HIGH ELECTRON MOBILITY TRANSISTORS,

MICROWAVE, LOW NOISE,

SMALL SIGNAL, GALLIUM ARSENIDE

BASED ON TYPE CFY67

ESCC Detail Specification No. 5613/004

ISSUE 1

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SCC

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DOCUMENTATION CHANGE NOTICE

Rev. Letter	Rev. Date	Reference	CHANGE Item	Approved DCR No.
'A'	Aug '94	P1. Cover page		None
		P2. DCN		None
		P11. Para. 4.2.3	: (c) and (d) deleted, (e) and (f) renamed and new (e) added	221173
		P15. Table 2 DC	: Test figure column deleted	221173
			: Test method numbers added	221173
		Table 2 AC	: Test figures renumbered	221173
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			: Test method numbers added	221173
		P18. Figure 4	: Fig. 4(a) deleted	221173
			: Fig. 4(b) renamed 4(a)	221173
		P19. Figure 4	: Fig. 4(c) and 4(d) renamed 4(b) and 4(c) resp.	221173
		P21. Figure 5	: Fig. 5(a) and 5(b) improved	221173
		P23. Table 6	: Change limits for tests 1 and 2 changed	221173

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TABLES

FIGURES

APPENDICES (Applicable to specific Manufacturers only)

None.

1. GENERAL

1.1 SCOPE

This specification details the ratings, physical and electrical characteristics, test and inspection data for a High Electron Mobility Transistor (HEMT), Microwave, Low Noise, Small Signal, Gallium Arsenide, based on Type CFY67. It shall be read in conjunction with ESA/SCC Generic Specification No. 5010, the requirements of which are supplemented herein.

1.2 TYPE VARIANTS

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

1.3 MAXIMUM RATINGS

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

1.4 PARAMETER DERATING INFORMATION

The derating information applicable to the HEMTs specified herein is shown in Figure 1.

1.5 PHYSICAL DIMENSIONS

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

1.6 FUNCTIONAL DIAGRAM

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

1.7 HANDLING PRECAUTIONS

These devices are susceptible to damage by electrostatic discharge. Therefore, suitable precautions shall be employed for protection during all phases of manufacture, testing, packaging, shipment and any handling.

These components are categorised as Class 1 with a Minimum Critical Path Failure Voltage of 250V.

TABLE 1(a) - TYPE VARIANTS

(1) VARIANT	(2) BASED ON TYPE	(3) FIGURE	(4) NOISE FIGURE NF_{min} at 12 GHz (dB)	(5) ASSOCIATE GAIN G_a at 12 GHz (dB)	(6) OUTPUT POWER P_{-1dB} at 12 GHz (dBm)	(7) LEAD MATERIAL AND FINISH
01	CFY67-08	2	0.8	11	N.A.	D2
02	CFY67-10	2	1.0	10.5	N.A.	D2
03	CFY67-08P	2	0.8	11	10	D2
04	CFY67-10P	2	1.0	10.5	10	D2

