

PCB 77401

16.1 Introduction

The intermodulation distortion card provides IMD measurement capability to S.M.P.T.E., D.I.N., or C.C.I.F. standards. The measurement standard can be selected by the combination of two on-card D.I.L. switches or by remote control.

The switch settings signal to the microcomputer system which I.M.D. measurement standard is required by the user. The MJS401D microcomputer in turn instructs the MD404B oscillator to provide the appropriate test tones for the standard selected.

16.1.1 S.M.P.T.E. and D.I.N. Technique

The S.M.P.T.E. distortion measurement standard requires a test tone comprising two signals mixed together, 60 Hz and 7 kHz, at an amplitude ratio of 4:1. The 60 Hz signal effectively sweeps the 7 kHz signal throughout the amplitude range of the system under test, and detects any non-linearity as amplitude modulation of the 7 kHz signal. Since the measuring bandwidth required is very much less than that required for total harmonic distortion measurement, it is a more sensitive method of measuring non-linearities. The standard specifies the distortion as the percentage amplitude modulation of the higher frequency component of the test tone.

The D.I.N. standard is similar to S.M.P.T.E., except that the tones are at 250 Hz and 8 kHz. The level ratio remains at 4:1.

16.1.2 C.C.I.F. Technique

The C.C.I.F. measurement applies a test tone of 14 kHz and 15 kHz, and equal amplitudes.

The measurement system filters out the composite 14 kHz/15 kHz signal, measures any signal at the difference frequency of 1 kHz, and displays this as a percentage of the peak level of the composite test signal returned from the equipment under test.

Figure 16.1.1 shows the IMD card block diagram.

