Foster Cambridge

PORTABLE POTENTIOMETER

OPERATING INSTRUCTIONS

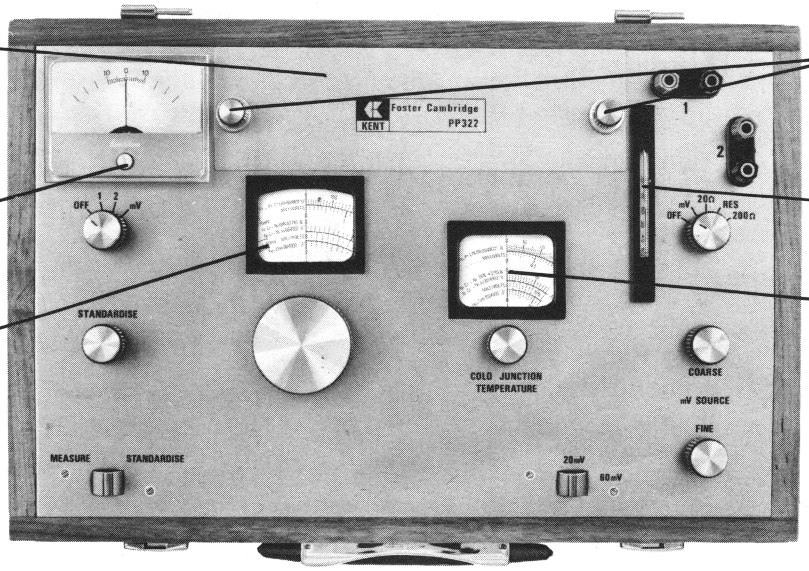

Fig. 1

INTRODUCTION

The Portable Potentiometer PP320 provides accurate measurement of millivolt signals in two ranges, 0–20mV or 0–60mV. For certain thermocouples, the temperature can be directly read from the scale, adjustment being provided for temperature variation of the cold junction. The instrument also incorporates a high impedance millivolt source for the calibration of electronic recorders.

Variants PP321 and PP322 also provide a low impedance millivolt source for the calibration of current indicators and variant PP322 has in addition a resistance measuring facility for resistances up to 200 ohms.

Specification

Main scale length	320 mm (nominal)
Main scale span	20mV and 60mV
Cold junction scale span	1mV and 3mV
Cold junction temperature measurement	By mercury-in-glass thermometer fitted near input terminals
Standardisation	Against internal standard cell
Intrinsic error	± 0.2% of span maximum
Sensitivity	20μV
Battery access	Under cover plate on main panel
Battery type	Mallory Mn–1300 as standard Mallory RM–42R when longer battery life required on continuous operation
Number of batteries	1 for PP320; 2 for PP321 and PP322
Overall dimensions	320 x 240 x 130 mm
Weight	5 kg

Foster Cambridge

PORTABLE POTENTIOMETER

OPERATING INSTRUCTIONS

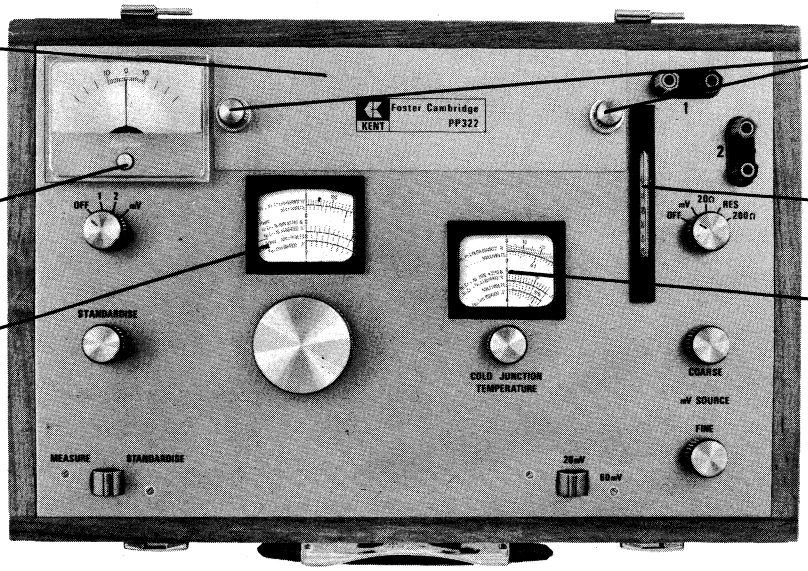

Fig. 1

INTRODUCTION

The Portable Potentiometer PP320 provides accurate measurement of millivolt signals in two ranges, 0–20mV or 0–60mV. For certain thermocouples, the temperature can be directly read from the scale, adjustment being provided for temperature variation of the cold junction. The instrument also incorporates a high impedance millivolt source for the calibration of electronic recorders.

Variants PP321 and PP322 also provide a low impedance millivolt source for the calibration of current indicators and variant PP322 has in addition a resistance measuring facility for resistances up to 200 ohms.

