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EIA STANDARD

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TEMPERATURE RISE VERSUS CURRENT TEST PROCEDURE FOR ELECTRICAL CONNECTORS AND SOCKETS

EIA/ECA-364-70B

(Revision of EIA-364-70A)

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Electronic Components, Assemblies & Materials Association

THE ELECTRONIC COMPONENTS SECTOR OF THE ELECTRONIC INDUSTRIES ALLIANCE

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EIA/ECA-364-70B

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(From Standards Proposal No. 4981-A formulated under the cognizance of the CE-2.0 National Connector Standards Committee.

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TEST PROCEDURE No. 70B

TEMPERATURE RISE VERSUS CURRENT TEST PROCEDURE FOR ELECTRICAL CONNECTORS AND SOCKETS

(From EIA Standards Proposal No. 4981-A, formulated under the cognizance EIA CE-2.0 Committee on National Connector Standards, and previously published in EIA-364-70A.)

1 Introduction

1.1 Scope

This procedure establishes the test procedures for determining temperature rise versus current for connectors and sockets with conductor sizes equal to or less than 0000 AWG or equivalent.

1.2 Test methods

1.2.1 Method 1, specified current

The object of this test is to determine the temperature rise of connectors/sockets carrying a specified current; see 4.2.

1.2.2 Method 2, temperature rise versus current curve

The object of this test is to establish a characteristic temperature rise versus current curve for the connector or socket: see 4.3. This curve may subsequently be used to create a derating curve as appropriate for the stated maximum operating temperature of the connector or socket.

1.2.3 Method 3, specified temperature rise

The object of this test is to determine the current level, that will not exceed a specified temperature rise; see 4.3.

1.2.4 Method 4, inaccessible contacts (TBD)

The object of this test is to determine the temperature rise and/or current derating curve when a group of signal contacts are energized in connectors or sockets with multiple rows (3 or more) and where size and access to the contacts is not practical; see 4.5.

2 Test resources

2.1 Equipment

2.1.1 Regulated power supply

Capable of regulating current within 5% of the desired value.

2.1.2 Ammeter, shunt or ohmmeter

Capable of determining the current within 1% of the desired value.

2.1.3 Temperature measuring system

Capable of indicating temperature to within ± 2 °C.

2.1.3.1 Thermocouples

In order to reduce heat sinking the cross sectional area of the thermocouple wire shall not exceed 50% of the cross sectional area of the contact(s) being measured.

2.1.3.2 Infrared temperature measurement, microscope or thermography

The infrared system shall be suitable for the spatial resolution and temperature range of interest.

2.2 Test room or enclosure

The specimens shall be placed in an enclosure or room that shields them from external movements of air. If an enclosure is used it shall be of non-reflective material, shall have a cover. The enclosure or room shall be of sufficient size to accommodate any test specimen spacing as described herein.

3 Test specimen

3.1 Description

3.1.1 Specimens terminated to conductors or cables

The specimens shall be in free air suspension. If free air suspension is not possible, a thermally insulating material (e.g., wood, cardboard, polystyrene, etc.) shall be used as a support, provided that not more than 20% of the specimen surface is in contact with the insulating surface. Specimens shall be arranged in a horizontal attitude and shall meet the following requirements:

3.1.1.1 Specimens shall not be closer than 20 centimeters (8 inches) from the walls of the enclosure or room.
3.1.1.2 Specimens shall be no closer than 15 centimeters (6 inches) from the top of the enclosure or room.

3.1.1.3 If free air suspension is used, the specimens shall be a minimum of 5 centimeters (2 inches) above the bottom of the room or enclosure.

3.1.1.4 See figure 1 for typical specimen mounting and wiring layout.

3.1.2 Printed circuit board connectors

3.1.2.1 Specimens shall be tested mounted to test boards. The current input/output traces shall be capable of conducting the maximum current that is to be applied; see table 1. The traces shall be on the termination side of the test board, unless otherwise specified in the referencing document. When traces are on both sides of the test board or multilayers, see note 2 in table 1.

3.1.2.2 An optional technique can be to direct attach the input/output conductors directly to the termination area of the contacts on the termination side of the test board.

