RESISTORS, HEATERS, FLEXIBLE, SINGLE AND DOUBLE LAYER

ESCC Detail Specification No. 4009/002

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DCR No.	CHANGE DESCRIPTION
1548 1552	Specification upissued to incorporate changes per DCR.

TABLE OF CONTENTS

1 GENERAL

1.1 SCOPE

This specification details the ratings, physical and electrical characteristics and test and inspection data for the component type variants and/or the range of components specified below. It supplements the requirements of, and shall be read in conjunction with, the ESCC Generic Specification listed under Applicable Documents.

1.2 APPLICABLE DOCUMENTS

The following documents form part of this specification and shall be read in conjunction with it:

(a) ESCC Generic Specification No. 4009.

(b) MIL-P-46112: Military Specification for Polyimide Plastic Sheet and Strip.

(c) ASTM-D5213: Standard Specification for Polymeric Resin Film for Electrical Insulation and Dielectric Applications.

1.3 TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

For the purpose of this specification, the terms, definitions, abbreviations, symbols and units specified in ESCC Basic Specification No. 21300 shall apply.

1.4 THE ESCC COMPONENT NUMBER AND COMPONENT TYPE VARIANTS

1.4.1 The ESCC Component Number

The ESCC Component Number shall be constituted as follows:

Example: 400900201A1234

- Detail Specification Reference: 4009002
- Component Type Variant Number: 01 (as required)
- Manufacturer Specific Heater Identification: A1234 (as applicable; see Para. 1.4.3) where:
  - A: First letter of the applicable Manufacturer's name
  - 1234: A unique 4 digit number, sequentially allocated by the applicable Manufacturer to a specific heater design.

1.4.2 Component Type Variants and Range of Components

The component type variants and range of components applicable to this specification are as follows:

Variant	Heater Type and Construction (Note 1)	Terminal Leads		Resistance Range Rn (Ω)	Resistance Tolerance (± %)	Heating Area S (cm^2) (Note 1)	Resistance Density ($Ω/cm^2$)	Temperature Coefficient (10^{-6}/°C)	Weight Max (g)
		Wire Gauge (AWG)	Configuration (Note 2)						
01	Individual, Strip or Module, Single Layer	20	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
02	Individual, Strip or Module, Single Layer	22	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
03	Individual, Strip or Module, Single Layer	24	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
04	Individual, Strip or Module, Single Layer	26	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
05	Individual, Strip or Module, Single Layer	28	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
06	Individual, Strip or Module, Single Layer	30	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
07	Individual, Strip or Module, Single Layer	20	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
08	Individual, Strip or Module, Single Layer	22	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
09	Individual, Strip or Module, Single Layer	24	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
10	Individual, Strip or Module, Single Layer	26	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
11	Individual, Strip or Module, Single Layer	28	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
12	Individual, Strip or Module, Single Layer	30	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
13	Individual, Strip or Module, Single Layer	20	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
14	Individual, Strip or Module, Single Layer	22	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
15	Individual, Strip or Module, Single Layer	24	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
16	Individual, Strip or Module, Single Layer	26	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
17	Individual, Strip or Module, Single Layer	28	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
18	Individual, Strip or Module, Single Layer	30	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
19	Individual, Strip or Module, Single Layer	20	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
20	Individual, Strip or Module, Single Layer	22	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
21	Individual, Strip or Module, Single Layer	24	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
22	Individual, Strip or Module, Single Layer	26	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
23	Individual, Strip or Module, Single Layer	28	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				

