ESA/ SCC QUALIFICATION REPORT FOR

NTC THERMISTOR PART TYPES:

1K3A351	G2K7D110
2K3A352	G4K7D108
3K3A353	G4K7D114
4K3A354	G15K4D112
5K3A355	G100K6D116

COVERED BY ESA/SCC 4006/013 Iss. 1 Rev. A & ESA/SCC 4006/014 Iss. 1 Rev. B

December 2001

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ABSTRACT

The following report describes the qualification activities conducted by Betatherm Ireland Ltd. in accordance with the requirements of the European Space Agency Space Components Co-ordination Group (ESA/SCC) towards qualification approval of thermistor components based on ESA/SCC Detail Specifications 4006/013 & 4006. The qualification testing was conducted as was detailed in ESA/SCC Generic specification 4006.

The content of this qualification test report is divided into 4 main sections:

- Section 1 Describes the two families of components that have been tested for qualification .The Evaluation Test Report and Process Identification Document are described in brief.

  The component construction and test equipment are defined as well as the test references that were used.

- Section 2 describes CHART II testing (Final Production Tests) in detail. Procedures used to perform each test are described and tables containing data from measurements are included where applicable. The relevant route sheets for the tests, which are contained in the Appendices to this report, are also referenced.

- Section 3 Describes CHART III testing (Burn in and Electrical Measurements) procedures used to perform each test are described and tables containing data from measurements are included where applicable. The relevant route sheets for the tests, which are contained in the Appendices to this report, are also referenced.

- Section 4 Describes CHART IV tests (Qualification Testing) procedures used to perform each test are described and tables containing data from measurements are included where applicable. The relevant route sheets for the tests are also referenced.

SECTION 1

1.0 Introduction

Betatherm Ireland is the European division, and company headquarters of Betatherm Corporation, which was founded in 1983 in Shrewsbury, Massachusetts USA. The company is a leading supplier of Negative Temperature Coefficient (NTC) thermistor products, from chip thermistor elements to precision epoxy or glass coated discrete devices with leads. The key markets for these devices are Medical; Automotive, Aerospace, Consumer Products, Industrial, Instrumentation and Computer/Communications.

1.1 Purpose

The purpose of this report is to describe in detail the tests that were conducted as per the requirements of ESA/SCC Generic Specification 4006 Issue 3, Rev. A; for the purpose of obtaining ESA/SCC qualification. The results obtained and the reference data used are also detailed.

1.2 Scope

The scope of this report applies to the Negative Temperature Coefficient Thermistors as defined in Detail Specifications 4006/013 and 4006/014.

The agreed 4006/013 qualification vehicles were variant 01 (1K3A351) and 05 (5K3A355). Variants 02, 03, 04 were not tested and will be approved by similarity on the basis of the test results from both the Evaluation Test Report and the Qualification Test Report.

The agreed 4006/014 qualification vehicles were variant 01 (G2K7D110), 04 (G15K4D112) and 05 (G100K6D116). Variants 02 (G4K7D108) and 03 (G4K7114) were not tested and will be approved by similarity on the basis of the test results from both the Evaluation Test Report and the Qualification Test Report.

1.3 Overview of Thermistor Operation

Thermistors are thermally sensitive semiconductor resistors that exhibit a large temperature coefficient of resistance. Thermistors can be either PTC type (Positive Temperature Coefficient) or NTC type (Negative Temperature Coefficient), depending on their material compositions. All of the thermistors referenced in this report are of the NTC type, and are characterised by a negative change in resistance for a corresponding positive change in temperature. These resistance changes are predictable and quite large (typically -3 to -6%/°C). Ceramic processing techniques are utilised in the fabrication of the thermistor component, whereby high purity inorganic powders (typically transition metal oxides) are intimately blended together, formed into large wafers and sintered. Depending on the types of oxides used, their relative proportions, and the prescribed time-temperature-atmosphere sintering cycle, a wide range of material resistivities and temperature coefficient characteristics can be obtained. A few of the more commonly used terms associated with the operation of thermistor components are explained below.

a) Zero Power Resistance – This term refers to the measured direct current resistance value at any specified temperature when thermistor power dissipation is negligible (that is, when any further decrease in power will result in not more than 0.1% change in resistance – ref. MIL-PRF-23648).

b) Thermal Time Constant – This is the time required for a thermistor component to change its body temperature by 63.2% of a specific temperature span when the measurements are made under zero power conditions in a thermally stable environment.

c) Dissipation Constant – This is defined as the power required to raise a thermistor component's body temperature by 1 degree Celsius in a particular measurement medium.

d) Self Heating – A thermistor dissipating power will experience an increase in body temperature if the current flowing through the device is sufficiently high. This results in a decrease in thermistor resistance causing further increases in component temperature to occur. This effect is known as self-heating.

1.4 Component Construction

Both families of component referenced in this report were assembled using ceramic chip elements as the starting material. The ceramic chip elements are produced by mechanically sawing or 'dicing' ceramic wafers or 'ware' that have been metallised on both sides, to the desired dimensions (see figure 1.4.1).

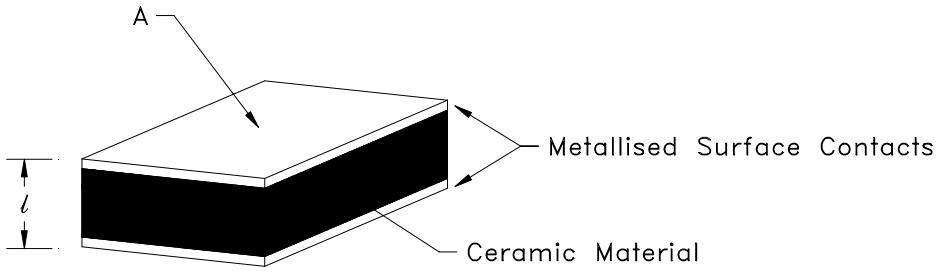

Figure 1.4.1 – Schematic of thermistor chip element

Components are characterised by the following equation:

$$\rho = \frac{RA}{\ell} \qquad \text{Equation 1.4.1}$$

where ρ, the material resistivity is predetermined for any particular component. The material system used to fabrication the ceramic wafers will determine the value of ρ.

Once the chip elements have been produced, final assembly of the component can take place. Since the final assembly operations for both families of component evaluated here differ significantly, their assembly operations are described separately as follows:

a) Components based on ESA/SCC Detail Specification No. 4006/013

For these components final assembly firstly involves soldering leads to the metallised surfaces of the thermistor chips. Resistance adjustments by means of abrasion or 'grinding' are then performed to yield components with the desired nominal resistance value. This is shown in Figure 1.4.2.

Figure 1.4.2 – Component before and after abrasion resistance adjustment

The final stage of assembly simply involves coating the thermistor elements with an epoxy encapsulant and curing. A picture of the final product is depicted in Figure 1.4.3.

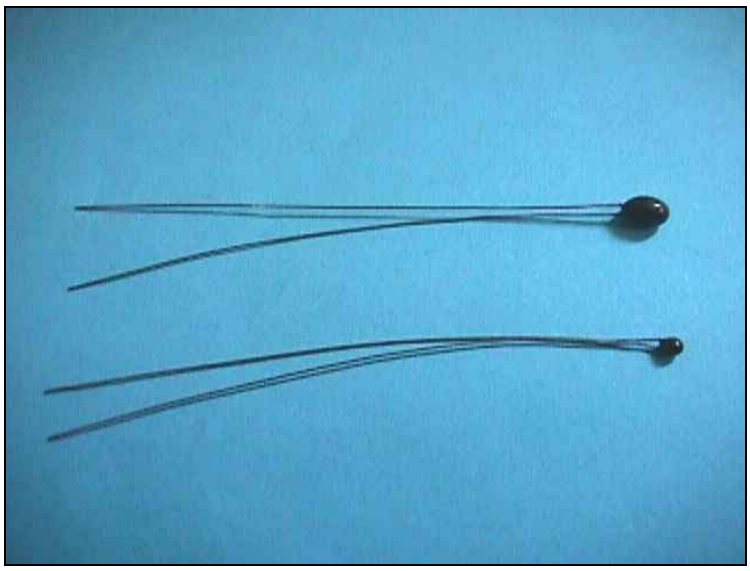

Figure 1.4.3 – Components based on ESA/SCC Detail Specification No. 4006/013

b) Components based on ESA/SCC Detail Specification No. 4006/014

These components consist of two sub-assemblies mounted and encapsulated onto a surface fastening disk structure made of aluminium. This structure is generally referred to as a 'housing'. The sub-assemblies or 'subs' are comprised of platinum iridium leads fired onto the surface contacts of the chip elements. The chip elements are then sealed using a glass encapsulant material. The thermistor pairs are selected on the basis of their combined resistance values satisfying the tolerance requirements of the finished component at one or more specified temperature points. Once selected, thermistor pairs are welded together as per configuration shown in Figure 1.4.4.

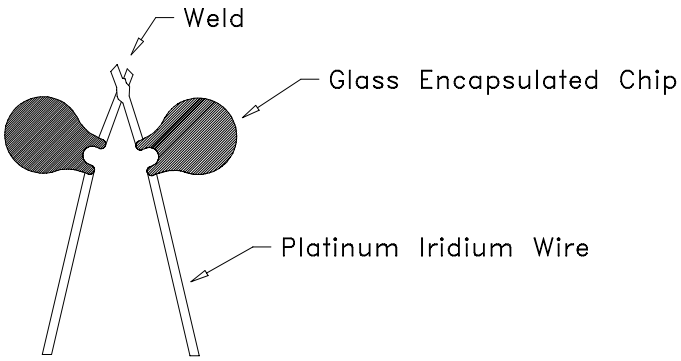

Figure 1.4.4 – Schematic of matched thermistor pair

Extension leads are then attached and these leads are crimped at one end with stainless steel ferrules, onto which the platinum iridium leads are welded. The sub-assemblies are then lightly coated with an epoxy material before being mounting onto the aluminium housings. The mounted assemblies are fastened to the aluminium housing by means of specially constructed tabs, which are crimped to the extension leads. The various stages of construction are shown in Figure 1.4.5 below.

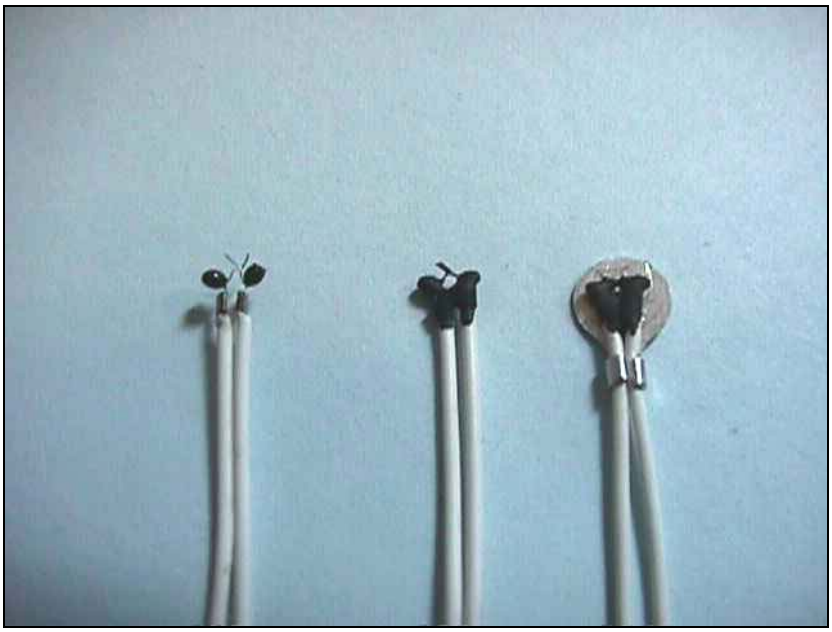

Figure 1.4.5 – Various stages of construction of components based on ESA/SCC Detail Specification No. 4006/014

Mounted and fastened assemblies are then completely encapsulated or 'potted' using an epoxy material. The components are then marked by means of identification sleeving heat-shrunk onto one of the extension leads. A picture of the final component assembly is shown below in Figure 1.4.6.

Figure 1.4.6 – Component based on ESA/SCC Detail Specification No. 4006/014

1.5 Evaluation Test Plans

The Evaluation Test Plans for these component families were successfully completed. The Evaluation phase was formally deemed by ESA to be concluded successfully in May 1999 and the Evaluation Test Report, dated March 2000, lists all the issues, the program followed and the results of this evaluation.

1.6 Process Identification Document

The Process Identification Document (PID) was developed to define in detail the Manufacturing Process that is used at Betatherm Ireland to manufacture NTC Thermistors to ESA/SCC Detail Specifications ESA/SCC 4006/013 and 4006/014. This is a controlled document under revision control of the quality department.

1.7 Equipment Listing

Table 1.7.1 is complete listing of inspection, test and measuring equipment used in this Qualification Report. The column ‘reference charts’ refer to Charts II, III, IV & V of ESA/SCC Generic Specification No. 4006 and to the PID.

1.7 Equipment Listing (Continued)

Plant No.	Description	Manufacturer	Calibration Frequency	Calibration Reference	Purpose	Reference Chart
P-12-05	Camera system	JVC	N/A	N/A	Visual Inspection	II, III, IV, V (SCC4006)
P-12-06	Camera system	JVC	N/A	N/A	Visual Inspection	II, III, IV, V (SCC4006)
P-210-01	Deviation bridge	E.S.I.	6	External	Thermal Time Constant	II, III, IV, V (SCC4006)
P-60-15	Hole Gauge	Moore &Wright	N/A	N/A	Dimension Check	II (SCC4006)
P-207-01	Hypot tester	Associated Research	12	External	Dielectric Withstanding Volt.	IV, V (SCC4006)
P-62-04	Meggermeter	MEGGER BM206	12	CAL-001-B62	Insulation Resistance	II, III, IV, V (SCC4006)
P-62-06	Meggermeter	MEGGER BM206	12	CAL-001-B62	Insulation Resistance	II, III, IV, V (SCC4006)
P-06-02	Microscope	Viking	N/A	N/A	Visual Inspection	II, III, IV, V (SCC4006)
P-06-14	Microscope	Olympus	N/A	N/A	Visual Inspection	II, III, IV, V (SCC4006)
P-06-15	Microscope	Mantis	N/A	N/A	Visual Inspection	II, III, IV, V (SCC4006)
P-06-19	Microscope	Kwoya	N/A	N/A	Visual Inspection	II, III, IV, V (SCC4006)
P-06-22	Microscope	Kwoya	N/A	N/A	Visual Inspection	II, III, IV, V (SCC4006)
P-53-06	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-11	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-25	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-133	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-135	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-136	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-14	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-17	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-26	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)

Table 1.7.1 – Inspection, Test and Measurement Equipment

1.7 Equipment Listing (Continued)

Plant No.	Description	Manufacturer	Calibration Frequency	Calibration Reference	Purpose	Reference Chart
P-53-90	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-91	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-96	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	I (P.I.D.)
P-53-12	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	II, III, IV, V (SCC4006)
P-53-121	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	II, III, IV, V (SCC4006)
P-53-122	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	II, III, IV, V (SCC4006)
P-53-93	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	II, III, IV, V (SCC4006)
P-53-95	Multimeter	Prema	12	CAL-001-B53	Zero Power Resistance	II, III, IV, V (SCC4006)
P-53-116	Multimeter	Prema	12	External	Voltage Meter	II, III, IV, V (SCC4006)
P-53-123	Multimeter	Prema	12	External	Voltage Meter	II, III, IV, V (SCC4006)
P-53-77	Multimeter	Prema	12	External	Current Meter	II, III, IV, V (SCC4006)
P-205-01	Multimeter	Prema	12	External	Bath Calibration	II, III, IV, V (SCC4006)
P-205-02	Multimeter	Prema	12	External	Bath Calibration	II, III, IV, V (SCC4006)
P-53-155	Multimeter	BK 391	N/A	N/A	Reference Meter	II, III, IV, V (SCC4006)
P-53-83	Multimeter	BK Precision	N/A	N/A	Reference Meter	II, III, IV, V (SCC4006)
P-53-50	Multimeter	BK Precision	N/A	N/A	Reference Meter	II, III, IV, V (SCC4006)
P-53-108	Multimeter	BK Precision	N/A	N/A	Reference Meter	I (P.I.D.)
P-53-110	Multimeter	BK Precision	N/A	N/A	Reference Meter	I (P.I.D.)
P-53-138	Multimeter	BK Precision	N/A	N/A	Reference Meter	I (P.I.D.)
P-53-139	Multimeter	BK Precision	N/A	N/A	Reference Meter	I (P.I.D.)
P-53-52	Multimeter	BK Precision	N/A	N/A	Reference Meter	I (P.I.D.)
P-53-37	Multimeter	Circuitmate	N/A	N/A	Reference Meter	I (P.I.D.)

Table.1.7.1 – Inspection, Test and Measurement Equipment (Cont.)

1.7 Equipment Listing (Continued)

Plant No.	Description	Manufacturer	Calibration Frequency	Calibration Reference	Purpose	Reference Chart
P-53-42	Multimeter	Circuitmate	N/A	N/A	Reference Meter	I (P.I.D.)
P-01-19	Oven	Despatch	6	CAL-001-B01	Burn-in & operating Life	III, IV, V (SCC4006)
P-20-01	Oven	Tenny Jnr	6	CAL-001-B20	Thermal Shock	III (SCC4006)
P-20-02	Oven	BMA	6	CAL-001-B20	Thermal Shock	III (SCC4006)
P-20-04	Oven	Fisons	6	CAL-001-B20	Still Air Chamber	II, III, IV, V (SCC4006)
P-37-07	Power supply	Sorensen	6	CAL-001-B37	Burn-in & Operating Life	III, IV, V (SCC4006)
P-37-01	Power supply	GW laboratory	6	CAL-001-B37	Burn-in & Operating Life	III, IV, V (SCC4006)
P-37-03	Power supply	BK Presion	6	CAL-001-B37	Burn-in & Operating Life	III, IV, V (SCC4006)
P-37-04	Power supply	Farnell	6	CAL-001-B37	Burn-in & Operating Life	III, IV, V (SCC4006)
P-37-05	Power supply	Thurlby	6	CAL-001-B37	Burn-in & Operating Life	III, IV, V (SCC4006)
P-37-06	Power supply	Farnell	6	CAL-001-B37	Burn-in & Operating Life	III, IV, V (SCC4006)
P-205-01	Probe (RTD)	Thermo-meterics	12	External	Bath Calibration	II, III, IV, V (SCC4006)
P-205-02	Probe (RTD)	Thermo-meterics	12	External	Bath Calibration	II, III, IV, V (SCC4006)
P-211-01	Probe (RTD)	Hart Platinum	12	External	Bath Calibration	II, III, IV, V (SCC4006)
P-209-01	Probe (Quartz)	Hewlett packard	12	External	Bath Calibration	II, III, IV, V (SCC4006)
P-208-02	Pull Test System	Ametek	12	External	Terminal Strength	IV (SCC4006)
P-43-02	Solder Pot	Plato	N/A	N/A	Solderability & Solder Heat	IV,V (SCC4006)
P-72-01	Steam age controller	Mountaingate	12	CAL-001-B72	Solderability	IV (SCC4006)
P-17-03	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)

Table 1.7.1 – Inspection, Test and Measurement Equipment (Cont.)

1.7 Equipment Listing (Continued)

Plant No.	Description	Manufacturer	Calibration Frequency	Calibration Reference	Purpose	Reference Chart
P-17-06	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-15	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-17	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-23	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-24	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-34	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-57	Temperature Bath	Hart Scientific	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-62	Temperature Bath	Hart Scientific	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-78	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-81	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	I (P.I.D.)
P-17-37	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-17-51	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-17-55	Temperature Bath	Hart Scientific	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-17-64	Temperature Bath	Hart Scientific	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-17-65	Temperature Bath	Hart Scientific	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-17-69	Temperature Bath	Hart Scientific	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-17-72	Temperature Bath	Hart Scientific	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-17-74	Temperature Bath	Neslab	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-17-79	Temperature Bath	Hart Scientific	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-17-43	Temperature Bath	Lauda	1	CAL-001-B59	Zero Power Resistance	II, III, IV, V (SCC4006)
P-209-01	Thermo-meter	Hewlett packard	12	External	Bath Calibration	II, III, IV, V (SCC4006)
P-57-01	Thermo-meter	Fluke	6	CAL-001-B57	Oven Calibration	II, III, IV, V (SCC4006)

Table 1.7.1 – Inspection, Test and Measurement Equipment (Cont.)

1.7 Equipment Listing (continued)

Plant No.	Description	Manufacturer	Calibration Frequency	Calibration Reference	Purpose	Reference Chart
P-57-02	Thermo-meter	Fluke	6	CAL-001-B57	Oven Calibration	II, III, IV, V (SCC4006)
P-57-05	Thermo-meter	Fluke	6	CAL-001-B57	Oven Calibration	II, III, IV, V (SCC4006)
P-55-09	Vernier Calipers	Mitutoyo	6	CAL-001-B55	Dimension Check	I (P.I.D.)
P-55-07	Vernier Calipers	Mitutoyo	6	CAL-001-B55	Dimension Check	II, III, IV (P.I.D.)
P-55-13	Vernier Calipers	Mitutoyo	6	CAL-001-B55	Dimension Check	I (P.I.D.)
P-55-08	Vernier Calipers	Mitutoyo	6	CAL-001-B55	Dimension Check	II (SCC4006)
P-55-11	Vernier Calipers	Mitutoyo	6	CAL-001-B55	Dimension Check	II (SCC4006)
P-56-08	Vernier Calipers	Mitutoyo	6	CAL-001-B55	Dimension Check	II (SCC4006)
P-55-14	Vernier Calipers	Mitutoyo	6	CAL-001-B55	Dimension Check	II (SCC4006)

Table 1.7.1 – Inspection, Test and Measurement Equipment (Cont.)

1.8 Test references

The following test references were used during the Qualification Testing.

TEST	GENERIC TEST REFERENCE 4006 Iss. 3 Rev. A	TEST STANDARD MIL-STD-202F Not. 14	TEST METHOD
Thermal shock	Para. 9.2	MIL-STD-202	107G
Insulation resistance		MIL-STD-202	302
Shock(specified pulse)	Para. 9.7	MIL-STD-202	213B
Vibration	Para. 9.8	MIL-STD-202	204D
Immersion	Para. 9.9	MIL-STD-202	104A
Dielectric withstanding voltage	Para. 9.10	MIL-STD-202	301
Resistance to Soldering heat	Para. 9.11	MIL-STD-202	210E
Moisture resistance	Para. 9.12	MIL-STD-202	106F
Terminal strength	Para. 9.13	MIL-STD-202	211A
Operating life	Para. 9.14.1	MIL-STD -202	108A
Solderability	Para. 9.18	MIL-STD-202	208H

Table 1.8.1 –Test References

1.9 Sample identification in sub groups

Each component of the 5 lots that were manufactured is identified by the Betatherm Part Number and a three-digit serial number. The Chip Fabrication Route Sheets for the Qualification Lots are shown in **Appendix A**, one Chip Fabrication Route Sheet for each of the five parts used as qualification vehicles. The Manufacturing Route Sheets for the Qualification Lots are shown in **Appendix B**, one Manufacturing Route Sheet for each of the five parts used as qualification vehicles. Note that, due to identified non-conformances and subsequent corrective actions, some of these Manufacturing Route Sheets were subsequently superseded. After Chart III testing the components were randomly selected for the 5 Sub Groups that make up the ESA/SCC 4006 Chart IV Qualification Testing. The allocation of the Part Numbers / Serial Numbers to the different Sub Groups of Chart IV were as follows.

