INTERNAL DOCUMENT 235

I.O.S.

PARTICLE CELL CALIBRATION UNIT MANUAL

P.I.WALLIN

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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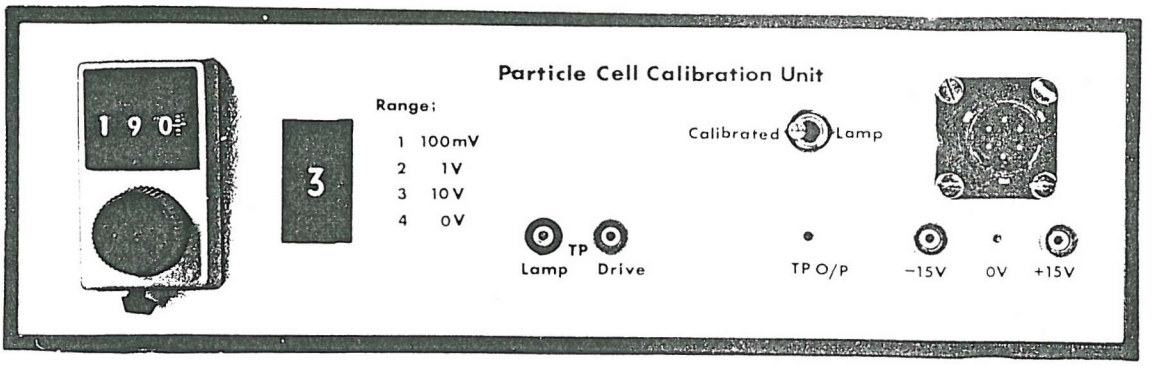
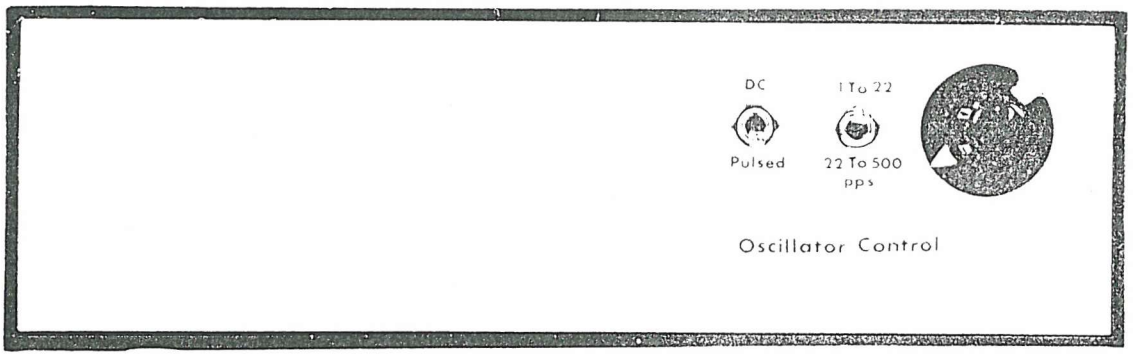
1985

INTERNAL DOCUMENT NO.235

INSTITUTE OF OCEANOGRAPHIC SCIENCES
WORMLEY,GODALMING
SURREY GU8 5UB.



FRONT PANEL



BACK PANEL

CONTENTS

Description And Specification

The unit is designed to give a calibrated output signal either pulsed or dc. The pulse is of fixed width 50 micro-seconds variable repitition rate of 1 to 500 pulses per second (pps). The output is of varible amplitude from 0 to 10.00 Volts to within 0.1% linearity of calibrated amplitude. The signal is referenced to -10.00 Volts (not zero volts). There are three ranges of calibrated amplitude;

Range 1 0 to 100 Millivolts

Range 2 0 t0 1 Volt

Range 3 0 to 10 Volts

As well as the pulsed output the output can be switched to direct current (dc) with the same calibrated range.

The unit's output is switchable between calibrated mode and lamp mode. The lamp mode provides a -10.00 Volt reference voltage which is varied by the light received by photodiode from the the lamp.

The power supply should be a regulated +15,0,-15 Volt supply.

Operation

The unit is intended to be a calibration unit for the paricle cell of an instrument called FIDO (Fluxes In Deep Ocean). Under normal use it is connected to the instrument by means of a 6-way connector. All the other connectors are intended as test points to monitor the unit's operation, but the power supply points can be used as alternative supply inputs. The lamp drive test points can similarly be used to provide an extenal supply to the lamp which is normally 2.5 to 3.5 Volts. The output test point labelled "TP O/P" gives either the calibrated output or the lamp output depending on the switch selection.

The oscillator controls provide a pulsed or dc output in two ranges. Both continuously variable with in the ranges 1 to 22 pps or 22 to 500 pps by turning the black knob on the rear panel . The pulse width is internally set to 50 microseconds (see setting up procedure).

The range selection switch provides three ranges of calibrated output. Range 4 and in fact any other number apart from 1,2,or 3 will give a signal of 0 Volts amplitude referenced to -10.00 Volts , which is purely for test and setting up purposes. When range 1,2,or 3 is selected this gives the maximum amplitude of the signal which can be adjusted by the dial referenced to -10.00 Volts. For example, if the dial is set to 126 ;

Range 1 gives 12.6mV ref to -10.00V which actually is -9.9874V

Range 2 gives 0.126V ref to -10.00V which actually is -9.874V

Range 3 gives 1.26V ref to -10.00V which actually is -8.74V

Selecting Lamp gives -10.00 Volts output which is dependant on the brilliance of the lamp which in turn is controlled by the lamp drive voltage. If the lamp drive voltage drops the brillince of the lamp drops and so if the lamp voltage drops below 2.5 Volts the output voltage rises towards 0 Volts. This is a test for the particle cell lamp servo control which should try adjust the lamp voltage up again

to increase the brilliance of the lamp until the output is at -10.00 Volts. The lamp servo tries to maintain the -10.00 Volts output constant. This can be tested by removing the cover of the unit and partially obscuring the photo-diode or by moving the lamp bulb slightly.