3.1.2.3 It is not recommended to utilize the trace technique for test currents in excess of 13 amperes.

Table 1 - Test board trace characterizations

Trace width		Trace length		Equivalent AWG wire size	Test current, amperes maximum
cm	in	cm	in		
0.03	0.010	1.3	0.50	36	0.1
0.06	0.025	2.3	0.90	32	0.5
0.13	0.050	3.0	1.20	28	1.5
0.19	0.075	3.8	1.50	26	2.0
0.25	0.100	4.3	1.70	24	3.0
0.64	0.250	6.9	2.70	20	7.5
1.27	0.500	9.4	3.70	16	13

NOTES

1. The above is based on 1.0 oz copper.
2. The table applies to single sided test boards. The values may be used as reference for multilayer or double-sided test boards that produce a temperature rise less than 30°C.
3. Minimum length is a slight function of temperature rise criteria assumed that is 30°C. For temperature rise criteria less than 30°C, these values are conservative.

3.1.3 Input / output conductors

3.1.3.1 The input/output conductors shall be capable of conducting the maximum current that is to be applied; see table 2.

3.1.3.2 To minimize and standardize heat-sinking conditions, the minimum conductor lengths specified in table 2 shall be used.

3.1.3.3 When multiple specimens are to be tested, the conductor lengths connecting the specimens shall comply with the minimum lengths as specified in table 2.

Table 2 - Conductor characteristics

Wire size			Test current, amperes maximum	Wire length, minimum	
AWG	mm^2	$in^2 \times 10^3$		cm	in
36	0.013	.020	0.9	4	1.5
34	0.020	.031	1.2	5	2.0
32	0.03	.047	1.5	5	2.0
30	0.05	.078	2.0	8	3.0
28	0.08	.124	2.7	9	3.5
26	0.13	.202	3.6	11	4.5
24	0.2	.310	4.8	14	5.5
22	0.3	.465	6.4	16	6.5
20	0.5	.775	8.5	20	8.0
18	0.8	1.240	11	25	10.0
16	1.3	2.015	15	29	11.5
14	2.0	3.100	20	36	14.0
12	3.0	4.650	27	42	16.5
10	5.0	7.750	35	50	19.5
8	8.0	9.200	47	57	22.5
6	13.0	20.150	63	67	26.5
4	21.0	32.550	84	79	31.0
2	34.0	52.700	111	93	36.5
0	50.0	77.500	148	108	42.5
00	70.0	108.500	171	117	46.0
000	80.0	124.000	197	126	49.5
0000	120.0	184.550	227	136	53.5

3.1.4 Series circuit

When more than one contact is to be energized, the following shall be adhered to in creating a series circuit.

3.1.4.1 For test specimens terminated to a conductor or cable, the conductor length or link shall be equal to that shown in table 2. Typical jumpering arrangements are shown in figures 2 and 3.

3.1.4.2 For test specimens terminated (soldered) to printed circuit boards, the jumper or links length shall be equal to the spacing between the contacts to be energized. The jumper or links shall be equivalent to the conductor size (cross-sectional area) that is to carry the maximum test current to be used; see table 2. Typical jumpering arrangements are shown in figures 2 and 4.

3.1.4.2.1 An alternative to the jumper technique for test specimens soldered to printed circuit boards, is to create a series circuit by interconnecting the positions by use of traces. Trace widths shall comply with 3.1.2.1, see table 1.

3.1.4.2.2 The technique for compliant terminations shall be the same as indicated in 3.1.4.2.1. Soldering in the termination area or on the pin shall not be allowed.

3.1.4.3 An alternative to 3.1.4.2 is to terminate conductors to the contact terminations. The conductor length or link shall be equal to that shown in table 2.

3.2 Preparation

3.2.1 Temperature measuring techniques

3.2.1.1 Thermocouple temperature measuring techniques

3.2.1.1.1 Thermocouples that are attached to metallic surfaces of current-carrying contacts shall be oriented with the bimetal junction perpendicular to the direction of current flow to prevent errors caused by voltage gradients when using direct current; see figure 5.

3.2.1.1.2 Temperature probes shall be attached to the specimens by any means that:

- makes intimate thermal contact with the specimen when required or located in air within contact system;
- does not alter the physical characteristics of the specimen;
- does not cause significant heat sinking of the specimen;
- does not physically disturb natural position orientation and/or operation of the contact system.