SUBGROUP I (12 Components)

Part No	
1K3A351	(001) (002) (005) (006) (008) (010) (011) (015) (017) (018) (021) (023)
5K3A355	(013) (014) (015) (016) (018) (019) (020) (022) (026) (027) (033) (034)
G2K7D110	(001) (002) (003) (004) (006) (007) (008) (013) (016) (017) (019) (021)
G15K4D112	(031) (035) (042) (046) (047) (048) (049) (053) (054) (055) (056) (057)
G100K6D16	(001) (002) (006) (007) (011) (012) (013) (020) (024) (026) (028) (031)

Table 1.9.1 –Sample Identification – Sub Group I – Chart IV

SUBGROUP II (12 Components)

Part No	
1K3A351	(009) (016) (019) (020) (025) (029) (036) (046) (047) (057) (062) (071)
5K3A355	(006) (007) (009) (012) (030) (031) (038) (043) (070) (071) (072) (073)
G2K7D110	(047) (055) (057) (059) (065) (066) (067) (068) (069) (070) (071) (072)
G15K4D112	(061) (062) (064) (066) (078) (079) (080) (081) (082) (083) (085) (086)
G100K6D116	(003) (005) (009) (016) (027) (037) (038) (042) (046) (047) (059) (067)

Table 1.9.2 –Sample Identification – Sub Group II – Chart IV

SUBGROUP III (6 Components)

Part No	
1K3A351	(037) (051) (060) (061) (066) (067)
5K3A355	(064) (065) (066) (067) (068) (069)
G2K7D110	(056) (060) (061) (062) (063) (064)
G15K4D112	(044) (045) (052) (058) (059) (060)
G100K6D16	(064) (065) (066) (068) (069) (071)

Table 1.9.3 –Sample Identification – Sub Group III – Chart IV

SUBGROUP 1V (20 Components)

Part No	
1K3A351	(068) (022) (003) (012) (065) (056) (063) (052) (007) (014)
	(013) (054) (059) (058) (055) (053) (042) (040) (031) (004)
5K3A355	(010) (008) (005) (004) (003) (002) (001) (011) (017) (021)
	(023) (024) (025) (028) (029) (032) (039) (040) (041) (042
G2K7D110	(043) (023) (005) (012) (011) (042) (041) (037) (035) (009)
	(027) (022) (029) (010) (014) (034) (018) (033) (015) (020)
G15K4D112	(017) (016) (014) (013) (011) (010) (009) (004) (003) (008)
	(034) (002) (001) (043) (041) (039) (038) (037) (021) (020)
G100K6D16	(004) (008) (010) (014) (015) (017) (018) (019) (021) (040)
	(039) (025) (029) (022) (023) (030) (032) (034) (035) (036)

Table 1.9.4 –Sample Identification – Sub Group IV – Chart IV

SUBGROUP V (20 Components)

Part No	
1K3A351	(035) (024) (026) (027) (028) (030) (032) (033) (064) (072)
	(034) (038) (039) (041) (043) (044) (045) (048) (049) (050)
5K3A355	(035) (036) (037) (044) (045) (046) (047) (048) (049) (050)
	(051) (052) (053) (054) (055) (056) (057) (058) (059) (060)
G2K7D110	(024) (025) (026) (028) (030) (031) (032) (036) (038) (039)
	(040) (044) (045) (046) (048) (049) (050) (051) (052) (053)
G15K4D112	(019) (022) (023) (024) (025) (040) (036) (033) (032) (030)
	(026) (027) (028) (029) (005) (006) (007) (012) (015) (018)
G100K6D16	(063) (062) (061) (060) (058) (057) (055) (056) (054) (053)
	(052) (051) (050) (049) (048) (045) (044) (043) (041) (033)

Table 1.9.5 –Sample Identification – Sub Group V – Chart IV

SECTION 2

2.0 Introduction

In this section the testing of the 5 Qualification Parts (ESA/SCC 4006/013 Variants 01 & 05 and ESA/SCC 4006/014 Variant 01,04 & 05) during Chart II are described in detail. Testing to Chart II consisted of the following steps:

- Internal (Pre-Encapsulation) Visual Inspection
- Final Assembly
- Marking and Serialisation
- Thermal Shock
- Electrical Measurements at Room Temperature
- External Visual Inspection (inspection Level II, AQL 1%)
- Dimension Check

The Route sheets for Chart II 'Final Production Tests' are shown in **Appendix C**, one Route Sheet for each of the five parts used as qualification vehicles. During Chart II of the part no ESA/SCC 4006/013/05 a Non Conformance was observed at Visual Pre Cap. The detail of this Non Conformance and the resulting Corrective Actions are described in Section 2.1 of this report.

Note that, due to Non-Conformances raised during Chart III testing, the ESA/SCC 4006/014 Variant 01,04 & 05 inspection lots were scrapped and replacement inspection lots were manufactured. The same ceramic material lot was used, i.e. the Chip Fabrication Route Sheet of Appendix A is the source of these devices. The Manufacturing Route Sheet for these replacement 4006/014 Variant 01,04 & 05 Qualification Lots are shown in **Appendix I** to this report. These replacement lots were subjected to Chart II testing, the Route Sheet being shown in **Appendix J. The results detailed in paragraph 2.5 of this report refer to these replacement lots**. The details of the Non-Conformances and the corrective actions are covered in Section 3 of this report.

2.1 (4006 Para.9.1) Internal (Pre–Encapsulation) Visual Inspection

ESA/SCC Detail Spec 4006/013 Variants 05:

The Pre Encapsulation Visual inspection was carried out on these two parts at the start of CHART II as defined in Generic spec ESA/SCC 4006. The visual inspection was carried out by the nominated ESA/SCC Inspector; Mr. John Howley of National Electronics Technology Centre (NETC), Enterprise Ireland, on 12 August 1999.

Part no ESA/SCC 4006/013 / Variant 05 failed the visual inspection. Of a random sample of 50 units in the lot of 80 units, 3 units were deemed to fail. The failure modes identified were 2 units with cracks in the thermistor chip and 1 unit with a residue between the device leads. In compliance with SCCG procedures a Non Conformance, numbered 2IEBET901, was raised and testing of this qualification device was halted. A copy of this Non Conformance Control Sheet is shown in **Appendix D** to this report.

The causes of this non-conformance were as follows:

- The Visual Workmanship Standards that were used for Visual Inspection did not adequately show cracks as an inspection criteria.

- The Visual Workmanship Standards were inadequate and did not show residue as an inspection criteria.

- The Workmanship Standards were based on drawings that were not clear.

- When the Visual Inspectors were trained there was not sufficient emphasis put on criteria such as quality of the ceramic and residues present. The main emphasis was on the quality of the solder pad.

- The Manufacturing Work Instructions did not include criteria for lead contamination and flux residue.

A Materials Review Board (MRB) was held, at the Galway facility, on 20 January 2000 to consider Non-Conformance 2IEBET901. The MRB concluded that the failure criteria were inadequately specified in the inspection documentation and that the training of visual inspector operators was also inadequate. Its disposition was as follows:

- **Proceed with the qualification ("use as is"), subject to 100% visual inspection and verification of electrical integrity of parts after long term storage.**

As part of the corrective actions agreed, the company were requested to produce two documents; "Actual Causes of Non-Conformance" and "MRB Actions/Decisions"; which would detail the causes and the agreed and implemented corrective actions. These documents, shown in **Appendix E** and **Appendix F** respectively were accepted by ESA/SCC on 18 April 2000 and the Non-Conformance was closed. Testing of the ESA/SCC 4006/13 variant 05 was then re started. As part of the Corrective Action Variant 05 parts were re–inspected, by re-trained and re-certified inspectors using the revised Betatherm Visual Inspection Criteria, and passed the inspection.

ESA/SCC Detail Spec 4006/013 Variants 1:

Part no ESA/SCC 4006/013 / Variant 01 passed the 'pre-cap' visual inspection and progressed to the Epoxy coating stage, where the parts were epoxy coated. As a major component of the Corrective Actions; resulting from Non-conformance 2IEBET901; was to develop new visual inspection criteria, the Variant 01 parts could not now be inspected to these revised criteria as the parts were coated. As a consequence of this it was decided, with the agreement of ESA/SCC, to manufacture a replacement inspection lot of this part. The same ceramic material lot was used, i.e. the Chip Fabrication Route Sheet of Appendix A is the source of these devices. The Manufacturing Route Sheet for this replacement 4006/013 Variant 1 Qualification Lot is shown in **Appendix G** to this report. This replacement lot of Variant 01 parts were subjected to Chart II testing, the Route Sheet being shown in **Appendix H.** The replacement inspection lot was visually, inspected, by re-trained and re-certified inspectors using the revised Betatherm Visual Inspection Criteria, and passed the inspection. **The results detailed in detailed in paragraph 2.5 of this report refer to this replacement lot**.

ESA/SCC Detail Spec 4006/014 Variants 01, 04 & 05.

The "Pre –Cap Visual Inspection" was carried out, by the ESA/SCC nominated inspector, on 12 August 1999. All three variants passed the inspection and progressed to the next phase of the build.

2.2 (4006 Para. 9.19) Final Assembly

ESA/SCC Detail Spec 4006/013 Variants 01 & 05.

This section refers to the Double Coating of the ESA/SCC 4006/013 components with 2850 Stycast Epoxy and the subsequent checking of the bead diameter using a hole gauge. The quantity, date of test and operator is shown on the relevant Route Sheets in Appendices C and H.

ESA/SCC Detail Spec 4006/014 Variants 01, 04 & 05

This section refers to the Final Assembly of the ESA/SCC 4006/014 components. This involves the wire prep, crimping, assembly by welding, visual inspection, encapsulation and application of a heatshrink sleeve. As well the assembly the process checks for crimping and welding are included. The quantity, date of test and operator details is shown on the relevant Route Sheets in Appendices C and J.

2.3 (4006 Para. 4.4) Marking & Serialisation For Level B

This section refers to the marking and serialisation of components as defined in ESA/SCC Basic Specification No 21700.

ESA/SCC Detail Specification 4006/013/Variant 01 & 05

It is not possible to mark the epoxy bead of these components. The components were serialised by placing in individually numbered bags, as defined in the PID.

The details are shown on the relevant Route Sheets in Appendices C and H.

ESA/SCC Detail Specification 4006/014 /Variant 01,04 & 05

These probes are identified by means of a “Heat – Shrinkable Marker Sleeve” which is attached to one of the Extension Leads by means of heat shrinking. The data on the sleeve is as per the detail specification .The Sleeve is printed on both sides. One side has the Detail Spec No, Variant and Testing Level. The other side has the date code and serial number.

The details are shown on the relevant Route Sheets in Appendices C and J.

2.4 (4006 Para. 9.2) Thermal Shock

The discrete components were subjected to Thermal Shock in accordance with ESA/SCC Generic Specification 4006 and the relevant detail specification. These requirements detail that the test may be performed in accordance with Test Condition C of Method 107 of MIL-STD-202, except that the maximum temperature, as specified, was the maximum operating temperature documented in Column 4 of Table 1(a) of the detail specification.

The quantity, date of test and operator details is shown on the relevant Route Sheets in Appendices C, H and J.

2.5 (4006 Para. 9.3.4) Electrical Measurements at Room Temperature

The electrical measurements were carried out as detailed by ESA/SCC Generic Specification 4006 and ESA/SCC Detail Specification 4006/013 and 4006/014. As proposed by Betatherm and agreed by ESTEC the testing for the Dissipation Constant does not apply to either of the parts. This is due to the fact that both detail specifications, in Note 1 to Table 1(b) 'Maximum Ratings, state that the thermistors shall not be used in the 'self heat' mode. As the Dissipation Constant measurement is only relevant for thermistors used in the 'self heat' mode, and as it can only be measured by using the thermistors in the 'self heat' mode, the measurement is not possible or useful in the case of these devices. It is proposed to update ESA/SCC 4006/013 Iss.1 Rev. A and ESA/SCC 4006/014 Iss.1 Rev. B, in order to take account of this fact.

2.5.1 ESA/SCC Detail Specification 4006/013 Variant 01 & 05

Both variants were tested to the following criteria:

Zero power resistance at 25°C	Data in Tables 2.5.1.A and 2.5.1.B
Insulation resistance (AQL)	Data in Tables 2.5.1.C and 2.5.1.D
Thermal time constant (S/S = 10)	Data in Tables 2.5.1.E and 2.5.1.F

The quantity, date of test and operator details is shown in the relevant Route Sheets in Appendices C and H.

COMP. NO.	RES. READING (ohms) at + 25°C 991.2 to 1008.8 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at +25 °C 991.2 to 1008.8 ohms	Pass/Fail (Indicate failure only)
001	1005.2		041	1001.3	
002	996.3		042	1001.8	
003	994.8		043	995.2	
004	993.7		044	994.5	
005	996.2		045	997.6	
006	997.7		046	995.8	
007	1002.4		047	996.4	
008	999.5		048	999.2	
009	999.4		049	999.6	
010	995.7		050	999.8	
011	996.7		051	1000.1	
012	993.8		052	995.1	
013	993.2		053	994.4	
014	1003.8		054	1002.7	
015	1000.6		055	994.0	
016	997.3		056	1002.1	
017	995.8		057	1000.5	
018	998.5		058	995.1	
019	996.7		059	993.0	
020	998.5		060	997.5	
021	997.9		061	996.5	
022	994.3		062	1000.5	
023	997.9		063	1002.4	
024	997.3		064	995.4	
025	995.4		065	1004.0	
026	995.9		066	996.1	
027	1001.2		067	1000.8	
028	997.3		068	1004.0	
029	999.8		069	1000.8	
030	1000.6		070	999.4	
031	1002.5		071	1001.3	
032	998.1		072	997.6	
033	996.7				
034	1000.4				
035	999.7				
036	998.8				
037	1001.6				
038	997.7				
039	997.2				
040	1002.3				

Table 2.5.1.A Zero Power Resistance Readings for variant 01(1K3A351) @ +25°C

COMP. NO.	RES. READING (ohms) at + 25°C 4956 to 5044 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at +25 °C 4956 to 5044 ohms	Pass/Fail (Indicate failure only)
001	4994		041	5031	
002	5008		042	5003	
003	5005		043	5016	
004	5001		044	5000	
005	5006		045	5026	
006	5016		046	5019	
007	5024		047	5015	
008	5028		048	5013	
009	5009		049	5013	
010	5021		050	5023	
011	5025		051	5016	
012	5015		052	4984	
013	5023		053	5007	
014	5015		054	5004	
015	5023		055	5025	
016	5017		056	5030	
017	5026		057	5018	
018	5020		058	5025	
019	5019		059	5010	
020	5010		060	5012	
021	5029		061	5025	
022	5021		062	5016	
023	5036		063	5024	
024	4994		064	5002	
025	5024		065	5002	
026	5020		066	5016	
027	5014		067	5016	
028	5003		068	5020	
029	5026		069	5014	
030	5011		070	5018	
031	5020		071	5010	
032	4997		072	5014	
033	5015		073	5028	
034	5017		074	5015	
035	5009				
036	5014				
037	5015				
038	5005				
039	4994				
040	5021				

Table 2.5.1.B Zero Power Resistance Readings for variant 05 (5K3A355) @ +25°C

COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
004	> 100 M ohm		065	> 100 M ohm	
008	> 100 M ohm		068	> 100 M ohm	
015	> 100 M ohm		070	> 100 M ohm	
025	> 100 M ohm				
029	> 100 M ohm				
033	> 100 M ohm				
038	> 100 M ohm				
043	> 100 M ohm				
049	> 100 M ohm				
061	> 100 M ohm				

Table 2.5.1.C Insulation Resistance Testing for Variant 01 (1K3A351)

	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
002	> 100 M ohm		069	> 100 M ohm	
009	>100 M ohm		070	> 100 M ohm	
011	> 100 M ohm		071	> 100 M ohm	
028	> 100 M ohm				
037	> 100 M ohm				
045	> 100 M ohm				
053	> 100 M ohm				
060	> 100 M ohm				
062	> 100 M ohm				
066	> 100 M ohm				

Table 2.5.1.D Insulation Resistance Testing for variant 05 (5K3A355)

COMP. NO.	ZERO POWER RESISTANCE @ +43.4°C	ZERO POWER RESISTANCE @ + 75°C	THERMAL TIME CONSTANT
005	465.2	148.1	17.8
010	465.4	148.3	18.5
015	465.6	148.4	19.5
020	466.1	148.2	20.5
025	466.3	148.0	19.9
030	465.9	148.2	18.7
035	465.1	148.3	22.0
040	465.3	148.1	21.6
045	465.8	148.2	22.4
050	465.2	148.4	23.6

Table 2.5.1.E Thermal Time Constant (1K3A351) Variant 01

COMP. NO.	ZERO POWER RESISTANCE @ +43.4°C	ZERO POWER RESISTANCE @ + 75°C	THERMAL TIME CONSTANT
003	2328	740.9	9.0
008	2328	741.0	10.1
013	2330	742.8	10.3
018	2329	743.2	10.0
023	2328	743.2	10.0
028	2329	744.7	9.0
033	2333	744.6	9.5
038	2334	743.2	9.4
043	2335	741.2	9.3
048	2334	743.1	9.5

Table 2.5.1.F Thermal Time Constant (5K3A355) Variant 05

2.5.2 ESA/SCC Detail Specification 4006/014 Variant 01,04 & 05

All three variants were tested for the following criteria.

Zero power resistance @ 25°C.	Data in Tables 2.5.2.A, 2.5.2.B, and 2.5.2.C.
Insulation Resistance (AQL)	Data in Tables 2.5.2.D, 2.5.2.E and 2.5.2.F.
Thermal time constant. (S/S = 10)	Data in Tables 2.5.2.G, 2.5.2.H and 2.5.2.I.

The quantity, date of test and operator details is shown in the relevant Route Sheets in Appendices C and J. Two units of 4006/014 Variant 05, numbered 080 and 129, failed due to no resistance reading being recorded and were removed from this lot.

COMP. NO.	RES. READING (ohms) at + 25°C 1973 to 2027 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at +25°C 1973 to 2027 ohms	Pass/Fail (Indicate failure only)
001	2005		041	2022	
002	2009		042	2020	
003	2005		043	2010	
004	2010		044	2010	
005	2017		045	2018	
006	2011		046	2008	
007	2003		047	2012	
008	2008		048	2014	
009	2021		049	2007	
010	2021		050	2004	
011	2020		051	2005	
012	2018		052	2010	
013	2015		053	2000	
014	2001		054	2022	
015	2003		055	2005	
016	2012		056	2018	
017	2018		057	2006	
018	2006		058	2021	
019	2004		059	2001	
020	2003		060	1996	
021	2004		061	2004	
022	2004		062	1999	
023	2021		063	2000	
024	2008		064	2008	
025	2007		065	2003	
026	2005		066	2009	
027	2023		067	2004	
028	2017		068	2003	
029	2006		069	2004	
030	2010		070	2005	
031	2016		071	2010	
032	2016		072	2004	
033	2000				
034	2001				
035	2000				
036	2016				
037	2024				
038	2006				
039	2006				
040	2005				

Table 2.5.2.A Zero Power Resistance Readings for variant 01(G2K7D110) @ +25°C

COMP. NO.	RES. READING (ohms) at + 25°C 14,789 to 15,212 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at + 25°C 14,789 to 15,212 ohms	Pass/Fail (Indicate failure only)
001	14,927		044	14,959	
002	14,863		045	14,957	
003	14,962		046	14,963	
004	14,917		047	14,965	
005	14,979		048	14,966	
006	14,941		049	14,966	
007	14,916		050	14,973	
008	14,864		051	14,947	
009	14,933		052	14,929	
010	14,926		053	15,029	
011	14,930		054	14,916	
012	14,945		055	14,928	
013	14,995		056	14,910	
014	14,932		057	14,974	
015	14,930		058	14,889	
016	14,973		059	14,951	
017	14,922		060	14,944	
018	14,968		061	14,962	
019	14,951		062	14,987	
020	14,989		063	14,930	
021	14,986		064	14,956	
022	14,968		065	14,947	
023	14,961		066	14,955	
024	14,956		067	14,960	
025	14,962		068	14.931	
026	14,930		069	14,907	
027	14,963		070	14,972	
028	14,944		071	14,986	
029	14,957		072	14,948	
030	14,949		073	14,925	
031	14,978		074	14,947	
032	14,970		075	14,942	
033	14,935		076	14,933	
034	14,982		077	14,938	
035	14,956		078	14,942	
036	14,931		079	14,952	
037	14,975		080	14,955	
038	14,974		081	14,931	
039	14,908		082	14,931	
040	14,953		083	14,871	
041	14,978		084	14,951	
042	14,957		085	14,960	
043	14,977		086	14,957	

Table 2.5.2.B. Zero Power Resistance Readings for variant 04(G15K4D112) @ +25°C

COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 ohms	Pass/Fail (Indicate failure only)
001	100,412		041	99,621	
002	99,751		042	99,791	
003	98,920		043	100,091	
004	99,371		044	100,032	
005	100,401		045	99,513	
006	100,273		046	99,960	
007	100,132		047	100,762	
008	100,394		048	99,899	
009	99,612		049	99,728	
010	99,390		050	100.481	
011	100,041		051	100,502	
012	100,042		052	99,721	
013	99,630		053	100,532	
014	100,491		054	100,296	
015	99,501		055	100,302	
016	99,652		056	99,390	
017	99,531		057	100,381	
018	99,401		058	100,192	
019	100,470		059	100,632	
020	100,221		060	100,112	
021	100,252		061	100,020	
022	99,501		062	99,911	
023	99,352		063	99,843	
024	99,752		064	99,742	
025	100,723		065	99,821	
026	100,140		066	100,592	
027	100,051		067	100,071	
028	100,091		068	100,061	
029	100,510		069	100,502	
030	99,414		070	99,742	
031	99,581		071	100,272	
032	100,352		072	99,533	
033	99,610		073	99,731	
034	99,491		074	99,822	
035	100,212		075	100,410	
036	99,312		076	99,710	
037	99,801		077	100,341	
038	99,632		078	100,432	
039	100,601		079	100,101	
040	100,081		080	No Reading	FAIL

Table 2.5.2.C. Zero Power Resistance Readings for variant 05 (G100K6D116) @ +25°C

Table 2.5.2.C (continued)

COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 ohms	Pass/Fail (Indicate failure only)
081	100,042		121	100,152	
082	99,330		122	100,212	
083	99,601		123	99,802	
084	100,661		124	100,321	
085	99,550		125	100,293	
086	99,941		126	99,852	
087	99,754		127	99,912	
088	99,321		128	100,701	
089	100,350		129	No Reading	FAIL
090	100,561		130	99,220	
091	99,571		131	100,272	
092	99,432		132	99,410	
093	100,171		133	99,942	
094	100,131		134	99,542	
095	100,091		135	100,230	
096	100,092		136	100,481	
097	100,801		137	99,962	
098	100,110		138	100,562	
099	100,011		139	100,091	
100	100,032		140	99,425	
101	99,770		141	100,701	
102	100,160		142	99,523	
103	100,691		143	99,601	
104	99,673		144	99,241	
105	99,291		145	99,943	
106	100,462		146	100,123	
107	100,305				
108	100,033				
109	100,332				
110	100,152				
111	100,081				
112	100,061				
113	99,674				
114	99,844				
115	99,330				
116	100,172				
117	99,501				
118	99,652				
119	100,961				
120	99,881				