Circuit Operation

The 4047B (IC8) is connected as an astable which by varying a 220K ohm potentiometer P13 varies the oscillator frequency. The frequency range is altered by a switch which changes the capacitance and a trimming potentiometer for each range. The oscillator output signal goes into a 4047B (IC9) connected as a monostable which is set as non-retriggerable, leading edge triggered and pulse output of 50 microseconds width. This output is connected to a switch which can select pulsed or dc operation. For pulsed operation the output of the monostable is connected to the 4049B (IC10) an inverting-buffer. For dc operation the switch connects +Vss (+15.0 Volts) to the inverting-buffer inputs. The outputs of the inverting-buffer are connected by screened leads to a 4066B (IC6) which is a CMOS quadruple bilateral switch array. Only two of the switches are used the unused switches have there control gates connected to 0 Volts. The outputs of the two switches are connected together. One of the switches is driven by an inverted signal from IC10 the other by a non-inverted signal. The non-inverted signal switches the -10.00 Volts refence to the output in 50 microsecond pulses. The inverted signal switches 0 Volts to the output. So the resulting output consists of a 10.00 Volt pulse 50 microseconds wide referenced to 0 Volts. If dc is selected there is no pulse only 10.00 Volts dc. This is then connected to IC1 a non-inverting unity gain buffer. The output of IC1 is connected to two 10K ohm potential dividers made of potentiometers P6 and a 100 ohm resistor R18 and P7 and a 1K ohm resistor R17. A signal of amplitude 10.00 Volts means the 1 K ohm resistor has a 1 Volt drop across it and the 100 ohm resistor has a 100 millivolts drop across it when the

potentiometers are set correctly. These voltage levels are connected to two switches of a 4066B (IC7), also the 10.00 Volts signal is connected to one of the switches and 0 Volts is connected to the fourth switch. The four switches are controlled by the Range selection switch on the front panel. Whichever range is selected by the switch results in the appropriate control gate being connected to Vss (+15V) and the required signal connected to IC2. This is another non-inverting unity gain buffer. The output of IC2 is connected by screened cable to the ten turn 10K ohm potrntiometer P 12 which has a dial indicating the number times the potentiometer has turned. The other end of the 10 K ohm potentiometer is connected to 0 Volts and its wiper is connected by screened lead to the input pin 3 of IC3. This is another buffer and this signal is known of amplitude as set by the dial. Also connected to the input of IC3 are two 1 nano-Farad capacitors which just take off the squareness of any pulse which reduces any spikes. The output of IC3 is connected to pin 2 of IC4 an inverting unity gain buffer. The output of IC4 is now of calibrated amplitude but refenced to 0 Volts. IC5 is an inverting summing unity gain buffer. The inverted pulse is added to +10.00 Volts and the whole signal inverted to produce the output required. This is a calibrated amplitude pulsed or dc signal referenced to -10.00 Volts.

IC11 is an inveting amplifer. The input to pin 2 is varied depending on the illumination of the photo-diode PD1 by lamp L1. The output to the Lamp or Calibrated select switch is dependant on the output of IC11 pin6 and the potentimeter P11. The maximum output of pin 6 is -15 Volts with the diode exposed to saturation by the lamp. So by adjusting potentiometer P11 the level can be set to -10.00 Volts. Then on the illumination level of the bulb dropping the output of pin 6 will rise towards 0 Volts and the -10.00 Volt output will

also rise towards 0 Vlots. This will indcate to the FIDO particle cell lamp drive servo, if connected, that the lamp drive voltage needs to be increased. This enables the servo drive to be tested.

Setting Up Procedure

Assuming the unit is to be set up from scratch.

Oscillator and Pulse width Adjustments

First the maximum freqency is adjusted. By connecting a frequency meter to test point A (TPA) the output frequency of IC8 a 4047B astable can be monitored. By setting the switch on back panel to a range 22 to 500 pps and turning the external black knob fully clockwise, the maximum frequency is obtained. To set this to 500 pps turning the adjusting screw of potentiometer P8 clockwise reduces the frequency. To set the minimum frequency to 1 pps select switch range to 1 to 22 pps and turn black knob fully anticlockwise. This can be set by turning the adjusting screw of potentimeter P9 clockwise which will reduce the frequency.

The pulse width is set to 50 micro-seconds. An oscilloscope can be connected to either the screened lead out of the 4047B monostable to the select pulse or dc switch, or to the lead out of the switch to the 4049B inverting buffer. Provided the switch is selecting pulsed signal. Then by adjusting potentiometer P10 the pulse width can be adjusted to 50 micro-seconds.

Offset Adjustments

For the offset adjustments to be made to null the op-amp offsets, range 4 must be selected on the front panel. The switch on the panel must be set to dc. The output of IC1 should be 10.00 Volts which is the buffered reference voltage. This can be monitored at test point TPB, and adjusted by turning the adjusting screw of poteniometer P1. The output of IC2 should be 0 Volts. This can be monitored at the point beside pin 6 which is connected by screened lead to the 10 turn potentiometer P12. By adjusting potentiometer P2 the offset can be nulled. Potentiometers P3 and P4 respectively are adjusted to null the offsets of IC3 and IC4 to 0 Volts. IC5 has an output of -10.00 Volts and by adjusting potentimeter P5 any offset can be nulled.

