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THERMISTORS (THERMALLY SENSITIVE RESISTORS), NTC, RANGE 2000 TO 100000 OHMS AT +25°C WITH A TEMPERATURE RANGE OF -60 TO +160°C

BASED ON TYPE G15K4D489, G10K4D453, G2K7D411, G4K7D421, G100K6D487, G15K4D589

ESCC Detail Specification No. 4006/014

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DOCUMENTATION CHANGE NOTICE

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617, 621	Specification up issued to incorporate editorial and technical changes per DCRs.

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1. GENERAL

1.1 SCOPE

This specification details the ratings, physical and electrical characteristics, test and inspection data for Thermistors, Thermally Sensitive Resistors, NTC, Range 2000 to 100000 Ohms at +25^{o}C with a Temperature Range of -60 to +160^{o}C, based on type G15K4D489, G10K4D453, G2K7D411, G4K7D421, G100K6D487, G15K4D589. It shall be read in conjunction with ESCC Generic Specification No. 4006, the requirements of which are supplemented herein.

1.2 COMPONENT TYPE VARIANTS

Variants of the basic type thermistors specified herein, which are also covered by this specification, are given in Table 1(a).

1.3 MAXIMUM RATINGS

The maximum ratings, which shall not be exceeded at any time during use or storage, applicable to the thermistors specified herein, are as scheduled in Table 1(b).

1.4 PARAMETER DERATING INFORMATION (FIGURE 1)

Not applicable.

1.5 PHYSICAL DIMENSIONS

The physical dimensions of the thermistors specified herein are shown in Figure 2.

1.6 FUNCTIONAL DIAGRAM

The functional diagram for the thermistors specified herein is shown in Figure 3.

2. APPLICABLE DOCUMENTS

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

(a) ESCC Generic Specification No. 4006, Thermistors (Resistors, Thermally Sensitive).
(b) ESCC Detail Specification No. 3901/001, Polyimide Insulated Wires and Cables, Low Frequency, 600V, -100 to +200 ^{o}C.
(c) ESCC Detail Specification No. 3901/012, Extruded, Crosslinked Fluoropolymer Insulated Wires on Silver Plated Coper Conductor, Low Frequency, 600V, -100 to +200 ^{o}C.
(d) IEC 60410, Sampling Procedures and Tables for Inspection by Attributes.
(e) MIL-STD-202, test Methods for Electronic and Electrical Component Parts.

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. In addition, the following symbols are used:-

NTC = Negative Temperature Coefficient.
R_Z = Zero Power Resistance.

Table 1(a) - Type Variants

(1) Variant	(2) Based on Type	(3) R_Z (Note 1)	(4) Resistance/Temperature Characteristics (Note 2)											(5) Lead Material
			-60°C	-40°C	-20°C	0°C	+25°C	+50°C	+70°C	+100°C	+125°C	+140°C	+160°C	
08	G15K4D489	R_Z (Ω)	1342000	371300	120100	44420	15000	5855	3009.0	1250	659.8	465.50	302.40	Note 3
		Tol. (±%)	10	6.3	3.35	1	1.01	1.03	1.05	1.01	2	3	4	
09	G10K4D453	R_Z (Ω)	847284	239768	78930	29490	10000	3893	1990	817.2	426.0	298.12	191.77	Note 3
		Tol. (±%)	7	3	2.6	2	2	1.7	1.6	3	3.5	4	4	
10	G2K7D411	R_Z (Ω)	-	43362	14658	5650	2000.0	815.0	432.0	187.40	102.00	-	-	Note 3
		Tol. (±%)	-	2.9	2.54	1.57	1.34	1.17	1.05	1.50	2.50	-	-	
11	G4K7D421	R_Z (Ω)	-	86724	29316	11300	4000	1630.0	864.0	374.80	204.00	-	-	Note 3
		Tol. (±%)	-	2.9	2.54	1.57	1.34	1.17	1.05	1.50	2.50	-	-	
12	G100K6D487	R_Z (Ω)	-	-	-	-	100000	-	-	5574	2642.4	1756.3	1059.0	Note 3
		Tol. (±%)	-	-	-	-	1.75	-	-	1.11	1.41	1.32	1.21	
13	G15K4D589	R_Z (Ω)	1342000	371300	120100	44420	15000	5855	3009.0	1250	659.8	465.50	302.40	Note 4
		Tol. (±%)	10	6.3	3.35	1	1.01	1.03	1.05	1.01	2	3	4	

