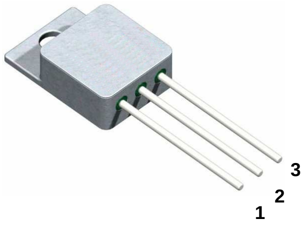
STRH100N10

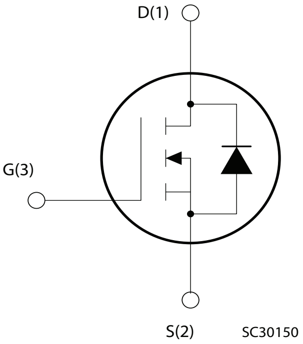
Rad-Hard 100 V, 48 A N-channel Power MOSFET

Datasheet - production data



TO-254AA

Figure 1. Internal schematic diagram



Features

V_{BDSS}	I_D	$R_{DS(on)}$	Q_g
100 V	48 A	30 mΩ	135 nC

- Fast switching
- 100% avalanche tested
- Hermetic package
- 70 krad TID
- SEE radiation hardened

Applications

- Satellite
- High reliability

Description

This N-channel Power MOSFET is developed with STMicroelectronics unique STripFET™ process. It has specifically been designed to sustain high TID and provide immunity to heavy ion effects. This Power MOSFET is fully ESCC qualified.

Table 1. Device summary

Part number	ESCC part number	Quality level	Package	Lead finish	Mass (g)	Temp. range	EPPL
STRH100N10HY1	-	Engineering model	TO-254AA	Gold	10	-55 to 150°C	-
STRH100N10HYG	5205/021/01	ESCC flight					Yes
STRH100N10HYT	5205/021/02			Solder dip			-

Note: Contact ST sales office for information about the specific conditions for product in die form and for other packages.

Contents

1 Electrical ratings

(T_C= 25 °C unless otherwise specified)

Table 2. Absolute maximum ratings (pre-irradiation)

Symbol	Parameter	Value	Unit
V_{DS} (1)	Drain-source voltage (V_{GS} = 0)	100	V
V_{GS} (2)	Gate-source voltage	±20	V
I_D (3)	Drain current (continuous)	48	A
I_D (3)	Drain current (continuous) at T_C= 100 °C	30	A
I_{DM} (4)	Drain current (pulsed)	192	A
P_{TOT} (3)	Total dissipation	170	W
dv/dt (5)	Peak diode recovery voltage slope	2.6	V/ns
T_{stg}	Storage temperature	- 55 to 150	°C
T_J	Operating junction temperature		°C

1. This rating is guaranteed @ T_J ≥ 25 °C (see *Figure 10: Normalized BV_{DSS} vs temperature*).
2. This value is guaranteed over the full range of temperature.
3. Rated according to the Rthj-case + Rthc-s.
4. Pulse width limited by safe operating area.
5. $I_{SD} \leq 48$ A, di/dt ≤ 100 A/μs, V_{DD} = 80% $V_{(BR)DSS}$.

Table 3. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case	0.52	°C/W
$R_{thc\text{-}s}$	Case-to-sink typ	0.21	°C/W

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_J max)	24	A
E_{AS}(1)	Single pulse avalanche energy (starting T_J=25 °C, I_D= I_{AR}, V_{DD}=50 V)	954	mJ
E_{AS}	Single pulse avalanche energy (starting T_J=110 °C, I_D= I_{AR}, V_{DD}=50 V)	280	mJ
E_{AR}	Repetitive avalanche (V_{dd} = 50 V, I_{AR} = 24 A, f = 10 KHz, T_J = 25 °C, duty cycle = 50%)	60	mJ

Table 4. Avalanche characteristics (continued)

Symbol	Parameter	Value	Unit
E_{AR}	Repetitive avalanche (V_{dd} = 50 V, I_{AR} = 24 A, f = 100 kHz, T_J = 25 °C, duty cycle = 10%)	24	mJ
	Repetitive avalanche (V_{dd} = 50 V, I_{AR} = 24 A, f = 100 kHz, T_J = 110 °C, duty cycle = 10%)	7.7	

1. Maximum rating value.

2 Electrical characteristics

(T_C = 25 °C unless otherwise specified).

