

MJS401D AUDIO MEASURING SYSTEM

OPERATION AND MAINTENANCE MANUAL

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OPERATING MANUAL

MJS401D AUDIO MEASURING SYSTEM AND MD404B OSCILLATOR

1 Introduction

The MJS401D is an extremely flexible and accurate audio measurement system, providing a means of rapidly measuring:

- LEVEL
- NOISE TO CCIR-468
- FREQUENCY
- CROSSTALK
- HARMONIC DISTORTION

In addition internal option slots are provided for :-

- "A", "B" OR "C" WEIGHTED MEASUREMENTS
- SMPTE/DIN IMD
- CCIF IMD
- OPTIONAL FILTERS
- WOW AND FLUTTER

Close attention has been paid throughout the design stage to the requirements of current and potential users, in order to produce an instrument with as many features as possible, whilst still retaining simplicity of operation.

All the MJS401D's functions are accomplished electronically wherever possible, or by the use of special high-quality relays. This has the dual advantages of greatly increasing the accuracy and reliability of measurements, together with a reduction of the length and area of signal paths, providing much reduced susceptibility to interference. A further advantage is the ability to control all functions by remote control.

The "setting up" of the MJS401D for a specific task is simply a matter of looking from left to right across the front panel, setting controls in the same order as the decisions would be made to perform a specific test. For example, to measure an audio signal level, select the input required at the left of the instrument, and moving across towards the right, select "Level" function, range, filter(s), rectifier characteristic, and finish the procedure by selecting the required meter scale.

The oscillator can then be set up to provide the required signal source. Oscillator setup is done by measuring the oscillator terminal voltage through the MJS401D measurement system with "READ OSC" function selected. This ensures that any deviation of the measurement set does not affect the measured results.

2 Description of Controls and Facilities - Measurement Section

2.1 Inputs

The MJS401D has two electronically balanced inputs, A and B, each having a selectable impedance, and a switch to select either input A or input B.

The MJS401D has comprehensive input protection. It will withstand DC on the inputs between -63 and +63 volts, and will tolerate gross overload. Furthermore, if the MJS401D is switched off, both inputs are disconnected and therefore the source will not be loaded or damage the MJS401D. However, it is not recommended to apply input signal levels in excess of +20 dBm for extended periods when the input sensitivity switch is set to 0 dBm or below.

The input protection circuitry, as well as protecting the MJS401D inputs from excessive signal levels, also serves to ensure that the MJS401D will recover quickly from gross overloads. This feature is particularly important for A.T.E. applications.

The three inputs converging in the MJS401D input module (input A, input B, and "Read Osc") are isolated from each other by more than 100 dB. It is, therefore, possible to reliably measure signals of widely different levels without the effect of "breakthrough" on accuracy.

Inputs "A" and "B" have selectable load impedances. The unterminated impedance is 100 k ohms. With the 600 ohm button depressed, the inputs are accurately loaded with 600 ohms.

2.2 Input Sensitivity

These controls are active in all functions except "THD+N", "IMD" and "W & F". There are two controls, located near the centre of the instrument panel. The left-hand one "dB Coarse" sets the MJS401D to indicate '0' at the centre of the logarithmic meter scales for incoming signal levels at between +40 and -90 dBm.

The second control "dB Fine" either increases or decreases the meter reading for a given setting of the main sensitivity control in 1 dB steps by up to 5 dB. This control can be used when it is required to "offset" the main sensitivity control when signal reference levels other than 0 dB are required.

In normal cases the reference measurement level is entered into the "dB Coarse" and "dB Fine" switches, bringing the required measurement to the "0" point on the meter. For example, a +8 dBm reference level would be set as "+10" on "dB Coarse" and "-2" on "dB Fine". Errors can then be read directly from the meter scale.

2.3 Frequency Display

This alphanumeric display gives a clear indication of the incoming signal frequency, as well as displaying error messages if out of range signals or illegal operating modes are selected. Frequency display is up to five digits or 0.001 Hz, whichever is the less precise. The frequency displayed is derived from frequency and period measurement which means that even low frequencies are measured and displayed rapidly, updating approx. 4 times per second. The frequency measurement range is from 5 Hz to 499.99 kHz. The

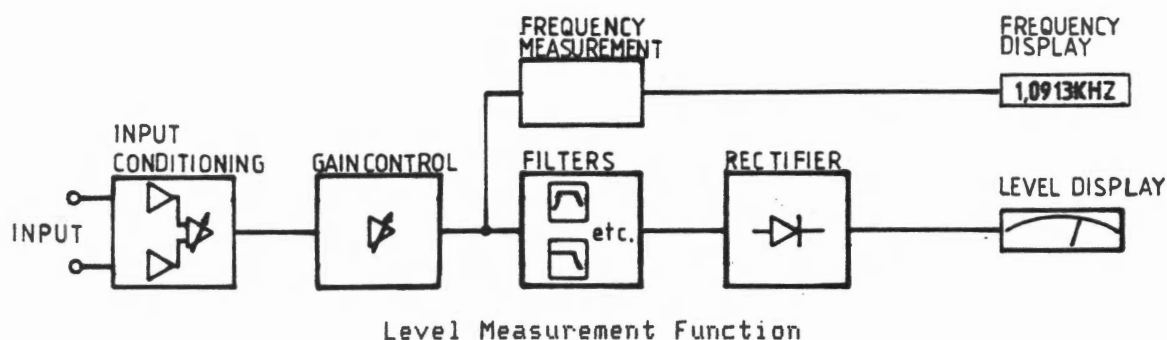
frequency display is continually operating, except in W & F and IMD functions.

2.4 Function Selection

The first group of five push-buttons below the sensitivity controls are used to select the MJS401D's main operating function.

2.4.1 Level

The MJS401D functions as a comprehensive noise and level measurement system, with simultaneous frequency display. By selecting the appropriate combination of filters the MJS401D can be used to measure noise to most of the international and national broadcasting standards.



