TRANSISTORS, POWER, MOSFET, N-CHANNEL, RAD-HARD
BASED ON TYPE STRH100N6
ESCC Detail Specification No. 5205/022 + DCR794

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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

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: 520502201F

- Detail Specification Reference: 520502201F
- Component Type Variant Number: 01 (as required)
- Total Dose Radiation Level Letter:F (as required)

1.4.2 Component Type Variants

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

Variant Number	Based on Type	Case	Lead Material and Finish	Weight max g	Total Dose Radiation Level Letter
01	STRH100N6	TO-254AA	S14	10	F [50kRAD/Si]
02	STRH100N6	TO-254AA	S4	10	F [50kRAD/Si]

The lead/terminal material and finish shall be in accordance with the requirements of ESCC Basic Specification No. 23500.

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 ESCC Generic Specification.

Characteristics	Symbols	Maximum Ratings	Unit	Remarks
Drain-Source Voltage	V_{DS}	60	V	Over Top V_{GS}=0V Note 2
Gate-Source Voltage	V_{GS}	±20	V	Over Top
Drain Current	I_{DS}	~~80~~ 40	A	Continuous At T_{case} ≤ +25°C Note 1
		~~50~~ 40	A	Continuous At T_{case} >+100°C Note 1
Drain Current (pulsed)	I_{DM}	320	A	Note 2
Power Dissipation	P_{TOT}	176	W	At T_{case} ≤ +25°C Note 1
Avalanche Energy (Single Pulse)	E_{AS}	954 280	mJ	V_{DS}=40V I_{AS}=40A T_j=+25±3°C T_j=+110 (+0 -5°C)
Avalanche Energy (Repetitive Pulse)	E_{AR}	24 7.7	mJ	V_{DS}=40V I_{AR}=40A f=100kHz Duty Cycle= 10% T_j=+25±3°C T_j=+110 (+0 -5°C)
Operating Temperature Range	Top	-55 to +150	°C	Note 3
Junction Temperature	Tj	+150	°C	
Storage Temperature Range	Tstg	-55 to +150	°C	Note 3
Soldering Temperature	Tsol	+260	°C	Note 4
ThermalResistance, Junction-to-Heat Sink	$R_{th(J-S)}$	0.71	°C/W	Note 5
ThermalResistance, Junction-to-Ambient	$R_{th(J-A)}$	48	°C/W	Note 2

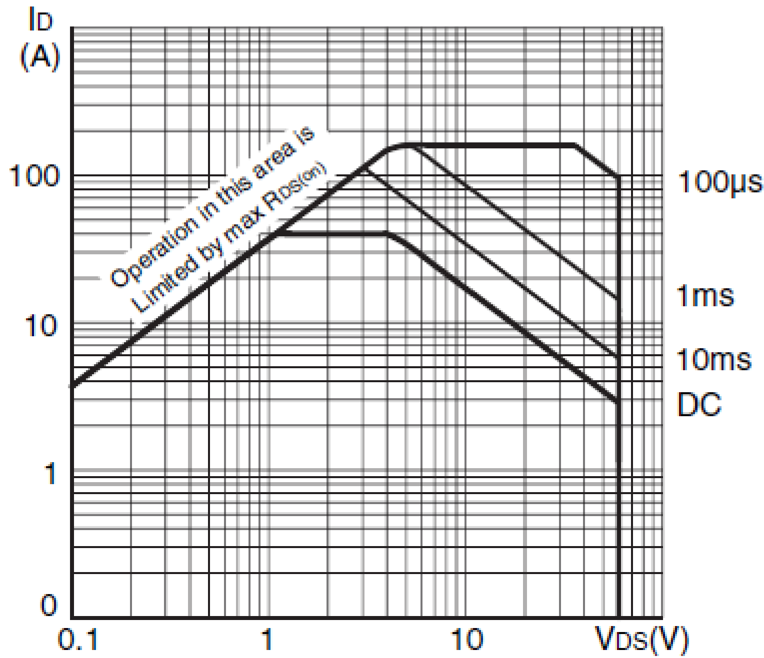
NOTES:

1. I_{DS} and P_{tot} ratings are in accordance with $R_{th(j-s)}$. The maximum theoretical I_D limit at T_{case} > +25°C can be obtained by using the following formula (I_D is limited by the package and device construction):

$$I_D = \sqrt{\frac{T_{j(max)} - T_{Case}}{(R_{th(j-s)}) \, x \, (R_{DS}(on) \, at \, T_{j(max)})}}$$

