 0 Lorlin	1	W8	1003	Switch MPS 0 Lorlin	1
W6	1003	Switch MPS 0 Lorlin	1	W9	1003	Switch MPS 0 Lorlin	1
W7	1003	Switch MPS 0 Lorlin	1	W10	1003	Switch MPS 0 Lorlin	1

7.7 Battery Parts (Option) 900.313

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
A1	1016	Black Wire 16/0.2mm	15	R75	130.109	470R Metal Film 250mW	1
A2	1018	Red Wire 16/0.2mm	15	R76	130.166	2R7 Metal Film 250mW	1
A3	1098	0.25in Female Spade Connector	2	R77	130.101	3K3 Metal Film 250mW	1
C43	270.102	47uF 35V Axial Electrolytic	1	R78	130.120	1K0 Metal Film 250mW	1
C44	240.102	47nF Ceramic Disc -20+80% 50V	1	R79	130.153	18K Metal Film 250mW	1
C46	270.102	47uF 35V Axial Electrolytic	1	R80	130.158	10R Metal Film 250mW	1
C61	210.112	1nF Ceramic Plate 10% 100V	1	R81	130.111	2K7 Metal Film 250mW	1
C62	210.112	1nF Ceramic Plate 10% 100V	1	R82	130.158	10R Metal Film 250mW	1
C74	260.104	22uF 16V Tantalum	1	RV8	170.120	1K0 200mW Sealed Pot.	1
D11	410.114	BAV10 60V G.P.Diode	1	T1	430.131	BDX35 NPN Power Transistor	1
D12	410.115	1N4001 1A 50V Rectifier	1	T2	430.131	BDX35 NPN Power Transistor	1
D13	410.114	BAV10 60V G.P.Diode	1	U21	440.110	L200CV Adj. 2A Regulator	1
D14	410.114	BAV10 60V G.P.Diode	1	Y2	550.104	Fuse Holder PCB Type Panel	1
L1	330.136	255/7 Battery Inverter Transformer	1	YF2	540.102	Fuse 1A 20mm Antisurge	1
L2	310.114	10uH SC10 Choke 10% 0.2W	1				

7.8 GPIB Board (Option) 900.136

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
C1	1027	100uF 35V Radial Electrolytic	1	R3	130.106	10K Metal Film 250mW	1
C2	210.119	470pF Ceramic Plate 10% 100V	1	R4	130.101	3K3 Metal Film 250mW	1
C3	270.114	220uF 10V Radial Electrolytic	1	R5	130.165	12K Metal Film 250mW	1
C4	270.114	220uF 10V Radial Electrolytic	1	R6	130.129	4K7 Metal Film 250mW	1
C5	270.123	10uF 35V Radial Electrolytic	1	R7	130.103	1MO Metal Film 250mW	1
C6	240.107	100nF X7R MCL 50V	1	R8	130.125	100K Metal Film 250mW	1
C7	250.111	1uF Polyester 5% 100V	1	R9	130.125	100K Metal Film 250mW	1
C8	240.101	10nF ceramic disc,-20+80%,50V	1	R10	130.125	100K Metal Film 250mW	1
C9	250.107	150nF Polyester 5% 100V	1	R11	130.125	100K Metal Film 250mW	1
C10	250.123	470nF Polyester 5% 100V	1	R12	130.125	100K Metal Film 250mW	1
C11	270.123	10uF 35V Radial Electrolytic	1	R13	130.106	10K Metal Film 250mW	1
C12	240.107	100nF X7R MCL 50V	1	R14	130.125	100K Metal Film 250mW	1
C13	240.107	100nF X7R MCL 50V	1	R15	130.129	4K7 Metal Film 250mW	1
C14	240.107	100nF X7R MCL 50V	1	R16	130.106	10K Metal Film 250mW	1
C15	240.107	100nF X7R MCL 50V	1	R17	130.125	100K Metal Film 250mW	1
C16	240.107	100nF X7R MCL 50V	1	R18	130.125	100K Metal Film 250mW	1
C17	260.103	1uF 35V Tantalum	1	RV1	170.126	5K0 200mW Sealed Pot.	1
C18	240.107	100nF X7R MCL 50V	1	S1	520.201	Receptacle R/A 57L2024077COD35	1
C19	240.107	100nF X7R MCL 50V	1	S2	1031	40 Way IDC Latched Header	1
C20	240.107	100nF X7R MCL 50V	1	T1	430.103	BC547B NPN G.P. Transistor	1
C21	240.107	100nF X7R MCL 50V	1	U1	1032	MC34063 Switching Regulator	1
D1	1028	11DQ04 1A 40V Schottky Diode	1	U2	1034	ICL 7109 12 Bit ADC	1
D2	410.122	BZY88C5V6 5.6V 400mW Zener	1	U3	470.148	2K x 8 CMOS SRAM	1
D3	410.102	1N4148 G.P.Diode	1	U4	470.149	27C64 8K x8 CMOS EPROM	1
D4	410.102	1N4148 G.P.Diode	1	U5	1014	CMOS Z80 MPU	1
D5	410.102	1N4148 G.P.Diode	1	U6	1033	18CV8 CMOS PAL	1
D6	410.102	1N4148 G.P.Diode	1	U7	460.114	DS75160AN GPIB Driver	1
D7	410.102	1N4148 G.P.Diode	1	U8	460.115	DS75161AN GPIB Driver	1
D8	410.102	1N4148 G.P.Diode	1	U9	460.116	TMS9914 GPIB Controller	1
D9	410.102	1N4148 G.P.Diode	1	U10	1035	71055 CMOS PPI	1
D10	410.102	1N4148 G.P.Diode	1	US1	520.146	8way Low Profile D.I.L.	1
D11	410.102	1N4148 G.P.Diode	1	US2	520.154	40way Low Profile D.I.L.	1
FX1	610.103	M3X8 Pan Hd. Pozi B.Z.P. Screw	1	US3	520.152	24 Way Low Profile D.I.L.	1
FX2	610.111	M3 B.Z.P. Nut	1	US4	520.153	28 Way Low Profile D.I.L.	1
FX3	610.118	M3 Crinkle B.Z.P. Washer	1	US5	520.154	40way Low Profile D.I.L.	1
L1	330.139	255/7 GPIB Inverter Xformer	1	US6	520.151	20 Way Low Profile D.I.L	1
L2	310.109	100uH SC10 Choke 10% 0.2W	1	US7	520.151	20 Way Low Profile D.I.L	1
PC1	1036	900136-02 255/7 GPIB PCB	1	US8	520.151	20 Way Low Profile D.I.L	1
Q1	1030	4MHz Crystal	1	US9	520.154	40way Low Profile D.I.L.	1
R1	130.156	1R0 Metal Film 250mW	1	US10	520.154	40way Low Profile D.I.L.	1
R2	130.156	1R0 Metal Film 250mW	1	W1	1038	4Way D.I.L Switch Right Angle	1

