2.2 ROUTINE CALIBRATION

2.2.1 General

The following section contains a calibration procedure which should be carried out at the end of the Specification Validity period, as stated in Section 4 1 1 of the Operating Manual, or when the instrument is found to be out of specification

Following repair or replacement of components, complete calibration of the instrument should be carried out consisting of the part of Section 2 3.2 of this manual applicable to the repaired board followed by the routine calibration.

During routine calibration full range adjustments are, in general, all that is required to bring the calibration of the instrument well inside its specified accuracy. Linearity and zeros need only be checked to verify the performance, thus saving considerable time This applies to all functions except d c. voltage where resetting of linearity is advisable. Steps which are normally not necessary for a routine calibration are marked *

In the case where a particular function is not required, or the appropriate calibrator is not available, the function need not be calibrated except for the 1 volt a c range (1, ACV) where a c current is required or, the 1 volt d.c range (1, DCV) where d c current or resistance is required Similarly, the higher voltage ranges need not necessarily be calibrated

Calibration of functions required should always be in the sequence given

Routine calibration should be completed at an ambient temperature of 23°C ± 1°C if the instrument is to meet its specification over the given operating range Before commencing calibration allow 2 hours 'warm up' at this temperature with the upper and lower covers fitted in position but not fastened in place

For the greatest accuracy and for minimum time spent calibrating, it is necessary for the boards to remain at their normal working temperature throughout calibration Each trim adjustment is to be made as quickly as possible and in the order described. Operate the instrument in its normal operating position as much as possible (i.e. tilt the instrument in preference to turning it over when calibrating the Current Converter) Remove the covers for as short a time as possible, replace loosely after each adjustment in order to minimize thermal gradients and loss of heat in the instrument (particularly when calibrating d c.) Check the reading has stabilized before moving to the next step in the calibration procedure

After calibration procedure has been completed the instrument should be left in its normal operating position for at least one hour to ensure the internal temperature has fully stabilized If the calibration procedure is now repeated it will be possible, with relatively few adjustments, to bring the instrument to optimum calibration Steps marked* need not be completed at this final stage of calibration

Extreme care should be exercised when handling high voltages, particularly in excess of 100V

Refer to the 'Operating Manual', Section 5.2 if in doubt as to the correct use of 'Guard' during the calibration procedure.

2.2.2 Test Equipment Required

Test equipment specifications for fault finding, calibration and performance verification are given below Generally, calibration sources should only be used where the accuracy specification exceeds that of the instrument by a factor of at least 4

2.2.2.1 DC Calibrator

Output voltage ranges.	100mV*	
	1V	in 10μV increments with 100% overrange i.e 1 99999 count
	10V)	
	100V)	Source resistance < 1Ω
	1000V)	
Accuracy	0 0012% reading ± 0 0005% range ± 1μV.	

*Note – In order to overcome thermal e m f 's generated in the calibrator or leads it is recommended that a precision 100 1 attenuator (< 100kΩ source), connected directly to input terminals of instrument, is used to obtain the 100mV voltage source

2 2.2.2 AC Calibrator

Output voltage ranges	10mV, 100mV, 1V (with 100% overrange), 10V, 100V, 1000V r m s
Accuracy	0 025% reading ± 0 025% range, 40Hz – 3kHz
	0 05% reading ± 0 05% range, 3kHz – 30kHz

2.2.2 3 Precision Resistors

A set of standard resistors, i e –

1kΩ, 10kΩ, 100kΩ	± 0 0025%
1MΩ	± 0 0075%
10MΩ	± 0 1%

2.2.2 4 DC Voltmeter

A fully floating DC Voltmeter with 1μV resolution

Accuracy 0 01% reading ± 0 01% Range

2.2.2.5 Oscilloscope

Oscilloscope with sensitivity of 10mV/division and 5MHz bandwidth Horizontal and vertical controls calibrated to ± 5%

2 2.2.6 Frequency Counter

A Frequency Counter capable of measuring 500,000 Hz ± 10Hz

2.2 2.7 Current Calibrator

An AC/DC current calibrator with the following ranges

			1mA, 10mA, 100mA and 1000mA
Accuracy	(a)	DC	0 0035% reading ± 0 0005% range (1mA, 10mA and 100mA)
			0 0075% reading ± 0 001% range (1000mA)
	(b)	AC	± 0 025% reading ± 0 025% range, 40Hz – 3kHz
			± 0 05% reading ± 0 05% range, 3kHz – 30 kHz (1mA and 10mA only)

2 2.2.8 Temperature Controlled Calibration Room

Final calibration should be completed in a temperature controlled environment of 23°C ± 1°C i e if the instrument is to meet the accuracy specification given in the 'Operating Manual' over the specified temperature range

2 2 3 Procedure

2.2 3 1 General

Read Section 2 2 1 before proceeding
All adjustments are to the Analogue Board (Assembly Drawing No 400096) except where otherwise stated
Other adjustments are to

Analogue to Digital Converter Board
(Assembly Drawing No 400105)

Current Converter Board
(Assembly Drawing No 400113)

External Reference (Ratio) Board, option R04
(Assembly Drawing No 400091)

Abbreviations T P – 'Test point'

w r t – 'with respect to'

2 2.3 2 DC Voltage

*1) Connect the Frequency Counter (2 2 2 6) to T P 23 w r t T P 39 on the A–D Converter Board Adjust R112 for an indication of 500,000Hz ± 100Hz Remove the Frequency Counter

2) Apply a short circuit to the voltage input of the instrument Select 10, DCV r e the 10V d c range Adjust R38 ('pA' offset control on the front panel of the instrument) for 0 0000, bouncing polarity

3) Select 100mV DC Adjust R54 ('μV' offset control on the front panel of the instrument) for 0 000, bouncing polarity

4) Select 1, DCV Adjust R82 (A–D Converter) for 00000, bouncing polarity

*5) Connect the DC Voltmeter (2 2 2 4) to T P 2 w r t voltage input 'Lo' Adjust R68 for an indication of zero ± 20μV on the DC Voltmeter

Remove the DC Voltmeter

6) Repeat steps 2, 3 and 4 until the instrument reads zero in all ranges without further adjustment

7) Select 100mV DC Connect the DC Calibrator (2 2 2 1) to the voltage input of the instrument Select the 1V range on the calibrator and apply 0 00000V Adjust the zero control on the calibrator front panel (if available) for an indication of 0 000, bouncing polarity on the instrument

8) Select 1, DCV Apply +0 00010V Adjust R80 (+ F/F on the A–D Converter) for +9 digits, bouncing +10 digits

9) Apply –0 00010V Adjust R81 (–F/F on the A–D converter) for –9 digits, bouncing –10 digits

10) Apply +0 00100V Adjust R46 ('100 digits' on the A–D Converter) for +100 digits

11) Repeat steps 4, 8, 9 and 10 until all readings are correct without further adjustment

12) Apply +1 00000V Adjust R76 ('+1V' on the A–D Converter) for +1 00000 ± ½ digit (i.e a worst case reading of +1 00000 bouncing + 99999 or +1 00000 bouncing +1 00001)