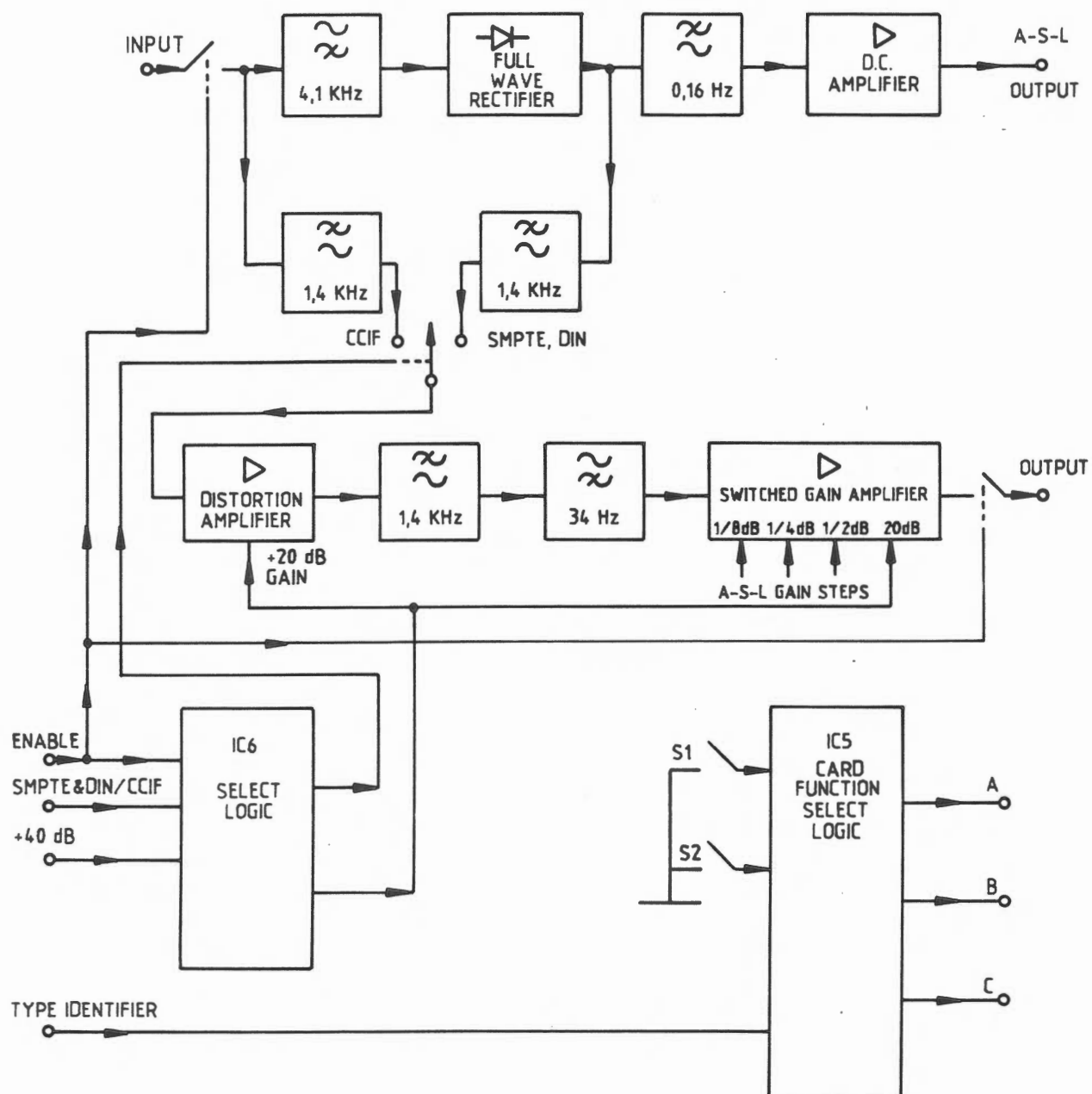


Figure 16.1.1 IMD Card - Block Diagram

16.2 Circuit Description

16.2.1 S.M.P.T.E. and D.I.N. Operation

The IMD card is enabled by the "enable" pin (SK1/5) going high (+5 V). This turns on RL1 and RL2, which connect the input and output of the IMD circuitry, inserting it in the MJS401D signal path. The enable line also sets the amplifier gains to minimum when low.

16.2.2 Input Filter

The 6 pole highpass filter comprising part of IC1 and IC2, has a cut off frequency of 4.1 kHz, and has flat response to signals above 6 kHz.

The 4.1 kHz HP filter removes the lower frequency (60 Hz or 250 Hz) component of the IMD input signal, leaving the higher frequency (7 kHz or 8 kHz), amplitude modulated by any non linearities of the system under test.

16.2.3 Rectifier

The higher frequency signal amplitude modulation is detected by a full wave rectifier, comprising unity gain inverter IC3, with D2 and D3. The diode connected transistor, TR2, provides a small amount of forward bias of D2 and D3, ensuring good rectifier linearity.

16.2.4 D.C. Amplifier and Auto-Set-Level Output

The amplitude of the higher frequency signal is averaged by the time constant VR1, R17 and C8, amplified by the d.c. amplifier part IC4, R18, R19, and VR2, to provide a d.c. output to the MJS401D microcomputer system. VR1 sets the averaging time constant to exactly that expected by the MJS401D microcomputer system, which is important because the microcomputer predicts a final value of the auto-set level voltage by taking successive A.S.L. voltage measurements, to speed measurement time.

16.2.5 Distortion Amplifier

The rectified, amplitude modulated higher frequency signal appears as a 14 kHz or 16 kHz signal with the d.c. component removed, at R26/R27 junction. According to the IMD range setting, the gain of the post rectifier amplifier IC10 has either R26 or R27 selected as its input resistor, depending on which sections of IC8 analogue switch IC are made.

When a 40 dB gain increase is required, a 20 dB gain increase is produced by substituting R26 for R27 as IC10 input resistor. A further 20 dB gain increase occurs in the output amplifier.

The rectified high frequency amplitude modulated signal (now doubled in frequency) is fed through a 6 pole 1.4 kHz lowpass filter, part IC10 and IC11, to the card output, via IC12.

