TRANSISTORS, POWER, MOSFET, N-CHANNEL, RAD-HARD

BASED ON TYPES BUY25CS12K, BUY25CS45B

ESCC Detail Specification No. 5205/030

Issue 3	May 2023

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DOCUMENTATION CHANGE NOTICE

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DCR No.	CHANGE DESCRIPTION
1562	Specification upissued to incorporate changes per DCR

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1 GENERAL

1.1 SCOPE

This specification details the ratings, physical and electrical characteristics and test and inspection data for the component type variants and/or the range of components specified below. It supplements the requirements of, and shall be read in conjunction with, the ESCC Generic Specification listed under Applicable Documents.

1.2 APPLICABLE DOCUMENTS

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

(a) ESCC Generic Specification No. 5000
(b) MIL-STD-750, Test Methods and Procedures for Semiconductor Devices
(c) MIL-STD-883, Test Method Standard Microelectronics

1.3 TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

For the purpose of this specification, the terms, definitions, abbreviations, symbols and units specified in ESCC Basic Specification No. 21300 shall apply.

1.4 THE ESCC COMPONENT NUMBER AND COMPONENT TYPE VARIANTS

1.4.1 The ESCC Component Number

The ESCC Component Number shall be constituted as follows:

Example: 520503001R

- Detail Specification Reference: 5205030
- Component Type Variant Number: 01 (as required)
- Total Dose Radiation Level Letter: R (as required)

1.4.2 Component Type Variants

The component type variants applicable to this specification are as follows:

Variant Number	Based on Type	I_{DS} @ $T_{case} \leq +25°C$ max A (Note 1)	I_{DS} @ $T_{case} = +100°C$ max A (Note 1)	$r_{DS(on)}$ @ $T_{amb} = +25°C$ max mΩ (Note 2)	Case (Note 3)	Weight max g	Total Dose Radiation Level Letter (Note 4)
01	BUY25CS12K-01	12.4	8	130	TO-257AA	5.1	R [100kRAD(Si)]
02	BUY25CS12K-11	12.4	8	130	TO-257AA	5.1	R [100kRAD(Si)]
03	BUY25CS45B-01	45	29	50	TO-254AA	9.5	R [100kRAD(Si)]
04	BUY25CS12K-02	12.4	8	130	TO-257AA	5.1	R [100kRAD(Si)]
05	BUY25CS12K-12	12.4	8	130	TO-257AA	5.1	R [100kRAD(Si)]
06	BUY25CS45B-02	45	29	50	TO-254AA	9.5	R [100kRAD(Si)]

NOTES:

1. See Para. 1.5.
2. See Para. 2.5.1.
3. See Para. 1.7 for Pin Out.
4. Total dose radiation level letters are defined in ESCC Basic Specification No. 22900. If an alternative radiation test level is specified in the Purchase Order the letter shall be changed accordingly.

1.5 MAXIMUM RATINGS

The maximum ratings shall not be exceeded at any time during use or storage.