Specification

Main scale length	320 mm (nominal)
Main scale span	20mV and 60mV
Cold junction scale span	1mV and 3mV
Cold junction temperature measurement	By mercury-in-glass thermometer fitted near input terminals
Standardisation	Against internal standard cell
Intrinsic error	± 0.2% of span maximum
Sensitivity	20μV
Battery access	Under cover plate on main panel
Battery type	Mallory Mn–1300 as standard Mallory RM–42R when longer battery life required on continuous operation
Number of batteries	1 for PP320; 2 for PP321 and PP322
Overall dimensions	320 x 240 x 130 mm
Weight	5 kg

Foster Cambridge

PORTABLE POTENTIOMETER

OPERATING INSTRUCTIONS

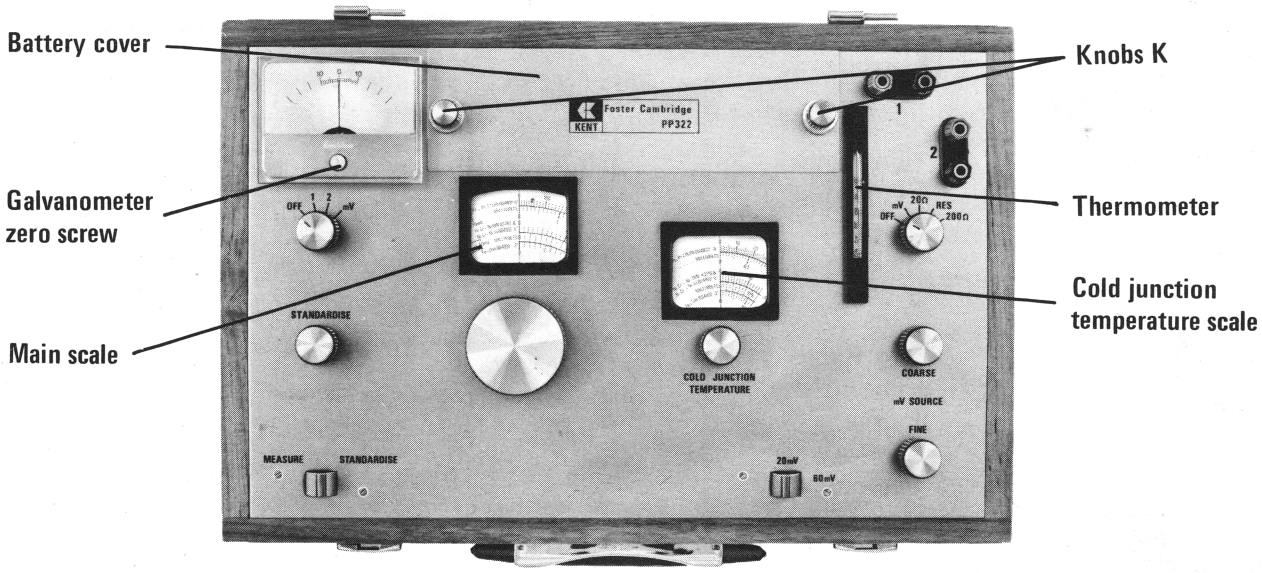

Fig. 1

INTRODUCTION

The Portable Potentiometer PP320 provides accurate measurement of millivolt signals in two ranges, 0–20mV or 0–60mV. For certain thermocouples, the temperature can be directly read from the scale, adjustment being provided for temperature variation of the cold junction. The instrument also incorporates a high impedance millivolt source for the calibration of electronic recorders.

Variants PP321 and PP322 also provide a low impedance millivolt source for the calibration of current indicators and variant PP322 has in addition a resistance measuring facility for resistances up to 200 ohms.

Specification

Main scale length	320 mm (nominal)
Main scale span	20mV and 60mV
Cold junction scale span	1mV and 3mV
Cold junction temperature measurement	By mercury-in-glass thermometer fitted near input terminals
Standardisation	Against internal standard cell
Intrinsic error	± 0.2% of span maximum
Sensitivity	20μV
Battery access	Under cover plate on main panel
Battery type	Mallory Mn–1300 as standard Mallory RM–42R when longer battery life required on continuous operation
Number of batteries	1 for PP320; 2 for PP321 and PP322
Overall dimensions	320 x 240 x 130 mm
Weight	5 kg

BBC BROWN BOVERI

Kent Industrial Measurements Limited
Foster Cambridge Industrial Instruments
Howard Road Eaton Socon St Neots Huntingdon Cambridgeshire England PE19 3EU
Telephone Huntingdon (0480) 75321 Telex 32676 FOSCAM G