16.2.6 Gain Control

The post filter amplifier gain is set from the microcomputer card in 40 dB, 1/2 dB, 1/4 dB and 1/8 dB steps on the IMD card, with 40 dB, 20 dB, 10 dB, 4 dB, 2 dB and 1 dB gain steps provided by the Gain Chain card.

The auto set level function is achieved by the microcomputer, which reads the MJS401D "% distortion" range, and also the average value of the high frequency signal, as described earlier. A 100 % modulation of the high frequency signal would correspond to 100 % IMD.

If the amplitude of the test signal increases, the microcomputer measures the increase in signal level, and reduces the post IMD detector circuit gain by the same amount (within $\pm 1/16$ dB). This effectively ensures that the measured IMD is always measured as a proportion of signal level, regardless of the actual IMD card input signal level.

16.2.7 Output Amplifier

20 dB of the 40 dB post IMD measurement gain is achieved by +5 V present on the input to IC6/1 (SK3/3). This reduces the input resistor value to IC10 by a factor of 10, increasing IC10 gain by 20 dB. (IC7 substitutes R24 for R25, for S.M.P.T.E. or D.I.N., IC8 substitutes R26 for R27 for CCIF). The remaining 20 dB is achieved by removing R60 from the parallel combination R59/R60, effectively increasing IC12 gain by 20 dB. R60 is switched across R59 by two sections of analogue switch IC13. The remaining section of IC13 prevents the 20 dB gain increase if the enable line is low.

The 1/2 dB, 1/4 dB, and 1/8 dB steps are provided by R28, R29 and R30, switched in by IC9.

16.2.8 C.C.I.F. Operation

To measure C.C.I.F. distortion, the input signal is passed through a 1.4 kHz lowpass filter comprising IC1 and associated components.

The residual signal at the difference frequency is passed through either R24 or R25 by analogue switch sections within IC7 to inverting amplifier part IC10. The residual signal is further filtered by 1.4 kHz lowpass filter part IC10, and IC11, and arrives at the card output via IC12 and RL1. The control at post filter gain and auto set level is accomplished in an identical manner to S.M.P.T.E. and D.I.N. intermodulation distortion.

16.2.9 Function and Gain Select Logic

IC6 functions as a 2 to 4 line decoder which controls the analogue switch sections within IC7 and IC8. With the "Enable" line (1/5) low, all IC6 outputs are high, and the signal path is broken. With the enable high, the analogue switches are set as in the following table:

Enable (1/5)	SMPTE & DIN/CCIF (2/4)	+40 dB (3/3)	Analogue Switches On
0	X	X	None
1	0	0	IC8/4,5
1	0	1	IC8/14,12; IC8/15,2
1	1	0	IC7/4,5
1	1	1	IC7/14,12; IC7/15,2

X = Don't care.

The +40 dB select line (3/3) goes high to increase the post-filter gain by 40 dB when required by the distortion range switch setting and input signal

level.

16.2.10 1st/2nd Level Type Identifier

The IMD slot in the MJS401D may be occupied by one of several IMD type cards. To identify the particular type in use, the 1st/2nd level identifier line is brought high by the microcomputer and the IMD type identifier lines (1/8, 1/7, 1/6) are read. This card (PCB 77401) is identified by a "0" on all three lines. This is achieved by taking the NOT ENABLE input of IC5, pin 6, high, forcing all its outputs low.

16.2.11 Card Function Select Logic

The particular standard of IMD measurement is selected by setting combinations of S1 and S2. When its NOT ENABLE input, pin 6, is low, IC5 encodes the switch settings onto three IMD card type identifier lines A, B and C (1/8, 1/7, 1/6), which are read by the microcomputer. The microcomputer then selects the appropriate S.M.P.T.E. or D.I.N./C.C.I.F. logic line, as well as instructing the MD404B oscillator to provide the appropriate test signal.

