SECTION 3

WIDE-BAND VISION AND SOUND MODULATOR MD2/502

Introduction

The MD2/502 provides a complete television signal on any channel in Band I or Band III. It incorporates two r.f. sources and means of modulating their outputs with a 405-line composite video signal and the accompanying sound signal. The vision signal is of double-sideband form. Sound and vision carriers are combined in a hybrid unit to provide a single output. The characteristics of the MD2/502 are such that it is suitable for use with colour television signals but for that purpose it is necessary to disconnect a sync-pulse stabilising circuit.

The unit is capable of a variety of applications, for example:—

(a) As a source of r.f. signals for test purposes.

(b) For closed-circuit distribution of t.v. programme material to non-technical areas at studio centres.

(c) Local radiation to cueing receivers by television O.B. units.

(d) Injection of locally originated programme or test signals into radio-link equipment; the modulator is suitable for use at the intermediate frequencies of the various link equipments.

(e) Injection of locally originated programme into translators.

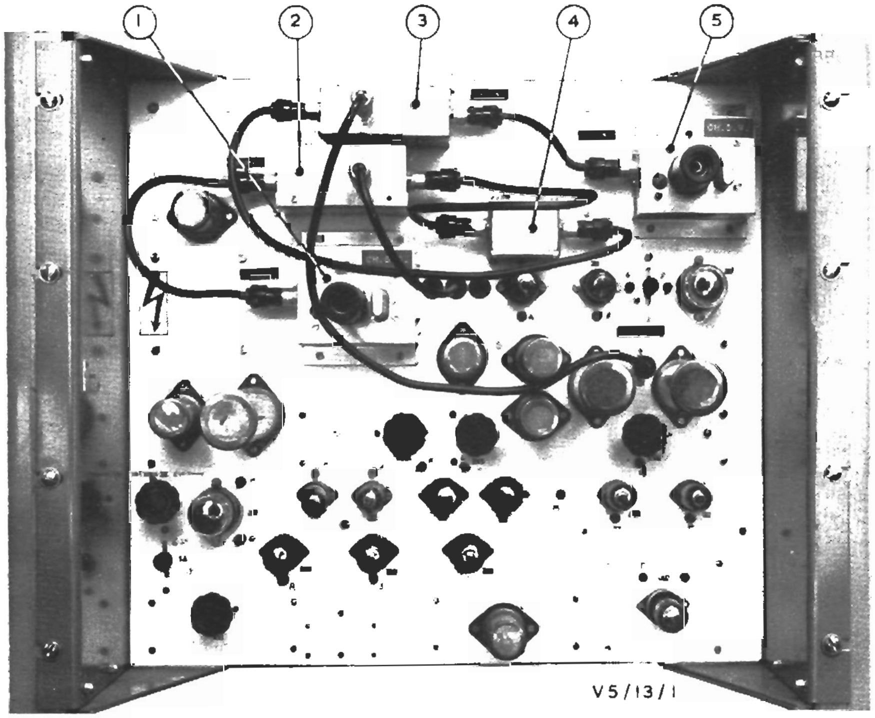


Fig. 3.1. Front View of MD2/502 showing positions of Plug-in Units.
1. Sound Oscillator. 2. Sound Modulator. 3. Vision Modulator. 4. Hybrid Unit. 5. Vision Oscillator.

Under development for purpose (c) is an equipment based on the MD2/502, but using transistors and incorporating plug-in assemblies to permit rapid changes between channels.

With simple modification the MD2/502 can be adapted to other television standards. Further developments from the basic design include a transistor version with switching to allow operation with either 405- or 625-line standards.

General Description

Fig. 3.1 is an annotated view of the equipment and in Fig. 3.2 is a block schematic of its arrangement.

The MD2/502 can be divided conveniently into five sub-groups:—

(a) Feedback clamp.
(b) Modulators.
(c) Oscillators.
(d) Hybrid unit and low-pass filter.
(e) Power supplies.

Two identical bridge modulators are used. The video input signal is amplified, clamped at blanking level and applied to one input of a bridge modulator. The other input to this bridge is fed from an oscillator working on the desired vision-channel frequency and a double-sideband output is obtained when modulation is applied.

The second modulator receives the output from another oscillator working on the appropriate sound-channel frequency. This bridge is biased by d.c. which is mixed with the sound input and a normal a.m. carrier is produced.

Outputs from the two modulators are combined in a hybrid unit and fed via a low-pass filter to the output socket SKTQ.

An integral mains unit provides a 6·3-volt supply for valve heaters and also d.c. supplies at −40 volts, +7 volts, and −7 volts; in some early units the last-mentioned supplies are at 9 volts. A 200-volt positive supply from an external source is necessary.

Tests are made on the MD2/502 by rearranging internal connections and using one modulator as a frequency changer. The output from the circuit under test is translated to 3·5 Mc/s (difference between vision and sound carriers) at which direct viewing with an oscilloscope is possible. This method obviates need of a test detector and avoids non-linearity which that would introduce.

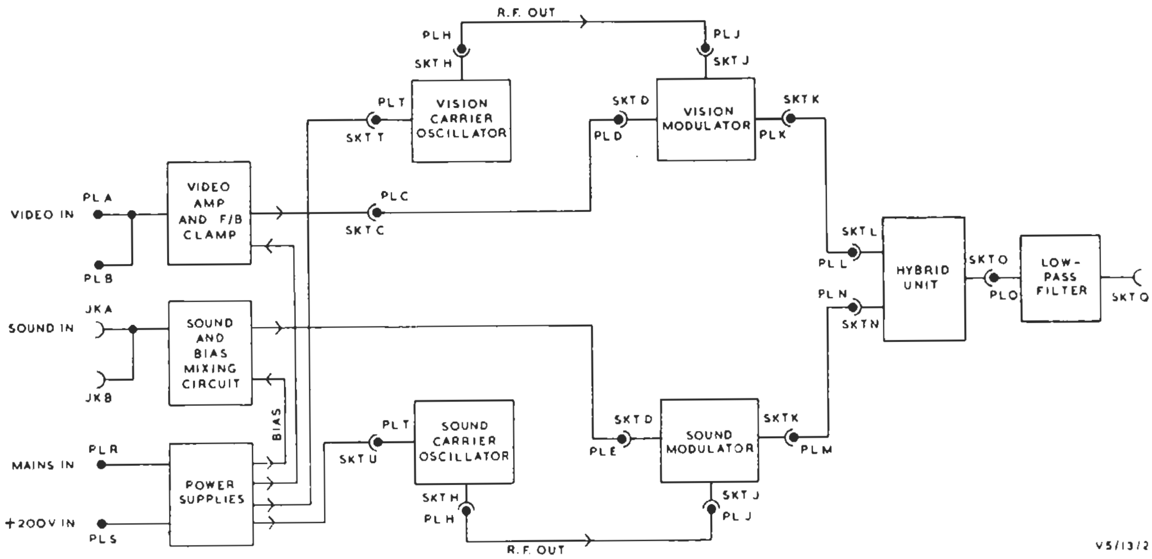


Fig. 3.2. Block Schematic of Unit Interconnections for MD2/502

Mechanical Arrangement

The unit is constructed on a $15\frac{3}{4}$-in. pan chassis type CH3/1. The video amplifier, feedback clamp and power unit are assembled in the usual manner but the remainder of the unit consists of a number of small sub-assemblies which, with the exception of the low-pass filter, are screwed to the front of the panel. The filter is mounted on brackets at the back of the panel.

