

PCB 75014 and PCB 75023

8.1 Introduction

The input card is a plug-in module, housed in a steel case to prevent corruption of the measurements by external or internal fields. It is located at the extreme left-hand side of the cabinet.

Its functions are:-

- Input Selection (A,B or Oscillator)
- Load Impedance Selection (100k or 600 ohms)
- Conversion of balanced signals to unbalanced for internal processing
- Attenuation on high level signals
- Initial gain for low level signals

The circuit can be subdivided into the following blocks:

- Input and Load Switching
- Input Select Logic
- 40 dB and 20 dB Attenuators
- Input protection circuitry
- Input Amplifiers
- Differential/single-ended Converter
- Atten/Gain Drivers

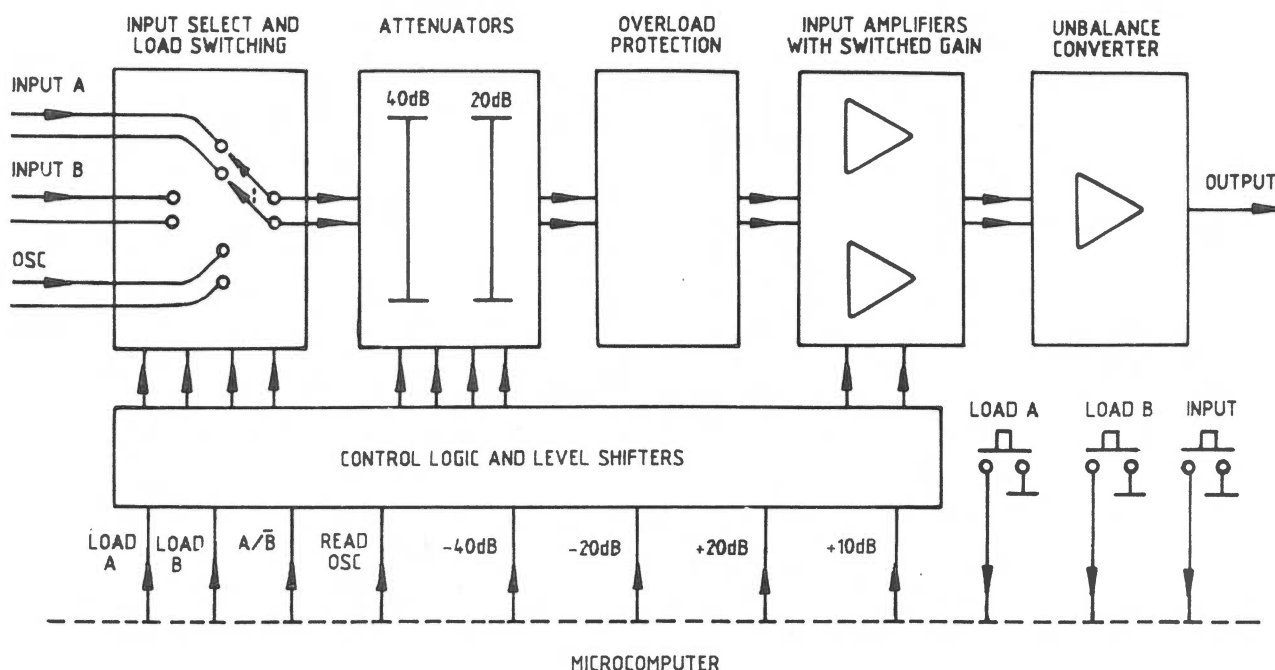


Figure 8.1.1 Input Module - Block Diagram

With all control inputs at logic 0, the gain of the input module is unity (actually about +0.3 dB). One of two attenuators (40 dB or 20 dB) and/or one of two gain steps (10 dB or 20 dB) may be selected by raising their control

lines to logic 1. The resultant stage gain from the active logic control inputs is the sum of the individual control input-pin gains (column headings of Table 8.1.1.) The corresponding switch settings can be read from the table.

dB Coarse	-40	-20	+20	+10	Gain
+40	1	0	0	0	-40
+30	1	0	0	1	-30
+20	0	1	0	0	-20
+10	0	1	0	1	-10
0	0	0	0	0	0
-10	0	0	0	1	+10
-20	0	0	1	0	+20

Table 8.1.1 Input Module Logic Inputs for "dB Coarse" Switch Settings

On-board LEDs indicate the status of control lines as an aid to fault finding.

The appropriate LED lights when the related control line is at Logic 1 (active high).

CONTROL LINE	LED
-40 dB	D20
-20 dB	D23
+10 dB	D26
+20 dB	D27
READ OSC	D17

8.2 Circuit Description

8.2.1 Input and Load Switching Circuit

The circuit network uses T-switches to connect the selected input (A,B or OSC IN) and to disconnect and earth the two unused input switch wiper sections in order to provide a high degree of isolation (-100 dB).

To prevent the short-circuit of any input, it is necessary that these earth shunts are disconnected before the signal paths are switched. This is achieved by delay circuits in the input select logic.

When 600 ohm input impedance is selected, an effective 600 ohm is connected across the appropriate input:

R1//R2 switched by RL1 for input A

R3//R4 switched by RL2 for input B

The selected input is coupled by a balanced RC network, R5,C1,R7 and R6,C2,R8 to the 40 dB attenuator.

8.2.2 600 ohm Selection

When 600 ohm load "A" pushbutton is depressed, the microcomputer detects the control closure and changes the logic state of the LOAD A signal signal to pin 20. This signal is applied to the base of TR7. A logic 1 will energise RL1 and activate front-panel LED indicator D7 in the collector of TR7.