1 Volt And 100mV Reference Adustments

Potentiometers P6 and P7, set up the 1 Volt and 100 millivolts reference levels. Test point TPC is the monitoring point for the 1Volt level and is set by adjusting potentiometer P6 and TPD is similarly for the 100 millivolt level and is adjusted by P7.

Lamp Output

With the selection switch on the front panel set to lamp the oscillator settings are not important. The output can be monitored at the yellow test point marked "TP O/P" on the front panel.The bulb must be positioned with the filament above the window of the photo-diode. The bulb should be driven at about 2.5 Volts either by connecting a varible power supply to the "TP Lamp Drive" terminals or through the 6-way connector. By adjusting the potentimeter P11 the output should be set to -10.00 Volts. Adjusting the lamp voltage above 2.5 Volts

should result in no change in the output voltage which should remain constant. DONOT exceed 5V and maintain the voltage above 3.5 Volts only for short peroids of time.On lowering the voltage below 2.5 Volts the output voltage should rise towards 0 Volts.

Calibration

Once the setting up procedure is completed the unit may be calibrated. For this the unit remains set to Calibrated dc output. An accurate digital voltmeter is connected to the "TP O/P" terminals. The dial is turned fully anticlockwise to check the zero.

If the dial does not zero at "000" but some other figure it is necessary to gently prise of the plastic knob off the dial . Loosen the allen headed screws with a 1mm allen key. Then turn the potentiometer P12 fully anticlockwise, ensure the dial still reads zero and tighten up the screws.

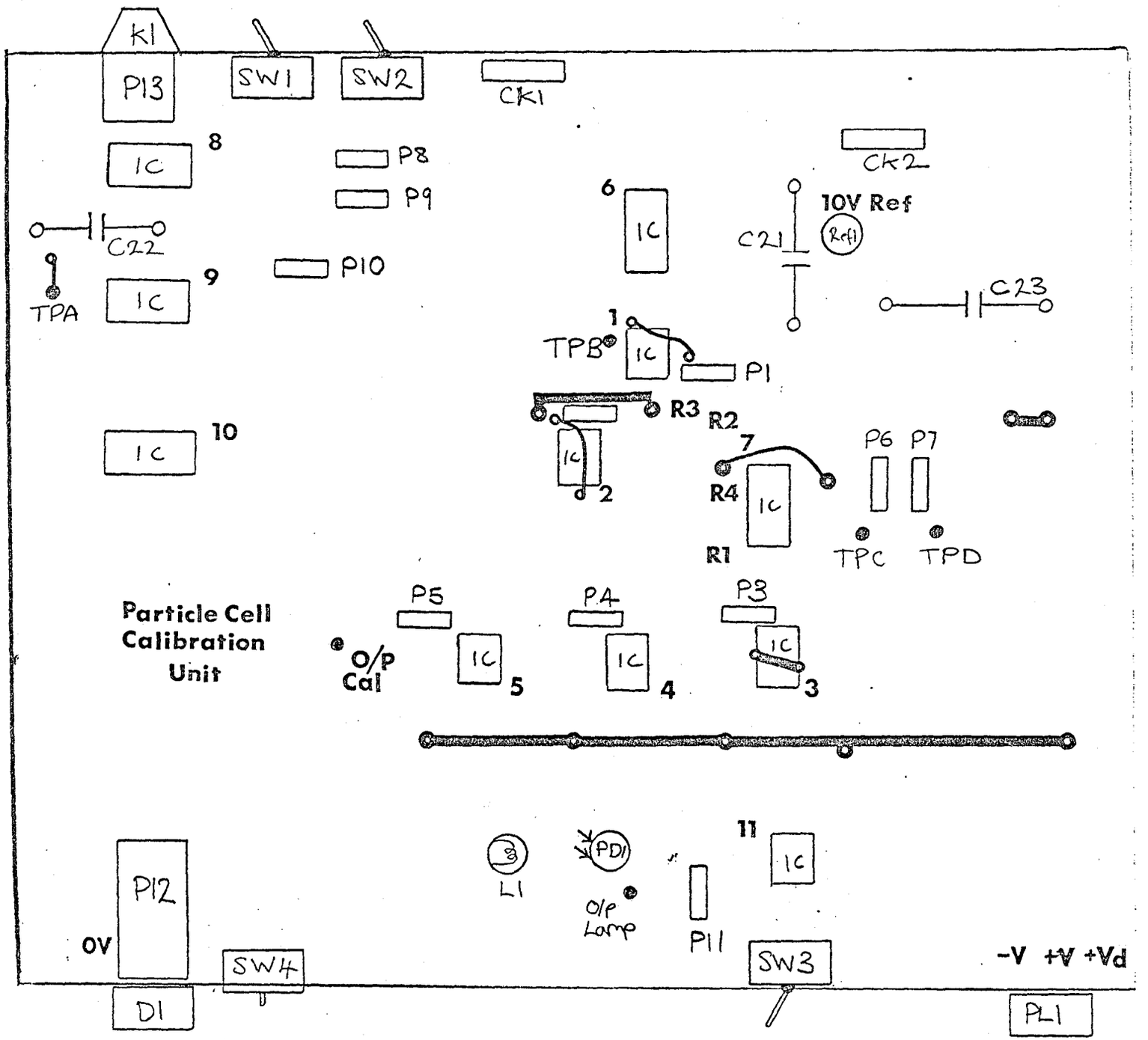
If the reading is not exactly -10.00 Volts refer to "Setting up section".