Signal connections between the various assemblies are made by means of coaxial leads fitted with plugs.

The unit weighs 28 lb.

Power requirements are approximately 85 watts.

Circuit Description

Video Amplifier (Fig. 7)

The MD2/502 uses the Savage feedback clamp in its original form with thermionic diodes in the sampling bridges. Its operation is identical with that described in V.2, Section 9 (Stabilising Amplifier AM18/502). For use in the MD2/502 the circuit has been modified by increasing the gain of the video amplifier, which necessitated reducing the gain of the clamp feedback-loop. The circuit is stable in the absence of a synchronising input.

Video input signal from plug PLA is fed via an attenuating network and a lever switch SA to the video amplifier. In the centre position of SA the signal is attenuated by RV1 only. Of the two alternative positions, one provides an extra 6-dB attenuation by the fixed pad R4, R5, R6 and the other connects a low-voltage a.c. source in parallel with the input. This is used to test the action of the clamp.

The two-stage amplifier using V1 and V2 has negative feedback applied from the cathode of V2 to the input. C14, C61 and R141 in the feedback path are adjusted to obtain a flat frequency response as detailed in the Test Specification.

The amplifier is followed by a cathode-follower V3 across which the feedback clamp is connected. The video output from V3 is connected through switch SB and a sync-pulse stretching and clipping circuit to the *Video Out* socket SKTC.

Sync Stretching and Clipping Circuit (Fig. 7)

For reasons given later in dealing with the vision modulator it is desirable that sync-pulse amplitude at the output remains unaffected by any change of amplitude at the input. This condition is achieved by the action of MR9 and MR10.

MR9 is biased to conduct when the video signal is above blanking level and its low impedance acts with R38 to attenuate the output signal. Sync pulses drive MR9 anode negative, the diode impedance becomes high and sync amplitude is increased. The stretched pulses are clipped by MR10. Amplitude of output sync pulses remains correct for input-amplitude changes of the order of 2 to 3 dB.

This circuit is disconnected when the MD2/502 is operating with a colour-signal input.

Feedback Clamp (Fig. 7)

The clamp circuit samples the voltage at V3 cathode during the back-porch period by means of the bridge circuit incorporating V9 and V10.

If blanking level in the output signal deviates from a specified voltage a train of pulses is generated, the amplitudes and polarity of which are determined by the extent and direction of the drift. The pulses are amplified by the a.c.-coupled stage V8 and fed via cathode follower V7a to a second sampling bridge using V5 and V6. This bridge acts as a demodulator and extracts the amplified error-signal which is present as modulation of pulse amplitude.

The waveform of the error signal developed across C18 has a polarity opposite to that of the drift. This waveform is smoothed by R48 and C17 and applied to cathode follower V4. The low-impedance source of smoothed error-signal at V4 cathode is connected in series with the input to V3.

The standing grid voltage of V7a, V4 and V3 can be adjusted, by means of RV4, to obtain zero error-signal from the feedback loop when blanking level is correct at V3 cathode (loop disconnected).

The capacitance of diodes V9 and V10 cause a differentiated signal to appear across R74 when the bridge is in the non-conducting state. This is effectively removed by cancellation with a differentiated phase-inverted signal derived from V7b.

Difference in potentials across the sampling bridge, owing to unequal conduction of the diodes, is eliminated by adjustment of RV6. RV5 is set to give zero output from the bridge when V3 cathode is at the required potential.

L5, C31 and C32 comprise a filter circuit that removes any colour-signal reference burst before sampling is affected.

Generation of Bridge Driving Pulses (Fig. 7)

Either a video input signal from the slider of RV1 or an external source of sync signals, connected through PLF, is selected by switch SE and fed to the low-pass filter incorporating L6, L7, L8 which removes the reference burst of a colour signal. The video signal is fed via cathode follower V11a, the output impedance of which is about 270 ohms to match the input to the filter. Attenuation and matching for the external-sync source is provided by the resistive pad R83, R84, R85.

Negative signal peaks are restored to earth, by the action of diode MR11, before amplification and phase reversal by V12.

V11b is connected as a conventional sync separator (Television Engineering, Volume 4) but the grid-circuit time-constant (5ms) is smaller than usual. This gives improved sync-separation action with distorted signals but at the expense of some distortion of field syncs. V13 is used in a window stage to produce negative-going undistorted sync pulses.

The reconstituted pulses are applied through R114 to the two-section delay line which is effectively short-circuited at the far end. Thus a positive pulse, delayed by 4 μs, follows each negative sync pulse at the grid of V14a. The sum of each pair of pulses is another pair, each 4 μs wide, whose leading edges coincide with the leading and trailing edges of the input sync pulses. The first pulse of the pair is negative-going and the second is positive-going. Because of grid bias developed by R118 and C48 the positive pulse only is effective and it occurs in the back-porch period.

A similar process applies to the input to V14b but, as this is taken from a tap on the delay line, the gating pulses are 3·4 μs wide.

Transformers T2 and T3 provide balanced feeds to drive the bridges in the clamp circuit. The narrower pulses are applied to the second bridge to eliminate disturbances at the edges of the error pulse-waveform.

Diodes MR12 and MR13 remove overshoots caused by the reduction of transformer damping while V14 anode current is cut off.

Sound Input Circuit (Fig. 7)

The sound input signal is mixed with a d.c. bias before application to the sound modulator. The mixing circuit, which incorporates means of adjusting the bias, is located on the main chassis and is shown in Fig. 7. This circuit is self-explanatory.

Modulators

Sound and vision modulators are identical but operate under different conditions. The modulator is a four-diode bridge circuit, as in Fig. 3.3, switched at carrier frequency by the output from a local oscillator. This circuit offers the following advantages:

(a) It is simple, robust and suited to unbalanced operation.

(b) When the bridge is balanced there is no r.f. output in the absence of modulation but by mixing d.c. with the input modulation a normal full-carrier a.m. signal can be produced.