The contacts of RL1 switch R1//R2 across the A input.

Similarly, selecting 600 ohm load "B" pushbutton results in a logic 1 enable signal being applied to TR8 to energise RL2 and activate front-panel LED D10.

The contacts of RL2 switch R3//R4 across the B input.

8.2.3 "A" Input Selection

When input A is selected, a logic 0 is output by the microcomputer to input pin 4 (B/NOT A). With input 13 of NAND-gate IC9 at logic 0, output IC9/11 and NAND-gate input IC8/2 are at logic 1. If READ OSC is not selected, input IC8/1 is also at logic 1, therefore output IC8/3 is at logic 0. In turn, this is applied to NAND-gate input IC8/5, giving a logic 1 on output IC8/4 to switch off PNP transistor TR10. Relay RL5 in its collector de-energises, first removing the shunt earth from the A input.

At the same time, the logic 0 from IC8/3 is applied via Schmitt inverter IC7/4 to give a logic 1 on NAND-gate input IC8/9. However, the network R70,C22 delays the logic 1 applied via Schmitt inverter IC7/6 to the other input, IC8/8 to ensure that the earth shunt contacts RL5 have had time to open. Then, after this delay, with both inputs at logic 1, NAND-gate output IC8/10 becomes logic 0 and the resulting signal on the base of PNP transistor TR9 energises relays RL3 and RL4 in its collector, indicated by the front-panel "A" input LED, D12.

Contacts RL3 and RL4 route the balanced A input signal to the 40 dB

attenuator.

The B path select logic is inhibited by the logic 1 on NAND-gate output IC9/11.

INPUT A	IC9/13	IC9/12	IC9/11	IC8/3	IC8/10	TR10	TR9	RELAYS	LED ON
	0	1	1	0	0	Off	On	5 Off 3,4 On	D12

Inhibits B (RL6, RL7 Off)	TR12 on, shunt RL8 energised
(Read Osc Off)	TR14 on, shunt RL11 energised

8.2.4 "B" Input Selection

In order to select input "B", a logic 1 signal is fed to input 4 (B/NOT A) from the microcomputer. Input IC9/13 is now at logic 1, and if READ OSC is not selected, input IC9/12 is also at logic 1. Output IC9/11 and therefore NAND-gate input IC9/9 are at logic 0. This gives a logic 1 on output IC9/10 to switch off TR12. Relay RL8 in its collector is thus de-energised to remove the shunt across the input B wiper contacts. Resistor R71 and C23 provide the necessary delay for the path via Schmitt inverter IC7/9,8 to input IC8/12. After this delay, the logic 0 on output IC8/11 switches on TR11 to energise RL6 and RL7 in its collector, indicated by the B input front-panel LED D14.

Contacts RL6 and RL7 route the balanced B input signal to the 40 dB attenuator.

The A path select logic is inhibited by the logic 0 on NAND-gate output IC9/11.

INPUT B	IC9/13	IC9/12	IC9/11	IC8/11	TR12	TR11	RELAYS	LED ON
	1	1	0	0	OFF	ON	8 Off 7 On	D12

Inhibits A (RL3, RL4 Off)	TR10 On, shunt RL5 energised
(Read Osc Off)	TR14 On, shunt RL11 energised

8.2.5 "READ OSC" Selection

With READ OSC function selected, a logic 1 on input pin 21 (READ OSC) is applied to NAND-gate input IC9/5 and gives a logic 0 on the output of Schmitt inverter IC7/12. This logic 0 inhibits the A and B input logic and also gives a logic 1 on NAND-gate IC9/3 output to switch TR14 off and de-energises the earth shunt relay in its collector. After the delay imposed by R67, C24, the logic 1 input from inverter IC7/10 on input IC9/6, and the logic 1 on IC9/5, give a logic 0 on output IC9/4.

This logic 0 is applied to the base of TR13 to energise the relays RL9 and RL10 in its collector, indicated by front-panel LED D17 (READ OSC).

The contacts of RL9 and RL10 route the OSC IN LIVE and OSC IN RETURN lines to the 40 dB attenuator.

READ OSC	IC7/13	IC7/12	IC9/4	IC9/3	TR14	TR13	RELAYS	LED	ON
1	0	0	1	OFF	ON	11	OFF	D17	
							9,10	ON	

Inhibits Input A TR10 On, shunt RL5 energised
 Inhibits Input B TR12 On, shunt RL8 energised

8.2.6 40 dB Attenuator

The selected input signal is capacitively coupled via C1 and C2 to a 40 dB balanced attenuator network. Since the two halves are identical, only the upper half is described. The attenuator network consists of an L-section, the series arm formed by R9//R10 and the shunt arm by R13//R15 and preset VR1. The attenuator is switched into circuit by RL12 or bypassed by RL13, controlled by TR15/TR16.

VR1 is used to set the gain change to exactly 40 dB in the "LIVE" or "IN PHASE" attenuator section.

VR2 likewise adjusts the "RETURN" or "ANTI-PHASE" attenuator section.

Each attenuator relay driver consists of two transistors operating in common-emitter configuration.

A logic 1 from the microcomputer control causes the first transistor to conduct, which energises the relay in the collector, activates the servicing-aid LED and switches off the second transistor.