NOTES:

1. For test purposes, when zero power is dissipated and the ambient temperature is held as specified, the value is referred to as R_Z (Zero Power Resistance).
2. The reference resistance is specified at +25°C.
3. The lead material shall be 26 AWG fluoropolymer insulated wire with ESCC Component Number 390101203B in accordance with ESCC Detail Specification No. 3901/012.
4. The lead material shall be 26 AWG polyimide insulated wire with ESCC Component Number 390100124B in accordance with ESCC Detail Specification No. 3901/001.

Table 1(b) - Maximum Ratings

No.	Characteristics	Symbol	Maximum Ratings	Unit	Remarks
1	Power Dissipation	P_D	2	mW	Note 1
2	Operating Temperature Range	T_{op}	Note 2	°C	
3	Storage Temperature Range	T_{stg}	Note 3	°C	
4	Soldering Temperature	T_{sol}	+245	°C	Note 4

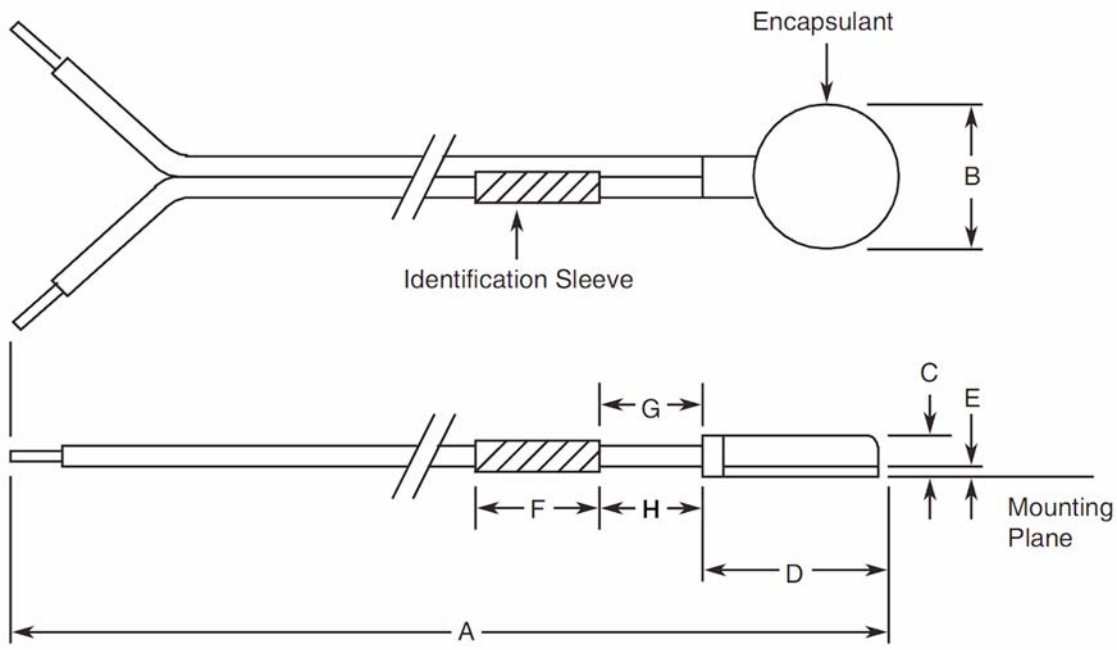
NOTES:

1. Never to be exceeded in the temperature measurement mode. The thermistors specified herein shall not be used in the self-heat mode.
2. See Column 4 of Table 1(a).
3. -40°C for Variants 10, 11, 12; and -60°C for Variants 08, 09, 13 to the Maximum Operating Temperature specified in Column 4 of Table 1(a).
4. Duration 10 seconds maximum not within dimension H in Figure 2 and the same lead shall not be resoldered until 3 minutes have elapsed.

FIGURE 1 - PARAMETER DERATING INFORMATION

Not applicable.

