AWA 3A56068 Distortion & Noise Meter

S.N. 451. April 2023

TR1	5TW6206			
TR2	1TX60180; 570Ω 0-220 sec;			
V1	EF86	Telefunken		
V2	EF86	Telefunken		
V3	EF86	Philips	8Y4 D3A2	
V4	EF86	Philips	8Y4 D3A2	
V5	6AN8A	RCA		
Caps	Ducon cans		174, 174, 174, 174	
	Ducon axial		184	
	UCC can		2564, 2564	
	Mustards		D 3W, D 3W, 044H, 044H, D1, D2N	
	Vane		18682 ,	
Pots	Colvern CLR		PLS 003/413	
Resistors		IRC	6423, 6418,	
		Welwyn		5905-99 021-6832

Issues: C32, C33 rely on clamp band for ground. Chassis used for power supply 0V rectifier and B+ filtering. 1 bad and 1 poor 1N3195 diodes in bridge. No bleed resistance for B+. V5 6AN8 with leaky grids. CRO output is effectively floating, and no nearby gnd terminal. Jittery RV3 wiper. No socket for external measurement of notch filter output – still need access to top of chassis for adjustments.

Differences: Humdinger RV8 wiper taken to chassis via 47k//1M, and via 0.47uF 400V mustard to mains protective earth (which is floating and goes to TR2 earth screen (check) – as per 1A56068 schematic.

Dating appears to be manufactured abt 1964-5. JKA = Hi input ; JKB = Lo input.

<u>Testing:</u>

- E-cap reforming:
  C32 100uF 350V; 122uF 1.8Ω 100Hz <95uA 335V   *
  C33 100uF 350V; 124uF 0.56Ω 100Hz <75uA 335V
  C2 16uF 450V; 20uF 2.9Ω 100Hz <70uA 440V
  C18 16uF 450V; 18.9uF 2.8Ω 100Hz <70uA 440V
  C31 16uF 450V; 20.0uF 2.9Ω 100Hz <90uA 440V
  C14 16uF 450V; 19.1uF 2.8Ω 100Hz <65uA 440V
  C6 16uF 450V; 22uF 4.5Ω 100Hz <90uA 430V
  C15 16uF 450V; 20uF 8.5Ω 100Hz <80uA 430V   *
  C16 8uF 300V; 8.7uF 7.5Ω 100Hz < 35uA 290V
- Replaced C20, C26, C27, C28 with 100uF 16V.
- Mains earth and IR ok (>2G at 1kVdc).
- Replaced rectifier diodes with UF4007 and modified 0V wiring.

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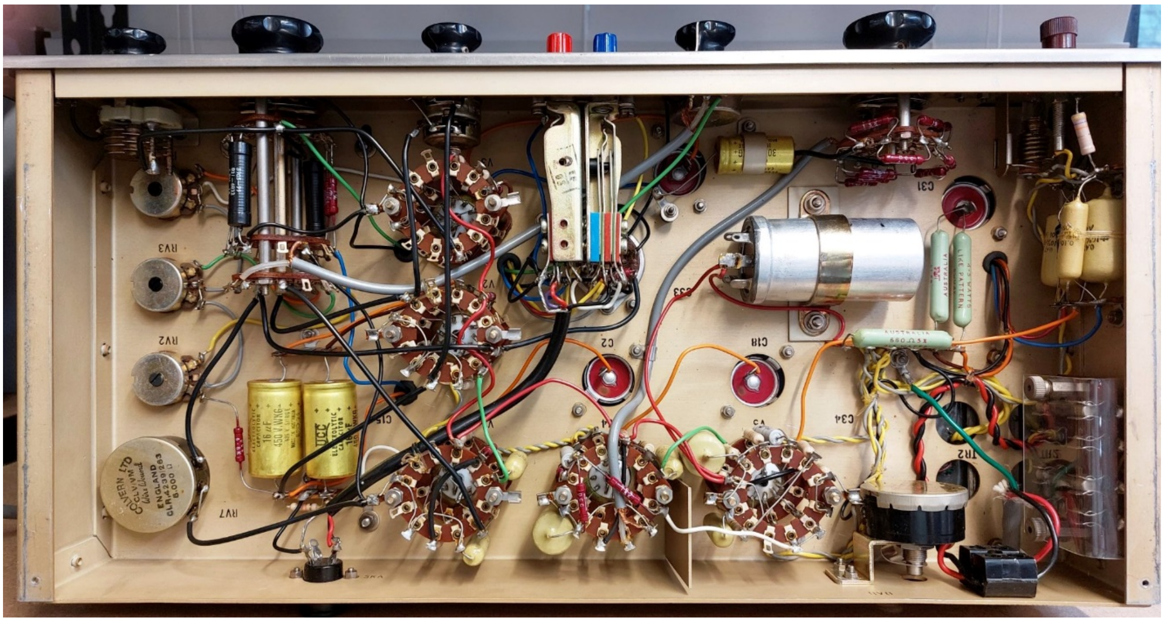
- Added 56kΩ PRO2 across C33 (3.6mA @ 200V) as bleed.
- Changed to 250V primary tap with Belling-Lee 1A 3AG fuses. No valves: 7.5Vac, 266V B+. All valves: 6.5Vac, 172V B+ (8.8mA loading due to 6AN8).
- Changed to PT secondary +10% Red. Swapped out 6AN8. 230Vdc overshoot on power up; 196V B+, 6V R61 = 8.8mA B+ load. V1/6=160V; V2/1=120V; V3/1=122V; V4/6=126V; V5/6=108V; V5/1=80V. Some noisy readings.
- Added 1MΩ load to CRO terminal.
- Noisy V4 and V5 stages. Shorted the C17 input to V4, but then just removed V4 and V5 – perhaps also removed noise on B+.
- Signal level after C16 reduces by 10dB for each resistor step. Distortion in CAL is <0.005% (ie. V1 amp only, with V2, notch, V3 bypassed) with 0.1M unbal input and 180mVrms output at top of atten. H3 increases a bit with Unbal bridging.
- REW and EMU-0404 via 10:1 probe across SWC/C16 attenuator to measure noise floor and spectrum of signal via CAL or notch setting of SWB, with CAL signal level adjust. 1kHz test tone from EMU-0404 unbalanced headphone with HD's <0.005% in to rear panel 4-pin socket. Coherent averaging used for better discrimination of harmonic distortion levels. Tone 1kHz frequency locked to RTA FFT.
- Distortion with notch cct in is ~0.3 to 0.4% 2nd and 3rd harmonics, but rises with signal level to >1%; ~60mVrms on top of atten for 0.3-0.4% H2 (20mVrms for <0.1%).
- REW frequency spectrum with notch tweaked to 1kHz gives about -12 to -13dB depth. REW confirms 1000Hz.
- Removing V4 and V5 raises B+ to ~ 234Vdc.
- Noisy CAL pot - cleaned.
- Better matching of R13 to R17 improved notch depth to ~-15dB (padded R17 with series 18k+1k8). Further careful adjustments of RV3, C8, C12, C10 (Δf), and RV6A (R) can suppress 1kHz fundamental to -65 to -70dB (it's a bit jittery below -65dB and depends on max signal level). Fundamental can be suppressed to same or just below H2 and H3, but depends on cal signal level due to added distortion from notch amp circuitry as H2 and H3 increase about 15-20dB when in distortion mode.
- RV3 appears to be unstable - sprayed and then better – still to do RV2 and RV4.
- Hum reduction with RV8 best done in distortion mode by observing 100Hz sidebands on 1kHz signal – hum 100Hz levels suppressed to at or below spectrum noise floor.