The identifier code is set out in the table below:

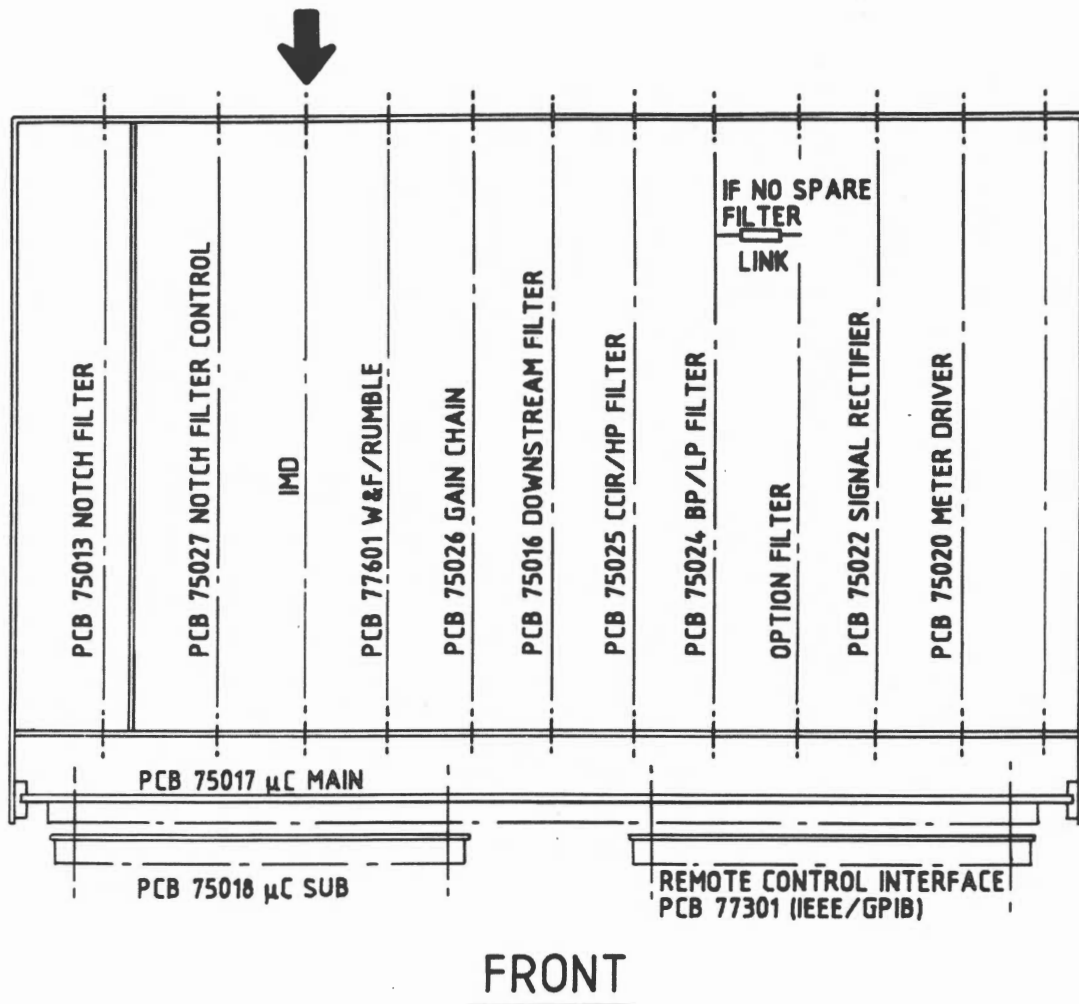
Select	S1	S2	C(SK1/6)	B(SK1/7)	A(SK1/8)
S.M.P.T.E. Closed	Closed	Closed	0	0	0
D.I.N. Closed	Closed	Open	0	0	1
C.C.I.F. Open	Open	Closed	0	1	0
OFF	Open	Open	1	1	1

16.3 Removal/Replacement

Switch off the MJS401D and remove the mains lead.

Remove the four screws retaining the top cover. Pull the top cover straight up.