FIGURE 2 - PHYSICAL DIMENSION

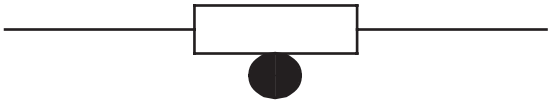


Symbol	Millimetres						Remarks
	Variant 08, 13		Variant 09		Variants 10, 11, 12		
	Min.	Max.	Min.	Max.	Min.	Max.	
A	356	406	500	550	280	330	
B	6.1	6.6	6.1	6.6	6.1	6.6	
C	-	2.4	-	2.8	-	2.8	
D	-	9.8	-	9.8	-	9.8	1
E	0.33	0.48	0.33	0.48	0.33	0.48	
F	-	50	-	50	-	50	
G	50	80	50	80	50	80	2
H	50	-	50	-	50	-	3

NOTES:

1. Within dimension D (housing/crimp) no part of the housing or leads shall protrude below the mounting plane by more than 0.13mm.
2. Location of the identification sleeve.
3. Leads shall not be stripped or cut within dimension H.

FIGURE 3 - FUNCTIONAL DIAGRAM



4. REQUIREMENTS

4.1 GENERAL

The complete requirements for procurement of the components specified herein are stated in this specification and ESCC Generic Specification No. 4006 for Thermistors (Resistors, Thermally Sensitive). Deviations from the Generic Specification, applicable to this specification only, are detailed in Para. 4.2.

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

4.2 DEVIATIONS FROM GENERIC SPECIFICATION

4.2.1 Deviations from Special In-process Controls

None.

4.2.2 Deviations from Final Production Tests (Chart II)

(a) Thermal Shock: Test Condition C except that the maximum temperature shall be the maximum operating temperature specified in Column 4 of Table 1(a) of this Specification.

4.2.3 Deviations from Burn-in and Electrical Measurements (Chart III)

None.

4.2.4 Deviations from Qualification Tests (Chart IV)

(a) Thermal Shock: Test Condition C except that the maximum temperature shall be the maximum operating temperature specified in Column 4 of Table 1(a) of this Specification.
(b) Para. 9.3.1.2, Dissipation Constant: Not applicable.
(c) Para. 9.15, Short Time Overload: Not applicable.
(d) Para. 9.17, High Temperature Storage: Not applicable.

4.2.5 Deviations from Lot Acceptance Tests (Chart V)

(a) Thermal Shock: Test Condition C except that the maximum temperature shall be the maximum operating temperature specified in Column 4 of Table 1(a) of this Specification.

4.3 MECHANICAL REQUIREMENTS

4.3.1 Dimension Check

The dimensions of the thermistors specified herein shall be verified in accordance with the requirements set out in Para. 9.4 of ESCC Generic Specification No. 4006 and they shall conform to those shown in Figure 2 of this specification.

4.3.2 Weight

The maximum weight of the thermistors specified herein shall be 4 grammes, with the exception of Variants 08 and 13 whose maximum weight shall be 2.3 grammes.

4.3.3 Terminal Strength

The requirements for terminal strength testing are specified in Para. 9.13 of ESCC Generic Specification No. 4006. The test conditions shall be as follows:

Applied Force	: 4.45 (+1.1 - 0)N.
Duration	: 5 seconds.

4.4 MATERIALS AND FINISHES

The materials and finishes shall be as specified herein. Where a definite material is not specified, a material which will enable the components specified herein to meet the performance requirements of this specification shall be used. Acceptance or approval of any constituent material does not guarantee acceptance of the finished product.

4.4.1 Case

The housing shall be aluminium filled with a black epoxy encapsulant.

4.4.2 Lead Material

The lead material shall be as specified in Table 1(a). One lead shall carry an identification sleeve which shall carry all part marking specified in Para. 4.5.

4.5 MARKING

4.5.1 General

The marking of all components delivered to this specification shall be in accordance with the requirements of ESCC Basic Specification No. 21700 and the following paragraphs. When the component is too small to accommodate all of the marking specified, as much as space permits shall be marked and the marking information, in full, shall accompany each component in its primary package.

The information to be marked and the order of precedence, shall be as follows:

(a) The ESA Symbol, for qualified components only.
(b) The ESCC Component Number.
(c) Traceability Information

4.5.2 ESCC Component Number

The ESCC Component Number shall be constituted and marked as follows:

Example: 400601408B

- Detail Specification Number: 4006014
- Type Variant (See Table 1(a)): 08
- Testing Level (B or C, as applicable): B

4.5.3 Traceability Information

Each component shall be marked in respect of traceability information in accordance with the requirements of ESCC Basic Specification No. 21700.

