WOW & FLUTTER METER A248
Type 1M70579

HANDBOOK 70579R

AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED

Engineering Products Division

422 LANE COVE ROAD, NORTH RYDE, N.S.W.

WOW & FLUTTER METER A248

TYPE 1M70579

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Handbook 70579R
Issue 1

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HANDBOOK 70579R Issue 1 - REVISION LIST No.1

Where applicable, all changes of value, transistor and transformer types, etc., should also be made on the associated diagram.

Some or all of the changes in this Revision List may have been incorporated in this printing of the Handbook.

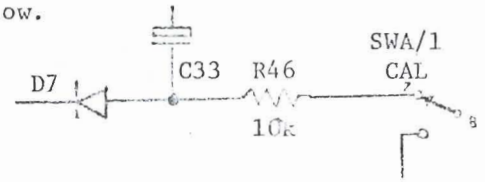
Page

1/2 In sub-section 1.3.3., Frequency Range,
change Wow range to read: 0.5 Hz to 10 Hz
change flutter range to read: 10 Hz to 200 Hz

3/1 In sub-section 3.1.3. Mode Switch;
change Wow range to read: 0.5. Hz to 10 Hz
change Flutter range to read: 10 Hz to 200 Hz

4/2 In sub-section 4.2.6. Filters and Weighting Network;
change Wow frequency range to read: 0.5 Hz to 10 Hz
change Flutter range to read: 10 Hz to 200 Hz
correct spelling of 'range' following 'Flutter'.

Drg 70579-1-09 Show R46 10 k as below.



Revision Record: Record the incorporation of this Revision List.

Authority: C/O 72375, 73717

Date of Issue: 14th August 1979

REVISION RECORD

Revision List	Date of Issue	Signature	Date of Incorporation
	This issue of the handbook incorporates Revision		
	Lists 1 to 4 of Issue 0. Future revision lists		
	will commence numbering at R/Ll for Issue 1.		
R/L1	14 Aug 79	John E. Howell	7/10/80

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TABLE OF CONTENTS

		Page
PART 1	GENERAL INFORMATION	
	1.1 Introduction	1/1
	1.2 Brief Description	1/1
	1.3 Performance	1/1
	1.3.1 Environmental	1/2
	1.3.2 Oscillator	1/2
	1.3.3 Meter	1/2
	1.4 General Information	1/2
	1.5 Mechanical	1/3
	1.6 Accessories Provided	1/3
	1.7 Ordering Information	1/3
PART 2	INSTALLATION	2/1
	2.1 General	2/1
	2.2 Mounting	2/1
	2.3 Connections	2/1
	2.3.1 Power	2/1
	2.3.2 3150 Hz Output	2/2
	2.3.3 Input	2/2
	2.3.4 Monitor Output	2/2
	2.4 Re-packing for Shipment	2/2
PART 3	OPERATION	
	3.1 Operating Controls	3/1
	3.1.1 Power Switch	3/1
	3.1.2 Set Drift Control	3/1
	3.1.3 Mode Switch	3/1
	3.1.4 Wow & Flutter Range Switch	3/2

TABLE OF CONTENTS

PART 3 OPERATION (Cont'd)

3.2 Measuring Drift 3/2

3.3 Measuring Wow & Flutter 3/2

PART 4 TECHNICAL DESCRIPTION 4/1

4.1 Principles of Operation 4/1

4.2 Circuit Drawing 4/1

4.2.1 3150 Hz Oscillator 4/1

4.2.2 Input Amplifier and Indicator 4/1

4.2.3 Phase Locked Loop 4/1

4.2.4 Drift Circuit 4/1

4.2.5 Wow & Flutter Range Switching 4/2

4.2.6 Filters and Weighting Network 4/2

4.2.7 Meter Amplifier 4/2

4.2.8 Power Supply 4/2

PART 5 MAINTENANCE 5/1

5.1 General 5/1

5.2 Service 5/1

5.3 Fault Finding Guide 5/2

PART 6 CALIBRATION & TEST PROCEDURE 6/1

6.1 Test Equipment Required 6/1

6.2 Instrument Calibration 6/1

6.2.1 Oscillator Frequency 6/1

6.2.2 V.C.O. Centre Frequency 6/1

6.2.3 Drift Calibration 6/1

6.2.4 Wow & Flutter Calibration 6/2

TABLE OF CONTENTS

PART 6 CALIBRATION & TEST PROCEDURE (Cont'd)

6.3 Test Procedure 6/3

6.3.1 Oscillator Output Level 6/3

6.3.2 Oscillator Distortion 6/3

6.3.3 Low Level Input 6/3

6.3.4 P.L.L. Frequency Range 6/3

6.3.5 Attenuator Accuracy 6/3

6.3.6 Frequency Response 6/4

6.3.7 Monitor Output 6/4

PART 7 COMPONENT SCHEDULE 7/1

7.1 Explanatory Notes 7/1

7.2 Wow & Flutter Meter A248, 1M70579 7/1

7.2.1 Components Mounted on Chassis 7/1

7.2.2 Components on Printed Circuit Board 1M70580 7/1

7.2.2.1 Capacitors 7/1

7.2.2.2 Connectors 7/2

7.2.2.3 Diodes 7/2

7.2.2.4 Fuses 7/3

7.2.2.5 Integrated Circuits 7/3

7.2.2.6 Resistors 7/3

7.2.2.7 Switches 7/4

7.2.2.8 Transformers 7/4

7.2.2.9 Transistors 7/5

7.2.2.10 Variable Resistors 7/5

PART 8 DIAGRAMS

Circuit Diagram 70579-1-09

1.3 PERFORMANCE

1.3.1 Environmental

Operating Temperature Range	:	0 °C to 50 °C

1.3.2 Oscillator

Frequency	:	3150 Hz ±0.1%
Output Level	:	+8 dBm from 600 Ω balanced source
Distortion	:	Less than 1%

1.3.3 Meter

Measurement Frequency	:	3150 Hz ±10%
Input Impedance	:	>300 kΩ balanced
Input Level Range	:	-30 dBm to +30 dBm

Measurement Range

Wow, Flutter, Weighted Wow & Flutter	:	0.1%, 0.3%, 1% & 3%
Drift	:	±2% (+4% or -4% by offsetting "Drift Cal")

Frequency Range

Wow	:	0.5 Hz to ~~6 Hz~~ 10 Hz
Flutter	:	~~0.6~~ Hz to 200 Hz
Unweighted Wow & Flutter	:	0.5 Hz to 200 Hz
Weighted Wow & Flutter	:	According to DIN/IEC/IEEE/ANSI Stds
Monitor output for Wow & Flutter	:	1 V p-p for F.S.D.

Input level lamp provides indication of sufficient level.

