BRITISH STANDARD AEROSPACE SERIES

BS 3G 148: 1981

Specification for

General purpose platinum temperature sensors for aircraft

UDC 629.7.054:536.531

Foreword

This British Standard, which is a revision of BS 2G 148:1963, is applicable to general purpose platinum resistance temperature sensors for use in aircraft. Sensors suitable for the measurement of outside air temperatures will be the subject of another British Standard in the "G" series. Although the sensors are intended for use on d.c. electrical supplies, they may, if non-inductively wound, be suitable for use in a.c. systems up to 400 Hz.

The revised standard differs from the 1963 edition in the following respects.

a) The introduction of a resistance of 100 Ω at 0 °C in line with other International Standards.

b) The sensor characteristics and tolerances are now in agreement with EEC standards.

c) The deletion of the connector and the introduction of high temperature capability cable (200 °C).

d) The deletion of the loose olive and replacement with a fixed olive of metric dimensions.

e) The dimensions of the sensor olive, nut and boss are compatible with those specified in SBAC[1)] standards AS 43021, AS 43022, and AS 43023.

f) The addition of specific test requirements relating to the performance of the sensors.

g) The introduction of a clause stating the characteristics to be declared by the manufacturer relating to immersion error.

This British Standard supersedes BS 2G 148:1963, which is therefore withdrawn.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

This British Standard, having been prepared under the direction of the Aerospace Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 December 1981

The following BSI references relate to the work on this standard:
Committee reference ACE/30
Draft for comment 80/76254 DC

ISBN 0 580 12482 7

[1)] Society of British Aerospace Companies Ltd.

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

blank

1 Scope

This British Standard specifies the general design and performance requirements for platinum resistance temperature sensors designed for the measurement of the temperature of gases or fluids in small diameter ducts. The sensors are designed for satisfactory operation for the measurement of fluid temperature whilst under high pressure. The temperature-resistance relationship is based on a sensor having a resistance of 100 Ω at 0 °C.

2 References

This standard makes reference to the following standards publications.

BS G 210, *PTFE insulated equipment wires (with silver plated copper conductors).*

BS 3G 100, *General requirements for equipment for use in aircraft.*

3 General constructional requirements

3.1 The design and construction of the platinum resistance temperature sensors shall conform to the outlines given in Figure 1 or Figure 2 and shall be such as to comply with the relevant environmental requirements of BS 3G 100.

3.2 The sensors shall be constructed from corrosion-resistant materials and no materials which are fungi nutrients shall be used.

The user shall exercise care in selecting materials for the overall assembly to minimize electrolytic action between dissimilar metals.

4 Design and performance requirements

4.1 Temperature range. The temperature range shall be – 70 °C to + 450 °C, subject to the connecting cable being kept to a temperature not exceeding + 200 °C.

4.2 Temperature-resistance relationship and tolerances. The sensor shall have a nominal resistance of 100 Ω at 0 °C.

The temperature-resistance relationship shall be as shown in Table 1. The limits of intrinsic error shall not exceed those given in Table 2. The values given in Table 1 have been calculated from the following temperature-resistance relationships.

Characteristics

For the range – 70 °C to 0 °C:

$$R_t = R_0 [1 + At + Bt^2 + C (t - 100\ °C)\ t^3]$$

For the range of 0 °C to 450 °C:

$$R_t = R_0 (1 + At + Bt^2)$$

The values of the constants in these equations are as follows:

$A = 3.908\ 02 \times 10^{-3}\ °C^{-1}$

$B = -\ 5.802 \times 10^{-7}\ °C^{-2}$

$C = -\ 4.273\ 50 \times 10^{-12}\ °C^{-4}$

R_0 is the resistance at 0 °C and R_t the resistance at t °C. These equations are listed as the basis for the temperature-resistance tables of this standard and are not intended to be used for the calibration of individual thermometers. Values of temperature in this standard are in the International Practical Temperature Scale (IPTS) of 1968.