4.6 ELECTRICAL MEASUREMENTS

4.6.1 Electrical Measurements at Room Temperature

The parameters to be measured at room temperature are scheduled in Table 2. Unless otherwise specified, measurements shall be performed at T_{amb}=+25±0.01°C.

4.6.2 Electrical Measurements at High and Low Temperatures

The parameters to be measured at high and low temperatures are scheduled in Table 3. The temperature tolerance shall be ±0.01°C.

4.6.3 Circuits for Electrical Measurements (Figure 4)

Not applicable.

4.7 BURN-IN TESTS

4.7.1 Parameter Drift Values

The parameter drift values applicable to burn-in are as specified in Table 4 of this specification. Unless otherwise stated, measurements shall be performed at T_{amb}=+25±0.01°C. The parameter drift values (Δ) applicable to the parameters scheduled shall not be exceeded. In addition to these drift value requirements for a given parameter, the appropriate limit values specified in Table 2 shall not be exceeded.

4.7.2 Conditions for Burn-in

The requirements for burn-in are specified in Section 7 of ESCC Generic Specification No. 4006. The conditions for burn-in shall be as specified in Table 5 of this specification.

4.7.3 Electrical Circuit for Burn-in (Figure 5)

Not applicable.

Table 2- ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - DC PARAMETERS

No.	Characteristics	Symbol	ESCC 4006 Test Method and Conditions	Limits		Unit
				Min	Max	
1	Zero Power Resistance	R_Z	Para. 9.3.1.1	Note 1		Ω
2	Insulation Resistance	R_I	Para. 9.3.1.4 T_{amb}=+25±1°C Note 2	100	-	MΩ
3	Thermal Time Constant Variant 08, 13 Variants 09, 10, 11, 12	KH	Para. 9.3.1.3 T_{amb}=+25±1°C In Still Air Note 3	 - -	 25 40	sec.

NOTES:
1. See Column 4 of Table 1(a) for resistance values.
2. If more than 20 devices have to be measured, the test shall be performed on a sample basis in accordance with Level II, Single Sampling Plan for Normal Inspection, AQL = 1.0 of IEC 60410.
3. Test to be performed on 10 samples during Chart II only.

Table 3 - ELECTRICAL MEASUREMENTS AT HIGH AND LOW TEMPERATURES

No.	Characteristics	Symbol	ESCC 4006 Test Method and Conditions	Limits		Unit
				Min	Max	
1	Zero Power Resistance	R_Z	Para. 9.3.1.1 At each specified temperature, over operating range	Note 1		Ω

NOTES:
1. See Column 4 of Table 1(a) for resistance values.

FIGURE 4 - CIRCUITS FOR ELECTRICAL MEASUREMENTS
Not applicable.

Table 4 - PARAMETER DRIFT VALUES

No.	Characteristics	Symbol	Methods and Test Conditions	Change Limits (Δ)	Unit
1	Zero Power Resistance Change	$\Delta R_Z/R_Z$	As per Table 2	±0.2	%

Table 5 - CONDITIONS FOR BURN-IN AND OPERATING LIFE TESTS

No.	Characteristics	Symbol	Condition	Unit
1	Ambient Temperature	T_{amb}	Note 1 Note 2	^oC
2	Power Dissipation	P_D	2	mW

NOTES:
1. Maximum Operating Temperature specified in Column 4 of Table 1(a).
2. The Temperature Tolerance = (+0 -3) ^oC.

FIGURE 5 - ELECTRICAL CIRCUIT FOR BURN-IN AND OPERATING LIFE TESTS
Not applicable.

4.8 ENVIRONMENTAL AND ENDURANCE TESTS (CHARTS IV AND V OF ESCC GENERIC SPECIFICATION NO. 4006)

4.8.1 Measurements and Inspections on Completion of Environmental Tests

The parameters to be measured and inspections to be performed on completion of environmental tests are scheduled in Table 2. Unless otherwise stated, the measurements shall be performed at T_{amb}=+25±0.01°C.