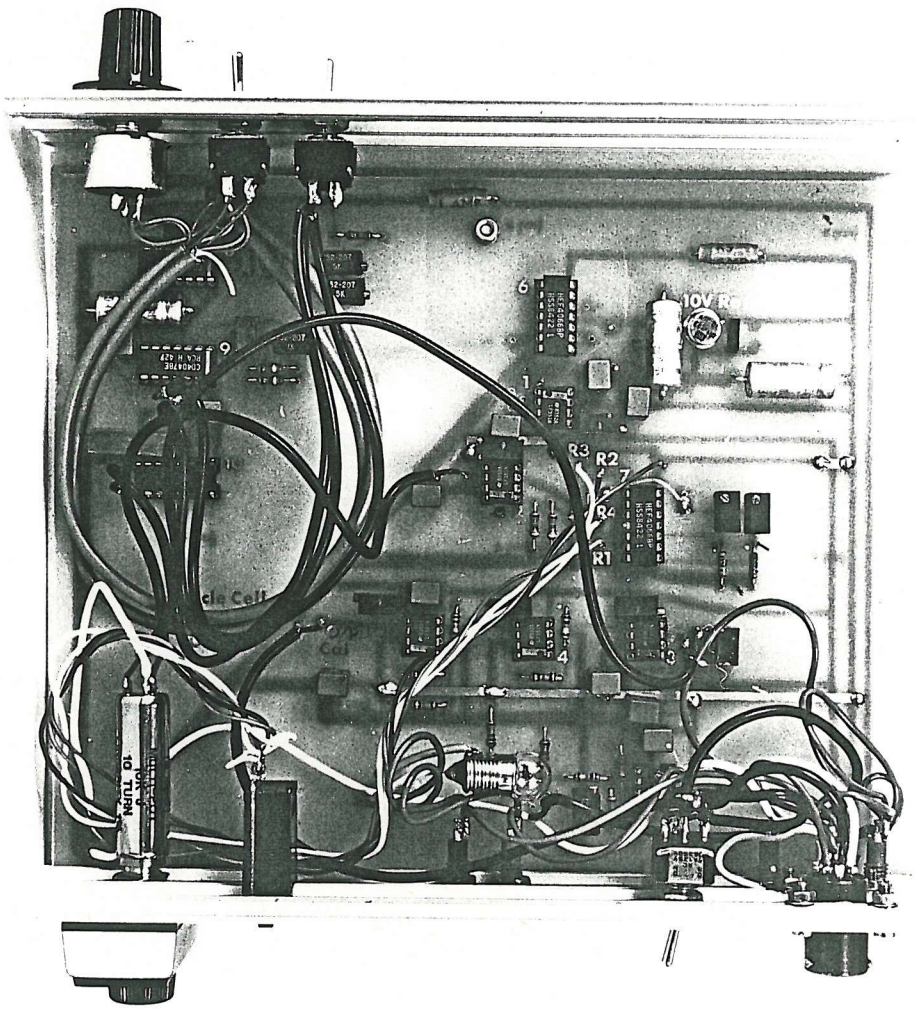
Voltage measurments at regular intervals in each range may then be made. In the 100 millivolt range because the signal is referenced to -10.00 Volts, measurements can only be made to the nearest millivolt which is not very accurate. If a better measurement is required, remove the unit's cover and moniter the voltage at pin 6 of IC5. This is the non-inverted buffered signal before being referenced (summed) to -10.00 Volts.