Variant	Heater Type and Construction (Note 1)	Terminal Leads		Resistance Range Rn (Ω)	Resistance Tolerance (± %)	Heating Area S (cm^2) (Note 1)	Resistance Density ($Ω/cm^2$)	Temperature Coefficient (10^{-6}/°C)	Weight Max (g)
		Wire Gauge (AWG)	Configuration (Note 2)						
24	Individual, Strip or Module, Single Layer	30	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
25	Individual or Module, Double Layer	20	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
26	Individual or Module, Double Layer	22	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
27	Individual or Module, Double Layer	24	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
28	Individual or Module, Double Layer	26	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
29	Individual or Module, Double Layer	28	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
30	Individual or Module, Double Layer	30	Straight	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
31	Individual or Module, Double Layer	20	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
32	Individual or Module, Double Layer	22	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
33	Individual or Module, Double Layer	24	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
34	Individual or Module, Double Layer	26	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
35	Individual or Module, Double Layer	28	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
36	Individual or Module, Double Layer	30	UTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
37	Individual or Module, Double Layer	20	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
38	Individual or Module, Double Layer	22	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
39	Individual or Module, Double Layer	24	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
40	Individual or Module, Double Layer	26	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
41	Individual or Module, Double Layer	28	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
42	Individual or Module, Double Layer	30	JTP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
43	Individual or Module, Double Layer	20	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
44	Individual or Module, Double Layer	22	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
45	Individual or Module, Double Layer	24	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
46	Individual or Module, Double Layer	26	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				
47	Individual or Module, Double Layer	28	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				

Variant	Heater Type and Construction (Note 1)	Terminal Leads		Resistance Range Rn (Ω)	Resistance Tolerance (± %)	Heating Area S (cm^2) (Note 1)	Resistance Density ($Ω/cm^2$)	Temperature Coefficient (10^{-6}/°C)	Weight Max (g)
		Wire Gauge (AWG)	Configuration (Note 2)						
48	Individual or Module, Double Layer	30	STP	1 ≤ Rn < 3	5, 10	Note 3	≤ 200	175	Note 4
				3 ≤ Rn ≤ 5000	2, 3, 5, 10				

NOTES:

1. See Para. 1.6.
2. UTP = Unjacketed Twisted Pair; JTP = Jacketed Twisted Pair; STP = Shielded Twisted Pair.
3. The Heating Area, S, shall be:
   - Individual or Module, single layer heaters: 0.2 to 1300cm^2
   - Strip, single layer heaters: 3.2 to 312cm^2
   - Individual or Module, double layer heaters: 1.6 to 1300cm^2
4. The maximum weight of the heaters, excluding the weight of the terminal leads, shall be:
   - Individual, strip or Module, single layer heaters: 50mg/cm^2
   - Individual or Module, double layer heaters: 75mg/cm^2

   The weight of the terminal leads shall be as specified in the applicable wire ESCC Detail Specification.

1.4.3 Manufacturer Specific Heater Identification

A Heater Design Drawing shall be produced by the Manufacturer after negotiation with the Orderer and shall be held under configuration control by the Manufacturer who will allocate a unique Manufacturer Specific Heater Identification sequentially when a request for a heater is received.

Each Heater Design Drawing shall include the following information:

(a) The heater outline and dimensions as required by Para. 1.6 Physical Dimensions and Heater Outline herein. This shall include details of the heater type and construction, and the terminal leads configurations including the angle of exit of each terminal lead with respect to the heater body.

(b) The ESCC Component Number for the heater, including the Manufacturer Specific Heater Identification (see Para. 1.4).

(c) The terminal leads' ESCC Detail Specification and Component Number.

(d) The heater electrical information as follows:
   - Resistance value Rn and tolerance by circuit at T_{amb} = +22 ±3°C.
   - Maximum rated power in still air at T_{amb} = +25°C.

(e) Track width and spacing with tolerances.

(f) Cover material (if fitted).

(g) Pressure sensitive tape (if fitted).

(h) Dimensions of pre-form, if required.

1.5 MAXIMUM RATINGS

The maximum ratings shall not be exceeded at any time during use or storage.

Maximum ratings shall only be exceeded during testing to the extent specified in this specification and when stipulated in Test Methods and Procedures of the ESCC Generic Specification.