<u>To do:</u>

- Possible increasing HD levels with signal level through notch filter – replace C6 and C15 with poly caps (lower leakage) and compare.
- Matching of R14/R16, R13/R17, R12/R18 – just used fixed resistors for series padding to achieve better than 0.02% matching (4-digit discrimination), and clean around switch terminals to minimise leakage noise, and clean RV2 and RV4 wipers/tracks.
- Add chassis top connection (2 terminals) for external connection of 10:1 scope probe for spectrum analyser measurement of notch filter output.
- Add in V4 and V5 and roll V4 to see influence.

Nominal photos from another unit:

AWA 3A56068 Distortion & Noise Meter



dalmura.com.au/projects

DISTORTION AND NOISE METER

TYPE 3A56068

HANDBOOK 2-56068R
Issue 2

Amalgamated Wireless (Australasia) Limited,

47 York Street,

SYDNEY.

041065

1. BRIEF DESCRIPTION

1.1 Application

The A.W.A. Distortion and Noise Meter type 3A56068 is suitable for the measurement of total waveform distortion, noise and/or hum voltages in all audio frequency circuits. It is useful as a level indicator, and may be used as a selective frequency measuring device.

When used with a suitable broadcast station monitor, such as A.W.A. Amplitude Modulation Monitor type 2A51926, overall performance tests can be carried out on the audio frequency characteristics of broadcast type transmitters.

The selective frequency range is continuously variable from 25 c/s to 25 kc/s in three steps, and the meter scale is calibrated for volume levels (dbm), noise levels (db), and distortion (%).

The instrument can be supplied for mounting in a standard 19 in. equipment rack, or in a cabinet for portable use.

1.2 Design Summary

The instrument consists essentially of an amplifier, a frequency selective network followed by a calibrated step attenuator, and a high-gain valve voltmeter.

The audio frequency signal to be measured is applied to the input and the reference level is set by the calibration control. The frequency selective network is then switched into circuit. This network has incorporated in it a continuously variable R.C. filter system which, when balanced, completely eliminates the fundamental frequency voltage and passes all frequencies that are spaced more than one octave away from the fundamental. After elimination of the fundamental, the remaining voltage, consisting of all frequencies that are multiples of the fundamental, together with noise and hum, is applied to the calibrated voltmeter and compared with the initial reference voltage. The ratio of these readings, when expressed as a percentage, gives the distortion factor of the signal being measured. As the gain of the voltmeter section can be varied by 50 db., full scale distortion factor readings as low as 0.3% can be measured.

Audio frequency noise voltages are measured with the frequency determining network out of circuit, and as the gain of the amplifier can be varied by 70 db., full scale readings of noise voltages down to -70 db can be read on the calibrated scale of the meter.

Audio signal levels can be measured with reference to 1mW in 600Ω.

1.3 Performance Data

(a) Distortion Measurement

Distortion Range:	Distortion is indicated by an average-reading meter. Five ranges are provided for full scale readings of 0.3, 1.0, 3.0, 10 and 30%.
Fundamental Frequency Range:	25 c/s to 25 kc/s, covered in three ranges.
Input Impedance:	0.1 MΩ unbalanced and 600 Ω bridging, both balanced and unbalanced. Bridging loss is less than 0.25 db.
Harmonic Response: (0.1 MΩ input)	Within 1 db at 2nd harmonic (with respect to CAL & NOISE position) up to 5 kc/s fundamental, improving at 3rd harmonic.
	Within 2 db at 2nd harmonic for 5 kc/s to 25 kc/s fundamental.
Residual Distortion:	Not exceeding 0.15% in the range 50 c/s to 10 kc/s, rising to not more than 0.3% outside this range.
Input Voltages:	0.1 MΩ input: 0.5 to 25V r.m.s. Bridging inputs: 0.5 to 8V r.m.s.