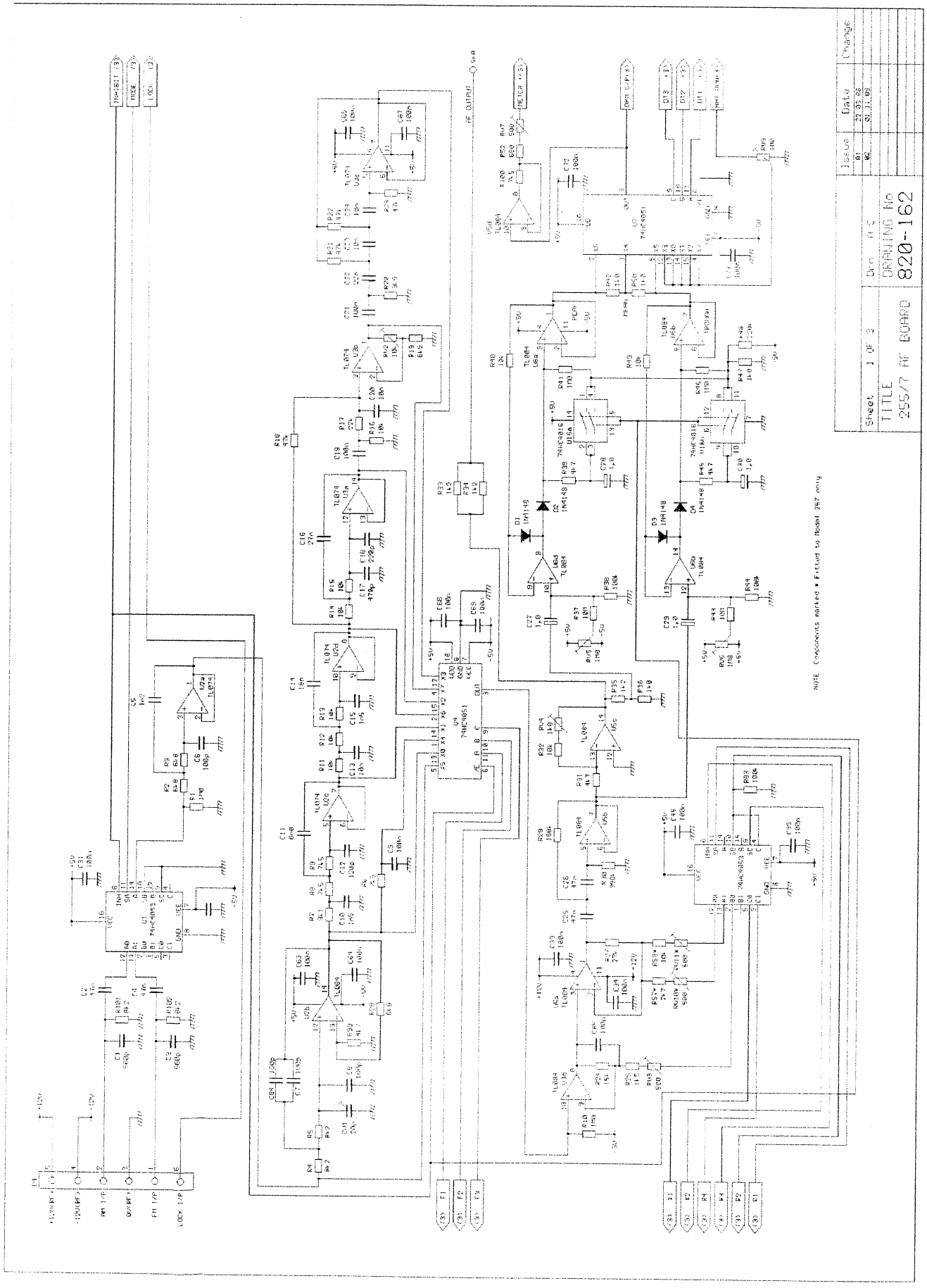
7.9 150Hz Notch Filter (Option) 900.155

Cir Ref	Stock Ref	Description	Qty	Cir Ref	Stock Ref	Description	Qty
C1	250.105	10nF Polyester 5% 400V	1	C12	240.107	100nF X7R MCL 50V	1
C2	240.107	100nF X7R MCL 50V	1	C13	240.107	100nF X7R MCL 50V	1
C3	240.107	100nF X7R MCL 50V	1	C14	250.105	10nF Polyester 5% 400V	1
C4	250.105	10nF Polyester 5% 400V	1	C21	250.105	10nF Polyester 5% 400V	1
C11	250.105	10nF Polyester 5% 400V	1	C22	240.107	100nF X7R MCL 50V	1