Pre-irradiation

Table 5. Pre-irradiation on/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	80% BV_{Dss}			10	μA
I_{GSS}	Gate body leakage current (V_{DS} = 0)	V_{GS} = 20 V V_{GS} = -20 V	 -100		100 	nA nA
BV_{DSS} (1)	Drain-to-source breakdown voltage	V_{GS} = 0, I_D = 1 mA	100			V
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 1 mA	2		4.5	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 12 V; I_D = 24 A		0.030	0.035	W

1. This rating is guaranteed @ T_J ≥ 25 °C (see *Figure 10: Normalized BV_{DSS} vs temperature*).

Table 6. Pre-irradiation dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0, V_{DS} = 25 V, f=1 MHz	3940	4925	5910	pF
C_{oss} (1)	Output capacitance		543	679	814	pF
C_{rss}	Reverse transfer capacitance		190	237	284	pF
$C_{oss\ eq.}$ (1)	Equivalent output capacitance (2)	V_{GS} = 0, V_{DD} = 80 V		480		pF
Q_g	Total gate charge	V_{DD} = 50 V, I_D = 48 A, V_{GS}=12 V	108	135	162	nC
Q_{gs}	Gate-to-source charge		21	27	33	nC
Q_{gd}	Gate-to-drain (“Miller”) charge		36	45	54	nC
R_G (3)	Gate input resistance	f=1 MHz gate DC bias=0 test signal level=20mV open drain	1.2	1.7	2	Ω
L_G	Gate inductance			4.5		nH
L_S	Source inductance			7.5		nH
L_D	Drain inductance			7.5		nH

1. This value is guaranteed over the full range of temperature.
2. This value is defined as the ratio between the Q_{oss} and the voltage value applied.
3. Not tested, guaranteed by process.

Table 7. Switching times (pre-irradiation)

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 50 V, I_D = 24 A, R_G = 4.7 Ω, V_{GS} = 12 V	23	29.5	36	ns
t_r	Rise time		29	40	52	ns
$t_{d(off)}$	Turn-off-delay time		79	99	119	ns
t_f	Fall time		33	64	95	ns

Table 8. Source drain diode (pre-irradiation) (1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
I_{SD}	Source-drain current				48	A
I_{SDM} (2)	Source-drain current (pulsed)				192	A
V_{SD} (3)	Forward on voltage	I_{SD} = 48 A, V_{GS} = 0			1.5	V
t_{rr}(4)	Reverse recovery time	I_{SD} = 48 A, di/dt = 100 A/μs V_{DD}= 50 V, T_J = 25 °C	328	413	498	ns
Q_{rr}(4)	Reverse recovery charge			5		μC
I_{RRM}(4)	Reverse recovery current			24		A
$t_{rr(4)}$	Reverse recovery time	I_{SD} = 48 A, di/dt = 100 A/μs V_{DD}= 50 V, T_J = 150 °C	400	500	600	ns
Q_{rr}(4)	Reverse recovery charge			7		μC
I_{RRM}(4	Reverse recovery current			28		A

1. Refer to the *Figure 16*.
2. Pulse width limited by safe operating area.
3. Pulsed: pulse duration = 300 μs, duty cycle 1.5%.
4. Not tested in production, guaranteed by process.

3 Radiation characteristics

The technology of the STMicroelectronics Rad-Hard Power MOSFETs is extremely resistant to radiative environments. Every manufacturing lot is tested, using the TO-3 package, in total ionizing dose (irradiation done according to the ESCC 22900 specification, window 1) and single event effect according to the MIL-STD-750E TM1080 up to a fluence level of 3e+5 ions/cm². Both pre-irradiation and post-irradiation performances are tested and specified using the same circuitry and test conditions in order to provide a direct comparison.

(T_{amb}= 22 ± 3 °C unless otherwise specified).

Total dose radiation (TID) testing

One bias conditions using the TO-3 package:

– V_{GS} bias: + 15 V applied and V_{DS}= 0 V during irradiation

The following parameters are measured (see *Table 9*, *Table 10* and *Table 11*):

- before irradiation
- after irradiation
- after 24 hrs @ room temperature
- after 240 hrs @ 100 °C anneal

Table 9. Post-irradiation on/off states @ T_J= 25 °C, (Co60 γ rays 70 K Rad(Si))

Symbol	Parameter	Test conditions	Drift values Δ	Unit
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	80% BV_{Dss}	+4	µA
I_{GSS}	Gate body leakage current (V_{DS} = 0)	V_{GS} = 20 V V_{GS} = -20 V	15 -15	nA
BV_{DSS}	Drain-to-source breakdown voltage	V_{GS} = 0, I_D = 1 mA	-25%	V
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 1 mA	-50% / + 5%	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 10 V; I_D = 36 A	±10%	W

Table 10. Dynamic post-irradiation @ T_J= 25 °C, (Co60 γ rays 70 K Rad(Si)) (1)