(b) Noise and Audio Signal Level Measurement

Meter Ranges:	
Noise Level Measurement:	0 to -85 db.
Signal Level Measurement:	+20 to -50 dbm.
Accuracy of Measurement:	±5% of full scale for sine waves.
Input Impedance:	As for Distortion Measurement.
Frequency Response:	
0.1 MΩ Input:	Within 3 db from 25 c/s to 200 kc/s.
Bridging Input:	±0.25 db from 50 c/s to 20 kc/s. ±1.0 db from 25 c/s to 25 kc/s.
Residual Noise:	15 db below full scale on the most sensitive range.

(c) Power Requirements

The instrument operates from a supply of 220 to 250V., 50 c/s. The power consumption is less than 20 watts.

(d) Valve Complement

Type	Quantity
* EF86	4
6AN8	1

* EF86 valve used in V1 must be Telefunken brand to minimise noise.

1.4 Mechanical Construction

The unit is constructed on a chassis, which is attached to the front panel to form a complete assembly. The ends of the chassis extend to the full height of the front panel, and are flanged to take top and bottom covers when the instrument is mounted in a rack. The top cover is secured by two quick-release fasteners, and the bottom cover by two 5BA screws. When the covers are in place, the instrument is totally screened. In the portable unit, a metal case is provided, and the covers are not required.

Each valve socket is mounted on a plate which carries a component assembly: the complete sub-assembly, consisting of the valve, socket and components associated with it, may be removed (after unsoldering the connecting wires) by releasing the two securing nuts.

The preset potentiometers for the dbm. adjustment (RV7) and the frequency ranges (RV2, RV3 and RV4) are mounted on the chassis at the left-hand side, and are accessible from the top. The hum adjustment potentiometer (RV8) is mounted on the back of the chassis and is accessible from the rear.

The mains fuses are under a protective cover beneath the right-hand end of the chassis.

The dimensions of the instrument are as follows:-

	Rack Mounting	Portable
Height:	7 in.	9.1/4 in.
Width:	19 in.	20.1/2 in.
Depth:	8 in.	9.1/2 in.
Weight:	15 lb.	24 lb.

2. INSTALLATION

2.1 Location

The instrument should not be installed or used in close proximity to any other unit or component with a strong magnetic field.

2.2 Valves and Fuses

When the instrument is first received, it should be inspected to check that the valves are firmly in place, and that the fuses are in the correct clips to suit the mains voltage being used (refer 2.4 below). The position of the valves may be checked by the stencilling on the chassis.

2.3 Removal from Case

(a) Portable Unit

1. Remove the two 1/4 in. Whitworth screws from each side of the front panel.
2. Slide the unit free of the case, threading the power cable through from the rear.
3. When replacing the case, check that the power cable does not become kinked inside.

(b) Rack Mounting Unit

1. To remove the top cover, turn the fasteners through one-quarter turn; the cover may then be withdrawn.
2. To remove the bottom cover, release the two screws underneath the ends of the chassis and slide the cover backwards.
3. The unit is secured to the rack by two 1/4 in. Whitworth screws at each end of the front panel.

2.4 Adjustment for Mains Supply Voltage

Adjustment of the tappings of the rectifier transformer primary is made by inserting the fuses in the appropriate clips, as shown on the circuit diagram, Drg. 56068H1.

The fuse arrangements for various voltages are as follows: -

Mains Voltage	FS1	FS2
220	220	0
230	220	10

Mains Voltage	FS1	FS2
240	240	0
250	240	10

2.5 Input Connections

The input connections may be made to jacks or terminals on the front panel, or to a plug and socket at the rear. This latter connection is useful in rack-mounted applications, where a semi-permanent connection is required. Note that the input from the plug is disconnected when the input jacks are used, but not when the terminals only are used.

The input jacks accommodate either:-

(a) Single tip-ring-sleeve patch plug in left side jack to make HIGH connection via tip.

OR(b) Single tip-ring-sleeve patch plug in right side jack to make HIGH connection via ring.

OR(c) Double carrier patch plug to make HIGH connection via tip in left side jack and LOW connection via tip in right side jack.

For the connection at the rear, a plug is supplied: the input should be wired to contacts 3 and 4, and contact 1 used for earthing the screening braid.

2.6 Earth Connection

When the rack-mounting type instrument is used, care should be taken that good earthing is achieved. The front panel should make good metallic contact with the rack, and the chassis should be bonded to the rack earth bus.

3. OPERATION

3.1 Setting Up

Set the mechanical zero of the meter. Connect the instrument to the mains supply, switch on and note that the pilot lamp is illuminated. Allow at least five minutes warm-up period to ensure accurate results.

Under very humid conditions the length of warm-up period required to bring the balance of the frequency selective amplifier back within the range of the "R" control may be considerably longer, particularly on the lowest frequency range. A coarse R control is provided in the form of a preset adjustment accessible by screwdriver through a hole in the "R" control knob.

NOTE: To avoid erroneous results make sure that there is no pick-up from strong magnetic fields in the vicinity of the instrument.

3.2 Audio Frequency Source

When making distortion and noise measurements on an amplifier or other equipment, an audio frequency source is required for feeding the unit under test. This source must be substantially free from distortion, noise and hum, particularly when low values are being measured. An instrument suitable for this purpose is the A. W. A. Low Distortion Oscillator type 1A57321.

CAUTION: The socket at the rear and the terminals on the front panel are wired in parallel. When using either connection, take care that undesired inputs are not connected to the other.

3.3 Distortion Measurements

1. Connect the audio frequency source to the input terminals of the unit under test, and set to the required frequency. Connect the output of the unit to whichever input terminals are convenient on the distortion and noise meter. Adjust the signal to give the desired output level from the unit under test. It will generally be necessary to terminate this output with a suitable load resistor, which is then bridged by the distortion meter. The input level to the 600 Ω circuit should not exceed 1V when working below 50 c/s and measuring very low distortion levels.