4.8.2 Measurements and Inspections at Intermediate Points During Endurance Tests

The parameters to be measured and inspections to be performed at intermediate points during endurance tests are scheduled in Table 6. Unless otherwise stated, the measurements shall be performed at T_{amb}=+25±0.01C.

4.8.3 Measurements and Inspections on Completion of Endurance Tests

The parameters to be measured and inspections to be performed on completion of endurance tests are scheduled in Table 6. Unless otherwise stated, the measurements shall be performed at T_{amb}=+25±0.01°C.

4.8.4 Conditions for Operating Life Tests (Part of Endurance Testing)

The requirements for operating life testing are specified in Section 9 of ESCC Generic Specification No. 4006. The conditions for operating life testing shall be as specified in Table 5 for the burn-in test.

4.8.5 Electrical Circuit for Operating Life Tests

Not applicable.

Table 6 - MEASUREMENTS AND INSPECTIONS ON COMPLETION OF ENVIRONMENTAL TESTS AND AT INTERMEDIATE POINTS AND ON COMPLETION OF ENDURANCE TESTING

No.	ESCC Generic Spec. No. 4006		Measurements and Inspections		Symbol	Limits		Unit
	Environmental and Endurance Tests (1)	Test Methods and Conditions	Identification	Conditions		Min	Max	
01	Thermal Shock	Para. 9.2 (2)	-	-	-	-	-	-
02	Thermal Time Constant	Para. 9.3.1.3 In Still Air	**Initial Measurements** Zero Power Resistance	Para. 9.3.1.3(c)	R_Z	Record Values		Ω
			Final Measurements Thermal Time Constant	Para. 9.3.1.3(f)	KH	Table 2 Item 3		
03	External Visual Inspection	Para. 9.5	ESCC 20500	-	-	-	-	-
04	Shock (Specified Pulse)	Para. 9.7	**Initial Measurements** Zero Power Resistance	Table 2 Item 1	R_Z	Table 2 Item 1		
			During Shock Intermittent Contact	No Open or Short Circuiting	-	-	-	-
			After Shock Zero Power Resistance Change	Table 2 Item 1	$\Delta R_Z/R_Z$	-2	+2	%
			Visual Examination	No evidence of damage	-	-	-	-
05	Vibration	Para. 9.8	**Initial Measurements** Zero Power Resistance	Table 2 Item 1	R_Z	Table 2 Item 1		

No.	ESCC Generic Spec. No. 4006		Measurements and Inspections		Symbol	Limits		Unit
	Environmental and Endurance Tests (1)	Test Methods and Conditions	Identification	Conditions		Min	Max	
			During Vibration Intermittent Contact	No Open or Short Circuiting	-	-	-	-
			After Vibration Zero Power Resistance Change	Table 2 Item 1	$\Delta R_Z/R_Z$	-2	+2	%
			Visual Examination	No evidence of damage	-	-	-	-
06	Immersion	Para. 9.9	Visual Examination	No evidence of damage	-	-	-	-
07	Dielectric Withstanding Voltage	Para. 9.10	**During Test** Visual Examination	No evidence of breakdown or flashover	-	-	-	-
			After Test Visual Examination	No evidence of damage, arcing or breakdown	-	-	-	-
08	Resistance to Soldering Heat	Para. 9.11	**After Test**	After a recovery period of 24±4 hrs No evidence of damage				
			Zero Power Resistance	Table 2 Item 1	R_Z	Table 2 Item 1		
			Visual Examination	No evidence of damage	-	-	-	-
09	Moisture Resistance	Para. 9.12	**Initial Measurements**	Not less than 1.5 hrs after removal from drying oven				
			Zero Power Resistance	Table 2 Item 1	R_Z	Table 2 Item 1		
			Final Measurements	Within 24 hrs of removal from 1.5 to 3.5 hr conditioning				
			Zero Power Resistance Change	Table 2 Item 1	$\Delta R_Z/R_Z$	-2	+2	%
			Insulation Resistance	Table 2 Item 2	R_i	100	-	MΩ
10	Terminal Strength	Para. 9.13	**Initial Measurements**					
			Zero Power Resistance	Table 2 Item 1	R_Z	Table 2 Item 1		
			Final Measurements					
			Zero Power Resistance Change	Table 2 Item 1	$\Delta R_Z/R_Z$	-2	+2	%
			Visual Examination	No evidence of damage	-	-	-	-
11	Operating Life	Para. 9.14	**Initial Measurements**					
			Zero Power Resistance	Table 2 Item 1	R_Z	Table 2 Item 1		
			Intermediate Measurements					
			Zero Power Resistance Change	Table 2 Item 1	$\Delta R_Z/R_Z$	-1	+1	%