February 1978
Issue 3

Foster Cambridge

PORTABLE POTENTIOMETER

OPERATING INSTRUCTIONS

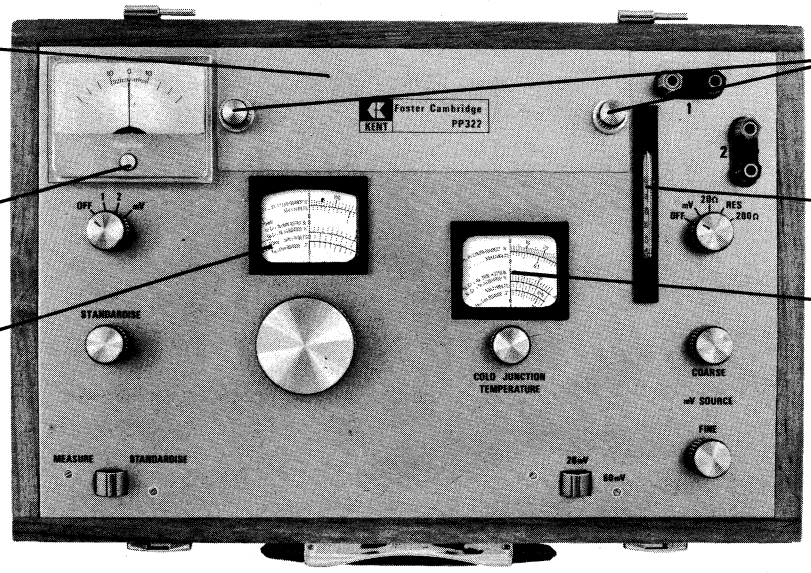

Fig. 1

INTRODUCTION

The Portable Potentiometer PP320 provides accurate measurement of millivolt signals in two ranges, 0–20mV or 0–60mV. For certain thermocouples, the temperature can be directly read from the scale, adjustment being provided for temperature variation of the cold junction. The instrument also incorporates a high impedance millivolt source for the calibration of electronic recorders.

Variants PP321 and PP322 also provide a low impedance millivolt source for the calibration of current indicators and variant PP322 has in addition a resistance measuring facility for resistances up to 200 ohms.

Specification

Main scale length	320 mm (nominal)
Main scale span	20mV and 60mV
Cold junction scale span	1mV and 3mV
Cold junction temperature measurement	By mercury-in-glass thermometer fitted near input terminals
Standardisation	Against internal standard cell
Intrinsic error	± 0.2% of span maximum
Sensitivity	20μV
Battery access	Under cover plate on main panel
Battery type	Mallory Mn–1300 as standard Mallory RM–42R when longer battery life required on continuous operation
Number of batteries	1 for PP320; 2 for PP321 and PP322
Overall dimensions	320 x 240 x 130 mm
Weight	5 kg

BBC BROWN BOVERI

Kent Industrial Measurements Limited
Foster Cambridge Industrial Instruments
Howard Road Eaton Socon St Neots Huntingdon Cambridgeshire England PE19 3EU
Telephone Huntingdon (0480) 75321 Telex 32676 FOSCAM G

February 1978
Issue 3

Identification

In the left hand battery holder is a label bearing the instrument number and the code number which identifies its type and use. Remove the battery for access to this label. The code number is derived as follows:

Basic Type Number	Form	Scale Ranges
PP32 Portable Potentiometer with 2 ranges having 320 mm scale lengths.	0 Two Range Basic Instrument	1 0–20 mV Pt. – Pt./13% Rh. BS4937 Type R 0–60 mV (Ni./Cr. – Ni./Al. BS4937 Type K (Ni./Cr. – Ni. DIN 43710 Fe. – Con. BS4937 Type J
	1 Two Range + Potential Source	2 0–20 mV Pt. – Pt./13% Rh. BS4937 Type R Cu. – Con. BS4937 Type T 0–60 mV (Ni./Cr. – Ni./Al. BS4937 Type K (Ni./Cr. – Ni. DIN 43710
	2 Two Range + Potential Source + Resistance Measurement Facility	3 0–20 mV Pt. – Pt./10% Rh. BS4937 Type S 0–60 mV (Ni./Cr. – Ni./Al. BS4937 Type K (Ni./Cr. – Ni. DIN 43710 Ni./Cr. – Con. BS4937 Type E

Note:
Code No. is built up thus: PP322–1✓
All code combinations are available

OPERATION

Fitting the Batteries

Remove the plate covering the battery compartment by unscrewing the two knobs marked 'K' in Fig. 1. Insert the battery or batteries, making sure that correct polarity is observed according to the + and – signs marked on the battery holders. The battery on the left provides power for the measuring slidewire. The one on the right powers the low impedance mV source and resistance measuring circuitry when fitted. To conserve the batteries when the instrument is not in use turn the left hand rotary switch to OFF.

Fit a new left hand battery when it is no longer possible to standardise the potentiometer. (See **Standardising the Potentiometer,** page 3).

Fit a new right hand battery if it is impossible to balance the galvanometer when adjusting the mV source rheostats to set the desired mV output or to measure resistance. (See **Low Impedance Millivolt Source** and **Measurement of Resistance,** page 4).

Electrical Connections

Signal connections are made to either of the pairs of terminals labelled 1 and 2 at the top right of the instrument. Correct polarity must be observed; red terminal positive, black terminal negative.

Setting the Galvanometer Zero

Turn the left hand rotary switch to the OFF position. Adjust the screw immediately below the galvanometer dial until the pointer indicates zero.

Standardising the Potentiometer

Provided that the left hand rotary switch is **not** in the OFF position, the instrument may be standardised with the rotary switches in any other position.

Push the lever of the MEASURE-STANDARDISE switch to STANDARDISE. Adjust the STANDARDISE control (above the switch) until the galvanometer pointer indicates zero and there is no movement of the galvalometer pointer when the MEASURE-STANDARDISE lever is released.