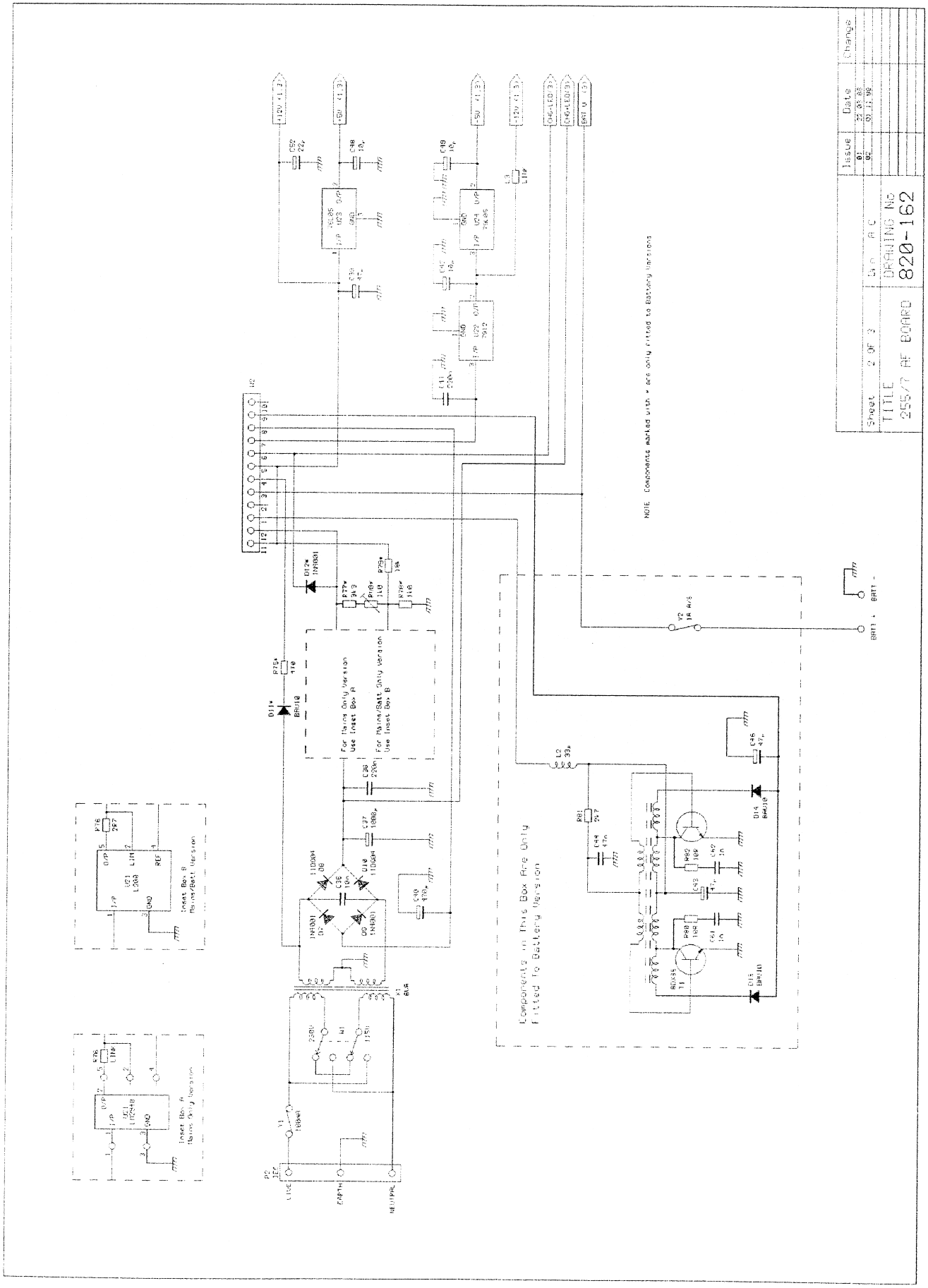
Cir Ref	Stock Ref	Description	Qty
C23	240.107	100nF X7R MCL 50V	1
C24	250.105	10nF Polyester 5% 400V	1
C25	270.123	10uF 35V Radial Electrolytic	1
C26	270.123	10uF 35V Radial Electrolytic	1
FX1	1090	8mm Standoff	1
FX2	610.103	M3x8 Pan Hd. Pozi B.Z.P. Screw	1
H1	1188	Link (Sleeve+tcw)	1
H2	1188	Link (Sleeve+tcw)	1
H3	1188	Link (Sleeve+tcw)	1
H4	1188	Link (Sleeve+tcw)	1
H5	1188	Link (Sleeve+tcw)	1
H6	1188	Link (Sleeve+tcw)	1
H7	1188	Link (Sleeve+tcw)	1
H8	1188	Link (Sleeve+tcw)	1
H9	1188	Link (Sleeve+tcw)	1
H10	1188	Link (Sleeve+tcw)	1
M1	1205	255/7 Filter Bracket	1
PC1	1202	255/7 Notch Filter PCB	1
R1	1197	3M9 Metal Film 5%	1
R2	1198	390K Metal Film 1%	1
R3	1198	390K Metal Film 1%	1
R4	1197	3M9 Metal Film 5%	1
R5	150.135	100K Metal Film 1% 250mW	1
R6	150.135	100K Metal Film 1% 250mW	1
R7	150.135	100K Metal Film 1% 250mW	1
R8	150.135	100K Metal Film 1% 250mW	1
R9	150.135	100K Metal Film 1% 250mW	1
R10	150.135	100K Metal Film 1% 250mW	1
R11	1199	8M2 Metal Film 5%	1
R12	1200	680k Metal Film 1%	1
R13	1200	680k Metal Film 1%	1
R14	1199	8M2 Metal Film 5%	1
R15	150.135	100K Metal Film 1% 250mW	1
R16	150.135	100K Metal Film 1% 250mW	1
R17	150.135	100K Metal Film 1% 250mW	1
R18	150.135	100K Metal Film 1% 250mW	1
R19	150.135	100K Metal Film 1% 250mW	1
R20	130.121	82K Metal Film 250mW	1
R21	140.109	1M5 Metal Film 5% 250mW	1
R22	130.167	1M8 Metal Film 250mW	1
R23	140.109	1M5 Metal Film 5% 250mW	1
R24	130.167	1M8 Metal Film 250mW	1
R25	150.135	100K Metal Film 1% 250mW	1
R26	150.135	100K Metal Film 1% 250mW	1
R27	150.135	100K Metal Film 1% 250mW	1
R28	150.135	100K Metal Film 1% 250mW	1
R29	150.135	100K Metal Film 1% 250mW	1
R30	1201	130K Metal Film 1%	1
R31	130.165	12K Metal Film 250mW	1
R32	130.106	10K Metal Film 250mW	1
R33	130.118	22K Metal Film 250mW	1
RV1	1204	20K Cermet Pot 3386F	1
RV2	1204	20K Cermet Pot 3386F	1
RV3	1204	20K Cermet Pot 3386F	1
RV4	170.119	10K 200mW Sealed Pot.	1
RV5	1204	20K Cermet Pot 3386F	1
RV6	1204	20K Cermet Pot 3386F	1
RV7	170.126	5K0 200mW Sealed Pot.	1
S1	1011	6Way Header Harwin M20 Series	1
SH1	1004	Special Lead Assembly (257)	1
U1	1203	TL074 JFET Input Op-Amp	1
U2	1203	TL074 JFET Input Op-Amp	1
U3	1203	TL074 JFET Input Op-Amp	1