13) Apply –1 00000V Adjust R78 ('–1V' on the A–D Converter) for –1 00000 ± ½ digit

14) Apply +1 90000 Check the reading is +1 90000 ± 5 digits

15) Apply –1 90000 Check the reading is –1 90000 ± 5 digits

16) Apply +0 01000V Check the reading is + 01000 ± 1 digit

17) Apply 0 01000V Check the reading is – 01000 ± 1 digit

18) Apply +0 10000V Check the reading is + 10000 ± 1 digit

19) Apply –0 10000V Check the reading is – 10000 ± 1 digit

20) Select 100mV DC Connect the DC Calibrator to the input via the 100 1 attenuator (see note in Section 2 2 2 1) Apply zero input Allow any thermals to stabilize then adjust R54 ('μV' offset control on the front panel of the instrument) for 0 000, bouncing polarity

21) Apply +100 00mV to the input of the instrument (i.e +10V selected on the DC Calibrator) Adjust R65 for +100 000 ± 2 digits

22) Apply –100 00mV to the input of the instrument Check the instrument reads –100 000 ± 4 digits Remove the DC Calibrator and 100 1 attenuator

23) Connect the 10MΩ resistor (2 2 2 3) to the voltage input terminals Check the reading settles to less than 450 digits Remove the 10MΩ resistor

24) Select 10, DCV Connect the DC Calibrator (2 2 2 1) to the voltage input terminals Apply +10 0000V Adjust R13 for +10 0000 ± ½ digit (i e. a worst case reading of +10 0000 bouncing to +9 9999 or +10 0000 bouncing +10 0001)

25) Apply –10 0000V Check the reading is –10 0000 ± 2 digits.

26) Select 100, DCV Apply +100 000V Adjust R9 for a reading of +100 000 ± ½ digit

27) Apply –100 000V Check the reading is –100.000 ± 2 digits.

28) Select 1000, DCV Apply +500 00V. Adjust R5 for +500 00V ± ½ digit

29) Apply +1000 00V Check the reading is +1000 00 ± 6 digits

NOTE – When applying 1000V.–

i) Check the DC Calibrator (2 2 2 1) does not exhibit excessive overshoot (i e < 10%) whenthe 1000V range is selected If in doubt, or if overshoot is excessive, increase output from calibrator gradually in 100V steps Transients exceeding the maximum working voltage may cause internal damage

ii) Switch DC Calibrator for zero output before applying the opposite polarity – since a 2000V edge (i.e. from +1000V to –1000V) may damage the instrument.

iii) Take care to ensure that greater than 500V is not applied between input 'Lo' and earth

30) Apply –1000 00V. Check the reading is –1000.00V ± 6 digits

31) Switch the DC Calibrator to zero output. Remove the DC Calibrator

2.2.3.3. Resistance

32) Apply a short circuit to the resistance input terminals Select 1kΩ. Adjust R45 for an indication of 00000 ± 1 digit

NOTE: If long leads to the precision resistors are to be used their resistance must be accounted for either by nulling out their lead resistance i.e by applying them as the short circuit in step 32 or, by calibrating the instrument high by the amount of measured lead resistance.

*33) Select 10, kΩ Check the reading is 0 0000 ± 1 digit.

*34) Select 100, kΩ Check the reading is 0.000 ± 1 digit.

*35) Select 1000, kΩ Check the reading is 0.00 ± 1 digit.

*36) Select 10MΩ. Check the reading is 0 0000 ± 1 digit Remove the short circuit from the input.

37) Select 10, kΩ Apply the 10kΩ Standard Resistor (2 2 2 3) to the resistance input Adjust R72 for a reading of 10.0000 ± 1 digit.

Remove the 10kΩ Standard Resistor.

38) Select 1, kΩ Apply the 1kΩ Standard Resistor (2 2 2 3) to the resistance input Adjust R15 for a reading of 1 00000 ± 2 digits

Remove the 1kΩ Standard Resistor

39) Select 100, kΩ Apply the 100kΩ Standard Resistor (2 2 2 3) to the resistance input Adjust R11 for a reading of 100 000 ± 2 digits

Remove the 100kΩ Standard Resistor

*40) Apply the 10kΩ Standard Resistor (2 2 2 3) to the resistance input Check the reading is 10 000 ± 1 digit

Remove the 10kΩ Standard Resistor

*41) Apply the 1kΩ Standard Resistor (2 2 2 3) to the resistance input Check the reading is 1 000 ± 1 digit

Remove the 1kΩ Standard Resistor

42) Select 1000, kΩ Apply the 1MΩ Standard Resistor (2 2 2 3) to the resistance input Adjust R7 for a reading of 1000 00 ± 3 digits

43) Select 10MΩ Adjust R84 for a reading of 1 0000 ± 5 digits

Remove the 1MΩ Standard Resistor

44) Apply the 10MΩ Standard Resistor (2 2 2 3) to the resistance input Check the reading settles to 10 0000 ± 250 digits

Remove the 10MΩ Standard Resistor

45) If the instrument has been zeroed as described in step 32, with long leads

Select 1, kΩ Apply a short circuit link to the resistance input Adjust R45 for an indication of 00000 ± 2 digits

2 2.3 4 AC Voltage

*46) Select 1, ACV Apply short circuit to voltage input Connect the DC voltmeter (2 2 2 4) to T P 6 w r t 'Voltage' input 'Lo' Adjust R105 for an indication of zero ±50μV on the DC voltmeter

Remove the Dc voltmeter

*47) Apply a short circuit to the voltage input terminals Connect the Oscilloscope (2 2 2 5) set to 100mV/ division, to T.P.8 w r t 'Lo' Adjust R119 for an indication of zero

NOTE Due to the high gain of this non-linear circuit at zero, the output will appear very 'noisy' as zero is approached The best zero is obtained when this noise is symmetrical about zero

Remove the Oscilloscope

*48) Connect the DC voltmeter (2 2 2 4) to T P 9 w r t 'Lo' Adjust R131 to obtain a positive indication on the DC voltmeter of approximately +0.3V (This should correspond to a minimum reading on the instrument's display).

*49) Connect the DC voltmeter to T P 11 w.r t 'Lo'. Adjust R147 for an indication on the DC voltmeter of −1mV ± 0 1mV

Remove the DC voltmeter

*50) Connect the Oscilloscope (2 2 2 5) to T P 12 w r t 'Lo' Adjust R150 for a 'noisy' zero

Remove the Oscilloscope

*51) Adjust R147 for a reading of .00000 ± 2 digits on the display.

Remove the short circuit from the voltage input.