Millivolt Measurements

1. Standardise the potentiometer.
2. Select position 1 or 2 on the left hand rotary switch, depending upon the input terminals used.
3. Select the appropriate millivolt range using the switch at the bottom right of the instrument panel. Move the switch to the right for the 0–60mV range or leave it in the central position for the 0–20mV range.
4. Select the normal (OFF) position on the right hand rotary switch (if fitted).
5. Set the COLD JUNCTION TEMPERATURE scale to zero by rotating the knob immediately below the dial.
6. Push the lever of the MEASURE-STANDARDISE switch to MEASURE and adjust the main scale until the galvanometer indicates zero.
   The main scale reading now indicates the millivolt signal.

Temperature Measurements Using a Thermocouple

Refer to the table of Scale Ranges on page 2 to determine whether the millivolt range is 20mV or 60mV. Follow the procedure described above for **Millivolt Measurements** but in step 5 set the COLD JUNCTION TEMPERATURE dial to the cold junction temperature instead of zero. If the thermocouple is connected to the potentiometer using the correct compensating leads, as detailed in the table below, the cold junction will be at the potentiometer terminals and can be read from the mercury thermometer on the panel. If the thermocouple is connected to the potentiometer by copper leads the cold junction is at the point where these leads are connected to the thermocouple and the cold junction temperature should be measured at this point.

The main scale reading when the galvanometer indicates zero gives the correct thermocouple temperature.

Type of Thermocouple	Standard No.	Compensating Cable		Casing Colour
		+	–	
Copper-Con (T)	BS4937 Pt. 5	Copper (white)	Constantan (blue)	Red
Iron-Con (J)	BS4937 Pt. 3	Iron (yellow)	Constantan (blue)	Black
(Ni/Cr-Ni/Al(K)	BS4937 Pt. 4	Copper (white)	Constantan (blue)	Red
(Ni/Cr-Ni	DIN43710	Copper (green/red)	Constantan (green)	Green DIN
Pt-Pt/Rh(S & R)	BS4937 Pts. 1&2	Copper (white)	Copper/Nickel(blue)	Green
Ni/Cr-Con (E)	BS4937 Pt. 6	Chrome (brown)	Constantan (blue)	Brown

High Impedance Millivolt Source

A millivolt signal suitable for the calibration of electronic recorders of input impedance greater than 100 kilohms is obtained from terminals marked 2 as follows:

1. Standardise the potentiometer.
2. Select mV position on left hand rotary switch.
3. Select the required range using the switch at the bottom right of the instrument panel (20mV or 60mV – refer to table of Scale Ranges on page 2 for thermoelectric ranges).
4. Turn the right hand rotary switch to the OFF position.
5. If the instrument to be calibrated is a mV indicator set the COLD JUNCTION TEMPERATURE scale to zero. Set the main scale to the required mV value. If the instrument to be calibrated is used to monitor a thermocouple and indicates ambient temperature for 0mV input, set the COLD JUNCTION TEMPERATURE scale to the ambient temperature as shown on the mercury in-glass thermometer on the panel. Set the main scale to the required temperature.

N.B. In the procedure above, the instrument is assumed to be at the same ambient temperature as the potentiometer.

Low Impedance Millivolt Source (PP321 and PP322 only)

A low impedance millivolt source suitable for calibrating instruments taking current from the source is available from terminals marked 2 and may be used as follows:

1. Standardise the potentiometer.
2. Select No. 2 position on left hand rotary switch.
3. Select the required range, using the switch at bottom right of the instrument panel (20mV or 60mV – refer to table of Scale Ranges on page 2 for thermoelectric ranges).
4. Select the mV position on the right hand rotary switch.
5. Disconnect the leads from the instrument to be calibrated.
6. If the instrument to be calibrated is a mV indicator, set the COLD JUNCTION TEMPERATURE scale to zero.
   If the instrument to be calibrated is used to monitor a thermocouple it will now normally indicate the ambient temperature. Set the COLD JUNCTION TEMPERATURE scale to the ambient temperature as shown on the mercury-in-glass thermometer (and on the indicator to be calibrated).
7. Connect the instrument to the terminals marked 2 on the potentiometer, replacing the disconnected leads and original source (e.g. thermocouple) with leads and a series resistor of equivalent total resistance.
8. If the instrument is a mV indicator, set the main scale to the required mV value.
   If the instrument is used to monitor a thermocouple, set the main scale to the required temperature.
9. Push the lever of the MEASURE-STANDARDISE switch to MEASURE and adjust the COARSE and FINE rheostats of the mV SOURCE at the right hand side of the panel until the galvanometer indicates zero. The output from the terminals marked 2 on the potentiometer is now at the required value, i.e. the main scale setting.

N.B. In the procedure above, the instrument is assumed to be at the same ambient temperature as the potentiometer.

Measurement of Resistance (PP322 only)

1. Standardise the potentiometer.
2. Connect the unknown resistance to terminals marked 2.
3. Set the main scale to 20mV and the cold junction scale to zero.
4. Set the range to 20mV using the switch at the bottom right of the panel.
5. Select No. 2 position on left hand rotary switch.
6. Select 200Ω position on right hand rotary switch.
7. Push the MEASURE-STANDARDISE lever to MEASURE and adjust the COARSE and FINE mV SOURCE rheostats at the right hand side of the panel until the galvanometer indicates zero.
8. Select the 'RES' position on the right hand rotary switch.
9. With the MEASURE-STANDARDISE lever in the MEASURE position adjust the main scale until the galvanometer again indicates zero.
10. The unknown resistance is equal to the main scale mV reading x 10, i.e. 0 to 20mV is equivalent to 0 to 200Ω.