4.3 Self-heating. With the sensor immersed in water at 20 °C flowing at 1 m/s transverse to the axis of the sensor, the I^2R power dissipated in it shall not cause an indicated temperature rise of greater than + 0.01 °C/mW. In still air the error shall not be greater than 0.25 °C/mW.

4.4 Time constant (response time). When quickly plunged into water at approximately 80 °C moving at 1 m/s with flow transverse to the axis of the sensor, 63 % of the response to the step of temperature shall take place in less than 1.5 s.

4.5 Stability. The sensor shall withstand 10 consecutive temperature shocks from – 70 °C to + 20 °C or 10 shocks from + 450 °C to + 20 °C at a rate of not less than 25 °C/min, after which the resistance at 0 °C shall not change by more than ± 0.05 %.

4.6 Insulation resistance. When measured with a 500 V d.c. insulation tester the insulation resistance between the electrical conductors and the sheath of the sensor shall be not less than 20 MΩ at 20 ± 5 °C, and 1 MΩ at the working temperature.

4.7 Maximum current. The sensor shall withstand a continuous current of 20 mA without de-rangement.

4.8 Pressure. The sensor sheath shall withstand a working pressure of 27.6 MPa (276 bar). Whilst at this pressure there shall be no change in measured resistance compared with the unpressurized state.

4.9 Vibration. The sensor when correctly mounted in the standard boss shall withstand without failure the vibration environment as specified in BS 3G 100-2.3.1, for region D, for use on any part of the airframe, excluding direct contact with the power unit. The cable shall be adequately supported. The supplier shall declare the maximum sensor length up to which this requirement can be met.