3.2.1.1.3 Temperature probes shall be attached to lead-in connecting wires in each specimen chain approximately 12.5 centimeters (5 inches) from the input connection to the test specimen or first specimen in the chain. Conductor temperature shall be measured by embedding a thermocouple in a slit cut longitudinally in the wire insulation, with the thermocouple junction contacting the conductor. Care shall be taken to ensure that conductor strands are not nicked. The insulation may be secured by a few wraps of fine cotton thread or equivalent.

3.2.1.1.4 When a thermocouple or temperature probe is inserted into a contact cavity through the housing wall, the hole shall be sealed with duck seal or other equivalent means.

3.2.2 Thermography temperature measuring techniques

3.2.2.1 Thermographic measurements may be performed when the contact is in direct line of sight.

3.2.2.2 Due to the complexity of this type of measurement, specific procedures necessary to ensure consistent results may vary depending on the characteristics of the test specimens. The procedures listed below are a general in nature. Additional procedures may be specified by the requesting organization as appropriate for the test specimen.

3.2.3 Ambient temperature measurement point

The ambient temperature shall be measured in the approximate horizontal plane adjacent to the middle of the test specimen or chain being tested. The thermocouple shall be placed a minimum of 15 centimeters (6 inches) from the closest specimen. The thermocouple shall be placed in an unpowered test specimen or open air and shall be shielded from any heating affects or air movement. See figure 6 for a typical radiation shield that may be employed.

4 Test procedure

4.1 General

4.1.1 Test conditions

The test shall be performed in at least one of the following conditions indicated in table 3:

Table 3 - Test conditions

Test condition	Description
1	Contacts in housing, single contact energized
2	Contacts in housing, multiple contacts energized
3	Contacts in housing, 100% of the contacts energized
4	Contacts in free air
5	As specified in the referencing document

4.1.1.1 Unless otherwise specified, test condition 1 shall be used.

4.1.1.2 The number of contacts to be energized for test condition 2 and their location within the specimen shall be specified in the referencing document.

4.1.2 Current measurement

The specimen or chain shall be connected to a regulated power supply through a voltmeter, ammeter or shunt using wires of suitable cross-section. Loading current may be ac or dc. When alternating current is used, the rms value applies.

4.1.3 Temperature measurement (via thermocouple technique)

When direct current is used, the specimen chain shall be energized in both forward and reversed-current modes to check for cross-junction thermocouple errors. If thermocouple readings are found to differ by more than ± 1 °C (1.8 °F) for equal forward and reversed-current, one of the following steps shall be taken:

— Use alternating current;
— Reattach thermocouple in error;
— Use forward and reverse current at each increment and average thermocouple readings.

4.1.3.1 Thermal stability

Maintain current until thermal stability is achieved on all specimens. Thermal stability shall be achieved when the temperature rise of a minimum of three consecutive readings taken at 5 minute intervals maximum does not differ by more than ± 1°C (1.8°F) for each thermocouple being used for monitoring. Thermal stability applies to all current applications for all test methods described herein.

4.1.4 Discrete wiring applications

For discrete wiring applications when a wire bundle is part of the test specimen, an additional thermocouple shall be located in the middle of the bundle within 2.54 centimeters (1.0 inch) of where the conductors exit the connector housing, and the temperature measured and recorded.

4.2 Method 1, specified current

4.2.1 The test specimen(s) shall be energized at the current level specified in the detail specification until thermal stability is achieved.

4.2.2 The specimen temperature, input wire temperature if specified and ambient temperature shall be measured and recorded.

4.3 Method 2, temperature rise versus current curve

4.3.1 Energize test specimen(s) with a test current to produce approximately 5° C to 10° C temperature rise (stabilized condition).

4.3.2 Measure and record specimen temperature, ambient temperature and test current. If specified, measure and record lead-in wire, wire bundle, and/or printed circuit board trace temperatures.

4.3.3 Repeat 4.3.1 at a minimum of 4 consecutively increasing current levels with each additional level generating an additional temperature rise (minimum) of 10°C above that previously recorded. The highest test current level used shall not exceed the temperature rating of the connector.

4.4 Method 3, specified temperature rise

4.4.1 The test specimen(s) shall be energized to generate a temperature rise equal to approximately 30% of the specified requirement.

4.4.2 The current shall then be increased in gradual increments and the temperature rise shall be measured and recorded along with the corresponding current after stabilization has been achieved.