40 dB ATTEN.	INPUT PIN	TR15	RL12	LED	TR16	RL13
ON Condition (1)	28	ON	ON	D20	OFF	OFF

8.2.7 20 dB Attenuator

The output from the 40 dB attenuator is direct-coupled to the 20 dB attenuator, which is identical except for the component values. The series arm resistors are R19//R20; the shunt arm resistors are R17//R21 and preset VR3.

The attenuator is switched into circuit by RL14 or bypassed by RL15, controlled by TR17/TR18.

VR3 is used to set the "IN-PHASE" attenuator leg gain change to exactly 20 dB.

VR4 likewise adjusts the "ANTI-PHASE" attenuator leg.

20 dB ATTEN.	INPUT PIN	TR17	RL14	LED	TR18	RL15
ON Condition	24	ON	ON	D23	OFF	OFF

8.2.8 Input Amplifier Protection Circuits

The output from the 20 dB attenuator is coupled via C3 and C4 to input amplifiers IC4 and IC6, via opto-coupled FETs, IC1 and IC2.

Diodes D5 and D6, plus Zener diodes D1 and D2, clamp the input signal at the non-inverting input of IC4 to ± 10.7 V maximum. Similarly, D3 and D4 clamp the non-inverting input of IC6.

The opto-coupled FETs, IC1 and IC2, work in conjunction with TR1, TR2, TR5 and TR6 to form an effective input-overload protection circuit. If the signal at input IC4/3 is sufficient to cause output IC4/6 to start clipping, the result is that the inverting input IC4/2 no longer follows the input signal of IC4/3. When the input signal increases by more than +0.6 V over the value required to cause output IC4/6 to clip, TR1 or TR2 conduct in alternate half-cycles, thereby introducing a large drop in input impedance seen at IC4/3.

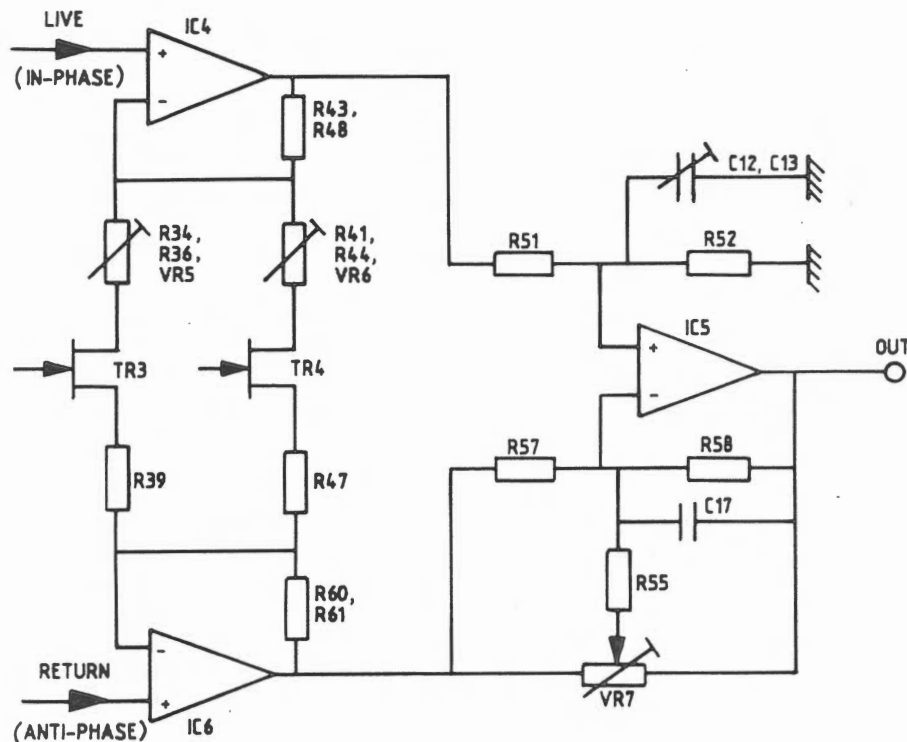


Figure 8.2.1 Input Module Amplifier Circuit

The opto-coupled FET, IC1, under non-overload conditions functions as a resistor of approximately 150 ohms in series with the input of IC4. With an excessive signal voltage, as experienced under overload conditions with TR1 or TR2 conducting, the resistance of IC1 rises.

IC1 thus acts as a bilateral current limiter, preventing excess input current from being "dumped" through TR1 or TR2 under severe overload conditions from a low-impedance source. The net effect of this circuit operation is to prevent C7 and C19 being charged or discharged by the input signal, thereby considerably reducing the overload recovery time required.

The arrangement around IC6 (TR5, TR6 and IC2) functions identically. Figure 8.2.2 shows the V-I curve of IC1 and IC2.

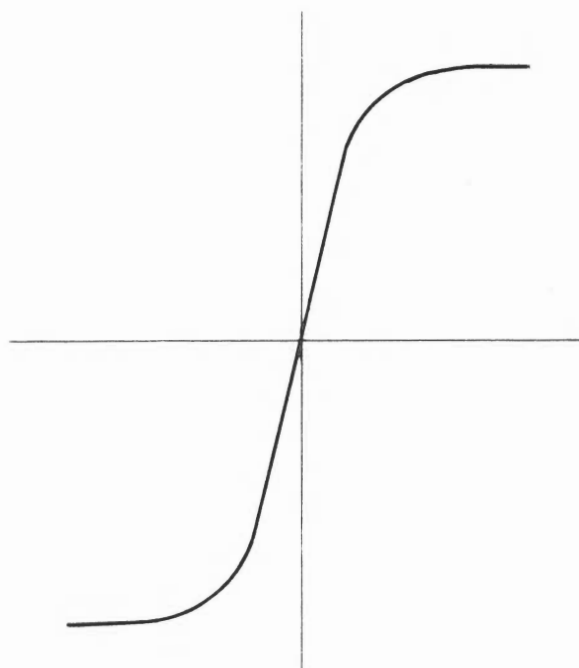


Figure 8.2.2 V-I Curve, H11F1

8.2.9 Input Amplifier Circuits

The input amplifiers are configured in a differential-input to single-ended output arrangement as shown in the simplified circuit of Figure 8.2.1.