If the resistance is less than 20Ω, carry out steps 1 to 5 as above. Select the 20Ω position on the right hand rotary switch and continue with steps 7 to 9. 0 to 20mV on the main scale is now equivalent to 0 to 20Ω. Thus the resistance may be read directly from the main scale.

THERMOCOUPLE REFERENCE TABLES

The following pages contain extracts from British Standards Reference Tables for Thermocouples.
Material from BS 4937 parts 1 to 6 is included by permission of the British Standards Institution.
Material from BS 1826, 1827, 1828 and 1829 is taken from British Standards now withdrawn and is included only for comparison with the up to date information.
Foster Cambridge Ltd., acknowledge the co-operation of the British Standards Institution in allowing the extracts to be reproduced.

Table 1 Platinum – Platinum/10% Rhodium: Type S, BS 4937 (Part 1) and BS 1826

Temp. °C	BS 1826 mV	BS 4937.1 mV	Temp. °C	BS 1826 mV	BS 4937.1 mV	Temp. °C	BS 1826 mV	BS 4937.1 mV
10	0.055	0.055	600	5.226	5.237	1190	11.826	11.827
20	0.112	0.113	610	5.329	5.339	1200	11.946	11.947
30	0.172	0.173	620	5.431	5.442	1210	12.066	12.067
40	0.233	0.235	630	5.535	5.544	1220	12.187	12.188
50	0.297	0.299	640	5.638	5.648	1230	12.307	12.308
60	0.363	0.365	650	5.742	5.751	1240	12.428	12.429
70	0.430	0.432	660	5.846	5.855	1250	12.550	12.550
80	0.499	0.502	670	5.950	5.960	1260	12.670	12.671
90	0.570	0.573	680	6.055	6.064	1270	12.791	12.792
100	0.642	0.645	690	6.160	6.169	1280	12.912	12.913
110	0.716	0.719	700	6.265	6.274	1290	13.034	13.034
120	0.791	0.795	710	6.371	6.380	1300	13.155	13.155
130	0.867	0.872	720	6.477	6.486	1310	13.277	13.276
140	0.945	0.950	730	6.584	6.592	1320	13.399	13.397
150	1.024	1.029	740	6.691	6.699	1330	13.520	13.519
160	1.104	1.109	750	6.798	6.805	1340	13.642	13.640
170	1.185	1.190	760	6.906	6.913	1350	13.764	13.761
180	1.268	1.273	770	7.013	7.020	1360	13.886	13.883
190	1.351	1.356	780	7.122	7.128	1370	14.007	14.004
200	1.435	1.440	790	7.230	7.236	1380	14.128	14.125
210	1.520	1.525	800	7.339	7.345	1390	14.250	14.247
220	1.605	1.611	810	7.448	7.454	1400	14.371	14.368
230	1.691	1.698	820	7.558	7.563	1410	14.492	14.489
240	1.778	1.785	830	7.667	7.672	1420	14.613	14.610
250	1.866	1.873	840	7.778	7.782	1430	14.734	14.731
260	1.954	1.962	850	7.888	7.892	1440	14.855	14.852
270	2.043	2.051	860	7.999	8.003	1450	14.976	14.973
280	2.133	2.141	870	8.110	8.114	1460	15.097	15.094
290	2.223	2.232	880	8.222	8.225	1470	15.218	15.215
300	2.314	2.323	890	8.334	8.336	1480	15.339	15.336
310	2.406	2.414	900	8.446	8.448	1490	15.459	15.456
320	2.498	2.506	910	8.559	8.560	1500	15.580	15.576
330	2.590	2.599	920	8.672	8.673	1510	15.700	15.697
340	2.683	2.692	930	8.786	8.786	1520	15.820	15.817
350	2.777	2.786	940	8.900	8.899	1530	15.940	15.937
360	2.871	2.880	950	9.014	9.012	1540	16.060	16.057
370	2.965	2.974	960	9.129	9.126	1550	16.180	16.176
380	3.059	3.069	970	9.244	9.240	1560	16.298	16.296
390	3.154	3.164	980	9.360	9.355	1570	16.416	16.415
400	3.249	3.260	990	9.475	9.470	1580	16.535	16.534
410	3.344	3.356	1000	9.591	9.585	1590	16.653	16.653
420	3.440	3.452	1010	9.707	9.700	1600	16.770	16.771
430	3.537	3.549	1020	9.823	9.816	1610	16.887	16.890
440	3.633	3.645	1030	9.940	9.932	1620	17.004	17.008
450	3.730	3.743	1040	10.055	10.048	1630	17.120	17.125
460	3.827	3.840	1050	10.172	10.165	1640	17.236	17.243
470	3.925	3.938	1060	10.290	10.282	1650	17.351	17.360
480	4.023	4.036	1070	10.405	10.400	1660	17.466	17.477
490	4.121	4.135	1080	10.522	10.517	1670	17.581	17.594
500	4.220	4.234	1090	10.640	10.635	1680	17.695	17.711
510	4.319	4.333	1100	10.757	10.754	1690	17.809	17.826
520	4.419	4.432	1110	10.875	10.872	1700	17.922	17.942
530	4.518	4.532	1120	10.993	10.991	1710	18.035	18.056
540	4.619	4.632	1130	11.111	11.110	1720	18.147	18.170
550	4.719	4.732	1140	11.229	11.229	1730	18.260	18.282
560	4.820	4.832	1150	11.348	11.348	1740	18.371	18.394
570	4.921	4.933	1160	11.467	11.467	1750	18.482	18.504
580	5.022	5.034	1170	11.586	11.587	1760	18.592	18.612
590	5.124	5.136	1180	11.706	11.707			

