POPPY
RECORDS

AUDIO INTERMODULATION METER

HANDBOOK

April 2020

Fig.1 The Intermodulation Meter

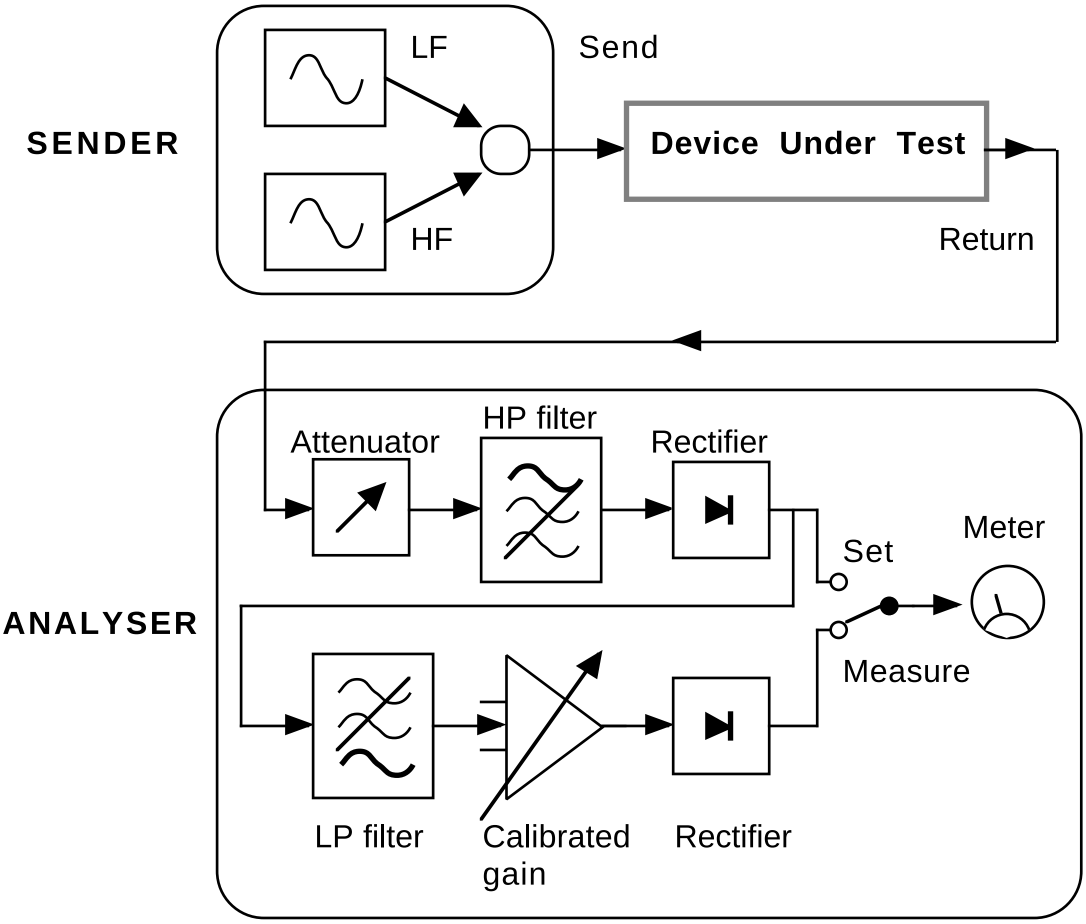

Fig.2 The Basic Layout

AUDIO INTERMODULATION METER MKI

1.0 INTRODUCTION

This is an instrument for sending two audio tones through a device under test and measuring the magnitude of the intermodulation that occurs between them.

The results from intermodualtion measurement represent the real situation arising from distortion in an audio system handling a complex signal made up of multiple tones. Other measurements, such as Total Harmonic Distortion (T.H.D.) are liable to give misleading results in some circumstances.

The two-tone intermodulation system of measurement is particularly useful in circumstances where a single-tone T.H.D distortion measurement would be difficult or impractical. For example, accurately tuning the filter notch of a T.H.D. meter to a signal returning from a recording chain or long transmission path, where there may be wow, flutter or phase changes from a variable time delay.

If device under test has a restricted bandwidth, particularly at higher frequencies, T.H.D. measurements may give a false picture because some of the harmonics resulting from the distortion are suppressed. The two-tone intermodulation test gives valid results under these condition.

SENDER

The tones are generated by two oscillators, one higher frequency and one lower frequency, and can be selected from the following spot frequencies:

Low frequency:	60	100	250	300		c/s
High frequency:	3	4	7	8	10	Kc/s

Any desired combination of tones can be selected but the most commonly-used pairs are:

CCIR	60	4k	...	General purpose
SMPTE	60	7k	...	Film soundtracks
Mullard	100	10k	...	High fidelity
DIN	250	8k	...	General purpose
GPO	300	3k	...	Low bandwidth communications

Provision is made for connecting external tone sources if other test frequencies are required.

The tones are combined in a way which minimises interaction between them and connected to the device under test. The signal level can be controlled in the range +10 to -50 dBm by coarse and fine attenuators; further reductions in level can be obtained by loading the output with resistors. The high frequency signal can be independently attenuated by 12dB if this is required by the testing protocol.

ANALYSER

The amplitude of the signal returning from the device under test is adjusted by means of attenuators to a standard level with the meter switch in the “SET” position. The meter is then switched to the “MEASURE” position and further gain introduced to bring the intermodulation to the same standard level. This extra gain represent the level of the intermodulation in dB relative to the signal.

Under suitable conditions, measurement of intermodulation distortion at least 90dB below the signal is possible.

AUDIO INTERMODULATION METER MKI

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TECHNICAL DATA

2.1 Dimensions

(approximate)

Width	11″	279mm
Depth	7″	178mm
Height	3″	3 76mm
Weight	4 lb	1.8Kg

2.2 Power Supply

Voltage range: 200 - 250 volts
Frequency range: 50c/s - 60 c/s
Power consumption: < 15 Watts
Mains connector: I.E.C.'C13'
This equipment must be earthed.

2.3 Send and Return Signals

Send frequencies:

Low frequency:	60	100	250	300 c/s	
High frequency:	3	4	7	8	10 Kc/s

Provision for external signals from 50c/s to 300c/s and from 3 Kc/s to 20 Kc/s into an impedance of 47 Kilohms unbalanced.

Send level:

-50 to + 10 dBm in steps of 10dB with fine control spanning between steps (10dB).
Source impedance 600 ohms.
Loading the output terminals with a 68-ohm resistor will reduce the level by a further 20dB

Return level:

-50 to +10 dBm into an impedance of 10 K ohms
-10 to +50 dBm into a probe impedance of 1 M ohm
Coarse attenuator steps of 10dB with fine control spanning 2 steps (20dB)
D.C. blocking is applied to the probe circuit up to a maximum of 800 Volts D.C.

Intermodulation measurement:

< -90dB for levels from +10dBm to -30 dBm reduced sensitivity on other ranges.