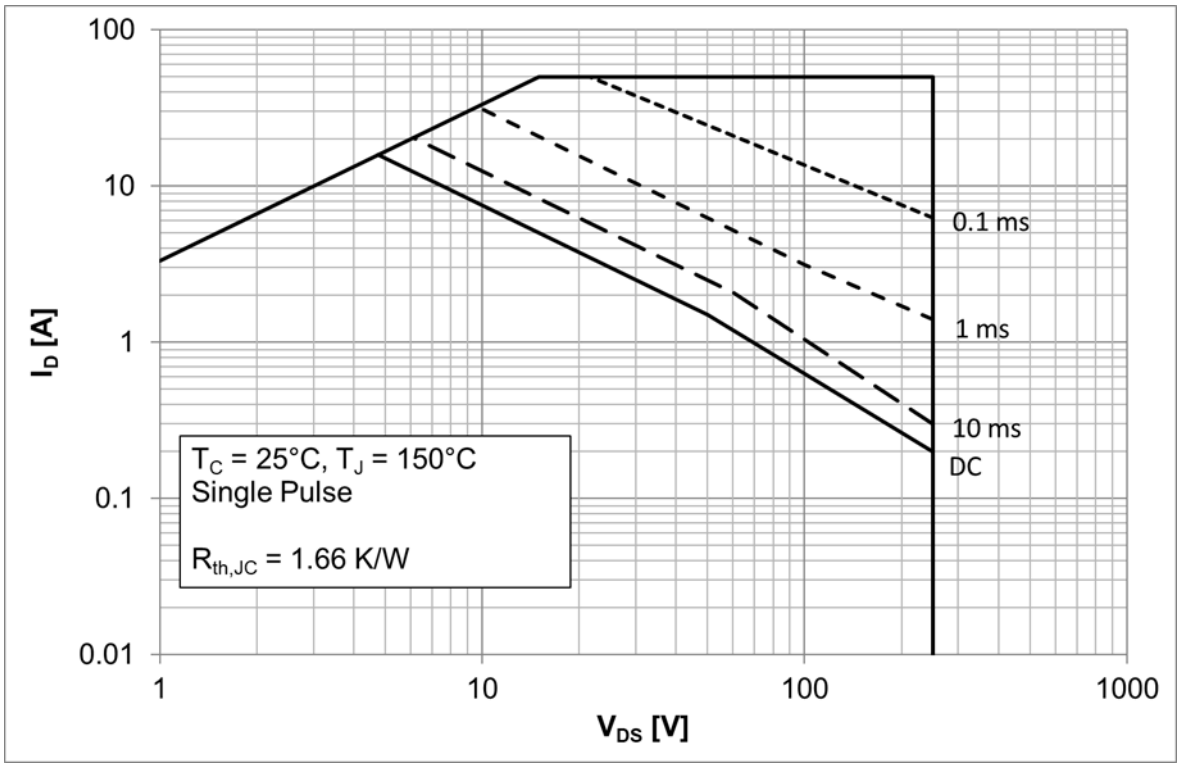
Maximum ratings shall only be exceeded during testing to the extent specified in this specification and when stipulated in Test Methods and Procedures of the ESCC Generic Specification.

Characteristics	Symbols	Maximum Ratings	Units	Remarks
Drain-Source Voltage	V_{DS}	250	V	Note 1
Gate-Source Voltage	V_{GS}	20	V	
Drain Current (Continuous)	I_{DS}	Note 2	A	At $T_{case} \leq +25°C$ Notes 1, 3, 4
		Note 2	A	At $T_{case} = +100°C$ Notes 3, 4
Drain Current (Pulsed) Variants 01, 02, 04, 05: Variant 03, 06:	I_{DM}	 50 180	Apk	At $T_{case} \leq +25°C$ Notes 1, 3
Power Dissipation Variants 01, 02, 04, 05: Variant 03, 06:	P_{tot}	 75 208	W	Note 5
Avalanche Energy (Single Pulse) Variants 01, 02, 04, 05: Variant 03, 06:	E_{AS}	 60 380	mJ	
Operating Temperature Range	T_{op}	-55 to +150	°C	T_{amb}
Storage Temperature Range	T_{stg}	-55 to +150	°C	
Junction Temperature	T_j	+150	°C	
Soldering Temperature	T_{sol}	+250	°C	Note 6
Thermal Resistance, Junction-to-Case Variants 01, 02, 04, 05: Variant 03, 06:	$R_{th(j-c)}$	 1.66 0.6	°C/W	