4.4.3 Incremental increases shall be repeated until the specified temperature rise has been achieved or exceeded.

4.4.4 If the specified temperature rise is exceeded, the next lowest current level that did not exceed the specified requirement shall be considered as the maximum current that can be used.

4.4.5 When multiple test specimens are involved, the test shall be terminated when any one of the specimens exceeds the specified requirement, and 4.4.4 shall apply.

4.5 Method 4, inaccessible contacts (TBD)

5 Details to be specified

The following details shall be specified in the referencing document:

5.1 Specimen preparation

5.2 Type and size of conductor where applicable

5.3 Temperature measurement location

5.4 Upper temperature rise or current limit

5.5 Number of specimens

5.6 Number and location of contacts within a specimen to be energized

5.7 Test current(s) (for method 1 only)

5.8 Test method and condition

5.9 Additional procedural requirements for thermographic imaging, if used, see 3.2.2.

6 Test documentation

Documentation shall contain the details specified in clause 5, with any exceptions, and the following:

6.1 Title of test, date of test, ambient conditions

6.2 Specimen description

6.3 Test equipment used, and date of last and next calibration

6.4 Thermograghic specific procedures, if used, see 3.2.2

6.5 Test method and condition including wiring and printed circuit board description

6.6 Thermocouple placement

6.7 Input and jumper conductor size including board traces where applicable

6.8 Values and observations

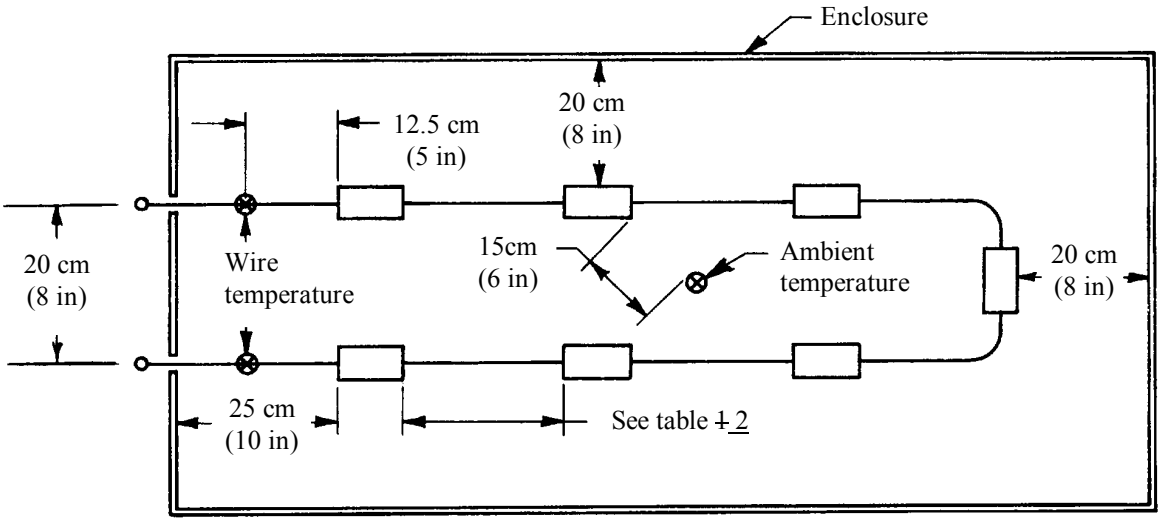
6.9 Temperature rise of specimen

6.10 Current levels

6.11 Ambient temperature

6.12 Input conductor temperature if required

6.13 Name of operator and start/finish dates of test



NOTE — All dimensions are minimum.

Figure 1 - Typical specimen mounting and wiring layout when an enclosure is used (top view)