(c) When the r.f. drive is sufficiently large, output amplitude is reasonably independent of drive amplitude. For example, with drive at 1·5 volts a 6-dB change

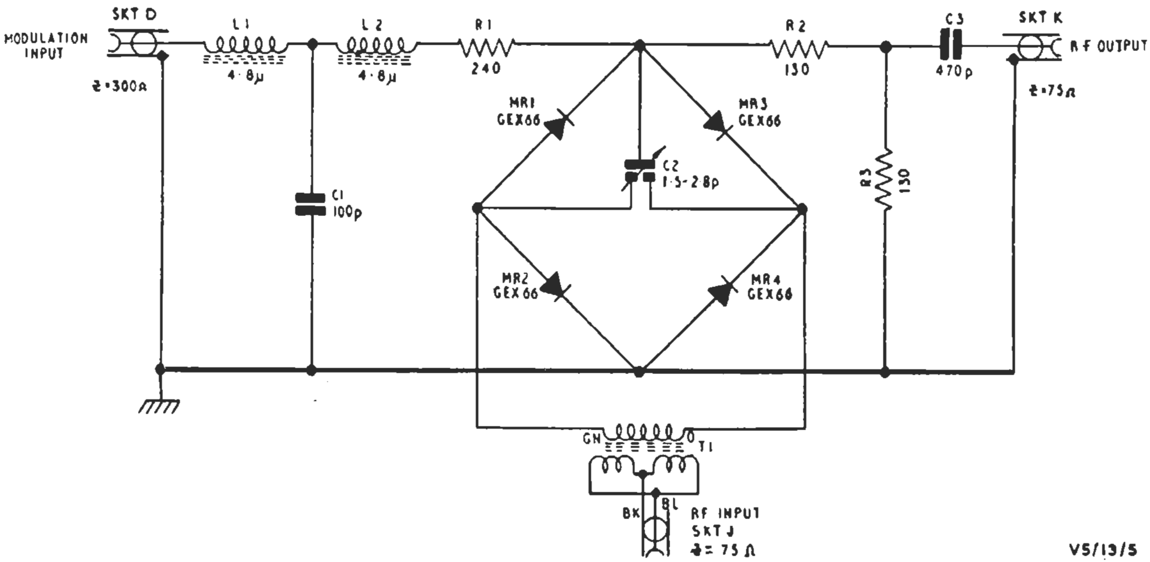


Fig. 3.3. Circuit of Vision and Sound Modulators in MD2/502

results in less than 1-dB change in modulated output from the bridge.

L1, L2, C1 form a r.f. filter that isolates the modulation input circuit from the r.f. oscillator. The filter has input and output impedances of 300 ohms, chosen so that the diode sync-stretching and clipping circuit operates between relatively high impedances and so that the bridge, which is of about 60 ohms impedance, has a relatively high-impedance source to switch.

Differential capacitor C2 is to adjust the balance of the diode bridge and is set for minimum carrier-leakage as detailed in the Test Specification.

Capacitor C3 blocks input modulating signals from the r.f. output. The attenuator pad R2, R3 presents a relatively high impedance to the bridge and provides a source impedance of 75 ohms for the output.

The P.I.D. specification for a vision signal rules that the carrier level at the bottom of sync pulses shall not be greater than 2 per cent. The MD2/502 can be set up to maintain a level of 1 per cent but for closed-circuit distribution purposes this specification is relaxed to 5 per cent. Note that neither specification can be met by over-modulation as the bridge circuit produces an r.f. output for negative values of modulating voltage.

The voltage at the bottom of sync pulses must be controlled within narrow limits. Therefore the signal is clamped at blanking level and pulse amplitude is stabilised by use of MR9 and MR10.

Rigorous tests of linearity are not possible because the MD2/502 was designed as test equipment and test detection-equipment of the requisite superior grade is not readily available.

Oscillators (Fig. 8)

Band I

The Band I oscillator unit uses one half of a double-triode as an oscillator and the other section of the valve as a buffer amplifier.

The oscillator has transformer-coupling and uses a series-connected crystal as the frequency-determining element. Tuned circuit L1, C4 suppresses spurious oscillation modes in the crystal.

The damping resistor R1 is selected on test to determine the current flowing through the crystal.

Output is taken from V1b anode via the resistive pad R6, R7, R8 to the output socket SKTH from whence connection is made to the modulator by coaxial lead.

Band III

The oscillator section of this unit is very similar to that of the Band I oscillator. To obtain carrier frequency the output from V1a is clipped at both extremities by MR1 and MR2 and the resulting square wave applied to the three-valve tuned amplifier incorporating V1b, V2, V3. This amplifier is tuned to select the third harmonic of the overtone crystal.

Hybrid Unit and Low-pass Filter

The combining circuit is a standard commercial unit. It is a bridge device and has an insertion loss of 6 dB.

The complete television signal is fed to the main output socket SKTQ via a low-pass filter. Two filters are provided, one with a cut-off frequency of 85 Mc/s for use in Band I and the other with a cut-off frequency of 250 Mc/s for Band III working. Details of these units are given in Fig. 3.4, (a) and (b) respectively.

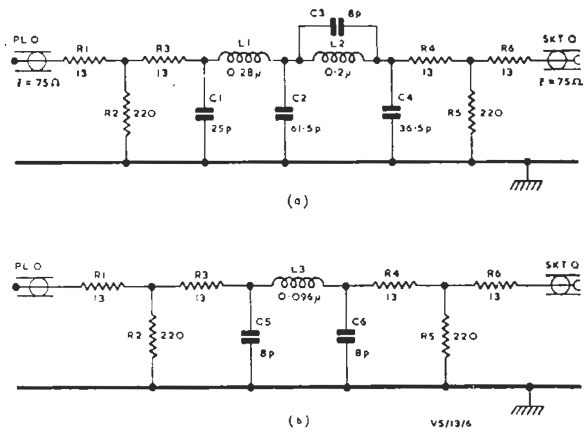


Fig. 3.4. Circuit of Low-pass Filters at Output of MD2/502

Power Supplies (Fig. 7)

Bias and heater supplies are obtained from a unit incorporated in the MD2/502. An external 200-volt positive supply is required.

A 12·6-volt secondary winding on transformer T1 feeds a voltage-doubling rectifier circuit using MR5 and MR6. The resulting d.c. supply is centre-tapped and stabilised by use of the two zener diodes MR7 and MR8 to provide positive and negative bias lines at 7 volts. In some early versions of the MD2/502, which have smoothing chokes of lower resistance, MR7 and MR8 are 9-volt types.

A 33-volt winding on T1 is used with a full-wave rectifier to provide 40-volt negative bias.

Test Specification

Apparatus Required

Stabilised power supply at 200 volts, 250 mA.
High-grade oscilloscope with high-impedance probes; Tektronix 515 or 545.
Calibrating Unit UN2/501, to calibrate oscilloscope.
Sine-squared Pulse and Bar Generator, Type GE4/504.
Source of composite video signal, standard 1 volt p-p.
Source of mixed sync waveform, standard 2 volt p-p.
Video change-over box.
Video oscillator; Wayne Kerr type 0.222.
Crystal dB meter; B.P.L. Type E 3233 or Type 25A.
Avometer Model 8.
Variable attenuator, (0—9 dB), S.T. and C., Type 74600, Group G.