Symbol	Parameter	Test conditions	Drift values Δ	Unit
Q_g	Total gate charge	I_G = 1 mA, V_{GS} = 12 V, V_{DS} = 50 V, I_{DS} = 40 A	-5% / +50%	nC
Q_{gs}	Gate-source charge		±35%	
Q_{gd}	Gate-drain charge		-5% / +130%	

1. Post irradiation data guaranteed at 25°C per ESCC 22900 specification.

Table 11. Source drain diode post-irradiation @ T_J= 25 °C, (Co60 γ rays 70 K Rad(Si))(1)

Symbol	Parameter	Test conditions	Drift values Δ.	Unit
V_{SD} (2)	Forward on voltage	I_{SD} = 50 A, V_{GS} = 0	±10%	V

1. Refer to *Figure 16*.
2. Pulsed: pulse duration = 300 μs, duty cycle 1.5%

Single event effect, SOA

The technology of the STMicroelectronics rad-hard Power MOSFETs is extremely resistant to heavy ion environment for single event effect according to MIL-STD-750E method 1080 (bias circuit in *Figure 3: Single event effect, bias circuit*) SEB and SEGR tests have been performed with a fluence of 3e+5 ions/cm² .

The accept/reject criteria are:

- SEB test: drain voltage checked, trigger level is set to V_{ds} = - 5 V. Stop condition: as soon as a SEB occurs or if the fluence reaches 3e+5 ions/cm².
- SEGR test: the gate current is monitored every 100 ms. A gate stress is performed before and after irradiation. Stop condition: as soon as the gate current reaches 100 nA (during irradiation or during PIGS test) or if the fluence reaches 3e+5 ions/cm².

The results are:

- SEB immune at 60 MeV/mg/cm2
- SEGR immune at 60 MeV/mg/cm2 within the safe operating area (SOA) given in *Table 12: Single event effect (SEE), safe operating area (SOA)* and *Figure 2: Single event effect, SOA*)

Table 12. Single event effect (SEE), safe operating area (SOA)

Ion	Let (Mev/(mg/cm^2)	Energy (MeV)	Range (µm)	V_{DS} (V)				
				@V_{GS}=0	@V_{GS}= -2 V	@V_{GS}= -5 V	@V_{GS}= -10 V	@V_{GS}= -20 V
Kr	32	768	94	100	80	60	30	10
Xe	60	1217	89	40	30	30	-	0

Figure 2. Single event effect, SOA

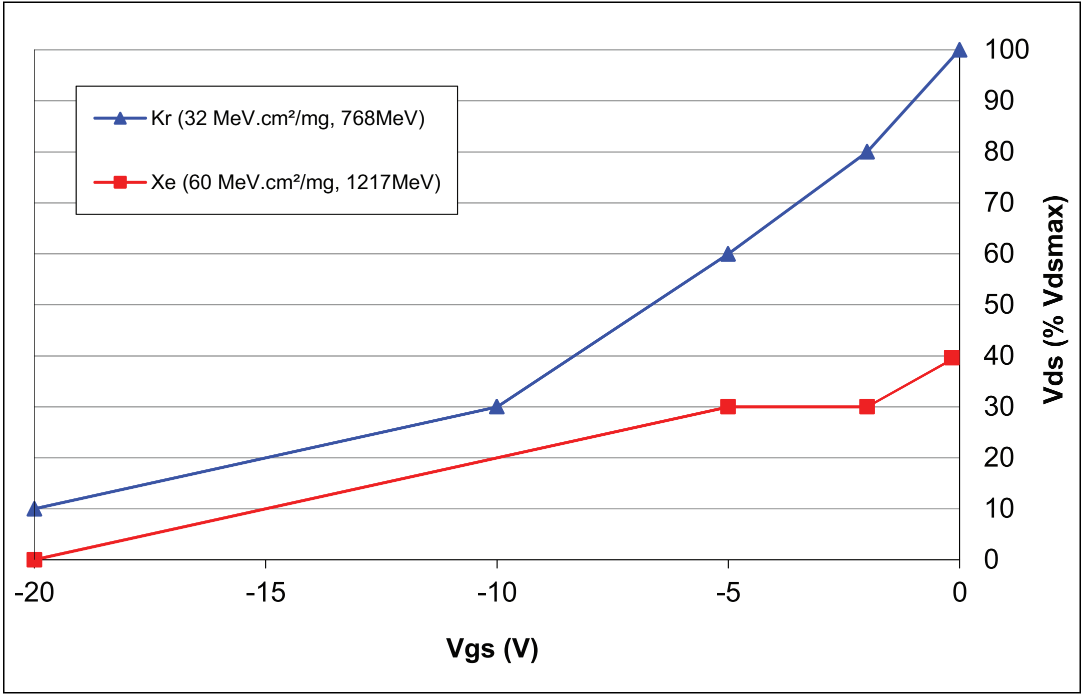
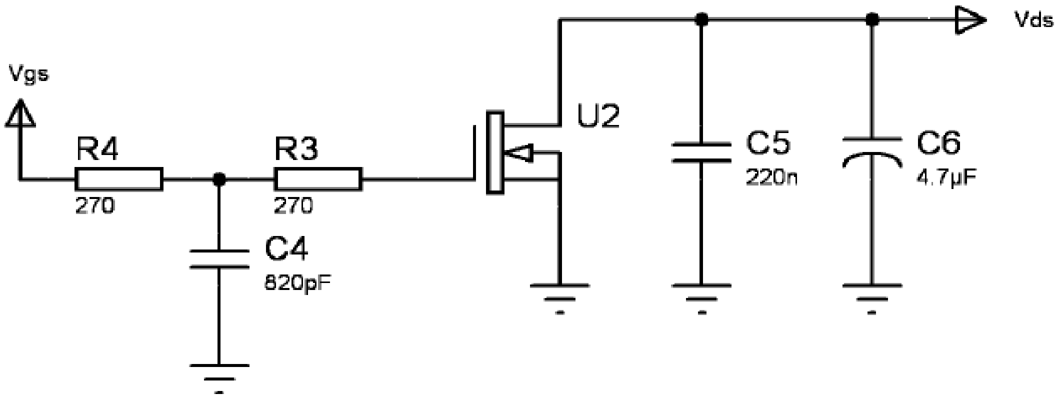