Table 1 — Resistance/temperature relationship

$R_0 = 100.00\ \Omega$ $\qquad \frac{R_{100}}{R_0} = 1.3850$

Degrees Celsius IPTS 1968	0	1	2	3	4	5	6	7	8	9	10	Degrees Celsius IPTS 1968
	Ω	Ω	Ω	Ω	Ω	Ω	Ω	Ω	Ω	Ω	Ω	
– 70	72.33											– 70
– 60	76.33	75.93	75.50	75.13	74.73	74.33	73.93	73.53	73.13	72.73	72.33	– 60
– 50	80.31	79.91	79.51	79.11	78.72	78.32	77.92	77.52	77.13	76.73	76.33	– 50
– 40	84.27	83.83	83.48	83.08	82.69	82.29	81.89	81.50	81.10	80.70	80.31	– 40
– 30	88.22	87.83	87.43	87.04	86.64	86.25	85.85	85.46	85.06	84.67	84.27	– 30
– 20	92.16	91.77	91.37	90.98	90.59	90.19	89.80	89.40	89.01	88.62	88.22	– 20
– 10	96.09	95.69	95.30	94.91	94.52	94.12	93.73	93.34	92.95	92.55	92.16	– 10
0	100.00	99.61	99.22	98.83	98.44	98.04	97.65	97.26	96.87	96.48	96.09	0
0	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12	103.51	103.90	0
10	103.90	104.29	104.68	105.07	105.46	105.85	106.24	106.63	107.02	107.40	107.79	10
20	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90	111.28	111.67	20
30	111.67	112.06	112.45	112.83	113.22	113.61	113.99	114.38	114.77	115.15	115.54	30
40	115.54	115.93	116.31	116.70	117.08	117.47	117.85	118.24	118.62	119.01	119.40	40
50	119.40	119.78	120.16	120.55	120.93	121.32	121.70	122.09	122.47	122.86	123.24	50
60	123.24	123.62	124.01	124.39	124.77	125.16	125.54	125.92	126.31	126.69	127.07	60
70	127.07	127.45	127.84	128.22	128.60	128.98	129.37	129.75	130.13	130.51	130.89	70
80	130.89	131.27	131.66	132.04	132.42	132.80	133.18	133.56	133.94	134.32	134.70	80
90	134.70	135.08	135.46	135.84	136.22	136.60	136.98	137.36	137.74	138.12	138.50	90
100	138.50	138.88	139.26	139.64	140.02	140.39	140.77	141.15	141.53	141.91	142.29	100
110	142.29	142.66	143.04	143.42	143.80	144.17	144.55	144.93	145.31	145.68	146.06	110
120	146.06	146.44	146.81	147.19	147.57	147.94	148.32	146.70	149.07	149.45	149.82	120
130	149.82	150.20	150.57	150.95	151.33	151.70	152.08	152.45	152.83	153.20	153.58	130
140	153.58	153.95	154.32	154.70	155.07	155.45	155.82	156.19	156.57	156.94	157.31	140
150	157.31	157.69	158.06	158.43	158.81	159.18	159.55	159.93	160.30	160.67	161.04	150
160	161.04	161.42	161.79	162.16	162.53	162.90	163.27	163.65	164.02	164.39	164.76	160
170	164.76	165.13	165.50	165.87	166.24	166.61	166.98	167.35	167.72	168.09	168.46	170
180	168.46	168.83	169.20	169.57	169.94	170.31	170.68	171.05	171.42	171.79	172.16	180
190	172.16	172.53	172.90	173.26	173.63	174.00	174.37	174.74	175.10	175.47	175.84	190
200	175.84	176.21	176.57	176.94	177.31	177.68	178.04	178.41	178.78	179.14	179.51	200
210	179.51	179.83	180.24	180.61	180.97	181.34	181.71	182.07	182.44	182.80	183.17	210
220	183.17	183.53	183.90	184.26	184.63	184.99	185.36	185.72	186.09	186.45	186.82	220
230	186.82	187.18	187.54	187.91	188.27	188.63	189.00	189.36	189.72	190.09	190.45	230
240	190.45	190.81	191.18	191.54	191.90	192.26	192.63	192.99	193.35	193.71	194.07	240
250	194.07	194.44	194.80	195.16	195.52	195.88	196.24	196.60	196.96	197.33	197.69	250
260	197.69	198.05	198.41	198.77	199.13	199.49	199.85	200.21	200.57	200.93	201.29	260
270	201.29	201.65	202.01	202.36	202.72	203.08	203.44	203.80	204.16	204.52	204.88	270
280	204.88	205.23	205.59	205.95	206.31	206.67	207.02	207.38	207.74	208.10	208.45	280
290	208.45	208.81	209.17	209.52	209.88	210.24	210.59	210.95	211.31	211.66	212.02	290
300	212.02	212.37	212.73	213.09	213.44	213.80	214.15	214.51	214.86	215.22	215.57	300
310	215.57	215.93	216.28	216.64	216.99	217.35	217.70	218.05	218.41	218.76	219.12	310
320	219.12	219.47	219.82	220.18	220.53	220.88	221.24	221.59	221.94	222.29	222.65	320
330	222.65	223.00	223.35	223.70	224.06	224.41	224.76	225.11	225.46	225.81	226.17	330
340	226.17	226.52	226.87	227.22	227.57	227.92	228.27	228.62	228.97	229.32	229.67	340
350	229.67	230.02	230.37	230.72	231.07	231.42	231.77	232.12	232.47	232.82	233.17	350
360	233.17	233.52	233.87	234.22	234.56	234.91	235.26	235.61	235.96	236.31	236.65	360
370	236.65	237.00	237.35	237.70	238.04	238.39	238.74	239.09	239.43	239.78	240.13	370
380	240.13	240.47	240.82	241.17	241.51	241.86	242.20	242.55	242.90	243.24	243.59	380
390	243.59	243.93	244.28	244.62	244.97	245.31	245.66	246.00	246.35	246.69	247.04	390
400	247.04	247.38	247.73	248.07	248.41	248.76	249.10	249.45	249.79	250.13	250.48	400
410	250.48	250.82	251.16	251.50	251.85	252.19	252.53	252.88	253.22	253.56	253.90	410
420	253.90	254.24	254.59	254.93	255.27	255.61	255.95	256.29	256.64	256.98	257.32	420
430	257.32	257.66	258.00	258.34	258.68	259.02	259.36	259.70	260.04	260.38	260.72	430
440	260.72	261.06	261.40	261.74	262.08	262.42	262.76	263.10	263.43	263.77	264.11	440
450	264.11											450

4.10 Acceleration. The sensor, when correctly mounted and with the cable adequately supported, shall withstand without damage an acceleration of 17 g_n in any direction. The sensor shall not break up or become detached under an acceleration of 25.5 g_n in any direction. The supplier shall declare the maximum sensor length up to which this requirement can be met.