General

Check that the mains transformer primary-tapping connection is correctly set.

Always allow half an hour for warm-up before making measurements on the MD2/502.

Owing to considerable interdependence of various individual stages the line-up of the video amplifier and clamp necessitates a particular order of procedure. To outline the method, for which details are given in items 7 to 38, there follows a summary of the operations involved.

(i) Check gain and frequency response of video amplifier.
(ii) Check operation of sync-separator and pulse generator circuits.
(iii) Set up feedback clamp:
  (a) Adjust sampling bridge to give no output when input to the bridge is earthed.
  (b) Check feedback amplifier V8.
  (c) Check operation of demodulator bridge.
  (d) With input to the video amplifier earthed and the clamp feedback-loop connected, adjust demodulator bridge to obtain zero potential at cathode of V3.
  (e) Adjust spike-cancellation circuit V7b.
  (f) Check operation of clamp.
(iv) Adjust sync-pulse stabilising circuit; this sets the blanking level in the output signal.

Power Supplies

1. Disconnect the junction L1, C1 from the rectifier bridge MR1-4. The value of resistance from this junction to chassis, with the positive lead of the Avometer to chassis, should be 2·1 kilohms ±20 per cent.
2. The value of resistance between pin 1 of h.t. input plug PLS and chassis (negative Avometer lead to chassis and h.t. switch in the *On* position) should be 8 kilohms ±20 per cent. Re-connect the junction L1, C1 to the rectifier bridge.
3. Connect the mains supply, switch on and ensure that all valves are lit.
4. Measure the voltage of the 40-volt negative bias line. Tolerance on the nominal value is +15 and −10 per cent.
5. Connect the 200-volt positive supply and measure the current drawn by the MD2/502. This should be 230 mA ± 25 mA.
6. Measure the low-voltage (±7 volts) supplies. The allowed tolerance is ± 5 per cent.

Video Amplifier

7. Remove V4 from its socket, earth the junction L4, R45 and disconnect MR9 and MR10 from the junction R38, R140. Connect a 91-ohm resistor from output socket SKTC to earth.
Set up the test circuit shown in Fig. 3.5.
Set the video oscillator to 10 kc/s and delivering 1 volt p-p across 75 ohms.
Set gain control RV1 at maximum.

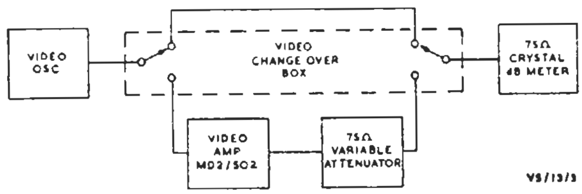


Fig. 3.5. Equipment Layout for Checking Frequency Response of Video Amplifier

8. With a high-impedance probe and the oscilloscope, measure the signal at monitoring socket *D*. This should be 12 volts ±10 per cent p-p.
9. Measure the voltage amplification of the amplifier between the slider of RV1 and monitoring socket *C*. This should be 15 ±10 per cent (23·5 dB ±1 dB).
10. Check the frequency response of the unit between the video input and output sockets. Do this by maintaining a constant output level from the oscillator and setting the variable attenuator so that the reading of the crystal

meter changes by less than 1 dB on operating the change-over box. Read the final figure, to an accuracy of 0·1 dB, from the scale of the crystal meter.

Adjust C14, C61, R141* to obtain the following characteristic relative to the gain at 10 kc/s:

±0·1 dB up to 3 Mc/s.
±0·5 dB from 3 Mc/s to 6 Mc/s.

11. Remove the 91-ohm resistor and restore the circuit to normal.

Sync Separator Chain

12. Connect a composite video signal, 1 volt p-p, to the video input plug PLA (preferably syncs and 100 per cent lift).
Set gain control RV1 to minimum.
Set sync-source selector switch *SE* to *Internal*.
13. Check waveform at the anode of V12 using the oscilloscope and high-impedance probe. The inverted video signal should have an amplitude of 25 volts p-p.
14. Check waveform at the anode of V11b as in (13). The negative-going sync pulses should have an amplitude of 30 volts and a duration of 9 μs.
15. Disconnect the diode bridges from the transformers T2 and T3 and earth pin 4 of each transformer.
16. Monitor in turn at pin 3 of each transformer. The signal should consist of a train of positive-going pulses occurring in the back-porch period and with an amplitude greater than 12 volts p-p. The pulses from T2 and T3 should have half-amplitude durations of 3·8 μs and 3·3 μs respectively. Pulse-duration tolerance is 10 per cent for either train, but that is subject to the pulses from T2 always having longer duration than those from T3. The difference in level between normal pulses and the double-line-frequency pulses of the field sync period should not exceed 5 per cent.
17. Operate switch *SA* to the up position. The signal at monitor point *R* should decrease by 6 dB but there should be no discernible change in the outputs from T2 and T3.
18. Operate switch *SA* to the down position. The signal at monitor point *R* should decrease by 3 dB. Added to the signal will be a 50-c/s sine wave at 0·25 volt p-p. There should be no discernible change in the outputs from the two transformers.
19. Connect a 2-volt p-p mixed sync signal to the *Ext. Sync. Input* plug PLF and set sync selector switch *SE* to *External*. There should be no change in the transformer outputs.
20. Restore the circuit to normal.

Feedback Clamp

21. Apply a 1-volt composite video signal to the input plug PLA. Earth the junction R35, R36 with a crocodile-clip lead. Operate switch *SB* to the up position.
22. Monitor successively at points *P* (positive-going) and *N* (negative-going) with the oscilloscope and a probe of maximum capacitance 12 pF. Pulse amplitudes should be greater than 5 volts with a difference of less than 25 per cent between the two waveform amplitudes.
23. Monitor at point *L*. Adjust RV5 and RV6 for minimum displayed signal. Remove the earth from junction R35, R36; pulses with an amplitude of 3 volts should be displayed.
24. Check the overload characteristic of the gain stage (V8) as follows:
Connect the junction L5, R37 (slider RV6, test point *Q*) to the junction R8, R10 using a crocodile-clip lead.
This should result in a train of pulses being displayed on the oscilloscope (point *L*). The pulses will be modulated at 50 c/s and should have maxima greater than 10 volts in the positive-going direction and greater than 15 volts in the negative-going direction.
Monitor at point *K*; the displayed pulse amplitudes should also be greater than +10 volts or −15 volts.
Restore the circuit to normal.
25. Earth the junction of R35, R36 and set switch *SB* to the up position. Monitor successively at points *H* (positive-going) and *J* (negative-going) with the oscilloscope and a probe of maximum capacitance 12 pF. Pulse amplitudes should be greater than 5 volts and the difference in amplitude between the two waveforms should be less than 25 per cent.
26. Monitor at point *G* with the oscilloscope and probe. Adjust RV6 for minimum field-frequency component in the display. If necessary readjust RV5 as in (23); RV5 and RV6 are interdependent.