Maximum Voltage D.C. or A.C. at any frequency

Terminals . . . 60v
Probe . . . 800v

2.4 Block Diagram and Principle of Operation

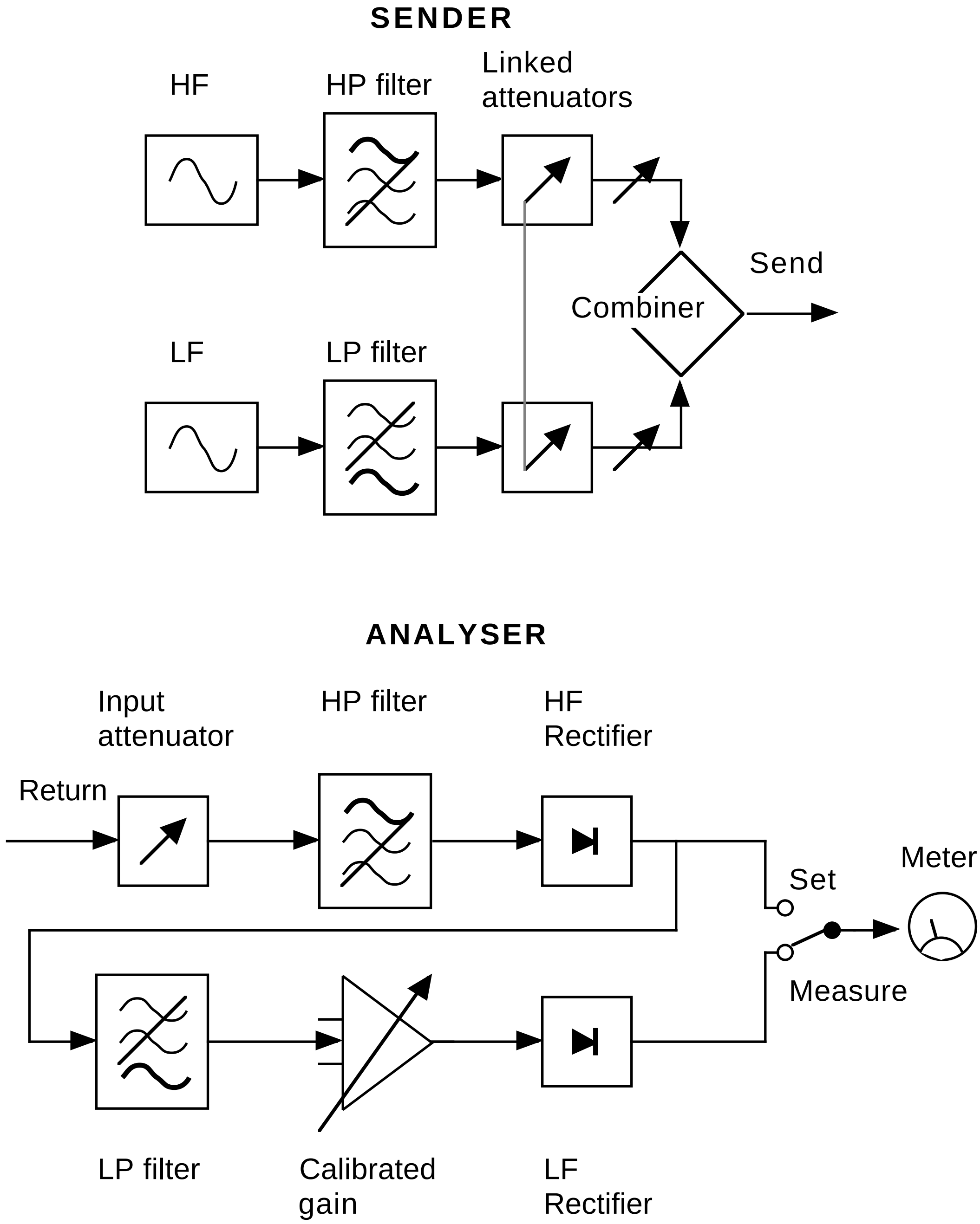

Fig.3 Block Diagram

Two audio tones of significantly different frequency are generated by separate oscillators. Each tone is filtered to remove any components which might interfere with the measurements and linked attenuators are used to select the required output level. (The high-frequency oscillator has an additional attenuator which can be used to reduce its level by 12dB, which is a requirement of some measuring standards.) The signals are combined in a way which minimises any interaction between them and then sent to the device under test.

The signal returning from the device under test is fed through a passive attenuator to a filter which effectively removes the low frequency tone and allows the high frequency tone to be amplified and rectified without creating any additional intermodulation. If no intermodulation has occurred, the output signal from the high frequency rectifier will contain no detectable low frequency component, but any intermodulation which has occurred will appear as a low frequency ripple in the amplitude of the high frequency signal.

The rectified high-frequency signal is passed through a filter which removes the high frequencies and allows only low frequency ripple components to pass. The low frequencies are amplified by an amplifier with 10dB steps of gain and are rectified.

The metering circuit can be switched to compare the output of the high frequency rectifier with the output of the ripple rectifier; the meter scale is calibrated to show their mean levels in dB. The amplitude of the high frequency signal is set to a known level (OdB on the meter scale), then the gain of the low frequency amplifier is adjusted until the meter pointer comes on scale. When the level of the amplified low frequency ripple component, as read from the scale, is added to the gain of the low frequency amplifier, this gives the total gain which would be needed to bring the low frequency ripple to the same level as the high frequency signal. The ratio of the two signals, expressed as dB, is defined as the level of intermodulation distortion.

Whilst Intermodulation Distortion readings are not always directly comparable with Total Harmonic Distortion readings, the following table may be helpful for an approximate comparison:

Im.D. dB	20	30	40	50	60	70	80	90
T.H.D. %	10	3·2	1·0	0·3	0·1	0·03	0·01	0·003

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2.5 Noise and Breakthrough

Internal noise can reduce the accuracy of measurement with weak Return signals at very low intermodulation levels. Filter breakthrough will limit the sensitivity for low frequencies of 250 and 300c/s and high frequencies of 3 and 4 Kc/s. The highest accuracy will be obtained with signals of 60 c/s and 7 Kc/s with the ratio switch set to 0dB and return signals greater than -30dBm.

CONTROL FACILITIES

3.1 Mains Connector
The connector is located on the back control panel. An I.E.C. connector, type 'C 13' which incorporates an earthing connection should be use. If hum loops are suspected, do NOT remove the safety earth connections, see Section 3.4 for more details.

3.2 Oscillator Frequencies
The individual oscillator frequencies are selected by two switches on the control panel, Either oscillator can be silenced by moving its switch to the position marked "o". External oscillators may be plugged into G.P.O./B.B.C. Gauge 'B' jacks on the rear panel. Signal levels around 0dBm are likely to be satisfactory; frequencies in the range 300c/s to 3 Kc/s should be avoided as these will give erroneous readings..

3.3 Send Level
The required signal level can be selected in 10dB steps by the 'Coarse SEND LEVEL' control and then trimmed to the final amplitude with the 'Fine SEND LEVEL' control. Do not exceed a maximum output level of +12dBm when plugging-in external oscillators, as the combining circuit will generate distortion and give rise to unreliable readings above this level.

3.4 Signal Connections and Earth Loops

The Send and Return signals are connected via 4mm sockets on the back panel. The Send signal socket is Yellow and its associated earth socket is Blue. The Return signal socket is White and its associated earth socket is Black.

The earthing system of the Send system is connected to the main earth and the earth of the Return system by a 600-ohm resistor. This is to avoid creating earth loops between the input and output of the device under test. Always ensure that both earthing connections are used, even if they are clipped to the same point on the device under test.

If hum appears to be a problem, the connections should be made in the form of two independent wires to the input and the output earths of the device under test.

3.5 Return Level
Return levels in the range -50 to +10 dBm can be accepted by the Return sockets, this range becomes -10 to +50 dBm when the probe is used. Any probe which contain a 1 megohm series resistor may be used for this range; a probe with a 10 megohm resistor may also be used, but the sensitivity will be reduced by a further 20dB (a total of 60dB below direct connection to the sockets).

The ‘RETURN LEVEL Coarse’ control is calibrated in steps of approximately 10dB which indicate the returning signal level in dBm required to produce a meter reading of 0dB in the ‘SET’ mode with the ‘RETURN LEVEL Fine’ gain control fully advanced. The Green figures correspond to input via the sockets and the Red figures correspond to input via a 1 megohm probe. These ranges are only approximate and should not be used for accurate voltage measurement.

A high quality capacitor rated at 850 V.D.C. is used to block D.C. from the probe input; this is particularly useful when making measurements on valve circuits.

3.6 Ripple Amplifier Gain

The gain of the ripple amplifier is controlled in accurate 10dB steps by the ‘MEASUREMENT’ control, interpolation between the steps is done by means of the meter.

3.7 Meter

The meter scale is calibrated in 1dB divisions approximately linearly spaced and reading backwards. This is so that its reading can be numerically added to the amplifier gain to give a total figure in dB which represents the intermodulation distortion level below the signal level. The meter scale is illuminated when power is applied to the instrument.

3.8 Monitoring

To check the signal reaching the distortion rectifier circuit, a pair of headphones of 600-ohms or higher impedance can be plugged into the monitoring socket. This may prove useful for understanding the causes of the distortion or checking for noise which has been included in the readings. A monitoring amplifier or oscilloscope may also be connected to this socket if preferred. The output level is in the range 0dBm to +10dBm from a source impedance of 600 ohms and the socket is a G.P.O./B.B.C. Gauge ‘B’ type.

If apparatus which is earthed to a different supply system is plugged into this socket, it may create a hum loop which can interfere with the measuring circuit.

OPERATION

4.1 Location
The apparatus should be installed in a clean dry location with temperatures in the range -10°C to +40°C.

4.2 Connections
Connect the apparatus to a source of mains power, the meter scale will be illuminated when power is applied.

Connect the Send sockets (Yellow = signal, Blue = earth) to the input of the device or circuit to be tested.

Connect either the Return sockets (White = signal, Black = Earth) or the probe (Red = Signal, Black = earth) to the output of the device or circuit to be tested.

Optionally plug headphones or an external amplifier into the ‘MONITOR’ socket

4.3 Generating a Signal
Using the two oscillator switches, select the required pair of frequencies. Check whether the testing protocol requires the two signals to be equal in amplitude or if the higher frequency must be attenuated by 12dB (voltage ratio 1:4) and set the ‘RATIO’ switch to the appropriate setting. The -12dB setting may be necessary to avoid damage to electromechanical transducers such as light valves or cutterheads. If frequencies are required which differ from those available internally, connect external signal generators to the appropriate ‘EXTERNAL Osc’ sockets.

Adjust the Coarse and Fine ‘SEND LEVEL’ controls to drive the device under test to a suitable operating condition. The output voltage will be adequate for most small signal devices, including valves, but may be insufficient for driving power output stages in isolation. Output stages may have to be be tested in conjunction with their driving stages - which is usually a more meaningful test.

If very low output signals are required, the output sockets can be terminated with a 68-ohm resistor, which will attenuate the signal by 20dB.

4.4 Setting the Return Level
The return signal sockets can be used when the signal is known not to exceed 60v RMS and the input impedance of 10 kilohms will not unduly load the device under test. For higher impedance circuits, signals which might exceed 60v RMS or signals with a large D.C. component, the probe should be used.

With the ‘SET/MEASURE’ switch in the ‘SET’ position, turn the ‘Fine’ return level control fully anti-clockwise (minimum gain) and operate the ‘Coarse’ return level control until the meter pointer comes on scale (the pointer is heavily damped and may take up to one second to respond to a change in level). Use the ‘Fine’ control to bring the meter pointer to the 0dB mark.

4.5 Measuring

After setting the return level to 0dB, switch the ‘SET/MEASURE’ switch to the ‘MEASURE’ position and operate the ‘MEASUREMENT’ switch until the meter pointer comes on scale.