The overall input - output gain of this circuit can be remotely switched to one of three gains: 0.3, 10.3 and 20.3 dB.

With TR3 and TR4 off, the two input amplifiers are practically voltage followers with a gain of approximately 0.3 dB. The output amplifier, IC5, has unity gain. Transistors TR3 and TR4 are low-resistance junction FETs and are held off by a gate bias of -18 V.

8.2.10 20 dB Gain Change

For 20 dB gain, the microcomputer applies a logic 1 to pin 27 of the module connector, thus turning TR21 on and TR22 off. Current flowing in the collector of TR21 and the LED of IC3a turns on the photo-transistor of IC3a. IC3b is not energised, thereby disconnecting TR3 gate from -18 V. Simultaneously IC3a turns on, connecting the gate via IC3a to a centre rail derived at the junction of R37, R38. This junction is at an A.C. potential halfway between the outputs of IC4 and IC6 in order for TR3 to operate at minimum distortion in the "on" condition.

With TR3 on (gate at 0V), the feedback arriving at the inverting inputs of IC4 and IC6 is attenuated through R34//VR5 and R36, TR3 and R39.

VR5 is used to trim the gain change, resulting from turning TR3 on, to exactly 20 dB.

The network R50, R59, C11 and R32 serves to bias the gates of TR3 and TR4 in

the "off" condition to a -18 V d.c. point at an a.c. potential midway between the outputs of IC4 and IC6. This arrangement ensures that TR3 and TR4 gates are held below the most negative a.c. signal peaks to avoid being brought into conduction unintentionally.

8.2.11 10 dB Gain Change

The 10 dB gain network, R41/(VR6 and R44), TR4 and R47 operates identically to that described for the 20 dB network. VR6 is used to trim the gain change to exactly 10 dB.

Identical operation applies as described in the 20 dB gain section for the gate drive circuit from the 10 dB gain activate control input (pin 26) to the gate of TR4, namely, TR19, TR20 and IC3d, IC3c.

8.2.12 Differential-to-single-ended converter

The stage around IC5 converts the differential signals from IC4 and IC6 to an unbalanced signal referred to the 0 V line. Presets VR7 and C13 provide adjustment of common-mode rejection. VR7 trims for best rejection at low to mid frequencies; C13 trims for best rejection at high frequencies.

The input module output is taken directly from IC5 pin 6 to pin 9 on the module connector.

8.3 Removal/Disassembly/Replacement

8.3.1 Module Removal

The input module is a plug-in assembly located at the left front of the MJS401D front panel.

First remove the 2 screws retaining the module front panel to the test set housing.

XLR VERSION

Insert an XLR type plug into the INPUT B socket. Pull gently to slide the module forward out of its housing.

JACK VERSION

Insert a jack plug into each of the two input sockets. Gently squeeze them together and pull outward to slide the module forward out of its housing.

EURO VERSION

Insert a SIEMENS 3 POLE PLUG into each of the two input sockets. Gently squeeze them together and pull outward to slide the module forward out of its housing.

8.3.2 Accessing Switch and LED Sub-Board

Locate the brackets which retain the front panel to the main PCB. See Figure 8.3.1 below.

Remove the 2 screws and nuts retaining the brackets to the PCB. Leave the brackets attached to the front panel.

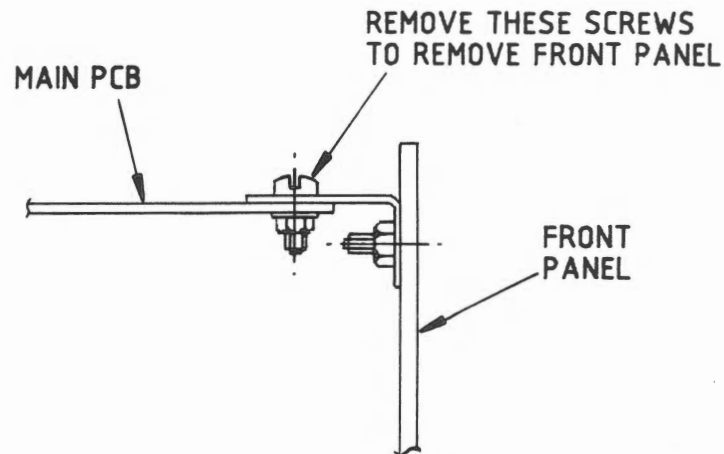


Figure 8.3.1 PCB - Front Panel Fixing

8.3.3 Switch Removal

Prise off the switch cap taking care not to stress the main to sub PCB connection.

Clip off the switch terminals as near the switch body as possible.

Desolder the switch terminals from the sub-board, pulling them out through the front of the PCB.

8.3.4 Switch Replacement

Orient the switch by ensuring that the flat is located as shown in Fig 8.3.2. Seat the new switch firmly against the PCB. Solder into place, then examine to ensure that it is still flush against the PCB.