Table 2.5.2.C. Zero Power Resistance Readings for variant 05 (G100K6D116) @ +25°C

COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
001	> 100 M ohm		066	> 100 M ohm	
004	> 100 M ohm		069	> 100 M ohm	
010	> 100 M ohm		070	> 100 M ohm	
017	> 100 M ohm				
025	> 100 M ohm				
029	> 100 M ohm				
031	> 100 M ohm				
040	> 100 M ohm				
052	> 100 M ohm				
055	> 100 M ohm				

Table 2.5.2.D Insulation Resistance Testing for Variant 01 (G2K7D110)

	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
003	> 100 M ohm		070	> 100 M ohm	
006	>100 M ohm		075	> 100 M ohm	
011	> 100 M ohm		080	> 100 M ohm	
020	> 100 M ohm				
023	> 100 M ohm				
026	> 100 M ohm				
029	> 100 M ohm				
043	> 100 M ohm				
050	> 100 M ohm				
069	> 100 M ohm				

Table 2.5.2.E Insulation Resistance Testing for variant 04 (G15K4D112)

	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
004	> 100 M ohm		058	> 100 M ohm	
007	>100 M ohm		067	> 100 M ohm	
011	> 100 M ohm		072	> 100 M ohm	
015	> 100 M ohm		074	> 100 M ohm	
020	> 100 M ohm		076	> 100 M ohm	
027	> 100 M ohm		080	> 100 M ohm	
033	> 100 M ohm		099	> 100 M ohm	
035	> 100 M ohm		105	> 100 M ohm	
043	> 100 M ohm		118	> 100 M ohm	
045	> 100 M ohm		135	> 100 M ohm	

Table 2.5.2.F Insulation Resistance Testing for variant 05 (G100K6D116)

COMP. NO.	ZERO POWER RESISTANCE @ +43.4°C	ZERO POWER RESISTANCE @ + 75°C	THERMAL TIME CONSTANT
007	1024	372.1	34
014	1026	372.2	34
021	1023	372.3	34
028	1024	372.5	34
035	1025	373.4	34
042	1021	373.2	34
049	1025	373.5	34
056	1030	375.6	34
063	1020	372.4	34
070	1022	372.3	34

Table 2.5.2.G Thermal Time Constant (G2K7D110) Variant 01

COMP. NO.	ZERO POWER RESISTANCE @ +43.4°C	ZERO POWER RESISTANCE @ + 75°C	THERMAL TIME CONSTANT
004	7368	2548	33
014	7350	2541	33
024	7365	2538	32
034	7371	2535	33
044	7378	2547	32
048	7350	2541	33
052	7366	2549	33
056	7377	2544	33
060	7372	2545	32
064	7339	2540	33

Table 2.6.2.H Thermal Time Constant (G15K4D112) Variant 04

COMP. NO.	ZERO POWER RESISTANCE @ +43.4°C	ZERO POWER RESISTANCE @ + 75° C	THERMAL TIME CONSTANT
006	44055	12980	32
012	44222	12945	32
018	44398	12964	32
024	44295	12995	32
030	44150	13010	32
036	44350	12976	32
042	44222	12987	32
048	44256	13012	32
054	44238	12978	32
060	44310	12999	32

Table 2.5.2.I Thermal Time Constant (G100K6D116) Variant 05

2.6 (4006 Para. 9.5) External Visual Inspection

All 5 inspection lots (ESA/SCC 4006/013 and ESA/SCC 4006/014) were externally visually inspected as per ESA/SCC Basic specification No. 20500 and the relevant Betatherm Manufacturing Work Instructions;. MFG-11-72-20 covering ESA/SCC 4006/014 and MFG-11-72-19 covering ESA/SCC 4006/013.

The sample size inspected was Inspection Level II and AQL 1%. No visual rejects were detected.

The quantities, inspector and date of test are shown on the relevant Route Sheets in Appendices C, H and J.

2.7 (4006 Para. 9.4) Dimension Check

All 5 inspection lots were dimensionally checked using a micrometer and a steel rule. The dimensions were checked against the relevant drawing in the Detail Specifications.

The sample size was 5 parts for ESA/SCC 4006/013 and 5 parts for ESA/SCC 4006/014. As no out of specification parts were measured for either type no further measuring or re checking was necessary.

The results, quantities, inspector and date of test are shown on the relevant Route Sheets in Appendices C, H and J.

SECTION 3

3.0 Introduction

In this section the testing of the 5 Qualification Parts (ESA/SCC 4006/013 Variants 01 & 05 and ESA/SCC 4006/014 Variant 01,04 & 05) during Chart III are described in detail. Testing to Chart III consists of the following steps:

- Parameter Drift Values (Initial Measurements)
- Burn-In, 168 hours
- Parameter Drift Values (Final Measurements)
- Electrical Measurements at High and Low Temperatures
- Electrical measurements at Room Temperature
- Radiographic Inspection
- External Visual Inspection
- Check for Lot Failure

The Route sheets for Chart III 'Final Production Tests' are shown in **Appendix K**, one Route Sheet for each of the five parts used as qualification vehicles. During Chart III testing of the ESA/SCC 4006/014 Inspection Lots, Non Conformances were detected at Parameter Drift Value measurement stage. The detail of these Non-Conformances and the resulting Corrective Actions are described in Section 3.3 of this report.

3.1 (4006 Para. 9.3.2) Parameter Drift Value, Initial Measurements

The components in all 5 qualification lots (ESA/SCC 4006/013 Variant 01, 05 and ESA/SCC 4006/014 Variant 01, 04, 05) had the zero power resistance at 25 degrees C measured (to Betatherm internal procedure MFG-11-09-00) and the values were recorded (to Betatherm internal procedure MFG-11-09-00-REC).

The quantities, inspector and date of test are shown on the relevant Route Sheets in Appendix K.

3.2 (4006 Para. 7.1) Burn-In, 168 Hours

The components in all 5 qualification lots (ESA/SCC 4006/013 Variant 01,05 and ESA/SCC 4006/014 Variant 01, 04, 05) were burnt in for 168 hours as defined in ESA Generic Specification 4006. The power applied during burn-in, as defined in both detail specifications, was 2.0 mW. The burn in temperature specified is the maximum operating temperature, for each variant, specified in the relevant detail specification. The relevant temperatures are as follows:

ESA/SCC 4006 /013 Variant 01	100^{O}C
ESA/SCC 4006/013 Variant 05	115^{O}C
ESA/SCC 4006/014 Variant 01	125^{O}C
ESA/SCC 4006/014 Variant 04	160^{O}C
ESA/SCC 4006/014 Variant 05	160^{O}C

The quantities, inspector and date of test are shown on the relevant Route Sheets in Appendix K.

3.3 (4006 Para. 9.3.2) Parameter Drift Value - Final Measurements

ESA/SCC Detail Spec 4006/014 Variants 01, 04 and 05

Post Burn-In, the Zero Power Resistance values; for ESA/SCC 4006/014 Variants 01, 04 and 05; were again measured and recorded. When the delta values were calculated, it was apparent that all components failed to satisfy the parameter drift limit of ± 0.2% specified in the detail specification. The observed percentage average drift was +1.0% for Variant 01, +3.9% for the Variant 04 and 1.6% for Variant 05.

In compliance with SCCG procedures three Non Conformances, numbered 2IEBET902, 2IEBET903 and 2IEBET904, were raised and testing of these qualification devices was halted. A copy of these Non Conformance Control sheet is shown in **Appendix L** to this report.

The common cause of these three non-conformances was the use of an incorrect firing profile during the application of the glass encapsulant material used to coat the thermistor sub-assemblies.

A Materials Review Board (MRB) was held, at the Galway facility, on 20 January 2000 to consider Non-Conformances 2IEBET902, 2IEBET903 and 2IEBET904. The MRB concluded that inadequate controls were present for the firing process used after the application of glass encapsulant materials. Its disposition was as follows:

- **Scrap all three lots and proceed to re-build after ESA/SCC are satisfied that corrective actions are completed.**

As part of the corrective actions agreed, the company were requested to produce two documents; “Actual Causes of Non-Conformance” and “MRB Actions/Decisions”; which would detail the causes and the agreed and implemented corrective actions. These documents, shown in **Appendix M** and **Appendix N** respectively were accepted by ESA/SCC on 20 July 2000 and the Non-Conformance was closed. The same ceramic material lot was used, i.e. the Chip Fabrication Route Sheet of Appendix A is the source of these devices. The Manufacturing Route Sheets for these replacement 4006/013 Variant 01, 04 and 05 Qualification Lots are shown in **Appendix I** to this report. These replacement lots were subjected to Chart II testing, the Route Sheets being shown in **Appendix J.**

The replacement lots were then subjected to Parameter Drift Values (Initial Measurements); Burn-In, 168 hours and Parameter Drift Values (Final Measurements) Chart III testing, **The results detailed in this section refer to these replacement lots (Note: the detailed pre- and post–Burn–In measurements with respect to the failed lots are included in the Appendix N documentation**. The replacement lots pre and post values, with the calculated delta values, are listed in Tables 3.3.1, 3.3.2 and 3.3.3.

It is noted that the delta values shown in Table 3.3.1(Variant G2K7D110 – Curve 7 Material) show a significant number of readings at the upper limit of +0.2%. This issue is further addressed in Section 4.4 of this Qualification Report (Sub Group IV – Endurance Test).

The Chart III route sheets for these replacement lots, showing the quantity, date of test and operator details are shown in **Appendix O** to this report.

COMP. NO.	RES. READING (ohms) at + 25°C 1973 to 2027 Pre Burn In	RES. READING (ohms) @+25C 1973 to 2027 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
001	2005	2009	0.20	
002	2009	2011	0.10	
003	2005	2009	0.20	
004	2010	2014	0.20	
005	2017	2021	0.20	
006	2011	2014	0.15	
007	2003	2007	0.20	
008	2008	2011	0.15	
009	2021	2023	0.10	
010	2021	2023	0.10	
011	2020	2023	0.15	
012	2018	2022	0.20	
013	2015	2018	0.15	
014	2001	2005	0.20	
015	2003	2007	0.20	
016	2012	2016	0.20	
017	2018	2021	0.15	
018	2006	2007	0.05	
019	2004	2008	0.20	
020	2003	2007	0.20	
021	2004	2008	0.20	
022	2004	2007	0.15	
023	2021	2022	0.05	
024	2008	2011	0.15	
025	2007	2011	0.20	
026	2005	2009	0.20	
027	2023	2024	0.05	
028	2017	2020	0.15	
029	2006	2005	- 0.05	
030	2010	2012	0.10	
031	2016	2020	0.20	
032	2016	2020	0.20	
033	2000	2004	0.20	
034	2001	2005	0.20	
035	2000	2004	0.20	
036	2016	2018	0.10	
037	2024	2025	0.05	
038	2006	2009	0.15	
039	2006	2009	0.15	
040	2005	2009	0.20	

Table 3.3.1 Pre / Post Burn In, Zero Power Resistance Readings, Variant 01 (G2K7D110) @ +25°C

Table 3.3.1 (continued)

COMP. NO.	RES. READING (ohms) at + 25°C 1973 to 2027 Pre Burn In	RES. READING (ohms) @+25C 1973 to 2027 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
041	2022	2026	0.20	
042	2020	2023	0.15	
043	2010	2007	- 0.15	
044	2010	2014	0.20	
045	2018	2022	0.20	
046	2008	2011	0.15	
047	2012	2014	0.10	
048	2014	2017	0.15	
049	2007	2011	0.20	
050	2004	2008	0.20	
051	2005	2008	0.15	
052	2010	2012	0.10	
053	2000	2004	0.20	
054	2022	2023	0.05	
055	2005	2008	0.15	
056	2018	2022	0.20	
057	2006	2009	0.15	
058	2021	2025	0.20	
059	2001	2005	0.20	
060	1996	2000	0.20	
061	2004	2007	0.15	
062	1999	2003	0.20	
063	2000	2004	0.20	
064	2008	2011	0.15	
065	2003	2006	0.15	
066	2009	2011	0.10	
067	2004	2007	0.15	
068	2003	2006	0.15	
069	2004	2007	0.15	
070	2005	2007	0.10	
071	2010	2013	0.15	
072	2004	2006	0.10	

Table 3.3.1 Pre / Post Burn In, Zero Power Resistance Readings, Variant 01 (G2K7D110) @ +25°C

COMP. NO.	RES. READING (ohms) at + 25°C 14,789 to 15,212 Pre Burn In	RES. READING (ohms) @+25C 14,789 to 15,212 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
001	14,927	14,935	0.05	
002	14,863	14,886	0.16	
003	14,962	14,990	0.19	
004	14,917	14,919	0.01	
005	14,979	14,979	0.00	
006	14,941	14,962	0.14	
007	14,916	14,937	0.14	
008	14,864	14,869	0.03	
009	14,933	14,935	0.01	
010	14,926	14,921	- 0.03	
011	14,930	14,932	0.01	
012	14,945	14,969	0.16	
013	14,995	14,998	0.02	
014	14,932	14,932	0.00	
015	14,930	14,949	0.13	
016	14,973	14,985	0.08	
017	14,922	14,922	0.00	
018	14,968	14,968	0.00	
019	14,951	14,962	0.07	
020	14,989	15,003	0.09	
021	14,986	14,983	- 0.02	
022	14,968	14,974	0.04	
023	14,961	14,967	0.04	
024	14,956	14,966	0.07	
025	14,962	14,971	0.06	
026	14,930	14,936	0.04	
027	14,963	14,973	0.07	
028	14,944	14,957	0.09	
029	14,957	14,973	0.10	
030	14,949	14,946	- 0.02	
031	14,978	14,980	0.01	
032	14,970	14,968	- 0.01	
033	14,935	14,958	0.15	
034	14,982	14,988	0.04	
035	14,956	14,976	0.13	
036	14,931	14,938	0.05	
037	14,975	14,985	0.07	
038	14,974	14,988	0.09	
039	14,908	14,915	0.05	
040	14,953	14,956	0.02	
041	14,978	14,990	0.08	
042	14,957	14,972	0.10	
043	14,977	14,994	0.11	

Table 3.3.2 Pre / Post Burn In, Zero Power Resistance Readings, Variant 04 (G15K4D112) @ +25°C

Table 3.3.2 (continued)

COMP. NO.	RES. READING (ohms) at + 25°C 14,789 to 15,212 Pre Burn In	RES. READING (ohms) @+25C 14,789 to 15,212 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
044	14,959	14,963	0.03	
045	14957	14,969	0.08	
046	14,963	14,983	0.13	
047	14,965	14,968	0.02	
048	14,958	14,967	0.06	
049	14,966	14,971	0.03	
050	14,973	14,986	0.09	
051	14,947	14,958	0.07	
052	14,929	14,937	0.05	
053	15,029	15,059	0.20	
054	14,916	14,929	0.09	
055	14,928	14,949	0.14	
056	14,910	14,916	0.04	
057	14,974	14,995	0.14	
058	14,889	14,900	0.07	
059	14,951	14,978	0.18	
060	14,944	14,954	0.07	
061	14,962	14,961	- 0.01	
062	14,987	15,013	0.17	
063	14,930	14,932	0.01	
064	14,956	14,971	0.10	
065	14,947	14,952	0.03	
066	14,955	14,951	- 0.03	
067	14,960	14,974	0.09	
068	14,931	14,942	0.07	
069	14,907	14,919	0.08	
070	14,972	14,979	0.05	
071	14,986	14,997	0.07	
072	14,948	14,956	0.05	
073	14,925	14,926	0.01	
074	14,947	14,963	0.11	
075	14,942	14,956	0.09	
076	14,933	14,945	0.08	
077	14,938	14,933	- 0.03	
078	14,942	14,956	0.09	
079	14,952	14,969	0.11	
080	14,955	14,969	0.09	
081	14,931	14,952	0.14	
082	14,931	14,952	0.14	
083	14,871	14,885	0.09	
084	14,951	14,942	0.06	
085	14,960	14,972	0.08	
086	14,957	14,966	0.06	

Table 3.3.2 Pre / Post Burn In, Zero Power Resistance Readings, Variant 04 (G15K4D112) @ +25°C

COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 Pre Burn In	RES. READING (ohms) @+25C 98,370 to 101,630 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
001	100,412	100,412	0.00	
002	99,751	99,701	-0.05	
003	98,920	98,898	-0.02	
004	99,371	99,383	0.01	
005	100,401	100,406	0.00	
006	100,273	100,189	-0.08	
007	100,132	100,130	0.00	
008	100,394	100,343	-0.05	
009	99,612	99,616	0.00	
010	99,390	99,401	0.01	
011	100,041	100,036	0.00	
012	100,042	100,068	0.03	
013	99,630	99,649	0.02	
014	100,491	100,484	-0.01	
015	99,501	99,510	0.01	
016	99,652	99,646	-0.01	
017	99,531	99,492	-0.04	
018	99,401	99,450	0.05	
019	100,470	100,464	-0.01	
020	100,221	100,106	-0.11	
021	100,252	100,238	-0.01	
022	99,501	99,508	0.01	
023	99,352	99,312	-0.04	
024	99,752	99,732	-0.02	
025	100,723	100,749	0.03	
026	100,140	100,094	-0.05	
027	100,051	100,046	0.00	
028	100,091	100,063	-0.03	
029	100,510	100,498	-0.01	
030	99,414	99,419	0.01	
031	99,581	99,588	0.01	
032	100,352	100,347	0.00	
033	99,610	99,573	-0.04	
034	99,491	99,511	0.02	
035	100,212	100,194	-0.02	
036	99,312	99,314	0.00	
037	99,801	99,804	0.00	
038	99,632	99,657	0.03	
039	100,601	100,629	0.03	
040	100,081	100,084	0.00	

Table 3.3.3 Pre / Post Burn In, Zero Power Resistance Readings, Variant 05 (G100K6D116) @ 25C

Table 3.3.3 (continued)

COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 Pre Burn In	RES. READING (ohms) @+25C 98,370 to 101,630 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
041	99,621	99,652	0.03	
042	99,791	99,820	0.03	
043	100,091	100,129	0.04	
044	100,032	100,034	0.00	
045	99,513	99,508	-0.01	
046	99,960	99,962	0.00	
047	100,762	100,785	0.02	
048	99,899	99,919	0.02	
049	99,728	99,864	0.14	
050	100,481	100,475	-0.01	
051	100,502	100,469	-0.03	
052	99,721	99,749	0.03	
053	100,532	100,518	-0.01	
054	100,296	100,248	-0.05	
055	100,302	100,288	-0.01	
056	99,390	99,425	0.04	
057	100,381	100,438	0.06	
058	100,192	100,221	0.03	
059	100,632	100,643	0.01	
060	100,112	100,135	0.02	
061	100,020	100,042	0.02	
062	99,911	99,936	0.03	
063	99,843	99,843	0.00	
064	99,742	99,748	0.01	
065	99,821	99,806	-0.02	
066	100,592	100,616	0.02	
067	100,071	100,065	-0.01	
068	100,061	100,060	0.00	
069	100,502	100,502	0.00	
070	99,742	99,737	-0.01	
071	100,272	100,326	0.05	
072	99,533	99,548	0.02	
073	99,731	99,752	0.02	
074	99,822	99,826	0.00	
075	100,410	100,472	0.06	
076	99,710	99,708	0.00	
077	100,341	100,350	0.01	
078	100,432	100,438	0.01	
079	100,101	100,150	0.05	
080	Not Included	Not Included	-	

Table 3.3.3 Pre / Post Burn In, Zero Power Resistance Readings, Variant 05 (G100K6D116) @ 25C

Table 3.3.3 (continued)

COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 Pre Burn In	RES. READING (ohms) @+25C 98,370 to 101,630 Post Burn In	**Drift %**	Pass/Fail (Indicate failure only)
081	100,042	100,046	0.00	
082	99,330	99,381	0.05	
083	99,601	99,626	0.03	
084	100,661	100,712	0.05	
085	99,550	99,566	0.02	
086	99,941	99,995	0.05	
087	99,754	99,769	0.02	
088	99,321	99,370	0.05	
089	100,350	100,424	0.07	
090	100,561	100,555	-0.01	
091	99,571	99,584	0.01	
092	99,432	99,443	0.01	
093	100,171	100,238	0.07	
094	100,131	100,123	-0.01	
095	100,091	100,135	0.04	
096	100,092	100,136	0.04	
097	100,801	100,864	0.06	
098	100,110	100,120	0.01	
099	100,011	100,046	0.03	
100	100,032	100,069	0.04	
101	99,770	99,747	-0.02	
102	100,160	100,207	0.05	
103	100,691	100,702	0.01	
104	99,673	99,694	0.02	
105	99,291	99,280	-0.01	
106	100,462	100,464	0.00	
107	100,305	100,329	0.02	
108	100,033	100,002	-0.03	
109	100,332	100,340	0.01	
110	100,152	100,145	-0.01	
111	100,081	100,083	0.00	
112	100,061	100,058	0.00	
113	99,674	99,652	-0.02	
114	99,844	99,779	-0.07	
115	99,330	99,270	-0.06	
116	100,172	100,169	0.00	
117	99,501	99,517	0.02	
118	99,652	99,662	0.01	
119	100,961	100,939	-0.02	
120	99,881	99,882	0.00	

Table 3.3.3 Pre / Post Burn In, Zero Power Resistance Readings, Variant 05 (G100K6D116) @ 25C

Table 3.3.3 (continued)

COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 Pre Burn In	RES. READING (ohms) @+25C 98,370 to 101,630 Post Burn In	**Drift %**	Pass/Fail (Indicate failure only)
121	100,152	100,146	-0.01	
122	100,212	100,176	-0.04	
123	99,802	99,773	-0.03	
124	100,321	100,169	-0.15	
125	100,293	100,261	-0.03	
126	99,852	99,842	-0.01	
127	99,912	99,879	-0.03	
128	100,701	100,698	0.00	
129	Not Included	Not Included	-	
130	99,220	99,244	0.02	
131	100,272	100,219	-0.05	
132	99,410	99,529	0.12	
133	99,942	99,920	-0.02	
134	99,542	99,502	-0.04	
135	100,230	100,254	0.02	
136	100,481	100,471	-0.01	
137	99,962	100,021	0.06	
138	100,562	100,570	0.01	
139	100,091	100,114	0.02	
140	99,425	99,391	-0.03	
141	100,701	100,667	-0.03	
142	99,523	99,549	0.03	
143	99,601	99,576	-0.03	
144	99,241	99,220	-0.02	
145	99,943	99,936	-0.01	
146	100,123	100,129	0.01	

Table 3.3.3 Pre / Post Burn In, Zero Power Resistance Readings, Variant 05 (G100K6D116) @ 25 C

ESA/SCC Detail Spec 4006/013 Variants 01 and 05

Post Burn-In, the Zero Power Resistance values; for ESA/SCC 4006/013 Variants 01 and 05; were again measured and recorded. The pre and post values, with the calculated delta values, are listed in Tables 3.3.4, and 3.3.5. The quantity, dates of test and operator details are shown in the relevant Route Sheets in Appendix K.