Add the MEASUREMENT switch reading to the meter reading to give the intermodulation distortion in dB.

4.6 Low Distortion Measurements

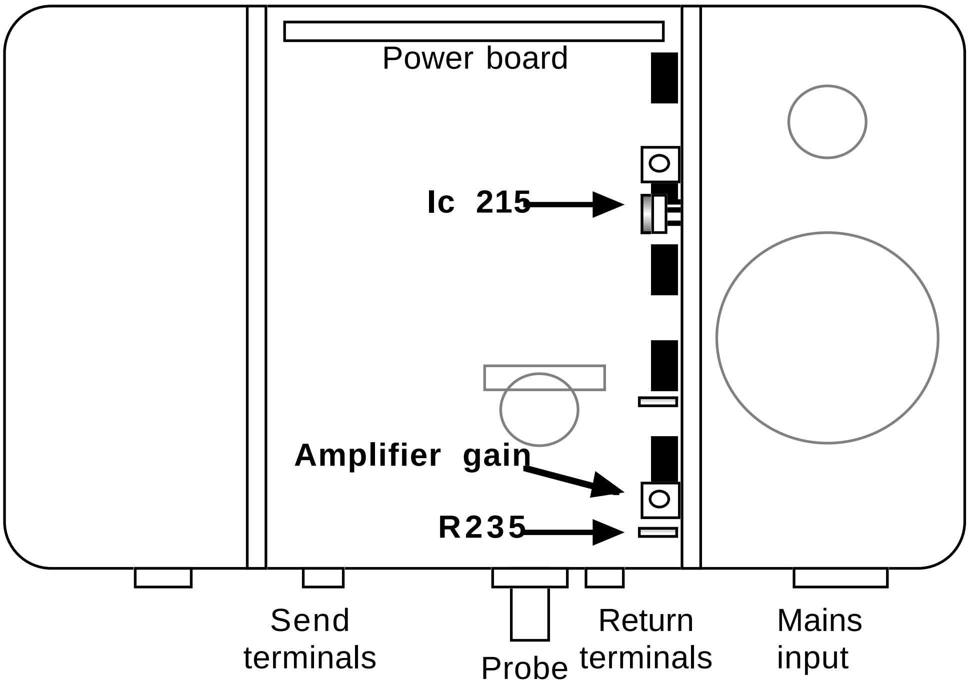
At low distortion levels, the internal noise level of the instrument and filter breakthrough can lead to incorrect readings. If switching off the low frequency oscillator does not result in a change of at least 6dB in the meter reading, noise or breakthrough is affecting the results.

The best result will be obtained by selecting frequencies of 60c/s and 7 Kc/s, a Ratio of 0dB and a Send level which gives a reading of ‘10’ on the meter with the Return attenuator set to 0(+40) dBm and the Fine gain control fully anticlockwise. When setting the meter to ‘0’, it may be found that the Return Fine gain control creates additional noise, so it can be left at minimum gain, with the Return attenuator and Send Fine gain control being used for this adjustment instead.

The equipment uses high quality components which should give a long and stable life without the need for adjustments. The following notes are given in case some of the settings have become disturbed, for instance by severe environmental conditions or replacement of damaged components - however, it must be emphasised that these adjustments must not be undertaken unnecessarily.

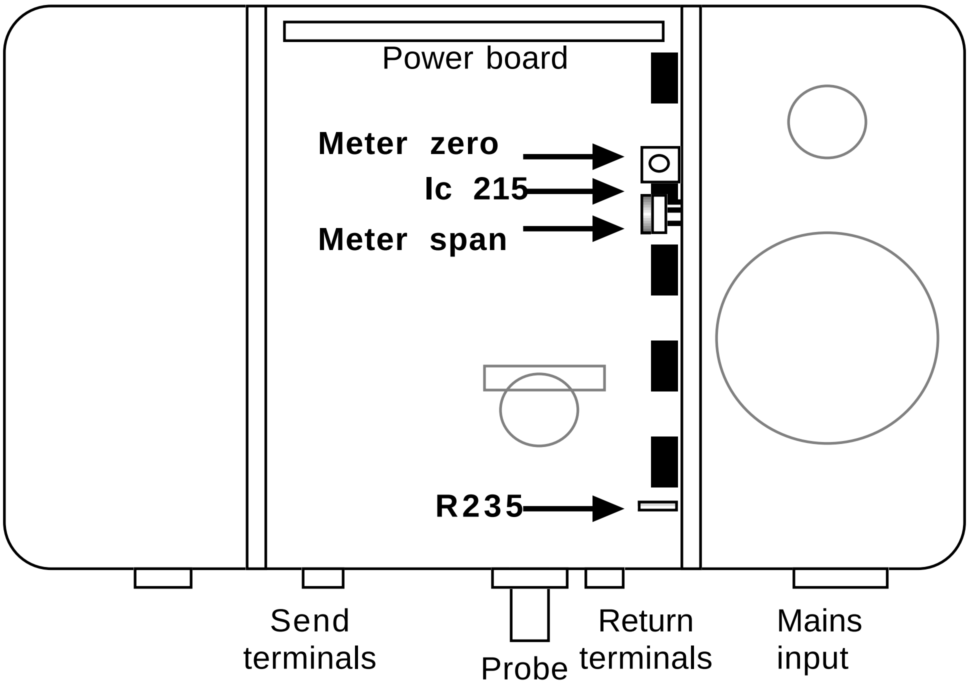
CAUTION: Mains voltage exists on the input connector and the mains fuse; when the cover is removed,take care to avoid electric shock.

5.1 Amplifier Gain Adjustment



Turn the MEASUREMENT switch fully anticlockwise to the 10dB position. Connect a signal generator set to any frequency in the range 50c/s to 250c/s to the test point formed by the top wire connection of R235. Connect a high impedance AC voltmeter to this point and adjust the output of the signal generator until the meter reads 0dBm (0.775v rms). Transfer the meter connection to the top wire connection of R227 which is adjacent to Pin 14 of Ic215 and adjust the Amplifier Gain control until the voltmeter reads +10dBm (2.449v rms).

5.2 Meter Adjustments



Stand the apparatus on a level surface with the front panel uppermost. With no power connected, check that the meter pointer comes to rest at the “10” mark. If adjustment is needed, carefully turn the adjusting screw on the meter cover a little at a time; there is considerable backlash in this adjustment, so skill and patience will be required.

Turn the MEASUREMENT switch fully anticlockwise to the 10dB position and the SET/MEASURE switch to the MEASURE position. Connect a signal generator set to any frequency in the range 50c/s to 250c/s to the test point formed by the top wire connection of R235. Connect a high impedance AC voltmeter to the top wire connection of R227 which is adjacent to Pin 14 of Ic215. Adjust the Amplifier Gain control until the voltmeter reads 0dBm (0.775v rms).

Adjust the Meter Zero control to bring the panel meter pointer to “10” on the scale. Turn the Coarse MEASUREMENT control one step clockwise (a 10dB increase), the voltmeter should now read +10 dBm (2.449v rms). Adjust the Meter Span control to bring the panel meter pointer to “0” on the scale.

Repeat the above adjustments with the instrument standing level after each adjustment, until satisfactory accuracy is obtained at both signal levels.

CIRCUIT DESCRIPTION

SENDER
(Component prefix 100)

6.1 Oscillator Amplitude Control

Any low frequency variations in the amplitude of the high frequency oscillator will be interpreted as intermodulation and give rise to inaccurate readings. Conventional methods of amplitude control, such as thermistors or FETs in a feedback loop will give rise to excess noise. If a potentiometer is used for fine control of the Send level, this can also give rise to noise and microphony.

The waveform of the high frequency oscillator is not critical, so a certain amount of peak clipping can be tolerated, allowing the amplitude to be stabilised by this means. By controlling the +ve and -ve supply rails to the oscillator amplifier, the clipping level and hence the oscillator output level can be controlled by means of a smoothed, noise-free, voltage level.

The Send Level Fine control, R102, in combination with R101, R103 sets the range of power supply voltages required to give a variable oscillator amplitude from 6dBm to 18dBm. This voltage is roughly smoothed by C109 then buffered by Ic110 to give the negative supply and inverted by Ic109 to give the positive supply.

As both oscillators must track together in amplitude, the low frequency oscillator must be controlled by the same method as the high frequency oscillator, but must be isolated from it so as to prevent interaction through any common power supply. The supplies to the low frequency oscillator are decoupled by R106 & C110, R107 & C111 and further buffered by Tr101 and Tr102. The supplies to the high frequency oscillator are decoupled by R108 & C112, R109 & C113 and further buffered by Tr103 and Tr104.

Because the amplitude of the low frequency oscillator is controlled by clipping, its output waveform must be filtered to remove unwanted harmonics which would pass through subsequent filters and give rise to erroneous readings.

6.2 Oscillator 1. (Low frequency)

This is a Wien Bridge oscillator with the frequency determined by phase-shift networks C118 & Ra, C119 & Ra’. The capacitors are fixed and various values of resistor are switched into circuit to give the required operating frequencies. The voltage gain of the amplifier Ic 101 is set to slightly more than 3 by the ratio of R110 to R111, which exceeds the losses in the frequency-determining components and causes oscillations to build up until the gain is reduced by the amplifier output clipping.