No.	ESCC Generic Spec. No. 4006		Measurements and Inspections		Symbol	Limits		Unit
	Environmental and Endurance Tests (1)	Test Methods and Conditions	Identification	Conditions		Min	Max	
			Insulation Resistance	Table 2 Item 2	R_i	100	-	MΩ
			Final Measurements					
			Zero Power Resistance Change	Table 2 Item 1	$\Delta R_Z/R_Z$	-1	+1	%
12	Low Temperature Storage	Para. 9.16	**Initial Measurements**					
			Zero Power Resistance	Table 2 Item 1	R_Z	Table 2 Item 1		
			Final Measurements					
			Zero Power Resistance Change	Table 2 Item 1	$\Delta R_Z/R_Z$	-2	+2	%
			Visual Examination	No evidence of damage	-	-	-	-
13	Solderability	Para. 9.18	-	-	-	-	-	-
14	Permanence of Marking	Para. 9.20	ESCC 24800	-	-	-	-	-

NOTES:

1. The tests in this Table refer to either Chart IV or V and shall be used as applicable.
2. Thermal Shock Test Method and conditions shall use the deviation of this specification as applicable.

APPENDIX 'A'

AGREED DEVIATIONS FOR MEAS Ireland (Betatherm) Ltd

ITEMS AFFECTED	DESCRIPTION OF DEVIATIONS
Para. 4.2.2 Deviations from Final Production Tests	Para. 9.2 Thermal Shock For Variants 08, 09, 10, 11, 12, 13 to Testing Level B, Parameter Drift Value Measurements in accordance with Para. 9.3.2 (and para. 4.7.1 of the Detail specification) shall be performed immediately before and after thermal Shock. Para. 9.3.1.4, Insulation Resistance For Variants 08, 09, 10, 11, 12, 13 Insulation Resistance may be measured in accordance with MEAS Ireland (Betatherm) Ltd Specification Ref. MFG 12-49-00.
Para. 4.2.3 Deviations from Burn-in and Electrical Measurements	Para. 7.4/7.4.1 Check for Lot Failure / Lot Failure During 100% Testing for Variants 08, 09, 10, 11, 12, 13 to Testing Level B, all Parameter Drift or Limit Failures during Parameter for Drift Value Measurements performed after Thermal Shock during Final Production Tests shall be included in the check for Lot Failure Percent Defective Allowable calculation. This Percent Defective shall be referenced against the quantity of components submitted to Burn-in and Electrical Measurements plus any Parameter Drift or Limit failures during Parameter Drift Value Measurements performed after Thermal Shock. Para. 9.6 Radiographic Inspection Inspection shall be with a single view such that the component's mounting plane is seated on the X-ray film holder. Para. 9.3.1.4, Insulation Resistance For Variants 08, 09, 10, 11, 12, 13 Insulation Resistance may be measured in accordance with MEAS Ireland (Betatherm) Ltd Specification Ref. MFG 12-49-00.
Para. 4.2.4 Deviations from Qualification Tests (Chart IV)	Para. 9.3.1.4, Insulation Resistance For Variants 08, 09, 10, 11, 12, 13 Insulation Resistance may be measured in accordance with MEAS Ireland (Betatherm) Ltd Specification Ref. MFG 12-49-00.
Para. 4.2.5 Deviations from Lot Acceptance Tests	Para. 9.14.2 Operating Life during Lot Acceptance Testing For Variants 08, 09, 10, 11, 12, 13 amend (f), Data Points, to be as follows: Measurements at intermediate and end points in accordance with Table 6 of the Detail specification at 0, 250, 500, 750 and 1000 ± 48 hours. Para. 9.3.1.4, Insulation Resistance For Variants 08, 09, 10, 11, 12, 13 Insulation Resistance may be measured in accordance with MEAS Ireland (Betatherm) Ltd Specification Ref. MFG 12-49-00.