DOCUMENT CHANGE REQUEST

DCR number 117	Changes required for: N/A	Originator: Steve Thacker
Date: 2004/10/13	Date sent: 2004/10/13	Organisation: ESA/ESTEC
Status: IMPLEMENTED		

Title:	Resistors Heaters Flexible Single and Double Layer, Follow-up Specification for ESA/SCC Detail		
Number:	4009/002	Issue:	2

Other documents affected:

Page:

Total reformat/re-write of the only ESCC detail specification under ESCC4009.

The changes incorporated into 4009/002 reflect the new content of generic specification 4009 as well as additional editorial and technical changes.

Both 4009/002 and 4009 ar

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Total reformat/re-write of the only ESCC detail specification under ESCC4009.

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Both 4009/002 and 4009 ar

Original wording:

Proposed wording:

Proposed specification is attached (4002/009 issue 3 Draft A)

A summary of the changes to the current layout, format and content of 4009/002 included in the reformat/re-write is as follows:

1) Rewording and restructure of various sections of the specification - for the purposes of simplicity, consistency and clarification.

2) Addition in para 2 and para 4.4.2 of applicable document ASTM-D5213 which supersedes the obsolete MIL-P-46112.

3) Deletion of any redundant paragraphs and text. e.g. Functional diagram, Parameter derating figures, electrical test circuits, burn-in circuit figure, etc.

4) Clarification in Max ratings Table 1(b) and Dimensions Figure 2, of the definition of heating area (s) (to exclude the

peripheral margin & terminal connection area).

5) Delete dimension 'D' requirement and add notes to Figure 2 to allow terminal leads to exit the terminal connection area at any angle, plus define the lead spacing (Dim. 'E') to be measured at the terminal connection area. The position of the connection pads, and hence leads, is now only limited by the peripheral margin (Dim. 'F'). The new RICA/Nicolitch lead attachment process allows more flexibility in the positioning and aspect of the terminal leads whilst maintaining mechanical and material integrity.

6) Radiographic inspection deviation from the generic para 4.2.3(a) is deleted. Radiographic inspection is not included in the new 4009

7) Terminal leads requirements para 4.4.3 have been clarified to be in line with the quality requirements of Generic 4009 to use ESCC specified terminal wire.

8) Robustness of terminations test conditions in para 4.3.3 have been clarified to show that tests shall be performed on one lead "at a time"

9) Burn-in recovery period of 4 hours minimum prior to a visual inspection in para 4.7.2 is deleted to bring the requirement in line with the 4009, which requires between 1 and 2 hours recovery after burn-in before electrical measurement of resistance. Visual inspection is performed after full electrical at room and high & Low Temperatures.

10) The maximum limit for Voltage Proof Leakage Current in Table 2 and Table 6 is amended to be 2mA or 4microA/cm2 (square) (whichever is greater based on the Heating Area (s) in cm2). The previous limit of 2mA maximum is insufficient for larger area heaters. The actual value is a characteristic of the polyimide and has been characterised by RICA. This new limit maintains the same minimum value of 2mA but allows upto 5.2 mA for a maximum area heater (1300cm2).

11) The sample for High & Low electrical tests (level II AQL=0.65%) in Table 3 note 1 has been replaced by the equivalent fixed sample of 3 components. A 100% test to be performed in the event of any failures.

12) Table 4 Parameter Drift Values is deleted. Serialisation with read & record electrical is not required during screening therefore Table 4 is redundant.

13) Table 6 amended to be consistent with 4009 test requirements. Several tests no longer need to be included in the detail specification and have been deleted from Table 6.

14) Addition to appendix A for RICA to change the requirement for rapid change in temperature test to have alternate mounting with optional measurements (at the manufacturer's discretion) during and after the test. This test is used by RICA during screening purely as a means of mechanical stabilisation for the kapton bonding process and hence special mounting with electrical tests are not considered as mandatory.

15) Addition to appendix A for RICA to allow serialisation and read & record electrical measurements (at the manufacturer's discretion). RICA expressed a preference to perform full serialisation and read & record electrical measurements during Screening Tests for commercial reasons.

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Justification:

a) To assist and simplify the software conversion process.

b) To make the detail spec fully consistent with the requirements and content of the new 4009 generic spec.

c) To improve the definition of requirements and improve presentation and application of the spec.

d) to incorporate specific technical changes as detailed and justified in DCR section 9 above.