With the instrument facing you, the IMD card is installed in the 4th slot from the left in the main card frame. Verify by noting the printing on the motherboard.



MJS401D PCB Location Guide

Remove the card by grasping the top corners and gently pulling up.

Replacement is the opposite of removal. Carefully line up the connectors before pushing down and ensure the card is properly held within the guides.

Extender card PCB 75035 may be used to facilitate repair and calibration.

16.4 Fault Finding

16.4.1 Standard and Test Signal Not Correct

Check that S1 and S2 are correctly set.

Check if S1, S2 or IC5 is faulty.

Check that the software in the MJS401D is version 4.2 or 4.3, or later, and that the software in the MD404B oscillator is 1.5 or later.

16.4.2 Standard Correct but Measurement System Incorrectly Set

Check function select logic line (2/4).

Check logic supply voltages to IC5-IC8.

16.4.3 No Output

Check logic supply voltage.

Check relays RL1 and RL2 are activated.

Trace signal through the card, referring to block and circuit diagrams.

16.4.4 Permanent "Level High" Indication

The auto-set-level output voltage (3/4) is permanently high. Trace back through IC4, IC3, IC2.

16.4.5 100 % Calibration Incorrect

Check full-wave rectified signal present on D2 and D3 cathodes. Remove input signal and check that the offset voltage at IC4 pin 7 is between 0 V and 0.2 V. If larger than 0.2 V, check that the offsets of IC2 and IC3 are within ± 10 mV of the voltage on TR2 collector. Check that TR2 collector-emitter voltage is about 0.55 V. Check IC4 offset voltage.

If these are all correct, and the calibration error is small, check VR2 calibration.

16.4.6 Gain Incorrect For Range Selected

Check logic levels. Check IC7, IC8, IC9, IC13.

16.4.7 High IMD Residual

Early Notch Filter Control cards had an F.E.T output gate, which does not fully cut off signals from the THD+N system. See section 10 of this manual. If your MJS401D has such a card, contact your local agent or dealer.

Some specimens of IC17 on the Notch Filter card exhibit parasitic instability when an IMD signal is present. This can be clearly seen on IC17 pin 6, or the Notch Filter "Output" pin. If your Notch Filter exhibits this problem, contact your local agent or dealer.

16.5 Calibration

16.5.1 Equipment Needed

MJS401D with MD404B.

A signal generator capable of generating a 7 kHz sine wave, amplitude modulated in calibrated steps from 100 % to 1 % at modulating frequencies from 30 Hz to 1.5 kHz; alternatively, a signal generator capable of generating one of those frequencies, and a modulator or multiplier with which to modulate the signal.

A signal mixer such as that described in Section 31, Appendix B.

A separate audio signal generator or function generator, capable of operation from 30 Hz to 1.5 kHz; distortion performance not important.

IMD Extender Card, PCB 75035.

16.5.2 S.M.P.T.E./D.I.N. Calibration

Set up the source to generate a 7 kHz sine wave, amplitude modulated at 500 Hz to a depth of 100 %. Connect this signal to input A of the MJS401D. Set the IMD card DIL switches to S.M.P.T.E. or D.I.N.

MJS401D Front Panel Setup

Input	Load	Function	Filters	Rectifier	Scale	Dist'n	Coarse	Fine
A	Off	IMD	---	RMS	% Dist	100 %	---	---

The display of the MJS401D should show "SMPTE" or "DIN".

Adjust VR2 on the IMD card for 100 % indication.

Reduce the modulation to exactly 1 % (if using an external modulating-frequency generator, reduce its output by exactly 40 dB).

MJS401D Front Panel Setup

Input	Load	Function	Filters	Rectifier	Scale	Dist'n	Coarse	Fine
A	Off	IMD	---	RMS	% Dist	1 %	---	---

Check that the reading is exactly 1 %. If not, first double-check that the modulation step was exactly 40 dB. If it was, check the ratio of R26 and R27 is exactly 100:1, and that IC8 and IC6 are operating correctly.