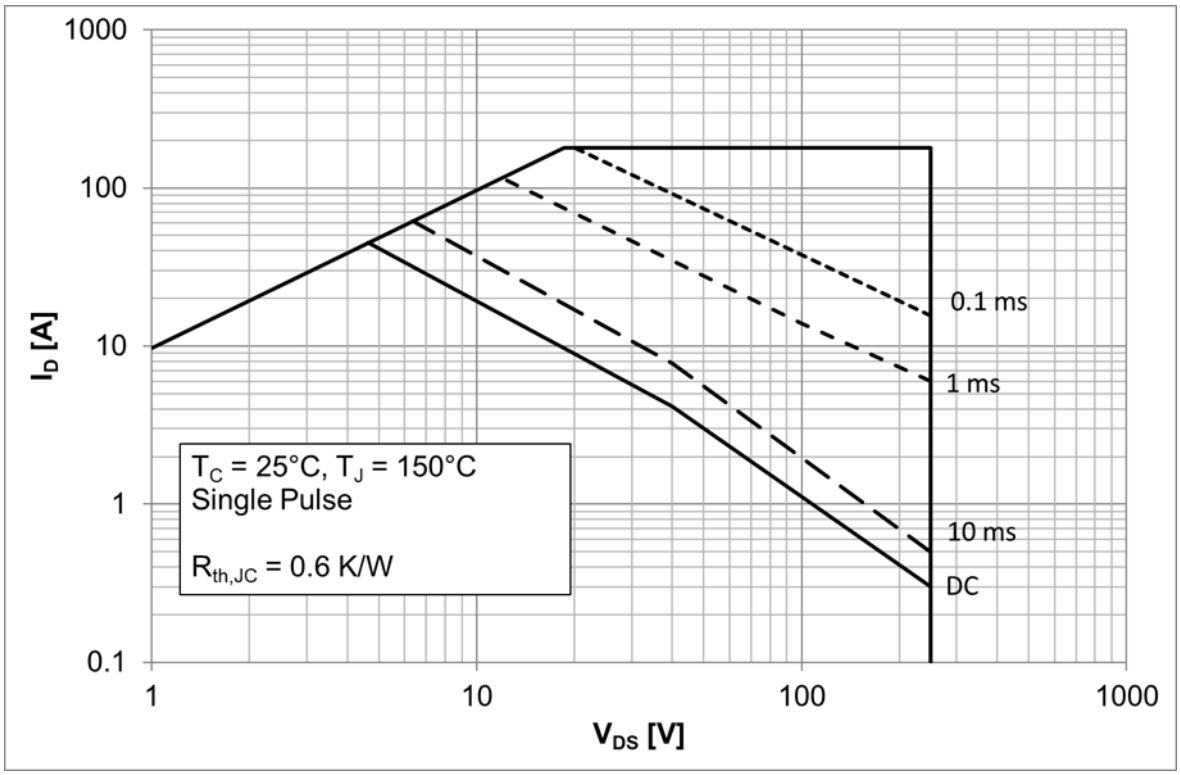
NOTES:

1. Safe Operating Area applies as follows:

VARIANTS 01, 02, 04, 05



VARIANTS 03, 06



2. See Para. 1.4.2 for I_{DS} value.
3. T_{case} is measured on the PCB at the soldering point to the Drain terminal.
4. For T_{case} > +25°C, derate as follows:

$$I_{DS} = \sqrt{\frac{T_{jmax} - T_{case}}{(R_{th(j-c)}) \times (r_{DS(on)} \text{at } T_{jmax})}}$$

where $r_{DS(on)}$ at T_{jmax} =

- For Variants 01, 02, 04, 05: 490mΩ
- For Variants 03, 06: 103mΩ

5. For T_{case} > +25°C, derate linearly to 0W at T_{case} = +150°C.
6. Duration 10 seconds maximum and the same terminal shall not be resoldered until 3 minutes have elapsed.

1.6 HANDLING PRECAUTIONS

The TO-257AA and TO-254AA packages contain Beryllium Oxide (BeO) and therefore must not be ground, machined, sandblasted or subjected to any mechanical operation which will produce dust. The case must not be subjected to any chemical process (e.g. etching) which will produce fumes.

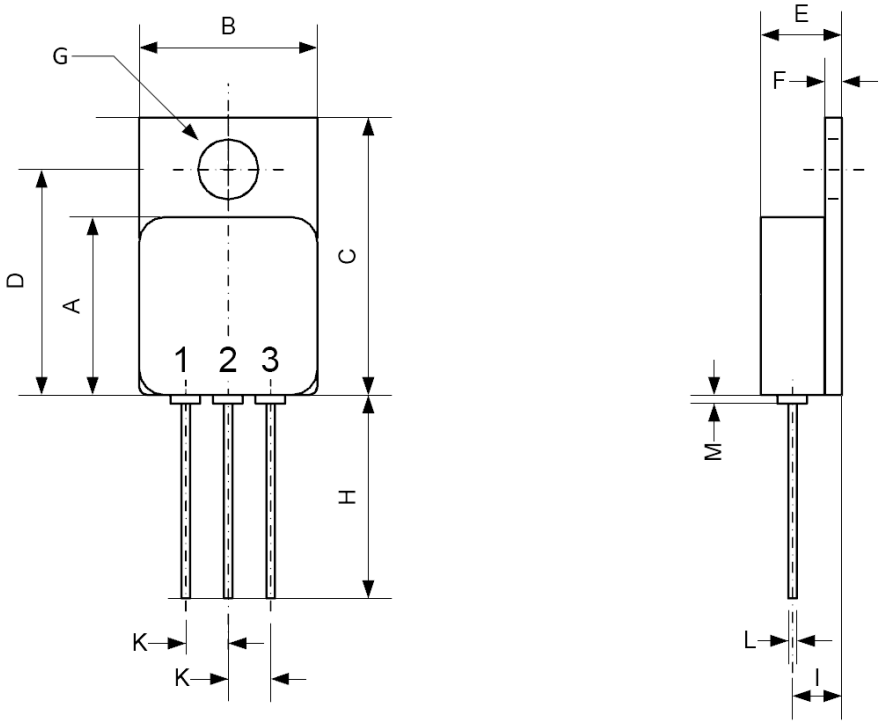
These devices shall not be handled by the terminals.