8. CIRCUIT DIAGRAMS

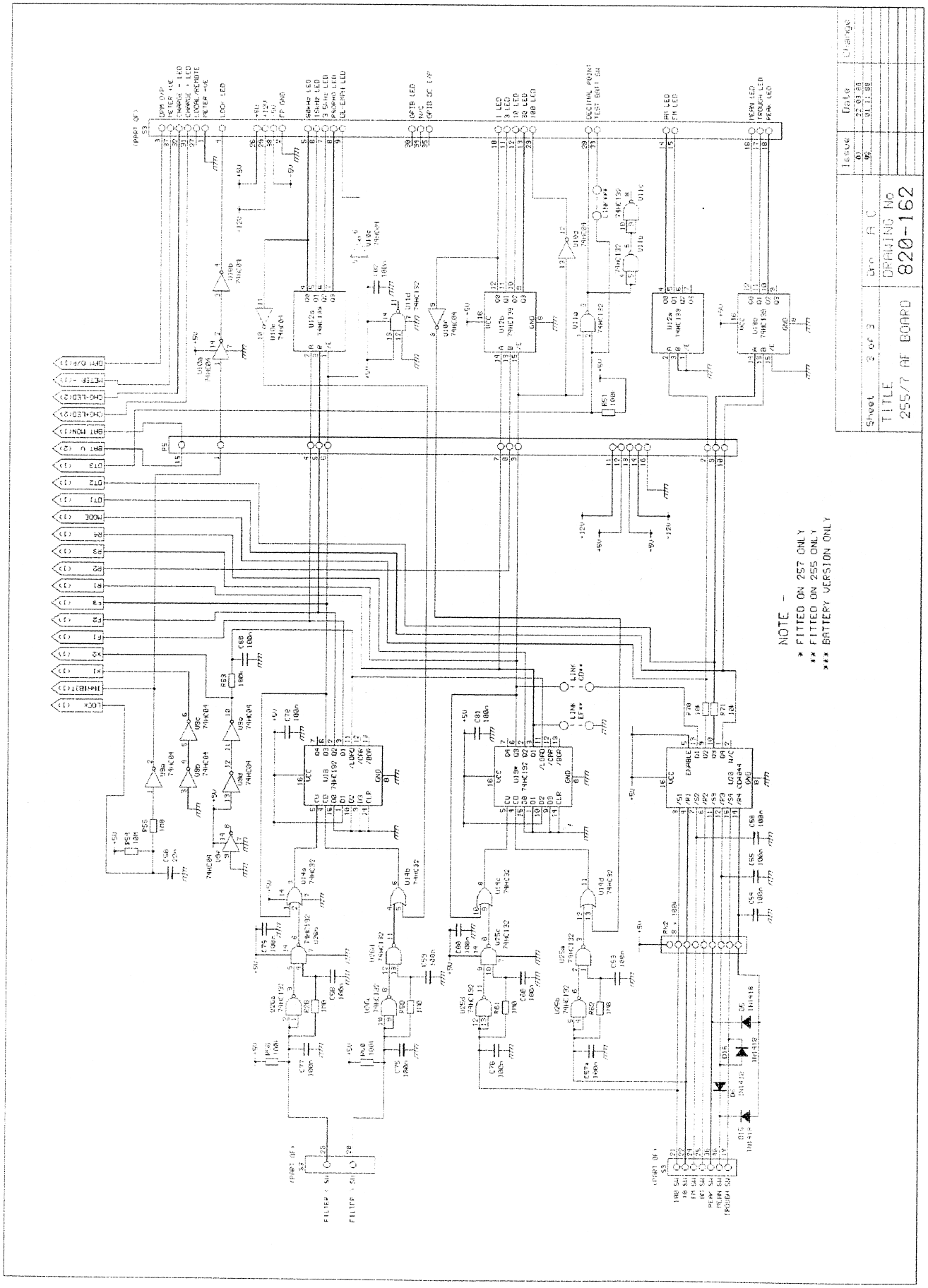
8.1 AF Board Circuit 1 of 3



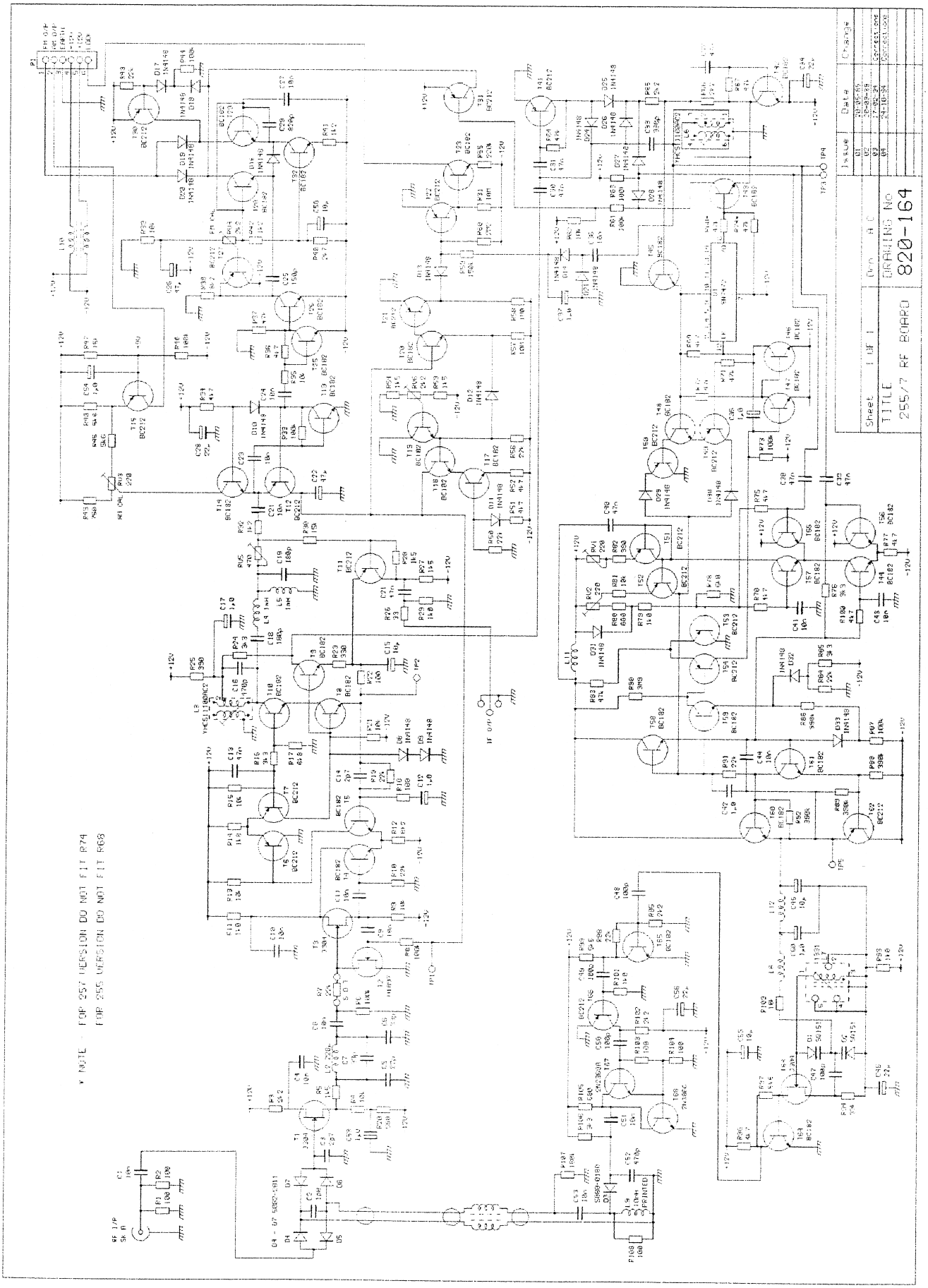
8.2 AF Board Circuit 2 of 3