4.11 Immersion error. With sensors manufactured to the minimum length it is possible for a significant immersion error to occur arising from the temperature differential between the fluid being measured and the ambient atmosphere.

The immersion error shall be measured using the apparatus described in Appendix A and the error shall be declared. This error shall not exceed 0.29 Ω (0.75 °C).

4.12 Thermo-electrical effect. The thermal e.m.f. produced by the sensor shall be the minimum practical and shall be measured using the apparatus described in Appendix A.

The e.m.f. value measured shall be declared and shall not exceed 20 V.

4.13 Temperature/pressure. It is essential to ensure adequate sealing of the cable entry into the sensor. The satisfactory manufacture of this joint will be demonstrated if the sensor operates satisfactorily during temperature/pressure test of BS 3G 100-2.3.2, appropriate to Equipment Grade V, Test D, Method 2.

5 Marking

Each unit shall be permanently marked with the following minimum information.

a) Model or type number.

b) The number of this British Standard, i.e. BS 3G 148[2)].

c) Serial number.

d) Name of the manufacturer.

Table 2 — Limits of intrinsic error

Temperature	Limits	
°C	C	Ω
− 70	0.65	0.25
0	0.3	0.12
100	0.8	0.30
200	1.3	0.40
300	1.8	0.64
400	2.3	0.79
450	2.55	0.86

NOTE The above permitted errors are calculated from the following.

Intrinsic error °C = 0.3 + 0.005 $|t|$

where $|t|$ is the modulus of temperature in °C without regard to sign.

[2)] Marking BS 3G 148 on or in relation to a product is a claim by the manufacturer that the product has been manufactured in accordance with the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility. Enquiries as to the availability of third party certification to support such claims should be addressed to the Director, British Standards Institution, Maylands Avenue, Hemel Hempstead, Herts HP2 4SQ in the case of certification marks administered by BSI or to the appropriate authority for other certification marks.

Appendix A Apparatus and procedures for immersion error test and thermo-electrical effect test

A.1 Apparatus

The apparatus (see Figure 4) consists of a container with a base manufactured from an insulating material with a conductivity of not more than 2.5 W/(m K). The base shall be approximately 12 mm thick. The sensing end of the sensor under test shall pass through the centre of the base of the container into a steam hypsometer.

The hole in the base through which the sensor passes shall be sealed with an "O" ring or similar device to prevent water leakage. The container shall contain divided ice and water to a depth of not less than 50 mm.

A.2 Immersion error test procedure

The sensor shall be fitted to the apparatus, without ice and water present, and subjected to steam passing around the sensing end until a stable measurement of sensor resistance can be made. The ice/water mixture shall then be added and the sensor resistance measured again when its resistance has stabilized. The difference in the measured values shall not exceed that specified. During this test the power dissipated in the thermometer shall not be greater than 1 mW.

A.3 Thermo-electrical effect test procedure

The sensor shall be fitted into the apparatus and the water mixture added. With the terminals of the sensor connected to a voltmeter the steam shall be admitted and the thermal electric potential shall be monitored as the sensor heats up.

The maximum value shall be recorded and shall not exceed that stated in **4.12**.