The clipping produces a small amount of distortion to the peaks of the waveform, which is removed by a filter comprising R114 & C122, R115 & C118, R116 & C123. The filter characteristic is determined by the voltage gain of Ic102, which is set to 2 by the ratio of R145 & R146. A second stage of filtering is provided by R117 & C124, R118 & C126, R119 & C125, with the gain of Ic103 determined by R120 & R121. The overall filter gain is 12dB, which is counteracted by 12dB of attenuation introduced by R112 & R113.

An external signal source can be plugged into Ext1, which disconnects the signal from Osc 1. C127 blocks any D.C. and R126 determines the input impedance.

6.3 Oscillator 2 (High frequency)

This is based around Ic106 and is similar to Oscillator 1 (above) with the following exceptions:

There is no filter network

The level-setting potential divider R124,R125 sets the 0dBm and -12dBm output levels. The required level is selected by the RATIO switch.

6.4 Combiner

Ic104 and Ic107 act as low-output-impedance buffers to drive the Send Level Coarse resistor banks. The bank resistors are selected by ganged switches to give accurate 10dB steps of gain. The gain of Ic105 is determined by the ratio of the selected bank resistor and R133, the gain of Ic 108 is determined by a similar bank resistor and R142.

The voltage gain of these stages is unity at the maximum switch setting and reduces thereafter, thus giving a high degree of negative feedback and a very low output impedance to prevent any interaction between the two signals from causing intermodulation in these amplifiers. The combining network R134 & R143 combines the two signal additively and produces an output impedance of 600 ohms at the SEND terminals.

External loads may be used to reduce the output signals when testing very sensitive amplifiers or other devices requiring low signal levels.

ANALYSER
(Component prefix 200)

6.5 Return Input Attenuator

The input signals are attenuated by a potentiometer comprising R202, R203, R204, R205, R206. The resistor values are chosen to give steps of approximately 10dB and to present the RETURN sockets with an input impedance of 10 kilohms. A further loss of 40dB is introduced by R201 in the probe input circuit, which has an input impedance of approximately 1 megohm. The high impedance probe is likely to be used for testing circuits with high D.C. voltages, so a high quality blocking capacitor, C201, is included to block these voltages. There is no equivalent capacitor in the SOCKETS circuit.

6.6 Return Signal Filter and Buffer

To prevent any possible intermodulation in the Return amplifier, the low frequency component must be attenuated before it reaches any amplification stages. This is performed by a high-pass filter comprising C202 & R207, C203 & R208, C204 & R209. The diodes D201 and D202 prevent damage to the low noise input buffer by excessive voltages; the current under overload conditions is limited by R210. R207 is bootstrapped to the Source terminal of Tr201 to reduce loading effects on the input potentiometer and slightly modify the filter response

Tr201 is configured as a unity-gain buffer (source follower) and normally runs at a signal level of -30dBm or lower. The high degree of feedback inherent in this configuration and the low level of signal with reduced low frequencies all combine to give extremely low intermodulation, ensuring that this buffer stage does not contribute any significant distortion to the signal being measured. Any noise on the +15v rail is removed by R211 and C205.

6.7 Return Signal Gain

After further filtering by C206 & R213, the Return signal is amplified by the low-distortion, low-noise, amplifier Ic201. The gain of Ic201 is determined by the network R214, R215, R216, R217, in steps of 10dB. The appropriate gain step is selected in conjunction with the Return Gain Coarse attenuator to obtain the most favourable noise figure.

A further stage of passive filtering is applied by C208 & R218, and the signal then passes through a unity-gain Sallen-Key high-pass filter formed by C209 & R219, C210 & R220, C211 & R221 and Tr202. After another stage of passive filtering by C223 & R273, the signal is amplified by the variable-gain stage Ic202 and further passive filtered by C212 & R226 before passing the signal to the detector stage.

The gain of Ic202 is determined by R223, R225 and potentiometer R224, which forms the Return Gain FINE control. The quality of this potentiometer is critical for low noise measurements and any replacement should be tested for noise and microphony before installation.

6.8 High Frequency Detector

The signal reaching the detector stage, based around Ic215, Ic203, Ic204, has been filtered to reduce the low frequency signal to a negligible level, thus only the high frequency signal is applied to the detector. Ic215 operates as a unity-gain inverting stage, ensuring Ic203 and Ic 204 are presented with equal amplitude signals of opposite polarity. The feedback loops around Ic203 and Ic204 compensate for the voltage drops of the rectifier diodes D203 & D205, so that the signal presented to R228 accurately represents the rectified high frequency waveform. The diodes are loaded by R228, which is connected to the virtual earth input of Ic205. R235 provides a convenient signal injection point for testing purposes.

The gain of Ic205 can be adjusted to counteract circuit losses and ensure that the overall gain of Ic205 + Ic206 + Tr203 is exactly 10dB. C213 reduces the high frequency ripple to a level that avoids overloading of Ic205, but does not affect the wanted intermodulation signal.

6.9 Ripple Filter

Low frequency amplitude ripple of the high frequency waveform corresponds to the degree of intermodulation undergone by the combined signals in passing through the device under test, but rectification also results in a large high-frequency ripple component. This component, which must be removed, is mainly at double the high frequency but may also contain a small residual component at the high frequency itself, caused by minor imbalances in the detector.

The rectified signal from Ic205 is fed into a three-stage low-pass filter where the unwanted high frequencies are reduced. This is a maximally-flat Sallen-Key filter which comprises R231 & C214, R232 & C215, R233 & C216, and Ic206. Any D.C. offset is removed by C217 & R234 before the signal is fed into Ic206. The overall gain of Ic206 is set to 8dB by the ratio of R236 to R237 + R238, but positive feedback of 6dB is tapped off the divider R237 & R238 and fed to C215 to give the filter the required characteristic.

The signal then passes through a second low-pass maximally-flat filter of the unity-gain Sallen-Key type, based around R239 &

C218, R240 & C219, R241 & C220 and Tr203, before passing to the main gain block.

6.10 Ripple Gain Block

Any residual D.C. and low frequency noise on the ripple signal is removed by C211 & R243 before it is applied to the input of Ic207. The configuration of two Op-amps, Ic207 & Ic208 allows switchable gain in steps of 10dB from 0dB to +80dB with a single switch. The first stage gain is increased initially, then the gain of the second stage is brought into play to achieve the full range.

6.11 Monitor Output and Low Frequency Rectifier

The ripple signal is fed from Ic108 to Ic109, which acts as a buffer for driving headphones or an external monitoring system. The signal at this point will be between 0dBm and +10dBm. C214 & R255 remove any residual D.C. and R256 ensures a source impedance of 600 ohms at the MONITOR output socket.

The rectifier based around Ic210, Ic211, Ic212 is fed with the ripple signal through C215; it is identical to the high frequency rectifier circuit (Ic215, Ic203, Ic204) but is loaded by R259 to earth.

6.12 Metering Circuits

The SET/MEASURE switch can select the output of either of the two rectifiers. Any rapid changes in signal voltage are removed by the integrating network R260 & C216 before being applied to Ic213. The function of Ic213 is to linearise the scale of the meter by using the current/voltage transfer curve of D208 & D209 to give an approximately logarithmic response.

The action of Ic213 is to generate whatever output voltage is necessary to ensure that the voltage between its two input terminals is always zero. This means that the voltage across R261 will be identical with the input voltage from C216, so the current through R261 and hence D208 & D209 will be proportional to that voltage. (Reverse voltage protection is provided by D207.) The voltage dropped across D208 & D209 is made up of a temperature-dependent component (about 0.6v per diode) and a component which varies with the logarithm of the current. D210 & D211 are in close thermal contact with D208 & D209, so their temperature-dependent component will be similar, but their current-dependent component will not vary because the current through them is set to a predetermined fixed value by R263 and variable R262.

Thus it can be seen that the difference between the voltages applied to R264 and R265 is only that due to the logarithmic component resulting from the difference between the current in D208 & D209 and the current in D210 & D211. This logarithmic component is amplified by the differential amplifier Ic214 with a gain which is determined by the ratio of R264 to R266 and R265 to R267. The amplified logarithmic voltage is applied to the meter through R268 & variable R269, their values being chosen so that Ic214 clips the signal before any damage can occur to the meter due to excess current. The meter scale is illuminated by light from D212 and D213, which are fed through R270 from the +15v rail.

The adjustment procedure for the meter circuits consists of arranging for a signal at 0dBm level to be applied to one of the rectifiers and adjusting the current through D210 & D211 until the meter reads ‘10’ (bottom of the scale), then increasing the signal to +10dBm and adjusting the sensitivity of the meter until it reads ‘0’ (near the top of the scale). The two adjustments interact and may need to be repeated several times to obtain a satisfactory result.