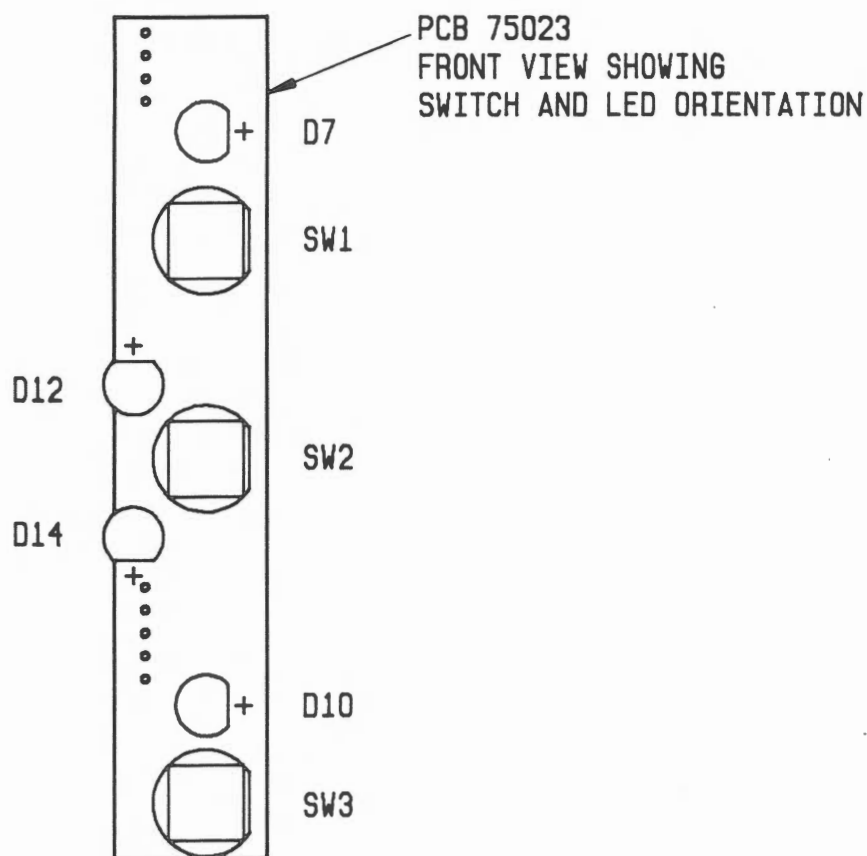


Figure 8.3.2 Switch and LED Orientation

8.3.5 LED Removal

Clip the LED leads off as near the LED body as possible.

Desolder the leads, removing them by pulling from the front of the PCB.

8.3.6 LED Replacement

Orient the LED as shown in Fig 8.3.2.

Insert the LED into clear holes in the PCB. DO NOT SOLDER YET!

Refit front panel as detailed in the section "Refitting Front Panel".

Push the LED through the panel as shown in Fig 8.3.3. Now solder the leads to hold it in place.

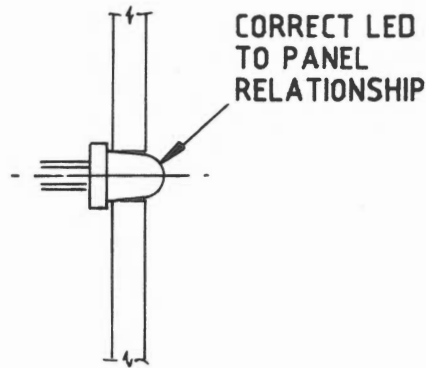


Figure 8.3.3 LED Fitting Through Panel

8.3.7 Connector Replacement - XLR Type

Connections are shown in Fig 8.3.4.

Contact failure can be overcome without removing the connector shell. Looking from the front note the screwdriver slot in the connector body. Rotate this screw about 30° anti-clockwise to unlock the body from the shell. The body can be withdrawn from the rear.

Replacement is exactly the opposite of removal.

If the shell is damaged, proceed as for the Euro type below.

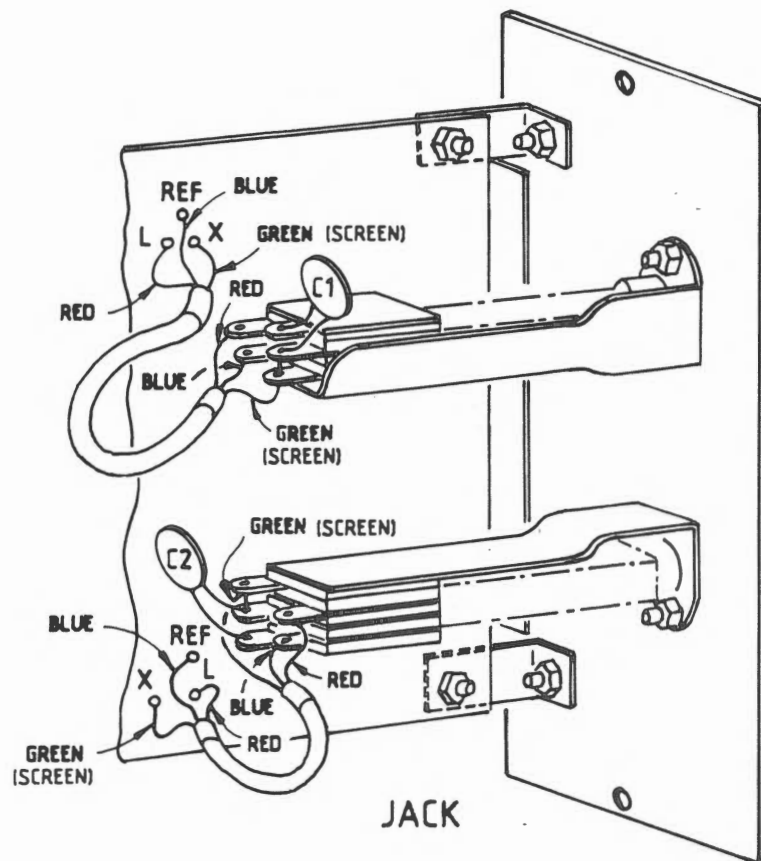
8.3.8 Connector Replacement - Jack and Euro Type

Connections are shown in Fig 8.3.4.