1.4 GENERAL INFORMATION

Connectors

3150 Hz Tone	:	3 Binding Posts (accepts 4 mm banana plugs)
Input	:	3 Binding Posts (accepts 4 mm banana plugs)
Monitor Output	:	BNC

PART 1

GENERAL INFORMATION

This apparatus has been designed according to Class 1 of IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The present instruction manual contains information and warnings which shall be followed by the user to ensure safe operation and to retain the apparatus in safe condition.

1.1 INTRODUCTION

The A.W.A. Wow & Flutter Meter A248 is designed to measure speed variations in all types of Consumer and Studio reproduction equipment, both balanced and unbalanced.

This instrument measures Drift, Wow and Flutter. Drift is long term variations in speed while Wow and Flutter are short term variations with Wow being variations below 6 Hz and Flutter above 6 Hz. The A248 has a "Weighted Total Wow & Flutter" to DIN, IEC, IEEE and ANSI Standards which gives the relative disturbing effect of the Wow & Flutter to the listener.

Also "Unweighted Total Wow & Flutter" measurements may be made for comparison with results made by equipments manufactured to old standards. This measurement, together with the separate Wow, Flutter measurements provides an invaluable aid to the service technician in determining the area of degradation of performance.

A pre-recorded disc or tape may be used to measure Drift, Wow & Flutter or if not available the 3150 Hz tone from the A248 may be recorded onto tape. However, results may vary from twice the actual Wow & Flutter to almost complete cancellation due to arithmetic addition of the variations. This may be detected by causing tape slippage on playback and noting the change in readings.

1.2 BRIEF DESCRIPTION

The A248 provides a 3150 Hz tone with very high frequency stability from a balanced 600 Ω source at +8 dBm. This tone is used internally on the "Drift Cal" mode and may also be used for recording the tone onto tape.

A CMOS Phase Locked Loop is used to lock onto the incoming tone in the A248 and provides a demodulated output to give a precise indication of variations in the reproducing equipment speed.

The input is balanced with an input impedance greater than 300 kΩ.

A green L.E.D. on the A248 is used to indicate when a tone is of sufficient level to operate the instrument.

The A248 has internal filters to allow the measurement of Wow, Flutter, Unweighted Wow & Flutter and Weighted Wow & Flutter (to DIN, IEC, IEEE, ANSI Standards). A "Monitor Output is provided to enable monitoring of the Wow & Flutter by C.R.O.

The A248 is of rugged construction and designed for compact size with maximum ease of servicing. All components are accessible by removing top and bottom covers.

Power Requirements

200 - 264 V, 50 - 60 Hz, 5 VA

100 - 132 V, 50 - 60 Hz, 7 VA

1.5 MECHANICAL

Height 99 mm (including feet)

Width 269 mm

Depth 273 mm (including binding posts)

Weight 2.1 Kg.

Case is provided with tilt stand

1.6 ACCESSORIES PROVIDED

1 x Mains Cable
1 x Spare Fuse
1 x Instruction Manual

1.7 ORDERING INFORMATION

The instrument is described as AWA Wow & Flutter Meter A248, Type 1M70579.

PART 2

INSTALLATION

2.1 GENERAL

The A248 Wow & Flutter Meter is a very compact instrument designed for bench operation and for operation from a.c. mains supply. For power and signal connections, see below.

The equipment should be inspected for any physical damage incurred during transportation. The accessories should be checked against the equipment schedule.

Whenever it is likely that the protection has been impaired, the apparatus shall be made inoperative and be secured against any unintended operation.

The protection is likely to be impaired if, for example:

- the apparatus shows visible damage;
- the apparatus fails to perform the intended measurements;
- after prolonged storage under unfavourable conditions;
- after severe transport stresses

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse-holders shall be avoided. The fuse should be of the current rating as marked on the rear panel for the mains voltage selected.

2.2 MOUNTING

The A248 is fitted with bottom feet and a tilt bar for bench operation. The tilt bar enables the unit to be tilted upwards for easier operation.

2.3 CONNECTIONS

2.3.1 Power

The A248 will operate from 110 V to 120 V and 220 V to 240 V nominal a.c. mains supply, 50 Hz - 60 Hz. The voltage range is selected by a plug on the rear of the circuit board inside the instrument. This voltage range should be checked before connecting to the supply. Ensure that the correct fuse rating is fitted for the supply voltage range selected. These are shown on the rear of the instrument. For 110 V to 120 V range, a 200 mA Anti-Surge fuse should be used.

For 220 V to 240 V range, a 100 mA Anti-Surge fuse should be used. An international mains socket is fitted on the rear panel of the F248. The power cord supplied should be plugged into this and connected then to the mains power receptacle.

The mains plug shall only be inserted in a socket-outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.

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The mains plug shall only be inserted in a socket-outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.

Warning!

Any interruption of the protective conductor inside or outside the apparatus or disconnection of the protective earth terminal is likely to make the apparatus dangerous. Intentional interruption is prohibited.

2.3.2 3150 Hz Output

Three binding posts are provided with the top two being the balanced output and the bottom being the earth terminal. For unbalanced operation either terminal may be grounded, however a shorting link is provided for convenience to ground the centre terminal.

2.3.2 Input

Three binding posts are provided with shorting link similar to that described for the 3150 Hz Output. Input is balanced with an input impedance greater than 300 kΩ.

2.3.4 Monitor Output

The Monitor Output is provided on a BNC connector on the rear panel. The output is 1 V p-p, for F.S.D. on the meter, with a 1 kΩ source impedance.

2.4 RE-PACKING FOR SHIPMENT

General guidance is furnished below in the event that re-packing of the instrument for shipment may be necessary at any time.

1. Should the original container be available, re-pack in the same manner as received. It is advisable to retain the original container and packing case for this purpose.

2. If the original container is not available, the unit should be wrapped in heavy paper or plastic sheet prior to placing in an inner container. Place liberal quantities of packing materials, which should be reasonably dust-free, on all sides of the container but DO NOT pack tightly. The instrument front panel side should receive extra attention when the container is being packed into the packing case.

3. Mark the case in which the instrument is shipped "DELICATE INSTRUMENT" or "FRAGILE".

PART 3

OPERATION

Warning!

Any interruption of the protective conductor inside or outside the apparatus or disconnection of the protective earth terminal is likely to make the apparatus dangerous. Intentional interruption is prohibited.

3.1 OPERATING CONTROLS

The following controls are mounted on the front panel of the A248.

3.1.1 Power Switch

This switch applies mains power to the instrument. For safety, both line and neutral are switched.

An associated red l.e.d. lamp indicates the presence of mains power.

Before switching on the apparatus, make sure that it is set to the voltage of the power supply.

3.1.2 Set Drift Control

This control is used to set the meter reading to zero when the "Drift Cal" button is selected. The meter may be set to either -3% or +2% using this control to extend the meter range from ±2% to 0 to +4% or 0 to -4% drift when in the "Drift Read" mode.