POWER SUPPLY
(Component prefix 300)

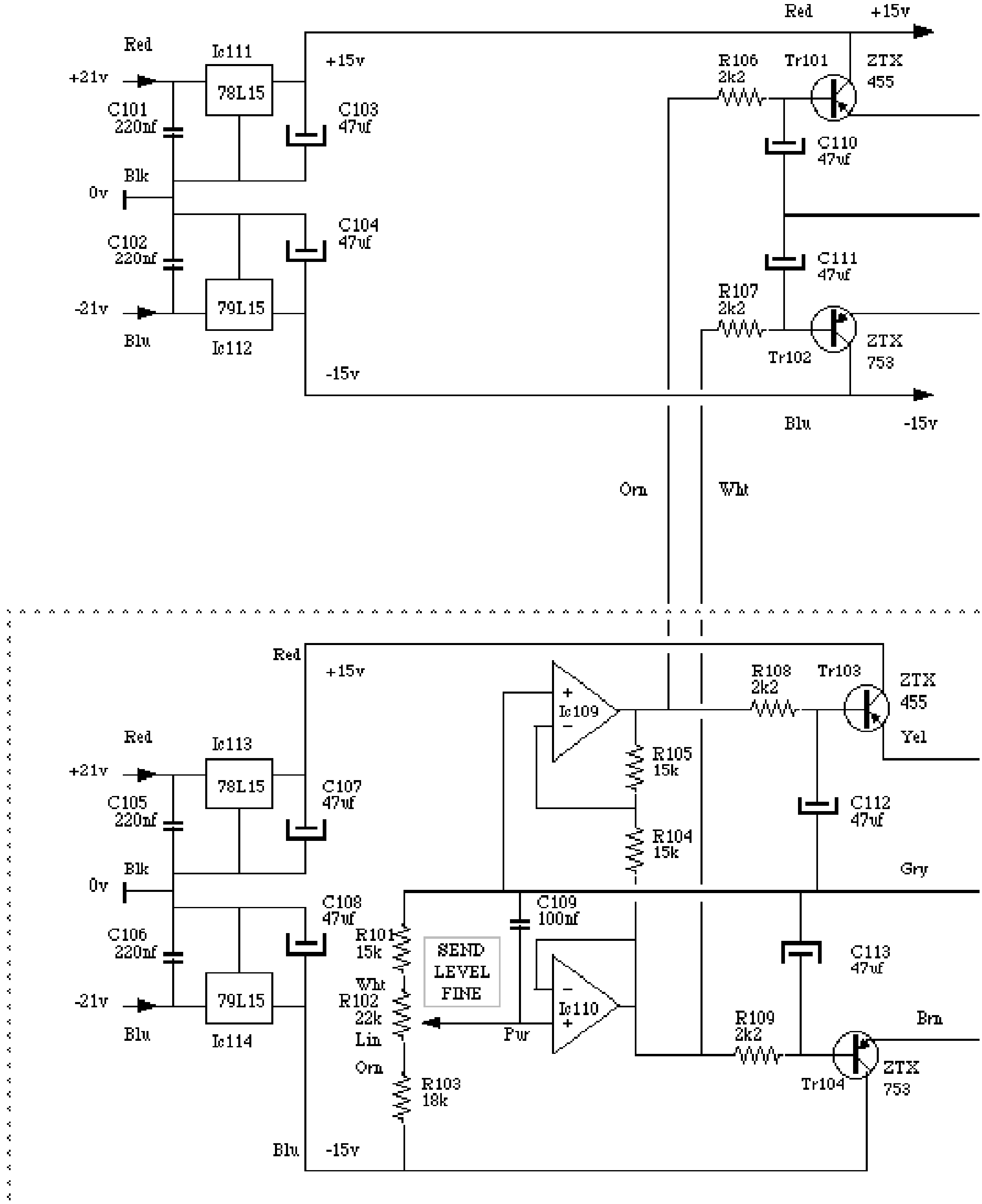
6.13 Power Supplies

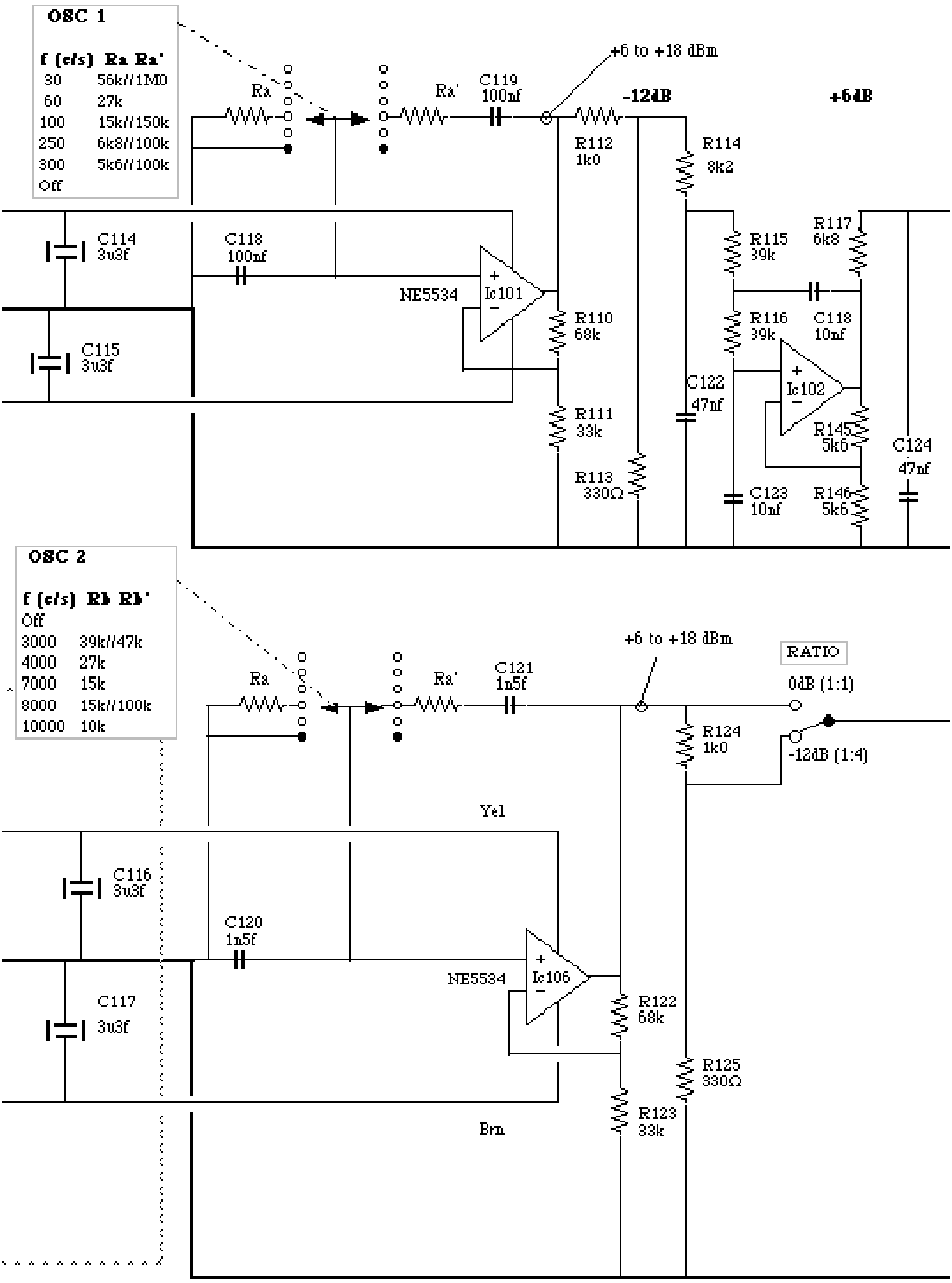
Mains power is connected to the instrument through an IEC connector, which must include an earthing connection. The mains transformer is a toroidal type to minimise magnetic interference with nearby circuits, it is also electrostatically screened on the side nearest to the Return Amplifier circuit board to minimise the capacitive transfer of high frequency noise. The 20v + 20v secondary is connected through R324 and R325, which act as fuses and help to damp shock-excited oscillation of the transformer winding, to a bridge rectifier consisting of D301, D302, D303, D304.

From the rectifier, unstabilised supplies of +27v and -27v are obtained and smoothed by C301 & C302 respectively. The positive supply is reduced to about 22v by R303 and stabilised by Zener D305; from this reference voltage Tr301 generates a stabilised 21v supply by emitter-follower action. R304 acts as a fuse to protect Tr301 in the event of overload. The negative stabilised 21v supply is generated in a similar way by D306 and Tr302.