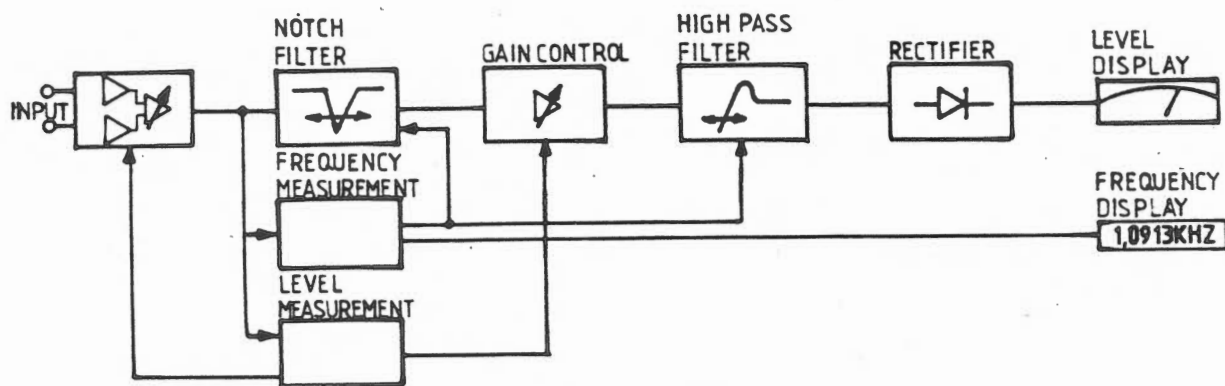
2.4.2 THD (Total Harmonic Distortion)

In this function the MJS401D will measure T.H.D. completely automatically except for setting the "% DISTORTION" switch. Providing that the incoming signal is at a level between -20 and +40 dBm, and of frequency between 20 Hz and 20 kHz, the MJS401D will do the rest, i.e. tune the fundamental out, select the required input sensitivity, and automatically set level.

The instrument will work equally well when using the internal oscillator, or when receiving unknown signals from elsewhere. If the input signal is out of range on either level or frequency, the display will flash and indicate "level/frequency high/low".

Distortion down to 0.01% full scale can be measured in this function, with typical residual limits down to 0.0008% when the 30 kHz filter is used to limit HF noise. The measurement time is less than 1 second at 1 kHz, or 2 seconds at 20 Hz.

Readings can be taken in % or dB as required. Selection is made in the "Scale" section described more fully later.



THD Measurement Function

The MJS401D has the additional feature of a tracking high-pass filter which is arranged to have a "hump" in its response near the cut off frequency. The high-pass filter serves two purposes, firstly to filter out unwanted signals such as hum or noise below the fundamental frequency, and secondly, to compensate for the second harmonic distortion product which is partially attenuated by the notch filter. This feature is illustrated in the graph Figure 1.

The notch filter and tracking high-pass filter are both automatically "tuned" by the frequency measurement system which also drives the frequency display.

2.4.3 IMD

Intermodulation Distortion can be measured using the MJS401D when the IMD option is fitted.

When an IMD option is not installed, this is detected by the microcomputer system and depressing the IMD button will be ignored.

The IMD system is designed to measure IMD to either SMPTE, DIN or CCIF standards, selectable either via the IEEE bus (if fitted) or by a switch mounted on the PCB. The MD404B oscillator already contains the required twin-tone generators.

The required standard is selected on the SMPTE/DIN/CCIF IMD card by means of two DIL switches, clearly legended on the card. The settings are as follows:

SW1	SW2	Function
1	1	SMPTE
1	0	DIN
0	1	CCIF
0	0	Card Off (disabled)

1 = Up, 0 = Down.

Remote control commands may be used to override any of these settings except Card Off. If the card is set to Off, and IMD is commanded remotely, error 16 will result.

The SMPTE and DIN standards are similar in requiring the combination

of a low frequency tone and a high frequency tone at a fixed ratio.

For SMPTE, the oscillator will generate 60 Hz and 7 kHz mixed in a 4:1 ratio.

For DIN, the frequencies will be 250 Hz and 8 kHz in a 4:1 ratio.

The IMD system is also designed to measure generally to the CCIF specifications which require a pair of adjacent high frequency tones. In the MJS401D system tones of 14 kHz and 15 kHz will be provided mixed in a 1:1 ratio.

In all cases operation is similar to that described in the THD section above.

2.4.4 X-Talk

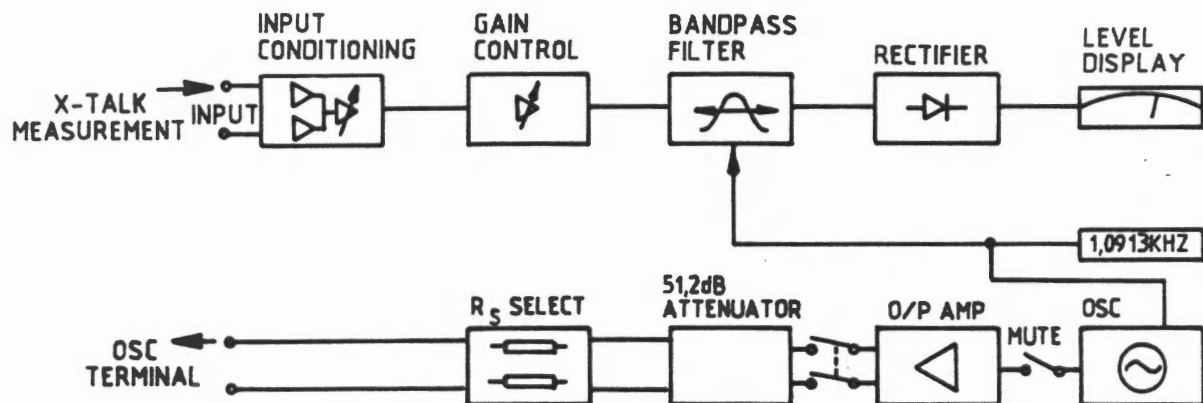
In crosstalk function, the MJS401D is configured as a level measuring instrument with an automatically tuned second order bandpass filter with a "Q" of 5 inserted in the signal path. See Figure 2 for the response of the X-Talk filter.

The bandpass filter centre frequency is automatically tuned to match the frequency of the signal generated by the MD404B oscillator, if fitted; otherwise the filter will be tuned to match the frequency of a signal applied to the MJS401D's "Oscillator" connectors. This function is particularly useful when extracting crosstalk signals buried below noise.

