



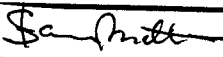

**european space agency
agence spatiale européenne**

Pages 1 to 26

**CRYSTAL UNITS IN METAL HOLDER,
BASED ON TYPE T2111,
FREQUENCY RANGE 0.8 - 50MHZ
ESA/SCC Detail Specification No. 3501/003**



**space components
coordination group**

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		SCCG Chairman	ESA Director General or his Deputy
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DOCUMENTATION CHANGE NOTICE

Rev. Letter	Rev. Date	Reference	CHANGE Item	Approved DCR No.
		This Issue supersedes Issue 2 and incorporates all modifications defined in Revisions 'A', 'B', 'C', 'D' and 'E' to Issue 2 and the changes agreed in the following DCRs:-		
		Cover Page		None
		DCN		None
		Table 1(a)	: Storage Temperature Range column deleted	221336
		Table 1(b)	: No. 4, in Remarks, Note number amended	221336
			: No. 5, in Remarks, Note number amended	221336
			: New Note 3 added	221336
			: Existing Note 3 renumbered as "4"	221336
		Table 1(c)	: Item 20 deleted	221336
			: Existing Item 21 renumbered as "20"	221336
		Figure 2	: Drawing and Table amended	221381
			: Vibration Axes and Notes added	221381
		Para. 4.3.3	: Second sentence deleted	221341
		Para. 4.5.1	: Existing text deleted and new text added	221465
		Para. 4.5.5	: Deleted in toto	221465
		Para. 4.5.6	: Renumbered to "4.5.5"	221465
		Para. 4.6.1	: Second sentence rewritten	221341
		Para. 4.6.3	: Deleted in toto	221341
		Para. 4.6.4	: Renumbered to "4.6.3"	221341
		Table 6	: Table reformatted	23799/ 221341/ 221380/ 221465 221336
		Ind. Tables 1(a)	: Item 20 deleted	

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1	Parameter Derating Information	N/A
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4	Circuits for Electrical Measurements	N/A
5	Electrical Circuit for Burn-in and Life Test	N/A

APPENDICES (Applicable to specific Manufacturers only)

None.

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1. GENERAL

1.1 SCOPE

This specification details the values, physical and electrical characteristics, test and inspection data for Crystal Units in Metal Holder, based on Type T2111, Frequency Range 0.8 - 50MHz.

It shall be read in conjunction with ESA/SCC Generic Specification No. 3501, the requirements for which are supplemented herein.

1.2 TYPE VARIANTS

A list of the type variants of the crystal units specified herein, which are also covered by this specification, is given in "Table 1(a) - Type Variant Summary".

For each type variant, the full electrical and physical characteristics are given in individual Tables 1(a) - "Type Variant Detailed Information" at the end of this specification.

The contents of the individual Tables 1(a) shall be as shown in Table 1(c) and the characteristics therein listed shall relate to the design parameters of the individual crystal units, optimised for the intended application.

The specific characteristics shall be negotiated between the Manufacturer and the Orderer. The Manufacturer shall then apply to the ESA/SCC Secretariat for a type variant number for each individual crystal unit concerned, by sending a finalised Table 1(a) which shall also be copied to the Qualifying Space Agency (QSA).

1.3 MAXIMUM RATINGS

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

1.4 PHYSICAL DIMENSIONS

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

1.5 FUNCTIONAL DIAGRAM

The functional diagram showing lead identification of the crystal units specified herein is shown in Figure 3.

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TABLE 1(a) - TYPE VARIANT SUMMARY

Variant	Resonance Frequency (MHz)	Load Capacitance (C _L pF)	Reference Temp. (T _o °C)	Operating Temp. Range (T _{op} °C)	Intended Applicat.	Lead Length (Dim. L mm)	
						Min.	Max.
01	2.0736	30	+ 25	-55 to + 105	-	25.0	26.0
02	2.0	30	+ 25	-20 to + 60	-	25.0	26.0
03	2.4576	20	+ 25	-40 to + 70	-	25.0	26.0
04	2.304	30	+ 25	-40 to + 70	-	25.0	26.0
25	20.125984	27.5	+ 56	+ 53 to + 58	-	25.0	26.0
60	1.536	30	+ 25	0 to + 80	-	25.0	26.0

NOTES

1. Full electrical and physical characteristics are given in the individual Tables 1(a) at the end of this specification.



TABLE 1(b) - MAXIMUM RATINGS

No.	Characteristic	Symbol	Values	Unit	Remarks
1	Nominal Frequency Range	f	0.8 to 50	MHz	Note 1
2	Drive Level Range	P	0.1 to 2.0	mW	
3	Operating Temperature Range	T _{op}	-	°C	Note 2
4	Storage Temperature Range	T _{stg}	-65 to +125	°C	Note 3
5	Soldering Temperature	T _{sol}	+260	°C	Note 4

NOTES

1.

Fundamental and Overtone Order	Approx. Frequency Range (MHz)
Fundamental	0.8 to 10
3	10 to 30
5	15 to 50

2. See Table 1(a).

3. The duration at maximum storage temperature shall not exceed 16 hours.

4. Duration 10 seconds maximum at a distance of not less than 3.0mm from the device body and the same lead shall not be resoldered until 3 minutes have elapsed.