Figure 3. Single event effect, bias circuit[a]



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a. Bias condition during radiation refer to *Table 12: Single event effect (SEE), safe operating area (SOA)* .

4 Electrical characteristics (curves)

Figure 4. Safe operating area

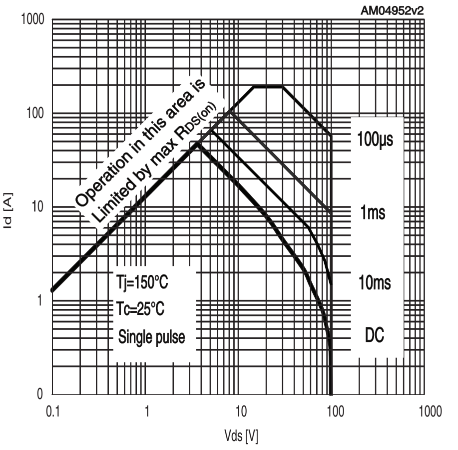


Figure 5. Thermal impedance

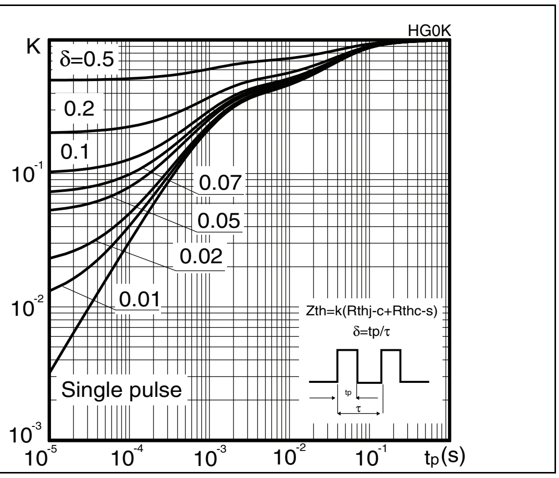


Figure 6. Output characteristics