Attachments:

4009002.pdf, null

Modifications:

N/A

Approval signature:



Date signed:

2004-10-13

RESISTORS, HEATERS, FLEXIBLE

SINGLE AND DOUBLE LAYER

ESCC Detail Specification No. 4009/002

Issue 3 - DRAFT A	April 2004

Document Custodian: European Space Agency - see https://escies.org

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DCR No.	CHANGE DESCRIPTION
TBD	Specification up issued to incorporate editorial and technical changes per DCR.

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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 Polymide 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) 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 (Note 1)	Terminal Lead		Resistance Range (Ω)	Tolerance Min/Max (±%)	Heating Area (cm^2)	Resistance Density (Ω/cm^2)	Temperature Coefficient ($10^{-6}/^oC$)	Weight Max (g)
	AWG	Configuration (Note 2)						
01, 25	20	Straight	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
02, 26	22	Straight	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
03, 27	24	Straight	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
04, 28	26	Straight	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
05, 29	28	Straight	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
06, 30	30	Straight	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
07, 31	20	UTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
08, 32	22	UTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
09, 33	24	UTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
10, 34	26	UTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
11, 35	28	UTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
12, 36	30	UTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
13, 37	20	JTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
14, 38	22	JTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
15, 39	24	JTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
16, 40	26	JTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
17, 41	28	JTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
18, 42	30	JTP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
19, 43	20	STP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
20, 44	22	STP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
21, 45	24	STP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
22, 46	26	STP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
23, 47	28	STP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3
24, 48	30	STP	1 to 5000	2, 3, 5, 10	1.6 to 1300	0.1 to 200	175	Note 3

NOTES:

1. Variants 01 to 24 are single layer heaters.
   Variants 25 to 48 are double layer heaters.
2. UTP = Unjacketed Twisted Pair, JTP = Jacketed Twisted Pair, STP = Shielded Twisted Pair.
3. The maximum weight of the heaters, excluding the weight of the terminal leads, shall be:
   Single layer heaters: $50mg/cm^2$
   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 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 Physical Dimensions herein. This shall include details of the terminal leads configurations and the angle of exit of each lead with respect to the heater body.
(b) The ESCC Component Number for the heater, including the Manufacturer Specific Heater Identification.
(c) The terminal lead 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) Dimension 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	Ratings		Units	Remarks
		Min.	Max.		
Rated Power Density	Pn	-	0.54	W/cm^2	Note 1, 2 , 3, 4
Operating Temperature Range	T_{op}	-65	+200	˚C	T_{amb} Note 3
Storage Temperature Range	T_{stg}	-65	+200	˚C	-
Rated Voltage	U_R	-	$\sqrt{Pn.Rn.s}$	V	Note 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 specified Heating Area (s) in cm^2.
3. Rated Power Density shall be derated against temperature and Heating Area as follows: .
   (a) Pn = 0.54W/cm^2 for T_{amb}= ≤ +25˚C. Derate to 0W/cm^2 at 0.00308W/cm^2/˚C for + 25 ˚C < T_{amb} ≤ +200˚C.
   (b) Pn = 0.54W/cm^2 for 1.6cm^2 ≤ Heating Area ≤ 300cm^2. Derate to 0.3W/cm^2 at

$0.00024W/cm^2/cm^2$ for $300cm^2$ < Heating Area ≤ $1300cm^2$.

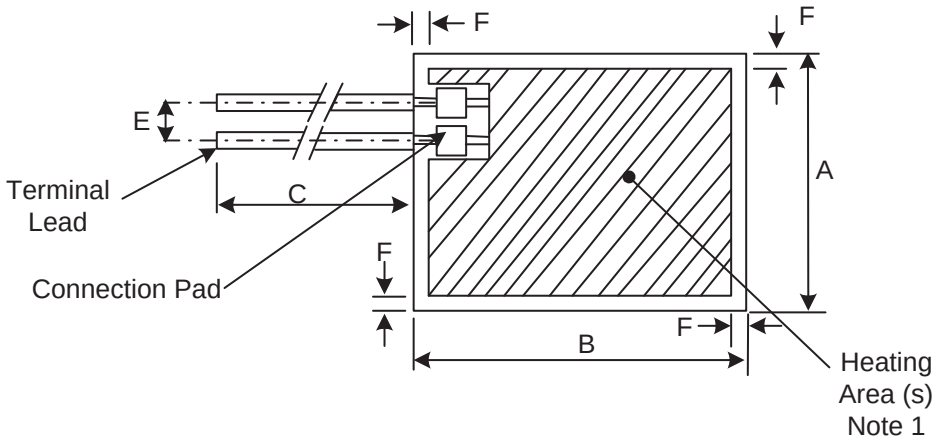
4. The following design rule shall be applied:

$$\frac{\text{Area of Heater Resistive Element}}{\text{Heating Area}} = 50 \pm 10\%$$