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TABLE 1(c) - FORMAT FOR INDIVIDUAL TABLES 1(a)**TABLE 1(a) - TYPE VARIANT DETAILED INFORMATION**

TYPE VARIANT NO. _____

No.	Characteristic	Symbol	Limits		Unit	Remarks
			Min.	Max		
1	Resonance Frequency	f_r or f_L			MHz	Note 1
2	Reference Temperature	T_o			°C	Note 2
3	Overtone Order	-				
4	Load Capacitance	C_L			pF	Note 3
5	Rated Drive Level	P_o			mW	Note 4
6	Frequency Adjustment Tolerance	$\frac{\Delta f}{f}$			10 ⁻⁶	At T_o °C Note 5
7	Resonance Resistance	R_r or R_L			Ω	At T_o °C Note 6
8	Frequency Variation with Temperature over T_{op}	$\frac{\Delta f}{f}$			10 ⁻⁹	From frequency measured at T_o °C Note 7
9	Resistance Variation with Temperature over T_{op}	$\frac{\Delta R}{R}$			%	From resistance measured at T_o °C Note 7
10	Operating Temperature Range	T_{op}			°C	
11	Frequency variation with Drive Level	$\frac{\Delta f}{f}$			10 ⁻⁶	From $P_{S1} =$ mW to $P_{S2} =$ mW Note 8
12	Resistance variation with Drive Level	$\frac{\Delta R}{R}$			%	From $P_{S1} =$ mW to $P_{S2} =$ mW Note 8
13	Motional Inductance	L_1			mH	Notes 9 and 10
14	Motional Capacitance	C_1			fF	Note 9
15	Static Capacitance	C_o			pF	Note 9
16	Q Factor	Q			-	Notes 9 and 11
17	Ratio of unwanted: Response Resistance to Resonance Resistance or Response Impedance to Resonance Resistance	R_p/R or $ Z_p /R$				In the frequency range: f - kHz to f + kHz
18	Ageing	$\frac{\Delta f}{f}$			10 ⁻⁶	Note 13
19	Terminal length	C			mm	Note 14
20	Intended Application					Note 16

NOTES: See Pages 9 and 10.

**NOTES TO TABLE 1(c)**

1. (a) If C_L is not specified, Symbol and measurement shall be f_r .
(b) If C_L is specified, Symbol and measurement shall be f_L .
2. Reference Temperature T_0
 - (a) For a crystal unit functioning in a non-controlled temperature environment, the reference temperature is normally $+25 \pm 2$ °C.
 - (b) For a crystal unit functioning in a controlled temperature environment, the reference temperature shall normally be the mid-point of the temperature range of the controlled environment.
3. Load Capacitance C_L
 - (a) When a crystal unit must function at its series resonance frequency, C_L shall be infinite.
 - (b) When a crystal must function with a load capacitance, the C_L value shall be specified. The standard values of load capacitance are as follows:
 - Fundamental Frequency Operation: 20pF, 30pF, 50pF and 100pF.
 - Overtone Operation: 8pF, 12pF, 15pF, 20pF and 30pF.

N.B

The tolerance on the load capacitance shall be that value which results in a frequency change not exceeding 10% of the frequency tolerance at T_0 or 1% of the nominal load capacitance, whichever is smaller.

4. Rated Drive Level P_0

The rated drive level shall be selected from the standard drive levels specified below:

 - Preferred values: 2mW, 1mW, 0.5mW, 0.2mW, 0.1mW, 0.05mW, 0.02mW, 0.01mW, 0.001mW or 0.0001mW at $\pm 20\%$.
 - Non-preferred values: 10mW, 5mW and 4mW all at $\pm 20\%$.
5. Frequency Adjustment Tolerance
 - (a) When a crystal must function at its series resonance frequency, the standard value of the adjustment tolerance shall be $\pm 10 \times 10^{-6}$.
 - (b) When a crystal has to function with a load capacitance, the standard value of the adjustment tolerance shall also be $\pm 10 \times 10^{-6}$. However, if the load capacitance is adjustable, it is preferable to specify that the nominal frequency be obtained with a load capacitance value between the minimum and maximum value when the crystal is functioning in its fundamental mode.
6. Resonance Resistance
 - (a) Generally, the maximum value only is specified.
 - (b) R_L may be calculated by $R_L = R_r \left(1 + \frac{C_0}{C_L} \right)^2$
7. Frequency and Resistance Variation with Temperature

These values shall be specified such that they are consistent with the operating temperature range.
8. Frequency and Resistance Variation with Drive Level

These limits and the Drive Level range (P_{S1} to P_{S2}) shall be specified for very special crystals only (i.e. crystals used in very high stability oscillators).

**NOTES TO TABLE 1(c) (Continued)****9. Electrical Values**

The electrical values shall be specified only when required for the correct functioning of the equipment in which the crystal is used.

10. Motional Inductance L_1

Because the inductance value may be restricted by other chosen parameters, the Manufacturer shall propose the value of L_1 in accordance with the Customer's requirements.

11. 'Q' Factor

If 'R' and 'L' have been already specified, it will not be necessary to specify the minimum value of the 'Q' factor.

The maximum value of the 'Q' factor is never specified.