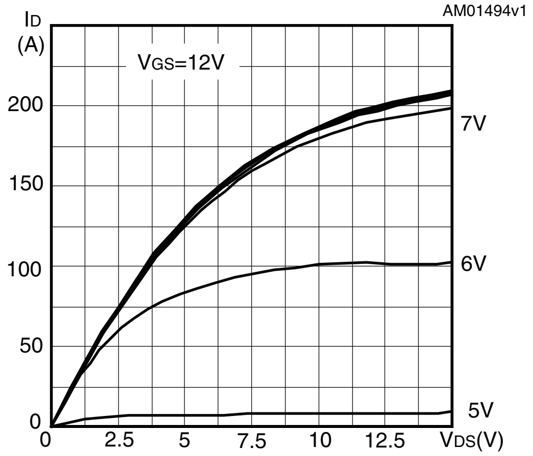


Figure 7. Transfer characteristics

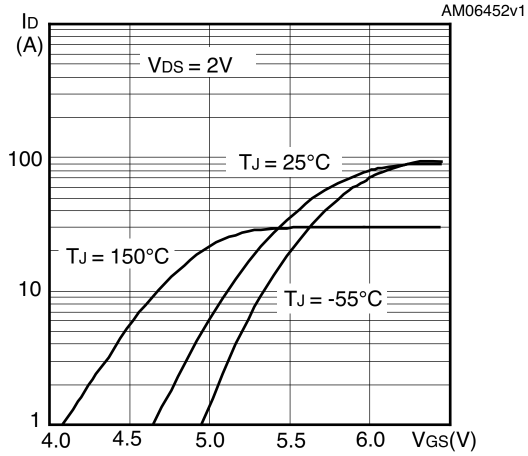


Figure 8. Gate charge vs gate-source voltage

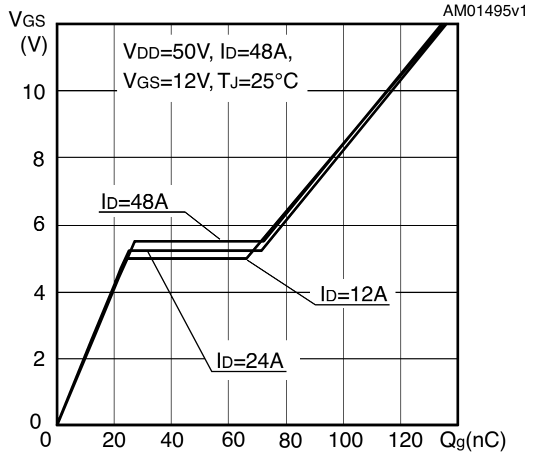


Figure 9. Capacitance variations

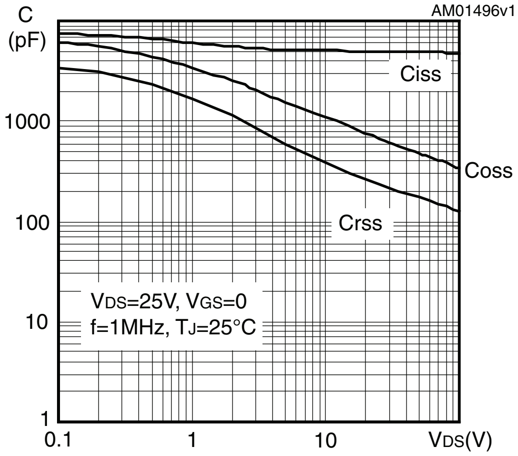


Figure 10. Normalized BV_{DSS} vs temperature

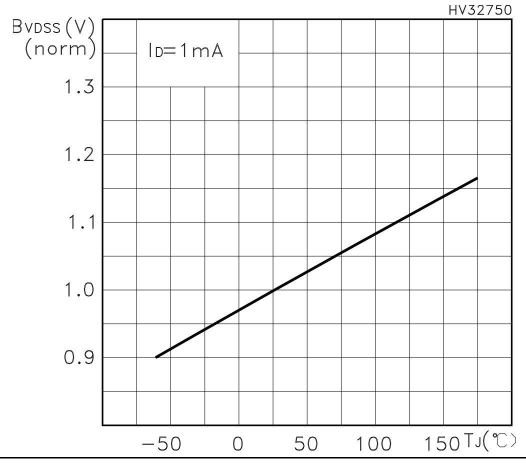


Figure 11. Static drain-source on resistance

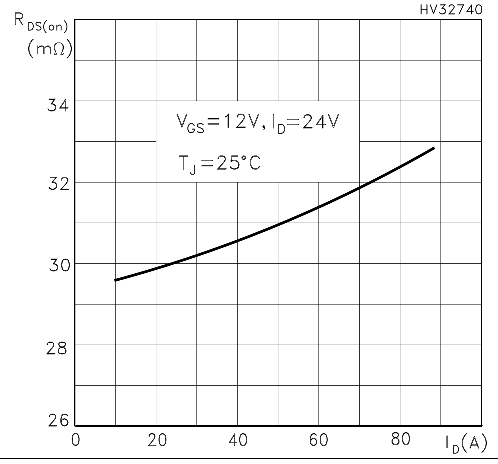