* C14 controls the response from 1 Mc/s to 4 Mc/s. The combination R141, C61 controls the response from 4 Mc/s to 6 Mc/s.

27. Remove the earth from the junction R35, R36. The d.c. potential at point *G* should increase by 3 volts.
28. Replace the earth at the junction R35, R36. Also earth the junction R9, C7.
Check that the d.c. potential at test point *C* can be varied over a range of 10 volts by adjustment of RV4.
29. Set switch *SB* to the centre position.
Monitor at test point *L* and set RV4 for minimum amplitude of displayed pulses.
30. Remove the earth from the junction R35, R36. Measure the voltage at test point *D*; this should be zero ±0·1 volt.
31. Remove the earth from the junction R9, C7. Disconnect R38 from junction of R37 and switch *SB*.
Monitor at test point *L* with the oscilloscope and high-impedance probe. Adjust C25 and RV5 for minimum spike and pulse amplitudes respectively in the display.
32. Monitor with the high-impedance probe at point *D*.
Move switch *SA* between normal and up positions; the displayed composite video signal should change amplitude by 6 dB without change of blanking level in the back-porch period.
33. Set switch *SA* to the down position; this introduces a 50-c/s component into the input of the video amplifier.
Measure the signal/interference ratio at the junction R8, R10 and also at test point *D*. The ratio of the two measurements should be greater than 20.
Restore the circuit to normal.

Sync Stretching and Clipping Circuit

34. Connect the pulse-and-bar generator to the video input plug PLA. Set the generator to deliver 1-volt p-p signal across 75 ohms with a pulse/sync ratio of 7 : 3 and a pulse/bar ratio of unity.
Set RV5 fully clockwise.
Set RV1 for maximum gain.
35. Monitor at the *Video Output* socket SKTC with the oscilloscope set for d.c. measurement and with an input impedance of 300 ohms. The displayed pulse-and-bar waveform should have an amplitude of 1·7 volts p-p with the back-porch about 0·7 volts above earth potential.
36. Rotate RV5 anti-clockwise. The d.c. level of the video signal should decrease until finally the syncs begin to stretch. Stretching should commence when the bottom of syncs is approximately +0·15 volts. When the bottoms of syncs reach earth potential they will be clipped. Check that sync pulses are completely removed from the waveform at maximum anti-clockwise setting of RV5.
37. Set RV5 to give a picture/sync ratio of 7 : 3 (bottom of syncs at earth potential).
38. Obtain the k-rating of the unit at SKTC. This should be not greater than 1 per cent. Correct any variation from unity of the pulse/bar ratio by adjustment of L4.

Colour Sub-carrier Filters

1. Switch off the mains and h.t. supplies to the MD2/502.
Set switch *SE* to *External.*
Disconnect MR11 from junction R95, C39. Connect the video oscillator to *Ext. Sync Input* plug PLF. Set the generator to give an output at 2·66 Mc/s, 1 volt p-p across 75 ohms. Measure at socket *R*; the signal should be attenuated by at least 30 dB (less than 32 mV).
2. Disconnect MR9 and MR10 from junction R38, R140.
Connect the 2·66-Mc/s oscillator to the *Video Output* socket SKTC. Measure at test socket *Q* with a high-impedance probe and adjust C32 for minimum displayed signal.
Check that the ratio of levels between points *D* and *Q* is greater than 30 dB.
3. Restore the circuit to normal.

Final Alignment

1. Connect the pulse-and-bar generator to the input plug PLA.
Set switch *SE* to *Internal.*
Switch on the mains and h.t. supplies.
Monitor at *Video Output* socket SKTC with the oscilloscope having an input impedance of 300 ohms.
2. Adjust RV1 to give a displayed bar-amplitude of 1·05 volts.
3. Adjust RV5 to give 0·45-volt sync amplitude in the display. Bottoms of syncs should be at earth potential.
4. Monitor test point *L* with a high-impedance probe. Adjust RV4 and C25 for minimum pulse and spike in the displayed waveform. N.B. If RV4 is moved more than 10 degrees it may be necessary to repeat (3) and (4).

Band I Oscillator

The following extra apparatus is required:

Valve Voltmeter, Marconi Type TF1041 or equivalent (two if available).

Make up the test power-connector shown in Fig. 3.6. The following components are required:

Painton connectors; Type 312010 and 311912 C1 and C2; Erie ceramic disc capacitors Type K7004/831 (0·0022 μF).

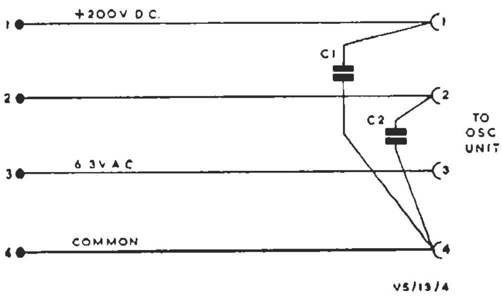


Fig. 3.6. Diagram of Extension for Test Powering of Oscillator Units

1. Remove the back cover from the oscillator assembly and ascertain that the value of C2 is appropriate to the crystal frequency.
   Check that the core of T1 is positioned with the visible end flush with the end of the former and that it is cemented in position.
   Adjust the core of L5 so that the visible end is half-way along the winding.
   Verify that R1 (10k nominal) is fitted.
   Replace the cover and attach the oscillator unit to the MD2/502 (with supplies off temporarily) through the test power-connector.
2. Terminate the oscillator output in a 75-ohm resistor (Erie 9) using a coaxial cable not more than 4 in. long. Connect the valve voltmeter across the resistor.
3. Remove the crystal from its plug-in socket and power the MD2/502.
4. Measure the total h.t. current at the back of socket SKTT (or SKTU) (junction of C55 and R133). This should be 20 mA ±3 mA.
5. Allow 10 minutes for warm-up.
   Replace the crystal. Adjust C3 for maximum output indicated on the valve voltmeter. Adjust L5 for maximum output and then check alternately the settings of C3 and L5.
   If output is not obtainable, adjust the core of L5 in discrete steps of, say, one turn and rotate C3 at each setting.
6. Measure the r.f. voltage across R2, using the (second) valve voltmeter. For this purpose connection can be made between chassis and the appropriate pin of the crystal holder by slightly withdrawing the holder from its socket.
   Before making the reading, readjust C3 for maximum voltage across R2, but do not adjust L5.
   Disconnect the (second) valve-voltmeter and re-tune C3 for maximum output across the terminating resistor.
   The output voltage should be 1·25 ±0·1 volts and the voltage across R2 must not exceed 1·5 volts, (measured as detailed above). If these requirements are not met, the value of R1 should be changed in small steps, the voltage across R2 being checked at each stage.