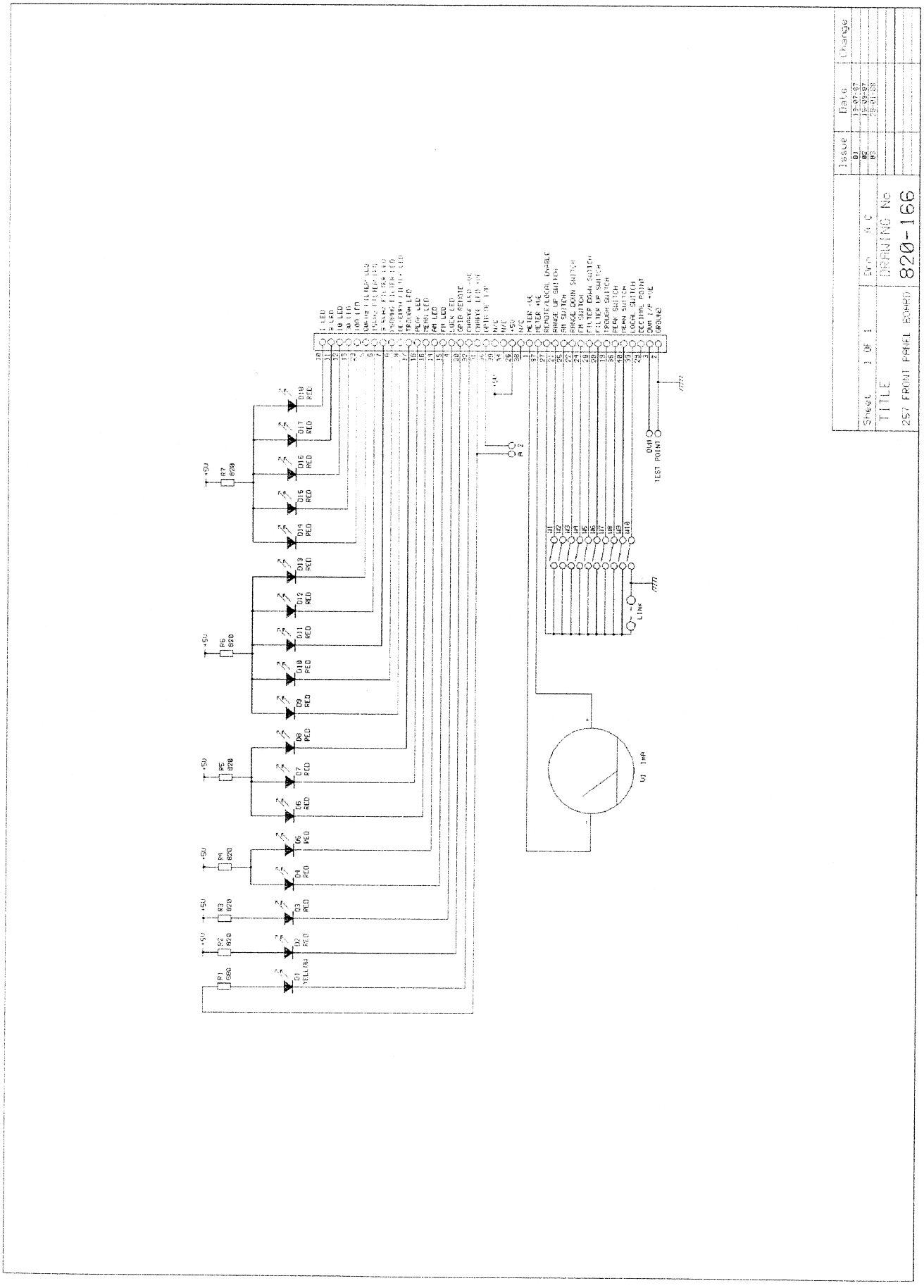
8.3 AF Board Circuit 3 of 3



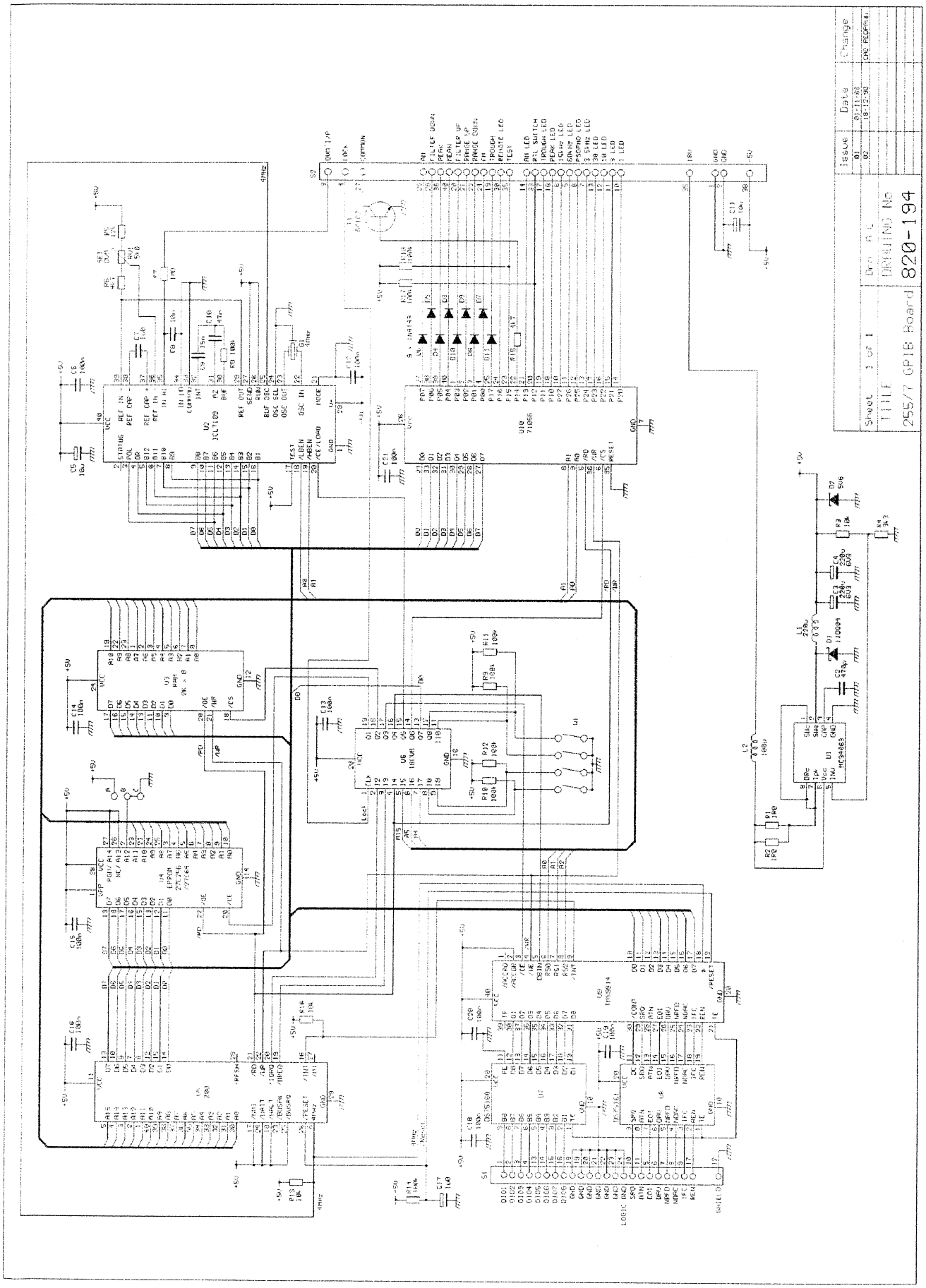
8.4 RF Board Circuit