3.1.3 Mode Switch

Drift Cal : This mode internally connects the 3150 Hz to the Phase Locked Loop to enable calibration of the Drift meter reading.

Drift Read : The incoming signal frequency is compared to the reference set by the 3150 Hz and a meter reading of % variation given.

Wow : The wow of the incoming signal is measured over a 0.5 Hz to 10.6 Hz frequency range.

Flutter : The flutter of the incoming signal is measured over a 10 Hz to 200 Hz frequency range.

Unweighted Wow & Flutter : This is measured over a 0.5 Hz to 200 Hz frequency range

Weighted Wow & Flutter : This is measured to the weighting curve to DIN, IEC, IEEE, ANSI Standards.

The frequency response of the filters and weighting networks is found on Drawing No.

3.1.4 Wow & Flutter Range Switch

This switch provides 4 ranges of reading Wow & Flutter - 3%, 1%, 0.3% and 0.1% F.S.D.

3.2 MEASURING DRIFT

1. Connect the signal to be measured to the "Input" terminals of the A248 and check that the green l.e.d. is glowing, i.e. there is sufficient input level.

2. Push the "Drift Cal" button and set the meter to centre scale using the "Set Drift" control.

3. Now push the "Drift Read" button and read the drift from the meter.

Note: To extend the drift reading range to 4% (in one direction only) the meter may be calibrated to either the +2% or -2% positions.

3.3 MEASURING WOW & FLUTTER

1. Connect the signal to be measured to the "Input" terminals of the E248 and check that the green l.e.d. is glowing.

2. Select the required filter or weighting mode, set the "Range" switch to the appropriate range and read the meter.

PART 4

TECHNICAL DESCRIPTION

4.1 PRINCIPLES OF OPERATION

The A248 has a high stability 3150 Hz oscillator for external recording and for the "Drift Cal" reference frequency.

The oscillator output is transformer coupled.

The incoming signal is amplified by a balanced input amplifier and fed into a CMOS Phase Locked Loop (P.L.L.). This loop locks onto this signal and the d.c. component of the input to the Voltage Controlled Oscillator (V.C.O.) in the P.L.L. is measured to give the Drift indication after calibration to the reference 3150 Hz frequency.

The a.c. component of the V.C.O. control voltage is amplified and filtered to give the Wow & Flutter signals.

The filter and weighting curves are shown on Drawing 70579-4-10.

This is then peak-peak detected to give a meter indication which is calibrated to read peak Wow & Flutter.

4.2 CIRCUIT DESCRIPTION

Refer to Circuit Drawing 70579-1-09.

4.2.1 3150 Hz Oscillator

IC9 is an active filter whose output is fed back to an inverting amplifier IC8 and then back into the filter input. This makes an oscillator tuned to the centre frequency of the active filter and amplitude stabilised by D9 and D11. Oscillator frequency is trimmed to 3150 Hz with RV7.

4.2.2 Input Amplifier and Indicator

IC1 is a balanced input amplifier with its output clamped by D2 and Q1. When the signal is of sufficient amplitude to cause current to flow in Q1 the green l.e.d. glows to indicate adequate signal input.

4.2.3 Phase Locked Loop (P.L.L.)

The output of IC1 is fed into IC2 which is a CMOS P.L.L. device. The Voltage Controlled Oscillator is locked to the incoming signal so that the variation of control voltage at IC2 pin 9 is proportional to the variation of input frequency.

RV1 is used to set the centre frequency of the VCO.

4.2.4 Drift Circuit

IC7 is used to measure the change in d.c. voltage at the input to the V.C.O. This gives a linear indication of frequency drift. RV8 is used to calibrate the Drift circuit by giving d.c. offset for centre meter reading when 3150 Hz is fed into the P.L.L. RV9 calibrates the gain of the meter.

4.2.5 Wow & Flutter Range Switching

The a.c. component of the V.C.O. control voltage is amplified by IC3. Range switching is by changing resistors in the feedback path of IC3.

Q3 is used to clamp and reduce the gain of IC3 when there is no input signal to the P.L.L.

4.2.6 Filters and Weighting Network

The Unweighted Wow & Flutter frequency range is 0.5 Hz to 200 Hz, low frequency roll off is by C11 and C28 and high frequency roll off by C8, C13, C16, C26, C27 and C31. RV2 calibrates the meter reading in this mode.

The Wow mode frequency range is 0.5 Hz to 10 Hz with C21 and C22 determining h.f. roll off. RV3 calibrates the meter reading in this mode.

The Flutter mode frequency range is 10 Hz to 200 Hz with C23 and C24 determining the l.f. roll off. RV4 calibrates the meter reading in this mode.

The Weighted Wow & Flutter frequency range as shown in Drawing is determined by C17, C18, C19, C20.

RV6 calibrates the meter reading in this mode.

Note RV6 also affects the calibration of the other modes of Wow & Flutter measurements and therefore should be set first.

4.2.7 Meter Amplifier

IC6 is the meter amplifier circuit. D6 and D7 charge C32 and C33 to a peak to peak voltage which is discharged through the meter. D3 and D4 linearise the metering circuit. The Monitor Output is taken from the meter amplifier.

4.2.8 Power Supply

The power supply consists of a +12 V and -12 V series regulators IC11 and IC12. Both supplies are internally protected against short circuits and thermal overloads.

The A248 may be used from either 120 V or 240 V mains, change over being made by removing and reversing SKB mounted on the printed circuit board.

PART 5

MAINTENANCE

5.1 GENERAL

This is a high performance instrument and to maintain this performance level, periodic checks are advisable. Inspection should include checks on resistors to ensure that no signs of over-heating are evident. The wire used has an insulating coating of polyvinyl chloride, and the styroseal capacitors also contain thermo-plastics which must not be subjected to excessive heat. Should servicing be required, take care against a hot soldering iron coming into contact with or being placed near the wiring forms or capacitors.

The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.

The apparatus shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the apparatus shall be opened.

If afterwards any adjustment, maintenance or repair of the opened apparatus under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved.

5.2 SERVICE

It is important to note when servicing this instrument, that any replacement of circuit components may require a re-adjustment of the pre-set controls to restore the instrument to its original calibrated condition.

Service work of any kind, particularly on sub-miniature components, should be carried out with care. Transistors and diodes, when being replaced, should receive scrupulous care because permanent damage may be caused by the application of excessive heat.

Should it be found during inspections that dust accumulation has built up inside the instrument this should be removed, preferably by a low pressure jet, or alternatively a soft brush may be lightly used.

Switch control cleaning and lubricating should always be done with a recommended agent and the use of abrasives should be avoided.