It is noted that the delta values shown in Table 3.3.4 (Variant 01) show unit 070 marginally outside the specification limit and a significant number of readings at the upper limit of +0.2%. This issue was investigated and it has been concluded that these readings are the result of a systematic measuring error and not indicative of a device problem. The results of this investigation are detailed in **Appendix P.** A consequence of this systematic measuring error is that the maximum power rating for variant 01, specified at 2.0 mW, requires to be changed to 0.01 mW. It is proposed to update ESA/SCC 4006/013 Iss. 1 Rev. A, in order to take account of this issue.

COMP. NO.	RES. READING (ohms) at + 25°C 991.2 to 1008.8 Pre Burn In	RES. READING (ohms) @+25C 991.2 to 1008.8 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
001	1005.2	1007.1	0.19	
002	996.3	997.8	0.15	
003	994.8	996.0	0.12	
004	993.7	994.9	0.12	
005	996.2	998.2	0.20	
006	997.7	998.7	0.10	
007	1002.4	1004.3	0.19	
008	999.5	1001.5	0.20	
009	999.4	1001.2	0.18	
010	995.7	997.2	0.15	
011	996.7	998.5	0.18	
012	993.8	995.1	0.13	
013	993.2	995.2	0.20	
014	1003.8	1005.8	0.20	
015	1000.6	1002.6	0.20	
016	997.3	999.3	0.20	
017	995.8	997.0	0.12	
018	998.5	1000.3	0.18	
019	996.7	998.5	0.18	
020	998.5	1000.4	0.19	
021	997.9	999.9	0.20	
022	994.3	995.4	0.11	
023	997.9	999.9	0.20	
024	997.3	998.6	0.13	
025	995.4	997.4	0.20	
026	995.9	997.5	0.16	
027	1001.2	1002.7	0.15	
028	997.3	999.3	0.20	
029	999.8	1001.2	0.14	
030	1000.6	1002.4	0.18	
031	1002.5	1004.0	0.15	
032	998.1	999.3	0.12	
033	996.7	998.5	0.18	
034	1000.4	1001.4	0.10	
035	999.7	1000.5	0.08	
036	998.8	1000.1	0.13	
037	1001.6	1003.1	0.15	
038	997.7	999.6	0.19	
039	997.2	998.8	0.19	
040	1002.3	1004.1	0.18	

Table 3.3.4 Pre / Post Burn In, Zero Power Resistance Readings, Variant 01 (1K3A351) @ +25°C

Table 3.3.4 (continued)

COMP. NO.	RES. READING (ohms) at + 25°C 991.2 to 1008.8 Pre Burn In	RES. READING (ohms) @+25C 991.2 to 1008.8 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
041	1001.3	1003.2	0.19	
042	1001.8	1003.5	0.17	
043	995.2	996.7	0.15	
044	994.5	996.4	0.19	
045	997.6	999.3	0.17	
046	995.8	996.5	0.07	
047	996.4	997.6	0.12	
048	999.2	1001.1	0.19	
049	999.6	1001.0	0.14	
050	999.8	1001.8	0.20	
051	1000.1	1000.3	0.02	
052	995.1	996.2	0.11	
053	994.4	996.0	0.16	
054	1002.7	1004.4	0.17	
055	994.0	996.0	0.20	
056	1002.1	1004.0	0.19	
057	1000.5	1000.8	0.03	
058	995.1	996.0	0.09	
059	993.0	994.7	0.17	
060	997.5	999.2	0.17	
061	996.5	998.3	0.18	
062	1000.5	1001.8	0.13	
063	1002.4	1004.3	0.19	
064	995.4	997.4	0.20	
065	1004.0	1005.9	0.19	
066	996.1	997.3	0.12	
067	1000.8	1002.8	0.20	
068	1004.0	1006.0	0.20	
069	1000.8	1002.7	0.19	
070	999.4	997.3	- 0.21	FAIL
071	1001.3	1003.2	0.19	
072	997.6	999.6	0.20	

Table 3.3.4 Pre / Post Burn In, Zero Power Resistance Readings, Variant 01 (1K3A351) @ +25°C

COMP. NO.	RES. READING (ohms) at + 25°C 4956 to 5044 Pre Burn In	RES. READING (ohms) @+25C 4956 to 5044 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
001	4994	4992	-0.04	
002	5008	5006	-0.04	
003	5005	5005	0.00	
004	5001	5000	-0.02	
005	5006	5008	0.04	
006	5016	5020	0.08	
007	5024	5024	0.00	
008	5028	5028	0.00	
009	5009	5010	0.02	
010	5021	5027	0.12	
011	5025	5030	0.10	
012	5015	5016	0.02	
013	5023	5023	0.00	
014	5015	5016	0.02	
015	5023	5021	-0.04	
016	5017	5017	0.00	
017	5026	5025	-0.02	
018	5020	5018	-0.04	
019	5019	5020	0.02	
020	5010	5011	0.02	
021	5029	5029	0.00	
022	5021	5022	0.02	
023	5036	5036	0.00	
024	4994	4994	0.00	
025	5024	5025	0.02	
026	5020	5021	0.02	
027	5014	5019	0.10	
028	5003	5005	0.04	
029	5026	5027	0.02	
030	5011	5013	0.04	
031	5020	5023	0.06	
032	4997	5005	0.16	
033	5015	5016	0.02	
034	5017	5020	0.06	
035	5009	5013	0.08	
036	5014	5022	0.16	
037	5015	5019	0.08	
038	5005	5012	0.14	
039	4994	4997	0.06	
040	5021	5028	0.14	

Table 3.3.5 Pre/Post Burn In, Zero Power Resistance Readings, Variant 05 (5K3A355) @ +25°C

Table 3.3.5 (continued)

COMP. NO.	RES. READING (ohms) at + 25°C 4956 to 5044 Pre Burn In	RES. READING (ohms) @+25C 4956 to 5044 Post Burn In	**Drift ±0.2 %**	Pass/Fail (Indicate failure only)
041	5031	5035	0.08	
042	5003	5009	0.12	
043	5016	5022	0.12	
044	5000	5005	0.10	
045	5026	5032	0.12	
046	5019	5023	0.08	
047	5015	5020	0.10	
048	5013	5023	0.20	
049	5013	5019	0.12	
050	5023	5028	0.10	
051	5016	5021	0.10	
052	4984	4992	0.16	
053	5007	5016	0.18	
054	5004	5010	0.12	
055	5025	5030	0.10	
056	5030	5034	0.08	
057	5018	5024	0.12	
058	5025	5028	0.06	
059	5010	5012	0.04	
060	5012	5017	0.10	
061	5025	5030	0.10	
062	5016	5019	0.06	
063	5024	5029	0.10	
064	5002	5006	0.08	
065	5002	5011	0.18	
066	5016	5019	0.06	
067	5016	5022	0.12	
068	5020	5023	0.06	
069	5014	5019	0.10	
070	5018	5027	0.18	
071	5010	5015	0.10	
072	5014	5009	-0.10	
073	5028	5031	0.06	
074	5015	5021	0.12	

Table 3.3.5 Pre / Post Burn In, Zero Power Resistance Readings, Variant 05 (5K3A355) @ +25°C

3.4 (4006 Para. 9.3.3) Electrical Measurements at High and Low Temperature

The components in all 5 qualification lots (ESA/SCC 4006/013 Variant 01,05 and ESA/SCC 4006/014 Variant 01,04,05)) had the resistance measured at High and Low temperatures and the values recorded
(to Betatherm internal procedure MFG-11-09-00 REC).

The High and Low test temperatures are as detailed in Column 4 of Table 1(a) of the appropriate detail specification. The resistance values, at the specified temperatures, are shown in Tables 3.4.1, 3.4.2, 3.4.3, 3.4.4 and 3.4.5. All measurements were within the limits as specified in the appropriate detail specification, with the exception of Variant G100K6D116, component numbered 170, which exceeded the upper temperature limit at 100°C.

It is noted that Table 3.4.1 shows a significant number of readings at the upper limit of resistance tolerance at 100°C. It is proposed to increase the tolerance of the nominal resistance value at 75°C and 100°C, detailed in Table 1(a), of ESA/SCC 4006/013 Iss.1 Rev. A, in order to take account of these marginal readings.

It is also noted that Table 3.4.3 shows a significant number of readings at the upper limit of resistance tolerance at 100°C and 125°C. It is proposed to marginally alter the thermistor pair selection, described in paragraph 1.4.b of this Qualification Report and specified in the controlled P.I.D., in order to take account of these marginal readings.

The quantity, date of test and operator details are shown in the relevant Route Sheets in Appendix K.

COMP. NO.	RES. READING (ohms) @ – 55°C 92,459 to 99,543	RES. READING (ohms) @ - 40°C 32,793 to 34,351	RES. READING (ohms) @ - 25°C 12,751 to 13,299	RES. READING (ohms) @ 0°C 3,232 to 3,298
001	98,634	34,120	13,068	3,252
002	98,520	34,108	13,072	3,255
003	95,610	33,681	12,995	3,240
004	98,041	33,696	12,972	3,240
005	95,610	33,909	13,013	3,249
006	95,750	34107	13,081	3,258
007	96,600	34,241	13,176	3,283
008	95,623	34186	13,143	3,269
009	95,717	34,334	13,185	3,272
010	94,892	33,890	12,992	3,249
011	93,811	34,012	13,075	3,257
012	94,001	33,612	12,976	3,242
013	95,328	33,526	12,942	3,236
014	96,045	34,266	13,206	3,286
015	94,023	34,106	13,025	3,269
016	94,478	33,968	12,994	3,255
017	94,991	33,745	12,982	3,247
018	94,611	34,025	13,082	3,262
019	95,098	34,258	13,195	3,281
020	94,849	34,004	13,016	3,260
021	95,009	33,969	13,051	3,262
022	95,607	33,764	12,997	3,243
023	94,527	34,067	13,120	3,260
024	94,157	34,074	13,064	3,258
025	93,701	33,632	12,967	3,246
026	93,214	33,861	12,933	3,244
027	95,654	34,177	13,197	3,277
028	94,248	34,314	13,038	3,260
029	94,174	34,179	13,034	3,264
030	95,871	34,334	13,090	3,278
031	93,934	34,270	13,161	3,284
032	93,805	34,345	13,060	3,257
033	94,900	34,240	13,044	3,252
034	94,706	34,072	13,116	3,269
035	94,440	33,794	13,014	3,261
036	93,721	33,831	13,188	3,263
037	96,590	34,350	13,284	3,295
038	95,013	33,604	13,083	3,257
039	93,214	33,770	13,035	3,253
040	96,578	34,308	13,184	3,283

Table 3.4.1 Electrical Measurements at High and Low Temperatures (1K3A351)

Variant 01.

Table 3.4.1 (continued)

COMP. NO.	RES. READING (ohms) @ – 55°C 92,459 to 99,543	RES. READING (ohms) @ - 40°C 32,793 to 34,351	RES. READING (ohms) @ - 25°C 12,751 to 13,299	RES. READING (ohms) @ 0°C 3,232 to 3,298
041	97,341	34,088	13,204	3,277
042	98,671	33,964	13,116	3,274
043	94,277	33,625	13,012	3,248
044	93,604	33,466	12,934	3,242
045	92,881	33,732	13,032	3,259
046	96,721	33,476	12,964	3,244
047	96,043	33,452	12,994	3,248
048	95,111	34,027	13,117	3,268
049	94,721	33,954	13,072	3,266
050	94,281	33,971	13,158	3,267
051	99,241	34,340	13,149	3,270
052	94,110	33,470	12,938	3,240
053	98,004	33,383	12,892	3,238
054	94,200	34,184	13,168	3,283
055	93,170	33,381	12,841	3,237
056	94,280	34,205	13,159	3,281
057	93,106	33,994	13,091	3,266
058	94,001	33,726	12,990	3,245
059	94,207	33,659	12,937	3,239
060	99,120	33,706	13,127	3,262
061	98,380	33,742	13,129	3,264
062	95,100	34,027	13,099	3,269
063	94,070	33,889	13,169	3,277
064	93,200	33,848	13,042	3,251
065	95,771	34,027	13,167	3,238
066	96,700	33,718	13,113	3,261
067	99,500	34,349	13,256	3,288
068	93,271	34,234	13,225	3,288
069	94,206	34,264	13,253	3,280
070	93,071	33,504	12,991	3,246
071	94,291	33,837	13,090	3,266
072	93,601	33,627	13,024	3,253

Table 3.4.1 Electrical Measurements at High and Low Temperatures (1K3A351)

Variant 01

Table 3.4.1 (continued)

COMP. NO.	RES. READING (ohms) @ + 50°C 357.4 to 362.8	RES. READING (ohms) @ + 75°C 147.0 to 149.0	RES. READING (ohms) @ + 100°C 67.46 to 68.26	
001	359.0	147.2	67.80	
002	359.7	148.0	68.00	
003	359.9	148.5	68.25	
004	358.9	147.9	68.00	
005	360.5	148.6	68.20	
006	359.8	148.0	68.10	
007	361.2	148.5	68.10	
008	360.4	148.3	68.10	
009	360.5	148.2	68.26	
010	359.8	148.3	68.25	
011	359.8	148.2	68.00	
012	359.0	147.9	68.00	
013	359.6	148.4	68.20	
014	361.8	148.7	68.10	
015	361.0	148.6	68.20	
016	360.5	148.5	68.20	
017	360.0	148.4	68.20	
018	360.2	148.2	68.20	
019	362.2	149.0	68.26	
020	360.6	148.6	68.26	
021	360.5	148.4	68.10	
022	359.3	148.1	68.10	
023	360.7	148.6	68.25	
024	360.0	148.0	68.10	
025	360.2	148.4	68.25	
026	360.4	148.6	68.26	
027	360.6	148.2	67.90	
028	360.3	148.3	68.20	
029	360.8	148.5	68.20	
030	360.4	148.1	67.90	
031	361.0	148.4	68.26	
032	360.3	148.3	68.20	
033	360.3	148.6	68.20	
034	360.6	148.3	68.10	
035	360.8	148.6	68.26	
036	360.3	148.0	68.00	
037	361.2	148.1	68.00	
038	360.0	148.1	68.20	
039	360.4	148.5	68.26	
040	361.0	148.5	68.10	

Table 3.4.1 Electrical Measurements at High and Low Temperatures (1K3A351)

Variant 01

Table 3.4.1 (continued)

COMP. NO.	RES. READING (ohms) @ + 50°C 357.4 to 362.8	RES. READING (ohms) @ + 75°C 147.0 to 149.0	RES. READING (ohms) @ +100°C 67.46 to 68.26	
041	360.9	148.3	68.00	
042	361.4	148.8	68.25	
043	359.7	148.2	68.24	
044	359.6	148.3	68.20	
045	360.4	148.3	68.10	
046	360.4	148.7	68.25	
047	360.2	148.6	68.26	
048	360.4	148.3	68.10	
049	360.8	148.5	68.20	
050	360.7	148.5	68.10	
051	360.8	148.4	68.10	
052	359.8	148.5	68.20	
053	359.9	148.4	68.26	
054	361.1	148.5	68.10	
055	359.9	148.7	68.26	
056	360.8	148.3	68.00	
057	360.8	148.6	68.10	
058	359.3	148.0	68.10	
059	359.0	147.8	68.10	
060	360.6	148.5	68.10	
061	360.4	148.2	68.10	
062	360.6	148.4	68.10	
063	361.8	148.8	68.26	
064	359.3	147.9	67.90	
065	362.3	149.0	68.26	
066	360.1	148.2	68.00	
067	361.0	148.3	67.95	
068	362.1	148.8	68.20	
069	360.5	148.1	68.00	
070	360.0	148.5	68.26	
071	361.3	148.8	68.20	
072	361.0	148.9	68.25	

Table 3.4.1 Electrical Measurements at High and Low Temperatures (1K3A351)

Variant 01

COMP. NO.	RES. READING (ohms) @ - 55°C 462,295 to 497,719	RES. READING (ohms) @ - 40°C 163,968 to 171,756	RES. READING (ohms) @ - 25°C 63,759 to 66,495	RES. READING (ohms) @ 0°C 16,159 to 16,492
001	481,324	167,900	64,939	16,316
002	484,583	167,500	65,040	16,367
003	484,261	166,900	65,733	16,369
004	485,782	167,700	65,571	16,357
005	482,975	167,300	64,836	16,366
006	490,235	169,280	65,630	16,449
007	488,653	168,600	65,379	16,453
008	485,432	167,900	65,365	16,444
009	484,970	166,900	65,469	16,374
010	486,430	168,500	65,250	16,476
011	483,520	167,700	66,110	16,460
012	481,260	167,400	66,010	16,402
013	485,460	169,300	65,820	16,468
014	480,110	166,800	65,940	16,396
015	484,750	168,400	65,810	16,444
016	485,970	168,800	64,480	16,427
017	483,230	168,150	66,430	16,430
018	483,630	168,400	64,725	16,395
019	483,600	167,500	65,775	16,429
020	483,790	167,360	65,632	16,387
021	487,560	169,200	65,890	16,466
022	484,290	169,800	64,490	16,454
023	483,750	168,350	66,350	16,475
024	481,350	166,560	64,910	16,327
025	485,630	168,200	65,390	16,451
026	483,230	167,700	65,880	16,446
027	484,200	167,450	65,810	16,398
028	481,200	166,200	65,390	16,359
029	482,680	170,150	65,350	16,462
030	480,390	167,100	65,740	16,388
031	487,330	168,300	64,340	16,437
032	478,200	169,400	65,090	16,340
033	478,120	169,300	65,760	16,388
034	484,970	169,200	66,090	16,442
035	479,400	168,250	65,320	16,372
036	487,150	169,200	65,490	16,432
037	480,950	167,400	65,720	16,394
038	479,800	167,700	65,520	16,359
039	477,900	167,150	66,020	16,313
040	484,300	170,250	65,990	16,447

Table 3.4.2 Electrical Measurements at High and Low Temperatures (5K3A355) Variant 05.

Table 3.4.2 (continued)

COMP. NO.	RES. READING (ohms) @ - 55°C 462,295 to 497,719	RES. READING (ohms) @ -40°C 163,968 to 171,756	RES. READING (ohms) @ - 25°C 63,759 to 66,495	RES. READING (ohms) @ 0° C 16,159 to 16,492
041	485,600	169,906	65,940	16,452
042	480,950	166,900	65,540	16,353
043	480,700	168,600	65,390	16,394
044	479,600	167,150	65,330	16,348
045	486,770	170,400	65,920	16,472
046	479,400	167,200	64,630	16,408
047	484,100	169,700	64,630	16,401
048	484,650	167,400	65,720	16,415
049	485,630	169,600	65,830	16,420
050	484,600	168,400	65,710	16,430
051	480,460	169,600	65,720	16,387
052	474,400	165,700	65,060	16,301
053	483,110	168,300	65,680	16,400
054	488,670	167,750	65,250	16,351
055	483,560	169,900	65,750	16,452
056	484,850	168,300	65,830	16,453
057	484,480	171,401	65,720	16,427
058	485,900	169,904	65,800	16,449
059	481,260	168,300	64,720	16,366
060	484,570	168,010	65,820	16,416
061	486,590	168,150	66,010	16,444
062	486,900	169,600	65,610	16,406
063	480,490	167,500	64,830	16,410
064	479,440	167,370	64,180	16,331
065	480,900	167,390	64,370	16,355
066	485,710	170,010	65,860	16,411
067	484,900	168,900	65,880	16,422
068	480,970	169,100	65,600	16,389
069	481,200	168,700	65,410	16,383
070	482,850	169,300	66,100	16,418
071	481,800	168,300	65,560	16,368
072	481,300	167,100	65,490	16,350
073	484,800	169,300	65,900	16,432
074	479,900	166,345	65,860	16,385

Table 3.4.2 Electrical Measurements at High and Low Temperatures (5K3A355)

Variant 05

Table 3.4.2 (continued)

COMP. NO.	RES. READING (ohms) @ + 50°C 1787 to 1814	RES. READING (ohms) @ + 75°C 735.2 to 744.9	RES. READING (ohms) @ + 100°C 337.3 to 341.3	RES. READING (ohms) @ + 115°C 219.2 to 225.3
001	1,800	740.0	338.7	222.1
002	1,805	741.7	339.5	222.6
003	1,804	741.4	339.2	222.4
004	1,802	740.4	338.8	222.1
005	1,806	742.3	340.0	222.9
006	1,806	740.8	338.9	221.9
007	1,809	742.4	339.5	222.4
008	1,811	744.0	340.5	223.3
009	1,806	742.1	339.8	222.8
010	1,808	741.4	338.7	221.8
011	1,811	743.7	340.2	222.9
012	1,807	742.4	339.8	222.7
013	1,807	741.2	338.8	222.0
014	1,807	743.0	340.1	223.0
015	1,807	741.7	339.1	222.2
016	1,806	741.4	339.2	222.3
017	1,810	744.0	340.6	223.2
018	1,809	743.6	340.6	223.3
019	1,808	742.6	339.6	222.6
020	1,806	741.8	339.6	222.6
021	1,810	742.6	339.6	222.3
022	1,806	740.9	338.7	221.9
023	1,813	744.7	340.8	223.3
024	1,796	739.7	338.5	221.8
025	1,809	742.7	339.6	222.6
026	1,806	740.8	338.6	221.8
027	1,805	741.0	338.9	222.3
028	1,803	740.8	339.1	222.3
029	1,809	742.6	339.6	222.5
030	1,806	742.1	339.5	222.4
031	1,808	742.7	339.7	222.7
032	1,794	738.5	337.7	221.1
033	1,807	743.0	340.2	223.0
034	1,806	741.3	338.8	222.0
035	1,804	741.6	339.1	222.5
036	1,805	741.1	338.8	220.0
037	1,807	742.0	339.5	222.6
038	1,805	742.0	339.6	222.6
039	1,795	739.8	338.6	222.0
040	1,808	742.0	339.3	222.4

Table 3.4.2 Electrical Measurements at High and Low Temperatures (5K3A355)

Variant 05

Table 3.4.2 (continued)

COMP. NO.	RES. READING (ohms) @ + 50°C 1787 to 1814	RES. READING (ohms) @ + 75°C 735.2 to 744.9	RES. READING (ohms) @ + 100°C 337.3 to 341.3	RES. READING (ohms) @ + 115°C 219.2 to 225.3
041	1,812	744.2	340.4	223.2
042	1,804	741.4	339.3	222.6
043	1,808	743.5	340.2	223.2
044	1,801	740.5	338.8	222.2
045	1,808	741.9	339.0	222.3
046	1,808	743.1	340.0	223.0
047	1,807	742.5	339.7	222.7
048	1,807	742.3	339.7	222.7
049	1,805	741.1	338.9	222.1
050	1,809	743.3	339.8	222.8
051	1,807	742.2	339.8	222.9
052	1,794	738.6	338.0	221.6
053	1,804	740.9	338.7	222.0
054	1,804	742.1	339.7	222.7
055	1,809	742.6	339.8	222.7
056	1,811	743.8	340.2	222.9
057	1,807	742.0	339.3	222.4
058	1,809	742.5	339.5	222.4
059	1,805	741.8	339.5	222.5
060	1,803	740.3	338.5	221.8
061	1,808	742.4	339.5	221.9
062	1,804	740.8	338.8	221.9
063	1,810	743.8	340.2	223.0
064	1,802	740.8	339.0	222.2
065	1,802	741.0	339.0	222.3
066	1,804	740.6	340.6	221.7
067	1,805	741.0	338.7	221.8
068	1,808	743.2	340.2	223.0
069	1,807	742.5	339.8	222.8
070	1,808	742.6	339.8	222.5
071	1,805	741.7	339.3	222.4
072	1,803	740.9	339.6	222.1
073	1,810	743.4	340.0	222.7
074	1,807	742.9	340.0	222.7

Table 3.4.2 Electrical Measurements at High and Low Temperatures (5K3A355)

Variant 05

COMP. NO.	RES. READING (ohms) @ - 40°C 42,164 to 44,682	RES. READING (ohms) @ - 20°C 14,291 to 15,035	RES. READING (ohms) @ + 0°C 5.561 to 5,739	RES. READING (ohms) @ + 50° C 805.2 to 824.3
001	43,580	14,645	5,673	815.5
002	43,740	14,656	5,680	817.2
003	42,330	14,654	5,678	816.0
004	43,080	14,675	5,688	817.5
005	43,480	14,751	5,710	819.8
006	42,850	14,628	5,677	818.4
007	42,990	14,596	5,721	815.7
008	42,220	14,609	5,671	817.0
009	43,510	14,765	5,718	821.0
010	43,020	14,757	5,717	821.4
011	43,460	14,738	5,712	822.3
012	42,468	14,727	5,706	820.9
013	43,540	14,704	5,696	819.3
014	42,766	14,644	5,670	814.7
015	43,330	14,612	5,665	815.8
016	43,650	14,675	5,688	818.6
017	42,180	14,715	5,704	821.2
018	42,880	14,607	5,669	816.5
019	42,220	14,613	5,671	816.0
020	42,995	14,616	5,692	818.2
021	42,520	14,585	5,664	816.3
022	42,655	14,633	5,671	815.1
023	43,135	14,772	5,718	820.8
024	42,595	14,628	5,672	816.9
025	42,832	14,620	5,670	816.8
026	42,705	14,634	5,673	816.2
027	43,237	14,713	5,706	821.7
028	44,270	14,721	5,704	819.8
029	42,715	14,645	5,674	815.9
030	43,730	14,678	5,685	816.2
031	43,280	14,711	5,698	819.7
032	43,225	14,716	5,702	820.0
033	42,770	14,609	5,650	814.4
034	42,530	14,563	5,653	815.1
035	42,710	14,587	5,657	814.6
036	42,995	14,690	5,696	820.0
037	43,668	14,778	5,725	822.6
038	42,885	14,654	5,675	815.7
039	42,825	14,606	5,667	816.7
040	42,805	14,602	5,664	815.5

Table 3.4.3 Electrical Measurements at High and Low Temperatures (G2K7D110) Variant 01.