Table 2 Platinum – Platinum/13% Rhodium: Type R, BS 4937 (Part 2) and BS 1826

Temp. °C	BS 1826 mV	BS 4937.2 mV	Temp. °C	BS 1826 mV	BS 4937.2 mV	Temp. °C	BS 1826 mV	BS 4937.2 mV
10	0.054	0.054	580	5.345	5.356	1150	12.532	12.532
20	0.111	0.111	590	5.458	5.469	1160	12.670	12.669
30	0.170	0.171	600	5.571	5.582	1170	12.807	12.808
40	0.231	0.232	610	5.685	5.696	1180	12.945	12.946
50	0.295	0.296	620	5.799	5.810	1190	13.084	13.085
60	0.361	0.363	630	5.914	5.925	1200	13.222	13.224
70	0.429	0.431	640	6.030	6.040	1210	13.361	13.363
80	0.499	0.501	650	6.146	6.155	1220	13.499	13.502
90	0.570	0.573	660	6.263	6.272	1230	13.638	13.642
100	0.644	0.647	670	6.380	6.388	1240	13.778	13.782
110	0.719	0.723	680	6.498	6.505	1250	13.917	13.922
120	0.796	0.800	690	6.616	6.623	1260	14.057	14.062
130	0.875	0.879	700	6.735	6.741	1270	14.196	14.202
140	0.955	0.959	710	6.855	6.860	1280	14.336	14.343
150	1.036	1.041	720	6.975	6.979	1290	14.476	14.483
160	1.119	1.124	730	7.095	7.098	1300	14.617	14.624
170	1.203	1.208	740	7.216	7.218	1310	14.758	14.765
180	1.289	1.294	750	7.338	7.339	1320	14.899	14.906
190	1.375	1.380	760	7.460	7.460	1330	15.041	15.047
200	1.463	1.468	770	7.582	7.582	1340	15.183	15.188
210	1.552	1.557	780	7.705	7.703	1350	15.325	15.329
220	1.641	1.647	790	7.828	7.826	1360	15.468	15.470
230	1.732	1.738	800	7.952	7.949	1370	15.610	15.611
240	1.823	1.830	810	8.076	8.072	1380	15.753	15.752
250	1.916	1.923	820	8.200	8.196	1390	15.896	15.893
260	2.010	2.017	830	8.325	8.320	1400	16.039	16.035
270	2.104	2.111	840	8.450	8.445	1410	16.182	16.176
280	2.199	2.207	850	8.576	8.570	1420	16.325	16.317
290	2.295	2.303	860	8.702	8.696	1430	16.468	16.458
300	2.392	2.400	870	8.828	8.822	1440	16.610	16.599
310	2.489	2.498	880	8.955	8.949	1450	16.753	16.741
320	2.587	2.596	890	9.082	9.076	1460	16.895	16.882
330	2.686	2.695	900	9.209	9.203	1470	17.038	17.022
340	2.786	2.795	910	9.337	9.331	1480	17.180	17.163
350	2.886	2.896	920	9.465	9.460	1490	17.322	17.304
360	2.987	2.997	930	9.594	9.589	1500	17.463	17.445
370	3.089	3.099	940	9.723	9.718	1510	17.604	17.585
380	3.191	3.201	950	9.853	9.848	1520	17.745	17.726
390	3.294	3.304	960	9.983	9.978	1530	17.885	17.866
400	3.397	3.407	970	10.114	10.109	1540	18.025	18.006
410	3.501	3.511	980	10.246	10.240	1550	18.165	18.146
420	3.605	3.616	990	10.378	10.371	1560	18.304	18.286
430	3.710	3.721	1000	10.510	10.503	1570	18.442	18.425
440	3.815	3.826	1010	10.643	10.636	1580	18.580	18.564
450	3.921	3.933	1020	10.775	10.768	1590	18.718	18.703
460	4.028	4.039	1030	10.909	10.902	1600	18.855	18.842
470	4.135	4.146	1040	11.042	11.035	1610	18.992	18.981
480	4.243	4.254	1050	11.176	11.170	1620	19.128	19.119
490	4.351	4.362	1060	11.310	11.304	1630	19.264	19.257
500	4.460	4.471	1070	11.445	11.439	1640	19.399	19.395
510	4.570	4.580	1080	11.580	11.574	1650	19.534	19.533
520	4.679	4.689	1090	11.715	11.710	1660	19.668	19.670
530	4.789	4.799	1100	11.850	11.846	1670	19.802	19.807
540	4.899	4.910	1110	11.986	11.983	1680	19.936	19.944
550	5.010	5.021	1120	12.122	12.119	1690	20.069	20.080
560	5.121	5.132	1130	12.258	12.257	1700	20.202	20.215
570	5.233	5.244	1140	12.395	12.394			