The following solution may be made up and applied with a fine brush:

12 oz. Anhydrous Lanoline (British Pharmocopeia Standard)

1 fl. oz. Mobil Aero Instrument Oil (MIL-L-7870A or NATO-O-142)

25 fl. oz. 1, 1, 1 Inhibited Trichlorethane (Dow Chemical Company "Chlorothene NU")

A convenient package of cleaner-lubricant is now available for contacts of wiping, knifing or sliding types. This fluid is pressure packed and the container is fitted with a flexible tube to facilitate the directing of fluid to obscure points. Packaged in 12 oz. cans, it may be ordered as AWA Electrical Contact Cleaning Lubricant.

5.3 FAULT FINDING GUIDE

1. If the instrument appears to malfunction, check that the front panel controls are set correctly. Refer to Operation Part 3.

2. Check that the power is connected to the instrument. The "Power" indicator l.e.d. should be on.

3. Check that the input signal is within the specified frequency and level ranges. The input l.e.d. should be glowing for adequate level input.

4. Remove the top cover and check that the +12 V and -12 V supply voltages are present.

5. Push the Drift Cal. button and check that the green l.e.d. is glowing, and there is a signal at IC1 pin 6.

6. Check that the Phase Locked Loop is locked, i.e. the waveform at IC2 pin 2 should have a constant mark to space ratio.

7. If Drift mode is faulty, check signal path through IC7 to the meter.

8. If the Wow & Flutter mode is faulty feed in the input signal, switch to Unweighted Wow & Flutter and check signal path from IC2 pin 2 to the meter.

PART 6

CALIBRATION & TEST PROCEDURE

6.1 TEST EQUIPMENT REQUIRED

1. Frequency Counter to measure 3150 Hz ±0.5 Hz
2. Low Frequency Sine Wave Oscillator with frequency range covering 0.5 Hz to 3150 Hz.
3. Test aid as described in Instrument Calibration (6.2.4).
4. Distortion & Noise Meter AWA F242 or equivalent.
5. 75 Ω Precision Attenuator.
6. 75 Ω ±0.5% Resistor.
7. Cathode Ray Oscilloscope with delayed time base and 15 MHz bandwidth.

6.2 INSTRUMENT CALIBRATION

6.2.1 Oscillator Frequency

1. Connect a suitable frequency counter to the oscillator output and adjust RV7 to be approx. 3150 Hz on a one second count.
2. Now switch to a ten second count and set RV7 for a counter reading of 3150 Hz ±0.5 Hz.

6.2.2 V.C.O. Centre Frequency

1. Set the A248 to the CAL mode and turn the SET DRIFT control to its centre position.
2. Adjust RV1 for an approximately centre reading on the meter.

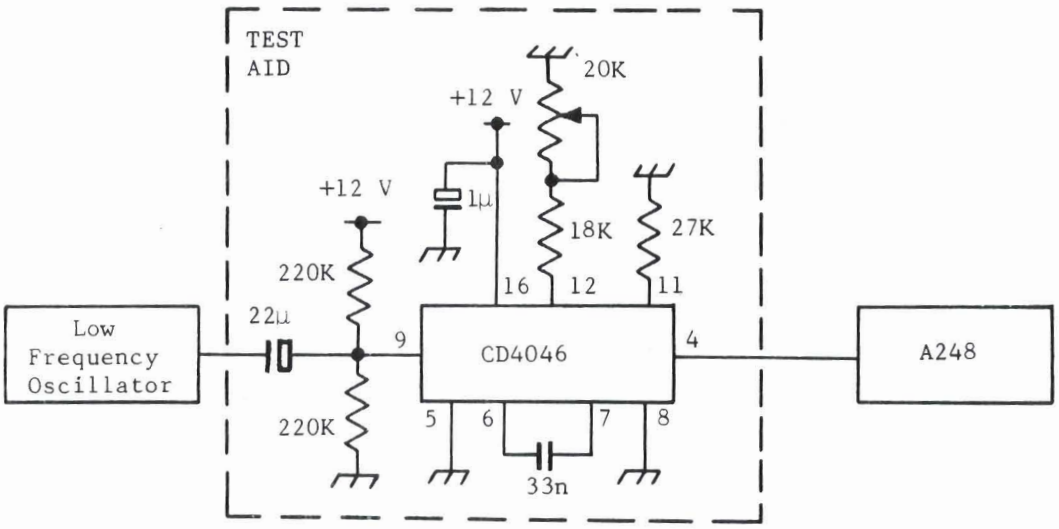
Note: The oscillator frequency should have already been calibrated as described in Section 6.2.1.

6.2.3 Drift Calibration

1. Connect Low Frequency Oscillator to the counter and set the output frequency to 3087 Hz ±1 Hz.
2. Connect the oscillator with say 1 V output to the A248. Depress the "Drift Read" button and adjust the "Set Drift" control to read -2% on the meter.
3. Now depress the "Drift Cal" button and adjust RV9 for a meter reading of 0% drift.

6.2.4 Wow & Flutter Calibration

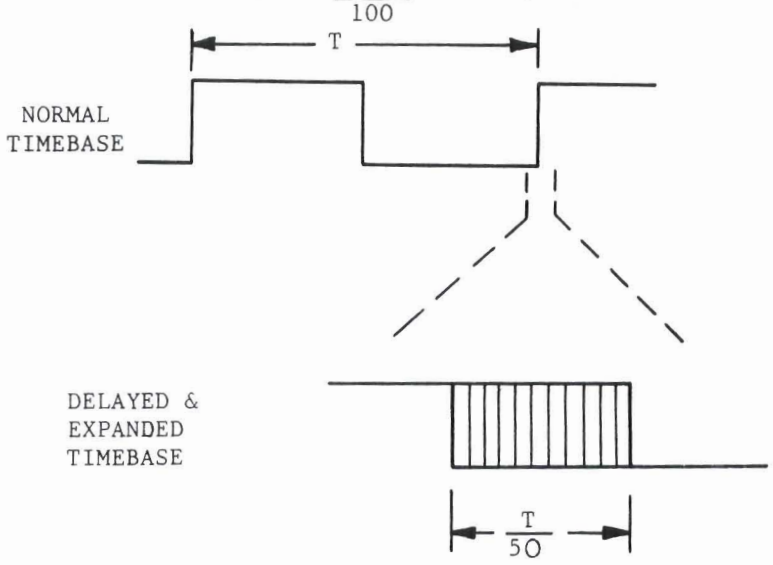
1. Connect the A248 to the test aid shown below



2. With no output from the Low Frequency Oscillator, adjust the 20 K potentiometer to 3150 Hz ±10 Hz.

3. Connect a C.R.O. to the output and measure the period of the square wave at the output of the test aid. This should be typically 317 µSec.