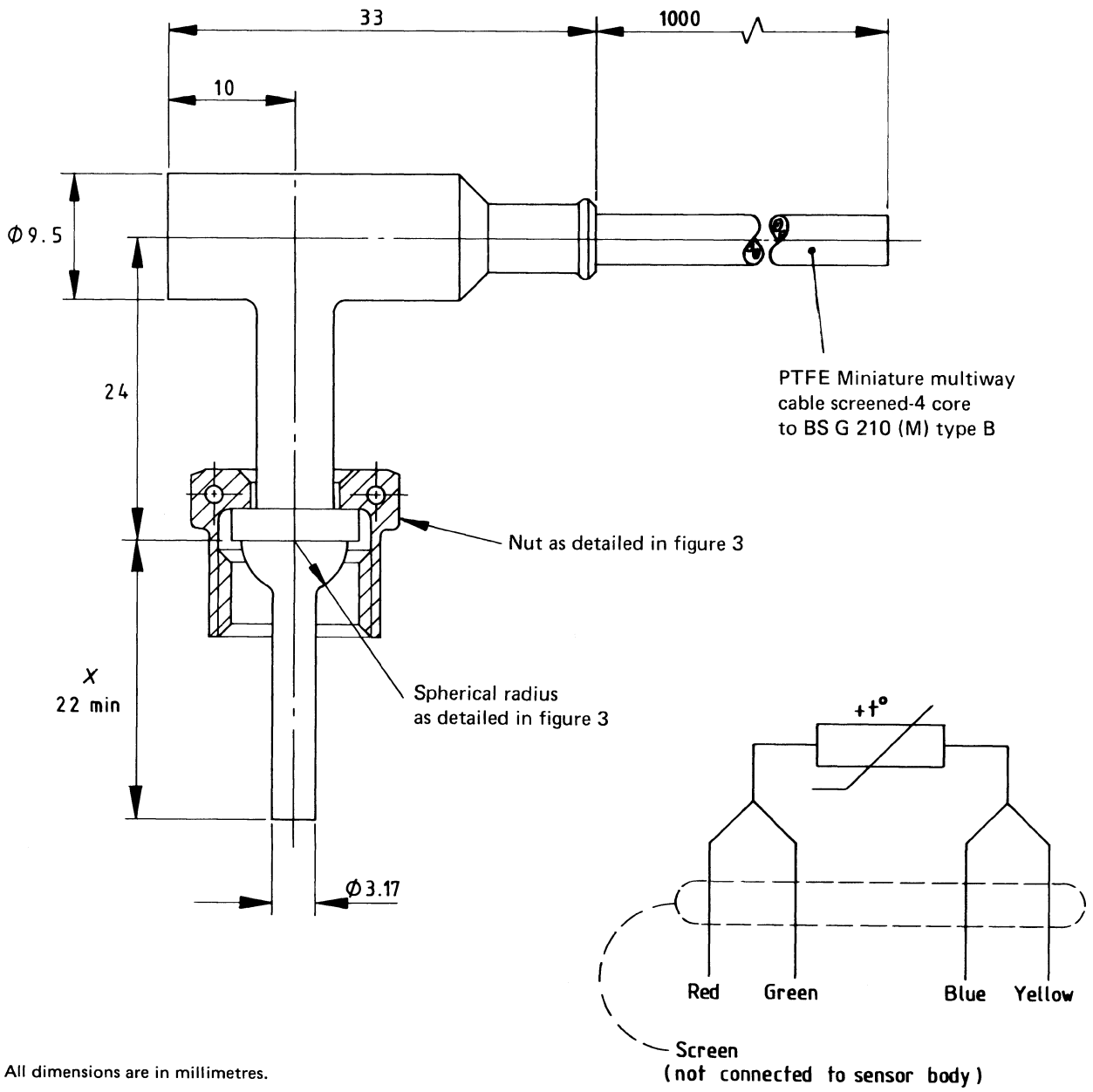