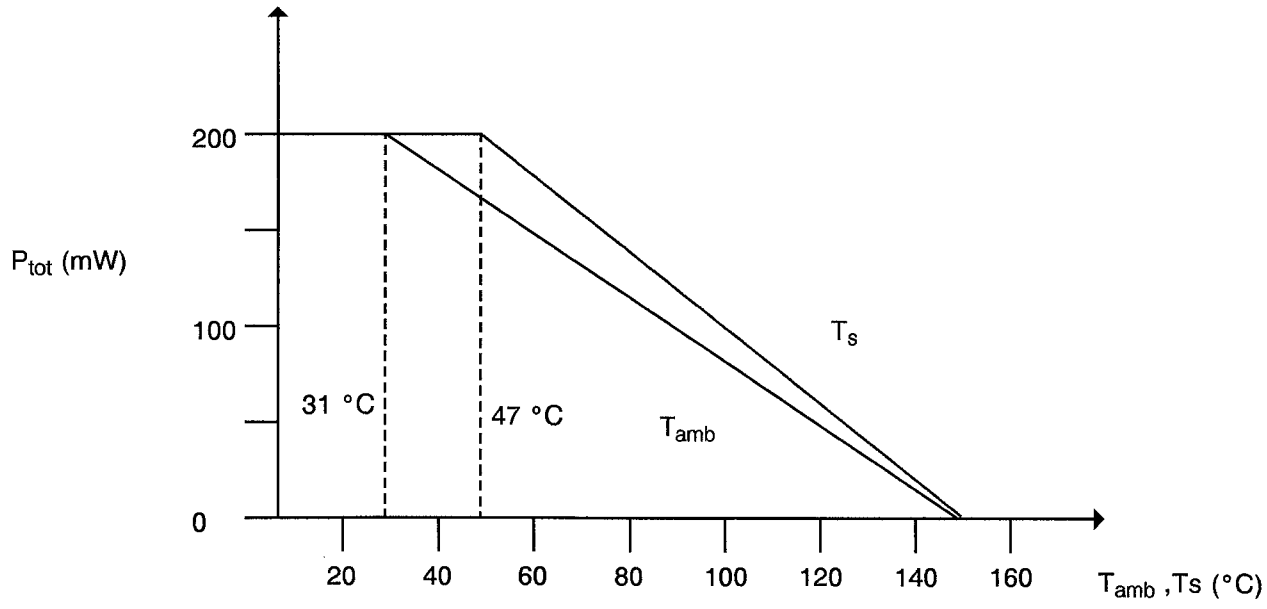
TABLE 1(b) - MAXIMUM RATINGS

No.	CHARACTERISTICS	SYMBOL	MAXIMUM RATINGS	UNIT	REMARKS
1	Drain-Source Voltage	V_{DS}	3.5	V	
2	Drain-Gate Voltage	V_{DG}	4.5	V	
3	Gate-Source Voltage	V_{GS}	-3.0	V	
4	Gate Forward Current	I_{GP}	2	mA	
5	Drain Current	I_D	60	mA	
6	Channel Temperature	T_{ch}	+150	°C	
7	Storage Temperature Range	T_{stg}	-65 to +150	°C	
8	Total Power Dissipation	P_{tot}	200	mW	Note 1
9	RF Input Power	P_{in}	10	dBm	
10	Soldering Temperature	T_{sol}	+230	°C	Note 2

NOTES

1. At Ts = +47°C (Ts is measured on the source lead). For derating at Ts > + 47 °C, see Figure 1. At Tamb = +31°C. For derating at Tamb > +31°C, see Figure 1.
2. Duration 15 seconds maximum, and the same termination shall not be resoldered until 3 minutes have elapsed.