4. With the oscilloscope triggered from the positive edge, examine the next positive edge, using the oscilloscope delayed sweep and adjust the output of the L.F. Oscillator for a peak to peak excursion of 2% of the previous period measurement.(i.e. $\frac{317 \times 2}{100}$ = 6.34 µSec)



5. Set the A247 to Weighted Wow & Flutter on the 1% Range and the L.F. Oscillator to 4 Hz and adjust RV6 for a reading of 1% on peaks of the meter excursions.

6. Now switch to Total Wow & Flutter and adjust RV2 for the same reading.

7. Set the L.F. Oscillator to 2 Hz and the A248 on Wow and adjust RV3 for a peak reading of 1%.

8. Set the L.F. Oscillator to 40 Hz and the A248 to Flutter and adjust RV4 for a reading of 1%.

6.3 TEST PROCEDURE

6.3.1 Oscillator Output Level

1. Connect the A248 3150 Hz output to the F242 with 600 Ω input impedance.

2. The output level should be +8 dBm ±1 dB.

6.3.2 Oscillator Distortion

1. Using the F242, measure the distortion which should be less than 1%.

6.3.3 Low Level Input

1. Connect L.F. Oscillator to the E248 and bridge with the F242 to monitor level.

2. Set the oscillator to 3150 Hz and -30 dBm and check that the input light is illuminated.

6.3.4 P.L.L. Frequency Range

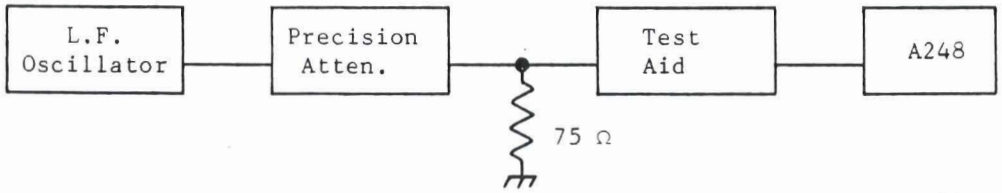
1. Connect a C.R.O. to IC2 pin 4.

2. Set the L.F. Oscillator to 2740 Hz and check that the phase locked loop is locked. i.e. a steady waveform on the C.R.O.

3. Now set the oscillator to 3560 Hz and check that the P.L.L. is locked.

6.3.5 Attenuator Accuracy

1. Connect the equipment as shown below:-



2. Set the L.F. Oscillator to 40 Hz and adjust the level to measure 3% on the A248 Unweighted Total Wow & Flutter mode.

3. Switch in 10 dB attenuation and check for a reading of 0.95% ±0.02 on the 1% Range. (Note: the Wow & Flutter Attenuators are not 10 dB)

4. Switch in 20 dB attenuation and check for a reading of 0.3% ±0.005 on the 0.3% Range.

5. Switch in 30 dB attenuation and check for a reading of 0.095% ±0.002 on the 0.1% Range.

6.3.6 Frequency Response

1. Set the L.F. Oscillator to 4 Hz and adjust the output level for 1% peak reading in the Weighted Wow & Flutter mode.

2. Set the oscillator to 1.2 Hz and check that the peak meter reading is 0.7% ±0.07.

3. Set the oscillator to 13 Hz and check that the meter reading is 0.7% ±0.07.

4. Now set the oscillator to 0.5 Hz and the A248 to the Unweighted Total Wow & Flutter mode and check that the peak meter reading is 0.7% ±0.07.

5. Set the oscillator to 200 Hz and check that the meter reading is 0.7% ±0.07.

6. Set the oscillator to 10 Hz and check that the meter reading is 0.7% ±0.07 in both the Unweighted Wow and the Unweighted Flutter modes.

6.3.7 Monitor Output

1. Set the oscillator output for a full scale meter reading and check for 1 V P-P at the Monitor Output with the C.R.O.

PART 7

COMPONENT SCHEDULE

7.1 EXPLANATORY NOTES

The component schedule is laid out as follows:

Column 1 Circuit Reference Number
Column 2 Description
Column 3 AWA Stock Code Number

Because of unavailability at the date of manufacture, some components in the equipment may differ slightly from the components listed in the schedule. These substitute components do not degrade the performance of the equipment.

When ordering replacement components from AWA, the type number of the unit (or sub-unit) and the circuit reference number of the component should be quoted in addition to the details appearing in the component schedule. This information will ensure the supply of a suitable substitute component should the listed component be obsolete or unavailable.

7.2 WOW & FLUTTER METER A248, 1M70579

7.2.1 Components Mounted on Chassis

SWC	Mains switch DP-DT Toggle	C&K Type 7201-P3-PYZQ C/w standard accessories
D1	Diode, light emitting. Green	Hewlett Packard Type 5082-4984
D13	Diode indicator, light emitting	Rodan Type BD701R
ME1	Meter	AWA 70579-3-01
RV8	Resistor, variable, 1k±10% linear	Clarostat 381N
SKA	Socket Assembly Utilux Receptacle H9373, Ulilux Terminal H9001 and Utilux Terminal H9002	
SKD	Socket. B.N.C. Bulkhead Receptacle UG.625B/U	234665
SKE	Socket. Light emitting diode Robinson Nugent Skinny Strip SB-25-100 25 Way Solder Dip	
PLC	Mains Input Plug	1019556

7.2.2 Components on Printed Circuit Board 1M70580

7.2.2.1 Capacitors

C1	Capacitor, ceramic disc, 1nF, ±20%, 500 V, HiK	1005381
C2	Capacitor, ceramic disc, 1nF, ±20%, 500 V, HiK	1005381
C3	Capacitor, ceramic disc, 33pF, ±5%, 500 V, N.P.O.	221162
C4	Capacitor, ceramic disc, 33pF, ±5%, 500 V, N.P.O.	221162
C5	Capacitor, ceramic disc, 2p2F, ±0P5, 500 V, N.P.O.	220131
C6	Capacitor, ceramic disc, 47nF, +80-20%, 25 V, HiK	226822
C7	Capacitor, polystyrene, 33nF, ±2%, 100 V	AEE. PFE216 DC533G
C8	Capacitor, electrolytic tantalum, 22µF, ±10%, 15 V	229320
C9	Capacitor, met. polyester, 47nF, ±10%, 250 V	226784