Characteristics	Symbols	Maximum Ratings	Units	Remarks
Rated Power Density	Pn	0.54	W/cm^2	Notes 1, 2, 3, 4
Operating Temperature Range	T_{op}	-65 to +200	°C	T_{amb} Note 3
Storage Temperature Range	T_{stg}	-65 to +200	°C	-
Rated Voltage	U_R	$\sqrt{Pn.Rn.S}$	V	Notes 2, 3, 5

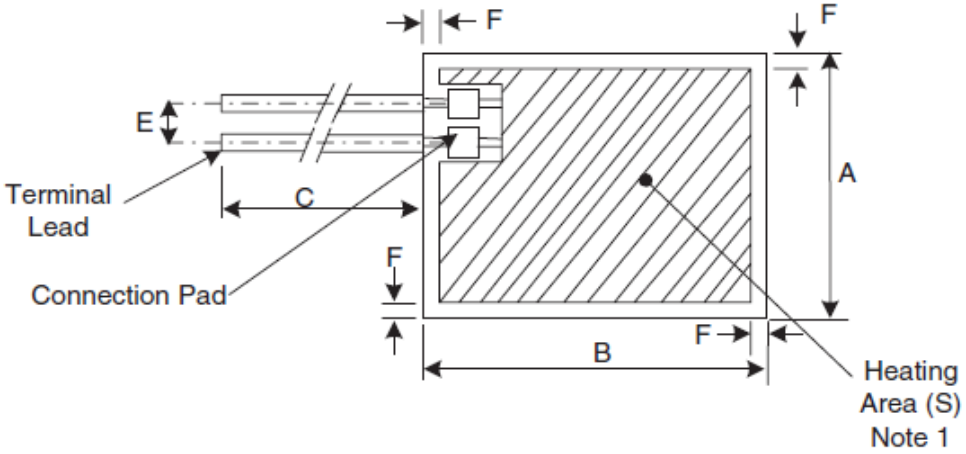
NOTES:

1. With heater suspended in still air at T_{amb} = +25°C.
2. Actual rated power shall be specified in the applicable Heater Design Drawing. It shall be determined from the Heating Area (S) in cm^2.
3. Rated Power Density shall be derated against temperature and Heating Area as follows:
   - Pn = $0.54W/cm^2$ for $T_{amb} \leq$ +25°C. Derate to $0W/cm^2$ at $0.00308W/cm^2/°C$ for +25°C < $T_{amb} \leq$ +200°C.
   - Pn = $0.54W/cm^2$ for $0.2cm^2 \leq$ Heating Area (S) $\leq 300cm^2$. Derate to $0.3W/cm^2$ at $0.00024W/cm^2/cm^2$ for $300cm^2$ < Heating Area (S) $\leq 1300cm^2$.
4. The following design rule shall be applied:
   - Area of Heater Resistive Element ÷ Heating Area (S) = 50 ±10%
5. Rn is the nominal resistance.

1.6 PHYSICAL DIMENSIONS AND HEATER OUTLINE

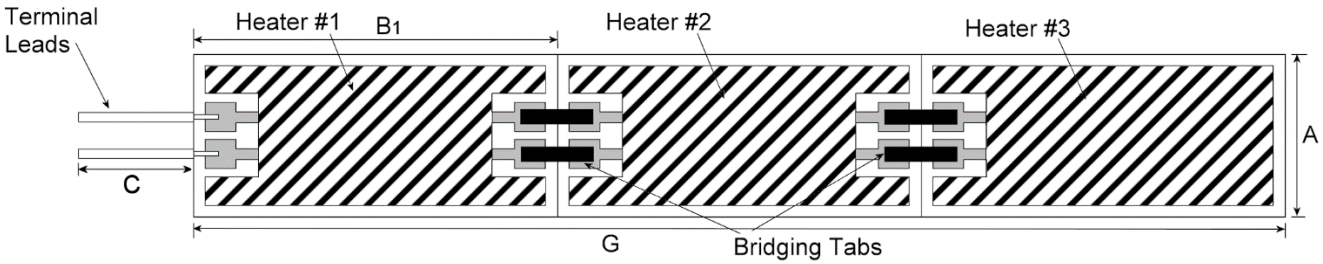
The general physical dimensions and heater layout shall be as follows (see Note 11). The heater type, construction, physical dimensions and heater layout applicable to a specific heater will be specified in the Heater Design Drawing held by the Manufacturer.