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 per ESCC Basic Specification No. 23800 with a Minimum Critical Path Failure Voltage of 1000V.

1.7 PHYSICAL DIMENSIONS AND TERMINAL IDENTIFICATION

1.7.1 TO-257AA and TO-254AA Packages – 3 Terminals



Symbols	Dimensions mm			
	Variants 01, 02, 04, 05 (TO-257AA)		Variants 03, 06 (TO-254AA)	
	Min	Max	Min	Max
A	10.4	10.8	13.5	13.9
B	10.4	10.8	13.5	13.9
C	16.2	16.8	19.9	20.4
D	13.1	13.9	16.8	17.5
E	4.8	5.4	6.4	6.9
F	0.9	1.1	1	1.3
G	3.5	3.7	3.5	3.8
H	14	19	12.9	15
I	2.7	3.2	3.6	4
K	2.54 BSC	2.54 BSC	3.81 BSC	3.81 BSC
L	0.6	1	0.8	1.2
M	-	1.3	-	1.3

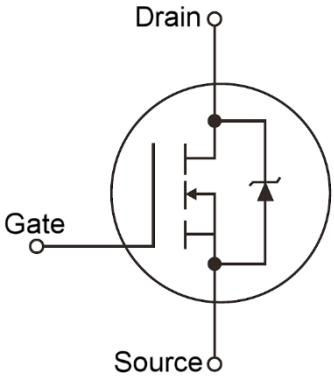
NOTES:

1. The terminal identification is specified by the component's geometry. The terminal identification shall be as follows:
   - Variants 01, 03, 04, 06: terminal 1 = Drain; terminal 2 = Source; terminal 3 = Gate
   - Variant 02, 05: terminal 1 = Gate; terminal 2 = Drain; terminal 3 = Source

1.8 FUNCTIONAL DIAGRAM

Variants 01, 03, 04, 06:
Terminal 1: Drain
Terminal 2: Source
Terminal 3: Gate

Variants 02, 05:
Terminal 1: Gate
Terminal 2: Drain
Terminal 3: Source



NOTES:
1. The case is not connected to any terminal.

1.9 MATERIALS AND FINISHES

Materials and finishes shall be as follows:

(a) Case
The case shall be hermetically sealed and have a ceramic/metal body.

(b) Terminals
The terminal material and finish shall be either D14 or H14 in accordance with the requirements of ESCC Basic Specification No. 23500.

2 REQUIREMENTS

2.1 GENERAL

The complete requirements for procurement of the components specified herein are as stated in this specification and the ESCC Generic Specification. Permitted deviations from the Generic Specification, applicable to this specification only, are listed below.

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

2.1.1 Deviations from the Generic Specification

2.1.1.1 Deviations from Screening Tests - Chart F3

(a) Verification of Safe Operating Area: The Safe Operating Area shall be verified by performing the Thermal Impedance ($Z_{th(j-s)}$) ΔV_{SD} test specified in Para. 2.5.1 Room Temperature Electrical Measurements.

(b) Particle Impact Noise Detection may be performed at any point after Temperature Cycling, prior to Seal.

(c) Power Burn-in: A high temperature steady-state gate bias test (HTGB) (see Para. 2.9) shall be performed instead of Power Burn-in.

(d) Radiographic Inspection: Not applicable.

2.2 MARKING

The marking shall be in accordance with the requirements of ESCC Basic Specification No. 21700 and as follows.

The information to be marked on the component shall be:

(a) The ESCC Qualified Component symbol (for ESCC qualified components only).
(b) The ESCC Component Number (see Para. 1.4.1).
(c) Traceability information.

2.3 WAFER LOT ACCEPTANCE

A SEM inspection shall be performed as specified in the ESCC Generic Specification.

2.4 TERMINAL STRENGTH

The test conditions for Terminal Strength, tested as specified in the ESCC Generic Specification, shall be as follows:

- Test Condition: A, tension, with an applied force of 40N for a duration of 10s.