5. Rn is the nominal resistance.

1.6 PHYSICAL DIMENSIONS AND HEATER OUTLINE

The general physical dimensions and heater layout shall be as follows. The physical dimensions and heater layout applicable to a specific heater will be specified in the heater design drawing held by the Manufacturer.



Symbol	Millimeters		Tolerances (± mm)	Remarks
	Min.	Max.		
A	6	590	0.5	Note 1
B	8	600	0.5	Note 1
C	300	-	Note 2	-
E	2	-	Note 3	Note 4
F	0.4	-	-	Note 5, 6
s	-	-	-	Note 1

NOTES:

1. The Heating Area, defined as the total area of the heater excluding the peripheral margin and the terminal connection area, shall have the following limits:

$1.6cm^2 \leq s \leq 1300cm^2$

The following design rule shall be applied:

$$\frac{\text{Area of Heater Resistive Element}}{\text{Heating Area}} = 50 \pm 10\%$$

Heater thickness:
- 0.2mm maximum for single layer heater
- 0.3mm maximum for double layer heater
except over terminal connection area.

2. The tolerance shall be ± 10% on the required dimension.
3. The tolerance shall be ± 0.5mm on the required dimension.
4. Terminal lead spacing shall be measured at the terminal connection area. Terminal leads may exit the terminal 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).
5. Peripheral margin dimension of the finished product.
6. Perforated holes in the peripheral margin are allowed provided that the distance between the edge of hole and the heater element or connection pad is equal to, or greater than, dimension F.

1.7 MATERIAL AND FINISHES

1.7.1 Heater Element

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

1.7.2 Protective Coating

Heater resistive elements and terminal lead connections shall be completely coated with Polymide Polymer/FEP in accordance with MIL-P-46112 (as superceded by ASTM-D5213).

1.7.3 Terminal Leads

Terminal leads 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 Component Type Variants and Range of Components herein. Terminal leads 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 specific heater 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 succesful 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.
   Note:
   For heaters which already have a backing foil applied the additional External Visual Inspection shall not be performed.

(b) For heaters where the specific heater 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 shall be:

(a) The ESCC qualified components symbol (for ESCC qualified components only).
(b) The ESCC Component Number.
(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 $\pm 3^{o}$C.

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 = 500Vrms	-	2 or (1) 4	mA μA/cm^2

NOTES:

1. Whichever is greater based on the Heating Area (s) in cm^2.

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	ΔR/R	ESCC No. 4009	0	-1.57	%
Resistance change between +200(+0 -3)˚C and +22 ±3˚C	ΔR/R	ESCC No. 4009	0	+3.17	%

NOTES:

1. Measurements shall be performed during 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 ±3^{o}C.

The test methods and test conditions shall be as per the corresponding test defined in 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	Limts		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: 500Vrms)	I_L	-	2 or (1) 4	mA $\mu A/cm^2$
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	

Test Reference per ESCC No. 4009	Characteristics	Symbols	Limts		Units
			Min.	Max.	
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: 500Vrms)	I_L	-	2 or (1) 4	mA μA/cm^2

NOTES:
1. Whichever is greater based on the Heating Area (s) in cm^2.

2.6 BURN-IN CONDITIONS

Characteristics	Symbols	Test Conditions	Units
Heater Temperature	T_{HTR}	+200 (Note 1)	^oC
Power Density	Pn	0.54 (Note 1)	W/cm^2

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.

APPENDIX 'A'

AGREED DEVIATIONS FOR RICA (I)

ITEMS AFFECTED	DESCRIPTION OF DEVIATIONS
Deviations from Screening Tests - Chart F3	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. Rapid change of temperature: Mounting: Heaters may be mounted using any suitable method Data points: Measurements during and after testing are optional at the Manufacturer's discretion.. Serialisation: Serialisation prior to Screening Tests, with subsequent read and record electrical measurements during Screening Tests, is optional at the Manufacturer's discretion.