INDIVIDUAL (& STRIP, MODULE) HEATER



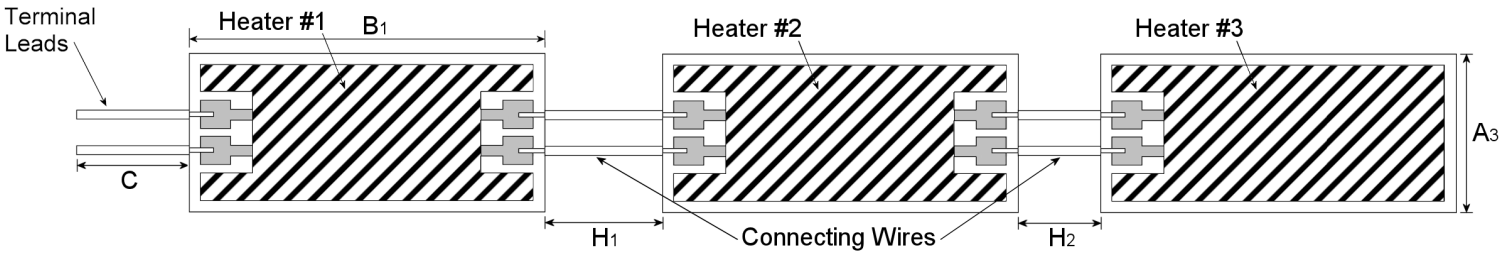
STRIP HEATER (NOTE 2)

Example with 3 individual heaters



MODULE HEATER (NOTE 3)

Example with 3 individual heaters



Symbol	Dimensions mm		Tolerance	Heater Type	Remarks
	Min	Max			
A	6	590	±0.5mm or (Note 4) ±0.5%	Individual	
A	6	15		Strip	Note 2
A_1 to A_5 (5)	8	200		Module	Note 3
B	8	600	±0.5mm or (Note 4) ±0.5%	Individual	
B_1 to B_5 (5)	300	590		Strip	Note 2
B_1 to B_5 (5)	10	590		Module	Note 3, 6
C	300	-	±10%	Individual, Strip & Module	
E	2	-	±0.5mm	Individual, Strip & Module	Note 7
F	0.4	-	-	Individual, Strip & Module	Notes 8, 9
G	610	2500	±0.5mm or (Note 4) ±0.5%	Strip	Note 10
H_1 to H_4 (5)	100	1000	±15mm or (Note 4) ±10%	Module	Note 3
S	Note 1		-	Individual, Strip & Module	Note 1

NOTES:

1. The Heating Area, S, is defined as the total area of the heater excluding the peripheral margin, and the terminal lead and/or bridging tab connection areas. The acceptable limits of S are specified in Para. 1.4.2.

   For Strip and Module heaters, the Heating Area is the total for all the individual heaters connected together.
2. A Strip heater is made up of 2 to 5 individual, single layer heaters connected together in series by means of bridging tabs welded to each individual heater's connection pads. All individual heaters in the Strip heater shall have the same width, dimension A, but may have different lengths, dimension B_n.
3. A Module heater is made up of 2 to 5 individual, single or double layer heaters connected together in series by means of wires of length H_n welded to each individual heater's connection pads. All individual heaters in a single Module heater shall either be single layer or double layer. Each individual heater of the Module heater may have any geometric shape (i.e. not limited to rectangular shapes) with different dimensions A_n and B_n, where A_n and B_n represent the overall dimensions of each individual heater.
4. Whichever is greater.
5. As applicable depending on the quantity of individual heaters in the Strip or Module heater.
6. The sum of all the individual dimensions B_n of a Module Heater shall not exceed 1500mm.
7. Terminal lead spacing shall be measured at the terminal lead connection area. Terminal leads may exit the terminal lead connection area at any angle. The terminal leads may be located on any side of the heater.

   There may be more than 2 terminal leads (for multiple resistive element and double layer heaters).
8. Peripheral margin dimension.
9. Perforated holes in the peripheral margin are allowed provided that the distance between the edge of the hole and the heater resistive element or connection pad is equal to, or greater than, dimension F.
10. The total length of the Strip heater.
11. In any case, the final feasibility of a particular heater design is established according to the limiting characteristics of the materials used and the production process, and shall be decided on by the Manufacturer; not all the configurations are possible.