C10	Not used	
C11	Capacitor, electrolytic tantalum, 22µF, ±10%, 15 V	229320
C12	Capacitor, ceramic disc, 47nF, +80-20%, 25 V, HiK	226822
C13	Capacitor, met. polyester, 100nF, ±10%, 250 V	227096
C14	Capacitor, ceramic disc, 33pF, ±5%, 500 V, N.P.O.	221162
C15	Capacitor, ceramic disc, 100pF, ±5%, 500 V, N750	222214
C16	Capacitor, met. polyester, 680nF, ±10%, 250 V	1006545
C17	Capacitor, met. polyester, 10nF, ±10%, 250 V	226388
C18	Capacitor, met. polyester 220nF, ±10%, 250 V	1006225
C19	Capacitor, met. polyester 330nF, ±10%, 250 V	1014720
C20	Not used	
C21	Capacitor, met. polyester, 680nF, ±10%, 250 V	1006545
C22	Capacitor, met, polyester, 150nF, ±10%, 250 V	1014719
C23	Capacitor, met. polyester, 330nF, ±10%, 250 V	1014720
C24	Capacitor, met. polyester, 100nF, ±10%, 250 V	227096
C25	Not used	
C26	Capacitor, ceramic disc. 330pF, ±10%, 100 V Philips	2222-630-03331
C27	Capacitor, ceramic disc, 33pF, ±5%, 500 V, N.P.O.	221162
C28	Capacitor, electrolytic tantalum, 22µF, ±10%, 15 V	229320
C29	Capacitor, ceramic disc, 33pF, ±5%, 500 V, N.P.O.	221162
C30	Not used	
C31	Capacitor, ceramic disc, 1nF, ±10%, 100 V Philips	2222-630-03102
C32	Capacitor, electrolytic tantalum, 100µF, ±10%, 10 V	229717
C33	Capacitor, electrolytic tantalum, 100µF, ±10%, 10 V	229717
C34	Capacitor, met. polyester, 1µF, ±10%, 250 V	227851
C35	Capacitor, ceramic disc, 47nF, +80-20%, 25 V, HiK	226822
C36	Capacitor, ceramic disc, 47nF, +80-20%, 25 V, HiK	226822
C37	Capacitor, ceramic disc, 150pF, ±5%, 500 V, N750	222716
C38	Capacitor, ceramic disc. 4p7F, ±OP5, 500 V, N.P.O.	220217
C39	Capacitor, ceramic disc, 150pF, ±5%, 500 V, N750	222716
C40	Capacitor, met. polyester, 680nF, ±10%, 250 V	1006545
C41	Capacitor, radial lead ceramic, 4n7F, ±5%, N.P.O. Vitramon	VK44BA472J
C42	Capacitor, radial lead ceramic, 4n7F, ±5%, N.P.O. Vitramon	VK44BA472J
C43	Capacitor, met. polyester 100nF, ±10%, 250 V	227096
C44	Capacitor, electrolytic aluminium, 1000µF, +50-10%, 25 V	1024578
C45	Not used	
C46	Capacitor, electrolytic aluminium, 1000µF, +50-10%, 25 V	1024578
C47	Capacitor, met. polyester, 330nF, ±10%, 250 V	1014720
C48	Capacitor, met. polyester, 330nF, ±10%, 250 V	1014720
C49	Capacitor, electrolytic tantalum, 1µF, ±10%, 35 V	227739
C50	Not used	
C51	Capacitor, electrolytic tantalum, 1µF, ±10%, 35 V	227739

7.2.2.2 Connectors

PLA	Plug. circuit board mounting	Utilux Molex M3099-P3A/1
PLB	Plug. five pin, circuit board mounting	A.M.P. Pin 153249-4
SKB	Socket Assembly. Wafer AMP 5 Way COMBO LINE TYPE 280060. CONNECTOR AMP TYPE 153351	70567-4-02

7.2.2.3 Diodes

D1	Not used	
D2	Not used	
D3	Diode 1N914	597291
D4	Diode 1N914	597291
D5	Not used	
D6	Diode 1N914	597291

70579R

D7	Diode 1N914	597291
D8	Diode 1N914	597291
D9	Diode BZX79 C5V6	1006326
D10	Not used	
D11	Diode BZX79 C5V6	1006326
D12	Diode 1N914	597291
D13	Not used	
D14	Diode 1N4003	1004811
D15	Not used	
D16	Diode 1N4003	1004811
D17	Diode 1N4003	1004811
D18	Diode 1N4003	1004811
D19	Diode 1N914	597291
D20	Not used	
D21	Diode 1N914	597291

229320
226822
227096
221162
222214
1006545
226388
1006225
1014720
1006545
1014719
1014720
227096

7.2.2.4 Fuses

30-03331
221162
229320

FS1	20 mm Fuse link. 100 mA delayed action	Australux DA 205

221162

7.2.2.5 Integrated Circuits

IC1	Integrated circuit LM308N	National Semiconductor
IC2	Integrated circuit CD4046AE	RCA
IC3	Integrated circuit LM301 A.N.	National Semiconductor
IC4	Integrated circuit LM301 A.N.	National Semiconductor
IC5	Not used	
IC6	Integrated circuit LM301 A.N.	National Semiconductor
IC7	Integrated circuit LM301 A.N.	National Semiconductor
IC8	Integrated circuit LM301 A.N.	National Semiconductor
IC9	Integrated circuit LM301 A.N.	National Semiconductor
IC10	Not used	
IC11	Integrated circuit MC7812 CP c/w Mounting Kit MK199-3	Motorola
IC12	Integrated circuit MC7912 CP c/w Mounting Kit MK199-3	Motorola

30-03102
229717
229717
227851
226822
226822
222716
220217
222716
1006545
44BA472J
44BA472J
227096
1024578

7.2.2.6 Resistors

R1	Resistor, metal glaze, 300kΩ±2%, 1/4 W	1008805
R2	Resistor, metal glaze, 300kΩ±2%, 1/4 W	1008805
R3	Resistor, carbon film, 10MΩ±10%, 1/3 W	Philips CR25 2322-211-12106
R4	Resistor, carbon film, 10MΩ±10%, 1/3 W	Philips CR25 2322-211-12106
R5	Not used	
R6	Resistor, metal glaze, 270Ω±2%, 1/4 W	1008732
R7	Resistor, metal glaze, 10kΩ±2%, 1/4 W	1008770
R8	Resistor, metal glaze, 18kΩ±2%, 1/4 W	1008776
R9	Resistor, metal glaze, 27kΩ±2%, 1/4 W	1008780
R10	Resistor, metal glaze, 33kΩ±2%, 1/4 W	1008782
R11	Resistor, metal glaze, 5k6Ω±2%, 1/4 W	1008764
R12	Resistor, metal glaze, 1kΩ±2%, 1/4 W	1008746
R13	Resistor, metal glaze, 10kΩ±2%, 1/4 W	1008770
R14	Resistor, metal glaze, 4k7Ω±2%, 1/4 W	1008762
R15	Not used	
R16	Resistor, metal glaze, 18kΩ±2%, 1/4 W	1008776
R17	Resistor, metal glaze, 47kΩ±2%, 1/4 W	1008786
R18	Resistor, metal glaze, 10kΩ±1%, 1/4 W	1014288
R19	Resistor, metal glaze, 30kΩ±1%, 1/4 W	1014334
R20	Not used	
R21	Resistor, metal glaze, 100kΩ±1%, 1/4 W	1014384
R22	Resistor, metal glaze, 300kΩ±1%, 1/4 W	1014430