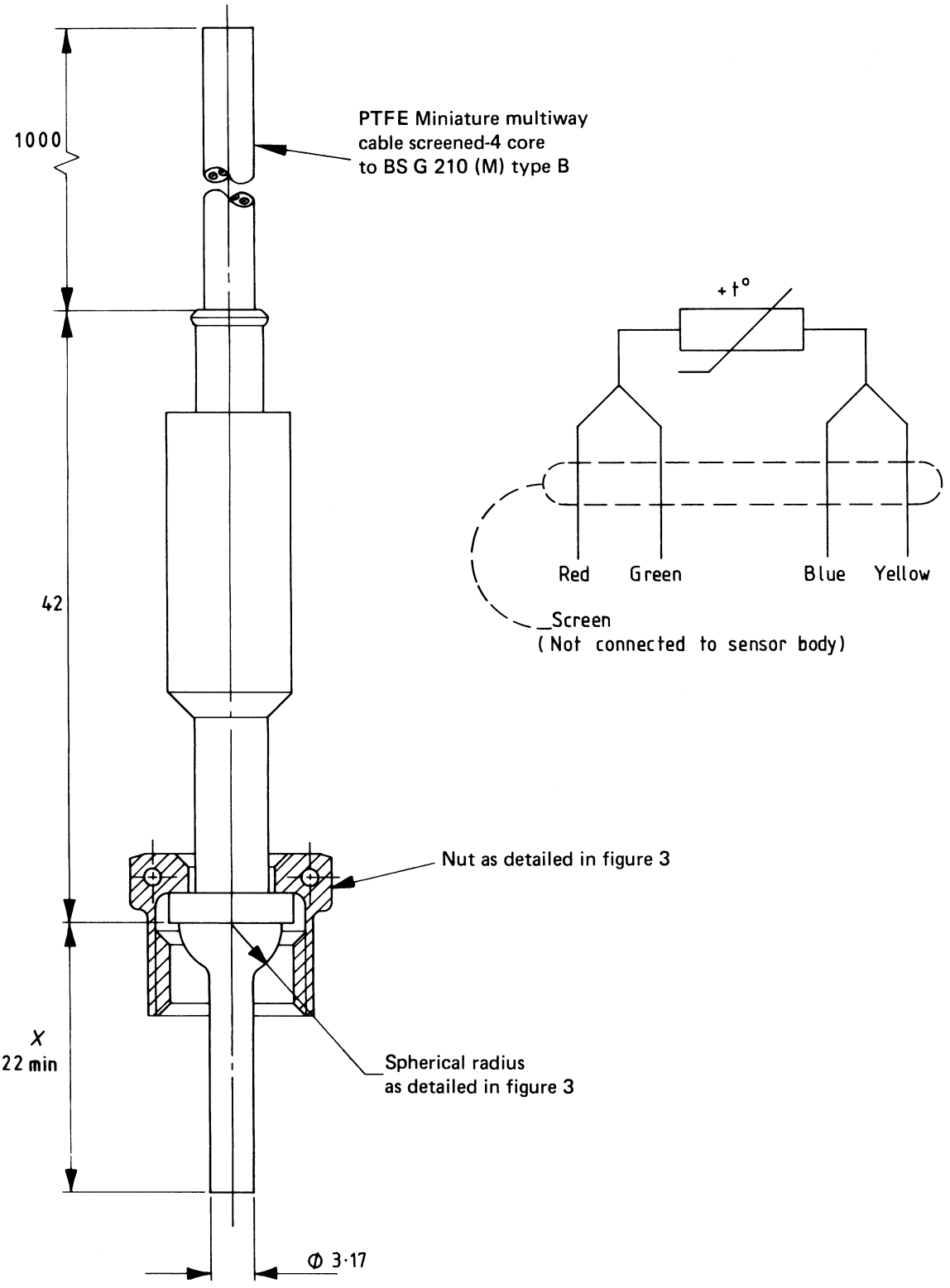