Figure 12. Normalized gate threshold voltage vs temperature

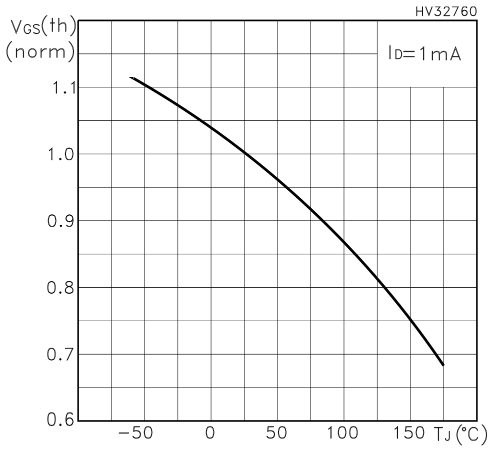


Figure 13. Normalized on-resistance vs temperature

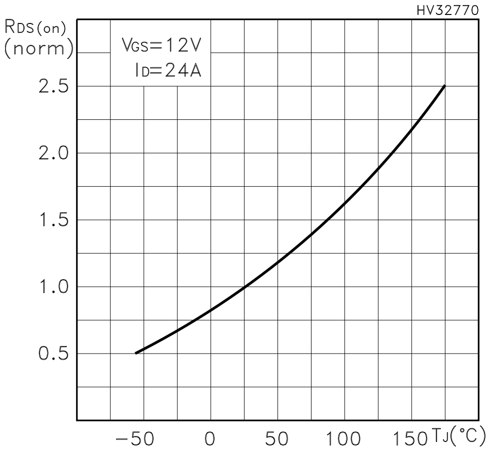
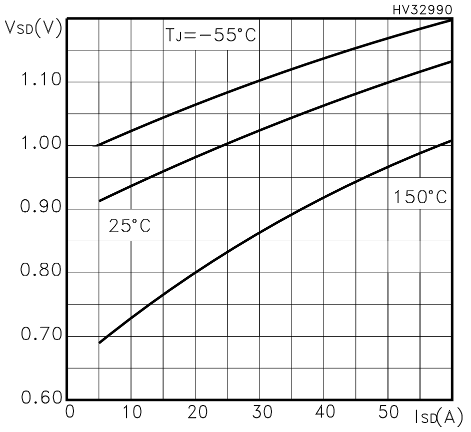
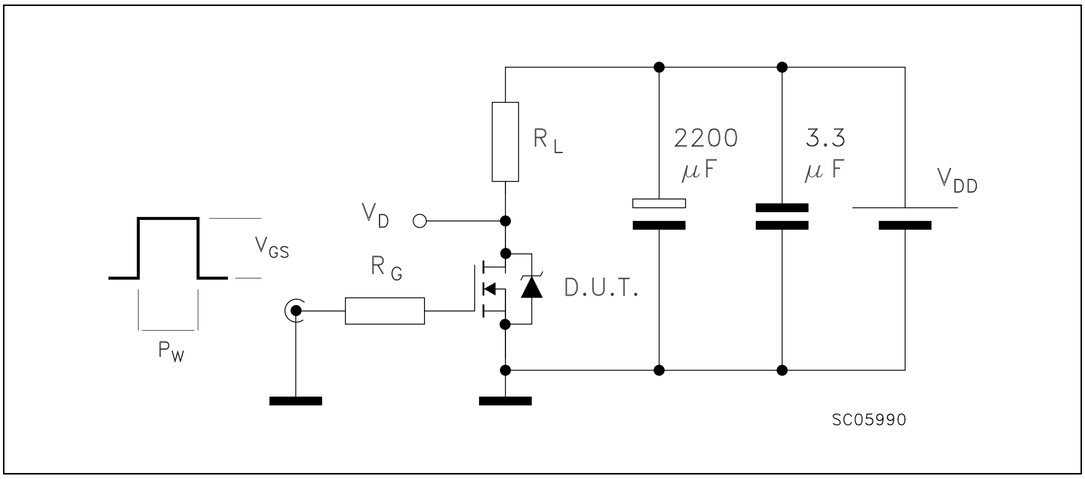


Figure 14. Source drain-diode forward characteristics



5 Test circuits

Figure 15. Switching times test circuit for resistive load [(1)]