12. Ratio of Unwanted Response Resistance to Resonance Resistance

The standard minimum value is 2, but it is possible to obtain higher values.

The frequency range within which the minimum value of the ratio is required shall also be specified.

13. Ageing

Specify limits under appropriate column and ageing period under "Remarks".

14. Terminal Lengths

To be specified if different from Figure 2 dimensions. If dimensions are as per Figure 2 then "Figure 2" to be entered in the Limits column.

15. Not applicable Items

For all items where limits are not specified, "Not applicable" shall be entered in the Limits column.

16. Intended Application

For definitions of the selected symbols to be added, see ESA/SCC Generic Specification No. 3501, Para. 3.



FIGURE 1 - PARAMETER DERATING INFORMATION

Not applicable.

FIGURE 2 - PHYSICAL DIMENSIONS

Symbol	Millimetres		Remarks
	Min.	Max.	
$\varnothing A$	-	22.00	
C	-	11.60	
H	9.29	9.77	Pitch 9.52mm
$\varnothing K$	0.40	0.48	
L	12.70	-	
P	-	0.90	Note 2
Q	-	0.95	Note 2

NOTES

- Lead No. 4 is grounded to case.
- The tag's position or presence is optional.

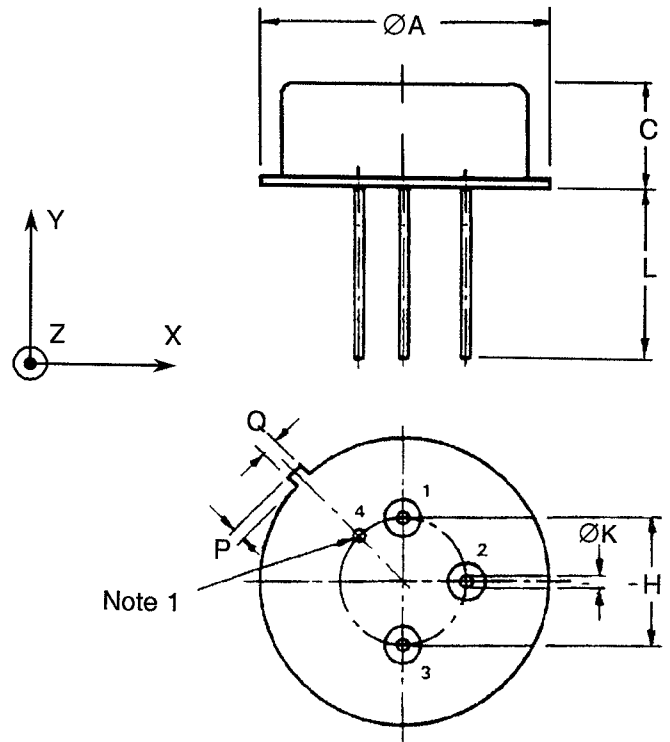
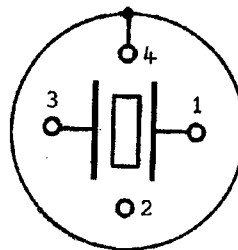


FIGURE 3 - FUNCTIONAL DIAGRAM



(Bottom View)

NOTES

- Crystal connections 1 and 3.
- Terminal 4 connected to Case.
- Terminal 2 not connected.

**2. APPLICABLE DOCUMENTS**

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

- (a) ESA/SCC Generic Specification No. 3501 for Quartz Crystal Units.

3. TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

For the purpose of this specification, the terms, definitions, abbreviations, symbols and units specified in ESA/SCC Basic Specification No. 21300 shall apply. In addition, the following symbols are used:-

Resonance Frequency	= f_r
Load Resonance Frequency	= f_L
Reference Temperature	= T_o
Resonance Resistance	= R_r
Load Resonance Resistance	= R_L
Rated Drive Level	= P_o
Static Capacitance	= C_o
Load Capacitance	= C_L
Motional Capacitance	= C_1
Motional Inductance	= L_1
Response Resistance	= R_p
Response Impedance	= $ Z_p $
Insulation Resistance	= R_i

4. REQUIREMENTS**4.1 GENERAL**

The complete requirements for procurement of the crystal units specified herein shall be as stated in this specification and ESA/SCC Generic Specification No. 3501 for Quartz Crystal Units. Deviations from the Generic Specification applicable to this specification only, are detailed in Para. 4.2.

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

4.2 DEVIATIONS FROM GENERIC SPECIFICATION**4.2.1 Deviations from Special In-process Controls**

None.

4.2.2 Deviations from Final Production Tests (Chart II)

None.

4.2.3 Deviations from Burn-in Tests (Chart III)

None.

4.2.4 Deviations from Qualification Tests (Chart IV)

None.

4.2.5 Deviations from Lot Acceptance Tests (Chart V)

None.



4.3 MECHANICAL REQUIREMENTS

4.3.1 Dimension Check

The dimensions of the crystal units specified herein shall be checked. They shall conform to those shown in Figure 2.

4.3.2 Weight

The maximum weight of the crystal units specified herein shall be 7.0 grammes.

4.3.3 Robustness of Terminations

The requirements for robustness of termination testing are specified in Section 9 of ESA/SCC Generic Specification No. 3501.

4.4 MATERIALS AND FINISHES

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

4.4.1 Case

4.4.1.1 Cap

Copper, nickel plated and gold plated.