Table 3 Iron – Constantan (Copper/Nickel): Type J, BS 4937 (Part 3) and BS 1829

Temp. °C	BS 1829 mV	BS 4937.3 mV	Temp. °C	BS 1829 mV	BS 4937.3 mV	Temp. °C	BS 1829 mV	BS 4937.3 mV
10	0.500	0.507	150	8.000	8.008	290	15.770	15.771
20	1.020	1.019	160	8.560	8.560	300	16.330	16.325
30	1.540	1.536	170	9.110	9.113	310	16.880	16.879
40	2.060	2.058	180	9.670	9.667	320	17.430	17.432
50	2.580	2.585	190	10.220	10.222	330	17.980	17.984
60	3.110	3.115	200	10.780	10.777	340	18.540	18.537
70	3.650	3.649	210	11.340	11.332	350	19.090	19.089
80	4.190	4.186	220	11.890	11.887	360	19.640	19.640
90	4.730	4.725	230	12.450	12.442	370	20.200	20.192
100	5.270	5.268	240	13.010	12.998	380	20.750	20.743
110	5.810	5.812	250	13.560	13.553	390	21.300	21.295
120	6.360	6.359	260	14.120	14.108	400	21.850	21.846
130	6.900	6.907	270	14.670	14.663	410	22.400	22.397
140	7.450	7.457	280	15.220	15.217	420	22.950	22.949

Table 3 (cont'd) Iron – Constantan (Copper/Nickel)

Temp. °C	BS 1829 mV	BS 4937.3 mV	Temp. °C	BS 1829 mV	BS 4937.3 mV	Temp. °C	BS 1829 mV	BS 4937.3 mV
430	23.500	23.501	580	31.950	31.933	730	41.050	41.013
440	24.060	24.054	590	32.530	32.513	740	41.680	41.647
450	24.610	24.607	600	33.110	33.096	750	42.320	42.283
460	25.160	25.161	610	33.700	33.683	760	42.960	42.922
470	25.720	25.716	620	34.290	34.273	770	43.600	43.563
480	26.270	26.272	630	34.880	34.867	780	44.250	44.207
490	26.830	26.829	640	35.480	35.464	790	44.890	44.852
500	27.390	27.388	650	36.080	36.066	800	45.530	45.498
510	27.950	27.949	660	36.690	36.671	810	46.180	46.144
520	28.520	28.511	670	37.300	37.280	820	46.820	46.790
530	29.080	29.075	680	37.910	37.893	830	47.460	47.434
540	29.650	29.642	690	38.530	38.510	840	48.090	48.076
550	30.220	30.210	700	39.150	39.130	850	48.730	48.716
560	30.800	30.782	710	39.780	39.754	860	49.360	49.354
570	31.370	31.356	720	40.410	40.382	870	49.980	49.989

Table 4 Nickel/Chromium – Nickel/Aluminium: Type K, BS 4937 (Part 4) and BS 1827

Temp. °C	BS 1827 mV	BS 4937.4 mV	Temp. °C	BS 1827 mV	BS 4937.4 mV	Temp. °C	BS 1827 mV	BS 4937.4 mV
10	0.400	0.397	470	19.360	19.363	930	38.560	38.519
20	0.800	0.798	480	19.790	19.788	940	38.950	38.915
30	1.200	1.203	490	20.220	20.214	950	39.350	39.310
40	1.610	1.611	500	20.650	20.640	960	39.750	39.703
50	2.020	2.022	510	21.070	21.066	970	40.140	40.096
60	2.430	2.436	520	21.500	21.493	980	40.530	40.488
70	2.850	2.850	530	21.920	21.919	990	40.920	40.879
80	3.260	3.266	540	22.350	22.346	1000	41.310	41.269
90	3.680	3.681	550	22.780	22.772	1010	41.700	41.657
100	4.100	4.095	560	23.200	23.198	1020	42.090	42.045
110	4.510	4.508	570	23.630	23.624	1030	42.480	42.432
120	4.920	4.919	580	24.060	24.050	1040	42.870	42.817
130	5.330	5.327	590	24.490	24.476	1050	43.250	43.202
140	5.730	5.733	600	24.910	24.902	1060	43.630	43.585
150	6.130	6.137	610	25.340	25.327	1070	44.020	43.968
160	6.530	6.539	620	25.760	25.751	1080	44.400	44.349
170	6.930	6.939	630	26.190	26.176	1090	44.780	44.729
180	7.330	7.338	640	26.610	26.599	1100	45.160	45.108
190	7.730	7.737	650	27.030	27.022	1110	45.540	45.486
200	8.130	8.137	660	27.450	27.445	1120	45.920	45.863
210	8.540	8.537	670	27.870	27.867	1130	46.290	46.238
220	8.940	8.938	680	28.290	28.288	1140	46.670	46.612
230	9.340	9.341	690	28.720	28.709	1150	47.040	46.985
240	9.750	9.745	700	29.140	29.128	1160	47.410	47.356
250	10.160	10.151	710	29.560	29.547	1170	47.480	47.726
260	10.570	10.560	720	29.970	29.965	1180	48.150	48.095
270	10.980	10.969	730	30.390	30.383	1190	48.520	48.462
280	11.390	11.381	740	30.810	30.799	1200	48.890	48.828
290	11.800	11.793	750	31.230	31.214	1210	49.250	49.192
300	12.210	12.207	760	31.650	31.629	1220	49.620	49.555
310	12.630	12.623	770	32.060	32.042	1230	49.980	49.916
320	13.040	13.039	780	32.480	32.455	1240	50.340	50.276
330	13.460	13.456	790	32.890	32.866	1250	50.690	50.633
340	13.880	13.874	800	33.300	33.277	1260	51.050	50.990
350	14.290	14.292	810	33.710	33.686	1270	51.410	51.344
360	14.710	14.712	820	34.120	34.095	1280	51.760	51.697
370	15.130	15.132	830	34.530	34.502	1290	52.110	52.049
380	15.550	15.552	840	34.930	34.909	1300	52.460	52.398
390	15.980	15.974	850	35.340	35.314	1310	52.810	52.747
400	16.400	16.395	860	35.750	35.718	1320	53.160	53.093
410	16.820	16.818	870	36.150	36.121	1330	53.510	53.439
420	17.240	17.241	880	36.550	36.524	1340	53.850	53.782
430	17.670	17.664	890	36.960	36.925	1350	54.200	54.125
440	18.090	18.088	900	37.360	37.325	1360	54.540	54.466
450	18.510	18.513	910	37.760	37.724	1370	54.880	54.807
460	18.940	18.938	920	38.160	38.122			