1.6.1 Heater Thickness

The maximum thicknesses for single layer and double layer heaters are as follows:

- 0.25mm maximum for Individual, Strip or Module, single layer heaters.
- 0.4mm maximum for Individual or Module, double layer heaters.

These maximum limits do not apply over the terminal lead and/or bridging tab connection areas.

1.7 MATERIALS AND FINISHES

1.7.1 Heater Resistive Element

The heater resistive element shall be made of flexible nickel/chromium/iron alloy (76/16/8 Inconel).

1.7.2 Strip Heater Bridging Tabs

Bridging Tabs used to connect individual heaters to form a Strip heater shall be made of flexible nickel/chromium/iron alloy (76/16/8 Inconel). They shall be electrically welded to the heater resistive elements.

1.7.3 Protective Coating

Heater resistive elements, terminal leads connections and, for Strip heaters, bridging tabs connections shall be completely coated with Polyimide Polymer/FEP in accordance with MIL-P-46112 (as superseded by ASTM-D5213).

1.7.4 Terminal Leads, and Connecting Wires for Module Heaters

Terminal leads and connecting wires for Module heaters shall be made of multi-strand silver-plated copper in accordance with ESCC Generic Specification No. 3901. The applicable Heater Design Drawing shall specify the wire ESCC Detail Specification and the wire ESCC Component Number. The wire gauge shall be as specified in Para. 1.4.2 Component Type Variants and Range of Components herein. Terminal leads and connecting wires shall be electrically welded to the heater resistive element.

2 REQUIREMENTS

2.1 GENERAL

The complete requirements for procurement of the components specified herein are as stated in this specification and the ESCC Generic Specification. Permitted deviations from the Generic Specification, applicable to this specification only, are listed below.

Permitted deviations from the Generic Specification and this Detail Specification, formally agreed with specific Manufacturers on the basis that the alternative requirements are equivalent to the ESCC requirement and do not affect the component's reliability, are listed in the appendices attached to this specification.

2.1.1 Deviations from the Generic Specification

2.1.1.1 Deviations from Screening Tests - Chart F3

(a) For heaters where the Heater Design Drawing requires the application of cover material or pressure sensitive tape the following additional steps shall be performed during Screening Tests:

(i) An additional 100% External Visual Inspection shall be performed after successful completion of High and Low Temperatures Electrical Measurements.

(ii) After successful completion of the additional External Visual Inspection the cover material and/or pressure sensitive tape shall be applied.

For heaters which already have a backing foil applied the additional External Visual Inspection shall not be performed.

(b) For heaters where the Heater Design Drawing requires pre-forming this shall be performed on successful completion of Screening Tests. The pre-forming operation shall be performed at a temperature not exceeding the maximum storage temperature. An additional External Visual Inspection shall be performed after the pre-forming operation to check for any damage.

2.2 MARKING

The marking shall be in accordance with the requirements of ESCC Basic Specification No. 21700 and as follows.

The information to be marked on the component or its primary package shall be:

(a) The ESCC qualified components symbol (for ESCC qualified components only).

(b) The ESCC Component Number (see Para. 1.4.1).

(c) Traceability information.

2.3 ROBUSTNESS OF TERMINATIONS

The test conditions for robustness of terminations, tested as specified in the ESCC Generic Specification, shall be as follows and apply to a single terminal lead at a time.

Wire Gauge (AWG)	20	22	24	26	28	30
Pull Strength (N)	45	36	22	13	9	4.5
Duration (s) minimum	5	5	5	5	5	5

2.4 ELECTRICAL MEASUREMENTS AT ROOM, HIGH AND LOW TEMPERATURES

The measurements shall be performed at room, high and low temperatures.

2.4.1 Room Temperature Electrical Measurements

The measurements shall be performed at T_{amb} = +22 ±3ºC.