2. Select one of the three input-impedance arrangements to suit the output of the unit under test.

3. Set the range switch to CAL & NOISE, and the meter switch to 100%. Adjust the CAL control until the meter reads full scale.

4. Set the range switch to the required range and the FREQUENCY dial to the same nominal frequency as the external oscillator.

5. Vary the FREQUENCY dial about the nominal setting, and at the same time adjust the R control, until the meter shows an absolute minimum reading. If a minimum cannot be obtained within the range of the "R" control (RV6A), adjust the preset "R" control (RV6B) by means of a screwdriver through the hole in the knob of the "R" control. The meter range switch should be changed as required to obtain a conveniently readable deflection. The Δ F control provides a vernier adjustment of frequency, but its use is not required except when measuring very low values of distortion.

   It will be appreciated, however, that the reading of a bridgetype meter, although calibrated in r.m.s. values, is proportional to the average value of the residual components. The error due to this is small except when two or more harmonics predominate and are of similar amplitude. If in this particular case, the highest possible accuracy is required, an external r.m.s. reading voltmeter should be used, connected to the C.R.O. terminal.

6. The meter reading finally obtained is the total harmonic distortion (plus noise) registered directly as a percentage on the scale.

3.4 Noise Measurements

1. Calibrate the instrument with a signal input to the unit under test, as described in steps 1 to 3 of sub-section 3.3 above.

2. Leave the range switch in the CAL & NOISE position, and remove the input signal. It is usual to then terminate the input of the unit under test by a resistance equivalent to the generator circuit impedance.

3. Increase the meter sensitivity by turning the meter switch clockwise until a convenient deflection is obtained. The arithmetic sum of the meter reading in db. and the switch position in db. is the voltage ratio between the noise and the initial signal. For convenience in reading, the noise figures are engraved in red, to distinguish them from the volume level figures, which are in black.

3.5 Audio Signal Level Measurements

NOTE: 0 dbm = 1 mW. in 600 Ω = 0.775V. across 600 Ω.

1. Turn the range switch to the dbm. position.

2. The level in a 600 Ω circuit carrying a steady tone sine wave may be measured directly in dbm. by turning the meter switch to the appropriate position. The signal level will be indicated by the arithmetical sum of the meter reading and the switch position.

3.6 <u>Use with Modulation Monitor</u>

1. Connect the output of the modulation monitor to the input of the instrument. A special cable is provided with the A.W.A. Modulation Monitor series A51926 to match the 4-pin connector at the rear of the unit.

2. Turn the input switch to the 0.1 M-Ω UNBAL. position.

3. When the transmitter is modulated by a suitable audio oscillator (see 3.2 above) the audio characteristics of the transmitter signal may be checked for noise and distortion as previously described.

4. TECHNICAL DESCRIPTION

4.1 Input Switching

The input is switched by SWA to the primary of TR1, for the 600 Ω connections, with one side earthed for the unbalanced condition. For the high impedance input, the signal is connected directly to the grid circuit via the potentiometer RV1 (CAL.). The CAL. control is essentially a gain control and is used for all measurements except audio signal level (dbm). For level measurements, the gain is preset by RV7, (dbm. ADJ.) for the standard reference level.

4.2 Amplifier

This section consists of a two-stage amplifier (V1 and V2), coupled via an R.C. filter network to a third amplifier stage (V3). The network is a Wien type bridge, with two resistive arms and two reactive arms which determine the rejection frequency by means of the ganged capacitors and switched resistors for the three ranges. One of the resistive arms is made variable to form the R control, which is used for balance. A small variable capacitor is used as a vernier adjustment of frequency. This is the △ F control (C10) across the lower reactive arm. The manipulation of these controls enables the fundamental to be completely suppressed, leaving only the distortion and noise products to be measured.

The feedback applied to the first two stages reduces the residual noise and distortion in this section: the overall feedback network (R28, C15) has the effect of sharpening the attenuation of the rejection circuit, and allows the amplifier to give approximately unity gain at all frequencies differing by an octave or more from the fundamental.

4.3 Voltmeter

The amplifier output is fed via the meter range potentiometer (SWC and R29 to R38) to a sensitive valve voltmeter. This consists of two pentode amplifiers followed by a triode output stage feeding the bridge rectifier meter. Approximately 16 db of feedback is used to keep the response flat.

The unrectified output is available at a terminal designated C.R.O. on the front panel. This enables the residual noise and distortion to be visually monitored.

4.4 Power Supply

The H.T. supply is derived from a bridge-connected silicon rectifier circuit fed by mains transformer TR2, which also supplies the valve heaters from a common 6.3V winding.

The transformer is tapped on the primary side to accommodate supply voltages between 220 and 250. The d.c. output of the rectifiers is filtered by a pi-network consisting of R58, R59, R61 and C31, C32, C33.

A balance control (RV8) is provided to allow optimum hum reduction to be achieved.

5. MAINTENANCE

5.1 General

The equipment has been carefully aligned and adjusted prior to delivery, and normal maintenance should be confined strictly to cleaning, and the lubrication of switches, when necessary, following the procedure given below.

PRESET CONTROLS SHOULD NOT BE DISTURBED WITHOUT GOOD REASON, and then only if the proper instruments are available for making the tests described in sub-section 5.3.

The circuit is not critical of valve replacement, and no special precautions need be taken in the selection of valves, other than to check that no excessive residual noise is produced.