Band III Oscillator

1. Remove the back cover from the oscillator assembly and check that L5 and L9 have the appropriate numbers of turns.
   Check that the core of T1 has the visible end flush with the end of the former and that it is cemented in position.
   Adjust the cores of L5 and L9 so that the visible ends are half-way along the windings.
   Adjust the core of L13 until the unseen end is judged to be half-way along the winding.
   Replace the cover and connect the assembly to the MD2/502 (with supplies off temporarily) using the test power-connector.
2. As in (2), Band I Oscillator.
3. As in (3), Band I Oscillator.
4. Measure the total h.t. current as for Band I oscillators. This should be 27 mA ±4 mA.
5. Replace the crystal. Adjust C3 for maximum output indicated on the valve voltmeter. Adjust L13, L9 and L5 in turn for maximum output. Readjust all four controls in turn for maximum output.
   Note: If an output is not obtainable, remove the crystal and inject a signal at the required output frequency into the cathode of V1b. Tune L13, L9 and L5 for maximum output. Remove the signal generator and repeat from (5).

6. As in (6) for the Band I oscillator, but note that the codings of R2 and R3 have been interchanged. The required output is 1 ±0·1 volts and the r.f. voltage across R3 should be 1·35 ±0·15 volts. If this specification is not met, the damping resistor R11 and also R3 should be adjusted in small steps and the above procedure repeated. The r.f. voltage across R3 must never exceed 1·5 volts.

Modulators

As these tests involve special cross-connecting arrangements their description should be read in conjunction with Fig. 3.2 which gives the coding of plugs and sockets. The following additional apparatus is required:

Video amplifier.
Signal generator, 40—220 Mc/s.
Audio-frequency oscillator, output impedance 600 ohms.

Vision Modulator

1. Verify that L1 and L2 have the correct value (tolerance ±5 per cent).
2. Mount vision and sound modulators on the chassis of an MD2/502 which has been aligned to specification.
   Connect the appropriate r.f. oscillators to sockets SKTJ.
   Connect the video-amplifier output (PLD) to vision-modulator video input (SKTD). Connect the two *R.F. Output* sockets SKTK together by taking PLL to SKTK of the sound modulator.
   Connect SKTD of the sound modulator to the oscilloscope via the video amplifier. Input impedance of the oscilloscope should be 75 ohms.
   Connected in this manner the sound modulator acts as a frequency changer producing a carrier modulated by the video input. The carrier frequency is the difference between the two oscillator frequencies, namely 3·5 Mc/s. If there is excessive hum in the display, connect a 0·001-μF capacitor between the amplifier and oscilloscope.
3. Apply a 1-volt p-p pulse-and-bar signal to the *Video Input* plug PLA. The displayed waveform should be a 3·5 Mc/s carrier modulated by the video input waveform.
4. Measure the r.f. voltage across T1 in the vision modulator (see Fig. 3.3) using the valve voltmeter and probe; tune the oscillator output circuit if necessary. The r.f. voltage should be 1 volt (tolerances +0·5 volt and −0·3 volt).
5. The displayed waveform should have a bar/sync ratio 7 : 3 and carrier at the bottom of syncs should be less than 5 per cent.
   If these requirements are not met, adjust C2 in the vision modulator to control the carrier level at sync bottoms and maintain the bar/sync ratio at 7 : 3 by resetting RV5. The two controls are interdependent.
6. *Linearity.* Substitute a sawtooth or step function waveform for the pulse-and-bar signal. Check that there is no apparent non-linearity in the output waveform.
   Note. When the MD2/502 is to be used for colour signals more stringent linearity tests are required. These tests require apparatus not readily available and Designs Department should be consulted.
7. *Output Level.* Measure the p-p amplitude of the displayed carrier.
   Disconnect the modulated vision signal from SKTK of the sound modulator and apply to that socket the unmodulated output of the signal generator.
   Adjust the output level of the signal generator to make the displayed-waveform amplitude equal to the peak amplitude noted from the previous display. The signal generator output (across 75 ohms) should be 90 mV ±10 mV.

Sound Modulator

1. As (1) under Vision Modulator.
2. Connect the modulators as for (2) under Vision Modulator, but with these differences of interconnection:
   (a) Vision input SKTD to the amplifier and oscilloscope.
   (b) Sound output plug PLE to sound-modulator input socket SKTD.
3. Measure r.f. voltage across T1 in sound modulator, by the method indicated in (3) and (4) under Vision Modulator.
4. Remove sound output plug PLE and balance out carrier leakage by adjustment of C2 in sound modulator.
5. Re-connect PLE. Apply 1 kc/s at a level of +8 dB from the a.f. oscillator and observe the modulated envelope displayed on the oscilloscope. With RV2 (main chassis), adjust the modulation depth to 90 per cent.
6. *Linearity.* Check that the waveform envelope

is a good sine wave.

7. *Output Level.* Measure the p-p amplitude of the displayed carrier.
Disconnect the modulated sound signal from SKTK of the vision modulator and apply to that socket the unmodulated output of the signal generator. Adjust the output level of the signal generator to make the displayed-waveform amplitude equal to the peak amplitude noted from the previous display. The signal generator output (across 75 ohms) should be 90 mV ±10 mV. If necessary, adjust the value of R136 to obtain the specified performance.

8. Restore all connections to normal, (see Fig. 3.2).

Low-pass Filters

Filters suspected of being faulty should be returned to Equipment Department.

Valve Operating Voltages

The following table gives typical d.c. measurements made on a video amplifier and clamp, using an Avometer Model 8. Measurements were made on the range nearest to and greater than the measured voltage except where indicated.