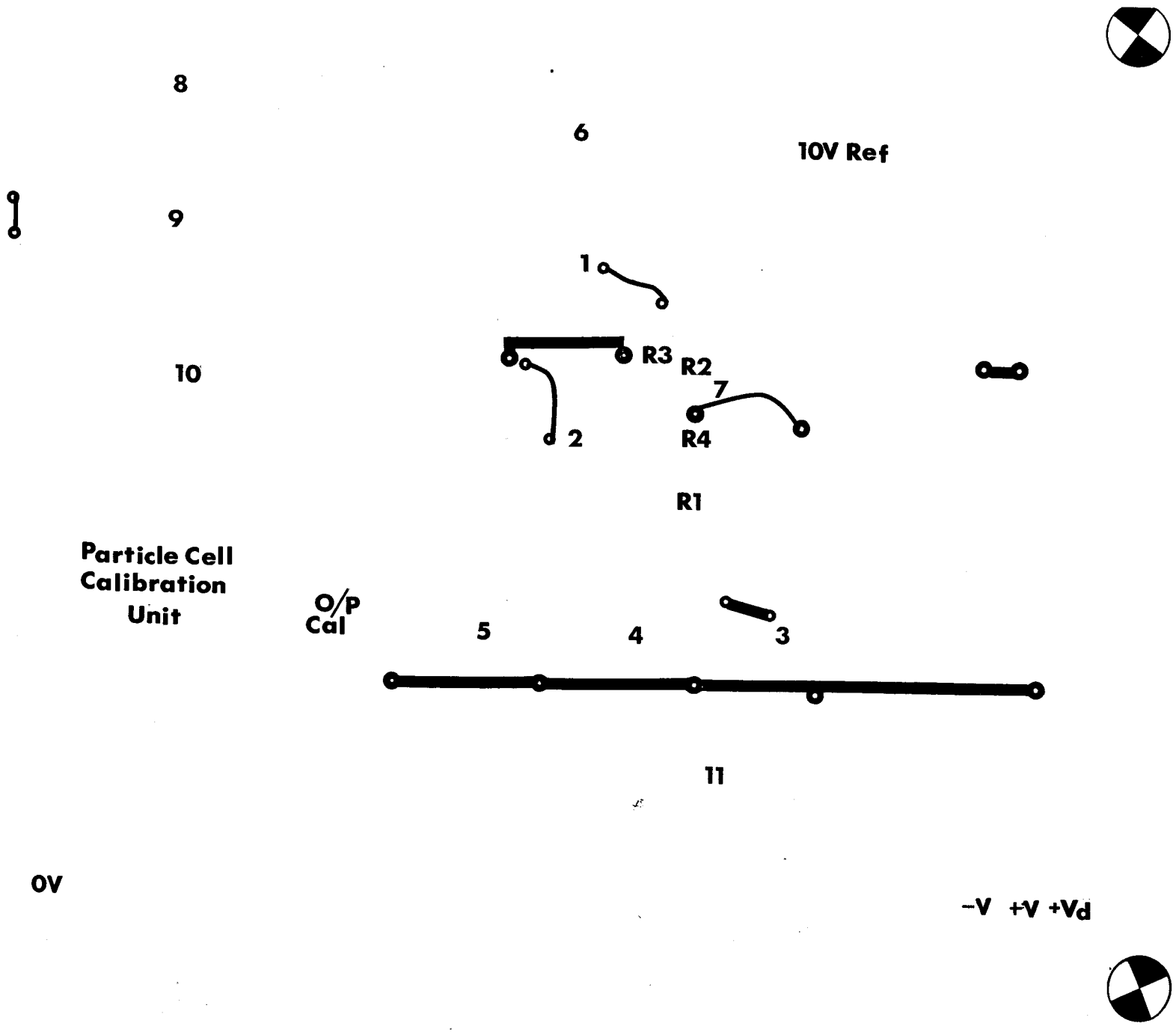
For original calibration see appendix. There the results are tabulated after being analysised by a least squares fit program on a BBC model B micro computer.

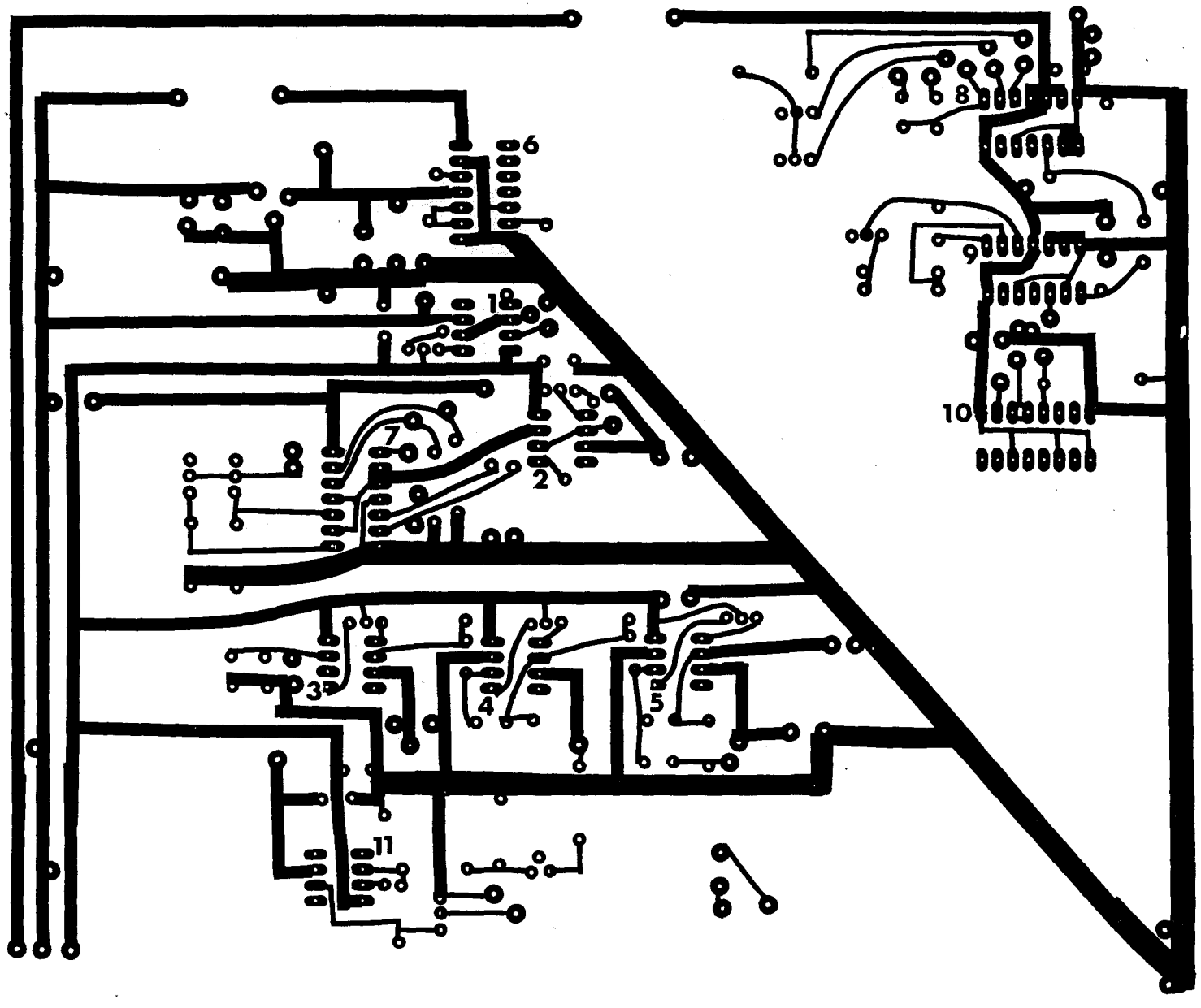
The cause of any errors in the calibrated amplitude is due almost entirely to the non-linearity of potentiometer P12 and the noise