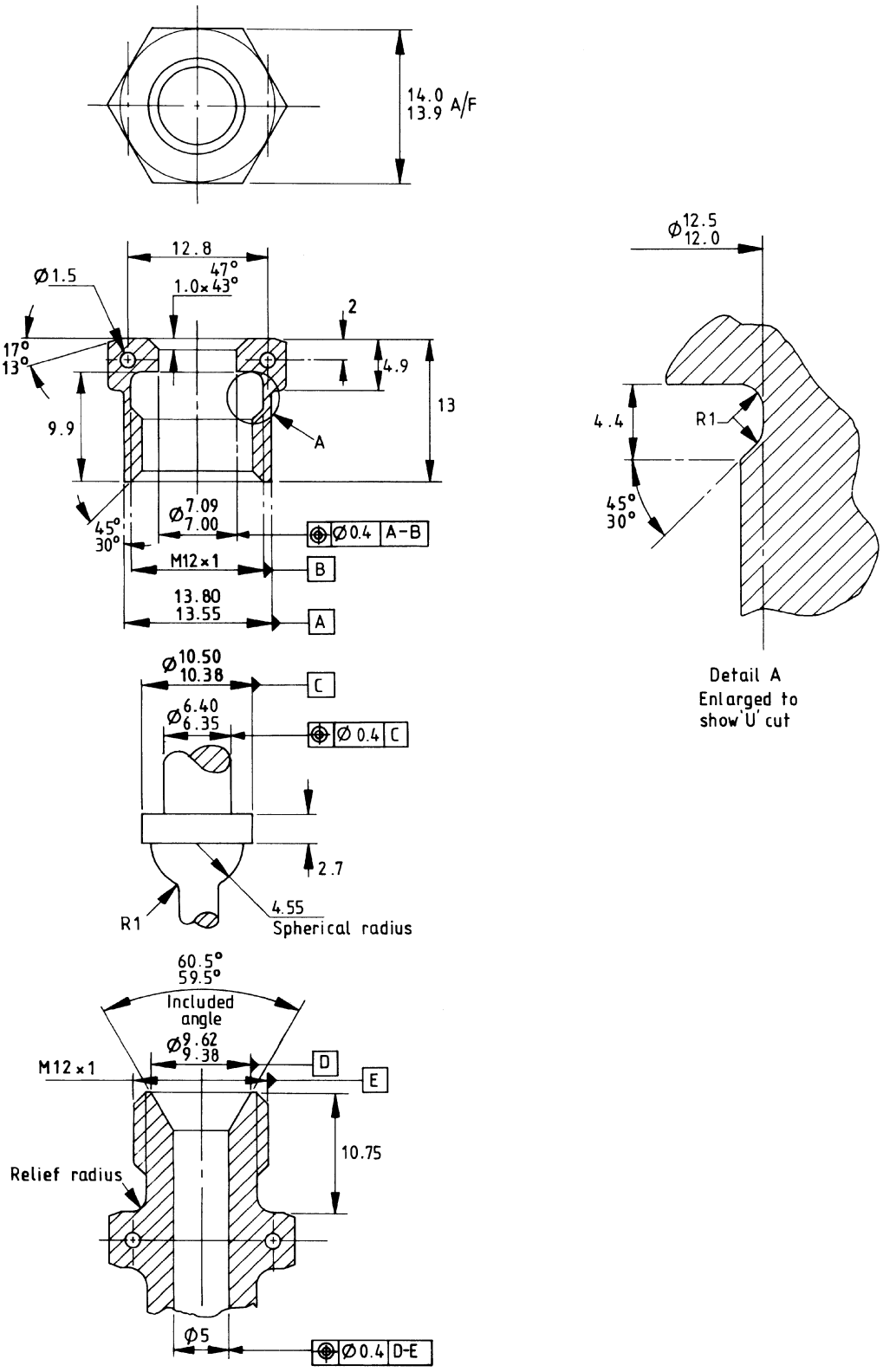