Table 3.4.3 (continued)

COMP. NO.	RES. READING (ohms) @ - 40°C 42,164 to 44,682	RES. READING (ohms) @ - 20°C 14,291 to 15,035	RES. READING (ohms) @ + 0°C 5.561 to 5,739	RES. READING (ohms) @ + 50°C 805.2 to 824.3
041	43,095	14,754	5,720	823.1
042	43,415	14,751	5,714	821.3
043	42,555	14,637	5,679	818.0
044	43,310	14,714	5,694	816.5
045	43,060	14,702	5,706	821.0
046	42,890	14,638	5,676	817.5
047	43,175	14,662	5,686	818.3
048	43,175	14,690	5,695	819.3
049	42,985	14,605	5,666	817.2
050	43,090	14,602	5,666	815.9
051	42,555	14,617	5,668	816.4
052	43,285	14,680	5,684	816.8
053	42,850	14,589	5,656	814.4
054	43,250	14,760	5,719	821.8
055	42,875	14,602	5,664	815.9
056	43,075	14,702	5,706	821.3
057	42,955	14,620	5,667	816.0
058	43,123	14,759	5,719	822.6
059	42,920	14,592	5,657	814.7
060	42,745	14,563	5,645	813.0
061	43,145	14,626	5,671	815.7
062	42,925	14,583	5,653	813.9
063	42,895	14,578	5,652	813.9
064	42,895	14,615	5,672	816.4
065	43,005	14,582	5,662	815.3
066	43,065	14,670	5,678	816.5
067	43,035	14,601	5,664	815.0
068	43,100	14,596	5,659	816.0
069	42,845	14,596	5,664	815.9
070	42,925	14,607	5,665	815.0
071	43,295	14,640	5,678	817.2
072	42,930	14,618	5,664	814.6

Table 3.4.3 Electrical Measurements at High and Low Temperatures (G2K7D110) Variant 01.

Table 3.4.3 (continued)

COMP. NO.	RES. READING (ohms) @ + 70°C 427.5 to 436.5	RES. READING (ohms) @ + 100° C 185.6 to 189.0	RES. READING (ohms) @ + 125°C 100.8 to 103.2	
001	432.8	187.9	101.5	
002	433.7	187.8	103.2	
003	433.2	187.8	102.2	
004	434.2	188.2	101.9	
005	435.4	188.5	103.2	
006	434.8	188.6	103.2	
007	433.2	187.9	102.8	
008	434.2	188.0	101.3	
009	435.4	188.6	103.0	
010	436.0	189.0	101.7	
011	436.3	188.9	101.4	
012	435.6	189.0	103.0	
013	434.9	188.6	103.2	
014	432.7	187.6	102.4	
015	433.4	188.0	101.3	
016	434.7	188.4	103.2	
017	436.0	189.0	103.0	
018	433.7	188.0	103.1	
019	433.7	187.7	101.2	
020	432.8	187.9	102.2	
021	433.9	188.0	101.9	
022	432.9	187.7	103.0	
023	435.5	188.7	103.0	
024	433.9	188.3	103.0	
025	433.8	188.4	101.4	
026	433.9	187.8	102.7	
027	435.4	189.0	102.9	
028	435.3	188.6	100.7	
029	433.4	187.9	103.0	
030	433.5	187.4	103.0	
031	434.9	188.6	103.0	
032	435.1	188.7	103.0	
033	432.5	187.4	100.9	
034	433.2	187.8	102.9	
035	432.5	187.7	102.2	
036	435.6	188.8	103.0	
037	436.5	189.0	101.2	
038	433.4	187.6	102.8	
039	433.5	188.0	103.0	
040	432.8	187.7	103.0	

Table 3.4.3 Electrical Measurements at High and Low Temperatures (G2K7D110)

Variant 01

Table 3.4.3 (continued)

COMP. NO.	RES. READING (ohms) @ + 70°C 427.5 to 436.5	RES. READING (ohms) @ + 100°C 185.6 to 189.0	RES. READING (ohms) @ + 125°C 100.8 to 103.2	
041	436.5	189.0	103.0	
042	436.2	189.0	103.0	
043	434.5	188.3	103.0	
044	433.0	187.4	103.0	
045	436.2	188.9	103.0	
046	434.2	188.3	103.0	
047	434.4	188.5	101.5	
048	434.8	188.7	103.0	
049	434.5	188.3	102.4	
050	433.3	187.8	101.7	
051	433.2	187.9	102.8	
052	434.4	187.9	102.6	
053	432.7	187.9	100.8	
054	436.1	189.0	103.0	
055	434.5	187.9	102.6	
056	435.8	189.0	102.5	
057	433.1	187.9	102.4	
058	436.5	189.0	103.0	
059	433.0	187.7	102.7	
060	432.1	187.3	102.1	
061	433.4	187.9	101.7	
062	432.6	187.4	100.9	
063	434.0	187.5	103.0	
064	434.3	188.3	101.0	
065	433.2	187.8	103.0	
066	434.2	188.1	101.4	
067	432.8	187.8	103.0	
068	433.2	187.9	103.0	
069	433.5	187.9	102.7	
070	432.8	187.6	103.0	
071	433.7	188.0	103.0	
072	432.8	187.6	101.5	

Table 3.4.3 Electrical Measurements at High and Low Temperatures (G2K7D110)

Variant 01

COMP. NO.	RES. READING (ohms) @ 0°C 43,518 to 44,952	RES. READING (ohms) @ + 50°C 5,768 to 5,913	RES. READING (ohms) @ + 70°C 2,952 to 3,018	RES. READING (ohms) @ + 100°C 1,214 to 1,237
001	44,285	5,809	2,958	1,223
002	44,115	5,789	2,993	1,218
003	44,510	5,825	2,974	1,223
004	43,635	5,802	2,958	1,220
005	44,472	5,819	2,972	1,222
006	44,356	5,822	2,972	1,225
007	44,270	5,806	2,967	1,221
008	43,730	5,794	2,962	1,221
009	44,194	5,809	2,967	1,222
010	44,416	5,828	2,975	1,223
011	44,285	5,806	2,967	1,220
012	44,455	5,814	2,971	1,221
013	44,526	5,827	2,970	1,224
014	44,200	5,813	2,967	1,221
015	44,288	5,814	2,969	1,223
016	44,427	5,831	2,979	1,226
017	44,254	5,804	2,964	1,219
018	44,495	5,816	2,965	1,219
019	44,443	5,816	2,966	1,220
020	44,518	5,830	2,981	1,225
021	44,391	5,827	2,978	1,226
022	44,383	5,834	2,978	1,226
023	44,450	5,821	2,969	1,221
024	44,010	5,827	2,975	1,225
025	44,250	5,825	2,972	1,223
026	44,385	5,820	2,967	1,220
027	44,320	5,820	2,967	1,222
028	44,356	5,822	2,973	1,224
029	44,395	5,837	2,976	1,224
030	44,323	5,811	2,970	1,222
031	44,505	5,828	2,973	1,222
032	44,357	5,817	2,971	1,223
033	44,390	5,822	2,970	1,223
034	44,520	5,829	2,974	1,227
035	44,273	5,826	2,973	1,223
036	44,065	5,816	2,977	1,223
037	44,464	5,824	2,976	1,224
038	44,508	5,826	2,979	1,223
039	44,254	5,806	2,972	1,222
040	44,233	5,827	2,982	1,228
041	44,458	5,837	2,979	1,228
042	44,398	5,822	2,976	1,225
043	44,426	5,831	2,973	1,224

Table 3.4.4 Electrical Measurements at High and Low Temperatures

(G15K4D112) Variant 04

Table 3.4.4 (continued)

COMP. NO.	RES. READING (ohms) @ 0°C 43,518 to 44,952	RES. READING (ohms) @ + 50°C 5,768 to 5,913	RES. READING (ohms) @ + 70°C 2,952 to 3,018	RES. READING (ohms) @ + 100°C 1,214 to 1,237
044	44,342	5,834	2,979	1,228
045	44,085	5,826	2,980	1,223
046	44,490	5,823	2,973	1,222
047	44,420	5,819	2,972	1,222
048	44,448	5,821	3,006	1,222
049	44,213	5,828	2,970	1,226
050	44,444	5,839	2,986	1,227
051	44,254	5,814	2,969	1,220
052	44,264	5,814	2,980	1,222
053	44,731	5,856	2,988	1,229
054	44,095	5,810	2,966	1,223
055	44,405	5,810	2,963	1,220
056	44,205	5,806	2,974	1,221
057	44,538	5,828	2,977	1,224
058	44,198	5,797	2,959	1,219
059	44,436	5,828	2,996	1,225
060	44,322	5,828	2,983	1,228
061	44,375	5,823	2,973	1,223
062	44,540	5,835	2,980	1,226
063	44,339	5,808	2,964	1,219
064	44,271	5,820	2,971	1,221
065	44,430	5,818	2,969	1,221
066	44,374	5,813	2,970	1,221
067	44,402	5,823	2,976	1,224
068	44,430	5,814	2,969	1,221
069	44,352	5,812	2,972	1,223
070	44,435	5,823	2,975	1,224
071	44,510	5,843	2,979	1,226
072	44,325	5,822	2,974	1,226
073	44,314	5,813	2,981	1,224
074	44,280	5,819	2,979	1,223
075	44,386	5,817	2,970	1,222
076	44,367	5,810	2,962	1,224
077	44,287	5,813	2,972	1,224
078	44,155	5,814	2,967	1,221
079	44,155	5,822	2,978	1,224
080	44,377	5,825	2,987	1,228
081	44,396	5,813	2,969	1,221
082	44,397	5,810	2,980	1,224
083	44,225	5,784	2,952	1,214
084	44,346	5,810	2,971	1,221
085	44,452	5,819	2,970	1,223
086	44,450	5,818	2,969	1,222

Table 3.4.4 Electrical Measurements at High and Low Temperatures

(G15K4D112) Variant 04

Table 3.4.4 (continued)

COMP. NO.	RES. READING (ohms) @ + 125°C 630.8 to 646.6	RES. READING (ohms) @ + 140°C 441.7 to 452.0	RES. READING (ohms) @ + 160°C 284.3 to 290.3	
001	642.9	450.6	288.4	
002	639.9	448.3	287.3	
003	643.1	449.1	287.1	
004	640.2	448.7	286.8	
005	642.0	450.4	287.3	
006	644.6	450.2	289.4	
007	642.7	450.3	287.8	
008	641.7	450.4	287.9	
009	641.7	449.2	288.0	
010	642.8	450.2	288.7	
011	641.9	449.0	287.8	
012	640.3	451.1	288.2	
013	643.3	451.1	288.0	
014	641.7	449.3	288.6	
015	641.8	450.0	288.9	
016	645.8	451.6	288.4	
017	640.3	448.1	287.3	
018	638.7	447.3	286.4	
019	640.8	447.2	286.7	
020	644.2	451.9	288.9	
021	644.8	451.6	288.4	
022	644.7	451.1	290.2	
023	640.7	448.6	287.1	
024	642.3	451.4	289.4	
025	644.3	449.2	288.5	
026	640.7	447.6	287.1	
027	640.5	450.3	288.1	
028	643.6	450.3	288.5	
029	644.1	451.1	288.7	
030	641.7	450.8	287.5	
031	640.3	449.8	287.2	
032	641.8	449.9	287.0	
033	640.2	449.4	288.3	
034	642.9	450.6	287.8	
035	641.6	449.7	288.8	
036	643.5	450.2	289.1	
037	644.1	449.5	289.6	
038	643.3	449.0	287.8	
039	641.9	450.1	287.9	
040	644.8	451.4	289.0	
041	644.8	450.4	289.3	
042	643.2	450.9	288.5	
043	642.3	450.6	288.5	

Table 3.4.4 Electrical Measurements at High and Low Temperatures

(G15K4D112) Variant 04

Table 3.4.4 (continued)

COMP. NO.	RES. READING (ohms) @ -+ 125°C 630.8 to 646.6	RES. READING (ohms) @ + 140°C 441.7 to 452.0	RES. READING (ohms) @ + 160°C 284.3 to 290.3	
044	645.1	451.0	290.1	
045	641.8	448.4	289.8	
046	642.0	450.0	288.8	
047	641.4	450.3	288.0	
048	641.4	449.0	289.0	
049	644.3	450.9	289.0	
050	643.2	451.1	289.9	
051	640.4	447.8	286.8	
052	641.7	449.8	287.8	
053	645.7	450.7	289.3	
054	641.4	448.8	287.3	
055	639.2	447.9	286.6	
056	641.4	450.0	287.3	
057	642.6	449.8	287.5	
058	641.4	449.2	286.8	
059	643.3	451.5	288.3	
060	645.9	451.5	289.6	
061	642.3	449.6	288.7	
062	644.0	451.3	289.4	
063	641.0	448.8	288.3	
064	641.1	448.7	287.1	
065	641.7	448.6	287.2	
066	641.3	448.3	289.1	
067	643.3	449.5	288.4	
068	642.2	449.5	286.4	
069	642.5	451.4	289.0	
070	642.7	449.8	287.4	
071	642.4	450.9	288.0	
072	643.9	451.1	289.4	
073	643.1	450.4	287.7	
074	642.1	450.5	287.5	
075	642.5	450.2	288.4	
076	642.1	448.6	287.2	
077	643.6	450.9	287.4	
078	640.9	450.3	287.1	
079	643.5	449.6	288.4	
080	643.1	451.0	289.2	
081	640.9	448.8	287.9	
082	639.7	447.6	287.5	
083	637.3	446.3	284.8	
084	641.5	450.2	288.6	
085	642.2	449.9	287.6	
086	642.1	450.1	287.9	

Table 3.4.4 Electrical Measurements at High and Low Temperatures

(G15K4D112) Variant 04

COMP. NO.	RES. READING (ohms) @ + 100°C 5,511 to 5,635	RES. READING (ohms) @ + 125°C 2,603 to 2,678	RES. READING (ohms) @ + 140°C 1,731 to 1,777	RES. READING (ohms) @ + 160°C 1,046 to 1,072
001	5,579	2,650	1,759	1,059
002	5,568	2,655	1,757	1,060
003	5,551	2,644	1,755	1,055
004	5,544	2,636	1,749	1,053
005	5,590	2,657	1,757	1,059
006	5,578	2,661	1,762	1,062
007	5,611	2,678	1,773	1,069
008	5,585	2,656	1,764	1,060
009	5,556	2,642	1,753	1,055
010	5,570	2,650	1,757	1,061
011	5,594	2,663	1,766	1,063
012	5,550	2,637	1,742	1,047
013	5,539	2,626	1,746	1,048
014	5,577	2,645	1,754	1,054
015	5,555	2,642	1,750	1,052
016	5,554	2,642	1,751	1,051
017	5,554	2,637	1,750	1,053
018	5,553	2,643	1,751	1,055
019	5,576	2,642	1,753	1,055
020	5,606	2,659	1,767	1,064
021	5,584	2,654	1,759	1,061
022	5,546	2,634	1,752	1,052
023	5,540	2639	1,751	1,054
024	5,568	2,654	1,758	1,062
025	5,585	2,656	1,761	1,055
026	5,587	2,661	1,757	1,063
027	5,590	2,663	1,769	1,065
028	5,585	2,654	1,759	1,063
029	5,585	2,657	1,765	1,060
030	5,537	2,633	1,752	1,055
031	5,551	2,641	1,757	1,057
032	5,598	2,666	1,767	1,064
033	5,572	2,653	1,762	1,059
034	5,538	2,635	1,748	1,050
035	5,548	2,639	1,747	1,048
036	5,549	2,643	1,756	1,054
037	5,576	2,650	1,758	1,058
038	5,595	2,668	1,765	1,066
039	5,576	2,652	1,755	1,056
040	5,610	2,673	1,771	1,067

Table 3.4.5 Electrical Measurements at High and Low Temperatures (G100K6D116) Variant 05).

Table 3.4.5 (continued)

COMP. NO.	RES. READING (ohms) @ -+ 100°C 5,511 to 5,635	RES. READING (ohms) @ + 125°C 2,603 to 2,678	RES. READING (ohms) @ + 140°C 1,731 to 1,777	RES. READING (ohms) @ + 160°C 1,046 to 1,072
041	5,541	2,633	1,742	1,052
042	5,560	2,646	1,753	1,054
043	5,592	2,665	1,759	1,063
044	5,589	2,658	1,759	1,058
045	5,549	2,644	1,749	1,058
046	5,583	2,659	1,759	1,060
047	5,582	2,652	1,755	1,058
048	5,543	2,636	1,746	1,052
049	5,537	2,634	1,737	1,046
050	5,566	2,643	1,753	1,056
051	5,609	2,668	1,765	1,066
052	5,561	2,645	1,752	1,055
053	5,600	2,667	1,758	1,062
054	5,585	2,651	1,757	1,058
055	5,609	2,674	1,769	1,063
056	5,579	2,661	1,759	1,063
057	5,596	2,660	1,762	1,065
058	5,540	2,633	1,745	1,048
059	5,599	2,664	1,765	1,063
060	5,554	2,645	1,751	1,053
061	5,596	2,667	1,766	1,068
062	5,532	2,632	1,743	1,050
063	5,548	2,638	1,750	1,049
064	5,560	2,645	1,755	1,053
065	5,572	2,653	1,753	1,060
066	5,606	2,667	1,766	1,062
067	5,555	2,644	1,746	1,052
068	5,571	2,650	1,750	1,057
069	5,557	2,644	1,748	1,051
070	5,532	2,633	1,736	1,054
071	5,581	2,659	1,763	1,057
072	5,536	2,636	1,746	1,051
073	5,564	2,644	1,749	1,052
074	5,543	2,636	1,746	1,048
075	5,595	2,664	1,761	1,065
076	5,547	2,639	1,744	1,051
077	5,602	2,665	1,767	1,063
078	5,586	2,655	1,755	1,060
079	5,606	2,670	1,765	1,068
080	Not Included	Not Included	Not Included-	Not Included

Table 3.4.5 Electrical Measurements at High and Low Temperatures

(G100K6D116) Variant 05).

Table 3.4.5 (continued)

COMP. NO.	RES. READING (ohms) @ -+ 100°C 5,511 to 5,635	RES. READING (ohms) @ + 125°C 2,603 to 2,678	RES. READING (ohms) @ + 140°C 1,731 to 1,777	RES. READING (ohms) @ + 160°C 1,046 to 1,072
081	5,571	2,650	1,758	1,055
082	5,570	2,635	1,755	1,061
083	5,542	2,640	1,741	1,050
084	5,600	2,656	1,759	1,059
085	5,538	2,633	1,739	1,055
086	5,593	2,665	1,765	1,065
087	5,567	2,652	1,750	1,058
088	5,555	2,649	1,751	1,056
089	5,583	2,655	1,754	1,062
090	5,600	2,664	1,763	1,064
091	5,540	2,631	1,742	1,052
092	5,562	2,651	1,756	1,056
093	5,554	2,641	1,745	1,048
094	5,555	2,640	1,749	1,049
095	5,605	2,673	1,768	1,064
096	5,571	2,648	1,753	1,058
097	5,556	2,663	1,759	1,062
098	5,572	2,650	1,753	1,053
099	5,611	2,674	1,774	1,064
100	5,607	2,674	1,773	1,066
101	5,554	2,642	1,772	1,052
102	5,595	2,665	1,758	1,062
103	5,600	2,661	1,760	1,060
104	5,570	2,654	1,757	1,057
105	5,544	2,636	1,748	1,055
106	5,609	2,678	1,765	1,066
107	5,642 (FAIL)	2,681 (FAIL)	1,790 (FAIL)	1,076 (FAIL)-
108	5,543	2,635	1,739	1,066
109	5,608	2,671	1,768	1,067
110	5,608	2,669	1,772	1,069
111	5,588	2,660	1,756	1,062
112	5,591	2,656	1,758	1,062
113	5,587	2,661	1,765	1,061
114	5,562	2,648	1,749	1,059
115	5,562	2,652	1,755	1,060
116	5,568	2,647	1,749	1,056
117	5,538	2,637	1,741	1,050
118	5,535	2,629	1,739	1,051
119	5,609	2,670	1,766	1,063
120	5,563	2,646	1,748	1,057

Table 3.4.5 Electrical Measurements at High and Low Temperatures

(G100K6D116) Variant 05)

Table 3.4.5 (continued)

COMP. NO.	RES. READING (ohms) @ -+ 100°C 5,511 to 5,635	RES. READING (ohms) @ + 125°C 2,603 to 2,678	RES. READING (ohms) @ + 140°C 1,731 to 1,777	RES. READING (ohms) @ + 160°C 1,046 to 1,072
121	5,608	2,672	1,762	1,067
122	5,590	2,661	1,758	1,060
123	5,600	2,663	1,769	1,069
124	5,601	2,665	1,768	1,067
125	5,610	2,671	1,770	1,066
126	5,578	2,660	1,756	1,053
127	5,554	2,639	1,743	1,059
128	5,599	2,661	1,758	1,059
129	Not Included	Not Included	Not Included-	Not Included
130	5,610	2,666	1,757	1,072
131	5,607	2,646	1,770	1,053
132	5,561	2,648	1,755	1,072
133	5,556	2,648	1,744	1,052
134	5,544	2,640	1,744	1,049
135	5,557	2,639	1,749	1,052
136	5,598	2,662	1,762	1,061
137	5,570	2,651	1,755	1,057
138	5,634	2,668	1,762	1,062
139	5,575	2,654	1,758	1,058
140	5,580	2,641	1,740	1,048
141	5,605	2,663	1,768	1,066
142	5,539	2,634	1,747	1,050
143	5,562	2,633	1,743	1,052
144	5,559	2,648	1,753	1,058
145	5,571	2,653	1,753	1,055
146	5,585	2,655	1,760	1,060

Table 3.4.5 Electrical Measurements at High and Low Temperatures

(G100K6D116) Variant 05)

As agreed with ESTEC the Temperature Coefficient, specified in Table 3 of both detail specifications (ESA/SCC 4006/013 Iss. 1 Rev. A and ESA/SCC 4006/014 Iss. 1 Rev. B), was not measured, as the test This measurement does not add any value due to the non-linearity of the temperature-resistance curve. It is proposed to update ESA/SCC 4006/013 Iss.1 Rev. A and ESA/SCC 4006/014 Iss.1 Rev. B, in order to take account of this fact.