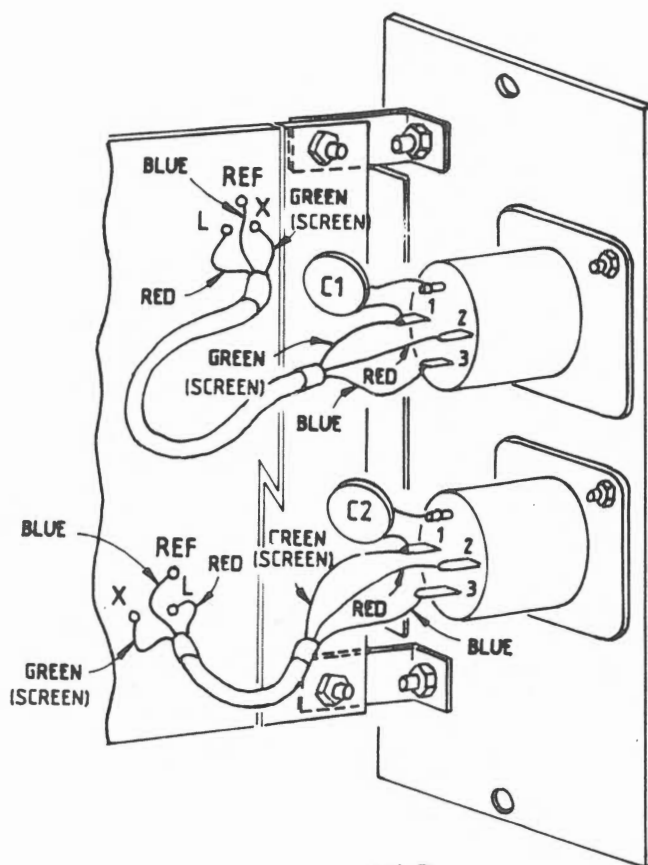
First remove the front panel. Leave the two brackets attached to the front panel.

Remove the connector retaining nut(s) and shakeproof washers carefully avoiding lateral stress on the ends of the stud(s).

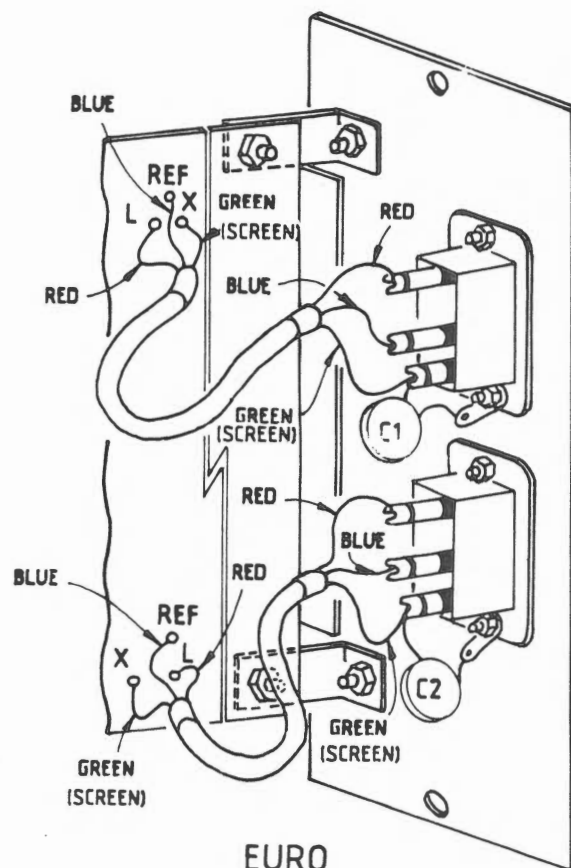
Replacement is the opposite of removal. Use low strength thread locking compound, e.g. Bostik T22, on the threads.



JACK



XLR



EURO

Figure 8.3.4 Connections

8.3.9 Refitting Front Panel

Locate the panel carefully over the switches and LEDs.

Using a low strength thread locking compound, e.g. Bostik T22, replace the screws, shakeproof washers and nuts. Tighten finger-tight.

Check switch clearance and align as required. Then fully tighten the nuts.

8.3.10 Module Replacement

Locate the PCB in the card guides on the right of the module housing.

Push the module carefully into the housing until the front panel is flush with the main front panel assembly.

Replace the 2 module retaining screws.

8.4 Fault Finding

Use Extender Card PCB 75038.

8.4.1 Common Mode Rejection Problems

For "dB COARSE" settings of 0 dB to -90 dB the principal adjustments occur at the last amplifier IC5. This stage **must** be working satisfactorily before the attenuator stages are adjusted. See Section 8.2.12 "Differential-to Single-Ended Converter" and Section 8.5.3.