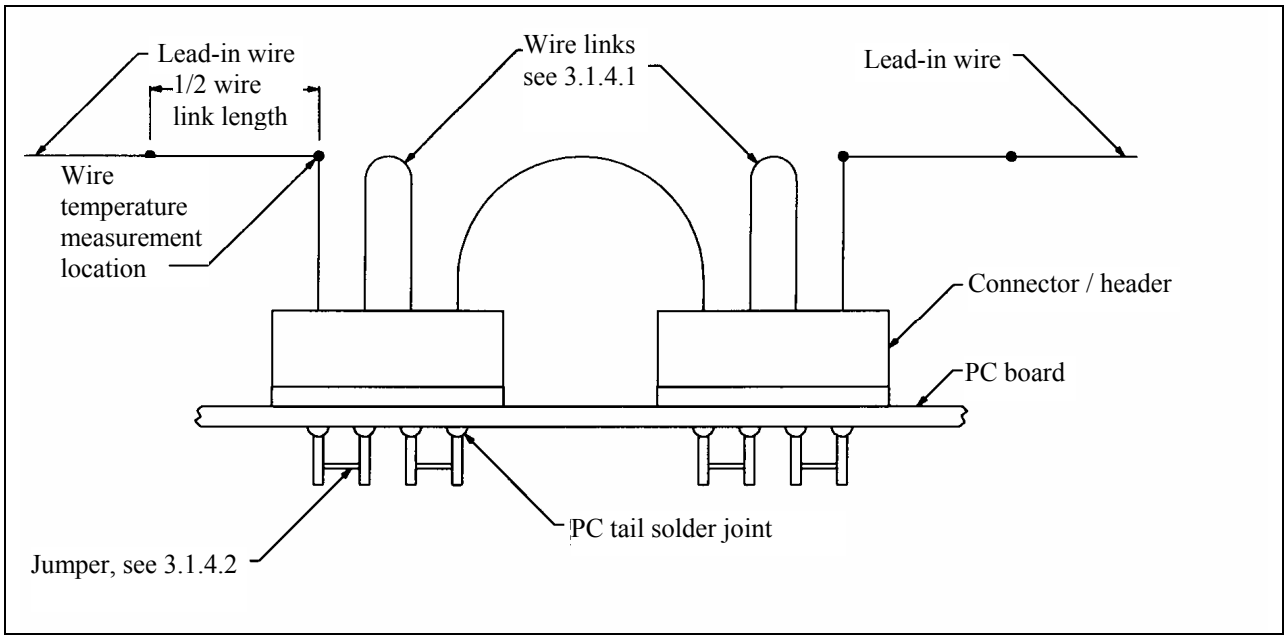


Figure 2 - Typical wire to printed board connectors

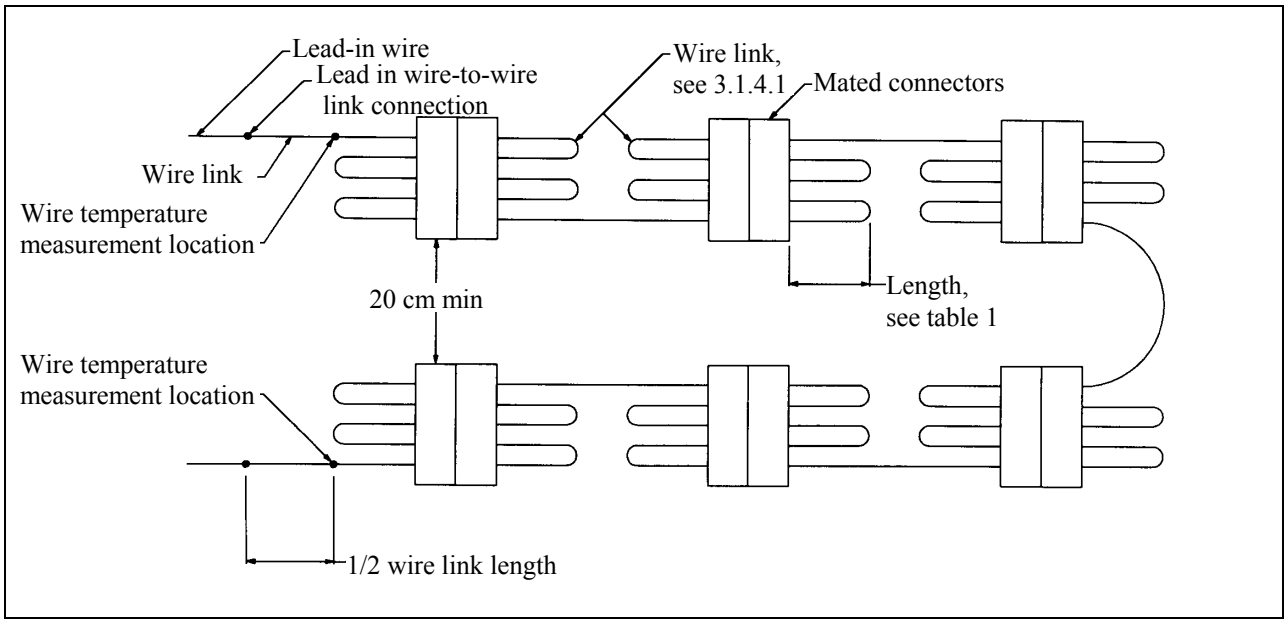


Figure 3 - Typical wire-to-wire connectors