   Where ($r_{DS(on)}$ at Tj(max) = 30mΩ
   For T_{case} > +25°C, the power Dissipation derates linearly to 0W at T_{case} = +150°C
2. Safe Operating Area applies as follows:

Maximun Safe Operating Area



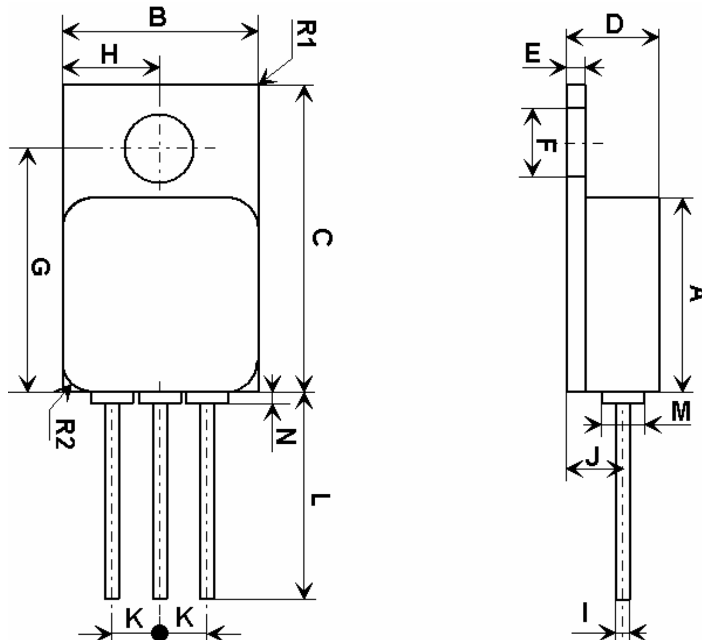
3. For Variants with hot solder dip lead finish all testing and handling performed at Tamb>+125°C shall be carried out in a 100% inert atmosphere.
4. Duration 10 seconds maximum at a distance of not less than 1.5mm from the device body and the same lead shall not be resoldered until 3 minutes have elapsed.
5. Package mounted on infinite heatsink..

1.6 HANDLING PRECAUTIONS

The TO-254AA package contains Beryllium Oxide (BeO) and therefore it 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.

1.7 PHYSICAL DIMENSIONS AND TERMINAL IDENTIFICATION

Metal Flange Mount Package (TO-254AA) - 3 Lead



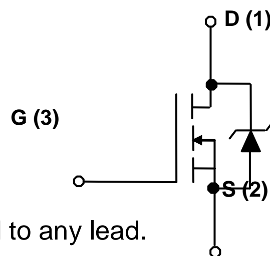
Symbols	Dimensions mm		Notes
	Min	Max	
A	13.59	13.84	
B	13.59	13.84	
C	20.07	20.32	
D	6.3	6.7	
E	1	1.35	
F	3.5	3.9	
G	16.89	17.4	
H	6.86 BSC		
ØI	0.89	1.14	2
J	3.81 BSC		
K	3.81 BSC		
L	12.95	14.5	
øM	3.05 Typical		2
N		0.71	2
R1		1.00	3
R2	1.65 Typical		4

NOTES:

1. The terminal identification is specified by the component's geometry. See Functional Diagram for the terminal connections.
2. 3 places.
3. Radius of heatsink flange corner, 4 places.
4. Radius of body corner, 4 places.

1.8 FUNCTIONAL DIAGRAM

Terminal 1 : Drain
Terminal 2 : Source
Terminal 3 : Gate



NOTES:

1. The case is not connected to any lead.

1.9 MATERIALS AND FINISHES

Materials and finishes shall be as follows:

a) Case
The case shall be hermetically sealed and have a metal body. The leads pass through ceramic eyelets brazed into the frame and the lid shall be welded.

b) Leads/Terminals
Raw Material: Cu/Zr.

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

- Verification of Safe Operating Area

The Safe Operating Area shall be verified by performing the VSD test specified in Room Temperature Electrical Measurements (Thermal Resistance, Junction-to-Heat Sink).

- A High Temperature Forward Bias test shall be performed instead of Power Burn-in.

2.2 WAFER LOT ACCEPTANCE

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

2.3 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 components symbol (for ESCC qualified components only).
(b) The ESCC Component Number.
(c) Traceability information (Date Code).
(d) Warning sign for Beryllium Oxide.

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 10N for 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 after the tables.