The filter is tuned by the signal causing the crosstalk but is in the circuit of the signal receiving the crosstalk. Therefore noise is suppressed in the measured signal leaving the actual crosstalk easily seen and measured. Typical improvement in measurements range from >20 dB at low frequencies to 9 dB at high frequencies.

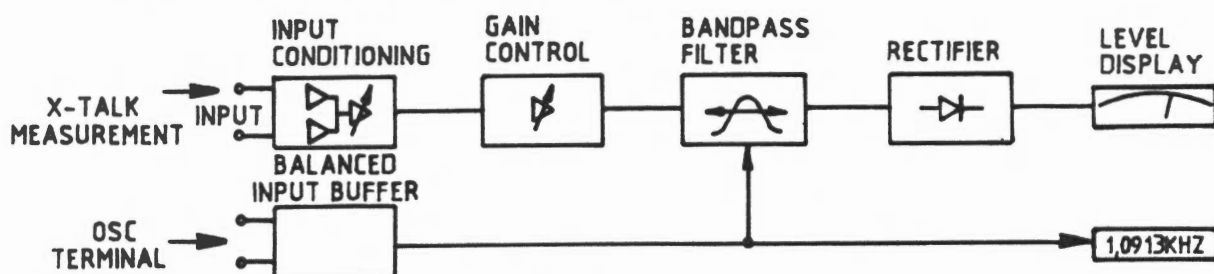
To measure crosstalk on a stereo piece of equipment, one circuit is fed from the MD404B oscillator which also provides the "reference" frequency internally to the MJS401D. Both outputs of the stereo device are taken to the inputs of the MJS401D and appropriately terminated.

To measure crosstalk on stereo lines, or any stereo device where the signal is not generated by the MD404B (but where the MJS401D has an MD404B fitted), both outputs are taken to the MJS401D inputs and appropriately terminated. The MD404B is tuned to the same frequency as the reference. The MD404B must not be muted; in the muted state, the oscillator is set to a very low frequency, and the MJS401D would attempt to follow.



X-TALK Measurement Function - MD404B Fitted

When no MD404B is fitted, the reference output from the device under test must be fed to one of the "Oscillator" connectors in order to provide the reference frequency; and also to one of the MJS401D inputs, if its level is to be measured.



X-TALK Measurement Function - MD404B Not Fitted

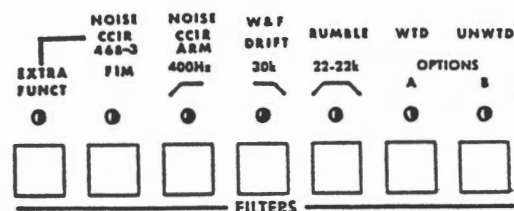
The crosstalk figure can be measured quickly by comparing the signal levels from the equipment channel outputs using the A/B input selector on the MJS401D. For example, if one side is driven by +10 dBu and its partner measures -42 dB, the crosstalk would be -52 dB at that frequency. To measure crosstalk at a different frequency simply change the oscillator frequency, and the MJS401D X-Talk bandpass filter will automatically tune to the new frequency.

2.4.5 Read Osc

This connects the MJS401D input to the oscillator in order to measure the terminal voltage appearing at the oscillator output. This function can be used with either an internal or external oscillator.

2.5 Extra Functions

Wow and Flutter and Rumble can be measured by the MJS401D when the W & F option is fitted. In this case, in order to make all options accessible from the front panel, the "Filters" switches are reconfigured. As shown in the drawing below, the filters become dual purpose, shifted by the former CCIR 468-2 switch.



Filter Configuration for W & F/Rumble Option

A label and replacement EPROMS are supplied with this option along with the plug-in W & F/Rumble PCB.

The CCIR 468-2 and CCIR ARM filters are replaced by NOISE CCIR 468-3 and NOISE CCIR ARM functions.

To select any of the extra functions, which appear over the filter buttons, first press the EXTRA FUNCT button. The NOISE CCIR 468-3 function will be the first extra function entered after switch-on, in the weighted state. The NOISE CCIR 468-3, NOISE CCIR ARM, W&F/DRIFT and RUMBLE functions interlock in the same way as the five main FUNCTION buttons.

All four extra functions are available weighted (WTD) or unweighted (UNWTD).

To enter any of the five main functions again, simply press the button for the desired function.

2.5.1 Noise CCIR 468-3

Weighted, this corresponds to the use of LEVEL function and CCIR 468-2 filter if the extra functions are not fitted. Unweighted, it corresponds to the use of LEVEL function, 22-22k filter and QUASI-PEAK rectifier. The quasi-peak rectifier is locked in; no other can be selected. No other filter can be selected. Scales allowed are dB NORM and VOLTS; the dB EXP scale cannot be selected.

2.5.2 Noise CCIR ARM

Weighted, this corresponds to the use of LEVEL function and CCIR ARM filter if the extra functions are not fitted. Unweighted, it corresponds to the use of LEVEL function, 22-22k filter and AVG rectifier. The AVG rectifier is locked in; no other can be selected. No other filter can be selected. Scales allowed are dB NORM and VOLTS; the dB EXP scale cannot be selected.

2.5.3 W & F

The required centre frequency and rectifier (detector) characteristic are set independently by the middle and rightmost DIL switches, clearly legended on the card. The middle pole sets the centre frequency; up = 3k15 Hz, down = 3k00 Hz. The rightmost pole sets the rectifier characteristic; up = IEC/DIN/CCIR/BS, down = IEC/JIS. These settings may, however, be overridden by remote control commands.

When W & F is installed the system will auto-range in level. The % DISTORTION control selects the W & F measurement sensitivity (only

valid for 0.1% to 10% ranges; other ranges produce error messages on the display). W & F will be displayed on the meter in %.

Simultaneously DRIFT will be displayed on the frequency display (unless an invalid range is selected).

Results are available weighted (WTD) or unweighted (UNWTD) by selection from the front panel.

The MD404B oscillator will be automatically set to output 3.000 kHz or 3.150 kHz as required.