Table 5 Copper–Constantan (Copper/Nickel): Type T, BS 4937 (Part 5) and BS 1828

Temp. °C	BS 1828 mV	BS 4937.5 mV	Temp. °C	BS 1828 mV	BS 4937.5 mV	Temp. °C	BS 1828 mV	BS 4937.5 mV
10	0.388	0.391	140	6.140	6.204	270	12.970	13.137
20	0.783	0.789	150	6.631	6.702	280	13.531	13.707
30	1.188	1.196	160	7.129	7.207	290	14.096	14.281
40	1.600	1.611	170	7.632	7.718	300	14.666	14.860
50	2.021	2.035	180	8.142	8.235	310	15.241	15.443
60	2.449	2.467	190	8.657	8.757	320	15.819	16.030
70	2.885	2.908	200	9.178	9.286	330	16.402	16.621
80	3.329	3.357	210	9.704	9.820	340	16.989	17.217
90	3.780	3.813	220	10.236	10.360	350	17.580	17.816
100	4.239	4.277	230	10.773	10.905	360	18.175	18.420
110	4.704	4.749	240	11.315	11.456	370	18.774	19.027
120	5.176	5.227	250	11.862	12.011	380	19.376	19.638
130	5.654	5.712	260	12.413	12.572	390	19.982	20.252

Table 6 Nickel/Chromium–Constantan (Copper/Nickel): Type E, BS 4937 (Part 6)

Temp. °C	mV	Temp. °C	mV	Temp. °C	mV
10	0.591	260	17.942	510	37.808
20	1.192	270	18.710	520	38.617
30	1.801	280	19.481	530	39.426
40	2.419	290	20.256	540	40.236
50	3.047	300	21.033	550	41.045
60	3.683	310	21.814	560	41.853
70	4.329	320	22.597	570	42.662
80	4.983	330	23.383	580	43.470
90	5.646	340	24.171	590	44.278
100	6.317	350	24.961	600	45.085
110	6.996	360	25.754	610	45.891
120	7.683	370	26.549	620	46.697
130	8.377	380	27.345	630	47.502
140	9.078	390	28.143	640	48.306
150	9.787	400	28.943	650	49.109
160	10.501	410	29.744	660	49.911
170	11.222	420	30.546	670	50.713
180	11.949	430	31.350	680	51.513
190	12.681	440	32.155	690	52.312
200	13.419	450	32.960	700	53.110
210	14.161	460	33.767	710	53.907
220	14.909	470	34.574	720	54.703
230	15.661	480	35.382	730	55.948
240	16.417	490	36.190	740	56.291
250	17.178	500	36.999	750	57.083

SERVICE CENTRES

London Service Centre
Chaseside Works
Chelmsford Road,
Southgate,
London N14 4JW
01-882 3737/8

Bristol Service Centre
119A Two Mile Hill Road,
Kingswood,
Bristol BS15 1BY
0272 679151/2

Birmingham Service Centre
Unit 14A,
Lee Bank House,
63 Blucher Street
Birmingham B1 1HR
021-643 4114 or 021-643 6783

Glasgow Service Centre
52 Waddell Street,
Glasgow, C.5
041-429 3371

Manchester Service Centre
Lord Street,
Manchester M3 1HL
061-832 5391/2

Newcastle Service Centre
10 Hannington Street,
Newcastle-upon-Tyne NE6 1JT
0632 656126