2.5.1 Room Temperature Electrical Measurements

The measurements shall be performed at Tamb=+22 ±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=1mA Bias Condition C	60	-	V
Gate-to-Source Leakage Current	I_{GSSF1}	3411	V_{GS}=+20V Bias Condition C, V_{DS}=0V	-	+100	nA
	I_{GSSR1}	3411	V_{GS}=-20V Bias Condition C, V_{DS}=0V	-100	-	nA
Drain Current	I_{DSS}	3413	V_{DS}=80% of rated B_{VDSS} Bias Condition C, V_{GS}=0V	-	10	µA
Gate-Source-Voltage (threshold)	$V_{GS(th)}$	3403	V_{GS}=V_{DS} I_D= 1mA	2	4.5	V
Static Drain-to-Source on resistance	$r_{DS(ON)}$	3421	I_D=40A V_{GS}=12V Note 1	-	0.0135	Ω
Forward Voltage	V_{SD}	4011	I_D=~~80~~ 40A V_{GS}=0V Note 1	-	1.5	V
Thermal Resistance Junction-to-Heat Sink	Rth(j-s)	3161	Note 2	-	0.71	°C/W
Input capacitance	Ciss	3431	V_{GS}=+0V V_{DS}=25V f=1MHz	~~3916~~ 3900	~~5874~~ 5900	pF
Output capacitance	Coss	3453		~~864~~ 860	~~1296~~ 1300	pF
Reverse transfer capacitance	Crss	3433		~~325~~ 300	~~488~~ 470	pF
Total Gate Charge	Q_g	3471	V_{DD}=30V I_D=~~80~~ 40A V_{GS}=12V	~~107~~ 100	~~161~~ 160	nC
Gate to Source charge	Q_{gs}			~~22~~ 18	~~33~~ 30	nC
Gate to Drain charge	Q_{gd}			~~39~~ 29	~~59~~ 51	nC
Turn-on delay time	$t_{d(on)}$	3472	V_{DD}=30V I_D=40A R_G=4.7Ω V_{GS}=12V	~~22~~ 16	~~33.5~~ 40	ns
Rise time	t_r			~~90~~ 60	~~135~~ 260	ns
Turn-off delay time	$t_{d(off)}$			~~62~~ 50	~~93~~ 120	ns
Fall time	tf			~~62~~ 60	~~93~~ 160	ns
Reverse Recovery Time	t_{rr}	3473	V_{DD}=48V I_{SD}=~~80~~ 40A di/dt=100A/µs Tj=+25 ±3°C	~~307~~ 170	~~461~~ 260	ns

2.5.2 High and Low Temperatures Electrical Measurements

Characteristics	Symbols	MIL-STD-750 Test Method	Test Conditions Note 3	Limits		Units
				Min	Max	
Gate-to-Source Leakage Current	I_{GSSF1}	3411	V_{GS}=+20V Bias Condition C, V_{DS}=0V Tcase= +125 (+0-5)°C	-	+200	nA
	I_{GSSR1}	3411	V_{GS}=-20V Bias Condition C, V_{DS}=0V Tcase= +125 (+0-5)°C	-200	-	nA
Drain Current	I_{DSS}	3413	V_{DS}=80% of rated B_{VDSS} Bias Condition C, V_{GS}=0V Tcase= +125 (+0-5)°C	-	100	µA
Gate-Source Voltage (threshold)	$V_{GS(th)}$	3403	V_{GS}=V_{DS} I_D= 1mA Tcase= +125 (+0-5)°C	1.6	3.5	V
			V_{GS}=V_{DS} I_D= 1mA Tcase= -55 (+5-0)°C	2.2	5.0	V
StaticDrain-Source on resistance	$R_{DS(ON)}$	3421	I_D=40A V_{GS}=12V Note 1 Tcase= +125 (+0-5)°C		0.024	Ω
Forward Voltage	V_{SD}	4011	I_{SD}=~~80A~~ **40A** V_{GS}=0V Note 1 Tcase= +125 (+0-5)°C		1.275	V