For "dB COARSE" settings of +20 dB to +10 dB the balance of the 20 dB ATTENUATOR is critical. See Section 8.2.7 "20 dB Attenuator" and Sections 8.5.4 and 8.5.5.

For "dB COARSE" settings of +40 dB to +30 dB the balance of the 40 dB ATTENUATOR is critical. See section 8.2.6 "40 dB Attenuator" and sections 8.5.4 and 8.5.5.

Severe errors can probably be traced to attenuator relays failing to open or close in one leg or the other, or major amplifier malfunctions. Both can be traced by comparing signal levels in each leg. This type of problem will be essentially uniform with frequency.

Common mode variation with frequency can often give a clue as to the cause of the problem. Set the oscillator to the frequency where the problem is worst and compare gains between the legs. Bear in mind that the differences will be small, a 1 dB gain error reduces common mode rejection to 20 dB.

8.4.2 Gain Error Problems

Constant Gain Error at all Sensitivities

This is unlikely to be in the input module. We suggest a complete re-calibration to find the cause.

dB COARSE +40 to +30 only

Look at the 40 dB attenuator. See Section 8.2.6, Section 8.5.4 and Section 8.5.5.

dB COARSE +20 to +10 only

Look at the 20 dB attenuator. See Section 8.2.7, Section 8.5.4 and Section 8.5.5.

dB COARSE +30, +10 and -10 only

Look at 10 dB Gain Block. See Section 8.2.11 and Section 8.5.4.

db COARSE -20 and below only

Look at 20 dB Gain Block. See Section 8.2.10 and Section 8.5.4.

dB COARSE -30 and below only

The fault is not in this module. Look at Gain Chain, Section 7.

8.4.3 Switch Selection Problems

In the MJS401D all switches are read by the microcomputer which then sends out appropriate control commands. The outputs from the microcomputer are latched, while the inputs are encoded and multiplexed. Therefore it is easier to check results than causes. To confirm basic microcomputer output operation, see Microcomputer Diagnostics in Section 3.

8.4.4 Switch or Indicator Failures

These faults are easy to trace but please follow the disassembly and assembly instructions in Section 8.3. See Section 8.2 for a description of the logic of the appropriate device.

8.5 Calibration

8.5.1 Instruments Required

For accurate calibration a precision calibrated AC DVM with adequate bandwidth is required together with a stable sinewave oscillator and an ordinary oscilloscope. If the DVM has not been calibrated in the last 6 months, have it calibrated by a laboratory with traceable standards before using it to calibrate the MJS401D.

Recommended specifications:-

DVM 4.5 digit.
 100 kHz minimum bandwidth.

OSC Frequency range 100 Hz to 10 kHz.
 < 1% distortion.
 Level stability < ± 0.05 dB over 30 minutes.
 Maximum output level < +20 dBu.
 Output level controllable over a range greater than 60 dB without serious degradation of signal-to-noise ratio.
 MD404B is suitable.

SCOPE Input impedance 1 Megohm.
 Bandwidth > 500 kHz.

8.5.2 General

Check D.C. conditions:

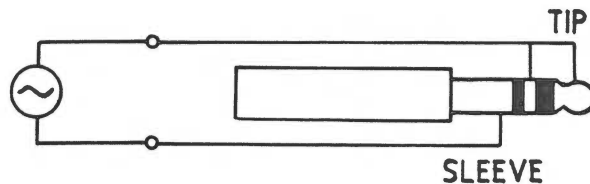
IC4 pin 6 +10 mV to -10 mV
IC6 pin 6 +10 mV to -10 mV
IC5 pin 6 +20 mV to -20 mV

Ensure basic functionality by inputting a balanced signal and switching "db COARSE" from +40 dB to -20 dB, with appropriate source levels at 1 kHz. Check a rough frequency response from 100 Hz to 10 KHz. Errors of more than 1 dB indicate a probable fault in the system. Smaller errors may be cured by recalibration.

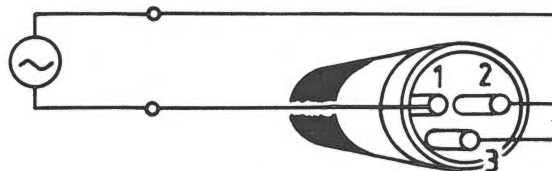
8.5.3 Common Mode Rejection - Sensitivity of 0 dB to -90 dB

Connect a sinewave oscillator (Source) in common mode to input connector A as shown. If MD404B is used, switch it to UNBAL.

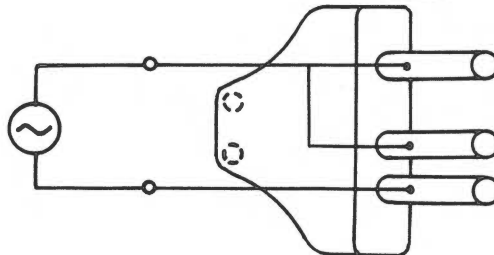
Jack Version



XLR Version



Euro Version



MJS401D Front Panel Setup

Input	Load	Function	Filters	Rectifier	Scale	Dist'n	Coarse	Fine
A	Off	Level	Off	RMS	dB Norm	---	-30	0

Source Set-up

Freq	Level	
	dBu	Volts
1kHz	-10	0.245

Adjust VR7 for minimum meter reading.

Increase meter sensitivity by turning "dB COARSE" clockwise until the reading is near mid-scale.

Again adjust VR7 for minimum meter reading.

Continue until no further improvement can be reached.