Valve	*Anode*	*Pin*	*Grid*	*Pin*	*Cathode*	*Pin*	*Screen*	*Pin*
V1 E180F	77	7	20**	2	28	1,3	200	9
V2 E180F	120	7	21**	2	28	1,3	183	9
V3 CV5112	200	4	2·25*	7	4·9	5	—	—
V4 CV5112	200	4	0**	7	2·3	5	—	—
V7a E88CC	200	1	−7**	2	−2·5	3	—	—
V7b	188	6	0	7	5·6	8	—	—
V8 E180F	20	7	−25**	2	−32	1,3	145	9
V11a E88CC	200	1	−3**	2	0·65	3	—	—
V11b	58	6	−23**	7	0	8	—	—
V12 E180F	90	7	0**	2	2·3	1,3	150	9
V13a E88CC	170	1	94†	2	105	3	—	—
V13b	198	6	97	7	105	8	—	—
V14a E88CC	104	1	−5**	2	0	3	—	—
V14b	104	6	−5**	7	0	8	—	—

* 25-volt range ** 100-volt range † 250-volt range

K.H.G. 0562

COMPONENT TABLE: FIG. 7

PAGE 1

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	Y5	Plessey CE17012/1		C50	X18	T.C.C. CP35N/PVC	
C2	X5	Plessey CE17165/13		C51	Y18	T.C.C. CP37N/PVC	
C3	Y3	Plessey CE17027/1		C52	P3	Hunt BM21KV	
C4	Y4	Plessey CE17027/1		C53	S5	Swindon Cond. Co.	
C5	Y3	Plessey CE17027/1				SC555/8LS	
C6	X3	Plessey CE17027/1		C54	M19	Erie N750L	
C7	F3	Hunt B503K		C55	AD8	Erie K7004	
C8	H5	Plessey CE17012/1		C56	AD9	Erie K7004	
C9	J2	T.C.C. SCE74PE/PVC		C57	AD10	Erie K7004	
C10	J2	Hunt B514K		C58	AD11	Erie K7004	
C11	J6	Plessey CE17012/1		C59	AC12	Plessey CE1214	
C12	L2	T.C.C. SCE74PE/PVC		C60	A11	Hunt BM21KV	
C13	L5	Plessey CE17027/1		C61	M5	Erie N750L	
C14	K6	Erie N750K					
C15	M3	Plessey CE824/1		FS1	AD4	Beswick P.O. 36A/1	
C16	N5	Plessey CE824/1		FS2	AD6	Beswick P.O. 36A/1	
C17	C12	Hunt BM15KV					
C18	D12	Hunt BM6KV		L1	Y6	B.B.C. ED.133/CH33	
C19	E14	Hunt BM15KV		L2	Y3	B.B.C. ED.TC/S/25	
C20	F14	Hunt BM15KV		L3	X3	B.B.C. ED.TC/S/25	
C21	H10	T.C.C. CP35N/PVC		L4	O5	B.B.C. EA11827	
C22	J9	T.C.C. SCE76PE/PVC		L5	S11	B.B.C. EA11829	
C23	K12	T.C.C. SCE76PE/PVC		L6	F18	B.B.C. EA11826	
C24	L12	T.C.C. SCE70C/PVC		L7	G18	B.B.C. EA11828	
C25	M10	Oxley A7/·65D		L8	H18	B.B.C. EA11826	
C26	N11	Hunt B500K					
C27	N12	Plessey CE1314		MR1	Z5	B.T.H. GJ5M	
C28	O8	Hunt BM15KV		MR2	Z5	B.T.H. GJ5M	
C29	P14	Hunt BM15KV		MR3	Z5	B.T.H. GJ5M	
C30	Q14	Hunt BM15KV		MR4	Z5	B.T.H. GJ5M	
C31	S12	T.C.C. CSM20N		MR5	AB3	B.T.H. GJ5M	
C32	S12	Mullard E7876		MR6	AB4	B.T.H. GJ5M	
C33	T10	Plessey CE811/1		MR7	W3	B.T.H. VR7-B *	
C34	C17	Hunt B501K		MR8	W4	B.T.H. VR7-B *	
C35	E18	T.C.C. CSM20N	2 (selected)				
C36	F19	T.C.C. CSM20N	2 (selected)	MR9	S4	G.E.C. GEX66	
C37	H18	T.C.C. CSM20N	2 (selected)	MR10	T4	Mullard OA10	
C38	G19	T.C.C. CSM20N	2 (selected)	MR11	J19	— CV425	
C39	J18	Hunt B501K		MR12	U17	— CV448	
C40	K16	T.C.C. SCE76PE/PVC		MR13	X17	— CV448	
C41	K19	Plessey CE17012/1					
C42	L19	T.C.C. SCE76PE/PVC		R1	Z3	Erie 109	2
C43	M17	T.C.C. CSM20N		R2	Z4	Erie 109	2
C44	P17	T.C.C. CP37N/PVC		R3	W3	Erie 108	2
C45	Q19	Hunt B500K		R4	B5	Erie 109	2
C47	T18	T.C.C. CP37N/PVC		R5	B4	Erie 109	2
C48	U18	T.C.C. CP35N/PVC		R6	C5	Erie 109	2
C49	V16	Hunt B513K		R7	C5	Erie 109	2