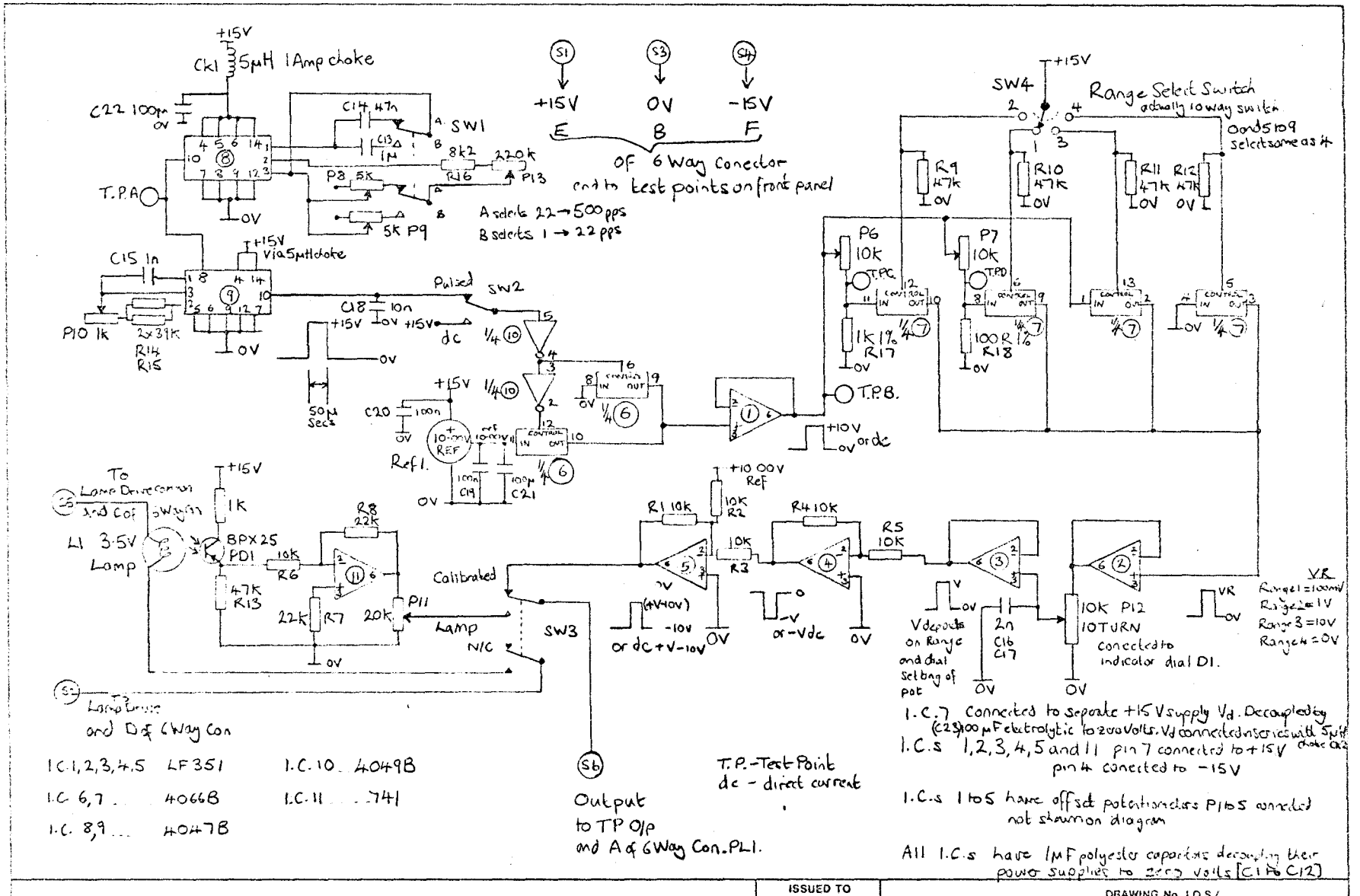
produced by Ref1 the 10.00 Volt reference voltage source.