227739
227739
099-P3A/1
53249-4
67-4-02
597291
597291
597291

R23	Resistor, metal glaze, 680Ω±2%, 1/4 W	1008742
R24	Resistor, metal glaze, 120kΩ±2%, 1/4 W	1008796
R25	Not used	
R26	Resistor, metal glaze, 100kΩ±2%, 1/4 W	1008794
R27	Not used	
R28	Resistor, metal glaze, 18kΩ±2%, 1/4 W	1008776
R29	Resistor, metal glaze, 68kΩ±2%, 1/4 W	1008790
R30	Not used	
R31	Resistor, metal glaze, 39kΩ±2%, 1/4 W	1008784
R32	Resistor, metal glaze, 82kΩ±2%, 1/4 W	1008792
R33	Resistor, metal glaze, 220kΩ±2%, 1/4 W	1008802
R34	Resistor, metal film, 1MΩ±2%, 1/4 W	1018704
R35	Not used	
R36	Resistor, metal glaze, 150kΩ±2%, 1/4 W	1008798
R37	Resistor, metal glaze, 22kΩ±2%, 1/4 W	1008778
R38	Resistor, metal glaze, 39kΩ±2%, 1/4 W	1008784
R39	Resistor, metal glaze, 330kΩ±2%, 1/4 W	1008806
R40	Not used	
R41	Not used	
R42	Resistor, metal glaze, 330Ω±2%, 1/4 W	1008734
R43	Resistor, metal glaze, 13kΩ±2%, 1/4 W	1008773
R44	Resistor, metal glaze, 1kΩ±2%, 1/4 W	1008746
R45	Not used	
R46	Resistor, metal glaze, 10kΩ±2%, 1/4 W	1008770
R47	Resistor, metal glaze, 470kΩ±2%, 1/4 W	1008810
R48	Resistor, metal glaze, 470kΩ±2%, 1/4 W	1008810
R49	Resistor, metal glaze, 220kΩ±2%, 1/4 W	1008802
R50	Not used	
R51	Resistor, metal glaze, 6k8Ω±2%, 1/4 W	1008766
R52	Resistor, metal glaze, 3k3Ω±2%, 1/4 W	1008758
R53	Resistor, metal glaze, 1kΩ±2%, 1/4 W	1008746
R54	Resistor, metal glaze, 680Ω±2%, 1/4 W	1008742
R55	Not used	
R56	Resistor, metal glaze, 10kΩ±2%, 1/4 W	1008770
R57	Resistor, metal glaze, 10kΩ±2%, 1/4 W	1008770
R58	Resistor, metal glaze, 3k9Ω±2%, 1/4 W	1008760
R59	Resistor, metal glaze, 120kΩ±2%, 1/4 W	1008796
R60	Not used	
R61	Resistor, metal film, 301kΩ±0.5%, 25 ppm, 1/4 W	Roederstein MK2
R62	Resistor, metal film, 332Ω±0.5%, 25 ppm, 1/4 W	Roederstein MK2
R63	Resistor, metal glaze, 10kΩ±2%, 1/4 W	1008770
R64	Resistor, metal glaze, 1k3Ω±2%, 1/4 W	1008749
R65	Not used	
R66	Resistor, metal glaze, 27kΩ±2%, 1/4 W	1008780
R67	Resistor, metal glaze, 470Ω±2%, 1/4 W	1008738
R68	Resistor, metal glaze, 2k2Ω±2%, 1/4 W	1008754

7.2.2.7 Switches

SWA	Switch assy	70580-5-03

7.2.2.8 Transformers

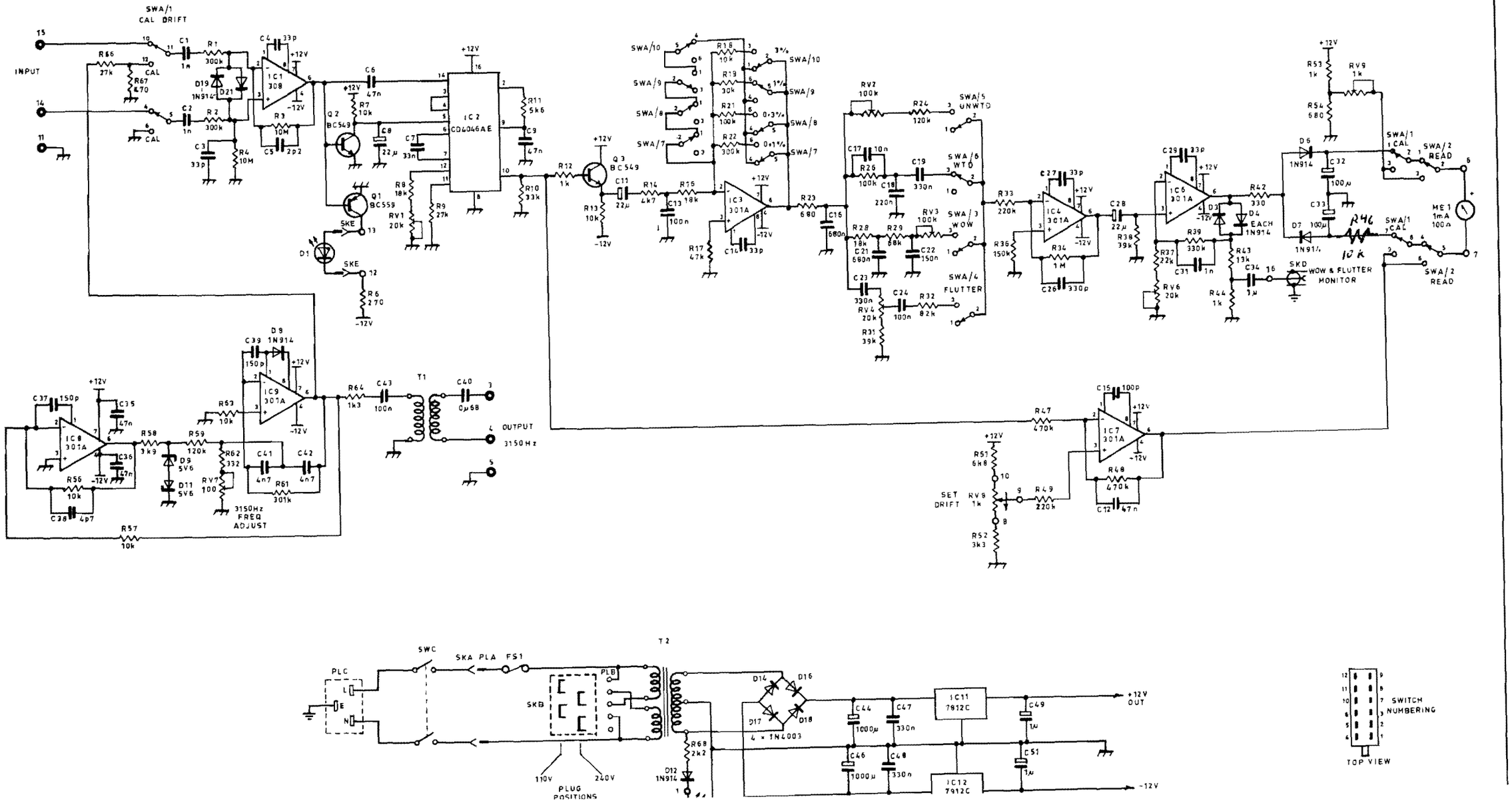
T1	Output Transformer	1LP69290
T2	Power Transformer. Circuit board mounting	Ferguson Type PF4016-1