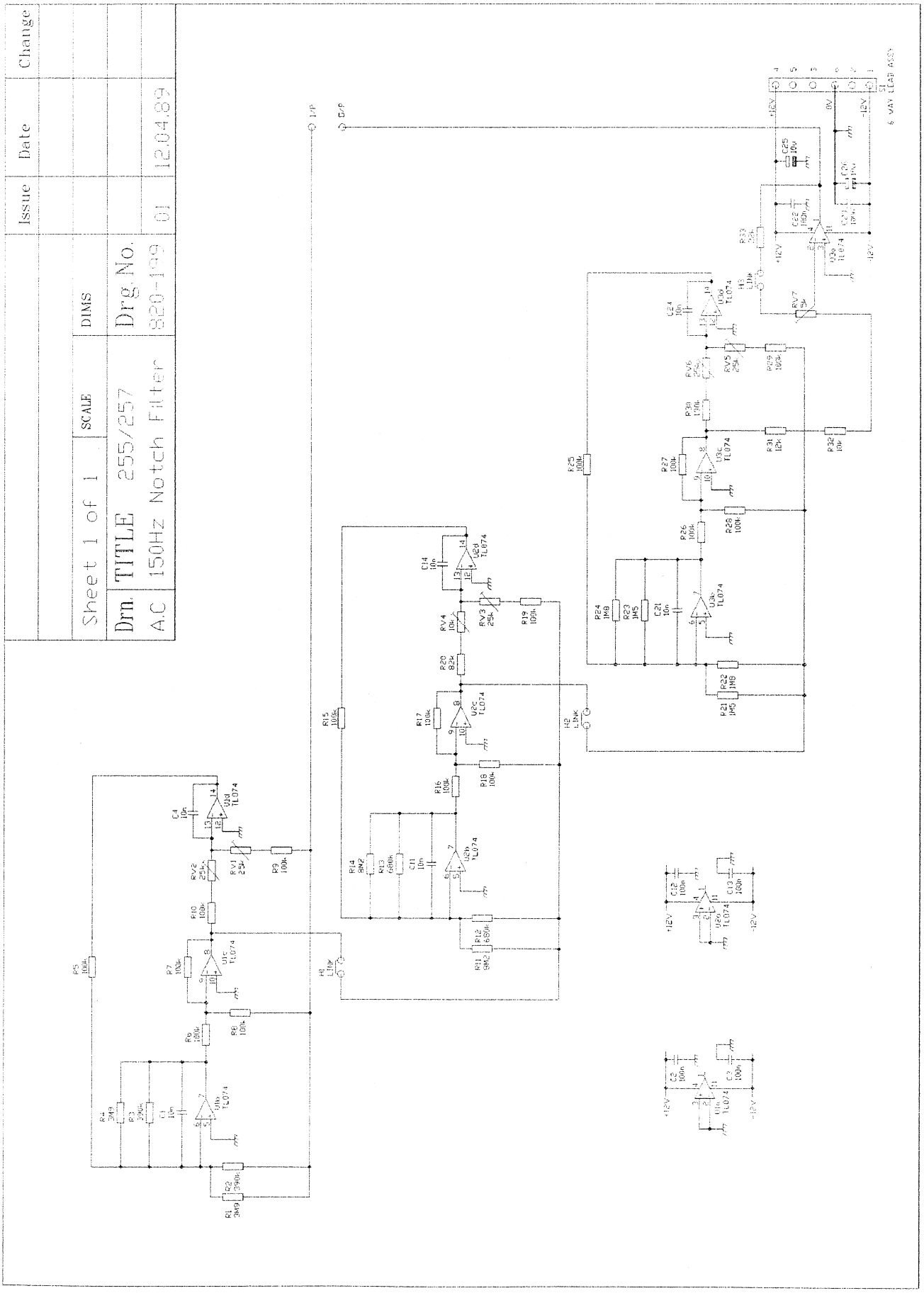
8.5 Front Panel Board Circuit



8.6 GPIB Board Circuit

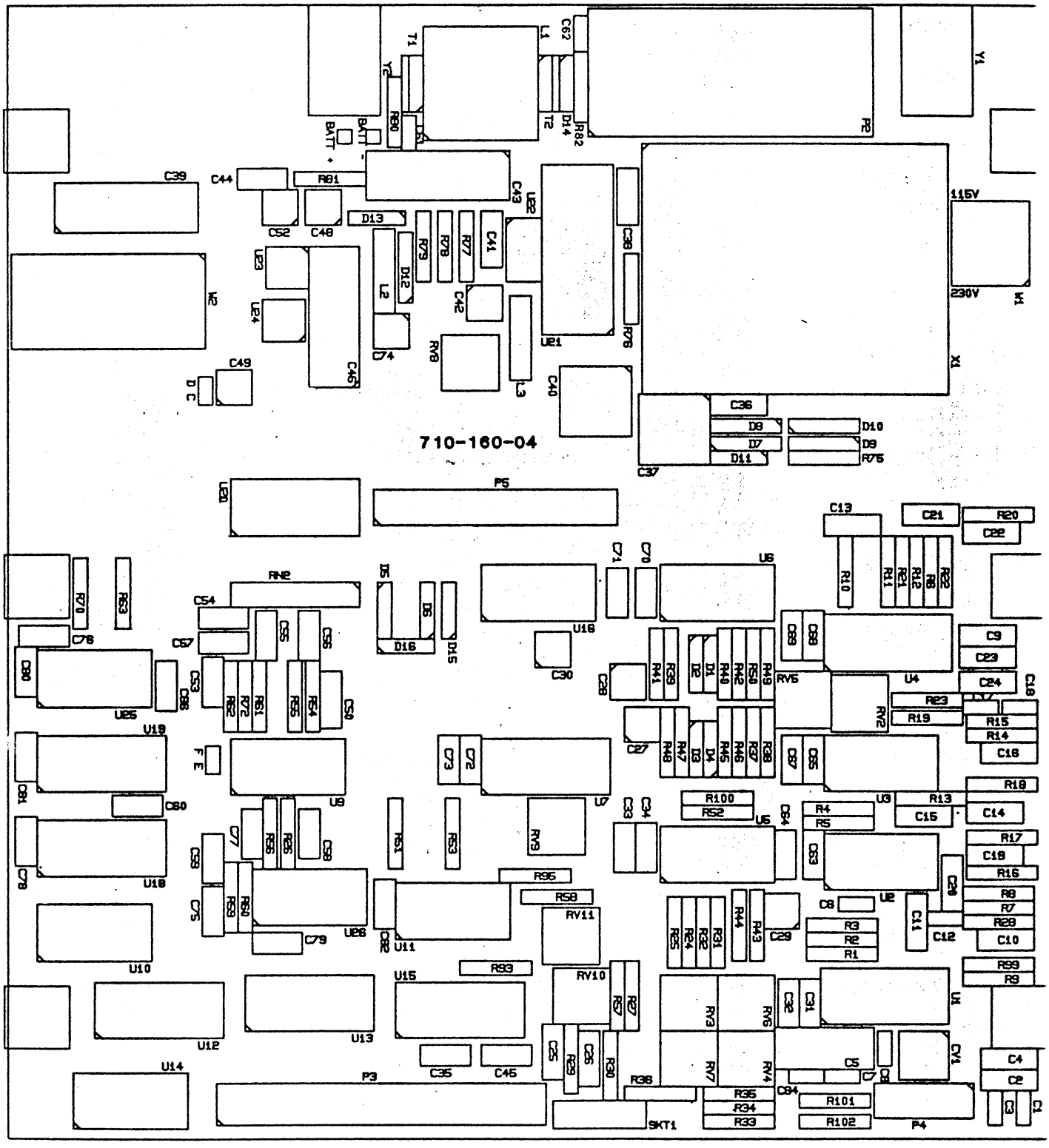