2.5.3 Notes to Electrical Measurement Tables

1) Pulse measurement: Pulse Width ≤ 680µs, Duty Cycle≤2%.
2) The Rth(j-s) limit is guaranteed by performing a ΔV_{SD} (go-no-go) test. The following test conditions and limits shall apply:
   a. V_{DS} = 5V
   b. I_D = 32A
   c. Ical = 29mA
   d. tpulse = 20ms
   e. tcal = 50µs
   f. V_{SD} = 60mV minimum, 200mV maximum.
3) 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 Tamb=+22 ±3°C.
The test methods and test conditions shall be as per the corresponding test defined in 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 Leakage Current	I_{GSSF1}	± 50 or (1) ± 100%	-	+100	nA
	I_{GSSR1}	± 50 or (1) ± 100%	-100	-	nA
Drain Current	I_{DSS}	± 4 or (1) ± 100%	-	10	µA
Gate-Source Voltage (threshold)	$V_{GS(th)}$	± 5%	2	4.5	V
StaticDrain-Source on resistance	$R_{DS(ON)}$	± 10%	-	0.0135	Ω

NOTES:

1. Whichever is the greater referred to the initial value.

2.7 INTERMEDIATE AND END-POINT ELECTRICAL MEASUREMENTS

Unless otherwise specified, the measurements shall be performed at Tamb=+22 ±3°C.
The test methods and test conditions shall be as per the corresponding test defined in Room Temperature Electrical Measurements.
The limit values for each characteristic shall not be exceeded.

Characteristics	Symbols	MIL-STD-750 Test Method	Test Conditions	Limits		Units
				Min	Max	
Drain Current	I_{DSS}	3413	V_{DS}=80% of rated B_{VDSS} Bias Condition C, V_{GS}=0V	-	10	µA
Gate-Source Voltage (threshold)	$V_{GS(th)}$	3403	V_{GS}=V_{DS} I_D= 1mA	2	4.5	V
StaticDrain-Source on resistance	$R_{DS(ON)}$	3421	I_D=40A V_{GS}=12V Note 1		0.0135	Ω

2.8 HIGH TEMPERATURE REVERSE BIAS BURN-IN CONDITIONS (HTRB)

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

Characteristics	Symbols	Test Conditions MIL-STD-750 Test Method 1042 Cond A	Units
Ambient Temperature	Tamb	+150	°C
Drain to Source	V_{DS}	+48	V
Duration	-	240	hrs

2.9 HIGH TEMPERATURE FORWARD BIAS BURN-IN CONDITIONS. (HTFB or HTGB)

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

Characteristics	Symbols	Test Conditions MIL-STD-750 Test Method 1042 Cond B	Units
Ambient Temperature	Tamb	+150	°C
Gate to Source	V_{GS}	+16	V
Duration	-	48	hrs

2.10 OPERATING LIFE CONDITIONS

Operating Life shall be performed in accordance with MIL-STD-750, Test Metho 1042, Test Condition A (HTRB) and B (HTFB) with the following conditions:

HIGH TEMPERATURE REVERSE BIAS CONDITIONS (HTRB)

Characteristics	Symbols	Test Conditions MIL-STD-750 Test Method 1042 Cond A	Units
Ambient Temperature	Tamb	+150	°C
Drain to Source	V_{DS}	+48	V
Duration	-	2000	hrs

HIGH TEMPERATURE FORWARD BIAS BURN-IN CONDITIONS. (HTFB or HTGB)

Characteristics	Symbols	Test Conditions MIL-STD-750 Test Method 1042 Cond B	Units
Ambient Temperature	Tamb	+150	°C
Gate to Source	V_{GS}	+16	V
Duration	-	2000	hrs

2.11 TOTAL DOSE RADIATION TESTING

All lots shall be irradiated in accordance with ESCC Basic Specification No.22900, standard dose rate (window 1: 3.6kRAD to 36kRAD per hour).

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

The following bias condition (worst-case) shall be used for Total Dose Radiation Testing at T_{amb}=22±3°C.

With V_{GS} bias = +15V and V_{DS} = 0V during irradiation.

The total dose level applied shall be as specified in the component type variant information herein 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 Room Temperature Electrical Measurements specified herein.

Unless otherwise stated the measurements shall be performed at T_{amb}=22 ± 3°C.

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

The parameters to be measured during and on completion of irradiation testing, after 24 hours anneal at Room Temperature and after 168 hours anneal at +100±3°C are shown below.

Symbol	**Characteristics**	**Units**	**Limits**
			Drift values Δ
BV_{DSS}	Drain-to-source Breakdown Voltage Note 1	V	-15% Note 2
$V_{GS(th)}$	Gate Threshold Voltage	V	- 60 % / + 25 %
I_{GSS}	Gate-to-Source Leakage Reverse / Forward	nA	+/- 1.5nA
I_{DSS}	Zero Gate Voltage Drain Current	µA	+10µA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-3)	Ω	+/- 15%
V_{SD}	Diode Forward Voltage	V	+/- 5%
Q_G	Total Gate Charge	nC	-5% / +50%
Q_{GS}	Gate-to-source charge	nC	+/- 35%
Q_{GD}	Gate-to-drain charge	nC	-5% / +110%

NOTES:

1. Drain-to-Source Voltage measurements shall be made in accordance with MIL-STD-750, Test Method 3405, with VGS = 0V and ID = 1mA.
2. Referred to an initial Drain-to-Source Voltage measurement made prior to the commencement of Total Dose Radiation Testing.