5.2 Mechanical

The wafer-type switches may be cleaned when necessary with carbon tetrachloride, applied sparingly to the contacts only, by means of a fine pointed brush. The contacts may afterwards be lubricated with a very small quantity of Servisol, or other approved switch lubricant. If the movement becomes stiff, a drop of light machine oil may be applied to the spindle bearing and clicker plate.

The units in the ganged capacitor should be in alignment mechanically, and the couplings tight. The pointer should be on the end mark below the 25 c/s calibration point when the gang is fully meshed.

5.3 Electrical

5.3.1 Test Instruments Required

(a) A.W.A. Low Distortion Oscillator 1A57321 (or equivalent).

(b) 600 Ω T-pad attenuator of known accuracy.

(c) Accurate A.C. voltmeter to read 2.45V ±2% at 1000 c/s.

(d) A.W.A. Voltohmyst A56010 or 1A56074 (or equivalent).

5.3.2 Noise Tests

NOTE: Both top and bottom covers must be in place, or in the case of the portable instrument, the unit must be in its case.

1. Set the range switch (SWB) to the CAL. & NOISE position, the input switch (SWA) to the 0.1 M-Ω position, and the meter switch (SWC) to the 0 db. position.

2. Set the CAL. control to minimum (fully anti-clockwise). The meter pointer should not read up scale by more than 1/16 in. approximately from zero.

3. Set the meter attenuator switch to the -70 db. position. The meter reading should be at least 16 db. below the full scale reading of the meter.

4. Turn SWB to the X1 position and the frequency dial to 50 c/s. Adjust the hum control RV8 at the rear of the chassis for minimum meter deflection, with the attenuator still set to -70 db.

5.3.3 Level Calibration

1. Set the range switch to the dbm. position, and input switch to 600 Ω UNBAL.

2. Set the audio oscillator to 1000 c/s and its output to 600 Ω unbalanced. Connect it to the distortion and noise meter via the 600 Ω pad.

3. Set the pad to 0 db. and the meter switch to +10 dbm.

4. Connect the A.C. voltmeter across the output of the oscillator and adjust the output control to give a reading of 2.45V. ±2%.

5. By means of the preset potentiometer RV7, set the pointer on the meter of the distortion and noise meter to exactly full scale.

5.3.4 Network Alignment

(a) Set-up

1. Screw on the bottom cover, and replace top cover as far as possible consistent with access to the preset adjustments.

2. Set the input switch SWA to the 0.1 M-Ω position and the range switch to the CAL. position.

3. Set the meter switch SWC to the 100% position and the CAL. control to maximum.

4. Set the FREQUENCY dial to 25 c/s, and the △ F and R controls to their mean positions (pointers vertical).

5. Set the preset controls RV2, RV3, RV6B and RV4 also to their approximate mean positions.

6. Connect the audio oscillator to the input jacks or terminals, using the high impedance output from the oscillator. Set the frequency to 250 c/s and adjust the output level to give full scale deflection on the distortion and noise meter.

(b) Alignment

1. Turn the range switch SWB to the X10 position and adjust the main frequency dial in conjunction with RV3 until an absolute minimum reading is obtained. It is important that neither the Δ F or the R control be touched during this operation. It is also essential that the main frequency dial and RV3 be adjusted alternately until an irreducible minimum is obtained, altering the setting of the attenuator as required to keep a readable deflection on the meter.

2. Set the oscillator to 2500 c/s and the FREQUENCY dial to 250 c/s, then, still using the X10 position, adjust trimmers C8 and C12 alternately until minimum deflection is obtained.

3. Re-set the oscillator frequency to 250 c/s, and the FREQUENCY dial to 25 c/s. Re-set RV3 for minimum deflection.

4. Repeat step 2, and then step 3, alternately until the alignment is accurate at both ends of the band.

5. As a check on the accuracy of alignment, tune for minimum deflection at both ends, using the FREQUENCY dial and R control only. The R control should not require to be moved from its centre position by more than ±45°, and the residual readings on the meter should be in the order of 0.12%.

6. Change the RANGE switch to X1 and check at 25 c/s, 100 c/s and 250 c/s for adequate range of R control. If necessary, reset RV4.

7. Change the RANGE switch to X100 and check at 2.5 kc/s, 10 kc/s and 25 kc/s for adequate range of R control. If necessary, reset RV2.

5.3.5 Voltages

The following voltages were measured with respect to earth using a Voltohmyst. These are typical figures, and may vary by ±15% due to commercial tolerances in valves and resistors.

Valve	Pin Number 1	3	6	7	8	9
V1	135	3.5	180	-	3.5	-
V2	160	3.5	160	-	3.5	-
V3	125	3.0	125	-	3.0	-
V4	120	3.0	135	-	3.0	-
V5	75	3.0	80	80	-	2.0

H.T.	MR1/MR4	C31	C32	C33
	270	210	205	200

6. COMPONENT SCHEDULE

When ordering replacement parts, please quote ALL details given below for a particular component, TOGETHER WITH the type number of the unit and the circuit reference of the component.

The component supplied against the order may not be identical with the original item in the equipment but will be a satisfactory replacement differing in only minor mechanical or electrical details; such differences will not impair the operation of the equipment.

Many resistors and capacitors in the component schedule have been described in terms of style (resistors) and manufacturer's reference (capacitors). For full details of the components so described, reference should be made to Forms 6000-A760 and 6000-A761, respectively. These Forms will be found at the end of this Section.