*52) Connect the AC Calibrator (2 2 2 2) to the voltage input of the instrument Apply 10mV r m s 300Hz Adjust R131 for a reading of 00990 ± 3 digits

Remove the AC Calibrator

*53) Repeat step 47

Remove the short circuit from the input

54) Select 1, DCV + ACV Connect the DC Calibrator (2 2 2 1) to the voltage input

i) Apply +1 00000V Note the reading

ii) Apply –1 00000V Adjust R126 for the same reading as obtained in 54(i) ± 20 digits

Remove the DC Calibrator

55) Select 1 ACV Connect the AC Calibrator (2 2 2 2) to the voltage input Apply 1V r m s 300Hz Adjust R157 for 1 00000 ± 10 digits

Remove the AC Calibrator

*56) Repeat in sequence given, steps 47, 52, 54 and 55 until all readings are correct without further adjustment

57) Connect the AC Calibrator (2 2 2 2) to the voltage input Apply 1 9V r m s , 300Hz Check the reading is 1 90000 ± 100 digits

58) Apply 100mV r m s 300Hz Check the reading is 10000 ± 50 digits

59) Apply 1mV r m s , 300Hz Check the reading is 00100 ± 50 digits

Remove the AC Calibrator

60) Apply short circuit input Check the reading is 00000 ± 50 digits

Remove the short circuit input

61) Connect the AC Calibrator (2 2 2 2) to the voltage input Apply 1V r m s , 30kHz Adjust C40 for a reading of 1 00000 ± 10 digits

62) Apply 1V r m s at the following frequencies and check the response-

3kHz,	1 00000	±	50 digits
300Hz,	1 00000	±	20 digits
40Hz,	1 00000	±	50 digits

CAUTION High voltages may appear on the input attenuator trimmers C2, C4 and C7 Only an adjusting tool which has a totally insulated body (to higher than the maximum output voltage capability of the A C Calibrator, 2 2 2 2) should be used DO NOT use an insulated handle screw driver

63) Select 1000, ACV Apply 700V r m s , 3kHz Adjust C7 for a reading of 700 00 ± 10 digits

64) Apply 100V r m s , 3kHz Select 100, ACV Adjust C4 for a reading of 100 000 ± 10 digits

65) Apply 10V r m s , 3kHz Select 10, ACV Adjust C2 for a reading of 10 0000 ± 10 digits

66) Repeat steps 63, 64 and 65 until the specified reading is obtained at each step without further adjustment

67) Select 1000, ACV Apply 700V r m s and check the frequency response at the following frequencies

3kHz,	700 00	±	100 digits
300Hz,	700 00	±	100 digits
40Hz,	700 00	±	100 digits

If necessary, re-adjust C7 to give the best average accuracy over this band

68) Apply 100V r m s Select 100, ACV and check the frequency response at the following frequencies

30kHz,	100 000	±	200 digits
3kHz,	100 000	±	100 digits
300Hz,	100 000	±	100 digits
40Hz,	100 000	±	100 digits

If necessary, re-adjust C4 to give the best averaged accuracy over this band

69) Apply 10V r m s Select 10, ACV and check the frequency response at the following frequencies

30kHz,	10 0000	±	200 digits
3kHz,	10 0000	±	100 digits
300Hz,	10 0000	±	100 digits
40Hz,	10 0000	±	100 digits

If necessary, re-adjust C2 to give the best averaged accuracy over this band

Remove the AC Calibrator

2.2 3.5 **DC Current.**

70) Select 1, DCI Connect the Current Calibrator (2 2 2 7) to the current input terminals Apply +1mA Adjust R17 on the Current Converter Board for a reading of +1 00000 ± 1 digit

NOTE A common gain adjustment, R60 is provided in the d c isolator which should not normally require adjustment If, however, the x2 feedback network in the d c isolator has been disturbed it may be found that the four range adjustments on the Current Board are at the extent of their travel and the ranges cannot be calibrated In this instance R60 should be adjusted so that all range adjustments are brought back to approximately the centre of their spans and the calibration procedure repeated.

71) Apply -1mA Check the reading is –1 00000 ± 5 digits

72) Select 10, DCI Apply +10mA Adjust R12 (Current Board) for a reading of +10 0000 ± 1 digit

73) Apply –10mA Check the reading is –10 0000 ± 5 digits

74) Select 100, DCI Apply +100mA Adjust R9 (Current Board) for a reading of +100 000 ± 1 digit

75) Apply – 100mA Check the reading is –100 000 ± 5 digits

76) Select 1000, DCI Apply +1000mA Adjust R6 (Current Board) for a reading of 1000 0 ± 1 digit

77) Apply –1000mA Check the reading is –1000 00 ± 5 digits

*78) Select 1, DCI Increase the input current to the instrument and check that the protection relay 'drops out' and the display blanks when the input current is greater than 2 5mA and less than 3mA Immediately the display blanks remove the overload, check the protection relay 'pulls in' and the display is no longer blanked after a period of greater than 8 seconds and less than 15 seconds

2.2.3.6 **AC Current:**

79) Select 10, ACI Apply 10mA r m s 300Hz. Adjust R115 for an indication on the display of 10 0000 ± 20 digits

80) Apply 10mA r m s at the following frequencies and check the frequency response

30kHz,	10 0000	±	200 digits
3kHz,	10 0000	±	100 digits
300Hz,	10 0000	±	100 digits
40Hz,	10 0000	±	100 digits

81) Select 1, ACI Apply 1mA r m s at the following frequencies and check the frequency response

30kHz,	1 00000	±	200 digits
3kHz,	1 00000	±	100 digits
300Hz,	1 00000	±	100 digits
40Hz,	1 00000	±	100 digits

82) Select 100, ACI Apply 100mA r m s at the following frequencies and check the response

3kHz,	100 000	±	100 digits
300Hz,	100 000	±	100 digits
40Hz,	100 000	±	100 digits

83) Select 1000, ACI Apply 1000mA r m s at the following frequencies and check the response

3kHz,	1000 000 ±	100 digits
300Hz,	1000 000 ±	100 digits
40Hz,	1000 000 ±	100 digits

*84) Select 1, ACI Increase the input current (at 300Hz) to the instrument and check that the protection relay 'drops Out' and the display blanks when the input current is greater than 2 4mA r m s (sine) and less than 3 6mA r m s

Remove the Current Calibrator

2 2.3.7 External Reference

The following steps only apply when External Reference (ratio), option R04 is fitted

Polarity Quadrant definitions –

Quadrant 1 – positive signal, positive external reference
2 – positive signal, negative external reference
3 – negative signal, positive external reference
4 – negative signal, negative external reference

85) Select External Reference on the rear panel slide switch Select 1, DCV Connect the DC Calibrator (2 2 2 1) to the voltage input terminals on the front panel of the instrument and the external reference 'Signal Inputs' to obtain a voltage ratio as defined by quadrant 1 when positive signal is applied

86) Apply +0 3V and –0 3V alternatively (i e from quadrant 1 to 4) and adjust R24 (on the External Reference Board) to obtain the same reading on the display ± 2 digits for both quadrants (allow adequate settling time when changing quadrants)

87) Apply +2V and adjust R14 (on the External Reference Board) for a reading on the display of 1 00000

88) Connect the external reference 'Signal Inputs' to obtain a voltage ratio as defined by quadrant 2 when a positive signal is applied Select External Reference

Apply +0 3V and –0 3V alternatively (i e from quadrant 2 to quadrant 3) and adjust R79 ('Ref Zero' on the A–D Converter Board) to obtain the same reading on the display ± 2 digits for both quadrants

89) Select Internal Reference Apply –1V Adjust R78 ('–1V' on the A–D Converter Board) for a reading of –1 00000 ± ½ digit