* Early models fitted with VR9-B

COMPONENT TABLE: FIG. 7

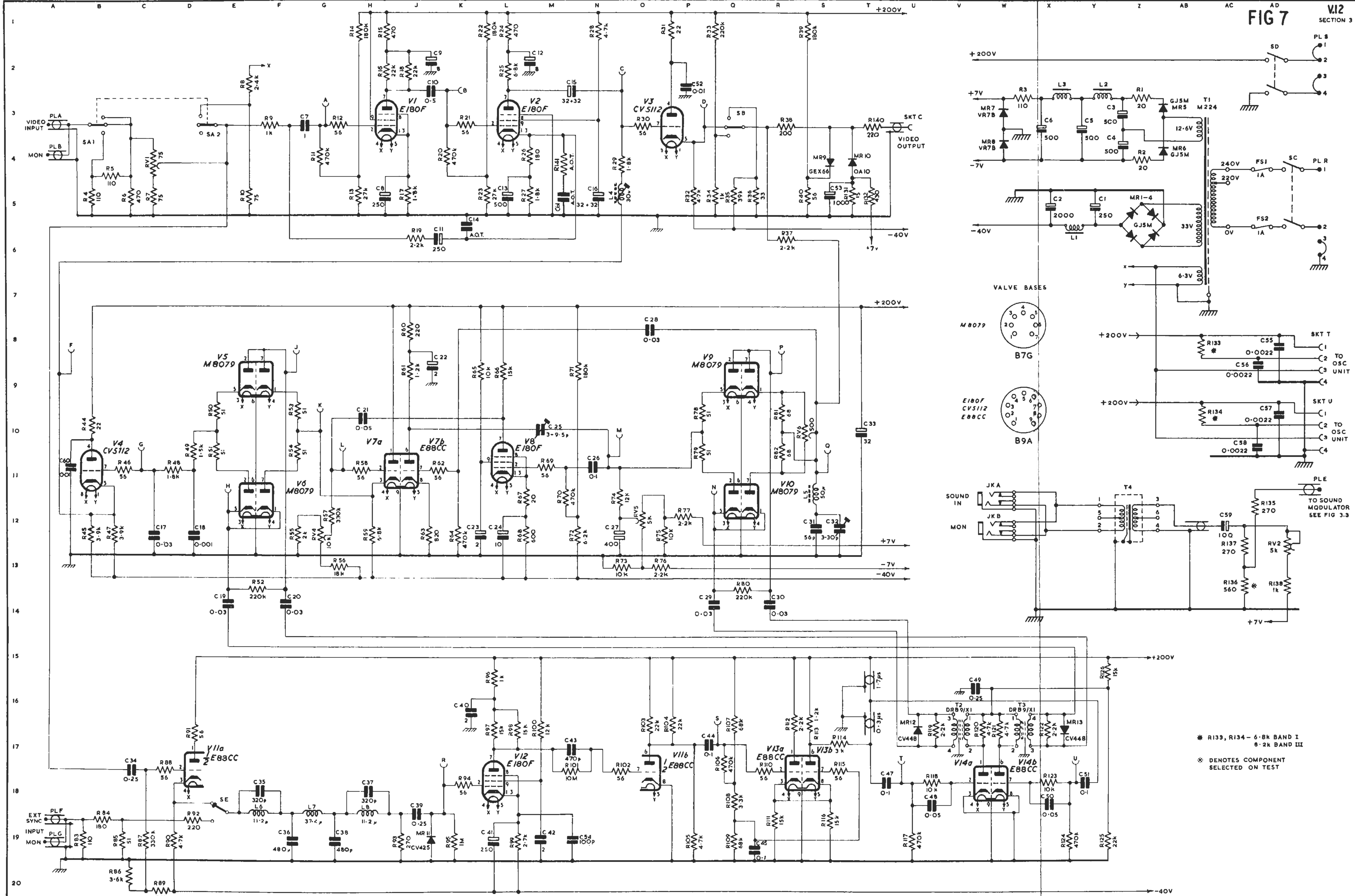
PAGE 2

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
R8	E2	Erie 109	2	R59	H12	Erie 108	2
R9	F3	Erie 109	2	R60	J8	Erie 9	10
R10	E5	Erie 109	2	R61	J9	Erie 9	10
R11	G4	Erie 9	10	R62	J11	Erie 9	10
R12	G3	Erie 9	10	R63	J12	Erie 9	10
R13	H5	Erie 109	2	R64	K12	Erie 9	10
R14	H1	Erie 109	2	R65	K9	Erie 108	2
R15	H1	Erie 9	10	R66	L9	Painton P306A	5
R16	H2	Erie 100	2	R67	L11	Erie 109	2
R17	J5	Erie 108	2	R68	L12	Erie 108	2
R18	J2	Erie 100	2	R69	L11	Erie 9	10
R19	J6	Erie 109	2	R70	M12	Erie 9	10
R20	K4	Erie 9	10	R71	M9	Erie 109	2
R21	K3	Erie 9	10	R72	M12	Erie 109	2
R22	K1	Erie 109	2	R73	N13	Erie 109	2
R23	K5	Erie 109	2	R74	N12	Erie 9	10
R24	L1	Erie 9	10	R75	O12	Erie 109	2
R25	L2	Erie 100	2	R76	O13	Erie 109	2
R26	L4	Erie 109	2	R77	O12	Erie 109	2
R27	L15	Erie 108	2	R78	P10	Erie 109	2
R28	N1	Erie 109	2	R79	P10	Erie 109	2
R29	N4	Erie 109	2	R80	Q13	Erie 9	10
R30	O3	Erie 9	10	R81	R10	Erie 109	2
R31	O1	Erie 9	10	R82	R10	Erie 109	2
R32	P5	Welwyn AWL3111	5	R83	A19	Erie 109	2
R33	Q1	Erie 109	2	R84	B18	Erie 109	2
R34	Q5	Erie 109	2	R85	B19	Erie 109	2
R35	Q5	Erie 109	2	R86	B20	Erie 109	2
R36	Q5	Erie 109	2	R87	C19	Erie 109	2
R37	R6	Erie 109	2	R88	C17	Erie 9	10
R38	R3	Erie 109	2	R89	C20	Erie 109	2
R39	R1	Erie 109	2	R90	C19	Erie 8	10
R40	S5	Erie 109	2	R91	C17	Erie 9	10
R44	A10	Erie 109	2	R92	C18	Erie 109	2
R45	A12	Erie 100	2	R93	H19	Erie 109	2
R46	B11	Erie 9	10	R94	K18	Erie 9	10
R47	B12	Erie 100	2	R95	K19	Erie 9	10
R48	C11	Erie 9	10	R96	L16	Erie 8	10
R49	D10	Erie 9	10	R97	L17	Erie 100	2
R50	D9	Erie 109	2	R98	L17	Erie 100	2
R51	D10	Erie 109	2	R99	L19	Erie 100	2
R52	E13	Erie 9	10	R100	L17	Erie 108	2
R53	F9	Erie 109	2	R101	M17	Erie 9	10
R54	F10	Erie 109	2	R102	N17	Erie 9	10
R55	F12	Erie 109	2	R103	O16	Erie 100	2
R56	G13	Erie 109	2	R104	O17	Erie 100	2
R57	G12	Erie 9	10	R105	P19	Erie 100	2
R58	G11	Erie 9	10	R106	Q17	Erie 9	10

COMPONENT TABLE: FIG. 7

PAGE 3

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
R107	Q16	Erie 109	2	R132	T5	Erie 109	2
R108	Q18	Erie 109	2	R133	AB8	Painton P301A	5
R109	Q19	Erie 109	2	R134	AB10	Painton P301A	5
R110	R17	Erie 9	10	R135	AD12	Erie 8	10
R111	R18	Erie 100	2	R136	AC13	Erie 8	10
R112	R16	Erie 8	10	R137	AC13	Erie 8	10
R113	R16	Erie 108	2	R138	AD14	Erle 8	10
R114	S17	Erie 108	2	R140	T3	Erie 109	2
R115	S18	Erie 9	10	R141	M4	Erie 109	2
R116	S19	Erie 100	2				
R117	U19	Erie 9	10	RV1	C4	Reliance TW/1/8S/W	
R118	U18	Erie 9	10			(Non-inductive)	10
R119	U16	Erie 9	10	RV2	AD13	Morganite LH/WN	20
R120	V16	Erie 9	10	RV4	G12	Morganite LH/WN	20
R121	V16	Erie 9	10	RV5	O12	Morganite LH/WN	20
R122	X16	Erie 9	10	RV6	R10	Morganite LH/WN	20
R123	X18	Erie 9	10				
R124	X19	Erie 9	10	T1	AB5	B.B.C. M244	
R125	Y19	Erie 100	2	T2	V16	B.B.C. DRB91/X1	
R126	Y15	Erie 100	2	T3	W16	B.B.C. DRB91/X1	
R131	T5	Erie 109	2	T4	Z12	B.B.C. LL/106SA	



WIDE-BAND MODULATOR MD2/502 : VIDEO AMPLIFIER AND FEEDBACK CLAMP

MD2/502 AMPR AND CLAMP