Circuit Ref. No.		Description	Manufacturer's Ref. No.
(a)	Capacitors		
C1	0.22μF		Philips C296AC
C2	16μF	-10+50%, 450VW, electro., tub. met. case	Ducon EE
C3	0.1μF		Philips C296AA
C4	0.1μF		Philips C296AA
C5	Not used		
C6	16μF	-10+50%, 450VW, electro., tub. met. case	Ducon ET
C7	24-880pF	var., part of 2-gang capacitor C7/C13	AWA Pt. 18682
C8	4-25pF	var., trimmer, concentric	Philips 82755/25E
C9	47pF		Ducon CTR. NPO
C10	3-10pF	variable, rotary, CVA50	5910-Z160015
C11	15pF		Ducon CTR. NPO
C12	4-25 pF	variable, trimmer, concentric	Philips 82755/25E
C13	24-880pF	var., part of 2-gang capacitor C7/C13	
C14	16μF	-10+50%, 450VW, electro., tub.met.case	Ducon EE
C15	16μF	-10+50%, 450VW, electro., tub.met.case	Ducon ET
C16	8μF	-10+50%, 300VW, electro., tub.met.case	Ducon ET2C
C17	.047μF		Philips C296AA
C18	16μF	-10+50%, 450VW, electro., tub.met.case	Ducon EE
C19	0.1μF		Philips C296AC
C20	64μF	-10+50%, 6VW, electro., sub-miniature	Ducon EUO402

C21	0.47μF	Philips C296AC
C22	0.1μF	Philips C296AC
C23	0.47μF	Philips C296AC
C24	0.47μF	Philips C296AC
C25	0.47μF	Philips C296AC
C26	64μF -10+50%, 6VW, electro., sub-miniature	Ducon EU0402
C27	64μF -10+50%, 6VW, electro., sub-miniature	Ducon EU0402
C28	80μF -10+50%, 3VW, electro., sub-miniature	Ducon EU0401
C29	Not used	
C30	0.1μF	Philips C296AC
C31	16μF -10+50%, 450VW, electro., tub. met. case	Ducon EE
C32	100μF 350VW, electro., tub. met. case	UCC type EMB
C33	100μF 350VW, electro., tub. met. case	UCC type EMB

(b) <u>Rectifiers</u>

MR1	Silicon diode	1N3195/RAS310AF
MR2	Germanium diode	OA160
MR3	Germanium diode	OA160
MR4	Silicon diode	1N3195/RAS310AF
MR5	Silicon diode	1N3195 "
MR6	Silicon diode	1N3195 "

(c) <u>Resistors</u>

R1	68kΩ style RC2-E	
R2	Not used	
R3	22kΩ ±5%, 1/2W, carbon film	Philips B8-305-06
R4	100kΩ style RC2-E	
R5	39kΩ style RC2-E	
R6	390kΩ ±5%, 1/2W, carbon film	Philips B8-305-06
R7	15kΩ ±5%, 1/4W, carbon film	Philips B8-305-05
R8	470kΩ ±5%, 1/2W, carbon film	Philips B8-305-06
R9	27kΩ style RC2-E	
R10	Not used	
R11	470Ω ±5%, 1/4W, carbon film	Philips B8-305-05
R12	6.8MΩ ±1%, 1W, carbon film	Welwyn C24
R13	680Ω ±1%, 1/4W, carbon film, grade 1	IRC type DCC
R14	68kΩ ±1%, 1/4W, carbon film, grade 1	IRC type DCC
R15	Not used	

R16	68kΩ	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R17	680kΩ	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R18	6.8MΩ	±1%, 1W, carbon film	Welwyn C24
R19	33kΩ	±5%, 1/4W, carbon film	Philips B8-305-05
R20	Not used		
R21	6.8kΩ	style RC2-E	
R22	2.2kΩ	style RC2-E	
R23	Not used		
R24	Not used		
R25	Not used		
R26	22kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R27	39kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R28	10kΩ	style RC2-E	
R29	15kΩ	style RC2-E	
R30	Not used		
R31	4.7kΩ	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R32	1.5kΩ	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R33	470Ω	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R34	150Ω	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R35	Not used		
R36	47Ω	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R37	15Ω	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R38	10Ω	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R39	22Ω	±1%, 1/4W, carbon film, grade 1	IRC type DCC
R40	Not used		
R41	470kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R42	22kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R43	100kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R44	4.7kΩ	style RC2-E	
R45	100Ω	style RC2-E	
R46	390kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R47	1MΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R48	100kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R49	1kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R50	Not used		
R51	390kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R52	15kΩ	style RC2-E	
R53	1MΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R54	47kΩ	±5%, 1/2W, carbon film	Philips B8-305-06
R55	47Ω	style RC2-E	

R56	1kΩ ±5%, 1/2W, carbon film	Philips B8-305-06
R57	2.2kΩ style RC2-E	
R58	4.7kΩ style RWV4-K	
R59	680Ω style RWV4-K	
R60	Not used	
R61	680Ω style RWV4-K	
R62	Not used	
R63	Not used	
R64	Not used	
R65	Not used	
R66	47kΩ ±5%, 1/2W, carbon film	Philips B8-305-06
RV1	100kΩ ±20%, 1W, comp., rotary log. law, ¾in. shaft, no flat.	Plessey E
RV2	100kΩ ±20%, 1/8W, comp., rotary, log. law	Ducon PTU
RV3	100kΩ ±20%, 1/8W, comp., rotary, log. law	Ducon PTU
RV4	100kΩ ±20%, 1/8W, comp., rotary, log. law	Ducon PTU
RV5	Not used	
RV6	Var., concentric; front sect. (RV6A) 5 kΩ, driven by shaft; rear sect. (RV6B) 25 kΩ, s/driver slot; linear law.	IRC type HMC
RV7	5kΩ ±10%, 1W, w-w, rotary, linear law	Colvern CLR4239/263
RV8	250Ω ±10%, 1W, w-w, rotary, linear law	Colvern CLR4239/263
(d)	Sockets	
V1	9-pin, miniature, P.T.F.E.	Clix VH499/902CPS
V2	9-pin, miniature, P.T.F.E.	Clix VH499/902CPS
V3	9-pin, miniature, P.T.F.E.	Clix VH499/902CPS
V4	9-pin, miniature, P.T.F.E.	Clix VH499/902CPS
V5	9-pin, miniature, P.T.F.E.	Clix VH499/902CPS
(e)	Switches	
SWA	Oak H type	AWA 56068V129
SWB	Oak H type	AWA 56068V130
SWC	Oak H type	AWA 56068V131
(f)	Transformers	
TR1		AWA 5TW8206
TR2		AWA 1TX60180