3.5 Electrical Measurements at Room Temperature

The electrical measurements were carried out as detailed by ESA/SCC Generic Specification 4006 and ESA/SCC Detail Specification 4006/013 and 4006/014. The following tests do not apply.

- Dissipation Constant Testing (reasons for exclusion described in paragraph 2.5 to this Qualification Report.
- Thermal Time Constant Testing – Note 3 to Table 2 of each of the detail specifications state that Thermal Time Constant Testing is performed on 10 samples during Chart II only.

3.5.1 ESA/SCC Detail Specification 4006/013 Variant 01 & 05

The devices were tested to the following criteria:

- Zero power resistance at 25^{O}C Data is shown in Tables 3.5.1.A and 3.5.1.B. Note that, as per the requirements of Note 1 to Chart III of ESA/SCC 4006, the measurements of parameters for the purposes of drift value measurements need not be repeated for electrical measurements at room temperature. Accordingly, the data of Tables 3.5.1.A and 3.5.1.B is identical to the pre-Burn – In zero power resistance readings shown in Tables 2.5.1.A and 2.5.1.B.

- Insulation resistance Data in Tables 3.5.1.C and 3.5.1.D. As more than twenty devices were to be measured, the requirements of Note 2 to Table 2 of 4006/013 is applicable – Test shall be performed on a sample basis – Level II, Table 2, AQL = 1.0 of MIL-STD-105. All measurements were within the limits as specified in the appropriate detail specification.

The quantity, date of test and operator details are shown in the relevant Route Sheets in Appendix K.

COMP. NO.	RES. READING (ohms) at + 25°C 991.2 to 1008.8 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at +25 °C 991.2 to 1008.8 ohms	Pass/Fail (Indicate failure only)
001	1005.2		041	1001.3	
002	996.3		042	1001.8	
003	994.8		043	995.2	
004	993.7		044	994.5	
005	996.2		045	997.6	
006	997.7		046	995.8	
007	1002.4		047	996.4	
008	999.5		048	999.2	
009	999.4		049	999.6	
010	995.7		050	999.8	
011	996.7		051	1000.1	
012	993.8		052	995.1	
013	993.2		053	994.4	
014	1003.8		054	1002.7	
015	1000.6		055	994.0	
016	997.3		056	1002.1	
017	995.8		057	1000.5	
018	998.5		058	995.1	
019	996.7		059	993.0	
020	998.5		060	997.5	
021	997.9		061	996.5	
022	994.3		062	1000.5	
023	997.9		063	1002.4	
024	997.3		064	995.4	
025	995.4		065	1004.0	
026	995.9		066	996.1	
027	1001.2		067	1000.8	
028	997.3		068	1004.0	
029	999.8		069	1000.8	
030	1000.6		070	999.4	
031	1002.5		071	1000.3	
032	998.1		072	997.6	
033	996.7				
034	1000.4				
035	999.7				
036	998.8				
037	1001.6				
038	997.7				
039	997.2				
040	1002.3				

Table 3.5.1.A Zero Power Resistance Readings for Variant 01 (1K3A351) @ +25°C

COMP. NO.	RES. READING (ohms) at + 25°C 4956 to 5044 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at +25 °C 4956 to 5044 ohms	Pass/Fail (Indicate failure only)
001	4994		041	5031	
002	5008		042	5003	
003	5005		043	5016	
004	5001		044	5000	
005	5006		045	5026	
006	5016		046	5019	
007	5024		047	5015	
008	5028		048	5013	
009	5009		049	5013	
010	5021		050	5023	
011	5025		051	5016	
012	5015		052	4984	
013	5023		053	5007	
014	5015		054	5004	
015	5023		055	5025	
016	5017		056	5030	
017	5026		057	5018	
018	5020		058	5025	
019	5019		059	5010	
020	5010		060	5012	
021	5029		061	5025	
022	5021		062	5016	
023	5036		063	5024	
024	4994		064	5002	
025	5024		065	5002	
026	5020		066	5016	
027	5014		067	5016	
028	5003		068	5020	
029	5026		069	5014	
030	5011		070	5018	
031	5020		071	5010	
032	4997		072	5014	
033	5015		073	5028	
034	5017		074	5015	
035	5009				
036	5014				
037	5015				
038	5005				
039	4994				
040	5021				

Table 3.5.1.B Zero Power Resistance Readings for Variant 05 (5K3A355) @ +25°C

COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
006	> 100 M ohm		060	> 100 M ohm	
009	> 100 M ohm		067	> 100 M ohm	
010	> 100 M ohm		069	> 100 M ohm	
022	> 100 M ohm				
025	> 100 M ohm				
031	> 100 M ohm				
036	> 100 M ohm				
044	> 100 M ohm				
050	> 100 M ohm				
052	> 100 M ohm				

Table 3.5.1.C Insulation Resistance Testing for Variant 01 (1K3A351)

	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
001	> 100 M ohm		066	> 100 M ohm	
005	>100 M ohm		068	> 100 M ohm	
013	> 100 M ohm		070	> 100 M ohm	
026	> 100 M ohm				
038	> 100 M ohm				
044	> 100 M ohm				
051	> 100 M ohm				
054	> 100 M ohm				
058	> 100 M ohm				
064	> 100 M ohm				

Table 3.5.1.D Insulation Resistance Testing for Variant 05 (5K3A355)

3.5.2 ESA/SCC Detail Specification 4006/014 Variant 01, 04 & 05

The devices were tested to the following criteria:

- Zero power resistance at 25^{O}C Data is shown in Tables 3.5.2.A, 3.5.2.B and 3.5.2.C. Note that, as per the requirements of Note 1 to Chart III of ESA/SCC 4006, the measurements of parameters for the purposes of drift value measurements need not be repeated for electrical measurements at room temperature. Accordingly, the data of these three Tables is identical to the pre-Burn – In zero power resistance readings shown in Tables 2.5.2.A, 2.5.2.B and 2.5.2.C.

- Insulation resistance Data in Tables 3.5.2.D, 3.5.2.E and 3.5.2.F. As more than twenty devices were to be measured, the requirements of Note 2 to Table 2 of 4006/013 is applicable – Test shall be performed on a sample basis – Level II, Table 2, AQL = 1.0 of MIL-STD-105. All measurements were within the limits as specified in the appropriate detail specification.

The quantity, date of test and operator details are shown in the relevant Route Sheets in Appendix K.

COMP. NO.	RES. READING (ohms) at + 25°C 1973 to 2027 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at +25 °C 1973 to 2027 ohms	Pass/Fail (Indicate failure only)
001	2005		041	2022	
002	2009		042	2020	
003	2005		043	2010	
004	2010		044	2010	
005	2017		045	2018	
006	2011		046	2008	
007	2003		047	2012	
008	2008		048	2014	
009	2021		049	2007	
010	2021		050	2004	
011	2020		051	2005	
012	2018		052	2010	
013	2015		053	2000	
014	2001		054	2022	
015	2003		055	2005	
016	2012		056	2018	
017	2018		057	2006	
018	2006		058	2021	
019	2004		059	2001	
020	2003		060	1996	
021	2004		061	2004	
022	2004		062	1999	
023	2021		063	2000	
024	2008		064	2008	
025	2007		065	2003	
026	2005		066	2009	
027	2023		067	2004	
028	2017		068	2003	
029	2006		069	2004	
030	2010		070	2005	
031	2016		071	2010	
032	2016		072	2004	
033	2000				
034	2001				
035	2000				
036	2016				
037	2024				
038	2006				
039	2006				
040	2005				

Table 3.5.2.A Zero Power Resistance Readings for variant 01 (G2K7D110) @ +25°C

COMP. NO.	RES. READING (ohms) at + 25°C 14,789 to 15,211 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at + 25°C 14,789 to 15,211 ohms	Pass/Fail (Indicate failure only)
001	14,927		044	14,959	
002	14,863		045	14,957	
003	14,962		046	14,963	
004	14,917		047	14,965	
005	14,979		048	14,958	
006	14,941		049	14,966	
007	14,916		050	14,973	
008	14,864		051	14,947	
009	14,933		052	14,929	
010	14,926		053	15,029	
011	14,930		054	14,916	
012	14,945		055	14,928	
013	14,995		056	14,910	
014	14,932		057	14,974	
015	14,930		058	14,889	
016	14,973		059	14,951	
017	14,922		060	14,944	
018	14,968		061	14,962	
019	14,951		062	14,987	
020	14,989		063	14,930	
021	14,986		064	14,956	
022	14,968		065	14,947	
023	14,961		066	14,955	
024	14,956		067	14,960	
025	14,962		068	14.931	
026	14,930		069	14,907	
027	14,963		070	14,972	
028	14,944		071	14,986	
029	14,957		072	14,948	
030	14,949		073	14,925	
031	14,978		074	14,947	
032	14,970		075	14,942	
033	14,935		076	14,933	
034	14,982		077	14,938	
035	14,956		078	14,942	
036	14,931		079	14,952	
037	14,975		080	14,955	
038	14,974		081	14,931	
039	14,908		082	14,931	
040	14,953		083	14,871	
041	14,978		084	14,951	
042	14,957		085	14,960	
043	14,977		086	14,957	

Table 3.5.2.B Zero Power Resistance Readings for variant 04 (G15K4D112) @ +25°C

COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 ohms	Pass/Fail (Indicate failure only)
001	100,412		041	99,621	
002	99,751		042	99,791	
003	98,920		043	100,091	
004	99,371		044	100,032	
005	100,401		045	99,513	
006	100,273		046	99,960	
007	100,132		047	100,762	
008	100,394		048	99,899	
009	99,612		049	99,728	
010	99,390		050	100.481	
011	100,041		051	100,502	
012	100,042		052	99,721	
013	99,630		053	100,532	
014	100,491		054	100,296	
015	99,501		055	100,302	
016	99,652		056	99,390	
017	99,531		057	100,381	
018	99,401		058	100,192	
019	100,470		059	100,632	
020	100,221		060	100,112	
021	100,252		061	100,020	
022	99,501		062	99,911	
023	99,352		063	99,843	
024	99,752		064	99,742	
025	100,723		065	99,821	
026	100,140		066	100,592	
027	100,051		067	100,071	
028	100,091		068	100,061	
029	100,510		069	100,502	
030	99,414		070	99,742	
031	99,581		071	100,272	
032	100,352		072	99,533	
033	99,610		073	99,731	
034	99,491		074	99,822	
035	100,212		075	100,410	
036	99,312		076	99,710	
037	99,801		077	100,341	
038	99,632		078	100,432	
039	100,601		079	100,101	
040	100,081		080	-	-

Table 3.5.2.C Zero Power Resistance Readings for variant 05 (G100K6D116) @ +25°C

Table 3.5.2.C continued

COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 ohms	Pass/Fail (Indicate failure only)	COMP. NO.	RES. READING (ohms) at + 25°C 98,370 to 101,630 ohms	Pass/Fail (Indicate failure only)
081	100,042		121	100,152	
082	99,330		122	100,212	
083	99,601		123	99,802	
084	100,661		124	100,321	
085	99,550		125	100,293	
086	99,941		126	99,852	
087	99,754		127	99,912	
088	99,321		128	100,701	
089	100,350		129	-	
090	100,561		130	99,220	
091	99,571		131	100,272	
092	99,432		132	99,410	
093	100,171		133	99,942	
094	100,131		134	99,542	
095	100,091		135	100,230	
096	100,092		136	100,481	
097	100,801		137	99,962	
098	100,110		138	100,562	
099	100,011		139	100,091	
100	100,032		140	99,425	
101	99,770		141	100,701	
102	100,160		142	99,523	
103	100,691		143	99,601	
104	99,673		144	99,241	
105	99,291		145	99,943	
106	100,462		146	100,123	
107	100,305				
108	100,033				
109	100,332				
110	100,152				
111	100,081				
112	100,061				
113	99,674				
114	99,844				
115	99,330				
116	100,172				
117	99,501				
118	99,652				
119	100,961				
120	99,881				

Table 3.5.2.C Zero Power Resistance Readings for variant 05 (G100K6D116) @ +25°C

COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
003	> 100 M ohm		045	> 100 M ohm	
006	> 100 M ohm		056	> 100 M ohm	
009	> 100 M ohm		062	> 100 M ohm	
011	> 100 M ohm				
024	> 100 M ohm				
025	> 100 M ohm				
033	> 100 M ohm				
034	> 100 M ohm				
036	> 100 M ohm				
038	> 100 M ohm				

Table 2.5.2.D Insulation Resistance Testing for Variant 01 (G2K7D110)

	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
002	> 100 M ohm		060	> 100 M ohm	
005	>100 M ohm		062	> 100 M ohm	
012	> 100 M ohm		063	> 100 M ohm	
019	> 100 M ohm				
023	> 100 M ohm				
025	> 100 M ohm				
028	> 100 M ohm				
041	> 100 M ohm				
049	> 100 M ohm				
055	> 100 M ohm				

Table 2.5.2.E Insulation Resistance Testing for variant 04 (G15K4D112)

	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)	COMP. NO.	INSULATION RESISTANCE TESTING	Pass/Fail (Indicate failure only)
008	> 100 M ohm		070	> 100 M ohm	
010	>100 M ohm		073	> 100 M ohm	
015	> 100 M ohm		078	> 100 M ohm	
020	> 100 M ohm		081	> 100 M ohm	
022	> 100 M ohm		085	> 100 M ohm	
029	> 100 M ohm		088	> 100 M ohm	
038	> 100 M ohm		090	> 100 M ohm	
045	> 100 M ohm		094	> 100 M ohm	
055	> 100 M ohm		096	> 100 M ohm	
068	> 100 M ohm		100	> 100 M ohm	

Table 2.5.2.F Insulation Resistance Testing for variant 05 (G100K6D116)

3.6 (4006, Para. 9.6) Radiographic inspection

All devices in the 5 inspection lots (ESA/SCC 4006/013 Variants 01 & 05 and ESA/SCC 4006/014 Variants 01, 04 and 05) were subjected to Radiographic Inspection as per ESA/SCC Basic Specification No. 20900. The following parameters were used.

X-ray Source	Philips MG 161 constant potential.
Film Type	Agfa –Gevaert Structurix D4
Voltage	60 kV
Current	5 mA
Exposure time	5.5 minutes
X –ray focal spot size	0.4 mm
Film Focus distance	1000 mm
Penetrameter	Nos. 4and 5 as per ASTM E801
Processing	4 minutes in Agfa Structurix G350 developer at 20C

NOTE: Pentrameter No. 4 of ASTM E801 is equivalent to penetrameter No. 2 of ESA Specification No. 20900 and that penetrameter No. 5 of ASTM E801 is equivalent to penetramerer No. 3 of ESA Specification No. 20900.
(ASTM E801, Standard Practice for Controlling Quality of Radiographic Testing of Electronic Devices.)

The radiographs were inspected using a light box and an eyepiece of X10 magnification. No defects were found in any of the parts. The quantity, date of test and operator details are shown in the relevant Route Sheets in Appendix K.

3.7 (4006 Para. 9.5) External Visual Inspection

All devices in the 5 inspection lots (ESA/SCC 4006/013 Variants 01 & 05 and ESA/SCC 4006/014 Variants 01, 04 and 05) were externally visually inspected as per ESA/SCC Basic specification No. 20500 and the relevant Betatherm Manufacturing Work Instruction (MFG-11-72-20 for ESA/SCC 4006/014 and MFG-11-72-19 for ESA/SCC 4006/013).

A microscope was of x 30 magnification was used.

Make:	KYOWA
Model:	SD - 2PL
Plant No:	P – 06 - 23

The parts were 100% inspected, to the relevant criteria, and no visual rejects were detected in any of the five inspection/qualification lots.

The quantity, date of test and operator details are shown in the relevant Route Sheets in Appendix K.

3.8 (4006 Para. 7.4) Check Lot Failure.

All devices in the 5 inspection lots (ESA/SCC 4006/013 Variants 01 & 05 and ESA/SCC 4006/014 Variants 01, 04 and 05) were subjected to calculation to determine that Chart III lot failure had not occurred. The details of the failures are shown in Tables 3.8.1 to 3.8.5. Calculations confirm that no lot failure occurred.

The quantity, date of test and operator details are shown in the relevant Route Sheets in Appendix K.

TEST METHOD		QUANTITY	No. OF FAILURES (COMMENTS)
Chart III		72	0
Sub Paragraph 9.3.2.	Parameter Drift Value, Initial Measurement		
	↓		
Paragraph 7.1	Burn In, 168 hours	72	0
	↓		
Sub paragraph 9.3.2	Parameter Drift Value, Final Measurement	72	0
	↓		
Para 9.3.3	Electrical Measurements at High / Low Temperatures	72	0
	↓		
Para 9.3.4	Electrical Measurements at Room Temperature	72	0
	↓		
Para 9.5	External Visual Inspection	72	0
	↓		
Para 7.4	Lot Acceptance (Total Number of Failures = 0) P.D.A = 0%	72	0

Table 3.8.1 Lot Failure Check for ESA/SCC 4006/013 Variant 01 (1K3A351)

TEST METHOD		QUANTITY	No. OF FAILURES (COMMENTS)
Chart III			
Sub Paragraph 9.3.2.	Parameter Drift Value, Initial Measurement	74	0
	↓		
Paragraph 7.1	Burn In, 168 hours	74	0
	↓		
Sub paragraph 9.3.2	Parameter Drift Value, Final Measurement	74	0
	↓		
Para 9.3.3	Electrical Measurements at High / Low Temperatures	74	0
	↓		
Para 9.3.4	Electrical Measurements at Room Temperature		
	↓		
Para 9.5	External Visual Inspection	74	0
	↓		
Para 7.4	Lot Acceptance (Total Number of Failures = 0 P.D.A. = 0%	74	0

Table 3.8.2 Lot Failure Check for ESA/SCC 4006/013 Variant 05 (5K3A355)

TEST METHOD		QUANTITY	No. OF FAILURES (COMMENTS)
Chart III			
Sub Paragraph 9.3.2.	Parameter Drift Value, Initial Measurement	72	0
	↓		
Paragraph 7.1	Burn In, 168 hours	72	0
	↓		
Sub paragraph 9.3.2	Parameter Drift Value, Final Measurement	72	0
	↓		
Para 9.3.3	Electrical Measurements at High / Low Temperatures	72	0
	↓		
Para 9.3.4	Electrical Measurements at Room Temperature	72	0
	↓		
Para 9.5	External Visual Inspection	72	0
	↓		
Para 7.4	Lot Acceptance (Total Number of Failures = 0) P.D.A = 0%	72	0

Table 3.8.3 Lot Failure Check for ESA/SCC 4006/014 Variant 01(G2K7D110)

TEST METHOD		QUANTITY	No. OF FAILURES (COMMENTS)
Chart III			
Sub Paragraph 9.3.2.	Parameter Drift Value, Initial Measurement	86	0
	↓		
Paragraph 7.1	Burn In, 168 hours	86	0
	↓		
Sub paragraph 9.3.2	Parameter Drift Value, Final Measurement	86	0
	↓		
Para 9.3.3	Electrical Measurements at High / Low Temperatures	86	0
	↓		
Para 9.3.4	Electrical Measurements at Room Temperature	86	0
	↓		
Para 9.5	External Visual Inspection	86	0
	↓		
Para 7.4	Lot Acceptance (Total Number of Failures= 0) P.D.A. = 0 %	86	0

Table 3.8.4 Lot Failure Check for ESA/SCC 4006/014 Variant 04 (G15K4D112)

TEST METHOD		QUANTITY	No. OF FAILURES (COMMENTS)
Chart III			
Sub Paragraph 9.3.2.	Parameter Drift Value, Initial Measurement	146	2
	↓		
Paragraph 7.1	Burn In, 168 hours	144	0
	↓		
Sub paragraph 9.3.2	Parameter Drift Value, Final Measurement	144	0
	↓		
Para 9.3.3	Electrical Measurements at High / Low Temperatures	144	1
	↓		
Para 9.3.4	Electrical Measurements at Room Temperature	143	0
	↓		
Para 9.5	External Visual Inspection	143	0
	↓		
Para 7.4	Lot Acceptance (Total Number of Failures = 1) P.D.A = 0.7 %	144	1

Table 3.8.5. Lot Failure Check for ESA/SCC 4006/014 Variant 05 (G100K6D116)

SECTION 4

4.0 Introduction

In this section the testing of the 5 Qualification Parts (ESA/SCC 4006/013 Variants 01 & 05 and ESA/SCC 4006/014 Variant 01,04 & 05) during Chart IV is described in detail. 70 components from each of the 5 "Qualification Variants" were selected for CHART IV "Qualification Testing." The serial numbers were allocated as shown in Section 1.9 to this report "Sample Identification In Sub Groups". The testing was carried out at the Betatherm facility with the following exceptions, which were documented and agreed by SCCG in advance:

- Environmental/Mechanical Sub-Group 2: Resistance to Soldering Heat; Zero power resistance @ 25^0C (post 'Drying' and pre-Moisture Resistance); Moisture Resistance test; Zero power resistance @ 25^0C (post 'Moisture Resistance' test) and Insulation Resistance (post 'Moisture Resistance' test) at N.M.R.C. (Cork).
- Environmental/Mechanical Sub-Group 1: Shock (Specific Pulse) and Vibration testing at B.S.I. (Luton).

The Route sheets for Chart IV 'Qualification Testing' are shown in **Appendix Q**, one Route Sheet for each of the five parts used as qualification vehicles.

The following tests were not conducted as defined in Detail Specifications:

- Environmental/ Mechanical Sub-Group III: 'Dissipation Constant' – excluded as per the requirements of paragraph 4.2.4 of both detail specifications 4006/013 Iss. 1, Rev. A and 4006/014 Iss. 1, Rev. B.