4.4.1.2 Base

Kovar, nickel plated and gold plated.

4.4.2 Lead Material and Finish

The lead material shall be Type 'D' with Type '2' finish in accordance with the requirements of ESA/SCC Basic Specification No. 23500.

4.5 MARKING

4.5.1 General

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

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

- (a) The SCC Component Number.
- (b) Characteristics.
- (c) Traceability Information.

4.5.2 The SCC Component Number

Each component shall bear the SCC Component Number, which shall be constituted and marked as follows:-

Detail Specification Number _____ 350100301B
Type Variant, (see Table 1(a)) _____
Testing Level (B or C, as applicable) _____



4.5.3 Characteristics

The resonance frequency of the crystal units shall be clearly specified in MHz. Where necessary, it shall be specified to 6 decimal places.

4.5.4 Traceability Information

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

4.5.5 Manufacturer's Name, Symbol or Code

The Manufacturer's marking shall be in accordance with the requirements of ESA/SCC Basic Specification No. 21700.

4.6 ELECTRICAL MEASUREMENTS

4.6.1 Electrical Measurements at Reference Temperature

The parameters to be measured in respect of electrical characteristics are scheduled in Table 2. The measurements shall be performed at the temperatures specified in the individual Tables 1(a), Item 2.

4.6.2 Electrical Measurements at High and Low Temperatures

The parameters to be measured at high and low temperatures are scheduled in Table 3. These measurements shall only be performed if values are specified in Table 1(a) Items 8 and/or 9.

4.6.3 Circuits for Electrical Measurements (Figure 4)

Not applicable.

4.7 BURN-IN TESTS

4.7.1 Parameter Drift Values

The parameter drift values applicable to burn-in are specified in Table 4 of this specification. Unless otherwise stated, measurements shall be performed at $T_{amb} = T_o \pm 2^\circ\text{C}$. The parameter drift values (Δ) applicable to the scheduled parameters shall not be exceeded. In addition to these drift value requirements for a given parameter, the appropriate limit value specified in Table 2 shall not be exceeded.

4.7.2 Conditions for Burn-in

The requirements for burn-in are specified in Section 7 of ESA/SCC Generic Specification No. 3501. The conditions for burn-in shall be as specified in Table 5 of this specification.

4.7.3 Electrical Circuits for Burn-in (Figure 5)

Not applicable.

**TABLE 2 - ELECTRICAL MEASUREMENTS AT REFERENCE TEMPERATURE**

No.	Characteristics	Symbol	ESA/SCC 3501 Test Method	Limits	Unit
1	Resonance frequency at reference temperature and rated drive level - with C_O - with C_L	$f_r (T_o, P_o)$ $f_L (T_o, P_o)$	Para. 9.2.1.1	Table 1(a), Item 1 \pm Item 6	MHz
2	Resonance resistance at reference temperature and rated drive level - with C_O - with C_L	$R_r (T_o, P_o)$ $R_L (T_o, P_o)$	Para. 9.2.1.1	Table 1(a), Item 7	Ω
3	Frequency variation with Drive Level	$\frac{\Delta f}{f} (T_o, \Delta P)$	Para. 9.2.1.1	Table 1(a), Item 11	10^{-6}
4	Resistance variation with Drive Level	$\frac{\Delta R}{R} (T_o, \Delta P)$	Para. 9.2.1.1	Table 1(a), Item 12	%
5	Motional Inductance	L_1	Para. 9.2.1.3	Table 1(a), Item 13	mH
6	Static Capacitance	C_o	Para. 9.2.1.4	Table 1(a), Item 15	pF
7	Unwanted response	R_p/R or $ Z_p /R$	Para. 9.2.1.5	Table 1(a), Item 17	-
8	Insulation Resistance	R_i	Para. 9.2.1.6	500 Min.	M Ω

TABLE 3 - ELECTRICAL MEASUREMENTS AT HIGH AND LOW TEMPERATURES

No.	Characteristics	Symbol	ESA/SCC 3501 Test Method	Limits	Unit
9	Frequency variation with Temperature over T _{op}	$\frac{\Delta f}{f} (\Delta T, P_o)$	Para. 9.2.1.2	Table 1(a) Item 8	10 ⁻⁶
10	Resistance variation with Temperature over T _{op}	$\frac{\Delta R}{R} (\Delta T, P_o)$	Para. 9.2.1.2	Table 1(a) Item 9	%

FIGURE 4 - CIRCUITS FOR ELECTRICAL MEASUREMENTS

Not applicable.

TABLE 4 - PARAMETER DRIFT VALUES

No.	Characteristics	Symbol	Spec. and/or Test Method	Test Conditions	Change Limits (Δ)	Unit
1	Resonance frequency drift	$\frac{\Delta f}{f}$	As per Table 2	As per Table 2	± 2.0	10 ⁻⁶
2	Resonance resistance drift	$\frac{\Delta R}{R}$	As per Table 2	As per Table 2	± 10 or (1) ± 1.0	% Ω

NOTES 1. Whichever is the highest value.

TABLE 5 - CONDITIONS FOR BURN-IN AND LIFE TEST

No.	Characteristics	Symbol	Condition	Unit
1	Ambient Temperature	T _{amb}	+ 85 ± 5	°C

FIGURE 5 - ELECTRICAL CIRCUIT FOR BURN-IN AND LIFE TEST

Not applicable.