Characteristics	Symbols	Test Method and Conditions	Limits		Units
			Min	Max	
Resistance	R_A	ESCC No. 4009 ±2% Tolerance ±3% Tolerance ±5% Tolerance ±10% Tolerance	 0.98 Rn 0.97 Rn 0.95 Rn 0.9 Rn	 1.02 Rn 1.03 Rn 1.05 Rn 1.1 Rn	Ω
Insulation Resistance	R_I	ESCC No. 4009	1000	-	MΩ
Voltage Proof Leakage Current	I_L	ESCC No. 4009 Test Voltage = 1000Vrms	-	6 or (1) 12	mA $\mu A/cm^2$

NOTES:

1. Whichever is greater based on the Heating Area, S.

2.4.2 High and Low Temperatures Electrical Measurements

Characteristics	Symbols	Test Method and Conditions (Note 1)	Limits		Units
			Min	Max	
Resistance change between -65 (+3 -0)°C and +22 ±3°C	$\Delta R_A/R_A(L)$	ESCC No. 4009	0	-1.57	%
Resistance change between +200 (+0 -3)°C and +22 ±3°C	$\Delta R_A/R_A(H)$	ESCC No. 4009	0	+3.17	%

NOTES:

1. Measurements shall be performed during Chart F3 Screening Tests on a sample of 3 components. In the event of any failure a 100% inspection shall be performed.

2.5 INTERMEDIATE AND END-POINT ELECTRICAL MEASUREMENTS

Unless otherwise specified, the measurements shall be performed at T_{amb} = +22 ±3ºC.

The test methods and test conditions shall be as per the corresponding test defined in Para. 2.4.1 Room Temperature Electrical Measurements.

The drift values (Δ) shall not be exceeded for each characteristic where specified. The corresponding absolute limit values for each characteristic shall not be exceeded.

Test Reference per ESCC No. 4009	Characteristics	Symbols	Limits		Units
			Min.	Max.	
Robustness of Terminations					
Initial Measurements	Resistance	R_A			Ω
	±2% Tolerance		0.98 Rn	1.02 Rn	
	±3% Tolerance		0.97 Rn	1.03 Rn	
	±5% Tolerance		0.95 Rn	1.05 Rn	
	±10% Tolerance		0.9 Rn	1.1 Rn	
Final Measurements	Resistance	R_A			Ω
	±2% Tolerance		0.98 Rn	1.02 Rn	
	±3% Tolerance		0.97 Rn	1.03 Rn	
	±5% Tolerance		0.95 Rn	1.05 Rn	
	±10% Tolerance		0.9 Rn	1.1 Rn	
	Change in Resistance	$\Delta R_A/R_A$	-	±1	%
Climatic Sequence					
Initial Measurements	Resistance	R_A			Ω
	±2% Tolerance		0.98 Rn	1.02 Rn	
	±3% Tolerance		0.97 Rn	1.03 Rn	
	±5% Tolerance		0.95 Rn	1.05 Rn	
	±10% Tolerance		0.9 Rn	1.1 Rn	
Final Measurements	Resistance	R_A			Ω
	±2% Tolerance		0.98 Rn	1.02 Rn	
	±3% Tolerance		0.97 Rn	1.03 Rn	
	±5% Tolerance		0.95 Rn	1.05 Rn	
	±10% Tolerance		0.9 Rn	1.1 Rn	
	Change in Resistance	$\Delta R_A/R_A$	-	±2	%
	Insulation Resistance	R_I	1000	-	MΩ
	Voltage Proof Leakage Current (Test Voltage: 1000Vrms)	I_L	-	6 or (1) 12	mA μA/cm²

Test Reference per ESCC No. 4009	Characteristics	Symbols	Limits		Units
			Min.	Max.	
Operating Life					
Initial Measurements (0 hours)	Resistance	R_A			Ω
	±2% Tolerance		0.98 Rn	1.02 Rn	
	±3% Tolerance		0.97 Rn	1.03 Rn	
	±5% Tolerance		0.95 Rn	1.05 Rn	
	±10% Tolerance		0.9 Rn	1.1 Rn	
Intermediate Measurements (1000 hours)	Resistance	R_A			Ω
	±2% Tolerance		0.98 Rn	1.02 Rn	
	±3% Tolerance		0.97 Rn	1.03 Rn	
	±5% Tolerance		0.95 Rn	1.05 Rn	
	±10% Tolerance		0.9 Rn	1.1 Rn	
	Change in Resistance	$\Delta R_A/R_A$	-	±1.4	%
Final Measurements (2000 hours)	Resistance	R_A			Ω
	±2% Tolerance		0.98 Rn	1.02 Rn	
	±3% Tolerance		0.97 Rn	1.03 Rn	
	±5% Tolerance		0.95 Rn	1.05 Rn	
	±10% Tolerance		0.9 Rn	1.1 Rn	
	Change in Resistance (related to 0 hours)	$\Delta R_A/R_A$	-	±2	%
	Insulation Resistance	R_I	1000	-	MΩ
	Voltage Proof Leakage Current (Test Voltage: 1000Vrms)	I_L	-	6 or (1) 12	mA μA/cm²