K1
P13
SW1
SW2
CK1
CK2
8
IC
P8
P9
6
IC
10V Ref
Ref1
C21
C22
C23
TPA
9
IC
P10
1
TPB
IC
P1
R3
R2
10
IC
IC
2
7
P6
P7
R4
IC
R1
TPC
TPD
Particle Cell
Calibration
Unit
O/P
Cal
P5
P4
P3
IC
IC
IC
5
4
3
L1
PD1
11
IC
O/P
Lamp
P11
P12
0V
SW4
SW3
-V +V +Vd
D1
PL1


10 Turn
10VR
R1
R2
R3
R4


8
6
10V Ref
9
1
10
R3
R2
7
2
R4
R1
Particle Cell
Calibration
Unit
O/P
Cal
5
4
3
11
0V
-V
+V
+Vd


6
8
1
9
7
10
2
3
4
5
11



Particle Cell Calibration Unit	ISSUED TO	DRAWING No. I.O.S./
INSTITUTE OF OCEANOGRAPHIC SCIENCES.	REVISED	DRAWN BY PAUL WALLIN DATE 19·3·85 SHEET No. 1
		ISSUED FOR ORDER No. FOR UNITS

CIRCUIT DIAGRAM SYMBOL	ELECTRONICS COMPONENT DESCRIPTION				IDENTIFICATION		ALTERNATIVES & REMARKS
	NAME	RATING	GRADE	TYPE	TRADE OR SUPPLIERS NAME	REFERENCE No	
I.C.1	Op-Amp			LF351M			
I.C.2	〃			〃			
I.C.3	〃			〃			
I.C.4	〃			〃			
I.C.5	〃			〃			
I.C.6	CMOS			4066B			
I.C.7	〃			〃			
I.C.8	〃			4047B			
I.C.9	〃			〃			
I.C.11	Op-Amp			UA741CP			
Ref1	Reference Voltage			10.00V precision ref. Voltage	R.S. Components	283-299	
P1	Potentiometer	10KΩ	0.3W	Cermet 3/8" Trimmer		075/207	
P2	〃	〃	〃	〃			
P3	〃	〃	〃	〃			
P4	〃	〃	〃	〃			
P5	〃	〃	〃	〃			
P7	〃	〃	〃	〃			
P8	〃	5KΩ	〃	〃			
P9	〃	〃	〃	〃			May need larger value. Files required to get 1 p.p.sec.
P10	〃	1KΩ	〃	〃			
P11	〃	20KΩ	〃	〃			
P12	〃	10KΩ	1% o/in	Ten turn potentiometer	RS Components	173-518	
P13	〃	220KΩ		Rotary Linear Potentiometer			
R1	Resistor	10K	0.25W	Metal Film MRF4			
R2	〃	〃		〃			

REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE

Particle Cell Calibration Unit

INSTITUTE OF OCEANOGRAPHIC SCIENCES

ELECTRONIC COMPONENTS FOR DRG. No. I.O.S.

COMPILED PAUL WALLIN DATE 20 3 85 SHEET No. 1

ISSUED FOR ORDER No. FOR UNITS

I.O.S. FORM No. 105 (E.75)

PRINT TRIMMING LINE

297 x 363mm

WORKING DYELINE 0705 82

CIRCUIT DIAGRAM SYMBOL	ELECTRONICS COMPONENT DESCRIPTION				IDENTIFICATION		ALTERNATIVES & REMARKS
	NAME	RATING	GRADE	TYPE	TRADE OR SUPPLIERS NAME	REFERENCE No.	
R3	Resistor	10Kn	0·25W	Metal Film MRF4	RS Components		
R4	〃	〃		〃			
R5	〃	〃		〃			
R6	〃	〃		〃			
R7	〃	22kn		〃			
R8	〃	〃		〃			
R9	〃	47kn		〃			
R10	〃	〃		〃			
R11	〃	〃		〃			
R12	〃	〃		〃			
R13	〃	〃		〃			
R14	〃	39kn		〃			
R15	〃	〃		〃			
R16	〃	8K2n		〃			
R17	〃	1kOn	1%	Welwyn TC. <10ppm			
R18	〃	100n	1%	〃			
C1	Capacitor	1MF	10%	Polyester Wima		Type MKS2 63V.	
C2	〃	〃	〃	〃			
C3	〃	〃	〃	〃			
C4	〃	〃	〃	〃			
C5	〃	〃	〃	〃			
C6	〃	〃	〃	〃			
C7	〃	〃	〃	〃			
C8	〃	〃	〃	〃			
C9	〃	〃	〃	〃			

REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE

Particle Cell Calibration Unit

INSTITUTE OF OCEANOGRAPHIC SCIENCES

ELECTRONICS COMPONENTS FOR DRG. No. TCS

DRAWN BY DATE SHEET No. 2

ISSUED FOR ORDER No. FOR UNITS

IOS FORM No. 105 (1/75)

PRINT TRIMMING LINE

297 x 363mm

WORKING DYELINE 21/5/82

CIRCUIT DIAGRAM SYMBOL	ELECTRONICS COMPONENT DESCRIPTION				IDENTIFICATION		ALTERNATIVES & REMARKS
	NAME	RATING	GRADE	TYPE	TRADE OR SUPPLIERS NAME	REFERENCE No.	
C10	Capacitor	1μF		Polyester			
C12		—"—		—"—			
C13		—"—		—"—			
C14		0·047μF		—"—			
C15		1nF		Silvamica		Lenco MS 89/m1R	
C16		—"—		—"—		—"—	
C17		—"—		—"—		—"—	
C18		10n		—"—		Lenco MS S10	
C19		100n		Ceramic			
C20		—"—		—"—			
C21		100μF		Electrolytic			
C22		—"—		—"—			
C23		—"—		—"—			
CK1	Choke	5μH	1Amp	High frequency suppressor	RS Components	238-255	
CK2	—"—	—"—	—"—				
PD1	Photo Diode			BPX 25			
L1	Lamp	3·5V		Standard torch bulb			
SW1	SWITCH	250V	3A	DPDT miniture.			
SW2	—"—	—"—	—"—	—"—			
SW3	—"—	—"—	—"—	—"—			
SW4	—"—			10Way Push Button	R.S. Components	337-453 + 337-419	* End cheeks required for mounting
D1	Dial			10turn Indicator dial	—"—	509-721	
S1	Socket	Red		2mm Socket	—"—	HH4-HH4	
S2	—"—	—"—		—"—	—"—	—"—	
S3	—"—	White		—"—	—"—	HH4-450	

REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE

Particle Cell Calibration Unit.