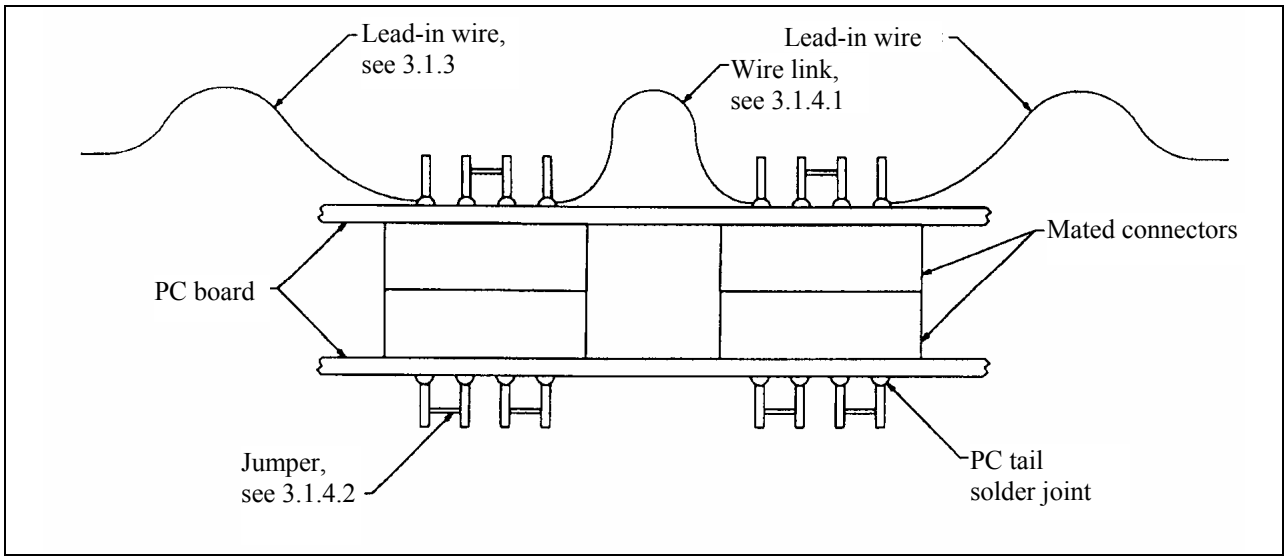


Figure 4 - Typical printed board to printed board connectors

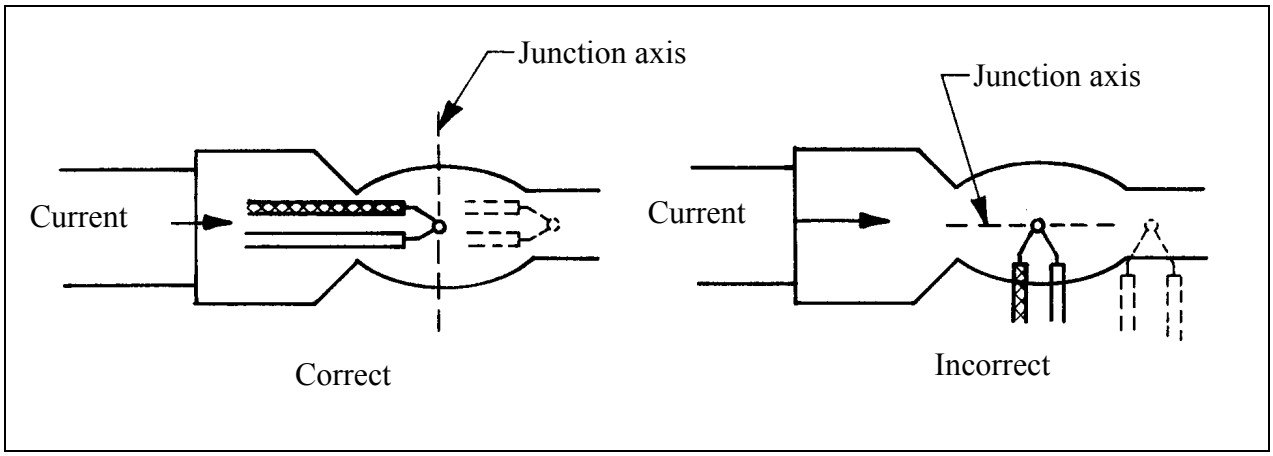