APPENDIX 'A'

AGREED DEVIATIONS FOR STMICROELECTRONICS (F)

ITEMS AFFECTED	DESCRIPTION OF DEVIATIONS
Deviations from Room Temperature Electrical Measurements	The AC characteristics Ciss, Coss, Crss, Qg, Qgs, Qgd, $td_{(on)}$, tr, $td_{(off)}$, t_f and trr, may be considered guaranteed but not tested if successful pilot lot testing has been performed on the wafer lot in accordance with STMicroelectronics procedure 8212069, which includes AC (Ciss, Coss, Crss, Qg, Qgs, Qgd, $td_{(on)}$, tr, $td_{(off)}$, t_f and trr) characteristic measurements per the Detail Specification. A summary of the pilot lot testing shall be provided if required by the Purchase Order.
Deviations from Electrical Measurements for Total Dose Radiation Testing	The AC characteristics Qg, Qgs and Qgd need not be measured because they are guaranteed by the results obtained by STMicroelectronics during the evaluation phase which proved these characteristics are directly correlated to the VGS(th) shift.
Deviations from Screening Tests –Chart F3	Solderability is not applicable unless specifically stipulated in the Purchase Order.

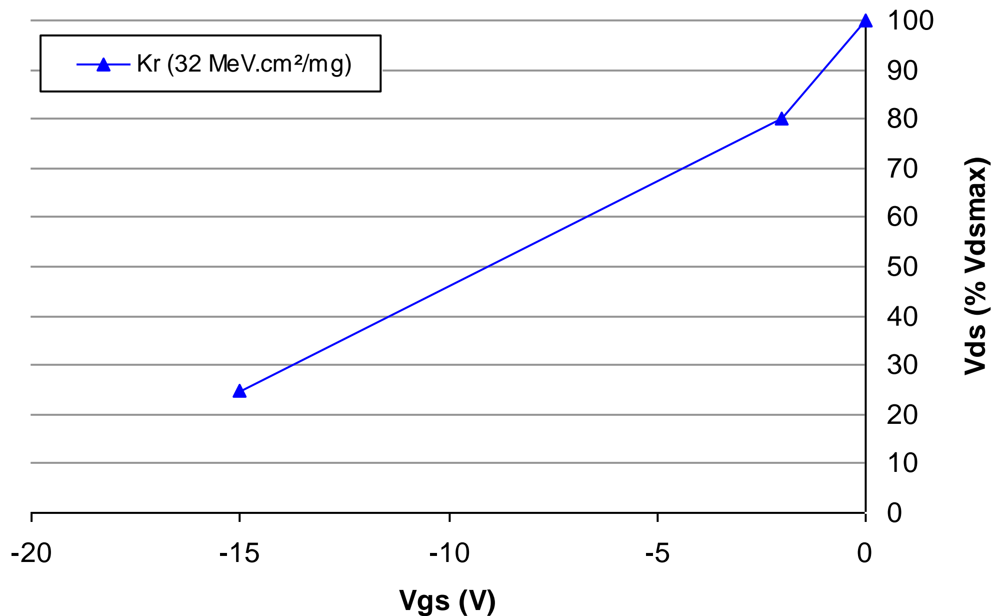
ADDITIONAL DATA – STMICROELECTRONICS (F)

(a) Derating for Space Application

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

VDS ≤ 100V when VGS = 0V,
VDS ≤ 80V when VGS = -2V,
VDS ≤ 25V when VGS = -15V.

Single Event Effect Safe Operating Area



NOTES:

1. The derating for space application was originally obtained under the following Test conditions:

Ion used	=	Kr
LET	=	32.1 (MeV/(mg/cm²))
Energy	=	768 MeV
Range	=	94 µm

Justification:
ST confirms that he didn't manufactured and sold any products since this spec was first published in June 2011. ST would like to reuse variants 01 & 02 for the new design.
Test conditions have been reviewed according to new Drain Current (I_{DS} ≤ 40A) due to package performances and gate-oxide modified to 470 Å instead of 350A.