4.8 ENVIRONMENTAL AND ENDURANCE TESTS (CHARTS IV AND V OF ESA/SCC GENERIC SPECIFICATION NO. 3501)

4.8.1 Measurements and Inspections on Completion of Environmental Tests

The parameters to be measured and inspections to be performed on completion of environmental tests are scheduled in Table 6. Unless otherwise stated, the measurements shall be performed at $T_{amb} = T_o \pm 2^\circ\text{C}$.

4.8.2 Measurements and Inspections at Intermediate Points and on Completion of Endurance Tests

The parameters to be measured and inspections to be performed at intermediate points and on completion of endurance tests are scheduled in Table 6. Unless otherwise stated, the measurements shall be performed at $T_{amb} = T_o \pm 2^\circ\text{C}$.

4.8.3 Conditions for Operating Life Test (Part of Endurance Testing)

The requirements for the operating life test are specified in Section 9 of ESA/SCC Generic Specification No. 3501. The test shall be performed as a high temperature storage test and the temperature to be applied shall be the maximum operating temperature specified in the individual Tables 1(a) given in this specification.



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

NO.	ESA/SCC GENERIC SPEC. NO. 3501		MEASUREMENTS AND INSPECTIONS		SYMBOL	LIMITS		UNIT
	ENVIRONMENTAL AND ENDURANCE TESTS (1)	TEST METHOD AND CONDITIONS	IDENTIFICATION	CONDITIONS		Min.	Max.	
01	Electrical Measurements at Reference Temperature	Para. 9.2.4	Electrical Measurements	Table 2		Table 1(a)		
02	Shock	Para. 9.3	Initial Measurements Resonance Frequency Resonance Resistance Final Measurements Resonance Frequency Drift Resonance Resistance Drift	Table 2 Item 1 Table 2 Item 2 Table 2 Item 1 Table 2 Item 2	f R $\frac{\Delta f}{f}$ $\frac{\Delta R}{R}$ ΔR	Table 2 Item 1 Table 2 Item 2 - 1.0 - 10 or (2) - 1.0	+ 1.0 + 10 + 1.0	10 ⁻⁶ % Ω
03	Vibration	Para. 9.4	Initial Measurements Resonance Frequency Resonance Resistance Final Measurements Resonance Frequency Drift Resonance Resistance Drift	Table 2 Item 1 Table 2 Item 2 Table 2 Item 1 Table 2 Item 2	f R $\frac{\Delta f}{f}$ $\frac{\Delta R}{R}$ ΔR	Table 2 Item 1 Table 2 Item 2 - 1.0 - 10 or (2) - 1.0	+ 1.0 + 10 + 1.0	10 ⁻⁶ % Ω
04	Seal Test	Para. 9.5	Fine Leak Gross Leak	Para. 9.5.1 Para. 9.5.2		Para. 9.5.1 Para. 9.5.2		
05	Permanence of Marking	Para. 9.8	Final Measurements Visual Examination	No corrosion or obliteration of marking	-	-	-	-
06	External Visual Inspection	Para. 9.9	Final Measurements Visual Inspection	ESA/SCC No. 20500	-	-	-	-
07	Solderability	Para. 9.13	-	-	-	-	-	-

NOTES

1. The tests in this table refer to either Chart IV or V, and shall be used as applicable.
2. Whichever is the highest value.



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**TABLE 6 - MEASUREMENTS AND INSPECTIONS ON COMPLETION OF ENVIRONMENTAL TESTS
AND AT INTERMEDIATE POINTS AND ON COMPLETION OF ENDURANCE TESTING (Cont.)**