NOTES:
1. Whichever is greater based on the Heating Area, S.

2.6 BURN-IN CONDITIONS

Characteristics	Symbols	Test Conditions	Units
Heater Temperature	T_{HTR}	+200 (Note 1)	°C
Power Density	Pn	0.54 (Note 1)	W/cm²

NOTES:
1. Voltage shall be applied until either the specified heater temperature or the power density is reached.

2.7 OPERATING LIFE CONDITIONS

The conditions shall be as specified for Burn-in in Para. 2.6.

APPENDIX A
AGREED DEVIATIONS FOR RICA (I)

<table>
<tr><th>ITEMS AFFECTED</th><th>DESCRIPTION OF DEVIATIONS</th></tr>
<tr><td rowspan="2">Para. 2.1.1 Deviations from the Generic Specification: Qualification and Periodic Tests - Chart F4</td><td>The specified period for the Endurance Subgroup shall be 24 months.</td></tr>
<tr><td>During Qualification and Periodic Testing, on completion of the Endurance Subgroup testing, 3 components selected at random from the test samples, shall be tested for Resistance change between +200 (+0 -3)°C and +22 ±3°C, $\Delta R_A/R_A(H)$, in accordance with Para. 2.4.2 of this specification. No failures are allowed.</td></tr>
<tr><td rowspan="4">Para. 2.1.1.1 Deviations from Screening Tests - Chart F3</td><td>(a) Heaters with cover material applied:
Where cover material has been applied during the heater lamination process, the deviations specified in Para. 2.1.1.1(a) of this specification are not applicable.</td></tr>
<tr><td>Serialisation:
A 100% serialisation, performed prior to Screening Tests with subsequent Electrical Measurements at Room, High and Low Temperatures performed read and record, is optional at the Manufacturer’s discretion.</td></tr>
<tr><td>Para. 8.2, Rapid Change of Temperature:
Mounting: Heaters may be mounted using any suitable method.
Data Points: Electrical measurements during and after testing are optional at the Manufacturer’s discretion.</td></tr>
<tr><td>Para. 8.3, Overload:
Data Points: Electrical measurements after testing are optional at the Manufacturer’s discretion.</td></tr>
<tr><td>Para. 8.4, Burn-in:
Under Test Conditions, amend the duration for Burn-in to be 120 (+48 -0) hours</td></tr>
<tr><td>Para. 2.2 Marking</td><td>When marking of the heater body is not possible, the marking may be performed on a Polyimide + PSA label applied to the heater leads.</td></tr>
<tr><td>Para. 2.4.2 High and Low Temperatures Electrical Measurements</td><td>Resistance change between +200 (+0 -3)°C and +22 ±3°C, $\Delta R_A/R_A(H)$, shall be guaranteed but not tested. This test shall be replaced by a test performed at +150°C instead of +200°C as follows:
<table>
<tr><th rowspan="2">Characteristics</th><th rowspan="2">Symbols</th><th rowspan="2">Test Method and Conditions (Note 1)</th><th colspan="2">Limits</th><th rowspan="2">Units</th></tr>
<tr><th>Min</th><th>Max</th></tr>
<tr><td>Resistance change between +150 (+0 -3)°C and +22 ±3°C</td><td>$\Delta R_A/R_A(H)$</td><td>ESCC No. 4009</td><td>0</td><td>+2.29</td><td>%</td></tr>
</table></td></tr>
</table>