FIGURE 1 - PARAMETER DERATING INFORMATION



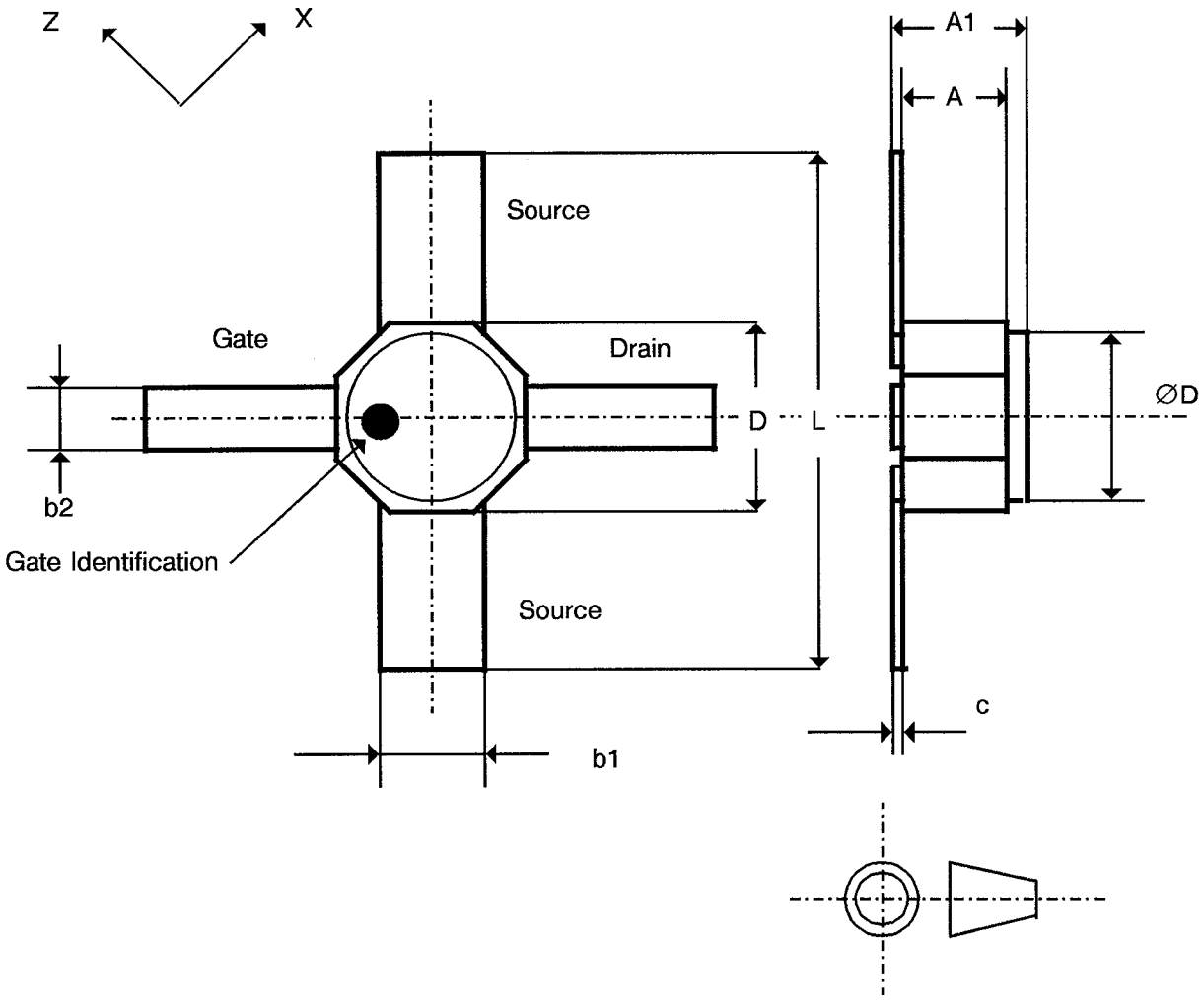
Power Dissipation versus Temperature

NOTES

1. R_{thchs} = 515 K/W
   $R_{thchamb}$ = 595 K/W
   (Mounted on Alumina 15.0 mm × 16.7 mm × 0.7 mm)

FIGURE 2 - PHYSICAL DIMENSIONS

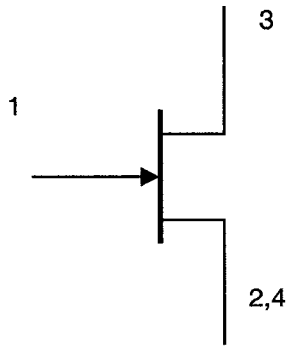
'MICRO-X" PACKAGE



SYMBOL	MILLIMETRES	
	MIN.	MAX.
A	0.66	0.86
A1	0.85	1.25
b1	0.92	1.12
b2	0.40	0.60
c	0.07	0.15
D	1.68	1.88
ØD1	1.55	1.75
L	4.0	4.4

FIGURE 3 - FUNCTIONAL DIAGRAM

1. Gate
2. Source
3. Drain
4. Source



NOTES 1. The gate is identified by the colour dot.

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. 5010 for Discrete Microwave Semiconductor Components.

(b) MIL-STD-750, Test Methods for Semiconductor Devices.

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:

NF_{min} = Noise Figure for Optimum Noise Matching.
G_a = Associated Gain for Optimum Noise Matching.
g_m = Transconductance.
Γ_{opt} = Impedance for Optimum Noise and Associated Gain.
T_{ch} = Channel Temperature.
T_s = Temperature on the Source Lead.
P_{-1dB} = Output Power at 1 dB Gain Compression.
P_{in} = Maximum RF Input Power.
S_{xy} = Scattering Parameters.

4. REQUIREMENTS

4.1 GENERAL

The complete requirements for procurement of the HEMTs specified herein shall be as stated in this specification and ESA/SCC Generic Specification No. 5010 for Discrete Microwave Semiconductor Components. Deviations from the Generic Specification applicable to this specification only, are listed 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)

(a) Para. 6.2, Pre-burn-in and associated Electrical Measurements: Shall not be performed.

(b) Para. 9.6, Constant Acceleration: Shall not be performed.

(c) Para. 9.14, Vibration, Variable Frequency: Shall not be performed.

(d) Para. 9.7, PIND test shall be performed in accordance with condition 'A'; it may be performed at any point after indicated position in Chart II.

(e) Para. 9.11, Dimension Check shall be performed using a gauge during RF measurements.

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

(a) Para. 9.9.1, Initial Parameter Drift Value Measurements: Parameters measured in Chart II shall not be repeated during electrical measurements at room temperature.

(b) Para. 7.1.1(b), Power Burn-in 2 and associated Electrical Measurements: Shall not be performed

(c) Para. 9.9.1, $\Delta 1$ Parameter Drift Value Measurements after HTRB shall only be performed on DC parameters (see Table 4, items 1 to 4).

(d) Para. 7.2.2, Parameter Limit Failure: After power burn-in, if NF_{min} for a particular Variant drifts to the value of another variant but remains within the allowable drift limits, the component shall not be counted when determining lot rejection. Instead, that component shall be reassigned to the other Variant number related to its new NF_{min} value.

(e) Para. 9.12, Radiographic Inspection: Shall not be performed.

4.2.4 Deviations from Qualification Tests (Chart IV)

(a) Subgroup I tests: Shall not be performed.

(b) Para. 9.5, Thermal Shock Test: Shall be performed in Subgroup II prior to Moisture Resistance Test.

(c) Subgroup II tests: Shall be performed on 12 components.

(d) Para. 9.20, Operating Life: Only one Operating Life Test shall be performed on 30 components.

(e) Para. 9.23, Special Testing: Shall not be performed.

4.2.5 Deviations from Lot Acceptance Tests (Chart V)

(a) Para. 9.13, Shock Test: Shall not be performed.

(b) Para. 9.14, Vibration: Shall not be performed.

(c) Para. 9.15, Constant Acceleration: Shall not be performed.

(d) Para. 9.5, Thermal shock and Para. 9.16, Moisture Resistance, shall be done in sequence on all 6 components of the Environmental/Mechanical Subgroups.

(e) Para. 9.20, Operating Life: Only one Operating Life Test shall be performed on 16 components.

(f) Para. 9.23, Special Testing: Shall not be performed.