NO.	ESA/SCC GENERIC SPEC. NO. 3501		MEASUREMENTS AND INSPECTIONS		SYMBOL	LIMITS		UNIT
	ENVIRONMENTAL AND ENDURANCE TESTS (1)	TEST METHOD AND CONDITIONS	IDENTIFICATION	CONDITIONS		Min.	Max.	
08	Climatic Sequence Dry Heat	Para. 9.14 Para. 9.14.1	Initial Measurements Resonance Frequency Resonance Resistance Final Measurements Resonance Frequency Drift Resonance Resistance Drift	Table 2 Item 1 Table 2 Item 2	f R	Table 2 Item 1 Table 2 Item 2		
			Resonance Frequency Drift	Table 2 Item 1	$\frac{\Delta f}{f}$	-2.0	+2.0	10 ⁻⁶
			Resonance Resistance Drift	Table 2 Item 2	$\frac{\Delta R}{R}$	-10 or (2)	+10	%
09	Cold	Para. 9.14.3	Initial Measurements Resonance Frequency Resonance Resistance Final Measurements Resonance Frequency Drift Resonance Resistance Drift	Table 2 Item 1 Table 2 Item 2	f R	Para. 9.14.1.3 Final Measurements		
			Resonance Frequency Drift	Table 2 Item 1	$\frac{\Delta f}{f}$	-2.0	+2.0	10 ⁻⁶
			Resonance Resistance Drift	Table 2 Item 2	$\frac{\Delta R}{R}$	-10 or (2)	+10	%
					ΔR	-1.0	+1.0	Ω
10	Damp Heat (Accelerated) Remaining Cycles	Para. 9.14.4	Initial Measurements Resonance Frequency Resonance Resistance Final Measurements Resonance Frequency Drift Resonance Resistance Drift Insulation Resistance	Table 2 Item 1 Table 2 Item 2 Table 2 Item 1 Table 2 Item 2 Table 2 Item 8	f R $\frac{\Delta f}{f}$ $\frac{\Delta R}{R}$ ΔR Ri	Para. 9.14.3.2 Final Measurements		
			Resonance Frequency Drift	Table 2 Item 1	$\frac{\Delta f}{f}$	-2.0	+2.0	10 ⁻⁶
			Resonance Resistance Drift	Table 2 Item 2	$\frac{\Delta R}{R}$	-10 or (2)	+10	%
					ΔR	-1.0	+1.0	Ω
						500	-	M Ω
11	Rapid Change of Temperature	Para. 9.15	Initial Measurements Resonance Frequency Resonance Resistance Final Measurements Resonance Frequency Drift Resonance Resistance Drift	Table 2 Item 1 Table 2 Item 2 After minimum Recovery of 2 hours Table 2 Item 1 Table 2 Item 2	f R $\frac{\Delta f}{f}$ $\frac{\Delta R}{R}$ ΔR	Para. 9.14.4.2 Final Measurements		
			Resonance Frequency Drift	Table 2 Item 1	$\frac{\Delta f}{f}$	-2.0	+2.0	10 ⁻⁶
			Resonance Resistance Drift	Table 2 Item 2	$\frac{\Delta R}{R}$	-10 or (2)	+10	%
					ΔR	-1.0	+1.0	Ω
12	Robustness of Terminations	Para. 9.16	Tensile Strength Visual Examination Bending Visual Examination	Gen. 3501 Para. 9.16.1 No visible damage Gen. 3501 Para. 9.16.2 No visible damage				

NOTES

1. The tests in this table refer to either Chart IV or V, and shall be used as applicable.
2. Whichever is the highest value.

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**TABLE 6 - MEASUREMENTS AND INSPECTIONS ON COMPLETION OF ENVIRONMENTAL TESTS
AND AT INTERMEDIATE POINTS AND ON COMPLETION OF ENDURANCE TESTING (Cont.)**

NO.	ESA/SCC GENERIC SPEC. NO. 3501		MEASUREMENTS AND INSPECTIONS		SYMBOL	LIMITS		UNIT
	ENVIRONMENTAL AND ENDURANCE TESTS (1)	TEST METHOD AND CONDITIONS	IDENTIFICATION	CONDITIONS		Min.	Max.	
13	Life Test	Para. 9.17	Initial Measurements					
			Resonance Frequency	Table 2 Item 1	f	Table 2 Item 1		
			Resonance Resistance	Table 2 Item 2	R	Table 2 Item 2		
			Intermediate Measurements	At 500 hours				
			Resonance Frequency	Table 2 Item 1	$\frac{\Delta f}{f}$	-2.0	+2.0	10 ⁻⁶
			Drift		f			
			Resonance Resistance	Table 2 Item 2	$\frac{\Delta R}{R}$	-10	+10	%
			Drift		R	or (2)		
			Intermediate Measurements	At 1000 hours	ΔR	-1.0	+1.0	Ω
			(Chart IV) and Final					
			Measurements (Chart V)					
			Resonance Frequency	Table 2 Item 1	$\frac{\Delta f}{f}$	-2.5	+2.5	10 ⁻⁶
			Drift		f			
			Resonance Resistance	Table 2 Item 2	$\frac{\Delta R}{R}$	-10	+10	%
			Drift		R	or (2)		
			Final Measurements	At 2000 hours	ΔR	-1.0	+1.0	Ω
			(Chart IV)					
			Resonance Frequency	Table 2 Item 1	$\frac{\Delta f}{f}$	-3.0	+3.0	10 ⁻⁶
			Drift		f			
Resonance Resistance	Table 2 Item 2	$\frac{\Delta R}{R}$	-10	+10	%			
Drift		R	or (2)					
		ΔR	-1.0	+1.0	Ω			

NOTES

1. The tests in this table refer to either Chart IV or V, and shall be used as applicable.
2. Whichever is the highest value.

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TABLE 1(a) - TYPE VARIANT DETAILED INFORMATION**TYPE VARIANT NO. 01**