- Endurance Sub-Group V 'Short Time Load'- As proposed by Betatherm and agreed by ESTEC the testing for the Short Time Load does not apply to any of the Qualification vehicles. This is due to the fact that both detail specifications, in Note 1 to Table 1(b) 'Maximum Ratings, state that the thermistors shall not be used in the 'self heat' mode. It is proposed to update ESA/SCC 4006/013 Iss.1 Rev. A and ESA/SCC 4006/014 Iss.1 Rev. B, in order to take account of this fact.

- Endurance Sub-Group V 'High Temperature Storage' As proposed by Betatherm and agreed by ESTEC the testing for 'High Temperature Storage' does not apply to any of the Qualification vehicles. This is due to the fact that 'Operating Life' test, in Endurance Sub-Group IV is carried out at the same temperature as 'High Temperature Storage'. It is proposed to update ESA/SCC 4006/013 Iss.1 Rev. A and ESA/SCC 4006/014 Iss.1 Rev. B, in order to take account of this fact.

- Endurance Sub-Group IV Permanence of Marking - the 4006/013 devices are not marked due to size constraints. The primary packaging of the qualification devices is marked to indicate the serialization of the devices. As a result of this, the Permanence of Marking test is not applicable to the 4006/013 devices. The 4006/014 qualification devices are marked, on the sleeve, without the ESA logo. Thus the Permanence of Marking test is relevant and applicable to these devices.

4.1 Sub – Group I: Environmental / Mechanical Testing

12 Components from each of the 5 “Qualification Lots” were tested to Sub Group I as described in ESA/SCC Generic specification 4006. (CHART IV) and the relevant requirements of ESA/SCC Detail Specifications 4006/013 and 014.

The tests conducted and the location of the tests was as follows:

TEST DESCRIPTION	LOCATION.
Shock / Specific Pulse	B.S.I (Luton)
Zero Power Resistance Measurement	Betatherm
(Ro)@ 25^0C	
Vibration (9.8)	B.S.I. (Luton)
(Ro)@ 25^0C	Betatherm
Immersion (9.9)	Betatherm
Dielectric Withstand Voltage	Betatherm
(Ro)@ 25^0C/Insulation Resistance	Betatherm
External visual,	Betatherm

The Test reports, for Shock and Vibration Testing at BSI are shown in **Appendix R** to this Qualification Report. One of their qualification samples failed Environmental/Mechanical Subgroup 1 at the vibration stage. This unit was ESA/SCC 4006/013 Variant 01 (1K3A351), serial number 010. The failure was the lead breaking between the thermistor body and the lead support points. This occurred during the vibration cycle, one of the two mutually perpendicular directions having being completed (reference ESA/SCC 4006, paragraph 9.8(c). Analysis of the failure has been carried out by the ‘Metallic Materials and Processes Section’ of ESTEC, who have issued a Report Number 2734 which is included as **Appendix S** to this Qualification Report.

The ESTEC report concluded that the cause of the failure of one lead of the thermistor serial number 010 of the qualification lot is considered to have been due to fatigue. The scrape and associated burr seen on the failed lead is considered to have acted as a stress raiser in this failure. None of the remaining 11 parts from the qualification lot or the 15 parts from the reference lot exhibited evidence of similar damage.

The other qualifications variants, and the remainder of the ESA/SCC 4006/013 Variant 1 (1K3A351) samples, passed the test. Results for ESA/SCC 4006/013 Variants 01 & 05 are in Tables 4.1.1 and 4.1.2. Results for ESA/SCC 4006/014 Variants 01, 04 & 05 are in Tables 4.1.3, 4.1.4 and 4.1.5.

Serial No.	Ro @25^{0}C Pre Shock	Ro @ 25^{0}C Post Shock	Drift % ± 2.0%Max	Ro @ 25^{0}C Post Vibration	Drift % ± 2.0 % Max	External Visual Post Immersion	D.W.V	Zero Power Resistance @ Room Temp	Insulation Resistance	External Visual Inspection
								991.2 to 1008.8		
001	1007.1	1007.3	0.02	1007.5	0.02	Pass	Pass	1008.7	Pass	Pass
002	997.8	1000.8	0.30	997.2	- 0.36	Pass	Pass	998.3	Pass	Pass
005	998.2	1000.6	0.24	997.5	- 0.31	Pass	Pass	998.9	Pass	Pass
006	998.7	998.2	- 0.05	997.8	- 0.04	Pass	Pass	999.7	Pass	Pass
008	1001.5	999.6	- 0.19	1000.6	0.10	Pass	Pass	1002.1	Pass	Pass
010	997.2	995.6	- 0.16	FAIL	xxxx	xxxx	xxxxx	xxxx	xxxx	xxxx
011	997.3	997.3	0.00	997.2	- 0.01	Pass	Pass	998.5	Pass	Pass
015	1002.6	1001.3	- 0.13	1001.6	0.03	Pass	Pass	1003.3	Pass	Pass
017	997.0	996.4	- 0.06	996.9	0.05	Pass	Pass	998.6	Pass	Pass
018	1000.3	997.7	- 0.26	999.0	0.13	Pass	Pass	1000.5	Pass	Pass
021	999.9	999.4	- 0.05	998.8	- 0.06	Pass	Pass	1001.1	Pass	Pass
023	999.9	999.8	- 0.01	999.3	- 0.05	Pass	Pass	1001.0	Pass	Pass

Table 4.1.1 Environmental / Mechanical SubGroup I, ESA/SCC 4006 /013 Variant 01 (1K3A351)

Serial No.	Ro@25^{0}C Pre Shock	Ro@25^{0}C Post Shock	Drift % ± 2.0 Max	Ro@25^{0}C Post Vibration	Drift % ± 2.0 Max	External Visual Post Immersion	D.W.V.	Zero Power Resistance Room Temperature	Insulation Resistance	External Visual Inspection
								4956 to 5044		
013	5023	5036	0.26	5034	- 0.04	Pass	Pass	5036	Pass	Pass
014	5016	5030	0.28	5026	- 0.08	Pass	Pass	5031	Pass	Pass
015	5021	5028	0.14	5030	0.03	Pass	Pass	5036	Pass	Pass
016	5017	5028	0.22	5026	- 0.04	Pass	Pass	5031	Pass	Pass
018	5018	5024	0.12	5022	- 0.04	Pass	Pass	5026	Pass	Pass
019	5020	5029	0.18	5028	- 0.02	Pass	Pass	5033	Pass	Pass
020	5011	5025	0.28	5021	- 0.08	Pass	Pass	5025	Pass	Pass
022	5022	5031	0.18	5030	- 0.02	Pass	Pass	5035	Pass	Pass
026	5021	5031	0.20	5031	0.00	Pass	Pass	5035	Pass	Pass
027	5019	5033	0.28	5026	- 0.14	Pass	Pass	5029	Pass	Pass
033	5016	5027	0.22	5028	0.02	Pass	Pass	5034	Pass	Pass
034	5020	5031	0.22	5029	- 0.04	Pass	Pass	5033	Pass	Pass

Table 4.1.2 Environmental/Mechanical Sub Group I, ESA/SCC 4006 /013 Variant 05, (5K3A355)

Serial No.	Ro@25^{0}C Pre Shock	Ro@25^{0}C Post Shock	Drift % ± 2.0 Max	Ro@25^{0}C Post Vibration	Drift % ± 2.0 Max	External Visual Post Immersion	D.W.V.	Zero Power Resistance Room Temperature	Insulation Resistance	External Visual Inspection
								1973 to 2027		
001	2009	2010	0.05	2009	- 0.05	Pass	Pass	2010	Pass	Pass
002	2011	2012	0.05	2011	- 0.05	Pass	Pass	2012	Pass	Pass
003	2009	2012	0.15	2011	- 0.05	Pass	Pass	2012	Pass	Pass
004	2014	2016	0.10	2014	- 0.10	Pass	Pass	2016	Pass	Pass
006	2014	2015	0.05	2013	- 0.10	Pass	Pass	2015	Pass	Pass
007	2007	2009	0.10	2007	- 0.10	Pass	Pass	2008	Pass	Pass
008	2011	2011	0.00	2010	- 0.05	Pass	Pass	2011	Pass	Pass
013	2018	2020	0.10	2017	- 0.15	Pass	Pass	2017	Pass	Pass
016	2016	2017	0.05	2015	- 0.10	Pass	Pass	2016	Pass	Pass
017	2021	2023	0.10	2020	- 0.15	Pass	Pass	2021	Pass	Pass
019	2008	2011	0.15	2010	- 0.05	Pass	Pass	2011	Pass	Pass
021	2008	2009	0.05	2008	- 0.05	Pass	Pass	2009	Pass	Pass

Table 4.1.3 Environmental/Mechanical Sub Group I, ESA/SCC 4006 /014 Variant 01, (G2K7D110)

Serial No.	Ro@25^{0}C Pre Shock	Ro@25^{0}C Post Shock	Drift % ± 2.0 Max	Ro@25^{0}C Post Vibration	Drift % ± 2.0 Max	External Visual Post Immersion	D.W.V.	Zero Power Resistance Room Temperature	Insulation Resistance	External Visual Inspection
								14789 to 15211		
031	14,980	15,017	0.25	15003	- 0.09	Pass	Pass	15012	Pass	Pass
035	14,976	15,004	0.19	14994	- 0.07	Pass	Pass	15005	Pass	Pass
042	14,972	14,988	0.11	14980	- 0.05	Pass	Pass	14999	Pass	Pass
046	14,983	15,005	0.15	14998	- 0.05	Pass	Pass	15015	Pass	Pass
047	14,968	14,990	0.15	14982	- 0.05	Pass	Pass	14992	Pass	Pass
048	14,967	14,996	0.19	14,988	- 0.05	Pass	Pass	15007	Pass	Pass
049	14,971	14,995	0.16	14987	- 0.05	Pass	Pass	15001	Pass	Pass
053	15,059	15,088	0.19	15076	- 0.08	Pass	Pass	15094	Pass	Pass
054	14,929	14,951	0.15	14945	- 0.04	Pass	Pass	14957	Pass	Pass
055	14,948	14,980	0.21	14959	- 0.14	Pass	Pass	14976	Pass	Pass
056	14,916	14,940	0.16	14,929	- 0.07	Pass	Pass	14949	Pass	Pass
057	14,995	15,022	0.18	15009	- 0.09	Pass	Pass	15027	Pass	Pass

Table 4.1.4 Environmental/Mechanical Sub Group I, ESA/SCC 4006 /014 Variant 04, (G15K4D112)

Serial No.	Ro@25^{0}C Pre Shock	Ro@25^{0}C Post Shock	Drift % ± 2.0 Max	Ro@25^{0}C Post Vibration	Drift % ± 2.0 Max	External Visual Post Immersion	D.W.V.	Zero Power Resistance Room Temperature	Insulation Resistance	External Visual Inspection
								98370 to 101630		
001	100,412	100,512	0.10	100,443	- 0.07	Pass	Pass	99940	Pass	Pass
002	99,701	99,789	0.09	99,761	- 0.03	Pass	Pass	99,860	Pass	Pass
006	100,189	100,212	0.02	100,236	0.02	Pass	Pass	99080	Pass	Pass
007	100,130	100,194	0.06	100,189	0.00	Pass	Pass	100270	Pass	Pass
011	100,036	99,991	- 0.04	100,042	0.05	Pass	Pass	100150	Pass	Pass
012	100,068	100,140	0.07	100,081	- 0.06	Pass	Pass	100030	Pass	Pass
013	99,649	99,721	0.07	99,651	- 0.07	Pass	Pass	99770	Pass	Pass
020	100,106	100,261	0.15	100,254	- 0.01	Pass	Pass	100390	Pass	Pass
024	99,732	99,801	0.07	99,771	- 0.03	Pass	Pass	98910	Pass	Pass
026	100,094	100,191	0.10	100,140	- 0.05	Pass	Pass	100230	Pass	Pass
028	100,063	100,142	0.08	100,139	0.00	Pass	Pass	100220	Pass	Pass
031	99,588	99,642	0.05	99,613	- 0.03	Pass	Pass	99780	Pass	Pass

Table 4.1.5 Environmental/Mechanical Sub Group I, ESA/SCC 4006 /014 Variant 05, (G100K6D116)

4.2 Sub – Group II: Environmental/Mechanical Testing

12 Components from each of the 5 “Qualification Lots” were tested to Sub Group II as described in ESA/SCC Generic specification 4006. (CHART IV) and the relevant requirements of ESA/SCC Detail Specifications 4006/013 and 014.

The tests conducted and the location of the tests was as follows:

TEST DESCRIPTION	LOCATION.
Thermal Shock	Beatherm
Resistance to Soldering Heat	N.M.R.C (Cork)
Zero power resistance (Ro) @ 25^0C	Betatherm
Visual examination	Betatherm
(Ro) @ 25^0C (post Drying and pre Moisture Resistance test	N.M.RC(Cork)
Moisture resistance	N.M.R.C.
Insulation Resistance	N.M.R.C
Zero power resistance @ 25^0C	N.M.RC.
Visual inspection.	Betatherm.

The NMRC Test report, for the relevant tests of Environmental/Mechanical Sub-Group II tests are shown in **Appendix T** to this Qualification Report.

Results for ESA/SCC 4006/013 Variants 01 & 05 are in Tables 4.2.1 and 4.2.2. Results for ESA/SCC 4006/014 Variants 01, 04 & 05 are in Tables 4.2.3, 4.2.4 and 4.2.5.

Serial No.	Ro@25^{0}C Pre Resistance Soldering Heat	Ro@25^{0}C Post Resistance Soldering Heat	Limit 991.2 to 1008.8	Visual Post Resistance Soldering Heat	Ro@25^{0}C Post Moisture Resistance	Drift % ± 2.0 Max	Insulation Resistance	Zero Power Resistance At Room Temp.	External Visual Inspection
047	997.8	995.8	Pass	Pass	998.4	0.26	Pass	996.5	Pass
009	1001.4	1000.0	Pass	Pass	1001.1	0.11	Pass	1002.0	Pass
057	1001.0	999.4	Pass	Pass	1002.2	0.28	Pass	1000.0	Pass
020	1001.1	999.6	Pass	Pass	999.5	0.01	Pass	999.8	Pass
062	1001.5	1001.0	Pass	Pass	1001.1	0.00	Pass	1001.0	Pass
029	1000.8	999.7	Pass	Pass	999.7	0.00	Pass	1001.0	Pass
071	1003.2	1003.2	Pass	Pass	1003.9	0.06	Pass	1004.6	Pass
036	999.9	1000.9	Pass	Pass	1004.9	0.39	Pass	1004.7	Pass
019	1003.2	1003.4	Pass	Pass	1005.8	0.24	Pass	1005.8	Pass
016	999.2	999.3	Pass	Pass	1003.0	0.37	Pass	1002.6	Pass
025	997.6	999.5	Pass	Pass	1001.1	0.16	Pass	999.7	Pass
046	999.5	999.8	Pass	Pass	999.7	0.01	Pass	999.6	Pass

Table 4.2.1 Environmental/Mechanical Sub Group II, ESA/SCC 4006 /013 Variant 01, (1K3A351)

Serial No.	Ro@25^{0}C Pre Resistance Soldering Heat	Ro@25^{0}C Post Resistance Soldering Heat	Limit 4956 to 5044	Visual Post R.S.H.	Ro@25^{0}C Post Moisture Resistance	% Delta ± 2.0 Max	Insulation Resistance	Zero Power Resistance At Room Temperature	External Visual Inspection
006	5020	5010	Pass	Pass	5020	0.19	Pass	5019	Pass
007	5024	5006	Pass	Pass	5008	0.03	Pass	5008	Pass
009	5010	4987	Pass	Pass	4988	0.02	Pass	4989	Pass
012	5016	4990	Pass	Pass	4991	0.02	Pass	4990	Pass
030	5013	4990	Pass	Pass	4992	0.04	Pass	4990	Pass
031	5023	5003	Pass	Pass	5003	0.00	Pass	5005	Pass
038	5012	4983	Pass	Pass	4982	- 0.02	Pass	4981	Pass
043	5022	4996	Pass	Pass	4996	0.00	Pass	4995	Pass
070	5027	5007	Pass	Pass	5010	0.05	Pass	5009	Pass
071	5015	4984	Pass	Pass	4987	0.06	Pass	4987	Pass
072	5009	4986	Pass	Pass	4987	0.02	Pass	4989	Pass
073	5031	5000	Pass	Pass	5003	0.06	Pass	5004	Pass

Table 4.2.2 Environmental/Mechanical Sub Group II, ESA/SCC 4006/013 Variant 05, (5K3A355)

Serial No.	Ro@25^{0}C Pre Resistance Soldering Heat	Ro@25^{0}C Post Resistance Soldering Heat	Limit 1973 to 2027	Visual Post R.S.H.	Ro@25^{0}C Post Moisture Resistance	% Delta $\pm$ 2.0 Max	Insulation Resistance	Zero Power Resistance At Room Temperature	External Visual Inspection.
066	2011	2011	Pass	Pass	2013	0.09	Pass	2013	Pass
068	2006	2005	Pass	Pass	2007	0.09	Pass	2009	Pass
067	2007	2006	Pass	Pass	2009	0.14	Pass	2009	Pass
055	2008	2007	Pass	Pass	2009	0.09	Pass	2009	Pass
057	2009	2008	Pass	Pass	2012	0.19	Pass	2010	Pass
059	2005	2004	Pass	Pass	2006	0.09	Pass	2006	Pass
065	2006	2006	Pass	Pass	2008	0.09	Pass	2009	Pass
069	2007	2007	Pass	Pass	2009	0.10	Pass	2009	Pass
070	2007	2006	Pass	Pass	2008	0.09	Pass	2008	Pass
071	2013	2012	Pass	Pass	2014	0.09	Pass	2014	Pass
072	2006	2005	Pass	Pass	2007	0.09	Pass	2007	Pass
047	2014	2014	Pass	Pass	2015	0.04	Pass	2015	Pass

Table 4.2.3 Environmental/Mechanical Sub Group II, ESA/SCC 4006/014 Variant 01, (G2K7D110)

Serial No.	Ro@25^{0}C Pre Resistance Soldering Heat	Ro@25^{0}C Post Resistance Soldering Heat	Limit 14,789 to 15,211	Visual Post R.S.H.	Ro@25^{0}C Post Moisture Resistance	% Delta ± 2.0 Max	Insulation Resistance	Zero Power Resistance At Room Temperature	External Visual Inspection
086	14966	14978	Pass	Pass	14991	0.08	Pass	14982	Pass
085	14972	14979	Pass	Pass	14995	0.10	Pass	14985	Pass
083	14885	14893	Pass	Pass	14903	0.06	Pass	14901	Pass
082	14952	14964	Pass	Pass	14974	0.06	Pass	14973	Pass
081	14952	14962	Pass	Pass	14978	0.10	Pass	14985	Pass
080	14969	14982	Pass	Pass	14992	0.06	Pass	14995	Pass
079	14969	14976	Pass	Pass	14999	0.15	Pass	14966	Pass
078	14956	14968	Pass	Pass	14984	0.10	Pass	14985	Pass
066	14951	14958	Pass	Pass	14983	0.16	Pass	14987	Pass
064	14971	14983	Pass	Pass	14992	0.06	Pass	14991	Pass
062	15013	15022	Pass	Pass	15036	0.15	Pass	15035	Pass
061	14961	14967	Pass	Pass	14981	0.09	Pass	14982	Pass

Table 4.2.4 Environmental/Mechanical Sub Group II, ESA/SCC 4006/014 Variant 04, (G15K4D112)

Serial No.	Ro@25^{0}C Pre Resistance Soldering Heat	Ro@25^{0}C Post Resistance Soldering Heat	Limit 98,370 to 101,630	Visual Post R.S.H	Ro@25^{0}C Post Moisture Resistance	% Delta ± 2.0 Max	Insulation Resistance	Zero Power Resistance At Room Temperature	External Visual Inspection.
003	98898	98923	Pass	Pass	99056	0.13	Pass	99042	Pass
005	100406	100443	Pass	Pass	100460	0.01	Pass	100522	Pass
009	99616	99610	Pass	Pass	99732	0.12	Pass	99731	Pass
016	99646	99675	Pass	Pass	99810	0.13	Pass	99780	Pass
027	100046	100038	Pass	Pass	100128	0.08	Pass	100156	Pass
037	99804	99809	Pass	Pass	99881	0.07	Pass	99934	Pass
038	99657	99641	Pass	Pass	99675	0.03	Pass	99743	Pass
042	99820	99843	Pass	Pass	99871	0.02	Pass	99932	Pass
046	99962	99977	Pass	Pass	100224	0.24	Pass	100123	Pass
047	100785	100807	Pass	Pass	100806	0.00	Pass	100880	Pass
059	100643	100645	Pass	Pass	100884	0.23	Pass	100787	Pass
067	100065	100063	Pass	Pass	100259	0.19	Pass	100203	Pass

Table 4.2.5 Environmental/Mechanical Sub Group II, ESA/SCC 4006/014 Variant 05, (G100K6D116)

4.3 Sub – Group III: Environmental/Mechanical Testing

6 Components from each of the 5 “Qualification Lots” were tested to Sub Group III as described in ESA/SCC Generic specification 4006. (CHART IV) and the relevant requirements of ESA/SCC Detail Specifications 4006/013 and 014. As specified in each of the Detail Specifications, reference paragraph 4.2.4 “Deviations from Qualification Tests (Chart IV)”, the Dissipation Constant test is not applicable

The tests conducted and the location of the tests was as follows:

TEST DESCRIPTION	LOCATION.
Thermal Time Constant (9.3.1.3)	Beattherm
Solderability (9.18)	Betatherm
Terminal Strength (9.13)	Betatherm
External Visual Inspection (9.5)	Betatherm

The results of testing of ESA/SCC 4006/013 Variant 01 & 05 are shown in Tables 4.3.1 and 4.3.2.

The results of testing of ESA/SCC 4006/014 Variant 01, 04 & 05 are shown in Tables 4.3.3, 4.3.4 and 4.3.5.