Change source frequency to 10kHz.

Adjust C13 in the above manner to achieve a minimum reading on the meter.

Repeat 1k - VR7

10K- C13

until no further improvement can be made.

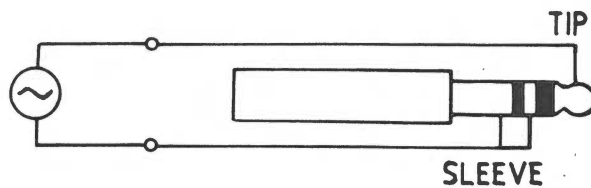
Meter should be

- < -80 dB at 1kHz
- < -80 dB at 10kHz

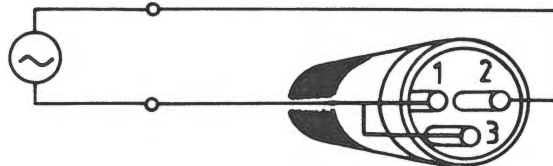
8.5.4 Gain Step and Attenuator adjustment

Connect the source to input "A" via a lead as shown. If MD404B is used, switch it to UNBAL.

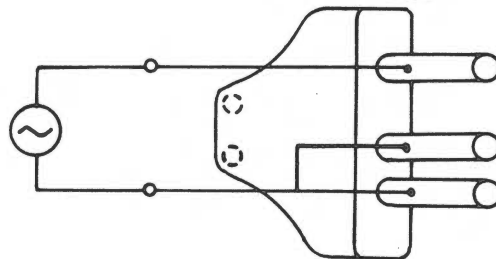
Jack Version



XLR Version



Euro Version



MJS401D Front Panel Setup

Input	Load	Function	Filters	Rectifier	Scale	Dist'n	Coarse	Fine
A	Off	Level	Off	RMS	dB Norm	---	0	0

Source frequency 1 kHz.

Connect DVM between module output and analogue 0 V.

ADJUST	dB COARSE SETTING	DVM READING	PURPOSE
Source Level	0	0.7750 V (0 dBu)	Reference Level
VR6	-10	2.451 V (+10 dBu)	Set 10 dB gain step
VR5	-20	7.750 V (+20 dBu)	Set 20 dB gain step
Set dB coarse control to +20 dB. Measure the source level, note it, and increase it by a factor of EXACTLY 10. Reconnect the DVM to the module output.			
VR3	+20	0.7750 V (0 dBu)	Set 20 dB Attenuator "IN-PHASE" leg
VR1	+40	0.07750 V (-20 dBu)	Set 40 dB Attenuator "IN-PHASE" leg

8.5.5 "Anti-Phase" attenuator leg adjustments

Re-connect source in common mode as in section 8.5.3 above. Set source to 1kHz at +30 dBu or maximum output if less than this. Connect the 'scope to the 'SCOPE output of the MJS401D and observe its trace.

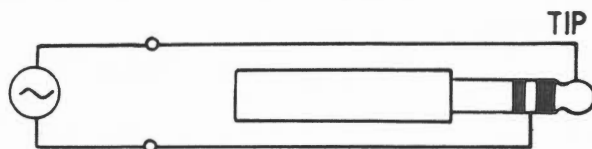
ADJUST	dB COARSE SETTING	SCOPE TRACE	PURPOSE
VR4	+10	Minimum	Set 20 dB Attenuator "Anti-phase" to match the "In-phase" setting
VR2	+30	Minimum	Set 40 dB Attenuator "Anti-phase" to match the "In-phase" setting

8.5.6 Confirmation of calibration

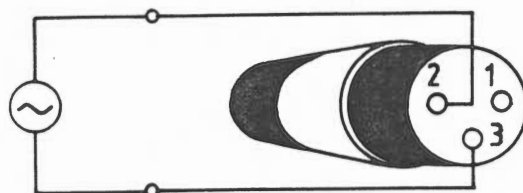
Replace the INPUT MODULE into its housing.

Connect source as shown below. If MD404B is used, switch it to BAL.

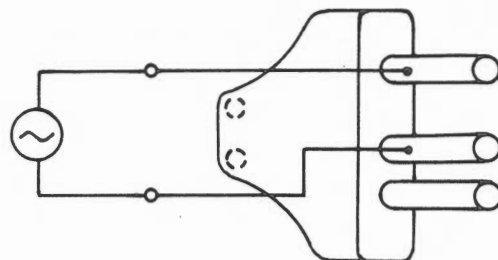
Jack Version



XLR Version



Euro Version



MJS401D Front Panel Setup

Input	Load	Function	Filters	Rectifier	Scale	Dist'n	Coarse	Fine
A	Off	Level	Off	RMS	dB Norm	---	as below	0

Connect DVM across the source.

Note: Some Oscillators or DVMs will produce errors due to excess noise. Check waveform on "'SCOPE" socket to confirm.

The meter may not read the correct level; the important thing to note is

changes in the reading. Ensure the meter does not depart from the expanded scale.

SOURCE		dB COARSE SETTING	METER READING	PURPOSE
7.750 V	(+20 dBu)	+20	Note	Check Meter Reference
24.51 V	(+30 dBu)	+30	less than 0.05 dB change	(This may not be possible, depending on the source used)
2.451 V	(+10 dBu)	+10	"	
0.7750 V	(0 dBu)	0	"	
0.2451 V	(-10 dBu)	-10	"	
0.07750 V	(-20 dBu)	-20	"	

EXTENDER TEST POINT OR INDICATOR REFERENCE