4.3 MECHANICAL AND ENVIRONMENTAL REQUIREMENTS

4.3.1 Dimension Check

The dimensions of the HEMTs specified herein shall be checked as specified in Para. 4.2.2 of this specification.

4.3.2 Weight

The maximum weight of the HEMTs specified herein shall be 0.03 grammes .

4.3.3 Terminal Strength

The requirements for terminal strength testing are specified in Section 9 of ESA/SCC Generic Specification No. 5010. The test conditions shall be as follows:-

(a) Condition: 'A' (Tension)

(b) Force: 2.23N.

(c) Duration: 5 seconds.

4.3.4 Bond Strength

The requirements for bond strength are specified in Section 9 of ESA/SCC Generic Specification No. 5010. The test conditions shall be as follows:-

(a) Condition: 'A'.

(b) Separating Force: 0.015N minimum.

4.3.5 Die Shear

The requirements for die shear are specified in Section 9 of ESA/SCC Generic Specification No. 5010. The test conditions shall be as follows:-

(a) Semiconductor Material Remaining: 50% minimum.

(b) Minimum Acceptable Die Shear Strength: 0.5N.

4.3.6 High Temperature Stabilisation Bake

The requirements for high temperature stabilisation bake are specified in Section 9 of ESA/SCC Generic Specification No. 5010. The temperature to be applied shall be +150 (+0 -3) °C.

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 HEMTs specified herein to meet the performance requirements of this specification shall be used. Acceptance or approval of any constituent material shall not guarantee acceptance of the finished product.

4.4.1 Case

The case shall be hermetically sealed and have a ceramic body.

4.4.2 Lead Materials and Finish

The end cap and 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 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 accomodate all 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) Terminal Identification.

(b) The SCC Component Number.

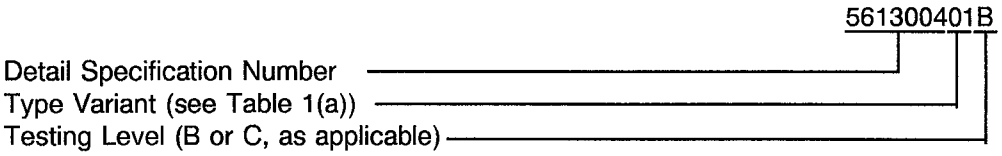
(c) Traceability Information.

4.5.2 Terminal Identification

Terminal identification shall be as shown in Figures 2 and 3 of this specification.

4.5.3 The SCC Component Number

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



4.5.4 Traceability Information

Each component shall be marked in respect of traceability information as defined in ESA/SCC Basic Specification No. 21700.

4.6 ELECTRICAL MEASUREMENTS

4.6.1 Electrical Measurements at Room Temperature

The parameters to be measured at room temperature are scheduled in Table 2. Unless otherwise specified, the measurements shall be performed at T_{amb} = +25 ± 3 °C.

4.6.2 Electrical Measurements at High and Low Temperatures

The parameters to be measured at high and low temperatures are scheduled in Table 3. Unless otherwise specified, the measurements shall be performed at +130(-5 +0) °C.

4.6.3 Circuits for Electrical Measurements

Circuits for use in performing electrical measurements listed in Table 2 of this specification are shown in Figure 4.

4.7 BURN-IN TESTS

Chart III (b): Only Burn-In 1 shall be performed.

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, the measurements shall be performed at T_{amb} = +25 ± 3 °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. Furthermore, the limit failure shall be in accordance with Para. 4.2.3(f) of this specification.

4.7.2 Conditions for High Temperature Reverse Bias Burn-in

The requirements for the high temperature reverse bias burn-in are specified in Section 7 of ESA/SCC Generic Specification No. 5010. The conditions for high temperature reverse bias burn-in shall be as specified in Table 5(a) of this specification.

4.7.3 Conditions for Power Burn-in

The requirements for power burn-in are specified in Section 7 of ESA/SCC Generic Specification No. 5010. The conditions for power burn-in shall be as specified in Table 5(b) of this specification.

4.7.4 Electrical Circuits for High Temperature Reverse Bias Burn-in

Circuit for use in performing the H.T.R.B. burn-in test is shown in Figure 5(a) of this specification.

4.7.5 Electrical Circuits for Power Burn-in

Circuit for use in performing the power burn-in test is shown in Figure 5(b) of this specification.

TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - D.C. PARAMETERS

No.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN.	MAX.	
1	Drain Saturation Current	I_{DSS}	3413 Cond. C	V_{DS} = 2.0V V_{GS} = 0V	15	60	mA
2	Gate Threshold Voltage	V_{Gth}	3403	V_{DS} = 2.0V I_D = 1.0mA	-0.2	-2.0	V
3	Gate Leakage Current at pinch-off	I_{GP}	3411 Cond. A	V_{DS} = 1.5V V_{GS} = -3.0V	-	200	µA
4	Transconductance	g_m	3403	V_{DS} = 2.0V I_D = 15mA	50	-	mS
5	Gate Leakage Current	I_G	3403	V_{DS} = 2.0V I_D = 15mA	-	-2.0	µA
6	Gate Voltage	V_G	3403	V_{DS} = 2.0V I_D = 15mA	-1.2	0	V

TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - A.C. PARAMETERS

No.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST FIG.	TEST CONDITIONS	LIMITS		UNIT
						MIN.	MAX.	
7	Noise Figure	NF_{min}	-	4(a)	V_{DS} = 2.0V I_D = 15mA f = 12GHz		Notes 1 and 5	
8	Associated Gain	G_a	-	4(a)	V_{DS} = 2.0V I_D = 15mA f = 12GHz	Note 2		
9	Output Power @ 1 dB Gain Compression	P_{-1dB}	3510	4(b)	V_{DS} = 2.0V I_D = 20mA f = 12GHz	Note 3		
10	Scattering Parameters	S_{11} to S_{22}	3570	4(c)	V_{DS} = 2.0V I_D = 15mA f = 1 to 12GHz	Notes 4 and 5		

NOTES

1. See Column 4 of Table 1(a).
2. See Column 5 of Table 1(a).
3. See Column 6 of Table 1(a). Not measured for Variants 01 and 02.
4. Typical parameters measured on a sample basis and supplied for information purpose only.
5. See Table 2 - Scattering and noise parameters (see Page 16).

SCATTERING AND NOISE PARAMETERS (NOTE 4)

f (GHz)	S_{11}		S_{12}		S_{21}		S_{22}		R_n (Ω)	Γ_{opt}		NF_{min} (dB)
	magn.	angle	magn.	angle	magn.	angle	magn.	angle		magn.	angle	
1	0.98	-22.5	0.021	75.3	5.642	158.8	0.65	-16.8	15.6	0.756	14	0.29
2	0.95	-42.2	0.042	61.3	5.387	140.4	0.64	-30.9	14.6	0.69	28	0.30
3	0.90	-61.7	0.059	49.0	5.099	122.2	0.60	-44.3	13.6	0.643	43	0.34
4	0.84	-81.4	0.073	36.7	4.783	104.8	0.56	-57.6	12.1	0.606	58	0.38
5	0.78	-100.7	0.082	25.2	4.430	87.9	0.52	-70.3	10.5	0.578	73	0.41
6	0.73	-117.2	0.088	15.3	4.040	72.2	0.49	-83.4	8.86	0.553	87	0.46
7	0.69	-130.6	0.091	7.3	3.713	58.3	0.48	-94.2	7.16	0.534	102	0.50
8	0.65	-144.2	0.096	-0.1	3.494	45.2	0.47	-102.6	5.62	0.518	116	0.55
9	0.62	-158.6	0.098	-7.2	3.323	32.3	0.45	-109.7	4.29	0.505	131	0.60
10	0.60	-173.8	0.101	-14.5	3.201	19.3	0.43	-118.8	3.23	0.495	145	0.64
11	0.57	170.5	0.103	-22.0	3.074	6.3	0.41	-129.1	2.53	0.486	159	0.69
12	0.56	155.2	0.104	-29.6	2.978	-7.2	0.39	-139.2	2.22	0.476	173	0.73
13	0.55	141.0	0.105	-37.7	2.884	-20.6	0.39	-150.5	2.37	0.467	-173	0.78
14	0.52	126.9	0.106	-45.2	2.804	-33.4	0.39	-160.9	2.96	0.455	-160	0.84
15	0.52	110.4	0.106	-53.9	2.746	-46.9	0.39	-169.0	4.01	0.443	-146	0.88
16	0.52	94.7	0.105	-63.0	2.679	-60.6	0.38	-178.0	5.47	0.428	-132	0.93
17	0.53	80.3	0.104	-73.4	2.619	-74.6	0.39	170.7	7.26	0.412	-118	0.99
18	0.53	65.9	0.104	-85.5	2.587	-89.3	0.40	162.7	9.61	0.394	-103	1.05

NOTES: See page 15.

TABLE 3 - ELECTRICAL MEASUREMENTS AT HIGH TEMPERATURES +130 (-5+0) C

No.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN.	MAX.	
2	Gate Threshold Voltage	V_{Gth}	3403	V_{DS} = 2.0V I_D = 1.0mA	-0.2	-2.0	V
3	Gate Leakage Current at pinch -off	I_{GP}	3411 Cond. A	V_{DS} = 1.5V V_{GS} = -3.0V	-	200	µA
4	Transconductance	g_m	3403	V_{DS} = 2.0V I_D = 15mA	40	-	mS

TABLE 4 - PARAMETER DRIFT VALUES

No.	CHARACTERISTICS	SYMBOL	SPEC.AND/OR TEST METHOD	TEST CONDITIONS	CHANGE LIMITS (Δ)	UNIT
1	Drain Saturation Current	I_{DSS}	As per Table 2	As per Table 2	±2.5 (1)	mA
2	Gate Threshold Voltage	V_{Gth}	As per Table 2	As per Table 2	±0.05 (1)	V
3	Gate Leakage Current at Pinch-off	I_{GP}	As per Table 2	As per Table 2	±50 (1)	µA
4	Transconductance	g_m	As per Table 2	As per Table 2	±2.5 (1)	mS
7	Noise Figure	NF_{min}	As per Table 2	As per Table 2	±0.1 (1)	dB
8	Associated Gain	G_a	As per Table 2	As per Table 2	±0.3 (1)	dB

NOTES 1. Δ1 = Δ2

FIGURE 4 - CIRCUITS FOR ELECTRICAL MEASUREMENTS

FIGURE 4(a) - NOISE FIGURE

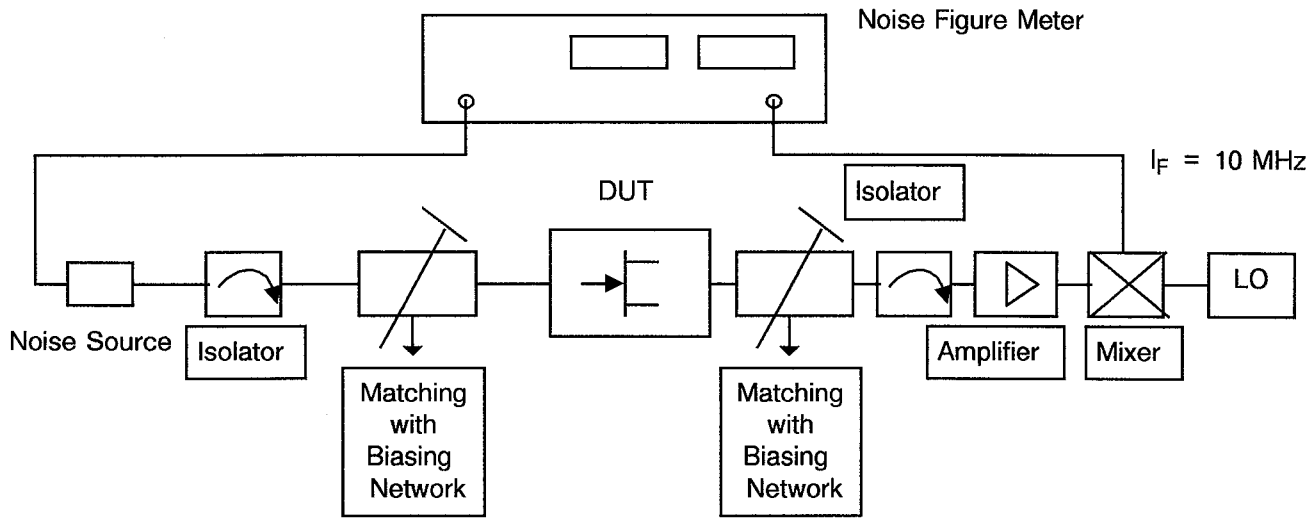


FIGURE 4 - CIRCUITS FOR ELECTRICAL MEASUREMENTS

FIGURE 4(b) - OUTPUT POWER

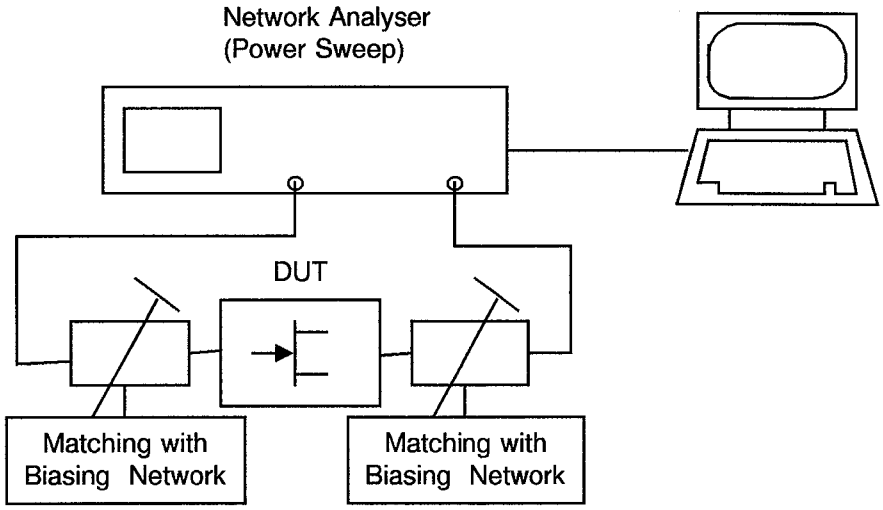


FIGURE 4(c) - SCATTERING PARAMETERS

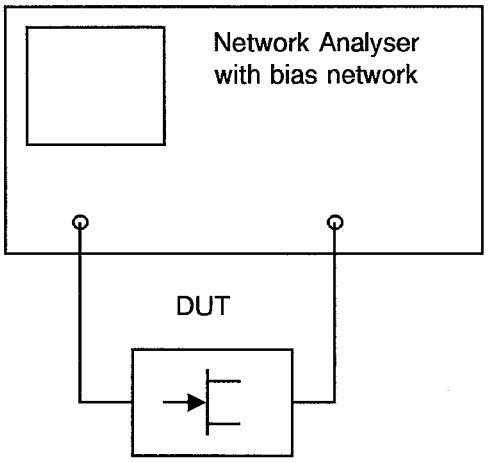


TABLE 5(a) - CONDITIONS FOR HIGH TEMPERATURE REVERSE BIAS BURN-IN

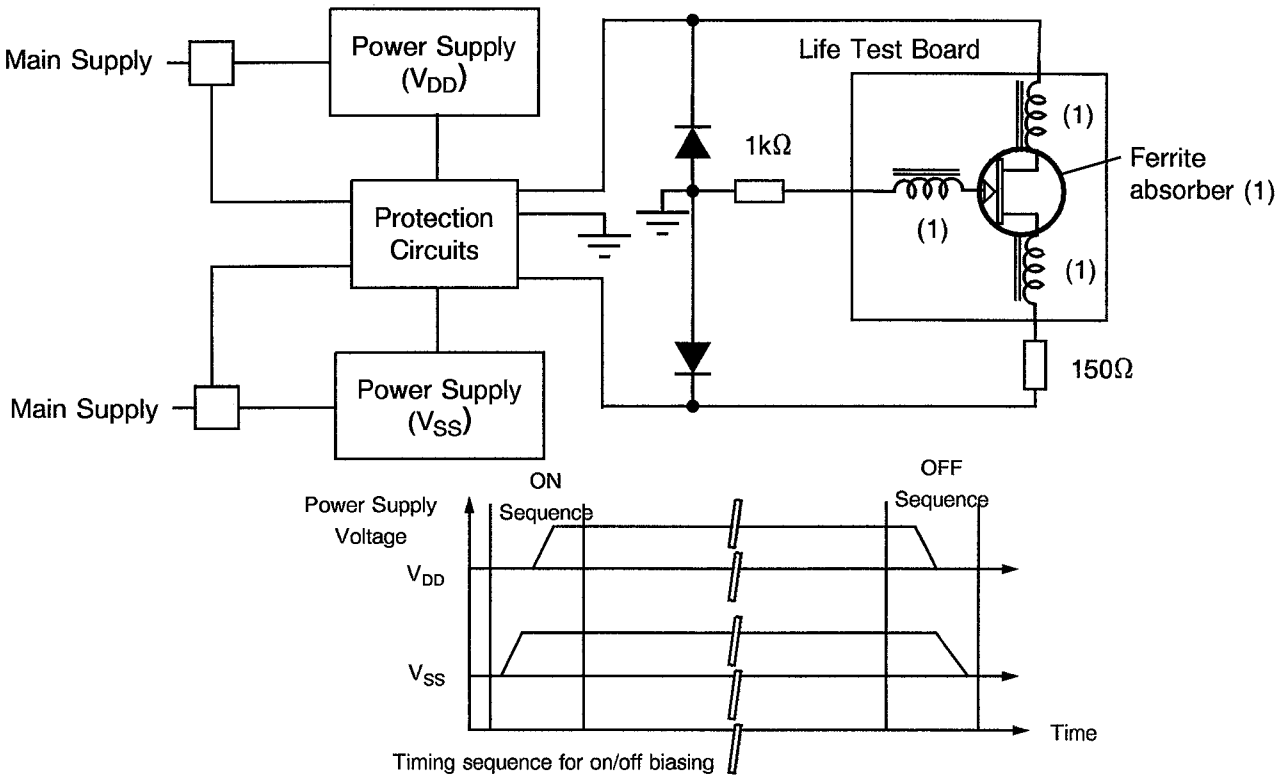
No.	CHARACTERISTICS	SYMBOL	CONDITIONS	UNIT
1	Ambient Temperature	T_{amb}	+150(+0 -3)	°C
2	Drain Source Voltage	V_{DS}	1.5 (+0 -0.2)	V
3	Gate Source Voltage	V_{GS}	-3.0 (+0.3 -0)	V

TABLE 5(b) - CONDITIONS FOR POWER BURN-IN AND OPERATING LIFE TESTS

No.	CHARACTERISTICS	SYMBOL	CONDITIONS	UNIT
1	Ambient Temperature	T_{amb}	+100(+0 -3)	°C
2	Drain Source Voltage	V_{DS}	+2.5 (+0 -0.2)	V
3	Drain Current	I_D	+30 (+0 -3)	mA

NOTES: 1. For $R_{thchamb}$: 660 K/W on burn-in board.

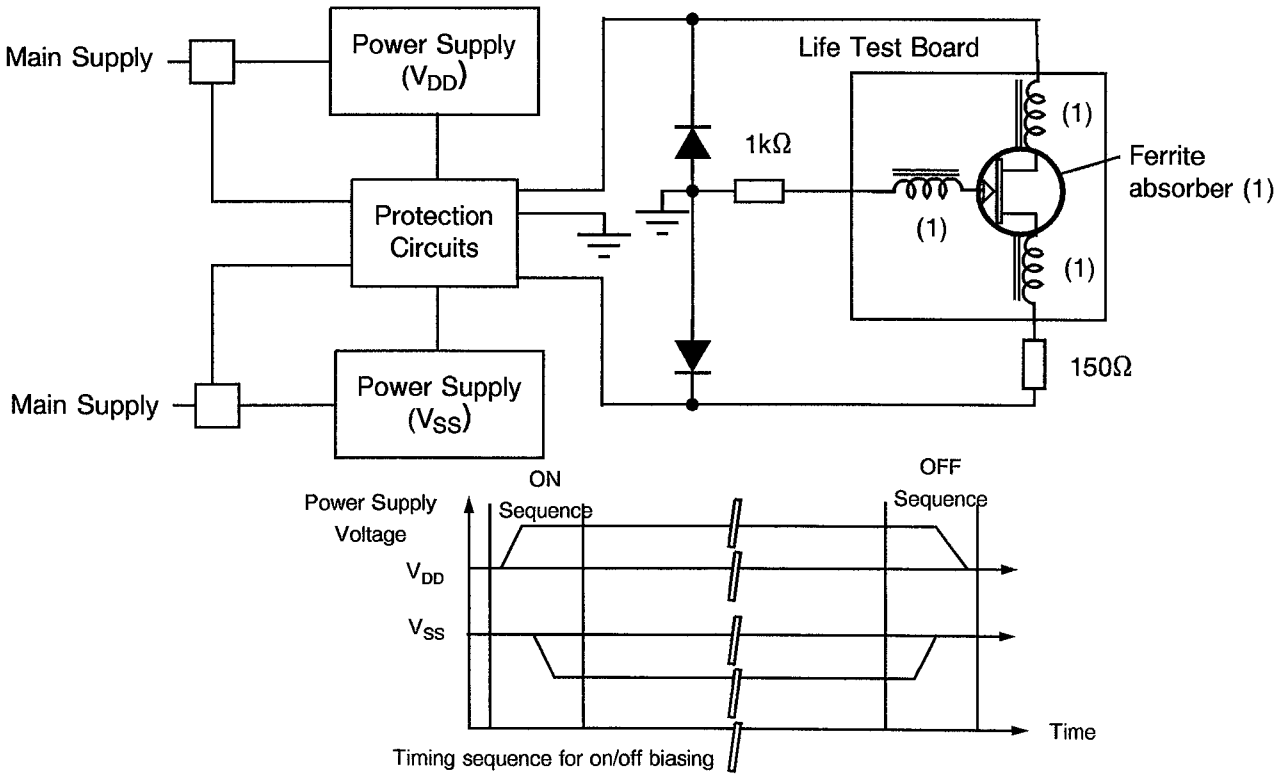
FIGURE 5(a) - ELECTRICAL CIRCUIT FOR HIGH TEMPERATURE REVERSE BIAS BURN-IN



NOTES

1. Damping elements against self oscillation.

FIGURE 5(b) - ELECTRICAL CIRCUIT FOR POWER BURN-IN AND OPERATING LIFE TESTS



NOTES

1. Damping elements against self oscillation.

4.8 ENVIRONMENTAL AND ENDURANCE TESTS (CHARTS IV AND V OF ESA/SCC GENERIC SPECIFICATION NO. 5010)

4.8.1 Electrical Measurements on Completion of Environmental Tests

The parameters to be measured on completion of environmental tests are scheduled in Table 2. Unless otherwise stated, the measurements shall be performed at T_{amb} = +25 ± 3 °C.

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

The parameters to be measured 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} = +25 ± 3 °C.

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

The requirements for operating life testing are specified in Section 9 of ESA/SCC Generic Specification No. 5010. The conditions for operating life testing are specified in Table 5(b) of this specification.

4.8.4 Electrical Circuits for Operating Life Tests

The circuit to be used for performance of the operating life test shall be the same as shown in Figure 5(b) for Power Burn-in.

4.9 RADIATION TESTING

Not applicable.

4.10 SPECIAL TESTING

Not applicable.

TABLE 6 - ELECTRICAL MEASUREMENTS AT INTERMEDIATE POINTS AND ON COMPLETION OF ENDURANCE TESTING

No.	CHARACTERISTICS	SYMBOL	SPEC. AND/OR TEST METHOD	TEST CONDITIONS	CHANGE LIMITS	UNIT
1	Drain Saturation Current	I_{DSS}	As per Table 2	As per Table 2	± 3.0	mA
2	Gate Threshold Voltage	V_{Gth}	As per Table 2	As per Table 2	±0.06	V
3	Gate Pinch-off Current	I_{GP}	As per Table 2	As per Table 2	±50	µA
4	Transconductance	g_m	As per Table 2	As per Table 2	± 2.5	mS
7	Noise Figure	NF_{min}	As per Table 2	As per Table 2	± 0.1	dB
8	Associated Gain	G_a	As per Table 2	As per Table 2	± 0.4	dB
9	Output Power @ 1dB Gain Compression	P_{out}	As per Table 2	As per Table 2	± 0.4	dB