(g) Miscellaneous

PLA	Plug, 4-pin, male contact, speaker	Teletron
PLB	Plug, 3-pin, male contact	Ringrip 53
SKA	Socket, 4-pin, female contact, speaker	Teletron
FS1	Fuse, glass cartridge, loaded 1A	Belling Lee L1055
FS2	Fuse, glass cartridge, loaded 1A	Belling Lee L1055
JKA	Jack, tip-ring-sleeve, special	Transmission Products TP1120
JKB	Jack, tip-ring-sleeve, special	Transmission Products TP1120
M1	Multimeter, moving coil 215μA movement, 750Ω resistance, Master PT35	AWA 56068V124
	Terminal, black, insulated	Gallard 2C
	Terminal, red, insulated	Gallard 2C
LP1	Lamp, 6.3V, 0.25A, tub., M.E.S. base	AWA code 428105

DATA ON RESISTORS

Composition and wire-wound vitreous enamelled resistors described by the "style" nomenclature are made by various manufacturers to RCS standards, except where marked *. Resistances available are shown where each manufacturer does not make the complete range. Wattage ratings are for 70°C ambient. Non-standard tolerances, where used, are specified in the Component Schedule.

COMPOSITION RESISTORS

STYLE	DESCRIPTION	MANUFACTURER	RANGE (ohms)
RC2-B	grade 1, ±5%, 1W	IRC type DCG	120-1M
		Welwyn C24	all
		Painton 75	10-3.9M
RC2-C	grade 1, ±5%, 3/4W	IRC type DCE	120-1M
		Welwyn C23	all
		Painton 74	10-1.8M
RC2-E	grade 1, ±5%, 1/4W	IRC type DCC	100-1M
		Welwyn C21	all
		Painton 72	10-100k
RC7-H	grade 2, ±10%, 1/2W	IRC type BTA	all
		Erie 8	all
		Morganite AY	all
RC7-J	grade 2, ±10%, 1/4W	Erie 9	10-680
RC7-K	grade 2, ±10%, 1/4W	Erie 16	all
		IRC type BTS	390-820k
RC7-M	grade 2, ±10%, 3/4W	IRC type BTB	all
RC20	grade 2, ±10%, 1/2W	Ducon RMB	all
RC32	grade 2, ±10%, 1W	Ducon RMC	all

WIRE-WOUND RESISTORS, VITREOUS ENAMEL COATED

Tolerance on all these resistors is ±10% up to and including 47 Ω; ±5% above 47 Ω. RWV3, 4, 5 have wire terminations; RWV1 has ferrule terminations.

STYLE	RATING	DUCON	I.R.C.	MANUFACTURER WELWYN	PAINTON	ERG.
RWV3-J	1.1/2W	RWV3-J		AW3101	MV1A	74BW
RWV4-J	3W	RWV4-J	RWV4-J	AW3115	306A	58AV
RWV4-K	4.1/2W	RWV4-K	RWV4-K	AW3111	301A	16AV
RWV4-L	6W	RWV4-L	RWV4-L	AW3112	302A	17AV
*RWV5-J	10W	RWV5-J (10-1.5kΩ)				
*RWV5-K	15W	RWV5-K				
*RWV1-J	10W	RWV1-J				
*RWV1-K	15W	RWV1-K				
*RWV1-L	30W	RWV1-L				
*RWV1-M	45W					
*RWV1-N	70W			C46 (10-22Ω)	P2006F (10-22Ω)	
*RWV1-P	100W			C47 (10-47Ω)	P2007F (10-47Ω)	

PHILIPS CARBON FILM RESISTORS SERIES B8-305

Carbon film resistors described in the component schedule, by only their value and manufacturer's type (e.g. Philips B8-305-05B), have a tolerance of ±5% and a power rating according to the following table: -

Type No.	Power Rating
B8-305-05B	1/4W
B8-305-06B	1/2W
B8-305-07B	1W
B8-305-08B	2W
B8-305-00B	0.1W

WELWYN METAL OXIDE INSULATED RESISTORS SERIES F

Metal oxide resistors described in the component schedule by only their value and manufacturer's type number (e.g. Welwyn F32) have a tolerance of ±5% and a power rating according to the following table: -

Type No.	Power Rating
F32	3.5W
F33	5W
F34	7W
F35	8.5W

DATA ON CAPACITORS

The following table gives the standard voltage rating and capacitance tolerance for capacitors described in the component schedule only by their capacitance and manufacturer's type. Non-standard tolerances, where used, are specified in the Component Schedule.