2.5 ELECTRICAL MEASUREMENTS AT ROOM, HIGH AND LOW TEMPERATURES

Electrical measurements shall be performed at room, high and low temperatures. Consolidated notes are given in Para. 2.5.3.

2.5.1 Room Temperature Electrical Measurements

Unless otherwise specified, the measurements shall be performed at T_{amb} = +25 ±3°C.

Characteristics	Symbols	MIL-STD-750 Test Method	Test Conditions	Limits		Units
				Min	Max	
Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	3407	V_{GS} = 0V, I_D = 0.25mA Bias condition C	250	-	V
Gate-to-Source Threshold Voltage	$V_{GS(th)}$	3403	$V_{DS} \geq V_{GS}$, I_D = 1mA	2	4	V
Gate-to-Source Leakage Current	I_{GSS}	3411	V_{GS} = ±20V, V_{DS} = 0V Bias condition C	-100	+100	nA
Drain Current	I_{DSS}	3413	V_{GS} = 0V, V_{DS} = 200V Bias condition C	-	25	µA
Static Drain-to-Source On Resistance	$r_{DS(on)}$	3421	V_{GS} = 10V, Note 1 Variants 01, 02, 04, 05: I_D = 8A: Variants 03, 06: I_D = 29A:	 - -	 130 50	mΩ
Source-to-Drain Diode Forward Voltage	V_{SD}	4011	V_{GS} = 0V, Note 1 Variants 01, 02, 04, 05: I_{SD} = 12.4A: Variants 03, 06: I_{SD} = 45A:	 - -	 1.2 1.4	V
Thermal Impedance	$Z_{th(j-c)}$	3161	Note 2 Variants 01, 02, 04, 05: I_H = 2.1A: Variants 03, 06: I_H = 6.7A:	 - -	 0.65 0.19	°C/W

Characteristics	Symbols	MIL-STD-750 Test Method	Test Conditions	Limits		Units
				Min	Max	
Turn-on Delay Time	$t_{d(on)}$	3472	V_{GS} = 10V, R_G = 4.7Ω, V_{DS} = 125V Note 3 Variants 01, 02, 04, 05: I_D = 8A: Variants 03, 06: I_D = 29A	 -	 25 50	ns
Rise Time	t_r	3472	V_{GS} = 10V, R_G = 4.7Ω, V_{DS} = 125V Note 3 Variants 01, 02, 04, 05: I_D = 8A: Variants 03, 06: I_D = 29A:	 -	 25 95	ns
Turn-off Delay Time	$t_{d(off)}$	3472	V_{GS} = 10V, R_G = 4.7Ω, V_{DS} = 125V Note 3 Variants 01, 02, 04, 05: I_D = 8A: Variants 03, 06: I_D = 29A:	 -	 35 80	ns
Fall Time	t_f	3472	V_{GS} = 10V, R_G = 4.7Ω, V_{DS} = 125V Note 3 Variants 01, 02, 04, 05: I_D = 8A: Variants 03, 06: I_D = 29A:	 -	 20 75	ns
Reverse Recovery Time	t_{rr}	3473	V_{DD} ≤ 50V, di/dt = 100A/µs Note 3 Variants 01, 02, 04, 05: I_{SD} = 12.4A: Variants 03, 06: I_{SD} = 45A:	 -	 400 600	ns
Input Capacitance	C_{iss}	3431	V_{GS} = 0V, V_{DS} = 100V, f = 1MHz Note 3 Variants 01, 02, 04, 05: Variants 03, 06:	 1.3 3.5	 1.9 6.5	nF
Output Capacitance	C_{oss}	3453	V_{GS} = 0V, V_{DS} = 100V, f = 1MHz Note 3 Variants 01, 02, 04, 05: Variants 03, 06:	 90 250	 150 400	pF
Reverse Transfer Capacitance	C_{rss}	3433	V_{GS} = 0V, V_{DS} = 100V, f = 1MHz Note 3 Variants 01, 02: Variants 04, 05: Variants 03, 06:	 1 - 5	 6 11 20	pF
Total Gate Charge	Q_g	3471	V_{GS} = 10V, V_{DS} = 125V, Note 3 Variants 01, 02, 04, 05: I_D = 12.4A: Variants 03, 06: I_D = 45A:	 - -	 42 100	nC
Gate-to-Source Charge	Q_{gs}	3471	V_{GS} = 10V, V_{DS} = 125V, Note 3 Variants 01, 02, 04, 05: I_D = 12.4A: Variants 03, 06: I_D = 45A:	 - -	 15 55	nC
Gate-to-Drain Charge	Q_{gd}	3471	V_{GS} = 10V, V_{DS} = 125V, Note 3 Variants 01, 02, 04, 05: I_D = 12.4A: Variants 03, 06: I_D = 45A:	 - -	 15 35	nC