8.7 150 Hz Notch Filter Board Circuit

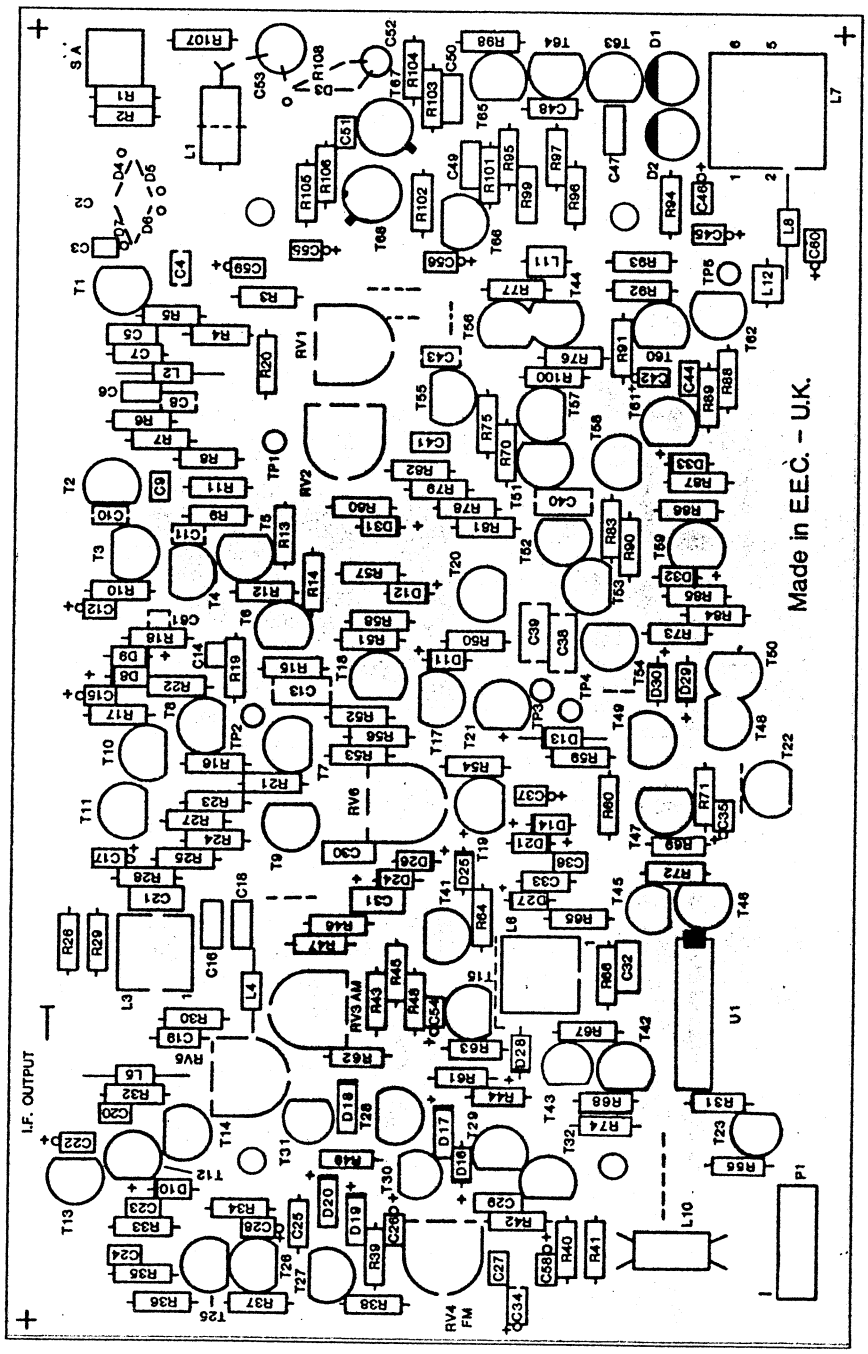


9. BOARD LAYOUTS

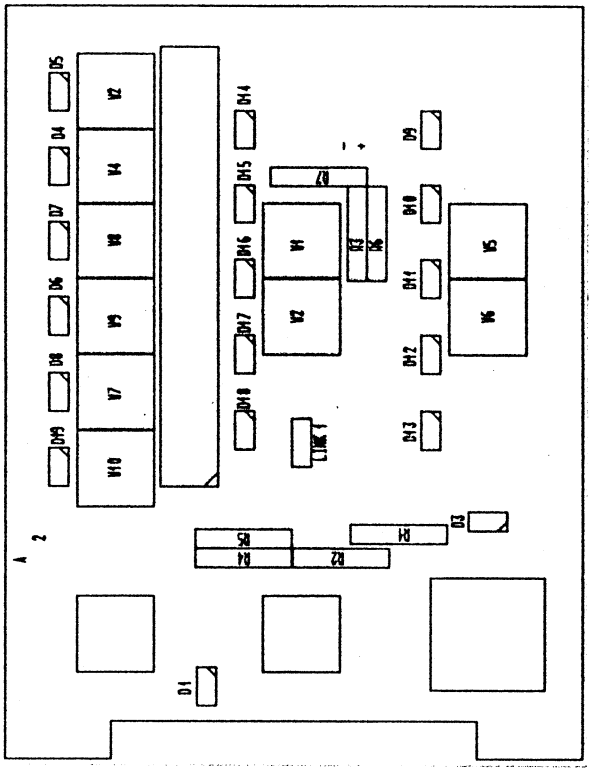
9.1 AF Board 900.302