No.	Characteristics	Symbol	Limits		Unit	Remarks
			Min.	Max.		
1	Resonance Frequency	f_L	2.0736		MHz	
2	Reference Temperature	T_o	+ 25		°C	
3	Overtone Order	-	Fundamental			
4	Load Capacitance	C_L	30		pF	
5	Rated Drive Level	P_o	0.1		mW	
6	Frequency Adjustment Tolerance	$\frac{\Delta f}{f}$	-10	+ 10	10 ⁻⁶	At T_o °C
7	Resonance Resistance	R_L	-	100	Ω	Over T_{op} °C
8	Frequency Variation with Temperature over T_{op}	$\frac{\Delta f}{f}$	-50	+ 50	10 ⁻⁶	From frequency measured at T_o °C
9	Resistance Variation with Temperature over T_{op}	$\frac{\Delta R}{R}$	Not applicable		%	
10	Operating Temperature Range	T_{op}	-55	+ 105	°C	
11	Frequency Variation with Drive Level	$\frac{\Delta f}{f}$	Not applicable		10 ⁻⁶	
12	Resistance Variation with Drive Level	$\frac{\Delta R}{R}$	Not applicable		%	
13	Motional Inductance	L_1	Not applicable		mH	
14	Motional Capacitance	C_1	Not applicable		fF	
15	Static Capacitance	C_o	-	7.0	pF	
16	Q Factor	Q	100 000		-	
17	Ratio of Unwanted: Response Resistance to Resonance Resistance or Response Impedance to Resonance Resistance	R_p/R $ Z_p /R$	3:1	-		In the frequency range: f_L -200kHz to f_L + 200kHz
18	Ageing	$\frac{\Delta f}{f}$	-2.0	+ 2.0	10 ⁻⁶	After burn-in and per year
19	Terminal Length	L	Figure 2		mm	



TABLE 1(a) - TYPE VARIANT DETAILED INFORMATION

TYPE VARIANT NO. 02

No.	Characteristics	Symbol	Limits		Unit	Remarks
			Min.	Max.		
1	Resonance Frequency	f_L	2.0		MHz	
2	Reference Temperature	T_o	+ 25		°C	
3	Overtone Order	-	Fundamental			
4	Load Capacitance	C_L	30		pF	
5	Rated Drive Level	P_o	0.1		mW	
6	Frequency Adjustment Tolerance	$\frac{\Delta f}{f}$	-10	+ 10	10^{-6}	At T_o °C
7	Resonance Resistance	R_L	-	400	Ω	At T_o °C
8	Frequency Variation with Temperature over T_{op}	$\frac{\Delta f}{f}$	-40	+ 40	10^{-6}	From frequency measured at T_o °C
9	Resistance Variation with Temperature over T_{op}	$\frac{\Delta R}{R}$	-10	+ 10	%	From resistance measured at T_o °C
10	Operating Temperature Range	T_{op}	-20	+ 60	°C	
11	Frequency Variation with Drive Level	$\frac{\Delta f}{f}$	Not applicable		10^{-6}	
12	Resistance Variation with Drive Level	$\frac{\Delta R}{R}$	Not applicable		%	
13	Motional Inductance	L_1	Not applicable		mH	
14	Motional Capacitance	C_1	Not applicable		fF	
15	Static Capacitance	C_o	Not applicable		pF	
16	Q Factor	Q	Not applicable		-	
17	Ratio of Unwanted: Response Resistance to Resonance Resistance or Response Impedance to Resonance Resistance	R_p/R $ Z_p /R$	3:1	-		In the frequency range: $f_L - 200\text{kHz}$ to $f_L + 200\text{kHz}$
18	Ageing	$\frac{\Delta f}{f}$	-3.0	+ 3.0	10^{-6}	After burn-in and per year
19	Terminal Length	L	Figure 2		mm	

**TABLE 1(a) - TYPE VARIANT DETAILED INFORMATION****TYPE VARIANT NO. 03**

No.	Characteristics	Symbol	Limits		Unit	Remarks
			Min.	Max.		
1	Resonance Frequency	f_L	2.4576		MHz	
2	Reference Temperature	T_0	+ 25		°C	
3	Overtone Order	-	Fundamental			
4	Load Capacitance	C_L	20		pF	
5	Rated Drive Level	P_0	0.1		mW	
6	Frequency Adjustment Tolerance	$\frac{\Delta f}{f}$	-10	+ 10	10^{-6}	At T_0 °C
7	Resonance Resistance	R_L	-	500	Ω	At T_0 °C
8	Frequency Variation with Temperature over T_{op}	$\frac{\Delta f}{f}$	-100	+ 100	10^{-6}	From frequency measured at T_0 °C
9	Resistance Variation with Temperature over T_{op}	$\frac{\Delta R}{R}$	-20	+ 20	%	From resistance measured at T_0 °C
10	Operating Temperature Range	T_{op}	-40	+ 70	°C	
11	Frequency Variation with Drive Level	$\frac{\Delta f}{f}$	Not applicable		10^{-6}	
12	Resistance Variation with Drive Level	$\frac{\Delta R}{R}$	Not applicable		%	
13	Motional Inductance	L_1	Not applicable		mH	
14	Motional Capacitance	C_1	Not applicable		fF	
15	Static Capacitance	C_0	Not applicable		pF	
16	Q Factor	Q	Not applicable		-	
17	Ratio of Unwanted: Response Resistance to Resonance Resistance or Response Impedance to Resonance Resistance	R_p/R or $ Z_{pl}/R$	Not applicable			
18	Ageing	$\frac{\Delta f}{f}$	-100	+ 100	10^{-6}	Over 6 years
19	Terminal Length	L	Figure 2		mm	