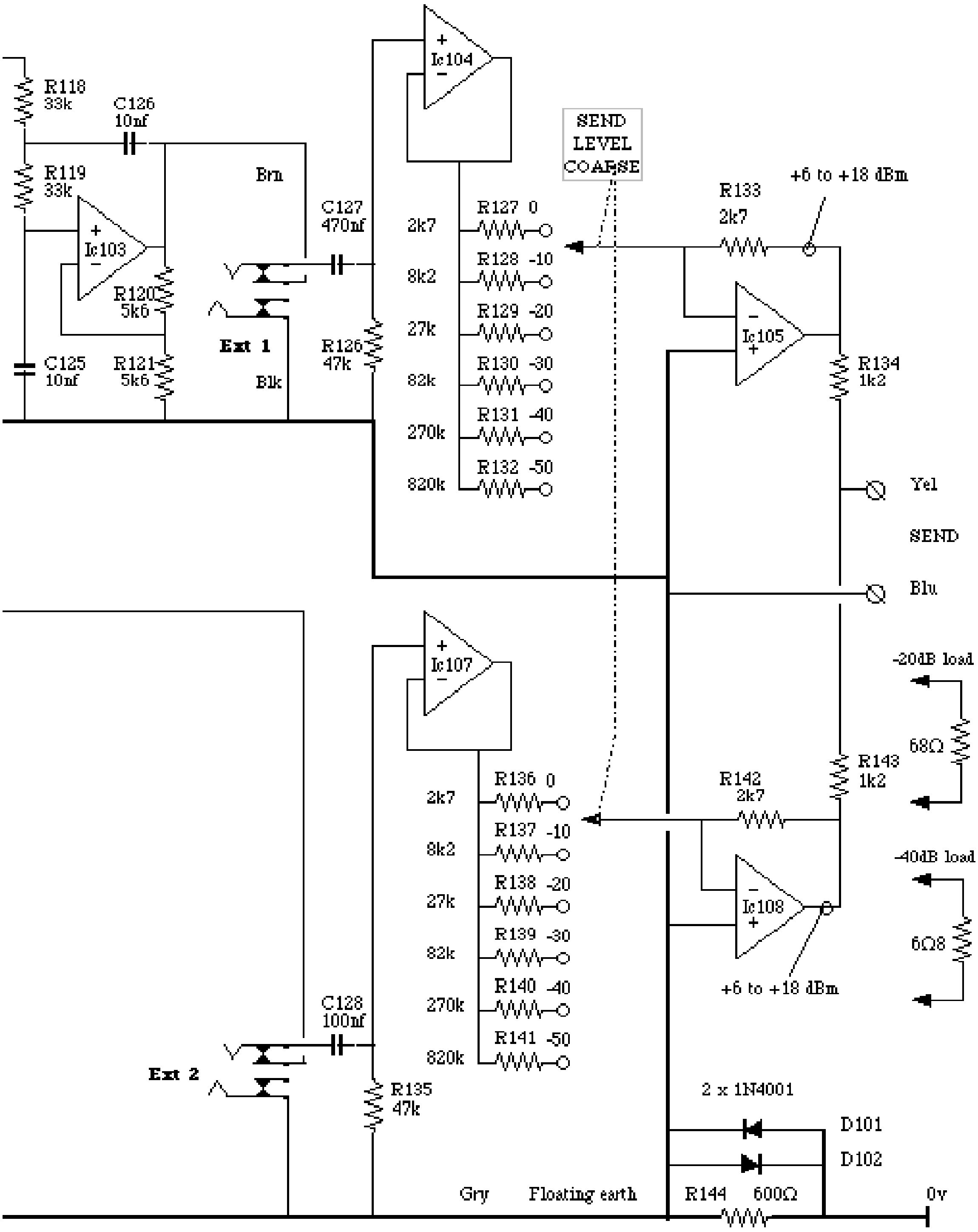
The stabilised supplies still contain a small amount of ripple, so further stabilisation is necessary to prevent noise pickup and unwanted signal transfer in the various circuit assemblies. Accordingly, each sub-section of the circuit has its own independent stabilised supply. Ic 111 & Ic112 supply the low frequency oscillator, filter and sender circuits, whilst Ic 113 & 114 independently supply the high frequency oscillator to ensure that no cross-talk can occur though the power supplies. The Return circuits are supplied by Ic215 & Ic216, with extra decoupling by R271 & C221, R272 & R222 for the supplies to Tr201, Tr202, Ic201, Ic202.

AUDIO FREQUENCY INTERMODULATION METER
Oscillators and Sender



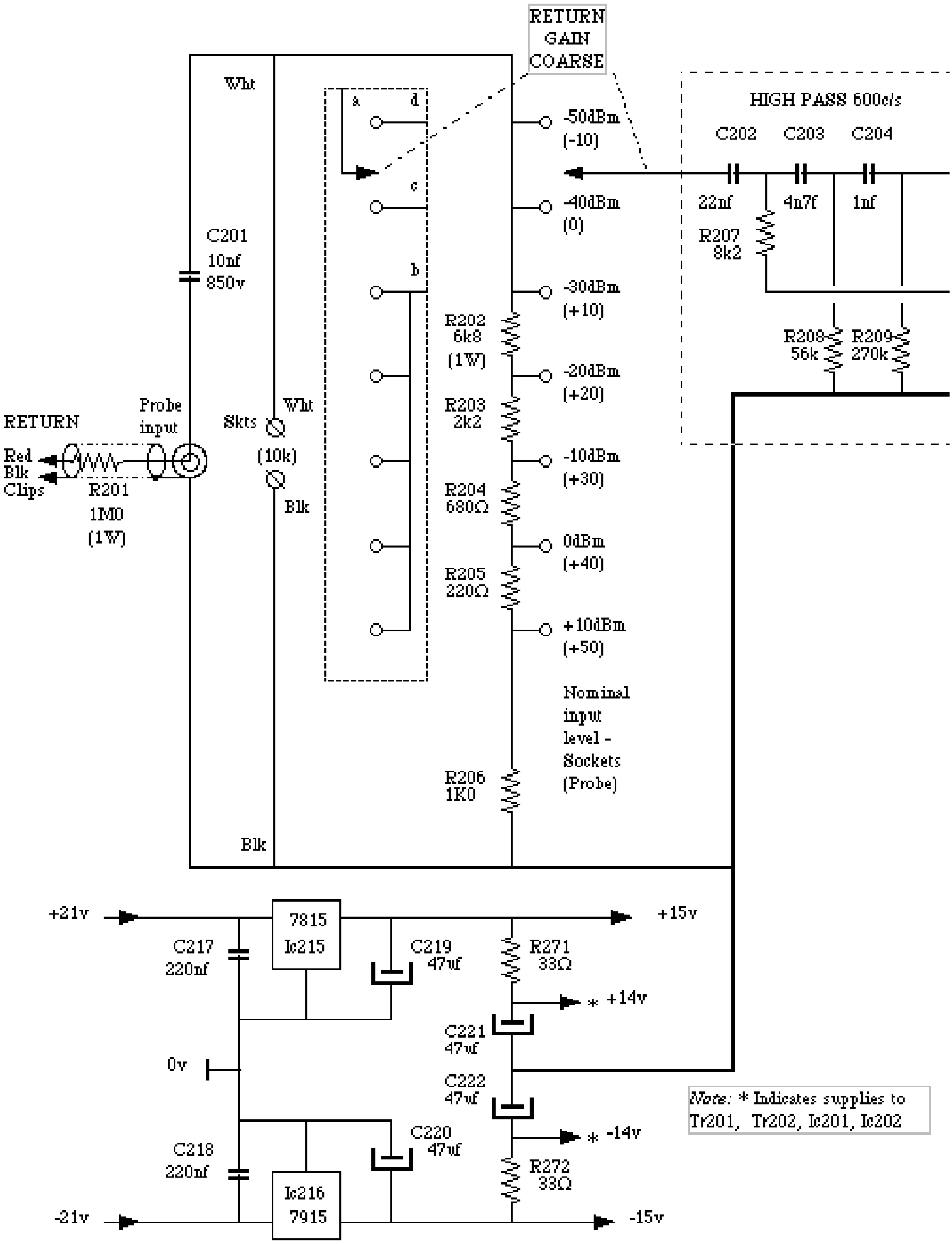

OSC 1
f (c/s) Ra Ra'
30 56k//1M0
60 27k
100 15k//150k
250 6k8//100k
300 5k6//100k
Off
Ra
Ra'
C119
100nf
+6 to +18 dBm
-12dB
+6dB
R112
1k0
R114
8k2
C114
3u3f
C118
100nf
NE5534
Ic101
R110
68k
R111
33k
R113
330Ω
C115
3u3f
R115
39k
R117
6k8
R116
39k
C118
10nf
Ic102
C122
47nf
R145
5k6
C124
47nf
C123
10nf
R146
5k6
OSC 2
f (c/s) Rb Rb'
Off
3000 39k//47k
4000 27k
7000 15k
8000 15k//100k
10000 10k
Ra
Ra'
C121
1n5f
+6 to +18 dBm
RATIO
0dB (1:1)
-12dB (1:4)
R124
1k0
Yel
C116
3u3f
C120
1n5f
NE5534
Ic106
R122
68k
C117
3u3f
R125
330Ω
R123
33k
Brn