DUCON CERAMIC DISC: RATING 500VW

TYPE	TOLERANCE ±0.5pF	±1pF	±5%	±20%	+100% -20%
CDS.NPO, styles A-D, F	1-6.8pF	10-15pF	18-100pF		
CDS.N750, styles A-F	3.3-6.8pF	8, 10pF	12-330pF		
CDS.HI-K, styles AY-FY				100-10000pF	
CDS.HI-K, styles AZ-FZ					470-15000pF

DUCON CERAMIC TUBULAR; RATING 500VW

TYPE	TOLERANCE ±0.5pF	±1pF	±5%	±20%	+100% -20%
CTR.NPO, styles A-F	6.8pF	10-18pF	22-330pF		
CTR.N750, styles A-F		10-18pF	22-1000pF		
CTR.HI-K, styles AY-DY				220-15000pF	
CTR.HI-K, styles AZ-CZ					1500-15000pF

PAPER, TUBULAR, METAL CASE, INSULATED

TYPE	RATING D.C.V.W.	TOLERANCE ±20%	±25%
Ducon PRC	200	0.25μF-1μF	0.05μF, 0.1μF
PRC	350		0.02μF-0.05μF
PRC	750	0.05μF-0.25μF	
PRC	1000	0.05μF, 0.25μF	
PRM (stud Mtg.)	200, 350, 500	0.1μF-0.5μF	
UCC PMM	200		0.05μF, 0.1μF
PMM	350		0.005μF, 0.02μF, 0.05μF
PMM	500		0.001μF-0.02μF
PMM	1000		0.001μF, 0.002μF
PMP	350	0.1μF-1μF	
PMP	500	0.05μF-0.5μF	
PMP	750	0.02μF	
PMP	1000	0.1μF	0.005μF, 0.01μF

SIMPLEX FOIL AND METALLISED MICA; RATING 500VW

TYPE	TOLERANCE ±1pF	±5%	±10%
PT (foil)			470-1000pF
SM (foil)			1500-10000pF
MS (metallised)	10-33pF	47-330pF	
SS (metallised)		470-1000pF	
SM (metallised)		1500-10000pF	

POLYESTER, TUBULAR, PHILIPS SERIES C296

TYPE	RATING	TOLERANCE
C296AA	125VW D.C.	±10%
C296AC	400VW D.C.	±10%

56068V135
56068V136
HIGH
LOW
JKA
JKB
C1
0·22
TR1
5TW8206
SWA
SWB/3R
PT9
RV1
100K
CAL.
R1
68K
R5
39K
RV7
5K
dbm.
ADJ.
C2
16
R3
22K
R4
100K
R6
390K
V1
EF86
C3
0·1
TELEFUNKEN
TYPE
ONLY
C4
0·1
R7
15K
V2
EF86
R8
470K
R9
27K
R11
470
C6
16
R19
33K
R21
6·8K
RVGA
5K
RVGB
25K
RV2
100K
RV3
100K
PLA
SKA
TR2
1TX60180
FS1
FS2
240v.
220v.
+10%
COM.
MR6
MR1
MR5
MR4
4 OFF
IN3195
RAS310AF.
R58
4·7K
R59
680
R61
680
C31
16
C32
100
C33
100
+200v.
R54
Y.E.T.
6·3v.
1·2A
RV8
250
TSA
PLB
LP1
V1
V2
V3
V4
V5

SWITCHING POSITIONS

SWA

1. — BAL. } 600Ω
2. — UNBAL. } BRIDGING
3. — 0·1MΩ UNBAL.

SWB

1. — c/s. X1
2. — c/s. X10
3. — c/s. X100
4. — CAL. & NOISE.
5. — dbm.

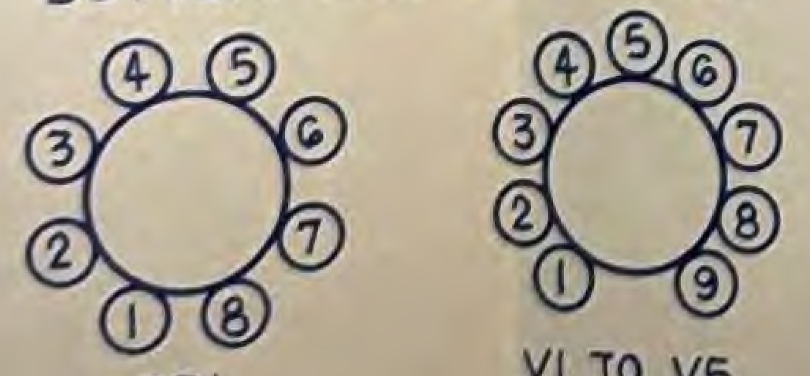
SWC.

	%D.	db.	dbm.
1.	— 100	— 0	+20
2.	— 30	−10	+10
3.	— 10	−20	— 0
4.	— 3	−30	−10
5.	— 1	−40	−20
6.	— 0·3	−50	−30
7.	———	−60	−40
8.	———	−70	−50

CHING POSITIONS

Ω / SING	SWC. %D.	db.	dbm.
	1. — 100	— 0	+20
	2. — 30	—10	+10
	3. — 10	—20	— 0
	4. — 3	—30	—10
	5. — 1	—40	—20
	6. — 0·3	—50	—30
	7. ——	—60	—40
	8. ——	—70	—50

BOTTOM VIEW OF SOCKETS



TR1   V1 TO V5

OAK SWITCHES VIEWED FROM KNOB-END IN EXTREME ANTICLOCKWISE POSITION.

NOTES:

1. RESISTORS IN OHMS. K = 1,000; M = 1,000,000. CAPACITORS IN μF (E.G. ·01) OR μμF (E.G. 150). ELECTROLYTICS IN μF.
2. ARROWS NEAR VARIABLE RESISTORS SHOW DIRECTION OF CLOCKWISE ROTATION.
3. CONNECTION NUMBERS ON VALVE ASSEMBLIES REPRESENT CONTACTS ON SKELETON WAFERS. SUFFIX 'C' INDICATES WAFER NEXT TO CHASSIS.
4. ON TYPE 2A C20, C26 & C27 ARE 25μF. C28 IS 100μF. C21 IS 0·1. C23 IS ·047. C16 IS 0·47.
5. EF86, 6BK8, Z729 ARE EQUIVALENT TYPES.

DISTORTION & NOISE METER

TYPES 2A & 3A56068

P.V.-1502-0   DRG. 56068H1