2.5.2 High and Low Temperatures Electrical Measurements

Characteristics	Symbols	MIL-STD-750 Test Method	Test Conditions (Note 4)	Limits		Units
				Min	Max	
Gate-to-Source Threshold Voltage	$V_{GS(th)}$	3403	T_{amb} = +125 (+0 -5)°C $V_{DS} \geq V_{GS}$, I_D = 1mA	1.5	-	V
			T_{amb} = -55 (+5 -0) °C $V_{DS} \geq V_{GS}$, I_D = 1mA	-	5	V
Gate-to-Source Leakage Current	I_{GSS}	3411	T_{amb} = +125 (+0 -5)°C V_{GS} = ±20V, V_{DS} = 0V Bias condition C	-200	+200	nA
Drain Current	I_{DSS}	3413	T_{amb} = +125 (+0 -5)°C V_{GS} = 0V, V_{DS} = 200V Bias condition C	-	250	µA
Static Drain-to-Source On Resistance	$r_{DS(on)}$	3421	T_{amb} = +125 (+0 -5)°C V_{GS} = 10V, Note 1 Variants 01, 02, 04, 05: I_D = 8A: Variants 03, 06: I_D = 29A:	 - -	 300 90	mΩ

2.5.3 Notes to Room, High and Low Temperatures Electrical Measurements

1. Pulsed measurement: Pulse Width ≤ 300µs, Duty Cycle ≤ 2%.
2. The $Z_{th(j-c)}$ limit is guaranteed by performing a ΔV_{SD} (go-no-go) test. The following test conditions and limits shall also apply:
   - V_{DS} = 20V
   - t_M < 75µs
   - I_M = 10mA
   - t_H = 25ms
   - V_{SD} = 40mV minimum, 60mV maximum
3. Read and record measurements shall be performed on a sample of 32 components with 0 failures allowed. Alternatively a 100% inspection may be performed.
4. Read and record measurements shall be performed on a sample of 5 components with 0 failures allowed. Alternatively a 100% inspection may be performed.

2.6 PARAMETER DRIFT VALUES

Unless otherwise specified, the measurements shall be performed at T_{amb} = +25 ±3°C.

The test methods and test conditions shall be as per the corresponding test defined in Para. 2.5.1 Room Temperature Electrical Measurements.

The drift values (Δ) shall not be exceeded for each characteristic specified. The corresponding absolute limit values for each characteristic shall not be exceeded.

Characteristics	Symbols	Limits			Units
		Drift Value Δ	Absolute		
			Min	Max	
Gate-to-Source Threshold Voltage	$V_{GS(th)}$	±20%	2	4	V
Gate-to-Source Leakage Current	I_{GSS}	±20 or (1) ±100%	-100	+100	nA
Drain Current	I_{DSS}	±10 or (1) ±100%	-	25	µA
Static Drain-to-Source On Resistance (Note 2)	$r_{DS(on)}$				mΩ
Variants 01, 02, 04, 05:		±20% (3)	-	130	
Variants 03, 06:		±20% (3)	-	50	

NOTES:

1. Whichever is the greater.
2. Measured only prior to HTRB Burn-in and after HTGB Burn-in.
3. Referred to the measurement prior to HTRB Burn-in.

2.7 INTERMEDIATE AND END-POINT ELECTRICAL MEASUREMENTS

Unless otherwise specified, the measurements shall be performed at T_{amb} = +25 ±3°C.

The test methods and test conditions shall be as per the corresponding test defined in Para. 2.5.1 Room Temperature Electrical Measurements.

The limit values for each characteristic shall not be exceeded.