1. Max driver V_{GS} slope = 1V/ns (no DUT)

Figure 16. Source drain diode

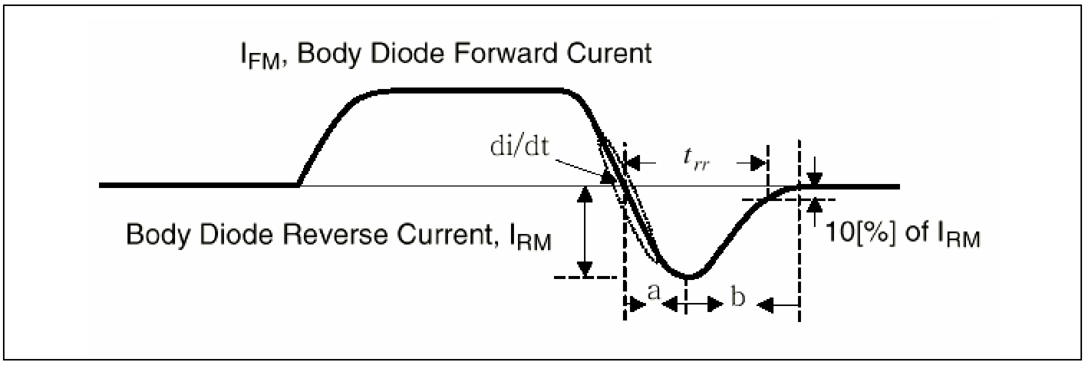
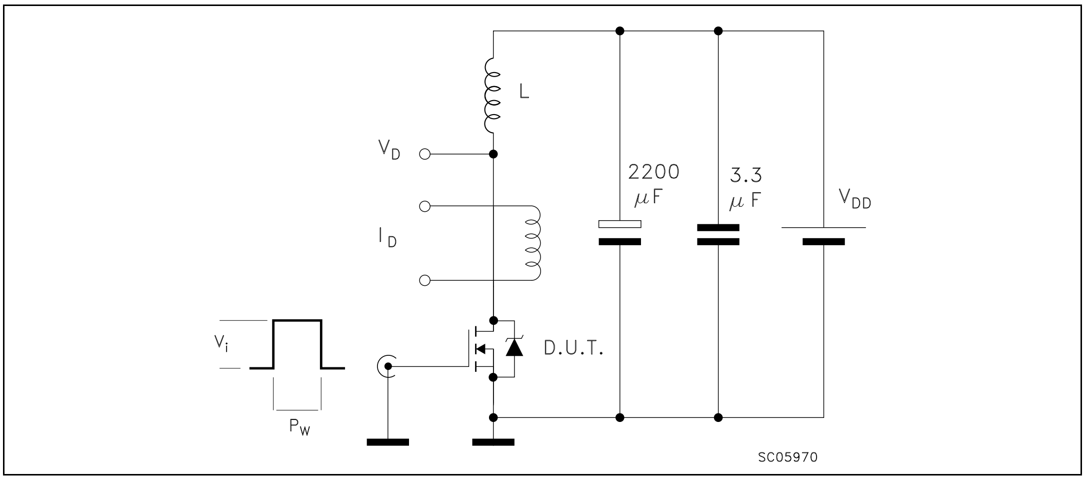


Figure 17. Unclamped inductive load test circuit (single pulse and repetitive)