Serial No.	Ro@ 43.4^{0}C	Ro@ 75^{0}C	Thermal Time Constant	Solderability	Ro@ 25^{0}C Pre Terminal Strength	Ro@ 25^{0}C Post Terminal. Strength	% Drift $\pm$ 2.0 Max	External Visual Inspection
037	466.3	148.1	17.9	Pass	1008.9	1008.7	-0.02	Pass
051	465.3	148.4	22.1	Pass	1005.6	1005.7	0.01	Pass
060	465.4	148.5	19.5	Pass	1004.8	1005.0	0.02	Pass
061	465.0	148.2	19.7	Pass	1004.5	1004.2	-0.03	Pass
066	464.5	148.2	21.2	Pass	1003.4	1003.4	0.00	Pass
067	466.1	148.3	18.6	Pass	999.1	999.1	0.00	Pass

Table 4.3.1 Environmental/Mechanical Sub Group III, ESA/SCC 4006/013 Variant 01 (1K3A351)

Serial No.	Ro@ 43.4^{0}C	Ro@ 75^{0}C	Thermal Time Constant	Solderability	Ro@ 25^{0}C Pre Terminal. Strength	Ro@ 25^{0}C Post Terminal. Strength	% Drift ± 2.0 Max	External Visual Inspection
064	2327	740.9	9.9	Pass	5014.8	5015.0	0.00	Pass
065	2328	741.1	7.5	Pass	5021.5	5019.2	-0.05	Pass
066	2328	740.4	8.0	Pass	5028.1	5028.1	0.00	Pass
067	2331	741.5	5.1	Pass	5031.4	5029.0	-0.05	Pass
068	2335	743.7	7.7	Pass	5033.0	5031.0	-0.04	Pass
069	2333	742.7	5.2	Pass	5029.2	5030.1	0.02	Pass

Table 4.3.2 Environmental/Mechanical Sub Group III, ESA/SCC 4006/013 Variant 05 (5K3A355)

Serial No.	Ro@ 43.4^{0}C	Ro@ 75^{0}C	Thermal Time Constant	Solderability	Ro @ 25^{0}C Pre Terminal Strength	Ro @ 25^{0}C Post Terminal Strength	% Drift ± 2.0 Max	External Visual Inspection
056	1030	375.6	34	Pass	2024	2024	0.00	Pass
060	1019	372.1	34	Pass	2003	2002	-0.05	Pass
061	1023	373.2	34	Pass	2011	2010	-0.05	Pass
062	1021	372.4	34	Pass	2006	2006	0.00	Pass
063	1020	372.4	34	Pass	2005	2006	0.05	Pass
064	1024	373.7	34	Pass	2012	2012	0.00	Pass

Table 4.3.3 Environmental/Mechanical Sub Group III, ESA/SCC 4006/014 Variant 01 (G2K7D110)

Serial No.	Ro@ 43.4^{0}C	Ro@ 75^{0}C	Thermal Time Constant	Solderability	Ro @25^{0}C Pre Terminal Strength	Ro @25^{0}C Post Terminal Strength	% Drift ± 2.0 Max	External Visual Inspection
044	7378	2547	32	Pass	14990	14991	0.01	Pass
045	7370	2539	33	Pass	14989	15001	0.08	Pass
052	7355	2536	32	Pass	14961	14961	0.00	Pass
058	7336	2530	34	Pass	14923	14920	-0.02	Pass
059	7376	2530	33	Pass	15030	15000	-0.20	Pass
060	7372	2545	32	Pass	14984	14980	-0.03	Pass

Table 4.3.4 Environmental/Mechanical Sub Group III, ESA/SCC 4006 /014 Variant 04 (G15K4D112)

Serial No.	Ro@ 43.4^{0}C	Ro@ 75^{0}C	Thermal Time Constant	Solderability	Ro @25^{0}C Pre Terminal Strength	Ro @25^{0}C Post Terminal Strength	% Drift ± 2 Max	External Visual Inspection
064	44050	12922	32	Pass	99841	99902	0.06	Pass
065	44091	12936	32	Pass	99,972	99942	-0.03	Pass
066	44422	13022	32	Pass	100784	100760	-0.02	Pass
068	44180	12947	32	Pass	100135	100211	0.08	Pass
069	44305	12948	32	Pass	100536	100669	0.13	Pass
071	44295	12982	32	Pass	100347	100448	0.10	Pass

Table 4.3.5 Environmental/Mechanical Sub Group III, ESA/SCC 4006/014 Variant 05 (G100K6D116)

4.4 Sub – Group IV: Endurance

20 Components from each of the 5 “Qualification Lots” were tested to Sub Group IV as described in ESA/SCC Generic specification 4006. (CHART IV) and the relevant requirements of ESA/SCC Detail Specifications 4006/013 and 014.

The tests conducted and the location of the tests was as follows:

TEST DESCRIPTION	LOCATION.
Life Test, 2000 hours (9.14.1)	Beattherm
Electrical measurements during test (9.3.5)	Betatherm
Drift calculation after Life Test.	Betatherm
Permanence of marking (9.20)	Betatherm
External Visual Inspection (9.5)	Betatherm

With respect to the ‘Permanence of Marking’ test, the 4006/013 devices are not marked due to size constraints. The primary packaging of the qualification devices is marked to indicate the serialization of the devices. As a result of this, the Permanence of Marking test is not applicable to the 4006/013 devices. The 4006/014 qualification devices are marked, on the sleeve, without the ESA logo. Thus the Permanence of Marking test is relevant and applicable to these devices.

The results of testing of ESA/SCC 4006/013 Variant 01 & 05 are shown in Tables 4.4.1 and 4.4.2.
The results of testing of ESA/SCC 4006/014 Variant 01, 04 & 05 are shown in Tables 4.4.3, 4.4.4 and 4.4.5.

The results of the 2000 hour drift limit for ESA/SCC 4006/014 Variant 01 (G2K7D110) indicate that device number 029 failed with a drift limit value of $\pm$ 1.0% (actual value was + 1.1%.

A further part number of this variant, device number 014, has a drift value for this test of 1.0%. The average drift of the 20 Variant 01 devices subjected to the 2000-hour test was +0.8%. This indicated a Quality Control issue, as previous data would not have suggested drifts of this magnitude. In compliance with SCCG procedures a Non Conformance, numbered 2IEBET101, was raised and testing of this qualification device was halted. A copy of this Non Conformance Control Sheet is shown in **Appendix U** to this report. This Non Conformance was identified in Betatherm Material System 7 and did not apply to any other material system used in the Qualification Programme.

Investigation of this issue indicated that Material 7, which is used to manufacture the G2K7D110 devices, is subject to batch-to-batch variability. For reasons not apparent, some batches of Material 7 have no difficulty meeting the Life Test drift limits, but some batches go close to and exceed the limits as was demonstrated by the Qualification Tests. Analysis of the Burn-In data for the G2K7D110 devices also indicated that Burn-In data could be used as a predictor of the Life Test outcome. In order to demonstrate this variability three lots of Material 7 were assembled into Bead Thermistor form and subjected to 2,000 hours Life Test. The results confirmed batch-to-batch variability and the ability to use Burn-In results as a predictor of the Life Test outcome for this material. These findings are documented in “Actual Causes of Non-Conformance”, shown in **Appendix V.** As a consequence of these findings, the company produced document “MRB Actions/Decisions”, shown in **Appendix W.**

A Materials Review Board (MRB) was held, on 3 December 2001 to consider Non-Conformance 2IEBET101. The MRB accepted the findings of the “Actual Causes of Non-Conformance” document and agreed with the corrective action proposed in the “MRB Actions/Decisions” document. On completion of the actions to implement the corrective action, the Non-Conformance was closed.

Serial No.	Ro @ 0 Hours	Ro @ 1000 H	Drift 1000 H % ± 1.0 Max	Insulation Resistance @ 1000 H	Ro @ 2000 H	Drift 2000 H % ± 1.0 Max	Insulation Resistance @ 2000 H	Mark Permancy	External Visual Inspection
							Pass		
013	995.2	997.1	0.19	Pass	1001.4	0.62	Pass	N/A	Pass
014	1005.8	1007.3	0.15	Pass	1011.2	0.54	Pass	N/A	Pass
031	1004.0	1004.1	0.01	Pass	1007.1	0.31	Pass	N/A	Pass
040	1004.1	1004.5	0.04	Pass	1008.2	0.41	Pass	N/A	Pass
042	1003.5	1004.8	0.13	Pass	1008.9	0.54	Pass	N/A	Pass
052	996.2	997.1	0.09	Pass	1000.4	0.42	Pass	N/A	Pass
053	996.0	996.7	0.07	Pass	999.9	0.39	Pass	N/A	Pass
055	996.0	997.3	0.13	Pass	1001.0	0.50	Pass	N/A	Pass
058	996.0	998.0	0.20	Pass	1001.7	0.57	Pass	N/A	Pass
059	994.7	995.7	0.10	Pass	998.5	0.38	Pass	N/A	Pass
054	1004.4	1005.2	0.08	Pass	1008.1	0.37	Pass	N/A	Pass
056	1004.0	1004.5	0.05	Pass	1007.4	0.34	Pass	N/A	Pass
063	1004.3	1008.3	0.40	Pass	1012.8	0.85	Pass	N/A	Pass
065	1005.9	1006.9	0.10	Pass	1009.8	0.39	Pass	N/A	Pass
068	1006.0	1008.6	0.26	Pass	1012.1	0.61	Pass	N/A	Pass
022	995.4	996.6	0.12	Pass	999.2	0.38	Pass	N/A	Pass
003	996.0	997.8	0.18	Pass	1001.1	0.51	Pass	N/A	Pass
007	1004.3	1005.4	0.11	Pass	1007.8	0.35	Pass	N/A	Pass
012	995.1	996.1	0.10	Pass	1000.7	0.56	Pass	N/A	Pass
004	994.9	996.6	0.17	Pass	998.5	0.36	Pass	N/A	Pass

Table 4.4.1 Endurance Sub Group IV, ESA/SCC 4006/013 Variant 01 (1K3A351)

Serial No.	Ro @ 0 Hours	Ro @ 1000 H	Drift 1000 H % ± 1.0 Max	Insulation Resistance @ 1000 H	Ro @ 2000 H	Drift 2000 H % ± 1.0 Max	Insulation Resistance @ 2000 H	Mark Permancy	External Visual Inspection
							Pass		
023	5048	5062	0.28	Pass	5073	0.50	Pass	N/A	Pass
041	5041	5052	0.22	Pass	5059	0.36	Pass	N/A	Pass
011	5046	5053	0.14	Pass	5070	0.48	Pass	N/A	Pass
021	5037	5047	0.20	Pass	5058	0.42	Pass	N/A	Pass
008	5039	5051	0.24	Pass	5064	0.50	Pass	N/A	Pass
040	5035	5050	0.30	Pass	5058	0.46	Pass	N/A	Pass
010	5036	5057	0.42	Pass	5070	0.68	Pass	N/A	Pass
029	5045	5058	0.26	Pass	5069	0.48	Pass	N/A	Pass
017	5035	5044	0.18	Pass	5054	0.38	Pass	N/A	Pass
025	5034	5046	0.24	Pass	5057	0.46	Pass	N/A	Pass
001	5018	5029	0.22	Pass	5043	0.50	Pass	N/A	Pass
024	5005	5018	0.26	Pass	5029	0.48	Pass	N/A	Pass
039	5001	5016	0.30	Pass	5024	0.46	Pass	N/A	Pass
004	5012	5024	0.24	Pass	5040	0.56	Pass	N/A	Pass
003	5018	5032	0.28	Pass	5047	0.58	Pass	N/A	Pass
028	5013	5023	0.20	Pass	5033	0.40	Pass	N/A	Pass
032	5003	5019	0.32	Pass	5028	0.50	Pass	N/A	Pass
002	5002	5015	0.26	Pass	5031	0.58	Pass	N/A	Pass
005	5019	5034	0.30	Pass	5052	0.66	Pass	N/A	Pass
042	5014	5026	0.24	Pass	5034	0.40	Pass	N/A	Pass

Table 4.4.2 Endurance Sub Group IV, ESA/SCC 4006/013 Variant 05 (5K3A355)

Serial No.	Ro @ 0 Hours	Ro @ 1000 H	Drift 1000 H % ± 1.0 Max	Insulation Resistance @ 1000 H	Ro @ 2000 H	Drift 2000 H % ± 1.0 Max	Insulation Resistance @ 2000 H	Mark Permancy	External Visual Inspection
033	2004	2015	0.55	Pass	2017	0.65	Pass	Pass	Pass
011	2023	2034	0.54	Pass	2037	0.69	Pass	Pass	Pass
012	2022	2032	0.49	Pass	2036	0.69	Pass	Pass	Pass
005	2021	2032	0.54	Pass	2036	0.74	Pass	Pass	Pass
023	2022	2035	0.64	Pass	2038	0.79	Pass	Pass	Pass
043	2007	2020	0.65	Pass	2022	0.75	Pass	Pass	Pass
037	2025	2039	0.69	Pass	2043	0.89	Pass	Pass	Pass
041	2026	2036	0.49	Pass	2039	0.64	Pass	Pass	Pass
042	2023	2035	0.59	Pass	2040	0.84	Pass	Pass	Pass
029	2005	2023	0.90	Pass	2027	1.10(FAIL)	Pass	Pass	Pass
022	2007	2019	0.60	Pass	2023	0.80	Pass	Pass	Pass
027	2027	2036	0.44	Pass	2040	0.64	Pass	Pass	Pass
009	2023	2036	0.64	Pass	2040	0.84	Pass	Pass	Pass
035	2004	2017	0.65	Pass	2021	0.85	Pass	Pass	Pass
020	2007	2020	0.65	Pass	2024	0.85	Pass	Pass	Pass
015	2007	2019	0.60	Pass	2024	0.85	Pass	Pass	Pass
018	2007	2019	0.60	Pass	2024	0.85	Pass	Pass	Pass
014	2005	2021	0.80	Pass	2026	1.00	Pass	Pass	Pass
034	2005	2017	0.60	Pass	2022	0.85	Pass	Pass	Pass
010	2023	2036	0.64	Pass	2040	0.84	Pass	Pass	Pass

Table 4.4.3 Endurance Sub Group IV, ESA/SCC 4006/014 Variant 01 (G2K7D110)

Serial No.	Ro @ 0 Hours	Ro @ 1000 H	Drift 1000 H % ± 1.0 Max	Insulation Resistance @ 1000 H	Ro @ 2000 H	Drift 2000 H % ± 1.0 Max	Insulation Resistance @ 2000 H	Mark Permancy	External Visual Inspection
020	15022	15076	0.36	Pass	15093	0.47	Pass	Pass	Pass
013	15008	15042	0.23	Pass	15049	0.27	Pass	Pass	Pass
043	14999	15068	0.46	Pass	15087	0.59	Pass	Pass	Pass
041	15008	15060	0.35	Pass	15074	0.44	Pass	Pass	Pass
003	15012	15088	0.51	Pass	15121	0.73	Pass	Pass	Pass
034	15000	15046	0.31	Pass	15048	0.32	Pass	Pass	Pass
038	14995	15061	0.44	Pass	15079	0.56	Pass	Pass	Pass
037	14992	15054	0.41	Pass	15067	0.50	Pass	Pass	Pass
016	14997	15054	0.38	Pass	15077	0.53	Pass	Pass	Pass
021	14990	15028	0.25	Pass	15035	0.30	Pass	Pass	Pass
008	14888	14915	0.18	Pass	14925	0.25	Pass	Pass	Pass
002	14907	14973	0.44	Pass	15011	0.70	Pass	Pass	Pass
039	14927	14967	0.27	Pass	14972	0.30	Pass	Pass	Pass
004	14933	14956	0.15	Pass	14958	0.17	Pass	Pass	Pass
010	14996	15072	0.51	Pass	15098	0.68	Pass	Pass	Pass
017	14932	14949	0.11	Pass	14946	0.09	Pass	Pass	Pass
011	14947	14982	0.23	Pass	14987	0.27	Pass	Pass	Pass
014	14956	15005	0.33	Pass	15015	0.39	Pass	Pass	Pass
001	14952	14974	0.15	Pass	14989	0.25	Pass	Pass	Pass
009	14949	14970	0.14	Pass	14971	0.15	Pass	Pass	Pass

Table 4.4.4 Endurance Sub Group IV, ESA/SCC 4006/014 Variant 04 (G15K4D112)

Serial No.	Ro @ 0 Hours	Ro @ 1000 H	Drift 1000 H % ± 1.0 Max	Insulation Resistance @ 1000 H	Ro @ 2000 H	Drift % 1.0 Max	Insulation Resistance @ 2000 H	Mark Permancy	External Visual Inspection
025	100790	101102	0.31	Pass	101352	0.56	Pass	Pass	Pass
039	100634	100988	0.35	Pass	101105	0.47	Pass	Pass	Pass
029	100480	100896	0.41	Pass	101058	0.58	Pass	Pass	Pass
014	100506	100840	0.33	Pass	100890	0.38	Pass	Pass	Pass
019	100500	100853	0.35	Pass	100897	0.40	Pass	Pass	Pass
032	100339	100678	0.34	Pass	100799	0.46	Pass	Pass	Pass
008	100366	100726	0.36	Pass	100987	0.62	Pass	Pass	Pass
021	100274	100601	0.33	Pass	100916	0.64	Pass	Pass	Pass
004	100237	100520	0.28	Pass	99,802	- 0.43	Pass	Pass	Pass
035	100237	100580	0.34	Pass	100,746	0.51	Pass	Pass	Pass
023	99376	99715	0.34	Pass	99801	0.43	Pass	Pass	Pass
036	99276	99678	0.40	Pass	99851	0.58	Pass	Pass	Pass
040	100084	100434	0.35	Pass	100654	0.57	Pass	Pass	Pass
010	99448	99766	0.32	Pass	99912	0.47	Pass	Pass	Pass
030	99435	99770	0.34	Pass	99864	0.43	Pass	Pass	Pass
018	99477	99884	0.41	Pass	100072	0.60	Pass	Pass	Pass
017	99455	99829	0.38	Pass	99917	0.46	Pass	Pass	Pass
022	99496	99829	0.33	Pass	100023	0.53	Pass	Pass	Pass
015	99491	99889	0.40	Pass	100034	0.55	Pass	Pass	Pass
034	99488	99841	0.35	Pass	100010	0.52	Pass	Pass	Pass

Table 4.4.5 Endurance Sub Group IV, ESA/SCC 4006/01 Variant 05 (G100K6D116)

4.5 Sub – Group V: Endurance

20 Components from each of the 5 "Qualification Lots" were tested to Sub Group V as described in ESA/SCC Generic specification 4006. (CHART IV) and the relevant requirements of ESA/SCC Detail Specifications 4006/013 and 014. As referenced in Section 4 to this Qualification Report, the testing for 'Short Time Load' and 'High Temperature Storage' does not apply to any of the Qualification vehicles.

The tests conducted and the location of the tests was as follows:

TEST DESCRIPTION	LOCATION.
Ro @ 25^0C Pre Low Temp Storage	Beattherm
Low Temperature Storage (9.16)	Betatherm
Ro @ 25^0C Post Low Temp Storage	Betatherm
Drift post Low Temp storage.	Betatherm
External Visual Inspection. (9.5)	Betatherm

The results of testing of ESA/SCC 4006/013 Variant 01 & 05 are shown in Tables 4.5.1 and 4.5.2.

The results of testing of ESA/SCC 4006/014 Variant 01, 04 & 05 are shown in Tables 4.5.3, 4.5.4 and 4.5.5.

Serial No.	Ro Pre L.T. Storage	Ro Post L.T.Storage	% Drift ± 2.0 Max	External Visual Inspection
024	998.6	1001.2	0.26	Pass
026	997.5	998.7	0.12	Pass
027	1002.7	1003.0	0.03	Pass
028	999.3	1000.6	0.13	Pass
030	1002.4	1003.0	0.06	Pass
032	999.3	999.7	0.04	Pass
033	998.5	998.8	0.03	Pass
034	1001.4	1002.7	0.13	Pass
035	1001.1	1001.3	0.02	Pass
038	999.6	1000.4	0.08	Pass
039	998.8	1001.5	0.27	Pass
041	1003.2	1005.4	0.22	Pass
043	996.7	999.3	0.26	Pass
044	996.4	998.6	0.22	Pass
045	999.3	1000.7	0.14	Pass
048	1001.1	1002.0	0.09	Pass
049	1001.0	1002.7	0.17	Pass
050	1001.8	1002.6	0.08	Pass
064	997.4	997.7	0.03	Pass
072	999.6	1000.4	0.08	Pass

Table 4.5.1 Endurance Sub Group V, ESA/SCC 4006/013 Variant 01 (1K3A351)

Serial No.	Ro Pre L.T. Storage	Ro Post L.T.Storage	% Drift ± 2.0 Max	External Visual Inspection
035	5013	5025	0.24	Pass
036	5022	5028	0.12	Pass
037	5019	5028	0.18	Pass
044	5005	5012	0.14	Pass
045	5032	5039	0.14	Pass
046	5023	5034	0.22	Pass
047	5020	5030	0.20	Pass
048	5023	5028	0.10	Pass
049	5019	5024	0.10	Pass
050	5028	5038	0.20	Pass
051	5021	5030	0.18	Pass
052	4992	4997	0.10	Pass
053	5016	5022	0.12	Pass
054	5010	5016	0.12	Pass
055	5030	5036	0.12	Pass
056	5034	5042	0.16	Pass
057	5024	5033	0.18	Pass
058	5028	5036	0.16	Pass
059	5012	5020	0.16	Pass
060	5017	5023	0.12	Pass

Table 4.5.2 Endurance Sub Group V, ESA/SCC 4006/013 Variant 05 (5K3A355)

Serial No.	Ro Pre L.T. Storage	Ro Post L.T.Storage	% Drift ± 2.0 Max	External Visual Inspection
053	2004	2005	0.05	Pass
052	2012	2014	0.10	Pass
051	2008	2010	0.10	Pass
050	2008	2011	0.15	Pass
049	2011	2011	0.00	Pass
048	2017	2018	0.05	Pass
046	2011	2015	0.20	Pass
045	2022	2023	0.05	Pass
044	2014	2013	-0.05	Pass
040	2009	2011	0.10	Pass
039	2009	2011	0.10	Pass
038	2009	2010	0.05	Pass
036	2018	2021	0.15	Pass
032	2020	2020	0.00	Pass
031	2020	2020	0.00	Pass
030	2012	2021	0.45	Pass
028	2020	2015	-0.25	Pass
026	2009	2013	0.20	Pass
025	2011	2017	0.30	Pass
024	2011	2013	0.10	Pass

Table 4.5.3 Endurance Sub Group V, ESA/SCC 4006/014 Variant 01 (G2K7D110)

Serial No.	Ro Pre L.T. Storage	Ro Post L.T.Storage	% Drift ± 2.0 Max	External Visual Inspection
040	14956	14982	0.17	Pass
036	14938	14963	0.17	Pass
033	14958	14984	0.17	Pass
032	14968	14,989	0.14	Pass
030	14946	14966	0.13	Pass
029	14973	15005	0.21	Pass
028	14957	14975	0.12	Pass
027	14973	14990	0.11	Pass
026	14936	14993	0.38	Pass
025	14971	15010	0.26	Pass
024	14966	14980	0.09	Pass
023	14967	15007	0.27	Pass
022	14974	14991	0.11	Pass
019	14962	15000	0.25	Pass
018	14968	14986	0.12	Pass
015	14949	14994	0.30	Pass
012	14969	14989	0.13	Pass
007	14937	14979	0.28	Pass
006	14962	14978	0.11	Pass
005	14979	15003	0.16	Pass

Table 4.5.4 Endurance Sub Group V, ESA/SCC 4006/014 Variant 04 (G15K4D112)

Serial No.	Ro Pre L.T. Storage	Ro Post L.T.Storage	% Drift ± 2.0 Max	External Visual Inspection
033	99573	99605	0.03	Pass
041	99652	99661	0.01	Pass
043	100129	100197	0.07	Pass
044	100034	100135	0.10	Pass
045	99508	99622	0.11	Pass
048	99919	100164	0.25	Pass
049	99864	100091	0.23	Pass
050	100475	100653	0.18	Pass
051	100469	100553	0.08	Pass
052	99749	99822	0.07	Pass
053	100518	100636	0.12	Pass
054	100248	100326	0.08	Pass
056	99425	99474	0.05	Pass
055	100288	100328	0.04	Pass
057	100438	100472	0.03	Pass
058	100221	100299	0.08	Pass
060	100135	100216	0.08	Pass
061	100042	100221	0.18	Pass
062	99936	99937	0.00	Pass
063	99843	99888	0.05	Pass

Table 4.5.5 Endurance Sub Group 5, ESA/SCC 4006/014 Variant 05 (G100K6D116)