INSTITUTE OF OCEANOGRAPHIC SCIENCES

ELECTRONIC COMPONENTS FOR DRG. No. D.O.S.

COMPILED BY DATE SHEET No. 3

ISSUED FOR ORDER No. FOR

I.O.S. FORM No 105 (1/75)

PRINT TRIMMING LINE

297 x 303mm

WORKING EXPLANATORY NOTES (E2)

CIRCUIT DIAGRAM SYMBOL	ELECTRONICS COMPONENT DESCRIPTION				IDENTIFICATION		ALTERNATIVES & REMARKS
	NAME	RATING	GRADE	TYPE	TRADE OR SUPPLIERS NAME	REFERENCE No.	
S4	Socket	Blue		2mm			
S5	—11—	Green		—11—			
S6	—11—	Yellow		—11—			
PL1	Plug			6 Way fixed plug	R S Components		Souriau 851-02E-10-6P50-A6
	PCB			See notes			
	Case			Schroff Instruments case		Stk No 20218-022	
	Screws	Cheesehead	10mm	M3 x4 To mount PL1			
	Nuts			M3 x6 —11—			
	Screw	Countersunk	20mm	To fix pcb			
	Vero pins			For mounting leads to PCB			
	Screened cable						
	Wire						
K1	Knob			Black knob for P13			

REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE

Particle Cell Calibration Unit

INSTITUTE OF OCEANOGRAPHIC SCIENCES

ELECTRONICS COMPONENTS FOR DRG. No. I.O.S.

COMPILED BY DATE SHEET No. 4

ISSUED FOR ORDER No. FOR UNITS

I.O.S. FORM No. 105 (1/75)

PRINT TRIMMING LINE

297 x 363mm

WORKING OUTLINE 0106 82

RANGE 1 CALIBRATION

DATE 10/4/85

LINEAR: Y=A+B*X WITH A= -9.99989092

AND B= 9.974546828E-5

COEFF. OF CORRELATION= 1.000034184

COEFF. OF DETERMINATION =1.000068369

DIAL RDG.	VOLTAGE O/P	Y-EST	DIFF	% DIFF
0.0000	-9.9999	-9.9999	0.0000	-0.0001
100.0000	-9.9899	-9.9899	-0.0000	0.0002
200.0000	-9.9799	-9.9799	-0.0000	0.0004
300.0000	-9.9699	-9.9700	-0.0001	0.0007
400.0000	-9.9600	-9.9600	0.0000	-0.0001
500.0000	-9.9501	-9.9500	0.0001	-0.0008
600.0000	-9.9401	-9.9400	0.0001	-0.0006
700.0000	-9.9302	-9.9301	0.0001	-0.0013
800.0000	-9.9200	-9.9201	-0.0001	0.0010
900.0000	-9.9101	-9.9101	-0.0000	0.0002
1000.0000	-9.9001	-9.9001	-0.0000	0.0005

RANGE 2 CALIBRATION

DATE 10/4/85

LINEAR: Y=A+B*X WITH A= -9.99764093

AND B= 9.972636676E-4

COEFF. OF CORRELATION= 0.9999997108

COEFF. OF DETERMINATION =0.9999994216

DIAL RDG.	VOLTAGE O/P	Y-EST	DIFF	% DIFF
0.0000	-9.9981	-9.9976	0.0005	-0.0046
100.0000	-9.8977	-9.8979	-0.0002	0.0022
200.0000	-9.7978	-9.7982	-0.0004	0.0040
300.0000	-9.6981	-9.6985	-0.0004	0.0037
400.0000	-9.5986	-9.5987	-0.0001	0.0014
500.0000	-9.4992	-9.4990	0.0002	-0.0020
600.0000	-9.3996	-9.3993	0.0003	-0.0034
700.0000	-9.3002	-9.2996	0.0006	-0.0069
800.0000	-9.1996	-9.1998	-0.0002	0.0025
900.0000	-9.1002	-9.1001	0.0001	-0.0011
1000.0000	-9.0000	-9.0004	-0.0004	0.0042

RANGE 3 CALIBRATION

DATE 10/4/85

LINEAR: Y=A+B*X WITH A= -9.975267269

AND B= 9.885163628E-3

COEFF. OF CORRELATION= 0.9999995031

COEFF. OF DETERMINATION =0.9999990063

DIAL RDG.	VOLTAGE O/P	Y-EST	DIFF	% DIFF
0.0000	-9.9797	-9.9753	0.0044	-0.0444
100.0000	-8.9847	-8.9868	-0.0021	0.0228
200.0000	-7.9947	-7.9982	-0.0035	0.0442
300.0000	-7.0063	-7.0097	-0.0034	0.0488
400.0000	-6.0200	-6.0212	-0.0012	0.0200
500.0000	-5.0342	-5.0327	0.0015	-0.0301
600.0000	-4.0470	-4.0442	0.0028	-0.0700
700.0000	-3.0615	-3.0557	0.0058	-0.1910
800.0000	-2.0655	-2.0671	-0.0016	0.0792
900.0000	-1.0790	-1.0786	0.0004	-0.0352
1000.0000	-0.0869	-0.0901	-0.0032	3.6389