90) Select External Reference Apply –2V (i e in quadrant 3) and adjust R19 (on the External Reference Board) for a reading on the display of –1 00000

91) Repeat steps 88 to 89 until the readings are correct without any further adjustment

92) Repeat steps 85 to 90 until the readings are correct without any further adjustment

This completes the routine calibration procedure and the covers should be secured

2 3 REPAIR AND COMPONENT REPLACEMENT

2.3 1 General

IT IS RECOMMENDED THAT THIS SECTION BE NOTED BEFORE UNDERTAKING ANY REPAIR

A fault in the analogue circuitry will require the internal Guard Shields removing for access to the components and subsequent recalibration Digital integrated circuits are fitted in sockets and can be replaced without disturbing the calibration of the instrument (although it is advisable to verify the performance after any component change)

The method of manufacture evolved by DATRON to ensure high reliability and stability involves elevated temperature 'burn-in' at both component and instrument level In addition, operational amplifiers and other devices are selected for certain parameters Hence many of the components used, although were originally of a standard type, have a performance which can only be identified by a DATRON part number These devices are held as stock items by DATRON who should be contacted if replacement is necessary

Replacement of certain active devices and precision resistors also necessitates the re-selection of their associated F.S V [Factory Selected Value] resistors to accommodate component tolerances These resistors, often high stability, metal film types are used to preset an offset or reference setting, usually with fine adjustment provided by an associated potentiometer Procedures for selecting these resistors are given in Section 2 3 2

Replacement of analog components should be followed by recalibration of the relevant part of the circuit as described in Section 2 3 2 Full routine calibration should then be carried out to ensure the instrument is within specification – if in any doubt consult our Customer Service Department

When replacing semiconductor devices take great care to avoid overheating them during soldering each joint being made as rapidly as possible Although the use of a thermal shunt between semiconductor device and the soldered joint is strongly recommended, it is realised that it is impractical to use one in many instances particularly when unsoldering a multi-lead device from a high density circuit board, a suction de-soldering tool is recommended

When working on the isolator board, special consideration should be given to the effects of board leakage Although active guarding is used extensively to reduce these effects, it should be borne in mind because of the high input impedance and sensitivity involved

2.3.2 Adjustments following component replacement

These procedures should be carried out with all boards mounted in the instrument Guard shields should be removed to enable F S V's to be changed where necessary (This will make the instrument slightly more 'noisy' than in normal operation with the shields fitted)

Before proceeding with any adjustments the instrument should be allowed a 30 minute warm-up period after switch on

NOTE – A small amount of interaction exists between certain controls, also the adjustment of certain controls has an effect which may not be immediately noticeable, i e zero drift with temperature. The user is therefore warned not to follow blindly all the sequences described, but to read and understand the reason behind each procedure, before embarking upon any actual adjustments on his own account This approach should minimize the amount of time spent on recalibration, and in a number of instances, will eliminate upsetting preset adjustments which are already correctly set

When the necessary procedures have been completed all F S V resistors should be soldered in position, the guard shields re-fitted, the instrument covers placed, but not secured, in position and a routine calibration carried out as specified in Section 2 2

2.3.2.1 Special Test Equipment

HIGH CREST FACTOR SIGNAL

A precision pulse train of approximately 5 1 crest factor and 100Hz repetition frequency The d c coupled output level to be 1V r.m s ± 0 05%

NOTE This item is only required for the a c. voltage procedure to set the linearity of the r m s converter for a high crest factor signal Advice on construction of a suitable piece of test equipment is available from our Customer Service Department

TEMPERATURE CONTROLLED OVEN
A Temperature Controlled Oven capable of maintaining the instrument at a known temperature of approximately 50°C Preferably with glass inner door, if available

THERMOMETER
A Thermometer to read the ambient temperature

NOTE. The above two items are only necessary after replacement of M9 on the Analogue Board

HEAT SOURCE
A temperature controlled heat source to heat an integrated circuit (TO–5 can) to a case temperature of 30°C ± 3°C above ambient

NOTE This item is only necessary when M1, M2 or M3 has been replaced on the External Reference option

2.3 3 Analogue to Digital Converter Board – Assembly Drawing No 400105

Adjustments and calibration are to the A–D Converter Board unless otherwise stated

Equipment required is as specified in Section 2 2 2 1, 2 2 2 4, 2 2 2 5, 2 2 2 6

1) Set all preset potentiometers to the centre of their span Ensure that R88 and R96 are fitted (100MΩ) In the case where Q1 has been replaced, remove the protection link on the device Switch out S1 S2 and S3 Select 1, DCV on the Analogue Board and apply short circuit to voltage input
2) Connect the D C Voltmeter to T P 33 w r t (with respect to) T P 39 Check the voltage is +5V ±0 25V
3) Connect the D C Voltmeter to T P 32 w r t T P 39 Check the voltage is –8 2V ± 0 3V
4) Connect the D C Voltmeter to the positive end of C108 w r t T P 39 Check the voltage is 165V ± 20V
5) Connect the D C Voltmeter to the output pad 6 at the rear of the board w i t T P 19 Check the voltage is +15V ± 0 75V
6) Connect the D C Voltmeter to the output pad 4 at the rear of the board w r t T P 19 Check the voltage is –15V ± 0 75V
7) Connect the D C Voltmeter to T P 12 w r t T P 19 Check the voltage is –10V ± 1V
8) Connect the D C Voltmeter to T P 4 w i.t T P 19 Check the voltage is +11V ± 0 5V
9) Connect the D C Voltmeter to T P 2 w r.t T P 19 Check the voltage is –5V +0V, –0 25V
10) Connect the D C Voltmeter to T P 3 w r t T.P 19 Check the voltage is +5V +0 25V, –0V
11) Connect the Oscilloscope to M47 input (pin nearest rear of board) w r t T P 19 Check for 100Hz ripple (not 50Hz – i e the rectifier bridge, W2, is working correctly)
12) Connect the Oscilloscope to M48 input (pin nearest rear of board) w r t T P 19 Check for 100Hz ripple (not 50Hz – i e the rectifier bridge, W3, is working correctly)
13) Connect the Oscilloscope to M50 input (pin nearest rear of board) w r t T P 39 Check for 100 Hz ripple (not 50Hz – i e the rectifier bridge, W1, is working correctly)
14) Connect the Oscilloscope to T P 23 w i t T P 39 Check for clock pulses of approximately 2μS period, 5V amplitude
15) Connect the Frequency Counter to T P 23 w i t T P 39 Adjust R112 to produce a clock frequency of 500kHz ± 100 Hz
16) Connect the Oscilloscope to M21, 6 w r t T P 39 Check for 'Command' pulses of approximately 100μS duration and repetition frequency of 3/second These should be of approximately 5V amplitude
17) Press 'HOLD' switch S1, and observe that 'Command' pulses observed in step 16 disappear Release S1.
18) Connect the Oscilloscope to T P 24 w r t T P 39 Check for 'Sig' pulses, negative going, of 20mS duration These should be of approximately 5V amplitude
19) Connect the Oscilloscope to T P 11 w r t T.P 19. Check for 'Sig' pulses, negative going, of 20mS duration These should be of approximately 30V amplitude.
20) Press 'HOLD' switch, S1 Check that 'Sig' pulses observed in step 19 disappear and the voltage at T P.11 is steady at approximately +15V (i e the analogue section of the A–D Converter is in the 'Reset' condition)
21) Connect the Oscilloscope to T P 1 w r t T P 19 Adjust R3 for less than 50mV (Allow sufficient time for 'Reset' to come out of saturation)
22) Connect the Oscilloscope to T P 10 w r t T P 19 Adjust R82 to produce a noisy signal of amplitude from 0V to +15V