Sweep the modulating frequency from 30 Hz to 1.5 kHz. The response should be flat within 1 % from 60 Hz to 1 kHz, and -3 dB at 33 Hz and 1.4 kHz (reading of 0.71 % IMD).

16.5.3 Check C.C.I.F. Calibration

Switch the IMD card DIL switches to C.C.I.F. Connect the output of the MD404B to input A of the signal mixer, and the output of the other signal generator to input B of the signal mixer. Connect the output of the signal mixer to input A of the MJS401D.

MJS401D Front Panel Setup

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

Switch the MJS401D to IMD. The display should show "CCIF". Switch back to Level.

Adjust the output level of the MD404B for a reading of exactly 0 dB.

Mute the MD404B.

MJS401D Front Panel Setup

Input	Load	Function	Filters	Rectifier	Scale	Dist'n	Coarse	Fine
A	Off	Level	Off	RMS	dB Exp	---	-40	+3

Set the other generator to 500 Hz. Adjust its level for a reading of exactly -37 dB.

Unmute the MD404B. The signal emerging from the signal mixer is a C.C.I.F. test signal containing 1 % distortion (-40 dB). Note that the relevant standard refers the RMS value of the distortion content to the peak value of the composite 14 kHz/15 kHz test signal; therefore the RMS values will be in a ratio of 37 dB.

MJS401D Front Panel Setup

Input	Load	Function	Filters	Rectifier	Scale	Dist'n	Coarse	Fine
A	Off	IMD	---	RMS	% Dist	1 %	---	---

Check that the reading is 1 %. There is no separate calibration adjustment for C.C.I.F. If the reading is significantly in error, check the values of R24 and R25, and the operation of IC7 and IC6.

16.5.4 Adjustment of VR1 and VR3

It is normally sufficient to set VR1 to mid-track.

To set VR3, connect a D.C. voltmeter to the "Output" test point on the extender. Set the MJS401D to "IMD" and the "DISTORTION" rotary control to 0.3 %.

Adjust VR3 for a reading of 0 mV $\pm$ 10 mV.

PROJECTION DO NOT SCALE IF IN DOUBT ASK

MAXIMUM
MINIMUM

REPRESENTS D.C. VOLTAGES MEASURED WITH A VOLTmeter OF 20,000Ω/V OR GREATER, "IMD" FUNCTION (ANY STANDARD), NO INPUT SIGNAL, 0.3% RANGE. MAXIMUM IS DEFINED AS THE MOST POSITIVE VOLTAGE. WHEN MEASURING VOLTAGE AT IC1 PIN 1, SUBTRACT THE VOLTAGE AT SKT 2/1 (INPUT) BEFORE COMPARING WITH THESE LIMITS.

USE EXTENDER CARD PCB 75035

EXTENDER TEST POINT OR INDICATOR REFERENCE

○ REPRESENTS A.C. VOLTAGES MEASURED WITH AN INPUT IMPEDANCE OF 10KΩ OR GREATER, "IMD" FUNCTION, "SMPT" OR "DIN" STANDARD, WITH AN INPUT OF +6 dBu (1.23V) OF 4:1 COMPOSITE SMPT OR DIN SIGNAL APPLIED TO TEST SET INPUT, 0.3% RANGE, "%DIST" SCALE. UNDER THESE CONDITIONS THE D.C. VOLTAGE AT IC4 PIN 7 SHOULD BE APPROX. 5.1 V AND THE AUTO SET LEVEL STEPS SHOULD INDICATE APPROX. 18 1/2

REVISION			
NO	DATE	CHANGE	APPROVE
2	29 JUL 86	PRODUCTION STANDARD <i>August</i>	
3	18 SEP 89	ALL 1. PAGES, WERE REWRITTEN. NEW INFO (EXTRACTED) L.S.P. IN EXTRACTED FROM NOTES. REWRITTEN & NEW INFO (REWRITTEN AND NEW INFO) <i>JD</i>	15-742-8