TABLE 1(a) - TYPE VARIANT DETAILED INFORMATION
TYPE VARIANT NO. 04

No.	Characteristics	Symbol	Limits		Unit	Remarks
			Min.	Max.		
1	Resonance Frequency	f_L	2.304		MHz	
2	Reference Temperature	T_o	+ 25		°C	
3	Overtone Order	-	Fundamental			
4	Load Capacitance	C_L	30		pF	
5	Rated Drive Level	P_o	0.1		mW	
6	Frequency Adjustment Tolerance	$\frac{\Delta f}{f}$	-10	+ 10	10^{-6}	At T_o °C
7	Resonance Resistance	R_L	-	500	Ω	At T_o °C
8	Frequency Variation with Temperature over T_{op}	$\frac{\Delta f}{f}$	-100	+ 100	10^{-6}	From frequency measured at T_o °C
9	Resistance Variation with Temperature over T_{op}	$\frac{\Delta R}{R}$	-20	+ 20	%	From resistance measured at T_o °C
10	Operating Temperature Range	T_{op}	-40	+ 70	°C	
11	Frequency Variation with Drive Level	$\frac{\Delta f}{f}$	Not applicable		10^{-6}	
12	Resistance Variation with Drive Level	$\frac{\Delta R}{R}$	Not applicable		%	
13	Motional Inductance	L_1	Not applicable		mH	
14	Motional Capacitance	C_1	Not applicable		fF	
15	Static Capacitance	C_o	Not applicable		pF	
16	Q Factor	Q	Not applicable		-	
17	Ratio of Unwanted: Response Resistance to Resonance Resistance or Response Impedance to Resonance Resistance	R_p/R or iZ_{pl}/R	Not applicable			
18	Ageing	$\frac{\Delta f}{f}$	-100	+ 100	10^{-6}	Over 6 years
19	Terminal Length	L	Figure 2		mm	

**TABLE 1(a) - TYPE VARIANT DETAILED INFORMATION****TYPE VARIANT NO. 25**

No.	Characteristics	Symbol	Limits		Unit	Remarks
			Min.	Max.		
1	Resonance Frequency	f_L	20.125984		MHz	
2	Reference Temperature	T_o	+ 55	+ 58	°C	
3	Overtone Order	-	5			
4	Load Capacitance	C_L	20	35	pF	
5	Rated Drive Level	P_o	0.1		mW	
6	Frequency Adjustment Tolerance	$\frac{\Delta f}{f}$	Not applicable		10 ⁻⁶	
7	Resonance Resistance	R_L	-	40	Ω	Over T_{op} °C
8	Frequency Variation with Temperature over T_{op}	$\frac{\Delta f}{f}$	-2.0	+ 2.0	10 ⁻⁶	From frequency measured at T_o °C
9	Resistance Variation with Temperature over T_{op}	$\frac{\Delta R}{R}$	Not applicable		%	
10	Operating Temperature Range	T_{op}	+ 53	+ 58	°C	
11	Frequency Variation with Drive Level	$\frac{\Delta f}{f}$	Not applicable		10 ⁻⁶	
12	Resistance Variation with Drive Level	$\frac{\Delta R}{R}$	Not applicable		%	
13	Motional Inductance	L_1	Not applicable		mH	
14	Motional Capacitance	C_1	Not applicable		fF	
15	Static Capacitance	C_o	Not applicable		pF	
16	Q Factor	Q	400 000	-	-	
17	Ratio of Unwanted: Response Resistance to Resonance Resistance or Response Impedance to Resonance Resistance	R_p/R $ Z_p /R$	Not applicable			
18	Ageing	$\frac{\Delta f}{f}$	Not applicable		10 ⁻⁶	
19	Terminal Length	L	Figure 2		mm	

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TABLE 1(a) - TYPE VARIANT DETAILED INFORMATION**TYPE VARIANT NO. 60**

No.	Characteristics	Symbol	Limits		Unit	Remarks
			Min.	Max.		
1	Resonance Frequency	f_L	1.536		MHz	
2	Reference Temperature	T_o	+ 25		°C	
3	Overtone Order	-	Fundamental			
4	Load Capacitance	C_L	30		pF	
5	Rated Drive Level	P_o	1.0		mW	
6	Frequency Adjustment Tolerance	$\frac{\Delta f}{f}$	-20	+ 20	10^{-6}	At T_o °C
7	Resonance Resistance	R_L	-	300	Ω	Over T_{op} °C
8	Frequency Variation with Temperature over T_{op}	$\frac{\Delta f}{f}$	-20	+ 20	10^{-6}	From frequency measured at T_o °C
9	Resistance Variation with Temperature over T_{op}	$\frac{\Delta R}{R}$	Not applicable		%	
10	Operating Temperature Range	T_{op}	0	+ 80	°C	
11	Frequency Variation with Drive Level	$\frac{\Delta f}{f}$	Not applicable		10^{-6}	
12	Resistance Variation with Drive Level	$\frac{\Delta R}{R}$	Not applicable		%	
13	Motional Inductance	L_1	Not applicable		mH	
14	Motional Capacitance	C_1	Not applicable		fF	
15	Static Capacitance	C_o	-	7.0	pF	
16	Q Factor	Q	Not applicable		-	
17	Ratio of Unwanted: Response Resistance to Resonance Resistance or Response Impedance to Resonance Resistance	R_p/R $ Z_p /R$	2:1	-		In the frequency range: $f_L - 1.0\text{MHz}$ to $f_L + 1.0\text{MHz}$
18	Ageing	$\frac{\Delta f}{f}$	-5.0	+ 5.0	10^{-6}	
19	Terminal Length	L	Figure 2		mm	