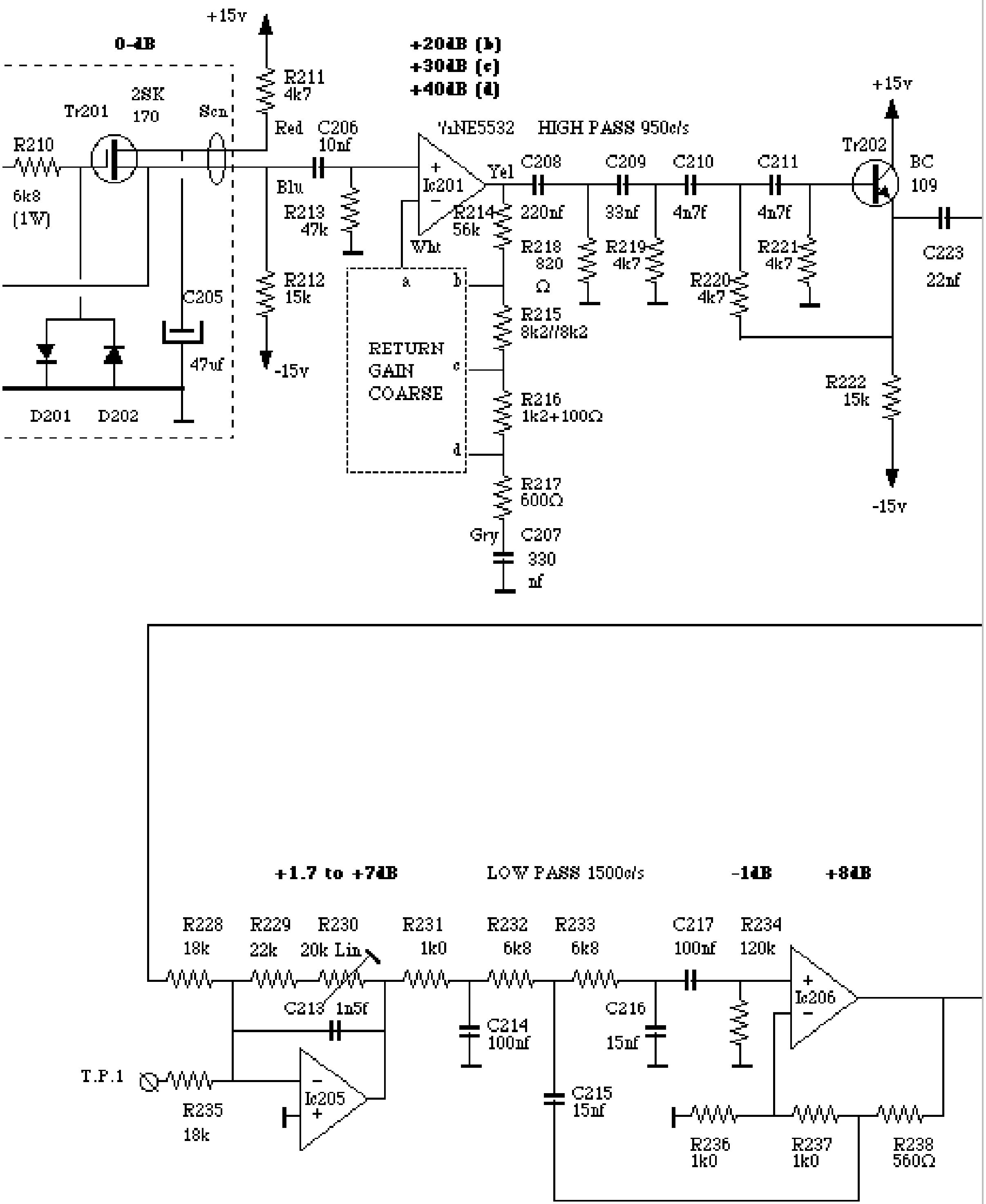
+6dB

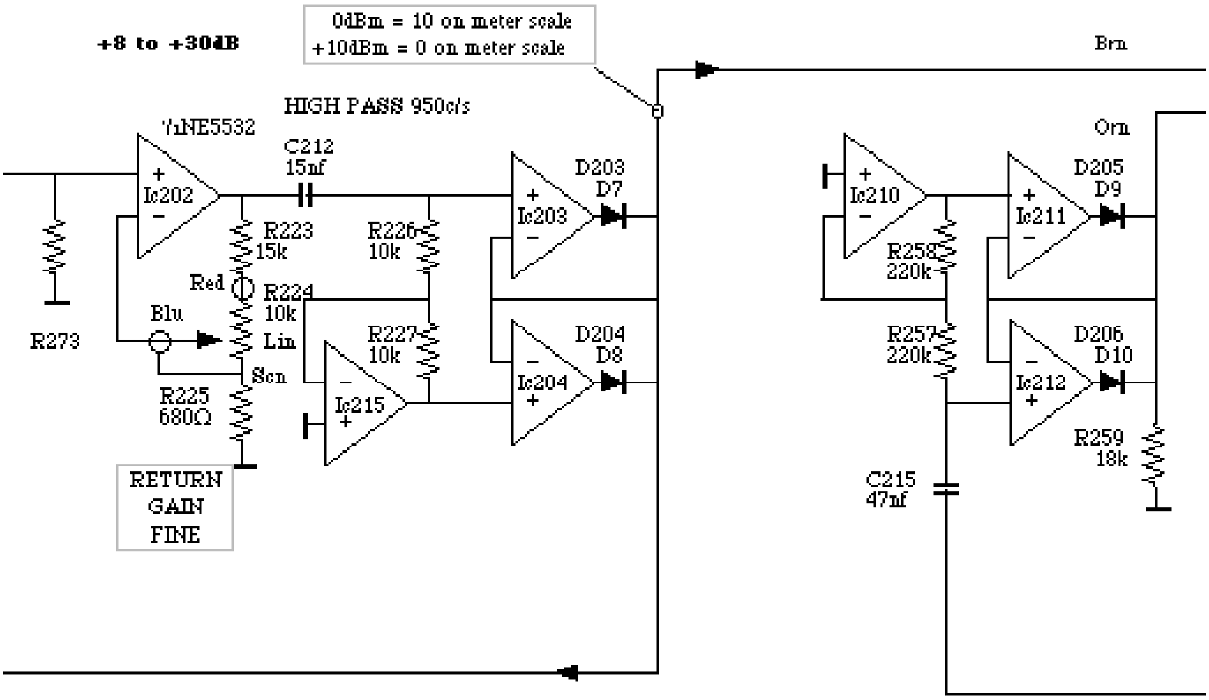


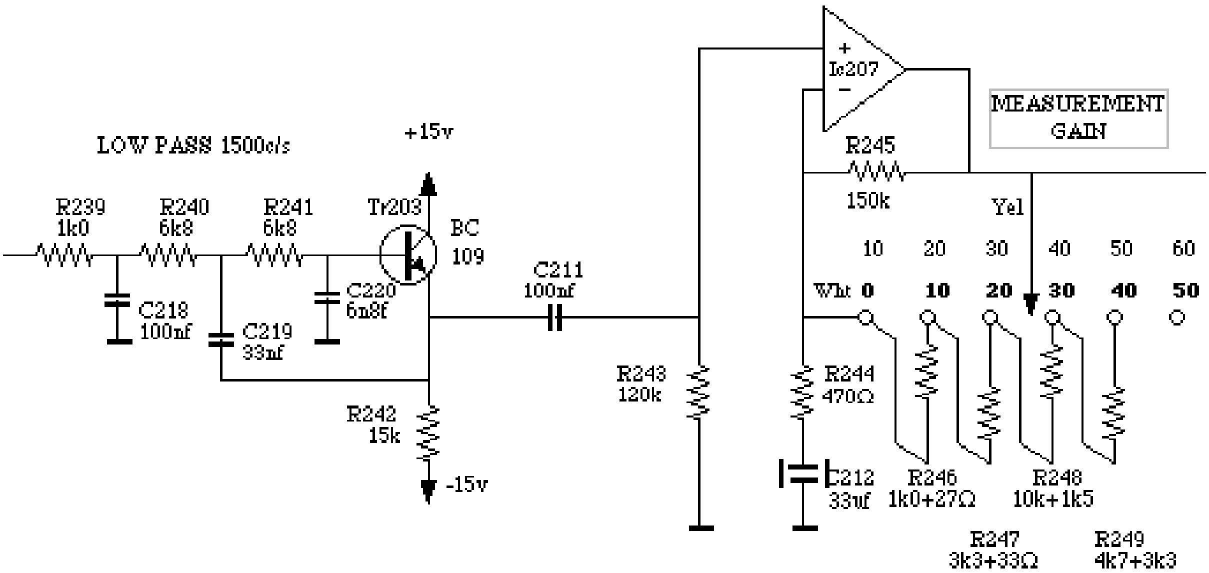
R118
33k
C126
10nf
R119
33k
Ic103
R120
5k6
R121
5k6
C125
10nf
Brn
Ext 1
Blk
C127
470nf
R126
47k
Ic104
2k7
8k2
27k
82k
270k
820k
R127 0
R128 -10
R129 -20
R130 -30
R131 -40
R132 -50
SEND
LEVEL
COARSE
R133
2k7
+6 to +18 dBm
Ic105
R134
1k2
Yel
SEND
Blu
-20dB load
68Ω
R143
1k2
-40dB load
6Ω8
Ic107
R136 0
R137 -10
R138 -20
R139 -30
R140 -40
R141 -50
R142
2k7
Ic108
+6 to +18 dBm
C128
100nf
Ext 2
R135
47k
2 x 1N4001
D101
D102
Gry
Floating earth
R144
600Ω
0v