Figure 5 - Thermocouple orientation

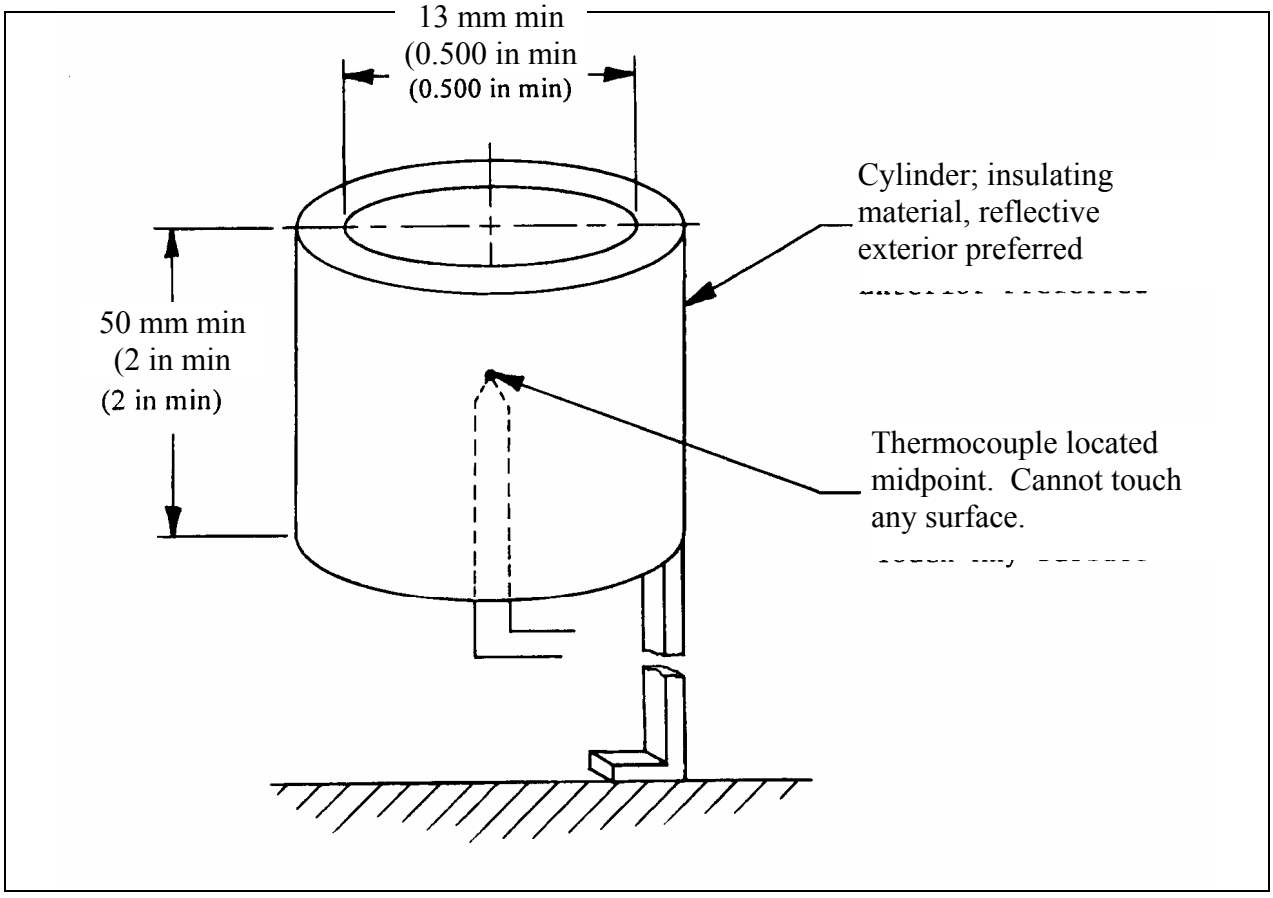


Figure 6 - Typical thermocouple radiation shield

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