23) Connect the Oscilloscope to T P 28 w r t T P 39 Check for a noisy signal, similar to that obtained in step 22, of 5V amplitude

24) Release 'HOLD' switch S1 The display on the instrument should read all zeros ±30 digits. Adjust R82 for a display of ± 00000, bouncing polarity If it is not possible to achieve this, then it is acceptable to set R82 for bouncing polarity only (e g +4 bouncing to −3)

25) Select

(a) all 'Ranges' in turn Check –

(i) When '1' (DCV) is selected that d p 1 is 'on' i e the display is ± 0000X (X need not be zero)

(ii) When '10' is selected that d p 2 is 'on' i e the display is ±0 000X

(iii) When '100' is selected that d p 3 is 'on' i e the display is ±*0 00X (* represents leading zero digit which is 'off')

(iv) When '1000' is selected that d p 4 is 'on' i e the display is ±**0 0X

(b) 100 mV D C Check as (a)(iii)

(c) 10MΩ Check as (a)(ii)

26) Select all 'Functions' in turn and check that the polarity sign is only displayed in the D C functions

27) Switch to 1 DCV Apply a d c input signal of greater than 2V and check that the display blanks without leaving any digit segments or decimal points glowing ('keep-alive' cathodes will still be illuminated but these should be masked by tape)

28) Apply + 1 9V to the input terminals Check that the display segments are of equal brightness and free from 'streamers' (ionization of display where not required)

29) Press 'HOLD' switch. S1 Connect the Oscilloscope to T P 9 w r t T P.19. Check the wideband noise level and 100 Hz content is less than 400 mV peak to peak. (A reduction in the 100Hz content may be achieved by slackening the mounting screw and rotating the mains transformer T4 if noise is in excess of 400mV peak to peak)

30) Apply short circuit input Select 1, DCV Adjust R82 for 0000X bouncing polarity

31) Press momentarily, 'MANUAL' switch S2 Check that another reading is taken

32) Apply +1V Select, F'S'V' resistors R70 and R71 to obtain a display of +1 00000 ±20 digits (If value of R70 or R71 is less than 1MΩ, use 50ppm/°C metal film resistors)

33) Apply −1V Select F S V R43 (typically 3M3) and adjust R78 for a display of −1 00000 ±20 digits

34) Recheck step 30

35) Apply +100μV Adjust R80 to produce a display of + 00009 to + 00010

NOTE If the span of R80 is insufficient, return R80 to mid-travel and select F S V R94 to produce a display of + 00010 ±3 digits, then use R80 to produce a display of + 00009 to + 00010

36) Apply +1mV Adjust R46 to produce a display of + 00100 ±1 digit

37) Repeat steps 34 to 36 until no further adjustment is necessary

38) Apply 100μV Adjust R81 for a display of 00009 to + 00010

39) Apply short circuit input Check that the display reads zero ± 1 digit

40) Apply short circuit input Select 10 DCV Adjust R38 'pA' offset control on front panel of instrument for ± 0 0000, bouncing polarity

41) Select 100mV D C Adjust R54 μV' offset control on front panel of instrument for ± 0 000 bouncing polarity

42) Select 1 DC V Adjust R82 for a reading of ± 00000, bouncing polarity

43) Repeat steps 40, 41 and 42 until the instrument reads zero in all ranges without further adjustment

44) Repeat steps 35, 36, 38 and 42 until all readings are correct without any further adjustment

45) Apply + 1V Adjust R76 for a reading of +1 00000 ± 2 digits

46) Apply –1V Adjust R78 for a reading of –1 00000 ± 2 digits

47) Apply + 1 9V Note the reading on the display

(a) If the display is (reading in step 45 x 1 9) ± 4 digits, then proceed to 48

(b) If the display is greater than (reading in step 45 x 1 9) + 4 digits, then –

(i) Cut out R96

(ii) Select F S V R89 (try 1MΩ initially), Reducing R89 will reduce reading

(iii) Repeat from step 45

(c) If the display is less than (reading in step 41 x 1 9) 4 digits, then

(i) Cut out R88

(ii) Select F S V R89 (try 1MΩ initially) Reducing R89 will increase reading

(iii) Repeat from step 45

48) Apply -1 9V The reading on the display should be (reading in step 46 x 1 9) ± 4 digits

49) Apply short circuit input Check the display for noise at zero This should be less than ½ digit e g 00001 bouncing 00002

50) Apply +1V Check the display for noise at 1V This should be less than 1 digit e g +1 00000 through +1 00001 to +1 00002

51) Apply +1 9V Check the display for noise at 1 9V This should be less than 1 digit e g +1 90002 through +1 90003 to +1 90004

2 3.4 Analogue Board – Assembly Drawing No. 400096

Adjustments and calibration are to the Analogue Board unless otherwise stated

2.3 4.1 Preliminary Checks

1) Select all 'Functions' in turn Check –

a) The polarity sign on the display is displayed in the following 'Functions' only
100mV DC, DCV and DCI

b) In 100mV DC check d p (decimal point) 3 is 'on' (Instruments display)

c) In 10MΩ check d p 2 is 'on'

d) The appropriate L E D (light emitting diode) is 'on'

e) The 'Range' L E D is cancelled when 100mV DC or 10MΩ is selected

2) Select DCV then select all 'Ranges' in turn Check

a) When '1' is selected, check d p 1 is 'on'

b) When '10' is selected, check d p 2 is 'on'

c) When '100' is selected, check d p 3 is 'on'

d) When '1000' is selected, check d p 4 is 'on'

e) The appropriate L E D is 'on' (except in 100mV DC or 10MΩ)

2 3 4 2 **DC Voltage**

Equipment required is as specified in Sections 2 2 2 1, 2 2 2 4, 2 2 2 5

1) Select 1, DCV Apply short circuit to the voltage input terminals Check the bootstrapped supplies are present at T P (test point) 3 (+10V) and T P 5 (–10V) w r t (with respect to) T P 2 (B S common) Check the supplies do not oscillate with the Oscilloscope

2) Check with Oscilloscope no oscillation occurs at T P 6 when the following are selected 100mV DC, 1, DCV, 10, DCV

3) Where the dc isolator, M9 has been replaced complete steps 1) to 4) of the Zero Drift Compensation procedure, Section 2 3 4 3

4) Select 100mV DC Short together the pins marked 'GND I/P' on the analogue board Connect the DC Voltmeter to T P 2 w r t T P 15 and adjust R68 for an indication of zero ± 20μV on the DC Voltmeter Remove the DC Voltmeter

5) Set the 'μV' offset potentiometer, R54 on the front panel of the instrument to the centre of its span Set the instruments display to 0 000 ± 20 digits by selection of F S V resistors R50, R51 and a link between R50 and +BS or –BS Use metal film resistors (50ppm/°C) if total resistance of R50 and R51 is below 1MΩ

6) Adjust R54 for an indication of 0 000, bouncing polarity

7) Remove the short circuit from the 'GND I/P' pins and replace with a short across the voltage input terminals

8) Select 10, DCV Adjust the 'pA' offset control, R38 on the front panel of the instrument for 0 0000, bouncing polarity

9) Select 100mV DC Adjust R54 for an indication of 0 000, bouncing polarity

10) Select 1, DCV Adjust R82 (on the A–D Converter) for 00000, bouncing polarity

11) Repeat steps 8, 9 and 10 until the instrument reads zero at all steps without further adjustment.

12) Select 1, DCV Apply + 00010V, adjust R80 ('+F/F' on the A–D Converter) for +9, bouncing +10 digits

13) Apply – 00010V, adjust R81 ('–F/F' on the A–D Converter) for –9, bouncing –10 digits

14) Apply + 00100V, adjust R46 ('100 digits' on the A –D Converter) for +100 digits.

15) Apply S/C input Check reading is 00000, bouncing polarity If not, repeat steps 8–14

16) Apply +1 00000V, adjust R76 ('+1V' on the A–D Converter) for +1 00000 ± 1 digit

17) Apply –1 00000V, adjust R78 ('–1V' on the A–D Converter) for –1 00000 ± 1 digit

18) Apply +1 90000V Check reading is +1 90000 ± 5 digits

19) Apply –1 90000V Check reading is –1 90000 ± 5 digits

20) Apply short circuit input and repeat step 9

21) Apply +100 000mV adjust R65 for +100 000 ± 2 digits

22) Apply –100 000mV, check instrument reads –(reading obtained in step 21) ± 4 digits

NOTE If changing polarity involves reversing leads, check zero again as thermal e m f 's may have changed If possible reverse polarity at a higher potential i e through an attenuator, so as not to change thermals

23) Select 10, DCV Apply +10 0000V, adjust R13 for +10 0000 ± 1 digit

24) Apply –10 0000V, check reading is –10 0000 ± 3 digits

25) Select 100, DCV Apply +100 000V, adjust R9 for +100 000 ± 1 digit

26) Apply –100 000V, check reading is –100 000 ± 3 digits

27) Select 1000, DCV Apply +500 00V, adjust R5 for +500 00 ± 1 digit

28) Apply +1000 00V, check reading is +1000 00 ± 10 digits

NOTE When applying 1000V

i) Check the DC Calibrator (2 2 2 1) does not exhibit excessive overshoot (i e <10%) when the 1000V range is selected If in doubt, or if overshoot is excessive, increase output from calibrator gradually in 100V steps Transients exceeding the maximum working voltage of the instrument may cause internal damage

ii) Switch to zero before applying the opposite polarity since a 2000V edge (i e from +1000V to –1000V) may damage the instrument

iii) Take care to ensure that 1000V does not appear between input 'Lo' and earth, if in any doubt apply 500V

29) Apply –1000 00V, check the reading is –1000 00 ± 10 digits

2.3.4.3 DC Isolator – Zero Drift Compensation

This procedure should be carried out following replacement of M 9 Covers and guard shields need not be fitted throughout the procedure Equipment required is a temperature controlled oven and thermometer as specified in Section 2 3.2 1

1) Select 100mV DC Set the 'μV' offset potentiometer, R54 on the front panel of the instrument to the centre of its span Remove F S V's R50 and R51, R42 and R43 Connect the DC Voltmeter to T P 2 w r t T P 15 Short together the pins marked 'GND I/P' on the analogue board Adjust R68 for the same voltage indication on the DC Voltmeter as on the instruments own display ± 50μV.

2) Zero instruments display with F S V resistors R42 and R43 ± 20 digits Do not solder in these resistors Use metal film resistors (50ppm/°C) for values below 1MΩ

3) Adjust R68 for same voltage indication on the DC Voltmeter as on the instruments display ± 20μV

4) Repeat steps 2 and 3 if the instruments displayed zero is greater than 20 digits Remove the DC Voltmeter from T P 2

5) Complete the pre-calibration procedure given in Section 2 3 4.2, paragraphs 6 to 19 to ensure that the d c isolator functions correctly

6) Select 100mV DC Apply a short circuit input to the instrument and zero the display using the 'μV' offset control, R54 Note the ambient temperature with the Thermometer

7) Place the instrument in the Temperature Controlled Oven at approximately 50°C with power 'on'.

8) Leave the instrument in the Oven for at least one hour then note the reading on the display and the temperature of the oven (Take care not to create draughts when opening the oven door, an oven with glass inner door is ideal if available)

9) Compute

a) the drift of the instrument in μV

i e Drift = ± Displayed offset in Oven (Step 8) ± Displayed offset at ambient (step 6)

b) The temperature rise of the instrument in °C

i e Temperature rise =Oven temperature (step 8) –
Ambient temperature (step 6)

c) The offset drift per degree of temperature rise

i e Drift/°C = ± Drift/Temp rise = step 9(a)/step 9(b)

The maximum drift should be less than 0 4μV/°C

10) If the drift is greater than 0 4μV/°C the following procedure is repeated until the drift is within the required specification If the drift is within 0 4μV/°C Complete steps 19 and 20

11) Remove the instrument from the Oven and allow to stabilize, with power 'on' to ambient for one hour

12) Compensation is achieved by adjusting R42 and R43 to produce an offset in the opposite direction to the drift obtained in step 9(c) The magnitude of the offset is $\frac{\Delta Vt}{6\ 6}$ mV where ΔVt is the calculated drift in μV/°C

e g If the drift is measured as +100μV in a temperature rise of 30°C, then the drift/°C is +100μV/30°C = +3 3μV/°C Hence the compensation required is

$$\frac{\Delta Vt}{6\ 6}\ mV = \frac{3\ 3}{6\ 6}\ mV = 500\mu V$$

Since the drift was positive this would require negative compensation i e –500μV Hence, if the temperature rise is approximately 30°C, then the magnitude of the offset should be about 5 times the magnitude of this drift The 5 1 factor should be reduced if it over compensates

Do not solder in position R42 or R43

13) Connect the DC Voltmeter to T P 2 w r t T P 15 and adjust R68 for an indication of zero ± 20μV on the d c voltmeter

14) In general after step 12 there will be a fixed offset which must be zeroed without affecting the temperature compensation This is achieved by selecting a link between R50 and +BS or –BS (at T P 3 and T P 5 respectively) and selecting R50 and R51 to reduce the offset to zero ± 20 digits with R54 adjusted to the centre of its span Do not solder R50 or R51 into position

15) Adjust R54, 'μV' offset, for zero indication on the instruments display

16) Select 10, DCV and zero the instruments display by adjustment of R38 'pA' offset

17) Repeat steps 15 and 16 until the display reads zero without further adjustment

18) Repeat the above procedure from step 6 until the drift obtained in step 9(c) is less than 0 4μV/°C

19) Select 100mV DC and check R54, 'μV' offset has at least 0 ± 50 digits of span If necessary repeat step 14

20) Solder in all F S V resistors and refit the environmental shild over M 9

2.3.4.4 Resistance

Equipment required is as specified in Section 2 2 2 3

1) Apply S/C to resistance input terminals Select 1,kΩ and adjust R45 for 00000 ± 3 digits

Note If long leads to the precision resistors are to be used their resistance must be accounted for either by nulling out their lead resistance i e by applying them as the S/C in step 1 or, by calibrating the instrument high by the amount of measured lead resistance

2) Select 10, kΩ Check reading is zero ± 1 digit

3) Select 100, kΩ Check reading is zero ± 1 digit

4) Select 1000, kΩ Check reading is zero ± 1 digit

5) Select 10MΩ Check reading is zero ± 1 digit

6) Apply 10kΩ to resistance input terminals Select 10, kΩ. Set R72 to the centre of its span and select R73 F S V for 10 0000 ± 50 digits Use a metal film resistor (<50ppm/°C) for R73

7) Adjust R72 for a reading of 10 0000 ± 1 digit

8) Select 1, kΩ Apply 1kΩ, adjust R15 for 1.00000 ± 2 digits

9) Select 100, kΩ Apply 100kΩ, adjust R11 for 100 000 ± 2 digits

10) Apply 10kΩ, check reading is 10 000 ± 1 digit

11) Apply 1kΩ, check reading is 1 000 ± 1 digit

12) Select 1000, kΩ Apply 1MΩ, adjust R7 for 1000 00 ± 5 digits

13) Select 10MΩ Apply 1MΩ, adjust R84 for 1 0000 ± 5 digits

14) Apply 10MΩ, check reading is 10.0000 ± 200 digits

2.3.4.5 AC Voltage

DC checks –

Equipment required is as specified in Section 2 2 2 1, 2 2 2 4, 2 2 2.5 and a High Crest Factor Signal as specified in Section 2 3.2 1

1) Select 1, DCI + ACI Connect the DC Voltmeter to T P 6 w r t T P 15 Set R105 to the centre of its span, select R107 and R108 for an indication on the DC Voltmeter of zero ±500μV

2) Adjust R105 for an indication of zero ± 50μV on the DC Voltmeter

3) (a) Select 1, ACV Check the output at T P 6 on the DC Voltmeter is zero ± 150μV

(b) Select 1, DCV + ACV Check the output at T P 6 on the DC Voltmeter is zero ± 150μV

4) Apply short circuit input Connect the Oscilloscope (set to 100mV/division) to T P 8 w r.t T P 15 and adjust R119 for an indication of zero

NOTE – Due to the high gain of this non-linear circuit at zero the output will appear very 'noisy' as zero is approached. The best zero is obtained when this noise is symmetrical about zero

5) Connect the DC Voltmeter to T.P 9 w r t T P.15 Adjust R131 to obtain a positive reading which should be approximately +0.3V (If necessary use F S.V resistors R130 and R133 selected so that the d c voltmeter just reads positive (+0 3V) with R131 set at the centre of its span

6) Connect the DC Voltmeter to T P 11 w r t T P 15 Adjust R147 for an indication of –1mV ± 0 1mV.

7) Connect the Oscilloscope (set to 100mV/division) to T P 12 w r t T P 15 Adjust R150 for 'noisy' zero.

8) Adjust R147 for an indication on the instruments display of zero ± 3 digits

9) Apply +10mV Adjust R131 for 00990 ± 5 digits

10) Repeat step 4

11) Set R126, R138 and R157 to the centre of their spans

(a) Apply +1V and note the reading on the display

(b) Apply –1V and select F S V R124 for the same reading obtained in 11(a) ± 800 digits Adjust R126 to obtain the same reading ± 10 digits

12) Apply +1V. Select F S V. R155 for an indication of 1 00000 ± 400 digits Adjust R157 for 1 00000 ± 10 digits

13) Apply the High Crest Factor signal of 1V r m s (2 3 2 1) Adjust R138 for 1.00000 ± 10 digits

14) Repeat, in sequence given, steps 12, 13, 4, 9, 4, 11, 12 and 13 until all readings are correct without any further adjustment

15) Apply +1 9V Select F S V R143 for 1 90000 ± 50 digits

16) Repeat steps 12 and 15 until the readings are correct without further adjustment

17) Repeat steps 4, 9, 11, 12, 13 and 15, until all readings are correct without further adjustment

18) Apply –1 9V Check the reading is 1 90000 ± 100 digits

19) Select 10, DCV + ACV Apply +10V, check the reading is 10.0000 ± 50 digits

AC Checks –

Equipment as specified in Section 2 2 2 2

20) Select 1, ACV Apply 1V r m s , 300Hz Adjust R157 for 1 00000 ± 10 digits

21) Apply 1 V r m s , 30kHz Adjust C40 for 1 00000 ± 10 digits

22) Apply 1V r m s at the following frequencies and check the response.–

3kHz, 1 00000 ± 50 digits
300Hz, 1 00000 ± 20 digits
40Hz, 1 00000 ± 50 digits

CAUTION High voltages may appear on the input attenuator trimmers C2, C4 and C7 Only an adjusting tool which has a totally insulated body (to higher than the maximum output voltage capability of the A C Calibrator, 2 2 2 2) should be used DO NOT use an insulated handle screw driver.

23) Select 1000, ACV Apply 100V r m s 3kHz, adjust C7 for 100 00 ± 10 digits

24) Select 100, ACV. Apply 100V r m s 3kHz, adjust C4 for 100 000 ± 10 digits

25) Select 10, ACV Apply 10V r m s 3kHz, adjust C2 for 10 0000 ± 10 digits

26) Repeat steps 23, 24 and 25 until the specified reading is obtained at each step, without further adjustment

27) Select 100, ACV Apply 100V r m s. and check the frequency response, at the following frequencies –

30kHz ± 200 digits
3kHz ± 100 digits
300Hz ± 100 digits
40Hz ± 100 digits

If necessary, readjust C4 to achieve best average accuracy over the frequency range.

28) Select 10, ACV Apply 10V r m.s and check the frequency response as in step 27

If necessary, readjust C2 to achieve best average accuracy over the frequency range.

NOTE If the frequency response is correct on the 10V and 100V range it is unlikely that the 1000V range will have a response problem Application of voltages above 100V with no guard shields fitted may cause the current protection trip to operate

2 3 5 Current Converter Board – Assembly Drawing No. 400113

Adjustments and calibration are to the Current Converter board unless otherwise stated

2 3.5 1 DC Current

Equipment required is as specified in Section 2 2 2 7

NOTE.– A common gain adjustment, R60 is provided in the d c isolator which should not normally require adjustment If, however, the x2 feedback netwerk in the d c isolator has been disturbed it may be found that the four range adjustments on the Current Board are at the extent of their travel and the ranges cannot be calibrated In this instance R60 should be adjusted so that all range adjustments are brought back to approximately the centre of their spans and the calibration procedure repeated

1) Select 10,ACI Apply 10mA r m.s 300Hz Adjust R115 (Analogue Board) for an indication on the display of 10 0000 ± 20 digits
2) Apply –1mA Check the reading is –1 00000 ± 5 digits
3) Select 10, DCI Apply +10mA Adjust R12 (Current Board) for +10 0000 ± 2 digits.
4) Apply –10mA Check the reading is –10 0000 ± 5 digits
5) Select 100, DCI Apply +100mA. Adjust R9 (Current Board) for 100 000 ± 2 digits
6) Apply –100mA Check the reading is –100.000 ± 5 digits
7) Select 1000, DCI Apply +1000mA Adjust R6 (Current Board) for 1000 00 ± 5 digits
8) Apply –1000mA Check the reading is –1000mA ± 10 digits
9) Select 1, DCI Increase the input current to the instrument and check that the protection relay 'drops out' and display blanks when the input current is > 2 5mA and < 3mA Immediately the display blanks remove the overload, check the protection relay 'pulls in' and the display is no longer blanked after a period > 8 seconds and < 15 seconds

2.3.5.2 AC Current

Equipment required is as specified in Section 2 2 2 7

1) Select 10, ACI Apply 10mA r m s 300Hz Adjust R115 (Analogue Board) for an indication on the display of 10 0000 ± 20 digits
2) Apply 10mA r m.s at the following frequencies and check the response –

30kHz	±	200 digits
3kHz	±	100 digits
300Hz	±	100 digits
40Hz	±	100 digits

3) Select 1, ACI Apply 1mA r m s at the frequencies given in step 2 and check the response.
4) Select 100, ACI Apply 100mA r m s at the frequencies given in Step 2 (up to 3kHz) and check the response
5) Select 1000, ACI. Apply 1000mA r m s at the frequencies given in step 2 (up to 3kHz) and check the response
6) Select 1, ACI. Increase the input current (at 100Hz) to the instrument and check that the protection relay 'drops out' and the display blanks when the input current is > 2 4mA r.m.s. (sine) and < 3 6mA r m.s

2 3 6 External Reference Board (Option R04) –Assembly Drawing No 400091

Adjustments and calibration are to the External Reference Board unless otherwise stated

Equipment required is as specified in Section 2 2 2 1, 2 2 2 4 and a heat source as specified in Section 2 3 2 1

1) Ensure that the d c signal measurement section is working correctly on the 1V d c range

2) Switch the rear panel slide switch to 'EXT REF' Check relay k1 is energised

3) Short circuit together 'Input Hi', 'Input Lo' and 'Signal Lo' on the external reference rear input socket

4) Set R10, R13, R24, R14 and R19 to the centre of their spans

5) Connect the DC Voltmeter (2 2 2 4) to T P 3 w r t 'Signal Lo' Check the voltage is less than 30mV

6) Connect the DC Calibrator (2 2 2 1) to 'Input Hi' w r t 'Input Lo' ('Input Lo' connected to 'Signal Lo') Apply +1V Check the voltage at T P 3 w r t 'Signal Lo' is –5V ± 50mV

7) Apply –1V Check the voltage at T P 3 w r t 'Signal Lo' is +5V ± 50mV Remove the DC Calibrator

8) Short circuit together 'Input Hi', 'Input Lo' and 'Signal Lo'

9) Where M3 has been replaced Connect the DC Voltmeter to T P 3 w r t 'Signal Lo'

   (a) Note the reading on the DC Voltmeter

   (b) Heat M3 with the Temperature Controlled Heat Source until the reading on the DC Voltmeter has stabilized Note the reading

   (c) If the observed change at T P 3 i e reading in (b) – reading in (a) is greater than 200μV, allow M3 to return to ambient temperature i e when the reading on the DC Voltmeter has again stabilized Inject an offset using R25 or R26 in the same direction as the drift of approximately five times the magnitude Use metal film (< 50ppm/°C) resistors for values below 1MΩ

   (d) Repeat steps 9(a), (b) and (c) until the observed drift is less than 200μV

10) When M1 has been replaced Connect the DC Voltmeter to T P 1 w r t 'Signal Lo'

   (a) Use F S V resistors R8 and R9 to bring the voltage at T P 1 to less than ± 100μV Note the reading on the DC Voltmeter

   (b) Heat M1 with the Temperature Controlled Heat Source until the reading on the DC Voltmeter has stabilized Note the reading

   (c) If the observed change at T P 1 i e reading in (b) – reading in (a) is greater than 40μV allow M1 to to return to ambient temperature i e when the reading on the DC Voltmeter has stabilized Inject an offset using R10 in the opposite direction to the drift and of approximately five times the magnitude

   (d) Repeat steps 10(a), (b) and (c) until the observed voltage drift is less than ± 40μV

   (e) Allow M1 to return to ambient temperature i e when the reading has stabilized on the DC Voltmeter Connect the DC Voltmeter to T P 3 w r t 'Signal Lo' Note the offset at T P 3 Centralize R10 and select F S V resistors R8 and R9 to produce the same offset at T P 3 ± 200μV [Use metal film (< 50ppm/°C) resistors for values below 1MΩ]

11) When M2 has been replaced Connect the DC Voltmeter to T P 2 w r t 'Signal Lo'

   (a) Use F S V resistors R11 and R12 to bring the voltage at T P 2 to less than ± 100μV Note the reading on the DC Voltmeter

   (b) Heat M2 with the Temperature Controlled Heat Source until the reading on the DC voltmeter has stabilized Note the reading

   (c) If the observed change at T P 2 i e reading in (b) – reading in (a) is greater than 40μV allow M2 to return to ambient temperature i e when the reading on the DC Voltmeter has stabilized Inject an offset using R13 in the opposite direction to the drift and approximately five times the magnitude

   (d) Repeat steps 11(a), (b) and (c) until the observed drift is less than ± 40μV

(e) Allow M2 to return to ambient temperature i e when the reading has stabilized on the DC Voltmeter Connect the DC Voltmeter to T P 3 w r t 'Signal Lo' Note the offset at T P 3 Centralize R13 and select F S V resistors R11 and R12 to produce the same offset at T.P 3 ± 200μV Use metal film (< 50ppm/°C) resistors for values below 1MΩ Adjust R13 to reproduce the offset at T P 3 ± 20μV and seal R13

12) Select F S V R17 (from either +15V or –15V supply – see Layout Drawing) for and indication on the DC Voltmeter of zero ± 200μV at T P 3 Use metal film resistors (< 50ppm/°C) for values below 100kΩ

13) Switch off the instrument and solder in position all F S V resistors Switch on

14) Connect the DC Calibrator (2 2 2 1) to 'Input Hi' w r t 'Input Lo' ('Input Lo' connected to 'Signal Lo') Apply +1V Connect the DC Voltmeter to T P 3 w r t 'Signal Lo' Check

(a) Rotation of R14 produces a span of greater than 4mV

(b) Rotation of R24 produces a span of greater than 4mV.

15) Apply –1V Check rotation of R19 produces a span of greater than 4mV on the DC Voltmeter