Figure 1 — Platinum temperature sensor 90° angled configuration



All dimensions are in millimetres.

Figure 2 — Platinum temperature sensor straight configuration



Linear dimensions are in millimetres.

Figure 3 — Mounting details

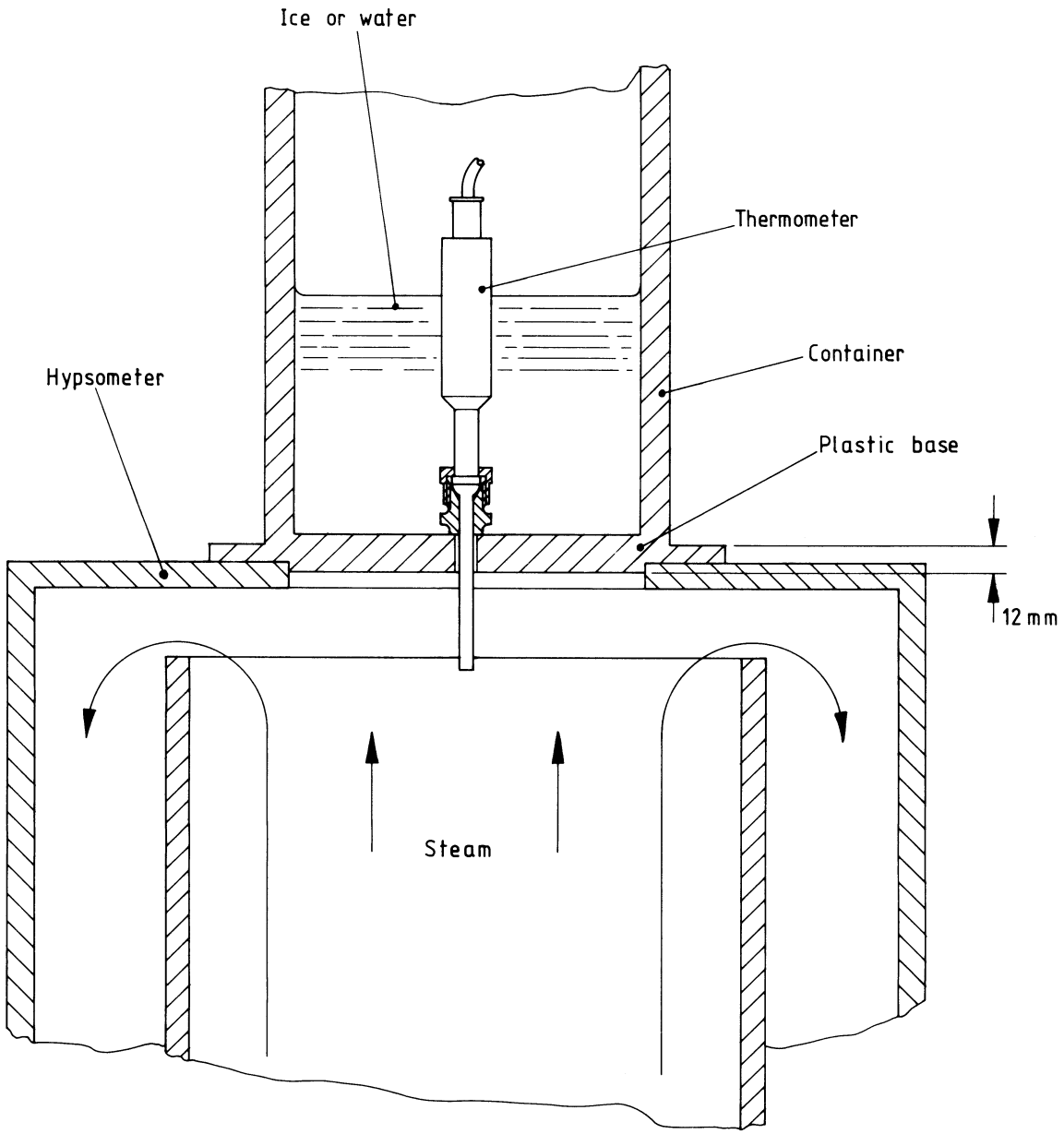


Figure 4 — Schematic diagram of test apparatus for determination of immersion error and thermo-electrical effect

blank

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL