TRANSISTORS, FIELD-EFFECT, N-CHANNEL,

BASED ON TYPES 2N4391/4392/4393

ESCC Detail Specification No. 5205/003

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ESA/SCC Detail Specification No. 5205/003

space components
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DOCUMENTATION CHANGE NOTICE

Rev. Letter	Rev. Date	CHANGE Reference	CHANGE Item	Approved DCR No.
		This Issue incorporates all modifications agreed on the basis of Policy DCR 21016 for adaptation to new qualification requirements		
'A'	Jul. '88	P1. Cover page		None
		P2. DCN		None
		P4. Table of Contents	: Reference to Appendices added	21019
		P6. Table 1(a)	: Lead Material and Finish added	21025
		P9. Para. 2	: MIL-STD-1276 deleted	21025
		Para. 4.1	: Reference to Appendices added	21019
		Para. 4.2.2	: PIND Test and Condition added	22639
		P10. Para. 4.4.2	: Text rewritten	21025
'B'	Feb. '92	P1. Cover page		None
		P2. DCN		None
		P5. Para. 1.2	: Paragraph amended	21021
		P9. Para. 2	: "ESA/SCC Basic Spec. No. 23500" added	21025
		Para. 4.2.2	: PIND deviation deleted	21043
		P16. Table 3	: Note deleted	21047
		This document has been transferred from hardcopy to electronic format. The content is unchanged but minor differences in presentation exist.		

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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 Transistors, Field-Effect, N-Channel based on Types 2N4391, 2N4392 and 2N4393.

It shall be read in conjunction with ESA/SCC Generic Specification No. 5000, the requirements of which are supplemented herein.

1.2 COMPONENT TYPE VARIANTS

See 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 transistors specified herein, are scheduled in Table 1(b).

1.4 PARAMETER DERATING INFORMATION

The applicable derating information for the transistors specified herein is shown in Figure 1.

1.5 PHYSICAL DIMENSIONS

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

1.6 FUNCTIONAL DIAGRAM

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

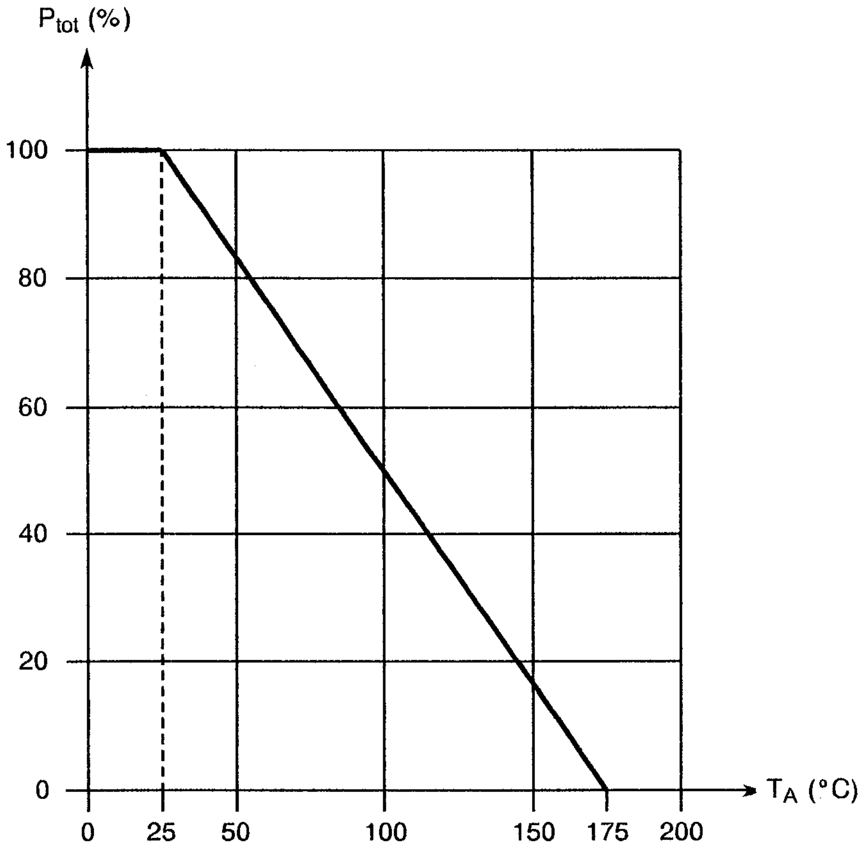
TABLE 1(a) - TYPE VARIANTS

VARIANT	BASED ON TYPE	CHARACTERISTICS	LEAD MATERIAL AND FINISH
01	2N4391	See Table 2	D2
02	2N4392		D2
03	2N4393		D2

TABLE 1(b) - MAXIMUM RATINGS

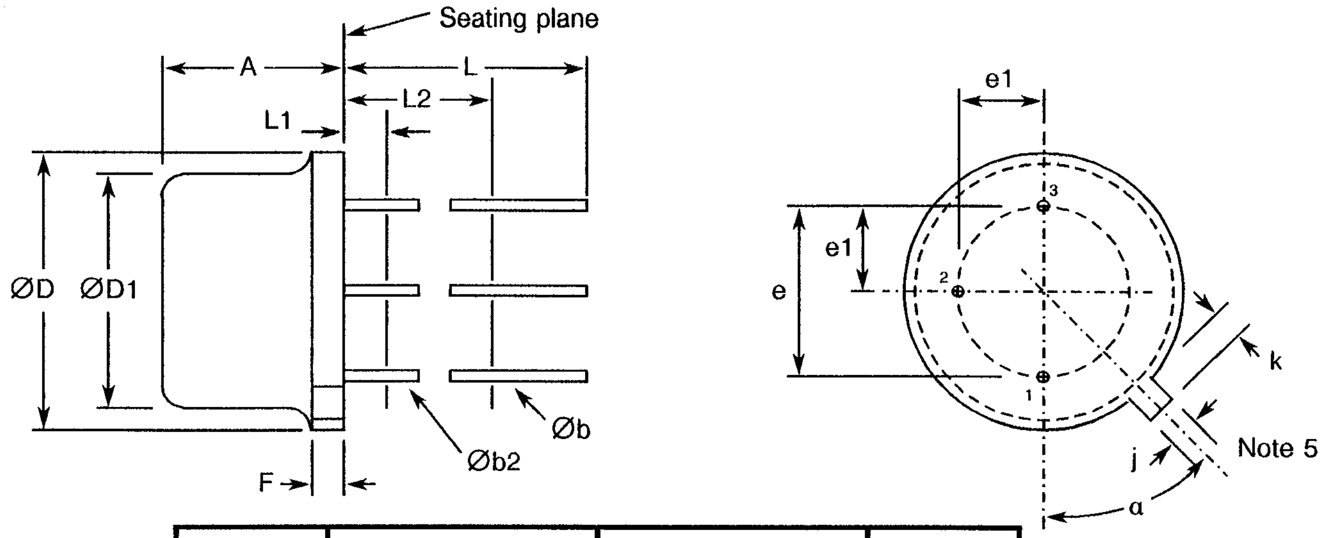
No.	CHARACTERISTICS	SYMBOL	MAXIMUM RATINGS	UNIT	REMARKS
1	Drain Source Voltage	V_{DS}	40	V	
2	Gate Source Voltage	V_{GS}	−40	V	
3	Gate Drain Voltage	V_{GD}	−40	V	
4	Gate Current	I_G	50	mA	
5	Total Power Dissipation (see Figure 1)	P_{tot}	300	mW	$T_{amb} = 25°C$
6	Operating Temperature Range	T_{op}	−55 to +175	°C	T_{amb}
7	Storage Temperature Range	T_{stg}	−65 to +200	°C	
8	Soldering Temperature	T_{sol}	+235	°C	$t \leq 10$ sec. Distance to case: ≥ 1.5mm

FIGURE 1 - PARAMETER DERATING INFORMATION



Power Dissipation versus Temperature

FIGURE 2 - PHYSICAL DIMENSIONS

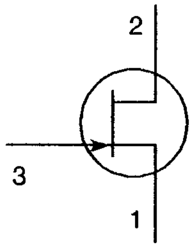


SYMBOL	INCHES		MILLIMETRES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.170	0.210	4.32	5.33	
Øb	0.016	0.021	0.406	0.533	1
Øb2	0.016	0.019	0.406	0.483	1
ØD	0.209	0.230	5.31	5.84	
ØD1	0.178	0.195	4.52	4.95	
e	0.100 T.P.		2.54 T.P.		2, 4
e1	0.050 T.P.		1.27 T.P.		2, 4
F	-	0.030	-	0.762	
j	0.036	0.046	0.914	1.17	4
k	0.028	0.048	0.711	1.22	3
L	0.500	-	12.70	-	1
L1	-	0.050	-	1.27	1
L2	0.250	-	6.35	-	1
α	45° T.P.		45° T.P.		5

NOTES

1. (3 leads) Øb2 applies between L1 and L2. Øb applies between L2 and 0.5 inch (12.70mm) from seating plane. Diameter is uncontrolled in L1 and beyond 0.5 inch (12.70mm) from seating plane.
2. Leads having maximum diameter 0.019 inch (0.483mm) measured in gauging plane 0.054 inch (1.37mm) + 0.001 inch (0.025mm) − 0.000 inch (0.000mm) below the seating plane of the device shall be within 0.007 inch (0.178mm) of their true positions relative to a maximum-width tab.
3. Measured from maximum diameter of the actual device.
4. The device may be measured by direct methods or by the gauge and gauging procedure described on gauge drawing GS-2.
5. Tab centreline.

FIGURE 3 - FUNCTIONAL DIAGRAM



1. Source.
2. Drain.
3. Gate (connected to case).

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. 5000 for Discrete Semiconductor Components.

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

(c) ESA/SCC Basic Specification No. 23500, Requirements for Lead Materials and Finishes for Components for Space Application.

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.

4. REQUIREMENTS

4.1 GENERAL

The complete requirements for procurement of the transistors specified herein shall be as stated in this specification and ESA/SCC Generic Specification No. 5000 for Discrete Semiconductors. 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)

None.

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

High Temperature Reverse Bias Test (H.T.R.B.) is not required.

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 transistors specified herein shall be checked. They shall conform to those shown in Figure 2.

4.3.2 Weight

The maximum weight of the transistors specified herein shall be 0.9 grammes.

4.3.3 Terminal Strength

The requirements for terminal strength testing are specified in Section 9 of ESA/SCC Generic Specification No. 5000. The test conditions shall be as follows:-

Test Condition:	'A', Tension.
Applied Force:	5.0 Newtons.
Duration:	10 seconds.

4.4 MATERIALS AND FINISHES

The materials and finishes shall be as specified herein. Where a definite material is not specified, a material which will enable the transistors 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

Metal case, hermetically sealed, similar to JEDEC TO-18.

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. Each component shall be marked in respect of:-

(a) Lead Identification.

(b) The SCC Component Number.

(c) Traceability Information.

4.5.2 Lead Identification

Lead identification shall be as shown in Figures 2 and 3.

4.5.3 The SCC Component Number

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

520500301B

Detail Specification Number —— 5205003
Type Variant —— 01
Testing Level (B or C, as applicable) —— B

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 Marking of Small Components

When it is considered that the component is too small to accommodate the marking as specified above, as much as space permits shall be marked. The order of precedence shall be as follows:-

(a) Lead Identification.

(b) The SCC Component Number.

(c) Traceability Information.

The marking information in full shall accompany each component in its primary package.

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. The measurements shall be performed at $T_{amb} = +22 \pm 3$ °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.

4.6.3 Circuits for Electrical Measurements

Circuits for use in performing the electrical measurements listed in Tables 2 and 3 are shown in Figure 4.

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 $T_{amb} = +22 \pm 3$ °C. The parameter drift values (Δ) applicable to the parameters scheduled, shall not be exceeded. In addition to these drift value requirements, the appropriate limit value specified for a given parameter 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. 5000. The conditions for burn-in shall be as specified in Table 5 of this specification.

4.7.3 Electrical Circuits for Burn-in

Circuits for use in performing the burn-in tests are shown in Figure 5 of this specification.

TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - d.c. PARAMETERS

No.	CHARACTERISTICS	SYMBOL	SPEC. AND/OR TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN.	MAX.	
1	Total Gate Leakage Current	I_{GSS}	MIL-STD-750 Method 3411	$V_{DS} = 0V$ $V_{GS} = -20V$	-	-0.1	nA
2	Gate Source Breakdown Voltage	$V_{(BR)GSS}$	MIL-STD-750 Method 3401	$V_{DS} = 0$ $I_G = -1.0\mu A$	-40	-	V
3	Drain Cut-off Current	I_{DSX}	MIL-STD-750 Method 3413	$V_{DS} = 20V$	-	0.1	nA
	- Variant 01			$V_{GS} = -12V$			
	- Variant 02			$V_{GS} = -7.0V$			
	- Variant 03			$V_{GS} = -5.0V$			
4	Drain Current	I_{DSS}	MIL-STD-750 Method 3413	$V_{DS} = 20V$			mA
	- Variant 01			$V_{GS} = 0V$	50	150	
	- Variant 02			Note 1	25	75	
	- Variant 03				5.0	30	
5	Gate Source Cut-off Voltage	V_{GSoff}	MIL-STD-750 Method 3403	$V_{DS} = 20V$ $I_D = 1.0nA$			V
	- Variant 01				-4.0	-10	
	- Variant 02				-2.0	-5.0	
	- Variant 03				-0.5	-3.0	
6	Drain Source Saturation Voltage	V_{Dsat}	MIL-STD-750 Method 3405	$V_{GS} = 0V$	-	0.4	V
	- Variant 01			$I_D = 12mA$			
	- Variant 02			$I_D = 6.0mA$			
	- Variant 03			$I_D = 3.0mA$			
7	ON-State Drain Source Resistance	r_{DSon}	MIL-STD-750 Method 3421	$V_{GS} = 0V$ $I_D = 1.0mA$			Ω
	- Variant 01				-	30	
	- Variant 02				-	60	
	- Variant 03				-	100	

NOTES

1. Pulse measurement: Pulse length ≤300μs, Duty Cycle ≤2%.

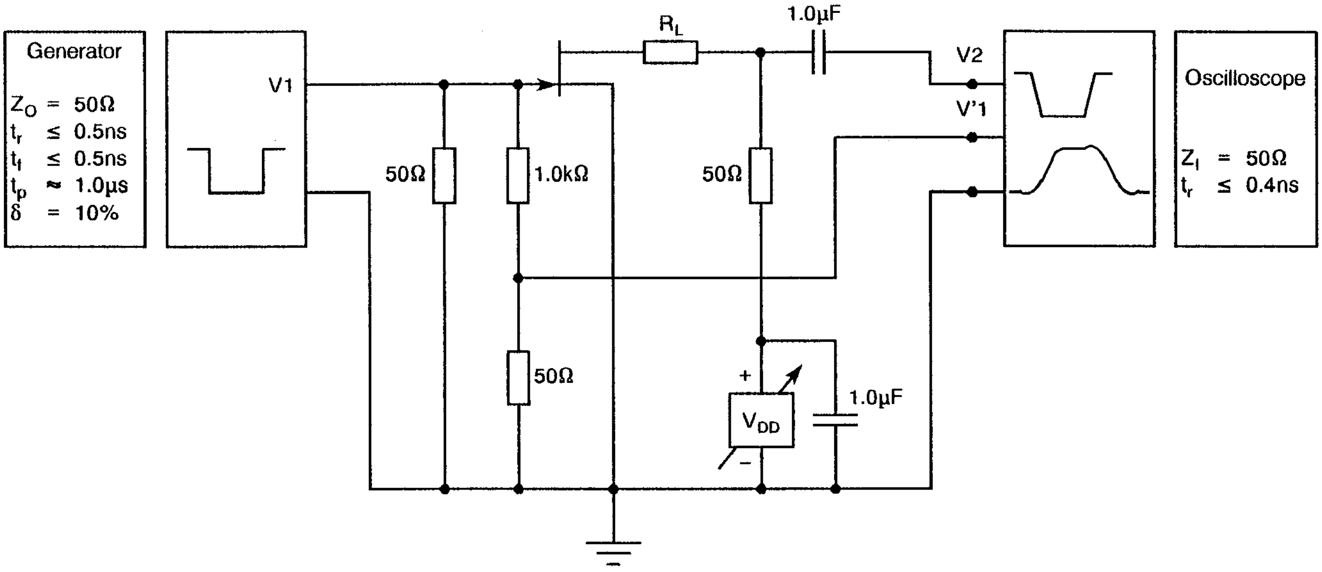
TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - a.c. PARAMETERS

No.	CHARACTERISTICS	SYMBOL	SPEC. AND/OR TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN.	MAX.	
8	ON-State Drain Source Resistance - Variant 01 - Variant 02 - Variant 03	r_{DSon}	MIL-STD-750 Method 3423	$V_{GS} = 0V$ $I_D = 0A$ f = 1.0kHz	- - -	30 60 100	Ω
9	Input Capacitance	C_{iss}	MIL-STD-750 Method 3431	$V_{GS} = 0V$ $V_{DS} = 0V$ f = 1.0MHz	-	26	pF
10	Reverse Transfer Capacitance - Variant 01 - Variant 02 - Variant 03	C_{rss}	MIL-STD-750 Method 3433	$V_{DS} = 0V$ f = 1.0MHz $V_{GS} = -12V$ $V_{GS} = -7.0V$ $V_{GS} = -5.0V$	-	4.0	pF
11	Rise Time - Variant 01 - Variant 02 - Variant 03	t_r	See Figure 4	$V_{DD} = 10V$ $V_{GS} = 0V$ $V_{GSX} = -12V$ $I_D = 12mA$ $V_{GSX} = -7.0V$ $I_D = 6.0mA$ $V_{GSX} = -5.0V$ $I_D = 3.0mA$	-	5.0	ns
12	Turn-on Delay Time - Variant 01 - Variant 02 - Variant 03	$t_{d(on)}$	See Figure 4	$V_{DD} = 10V$ $V_{GS} = 0V$ $V_{GSX} = -12V$ $I_D = 12mA$ $V_{GSX} = -7.0V$ $I_D = 6.0mA$ $V_{GSX} = -5.0V$ $I_D = 3.0mA$	-	15	ns
13	Fall Time - Variant 01 - Variant 02 - Variant 03	t_f	See Figure 4	$V_{DD} = 10V$ $V_{GS} = 0V$ $V_{GSX} = -12V$ $I_D = 12mA$ $V_{GSX} = -7.0V$ $I_D = 6.0mA$ $V_{GSX} = -5.0V$ $I_D = 3.0mA$	- - -	15 20 30	ns
14	Turn-off Delay Time - Variant 01 - Variant 02 - Variant 03	$t_{d(off)}$	See Figure 4	$V_{DD} = 10V$ $V_{GS} = 0V$ $V_{GSX} = -12V$ $I_D = 12mA$ $V_{GSX} = -7.0V$ $I_D = 6.0mA$ $V_{GSX} = -5.0V$ $I_D = 3.0mA$	- - -	20 35 50	ns

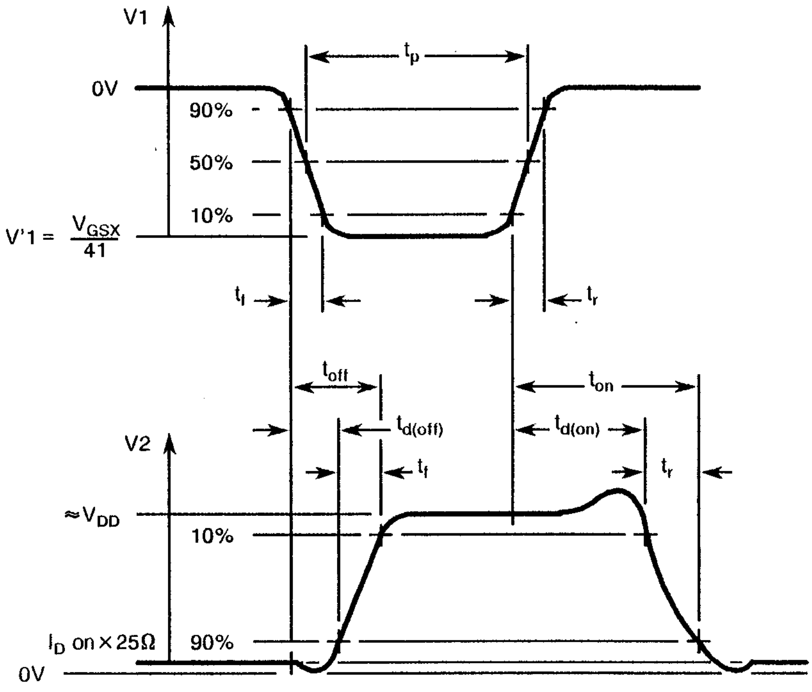
NOTES

1. If more than 20 units have to be measured, the measurements shall be made on a sample basis in accordance with Para. 7.4.2 of ESA/SCC Generic Specification No. 5000. Inspection Level II with an AQL = 2.5%.

FIGURE 4 - SWITCHING TIMES TEST CIRCUIT



V_{GSX}	=	−12V	(2N4391)
		−7.0V	(2N4392)
		−5.0V	(2N4393)



I_D on	≈	12mA	(2N4391)
		6.0mA	(2N4392)
		3.0mA	(2N4393)

TABLE 3 - ELECTRICAL MEASUREMENTS AT HIGH AND LOW TEMPERATURES

No.	CHARACTERISTICS	SYMBOL	SPEC. AND/OR TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN.	MAX.	
1	Total Gate Leakage Current	I_{GSS}	MIL-STD-750 Method 3411	$V_{DS} = 0V$ $V_{GS} = -20V$ $T_{amb} = +150°C$	-	-0.2	µA
2	Drain Cut-off Current	I_{DSX}	MIL-STD-750 Method 3413	$V_{DS} = 20V$ $T_{amb} = +150°C$	-	0.2	µA
	- Variant 01			$V_{GS} = -12V$			
	- Variant 02			$V_{GS} = -7.0V$			
	- Variant 03			$V_{GS} = -5.0V$			

TABLE 4 - PARAMETER DRIFT VALUES

No.	CHARACTERISTICS	SYMBOL	SPEC. AND/OR TEST METHOD	TEST CONDITIONS	CHANGE LIMITS (Δ)	UNIT
1	Total Gate Leakage Current	I_{GSS}	MIL-STD-750 Method 3411	$V_{DS} = 0V$ $V_{GS} = -20V$	± 100 or (2) ± 50	% pA
2	Gate Source Cut-off Voltage	V_{GSoff}	MIL-STD-750 Method 3403	$V_{DS} = 20V$ $I_D = 1.0nA$	± 10	%
3	Drain Current	I_{DSS}	MIL-STD-750 Method 3413	$V_{DS} = 20V$ $V_{GS} = 0V$ Note 1	± 15	%

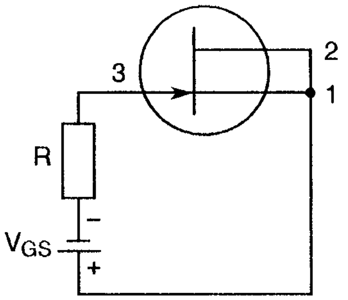
NOTES

1. Pulse measurement: Pulse length ≤300µs, Duty Cycle ≤2%
2. Whichever is greater.

TABLE 5 - CONDITIONS FOR BURN-IN

No.	CHARACTERISTICS	SYMBOL	CONDITION	UNIT
1	Ambient Temperature	T_{amb}	150	°C
2	Drain Source Voltage	V_{DS}	0	V
3	Gate Source Voltage	V_{GS}	−28	V

FIGURE 5 - ELECTRICAL CIRCUITS FOR BURN-IN



4.8 ENVIRONMENTAL AND ENDURANCE TESTS (CHARTS IV AND V OF ESA/SCC GENERIC SPECIFICATION No. 5000)

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. The measurements shall be performed at $T_{amb} = +22 \pm 3$ °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.

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. 5000. The conditions for operating life testing shall be as specified in Table 5 for the burn-in test.

4.8.4 Electrical Circuits for Operating Life Tests

The circuit to be used for performance of the operating life tests shall be as shown in Figure 5 for burn-in.

4.8.5 Conditions for High Temperature Storage Test (Part of Endurance Testing)

The requirements for the high temperature storage test are specified in ESA/SCC Generic Specification No. 5000. The temperature to be applied shall be the maximum storage temperature specified in Table 1(b) of this specification.

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

No.	CHARACTERISTICS	SYMBOL	SPEC. AND/OR TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN.	MAX.	
1	Total Gate Leakage Current	I_{GSS}	MIL-STD-750 Method 3411	$V_{DS} = 0V$ $V_{GS} = -20V$	-	-0.1	nA
2	Gate Source Cut-off Voltage	V_{GSoff}	MIL-STD-750 Method 3403	$V_{DS} = 20V$ $I_D = 1.0nA$			V
	- Variant 01				-4.0	-10	
	- Variant 02				-2.0	-5.0	
	- Variant 03				-0.5	-3.0	
3	Drain Current	I_{DSS}	MIL-STD-750 Method 3413	$V_{DS} = 20V$ $V_{GS} = 0V$ Note 1			mA
	- Variant 01				50	150	
	- Variant 02				25	75	
	- Variant 03				5.0	30	

NOTES

1. Pulse measurement: Pulse length ≤300µs, Duty Cycle ≤2%