2.5.4 Rumble

The Wow and Flutter option also allows rumble to be measured to BS 4852 or IEC 98A (DIN) standards. Selection is by means of the leftmost pole of the DIL switch on the card; up = IEC, down = BS. Operation is essentially as LEVEL function with predetermined filter and rectifier.

Results are available weighted (WTD) or unweighted (UNWTD) by selection from the front panel.

2.6 Filters

The MJS401D has five standard resident filters, with provisions for an extra two option filters.

2.6.1 CCIR 468-2

This is a CCIR Recommendation 468/1, 468/2 and 468/3 noise weighting filter. It is required for noise measurements in accordance with broadcast standards in the U.K. and Europe. CCIR 468/2 and 468/3 specify a particular "Quasi-Peak" rectifier response for noise measurement. The instrument forces selection of this rectifier whenever the CCIR 468 noise filter is in use. A graph of the frequency response of the CCIR weighting filter is given in Figure 3.

2.6.2 CCIR ARM

This uses the same CCIR filter as described earlier but the filter operates 6 dB lower in level. It is used in conjunction with the "AVG" rectifier characteristic to provide noise measurements in accordance with the standard specified by Dolby Laboratories Inc. This standard is generally intended for use with Hi-Fi equipment.

2.6.3 400 Hz

This is a 36 dB/octave, maximally flat high pass filter with its -3 dB point at 400 Hz. The steep roll off rate is especially useful for filtering out 50 Hz hum and its harmonics.

2.6.4 30 kHz

This filter features a maximally flat response, and rolls off at 36 dB/octave above 30 kHz. Since this filter keeps the MJS401D

frequency response to within ± 0.15 dB up to 20 kHz, it can be left "in" for most measurements, especially where there is the likelihood of interference from out of band signals. NOTE: Remember to switch this filter out when carrying out T.H.D. measurements with fundamentals above 10 kHz, since it will reduce the third harmonic and eliminate all higher harmonics.

2.6.5 22-22 kHz

This filter is comprised of two sections, a 36 dB/octave maximally flat low pass filter with its -3 dB point at 22.4 kHz, and an 18 dB/octave maximally flat high pass filter with its -3 dB point at 22 Hz. This filter is a requirement for measuring noise across the audio band, and is specified for "unweighted" noise according to CCIR and most broadcasting authorities. Naturally, this filter must be switched out when carrying out T.H.D. measurements with fundamental frequencies above 6 kHz.

2.6.6 Options A and B

Various filters are available for special purposes which can be plugged into a pre-assigned slot. On the standard MJS401D, pressing these buttons has no effect.

Since two option filters are available in one slot, a motherboard system is used to allow installation of any combination of two filters. Thus to fit option filters, an Option Filter Motherboard is required. All filters are supplied with labels to be attached to the front panel.

2.7 Available Filter Options

The following filter options are available. Others will be made available as circumstances require.

2.7.1 User Configurable Filter

The User Configurable Filter consists of a stripboard assembly with an input buffer, four other uncommitted op-amps and provision for two trimmers. The remainder of the PCB is available for a customer determined filter configuration. The filter design should have unity gain at an appropriate frequency, and a low output impedance.

2.7.2 "A, B, C" Weighting Filters

The "A", "B", and "C" Weighting Filter occupies a single option filter position. Links are installed to select one or two of the weighting filters as OPTION "A" and/or "B". If two are used then the second option filter is not available for further use.

2.7.3 80 kHz Low Pass Filter

80 kHz Low Pass Filter, third order, maximally flat, -3 dB at 80 kHz. Commonly used for THD+N measurements at fundamental frequencies over about 8 kHz, and to correlate results with some other available distortion meters.

2.7.4 IBA Crosstalk Weighting Filter

The IBA Crosstalk Weighting Filter is designed to a recommended code of practice circuit specification issued by the Independent Broadcasting Authority in the U.K.

2.8 Rectifiers

The MJS401D offers a choice of four rectifier characteristics, which can be used with the appropriate filters to provide noise measurements to most of the commonly used standards.

2.8.1 AVG

The average is the same as that used on most standard A.C. millivoltmeters, and is included to facilitate obtaining comparative measurements with other instruments. This gives the correct RMS value for pure sine wave signals only.

2.8.2 True R.M.S.

This rectifier is most commonly used for audio frequency noise measurements in industrial electronics, as well as noise and level measurement by broadcast establishments on studio equipment. Use this rectifier characteristic also when measuring T.H.D. to obtain measurements comparable with those made on most modern T.H.D. measurement equipment.

2.8.3 Quasi-Peak

This is a dual time-constant type of rectifier with a high overload margin, used specifically for noise measurement in accordance with CCIR Recommendation 468/2 and 468/3 in conjunction with the -12 dB to +12 dB meter scale. The instrument is forced to this rectifier when the CCIR-468 noise weighting filter is in use.

2.8.4 P.P.M.

With this characteristic, the MJS401D functions in exactly the same manner as a broadcast peak programme meter (with the "dB NORM" logarithmic scale selected). This is particularly useful as a standard P.P.M. to BS 5428 for broadcast users, and also for impulse noise measurements. Calibration matches most broadcasting practice when both "dB Coarse" and "dB Fine" range controls are set to "0".

NOTE: Precision rectifiers and peak detectors often exhibit different frequency response characteristics at different signal voltage levels. Due to certain design innovations in this area, the MJS401D does not suffer from these shortcomings. The frequency response remains within ± 0.5 dB at all levels between -12 and +12 dB relative to the centre scale '0' up to 100 kHz.

2.9 Scales

The MJS401D has four meter scales, two linear and two logarithmic. The two linear scales are for volts/millivolts or % distortion use. The two logarithmic scales read up to ± 12 dB in 1 dB steps about a central '0' or ± 1.5 dB in 0.1 dB steps about the same "0". The level required to read '0' on both the logarithmic scales is that indicated by the setting of the two input sensitivity controls.

All four scales are indicated by LEDs within the meter to clearly indicate the scale in use. It is therefore advisable to cultivate the habit of checking which scale LED is on before taking a reading. This is especially important in the case of the expanded scale.

2.9.1 dB NORM

In the "normal" logarithmic scale, the scale is similar to a peak programme meter. Having a centre scale "0" is useful for calibration to a known level which can be preset on the sensitivity controls, or for examining equalizer responses. When used as a broadcast standard PPM, the principal marked scale points correspond to numbers 1-7 on the PPM. i.e.

MJS401D Meter Reading	-12	-8	-4	0	+4	+8	+12
Broadcast PPM Scale Point	1	2	3	4	5	6	7

2.9.2 dB EXP

The "expanded" logarithmic scale requires exactly the same input level to produce a centre '0' as the "normal" scale. However, the scale length is 3 dB instead of 24 dB, which enables deviations from flat response to be measured more accurately and quickly. This is very useful when calibrating equipment as the result of adjustment is immediate and unlike a digital type readout.

Should the incoming signal be out of the ± 1.5 dB range of the "dB EXP" scale, the MJS401D automatically switches to the "dB Norm" logarithmic scale. The LED adjacent to the ± 12 dB scale will flash, indicating that this scale has been automatically selected. The expanded scale is restored if the signal level returns to within 1.5 dB of the central '0'. This allows for a 24 dB logarithmic scale with an automatically selected 3 dB expanded section.

2.9.3 Volts/% Dist

The lower two scales on the MJS401D meter are used for linear volts or percent distortion measurements. Selection of the appropriate scale is made by a combination of the "Volts/% Dist" pushbutton and the setting of the "dB Coarse" control which is also calibrated in volts. When Volts/% Dist scale is selected, the "dB Fine" range control has no effect. LEDs indicate the scale currently in use.

2.10 Signal Monitoring

The conditioned signal of the input to the rectifier section of the MJS401D is made available for visual and aural observation.

2.10.1 Scope Output

Via BNC connector, this output supplies approximately 2.2 volts peak to peak when the meter reads "0" on the logarithmic scales. It remains in phase with the selected MJS401D input, regardless of the selected function. Loading this output does not affect the meter reading, but it should not be loaded with any impedance less than 1 k Ω .

2.10.2 Audible Monitor

There is a small speaker located underneath the MJS401D and controlled by a front panel volume control for audio monitoring. Alternatively, dynamic headphones can be plugged into the "Phones" socket, disabling the loudspeaker.

2.11 Switch Interlocks

All the switch functions of the MJS401D are under microprocessor control. Certain switch functions are interlocked by software to ensure the correct combination of operating function, filter, rectifier characteristics, etc.

When the MJS401D operating function is changed, the appropriate filter(s), rectifier characteristic, and meter scale selected for the previous function are 'remembered'. These are restored when the previous function is re-selected. This reduces the amount of button-pushing required and also reduces the likelihood of operator error.

When turned on, the MJS401D sets itself up to the most commonly required combination of settings. These combinations, and meaningless combinations which are prevented (disabled) are shown in the table below.

INITIAL MJS401D SETUP CONDITIONS

FUNCTION	SELECTED ON SWITCH-ON		DISABLED
	RECTIFIER	SCALE	
LEVEL	RMS	dB NORM	--
THD+N	RMS	% DIST/VOLTS	CCIR-468 AND ARM FILTERS
IMD	(Depends on IMD option installed)		ALL FILTERS
X-TALK	RMS	dB NORM	CCIR-468 AND ARM FILTERS
READ OSC	RMS	dB NORM	ALL FILTERS
NOISE 468-3	QUASI-PEAK	dB NORM	ALL FILTERS *
NOISE ARM	AVG	dB NORM	ALL FILTERS *
W&F, DRIFT	Special	%	ALL FILTERS *
RUMBLE	Special	dB NORM	ALL FILTERS *

* Except the weighting or bandpass filters as necessary, selected by the WTD or UNWTD buttons.

Notice that the 'Read Osc' function prevents any filter from being used. This is to prevent accidental oscillator output calibration error. To measure the oscillator THD, or to look at the response of the internal filters, a jumper lead should be plugged between the oscillator and input sockets and appropriate source and termination impedances selected.

If the 400 Hz high pass, 22 Hz - 22 kHz bandpass or 30 kHz lowpass filters are selected whilst the MJS401D is in the "THD" function, there is the risk that the harmonics of the incoming signal frequency will fall within the attenuation band of the selected filter, giving a reduced THD reading.

Some "FILTERS" have characteristics similar to "FUNCTIONS". In general this applies to noise measurement standards requiring a specific rectifier characteristic and filter response. Thus incorrect rectifiers are disabled and additional filters cannot be selected simultaneously when these are in use. Selection of another filter is interpreted by the instrument as a move from a weighted noise to another type of measurement. The weighting filter will be turned off and the other filter turned on.

FILTER	MUST USE		TURNED OFF
	RECTIFIER	DISABLED	
CCIR-468-2	QUASI-PEAK	ALL OTHER RECTIFIERS	ALL OTHER FILTERS
CCIR-ARM	AVG	ALL OTHER RECTIFIERS	ALL OTHER FILTERS

De-selecting the 468/2 or ARM filter will reinstate the previous rectifier in use.

3 IEEE-488 Bus Control

The MJS401D has been designed from the beginning to be fully bus controllable, and the necessary means to add an IEEE-488 interface card has been included. All front panel controls can be set and the frequency and level meters read out over the bus. Additional facilities not available from the front panel may also be controlled by the bus.

The speed of measurement and fast recovery from overload features have been designed in particularly for ATE applications.

The IEEE-488 option is field retrofittable to the right side of the microcomputer system assembly.

Programming is in plain language (English, with some French and German words also available). The result is that programmes tend to be self-documenting, and are therefore easier to write and maintain. Experience has shown that anyone who is not afraid to try to write a BASIC programme can soon have a successful test programme running. It is not necessary to be a professional programmer.

Many commands may be abbreviated, and some words omitted altogether. In other cases, the order of phrases is unimportant. The aim has been to create a command language which is so natural (similar to the way we speak) that it is only necessary to read the IEEE-488 manual once.

Results are returned in a form understandable both by computers and human beings. For example:

```
3.1500E3 Hz  
-4.76 dBu  
775E-3 V  
Level low
```

The last example is a case of a message indicating an out-of-limits measurement condition.

The command syntax is necessarily extensive, and a separate IEEE-488 Instruction Manual is published.

4 MD404B OSCILLATOR

The MJS401D can be fitted with a MD404B fast settling, low distortion oscillator module.

The description of the controls starts at the top of the module and works down.

To set up the oscillator output with the MJS401D measuring system, select the "READ OSC" function.

4.1 Frequency Setting

Three controls are provided for frequency selection. These can be used separately or together according to the measurements required.

The main frequency control is the front rotary control on the top of the module. This is the "NORM" frequency control. It is an opto-encoder with no end stops. A magnetic detent system provides 50 steps per rotation, while a flywheel effect enables several rotations to be made with a flick of the fingers. Each detent corresponds to a 1% change in frequency. Any frequency in the range from 10 Hz to 300 kHz can be selected by rotating this control.

To the right are located frequency "STEP" buttons. The upper one steps "UP" in frequency, the lower one "DOWN" as indicated by the engraved labels. These work in conjunction with the button below labelled "X10 ALT". When "X10" is illuminated the "STEP" buttons work in decade steps to enable quick switching up or down the range. For example they could be used to switch over 100 Hz, 1 kHz and 10 kHz for a quick check on a circuit. Once in about the right range, the rotary frequency control can be used to adjust if required.

When "ALT" is illuminated by depressing "X10 ALT", a series of alternative frequency steps are selected. An internal DIL switch on the right hand side of the oscillator module selects which set of steps is available when "ALT" is selected on the front panel.

On switch-on the first frequency selected will be 1 kHz. Depressing the "STEP" buttons in "ALT" mode will step up or down through these frequency steps. In "ALT" mode, the rotary "NORM" frequency control is disabled.

The table below details the various ALTERNATE FREQUENCY STEPS which are available.

"ALT" FREQUENCY TABLE SELECTION

Software Version 1.5

DIL Switch Settings			TABLE NAME	FREQUENCY TABLE
6	7	8		
OFF	OFF	OFF	1-2-5-10	10,20,50,100,200,500,1K0, 2K0,5K0,10K,20K,50K,100K, 150K,200K,250K,300K
OFF	ON	OFF	ISO 1/3 OCT	20,25,31.5,40,50,63,80,100, 125,160,200,250,315,400,500, 630,800,1K0,1K25,1K6,2K0, 2K5,3K15,4K0,5K0,6K3,8K0, 10K,12K5,16K,20K.
OFF	OFF	ON	BBC STD	31.5,40,63,125,250,500,1K0, 2K0,4K0,6K3,8K0,10K,12K,14K, 16K.
OFF	ON	ON	IBA STD	40,50,125,250,500,1K0,2K0, 4K0,6K0,8K0,10K,12K,14K,15K.

"ALT" remembers the last frequency selected as does "X10". This can be used to quickly switch between one measurement frequency and another which may be a reference.

The last frequency control is the rear knob at the top labelled "FINE". Super-fine might be more appropriate. This control allows adjustment over a $\pm 1\%$ range to select an exact frequency. It is unlikely to be needed except perhaps to check the cut-off of an anti-aliasing filter. It is operative in both "X10" and "ALT" modes of operation. Preset frequencies are nominally correct with this control at mid-travel, i.e. with the white line uppermost.

4.2 Level Setting

Level setting is very similar to Frequency setting.

The front "NORMAL" level control is an opto-encoder having no end stops with 50 detents per rotation. Each detent corresponds to a 0.1 dB or approximately 1% level variations. Using this control levels from -70 dBu to +30 dBu (EMF) can be set.

To the right of the rotary level control are 10 dB level step buttons. These provide very accurate 10 dB steps and are useful for changing levels quickly.

The rear "FINE" knob on the level control allows for precision adjustment of level over a ± 0.1 dB range. Levels are nominally correct with this control at mid-travel, i.e. with the white line uppermost.

To the left of the rotary level control is an LED ladder array which indicates the output level range that the oscillator is set to. The top LED of the ladder indicates that the output is within the range from that LED up to 9.9 dB higher. In other words, if the highest illuminated LED is "0", the

output will be in the range from 0 dBu to +9.9 dBu.

4.3 Mute

The "MUTE" button turns off the oscillator outputs, while keeping the source impedance unchanged. This would usually be used to allow noise and crosstalk measurements.

4.4 R_{out} - 0/150/600

This button sets the oscillator source impedance to one of the three values shown. Depressing the "R_{out}" button steps through each in turn.

4.5 Bal/Unbal

This is used to select an electronically balanced output, or an output referenced to the ground of the equipment under test. The balanced output has the centre directly connected to the MJS401D chassis ground. The unbalanced output is disconnected from ground, but expects to be grounded by the equipment under test.

In BAL mode the maximum output level is +30 dBu, while in UNBAL mode the maximum level is +24 dBu.

4.6 (Square/Sine)

This is used to select sine or square wave signal outputs. Following the use of IMD or W & F functions, this button reinstates the previously used waveform.

4.7 W & F LED

The MD404B contains a crystal controlled oscillator capable of generating an accurate 3 kHz or 3.150 kHz sinewave output for use on Wow and Flutter measurements. This can be activated only if the W & F option is fitted in the MJS401D.

4.8 IMD LED

The MD404B contains a second programmable oscillator to allow "Twin-Tone" type distortion measurements to SMPTE/DIN or CCIF standards. This second oscillator can only be activated if the IMD option is fitted in the MJS401D.

5 Power-On Settings

If your oscillator has serial number 290 or greater, AND software of version 1.5 or higher, you are able to set the power-on states of BAL/UNBAL, R_{out} and level. These states are set as shown below.

SW1	ON	BAL
SW1	OFF	UNBAL
SW2	ON	0 dBu
SW2	OFF	-60 dBu
SW3	SW4	
ON	ON	0 R
ON	OFF	150 R
OFF	ON	600 R
OFF	OFF	0 R

If your oscillator has serial number 289 or lower, OR software of version 1.4 or lower, or both, the power-on state will be BAL, 0 dBu, and 0 R.

If your oscillator has serial number 289 or lower, SW1 to SW4 must be left in the OFF position, or operation of the FREQ and LEVEL opto-encoders will be impaired.

6 Extra Functions

Users who have the Wow and Flutter option board have a label stuck over the FILTERS group of buttons. These buttons control the Wow & Flutter/Drift and Rumble functions. In addition they control two Noise functions (CCIR 468 and CCIR ARM) since the previous CCIR 468 button now acts as a "shift key". Thus, in effect, there are two different front panels and sets of functions to consider. The bus control software has been designed so that users can write test programmes for either version, and run it on the other version with identical results (total compatibility), on condition that it has been written using only the command set of one version.

If you are writing for the version without extra functions

To measure noise to CCIR rec.468 (-3 or -2) weighted enter the LEVEL function and command FILTER CCIR 468-3 (or -2). For 468-3 unweighted, enter the LEVEL function, command FILTER BANDPASS and RECTIFIER QUASI-PEAK. For CCIR ARM, enter the LEVEL function and command FILTER CCIR ARM.

The version with extra functions will react to these filter commands by entering the appropriate NOISE function but maintaining the same SCALE as in the LEVEL function. Subsequent FILTER OFF or other FILTER commands will return to the LEVEL function.

If you are writing for the version with extra functions

For noise 468-3 weighted (or unweighted) enter FUNCTION NOISE CCIR 468-3 WEIGHTED (or UNWEIGHTED). For noise ARM, enter FUNCTION NOISE CCIR ARM WEIGHTED (or UNWEIGHTED).

The version without extra functions will react to these commands by entering the commanded noise function, but will indicate that it is in the LEVEL function. The scale and weighting state are stored and recalled just as they are in the version with the extra functions, and default (on power-up, DCL, SDC, or "RESET") to WEIGHTED and SCALE DB.

If you have MJS401Ds with earlier EPROMS

Many enhancements and a few changes have been made to the operating programme. To ensure no annoying and expensive compatibility problems, we recommend that you contact your agent to obtain new EPROMs.

6.1 Extra Functions - Noise CCIR 468 and ARM

To give maximum flexibility and ease of use, the order of the argument is optional. This unfortunately makes it harder to explain!

(FUNC[TION] NOISE (CCIR) 468[-3]	(WEIGHTED)
468[-2]	(WTD)
ARM	(UNWEIGHTED)
	(UNWTD)

The order of the arguments for weighting and standards definition can be exchanged, so e.g. NOISE WEIGHTED 468-3 works just as well as NOISE 468-3 WEIGHTED. The weighting argument is optional; if not supplied the instrument will recall the last used weighting setting, which defaults (on power-up, DCL,

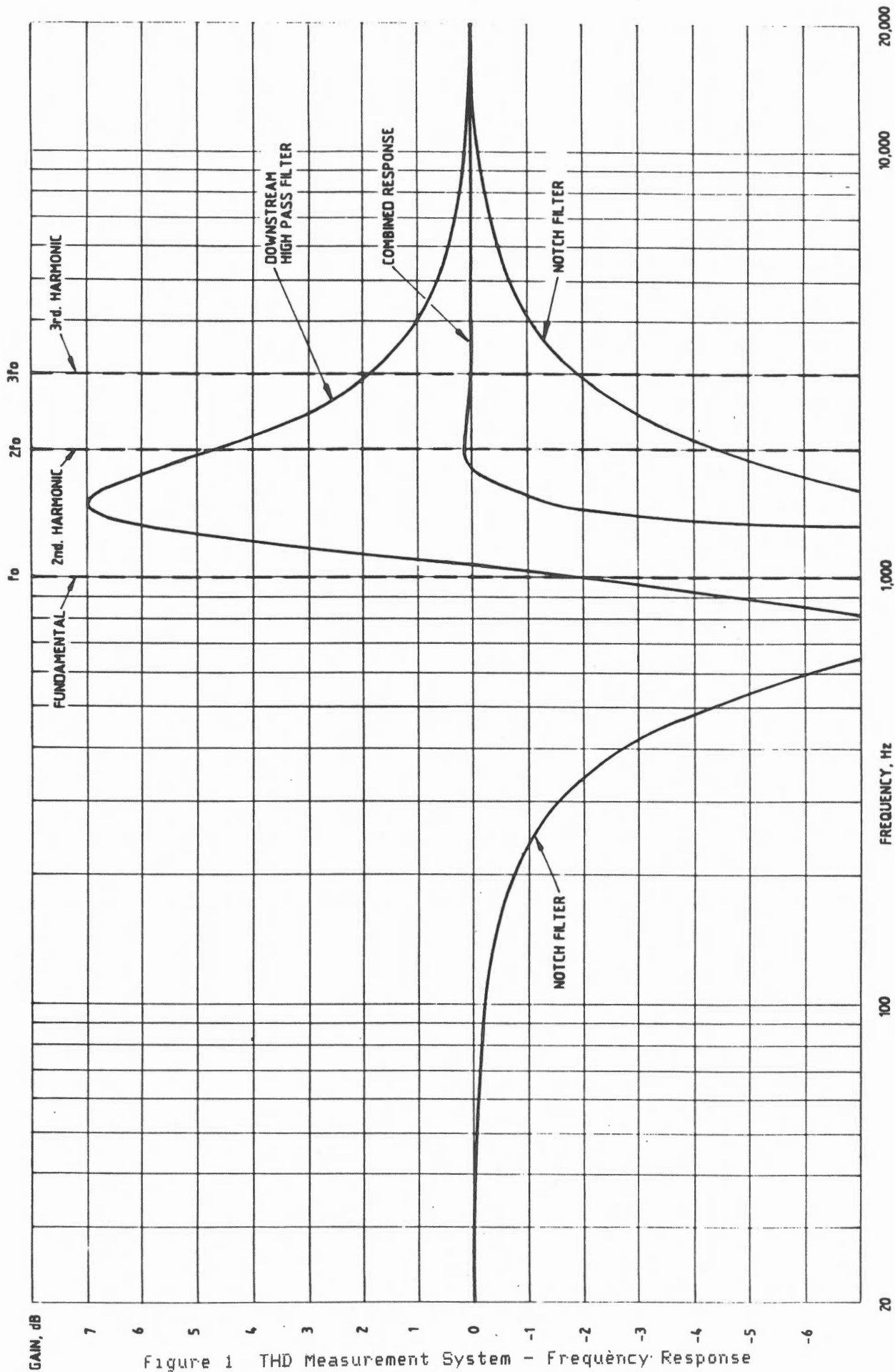


Figure 1 THD Measurement System - Frequency Response

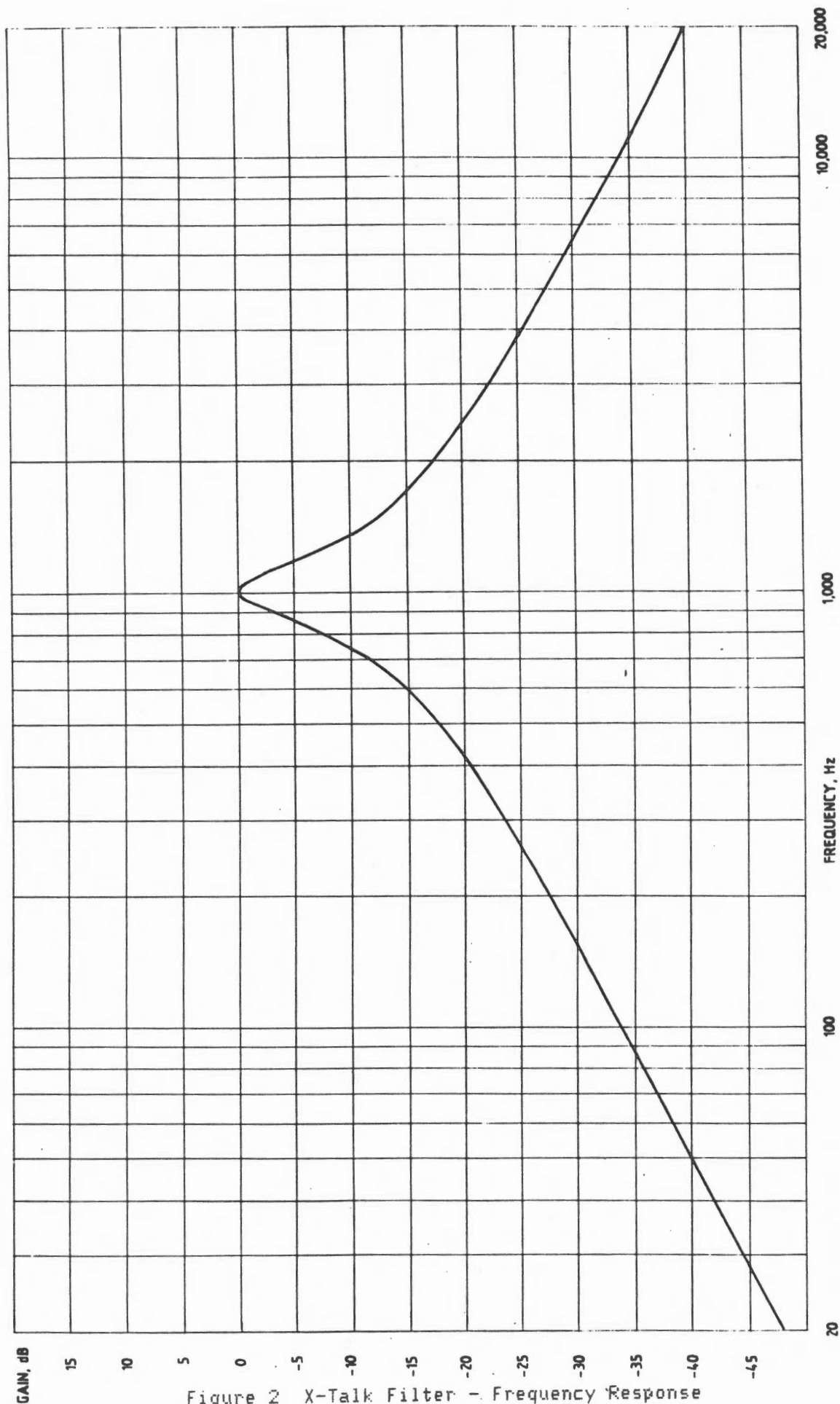


Figure 2 X-Talk Filter - Frequency Response

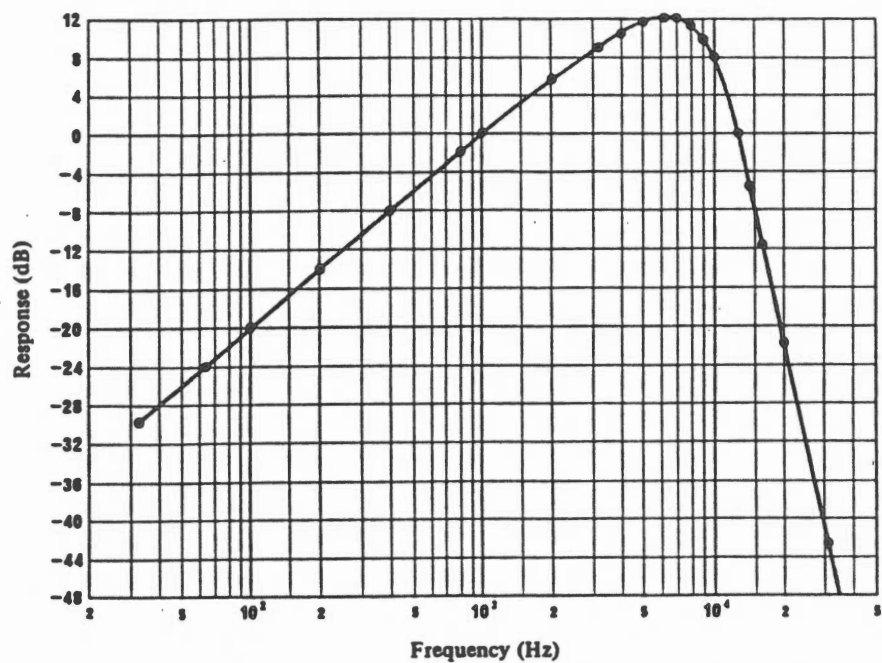


Figure 3 CCIR 468 Weighting Filter - Frequency Response