Characteristics	Symbols	Limits			Units
		Drift Value Δ	Absolute		
			Min	Max	
Gate-to-Source Threshold Voltage	$V_{GS(th)}$	±20%	2	4	V
Gate-to-Source Leakage Current	I_{GSS}	±20 or (1) ±100%	-100	+100	nA
Drain Current	I_{DSS}	±10 or (1) ±100%	-	25	µA
Static Drain-to-Source On Resistance Variants 01, 02, 04, 05: Variants 03, 06:	$r_{DS(on)}$	 ±20% ±20%	 - -	 130 50	mΩ

NOTES:

1. Whichever is greater.

2.8 HIGH TEMPERATURE REVERSE BIAS BURN-IN CONDITIONS

HTRB Burn-in shall be performed in accordance with MIL-STD-750, Test Method 1042, Test Condition A with the following conditions:

Characteristics	Symbols	Test Conditions	Units
Ambient Temperature	T_{amb}	+150 (+0 -5)	°C
Drain-to-Source Voltage	V_{DS}	200 (Note 1)	V
Gate-to-Source Voltage	V_{GS}	0	V
Duration	t	240 minimum	Hours

NOTES:

1. Voltage may be switched off during cool down.

2.9 HIGH TEMPERATURE STEADY-STATE GATE BIAS BURN-IN CONDITIONS

HTGB Burn-in shall be performed in accordance with MIL-STD-750, Test Method 1042, Test Condition B with the following conditions:

Characteristics	Symbols	Test Conditions	Units
Ambient Temperature	T_{amb}	+150 (+0 -5)	°C
Drain-to-Source Voltage	V_{DS}	0	V
Gate-to-Source Voltage	V_{GS}	16	V
Duration	t	48 minimum	Hours

2.10 OPERATING LIFE CONDITIONS

Operating Life shall consist of High Temperature Reverse Bias in accordance with MIL-STD-750, Test Method 1042, Test Condition A, followed by High Temperature Steady-State Gate Bias in accordance with MIL-STD-750, Test Method 1042, Test Condition B. The test conditions are as follows:

High Temperature Reverse Bias Conditions

Characteristics	Symbols	Test Conditions	Units
Ambient Temperature	T_{amb}	+150 (+0 -5)	°C
Drain-to-Source Voltage	V_{DS}	200 (Note 1)	V
Gate-to-Source Voltage	V_{GS}	0	V
Duration	t	1000 minimum	Hours

High Temperature Steady State Gate Bias Conditions

Characteristics	Symbols	Test Conditions	Units
Ambient Temperature	T_{amb}	+150 (+0 -5)	°C
Drain-to-Source Voltage	V_{DS}	0	V
Gate-to-Source Voltage	V_{GS}	16	V
Duration	t	1000 minimum	Hours

NOTES:

1. Voltage may be switched off during cool down.

2.11 TOTAL DOSE RADIATION TESTING

2.11.1 Bias Conditions and Total Dose Level for Total Dose Radiation Testing

The following bias condition shall be used during irradiation testing:

- V_{GS} = +15V
- V_{DS} = 0V

The total dose level applied shall be as specified in Para. 1.4.2 or in the Purchase Order.

2.11.2 Electrical Measurements for Total Dose Radiation Testing

Prior to irradiation testing the devices shall have successfully met Para. 2.5.1 Room Temperature Electrical Measurements.

Unless otherwise stated the measurements shall be performed at T_{amb} = +25 ±3°C.

Unless otherwise specified the test methods and test conditions shall be as per the corresponding test defined in Para. 2.5.1 Room Temperature Electrical Measurements.

The parameters to be measured during irradiation testing and on completion of irradiation testing are shown below:

Characteristics	Symbols	Limits			Units
		Drift Values (Δ)	Absolute		
			Min	Max	
Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	±20%	250	-	V
Gate-to-Source Threshold Voltage	$V_{GS(th)}$	+10%, -50%	2	4	V
Gate-to-Source Leakage Current	I_{GSS}	±20	-100	+100	nA
Drain Current	I_{DSS}	-	-	25	µA
Static Drain-to-Source On Resistance	$r_{DS(on)}$				mΩ
Variants 01, 02, 04, 05:		±20%	-	130	
Variants 03, 06:		±20%	-	50	
Source-to-Drain Diode Forward Voltage	V_{SD}	±10%			V
Variants 01, 02, 04, 05:			-	1.2	
Variants 03, 06:			-	1.4	

APPENDIX A

AGREED DEVIATIONS FOR INFINEON TECHNOLOGIES (D)