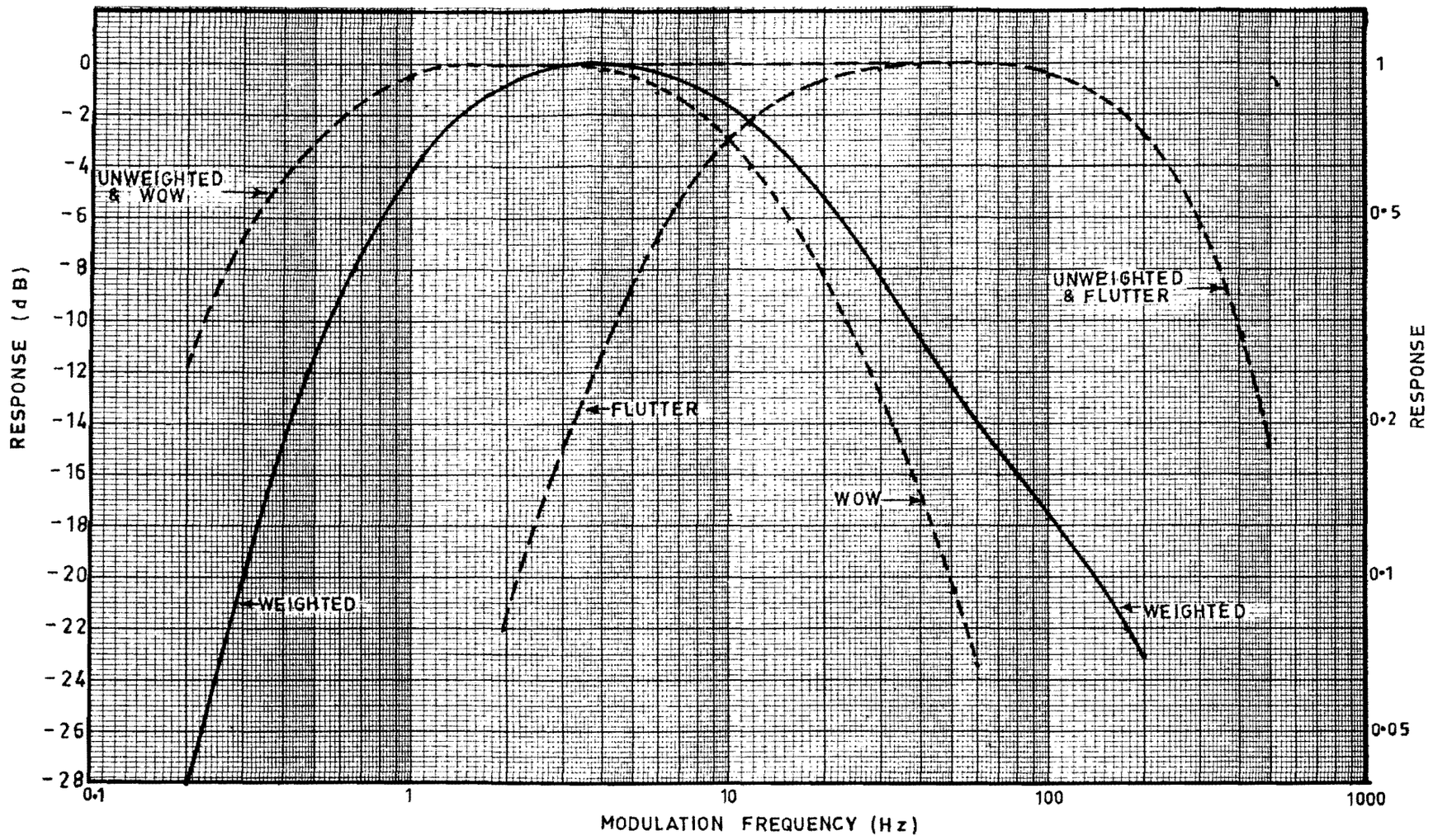
7.2.2.9 Transistors

Q1	Transistor BC559	Philips BC559
Q2	Transistor BC549	1024854
Q3	Transistor BC549	1024854

7.2.2.10 Variable Resistors

RV1	Resistor, variable, cermet 20 kΩ ±10%	Beckman 72PM
RV2	Resistor, variable, cermet 100 kΩ ±10%	Beckman 72PM
RV3	Resistor, variable, cermet 100 kΩ ±10%	Beckman 72PM
RV4	Resistor, variable, cermet 20 kΩ ±10%	Beckman 72PM
RV5	Not used	
RV6	Resistor, variable, cermet 20 kΩ ±10%	Beckman 72PM
RV7	Resistor, variable, cermet 100 Ω ±10%	Bourns 3299W-1-101
RV8	Resistor, variable, cermet 1 kΩ ±10%	AWA 70579-4-12
RV9	Resistor, variable, cermet 1 kΩ ±10%	Beckman 72PM


SWA/1
CAL DRIFT
INPUT
CAL
IC1 308
IC2 CD4046AE
Q1 BC559
Q2 BC549
Q3 BC549
SKE
SWA/10
SWA/9
SWA/8
SWA/7
IC3 301A
SWA/5 UNWTD
SWA/6 WTD
SWA/3 WOW
SWA/4 FLUTTER
IC4 301A
IC6 301A
SWA/1 CAL
SWA/2 READ
ME1 1mA 100Ω
SKD WOW & FLUTTER MONITOR
IC9 301A
IC8 301A
OUTPUT 3150Hz
3150Hz FREQ ADJUST
IC7 301A
SET DRIFT
T1
T2
SWC
SKA PLA FS1
PLC
SKB
PLB
110V
240V
PLUG POSITIONS
4 = 1N4003
IC11 7812C
IC12 7912C
+12V OUT
-12V
SWITCH NUMBERING
TOP VIEW



FREQUENCY RESPONSE WEIGHTING CURVES
WOW & FLUTTER METER
A248