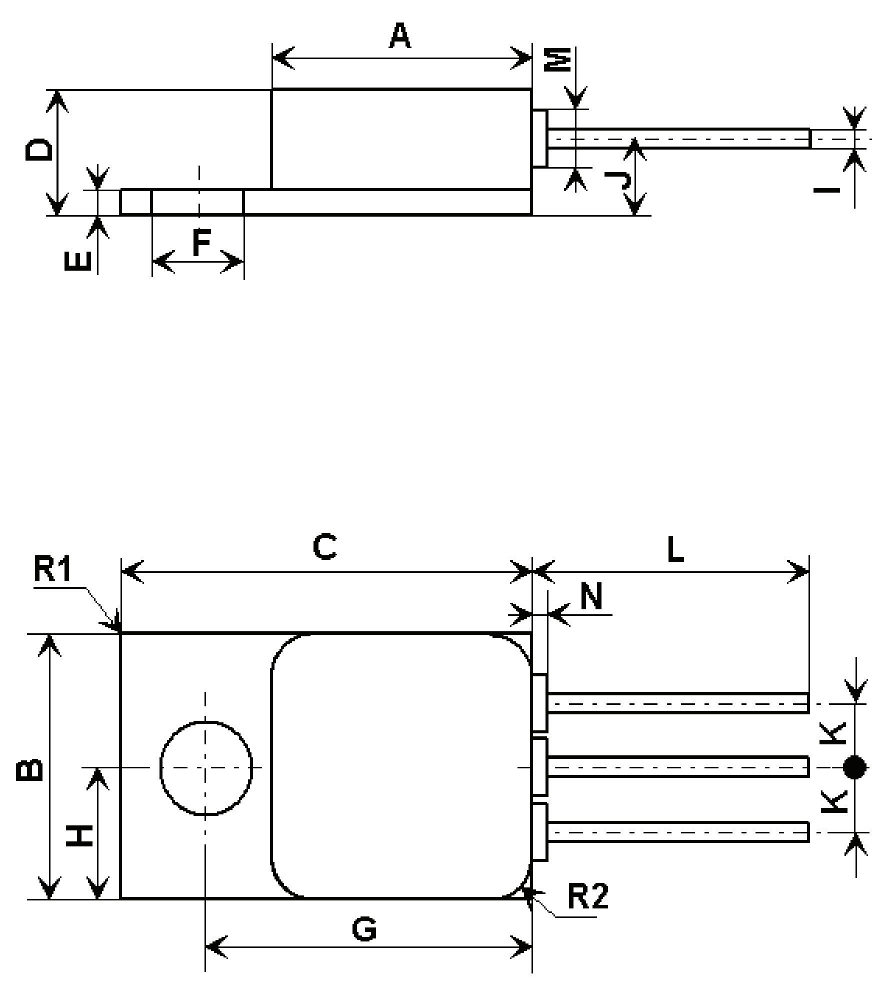
6 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

Table 13. TO-254AA mechanical data

Dim.	mm			Inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	13.59		13.84	0.535		0.545
B	13.59		13.84	0.535		0.545
C	20.07		20.32	0.790		0.800
D	6.32		6.60	0.249		0.260
E	1.02		1.27	0.040		0.050
F	3.56		3.81	0.140		0.150
G	16.89		17.40	0.665		0.685
H		6.86			0.270	
I	0.89	1.02	1.14	0.035	0.040	0.045
J		3.81			0.150	
K		3.81			0.150	
L	12.95		14.50	0.510		0.571
M	2.92		3.18			
N			0.71			
R1			1.00			0.039
R2	1.52	1.65	1.78	0.060	0.065	0.070

Figure 18. TO-254AA mechanical drawing



7 Order codes

Table 14. Ordering information

Order code	ESCC part number	Quality level	EPPL	Package	Lead finish	Marking	Packing
STRH100N10HY1	-	Engineering model	-	TO-254AA	Gold	STRH100N10HY1+ BeO	Strip pack
STRH100N10HYG	5205/021/01	ESCC flight	Yes			520502101F + BeO	
STRH100N10HYT	5205/021/02		-		Solder dip	520502102F + BeO	

For specific marking only the complete structure is:

- ST Logo
- ESA Logo
- Date code (date of sealing of the package) : YYWWA
  - YY: year
  - WW: week number
  - A: week index
- ESCC part number (as mentioned in the table)
- Warning signs (e.g. BeO)
- Country of origin: FR (France)
- Part serial number within in the assembly lot

Contact ST sales office for information about the specific conditions for products in die form and for other packages.

7.1 Other information

Date code

The date code for “ESCC flight” is structured as follows: yywwz

where:

- yy: last two digits of year
- ww: week digits
- z: lot index in the week

Documentation

The table below provide a summary of the documentation provided with each type of products.

Table 15. Summary of the documentation provided

Quality level	Radiation level	Documentation
Engineering model	-	-
ESCC flight	70Krad	Certificate of conformance radiation verification test report

8 Revision history

Table 16. Document revision history

Date	Revision	Changes
13-May-2010	1	First release.
14-Jun-2010	2	Updated *Table 1: Device summary*.
18-Oct-2010	3	Updated *Table 1*, *5*, *9* and *14*.
23-Dec-2010	4	Updated *Figure 2: Single event effect, SOA*. and TO-254AA mechanical data.
25-Jul-2011	5	Updated part numbers in *Table 1: Device summary* and *Table 14: Ordering information*. Minor text changes to improve readability.
09-Nov-2011	6	Updated dynamic values on *Table 6: Pre-irradiation dynamic*, *Table 7: Switching times (pre-irradiation)* and *Table 8: Source drain diode (pre-irradiation)*.
31-May-2013	7	Updated *Table 1*, *Table 12*, *Table 14*, *Figure 2* and *Section 7: Order codes*. Minor text changes in *Section 3: Radiation characteristics*
09-Apr-2014	8	Modified: *Figure 2* Minor text changes

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