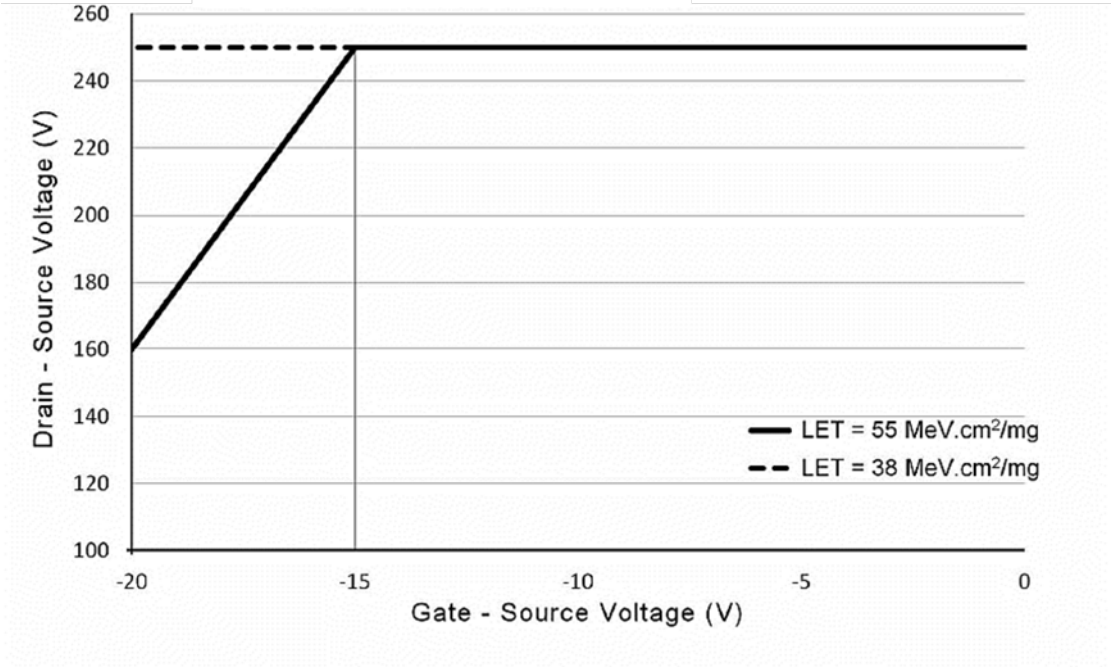
ITEMS AFFECTED	DESCRIPTION OF DEVIATIONS
Para. 1.4.2 Component Type Variants	The following note applies: Variants 01, 02, 03 originate from an 8 inch wafer process. Variants 04, 05, 06 originate from a 12 inch wafer process.
Para. 2.1.1 Deviations from the Generic Specification: Deviations from Production Control - Chart F2	The 3 component sample Dimension Check need only be performed once on each component package production lot.
Para. 2.1.1 Deviations from the Generic Specification: Deviations from Qualification and Periodic Tests - Chart F4	Temperature Cycling shall be performed in accordance with MIL- STD-883, Test Method 1010, Test Condition C, 100 cycles at maximum storage temperature rating specified in the Detail Specification.
	Seal, Fine Leak shall be performed in accordance with MIL-STD-883, Test Method 1014, Test Condition A1 or A2.
Para. 2.1.1.1 Deviations from Screening Tests - Chart F3	Temperature Cycling shall be performed in accordance with MIL-STD-883, Test Method 1010, Test Condition C, 20 cycles at maximum storage temperature rating specified in the Detail Specification.
	High and Low Temperatures Electrical Measurements may be performed at any point after High Temperature Steady-State Gate Bias Burn-in, prior to Seal, but shall still count towards Check for Lot Failure.
	Seal, Fine Leak shall be performed in accordance with MIL-STD-883, Test Method 1014, Test Condition A1 or A2.
	Solderability is not applicable unless otherwise stipulated in the Purchase Order.
Para. 2.5.1 Room Temperature Electrical Measurements	The read and record 32 component sample electrical measurements for characteristics $t_{d(on)}$, t_r, $t_{d(off)}$, t_f, t_{rr}, C_{iss}, C_{oss}, C_{rss}, Q_g, Q_{gs} and Q_{gd} need only be performed once on each wafer lot used to supply components to this specification. Any failure shall result in rejection of the wafer lot. The sample measurement may be performed at any time during production.

ADDITIONAL DATA – INFINEON TECHNOLOGIES (D)

(a) Derating for Space Application

These components are susceptible to Single Event Gate Rupture if operated in a space environment unless the following derating is applied:

SINGLE EVENT SAFE OPERATING AREA - VARIANTS 01, 02, 03



SINGLE EVENT SAFE OPERATING AREA - VARIANTS 04, 05, 06