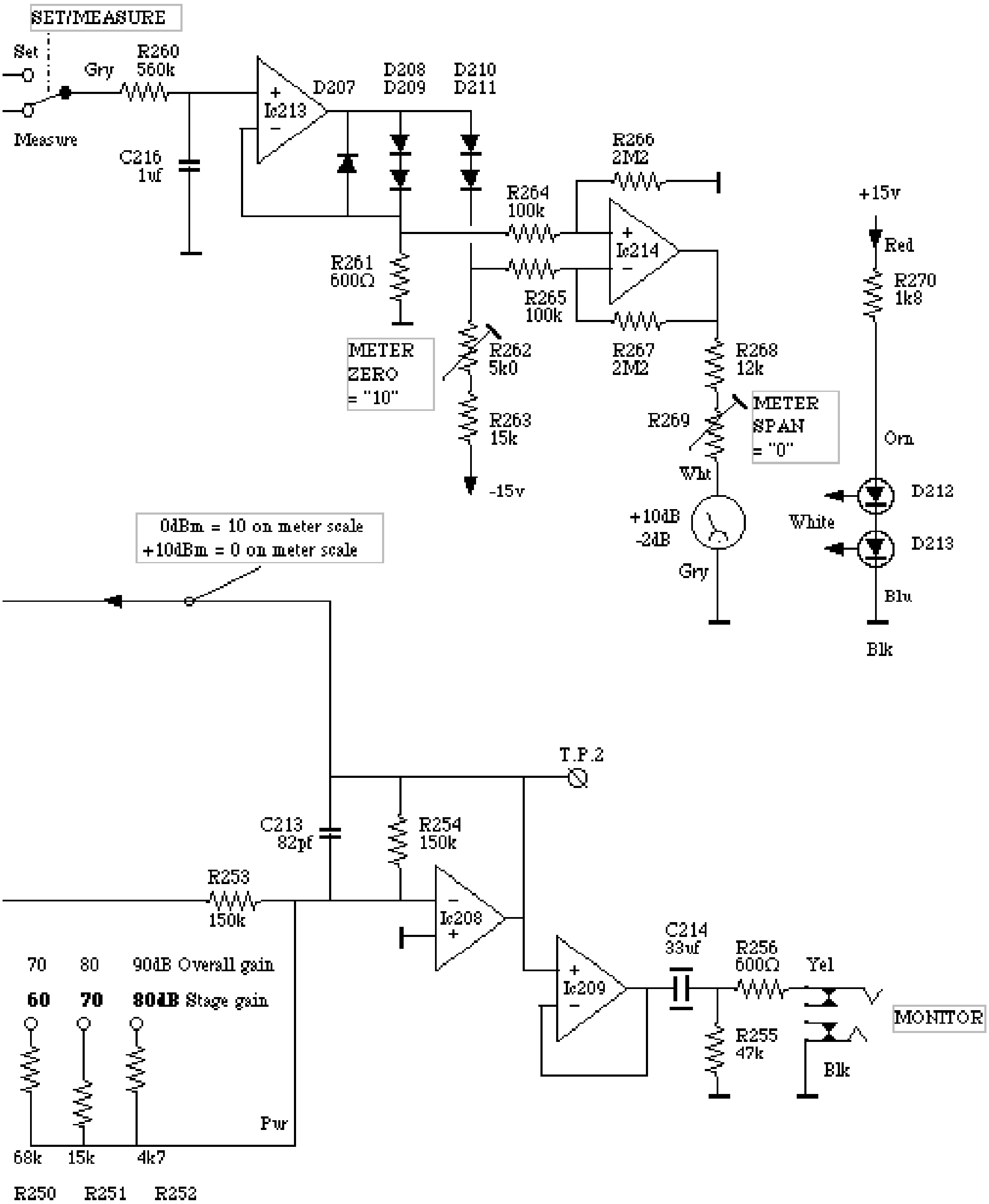
AUDIO FREQUENCY INTERMODULATION METER
Analyser




+15v
0-dB
+20dB (b)
+30dB (c)
+40dB (d)
R211
4k7
Tr201
2SK
170
Scn
Red
C206
10nf
½NE5532
HIGH PASS 950c/s
+15v
R210
6k8
(1W)
Blu
Ic201
Yel
C208
C209
C210
C211
Tr202
BC
109
R213
47k
R214
56k
220nf
33nf
4n7f
4n7f
Wht
R218
820
Ω
R219
4k7
R221
4k7
C223
22nf
R212
15k
C205
R220
4k7
a
b
R215
8k2//8k2
RETURN
GAIN
COARSE
c
47uf
-15v
R222
15k
R216
1k2+100Ω
D201
D202
d
R217
600Ω
-15v
Gry
C207
330
nf
+1.7 to +7dB
LOW PASS 1500c/s
-1dB
+8dB
R228
18k
R229
22k
R230
20k Lin
R231
1k0
R232
6k8
R233
6k8
C217
100nf
R234
120k
Ic206
C213
1n5f
C216
15nf
C214
100nf
T.P.1
Ic205
C215
15nf
R235
18k
R236
1k0
R237
1k0
R238
560Ω

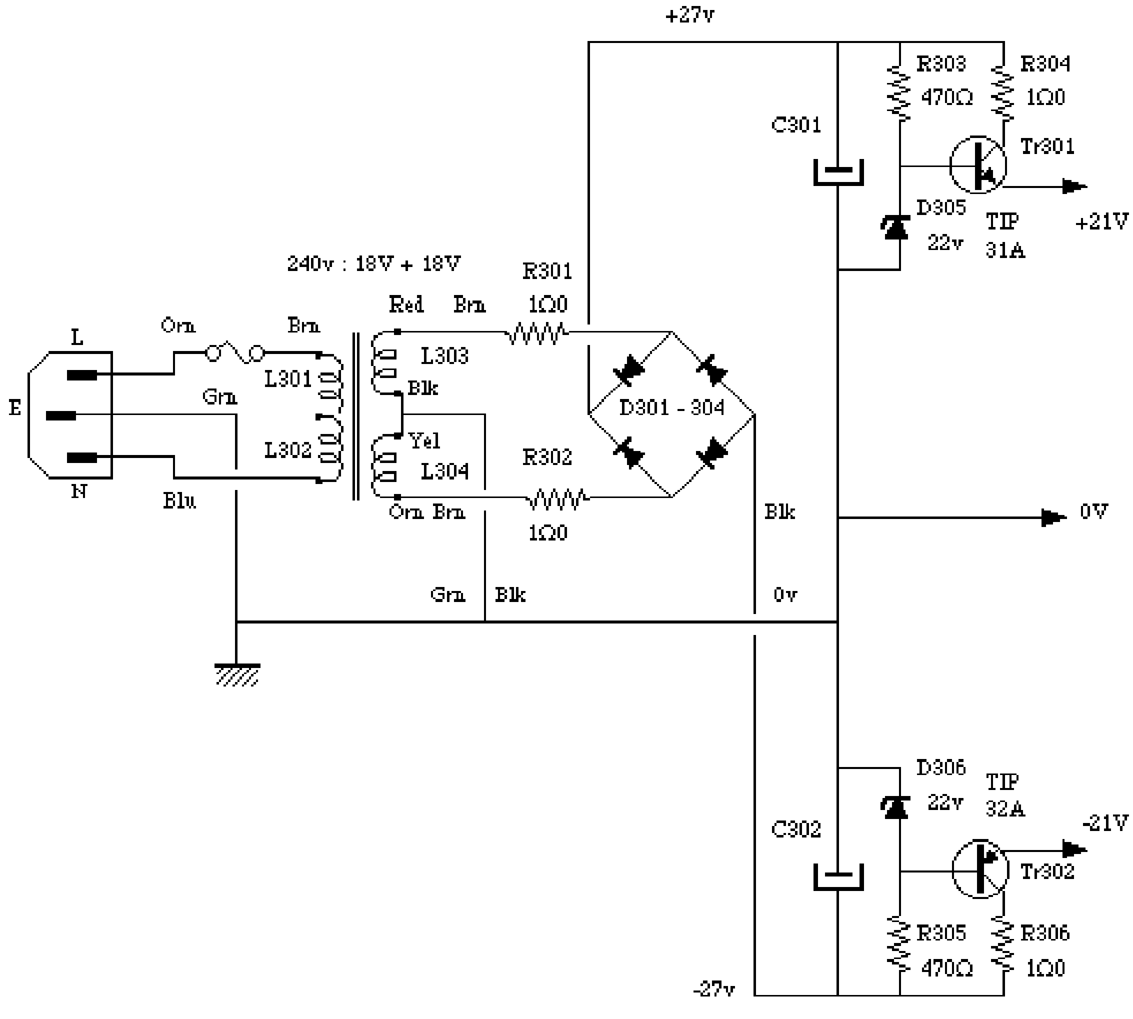

+8 to +30dB
0dBm = 10 on meter scale
+10dBm = 0 on meter scale
Brn
HIGH PASS 950c/s
½NE5532
C212
15nf
Orn
Ic202
R223
15k
R226
10k
D203
D7
Ic203
Ic210
R258
220k
Ic211
D205
D9
Red
R224
10k
Blu
Lin
R273
R227
10k
D204
D8
Ic204
R257
220k
D206
D10
Ic212
Scn
R225
680Ω
Ic215
R259
18k
C215
47nf
RETURN
GAIN
FINE


Ic207
MEASUREMENT
GAIN
LOW PASS 1500c/s
+15v
R245
150k
Yel
R239
1k0
R240
6k8
R241
6k8
Tr203
BC
109
10 20 30 40 50 60
C211
100nf
Wht 0 10 20 30 40 50
C218
100nf
C219
33nf
C220
6n8f
R243
120k
R244
470Ω
R242
15k
-15v
C212
33uf
R246
1k0+27Ω
R248
10k+1k5
R247
3k3+33Ω
R249
4k7+3k3



SET/MEASURE
Set
Measure
Gry
R260
560k
C216
1uf
Ic213
D207
D208
D209
D210
D211
R261
600Ω
R264
100k
R265
100k
R266
2M2
R267
2M2
Ic214
METER
ZERO
= "10"
R262
5k0
R263
15k
-15v
R268
12k
R269
METER
SPAN
= "0"
Wht
+10dB
-2dB
Gry
+15v
Red
R270
1k8
Orn
D212
White
D213
Blu
Blk
0dBm = 10 on meter scale
+10dBm = 0 on meter scale
T.P.2
C213
82pf
R254
150k
R253
150k
Ic208
Ic209
C214
33uf
R256
600Ω
Yel
R255
47k
Blk
MONITOR
70
80
90dB Overall gain
60
70
80dB Stage gain
Pwr
68k
15k
4k7
R250
R251
R252

AUDIO FREQUENCY INTERMODULATION METER
Power Supply



POPPY
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