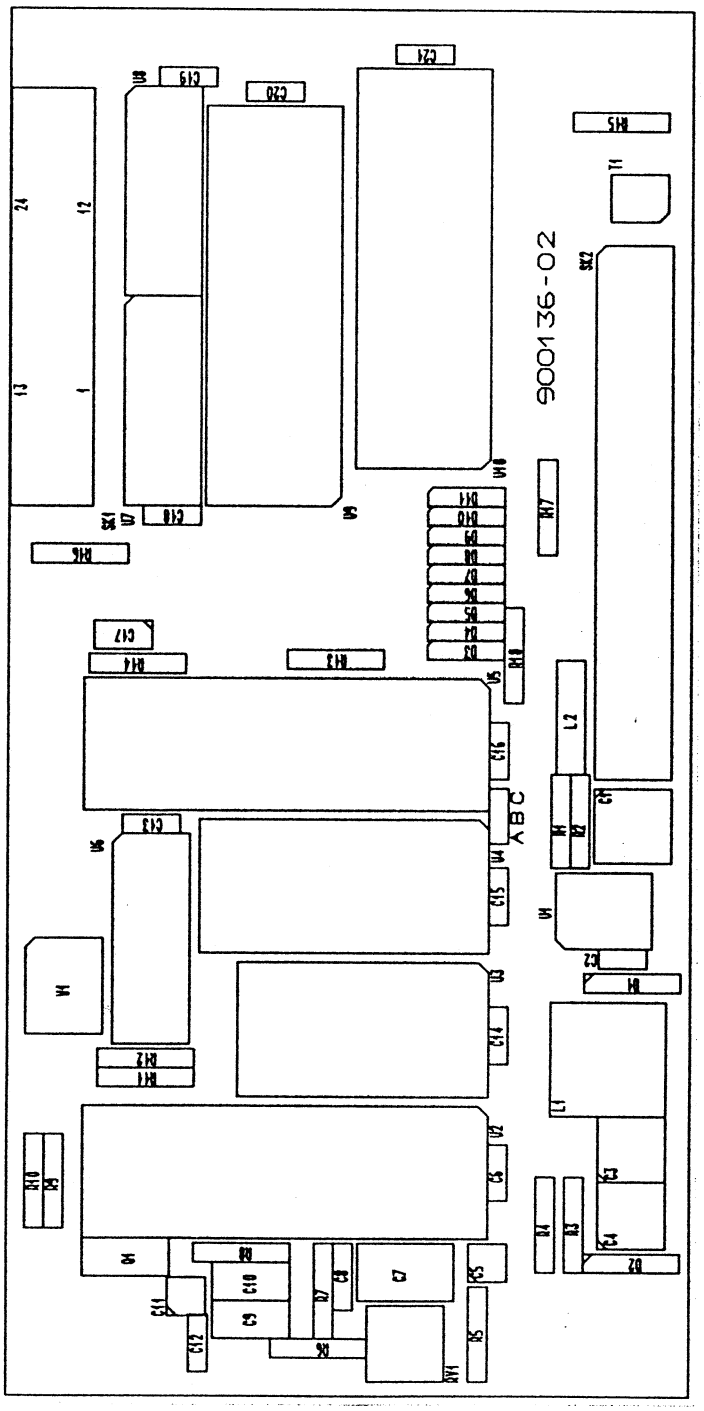
9.2 RF Board 900.115



9.3 Front Panel board 900.132



9.4 GPIB Board 900.136



9.5 150Hz Notch Filter Board 900.155