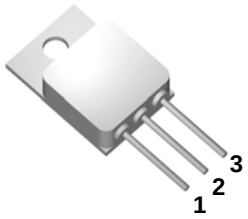
STRH100N6

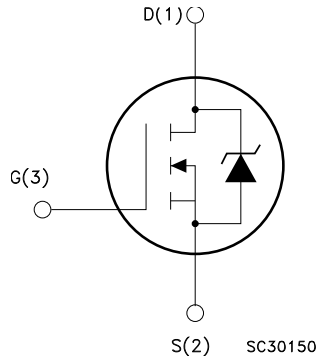
Rad-Hard N-channel, 60 V, 40 A Power MOSFET

Datasheet - production data



TO-254AA

Figure 1. Internal schematic diagram



Features

V_{DSS}	I_D	$R_{DS(on)}$	Q_g
60 V	40 A	12 mΩ	134.4 nC

- Fast switching
- 100% avalanche tested
- Hermetic package
- 50 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 numbers	ESCC part number	Quality level	Package	Lead finish	Mass (g)	Temp. range	EPPL
STRH100N6HY1	-	Engineering model	TO-254AA	Gold	10	-55 to 150 °C	-
STRH100N6HYG	5205/022/01	ESCC flight					Target
STRH100N6HYT	5205/022/02			Solder dip	10		-

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)	60	V
V_{GS} (2)	Gate-source voltage	±20	V
I_D (3)	Drain current (continuous) at T_C= 25 °C	40	A
I_D (3)	Drain current (continuous) at T_C= 100 °C	25	A
I_{DM} (4)	Drain current (pulsed)	160	A
P_{TOT} (3)	Total dissipation at T_C= 25 °C	176	W
dv/dt (5)	Peak diode recovery voltage slope	2.5	V/ns
T_{stg}	Storage temperature	-55 to 150	°C
T_j	Max. operating junction temperature	150	°C

1. This rating is guaranteed @ $T_J \geq$ 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. $I_{SD} \leq$ 40 A, di/dt $\leq$ 600 A/µs, V_{DD} = 80 %$V_{(BR)DSS}$.

Table 3. Thermal data

Symbol	Parameter	Value	Unit
Rthj-case	Thermal resistance junction-case max	0.50	°C/W
Rthc-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 Tj max)	40	A
E_{AS}(1)	Single pulse avalanche energy (starting Tj= 25 °C, I_D= I_{AR}, V_{DD}=40 V)	954	mJ
E_{AS}	Single pulse avalanche energy (starting Tj= 110 °C, I_D= I_{AR}, V_{DD}=40 V)	280	mJ
E_{AR}	Repetitive avalanche (V_{DD} = 40 V, I_{AR} = 40 A, f = 10 KHz, T_J = 25 °C, duty cycle = 50%)	40	mJ
E_{AR}	Repetitive avalanche (V_{DD} = 40 V, I_{AR} = 40 A, f = 100 KHz, T_J = 25 °C, duty cycle = 10%)	24	mJ
	Repetitive avalanche (V_{DD} = 40 V, I_{AR} = 40 A, f = 100 KHz, T_J = 110 °C, duty cycle = 10%)	7.7	mJ

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
		80% BV_{Dss} T_C = 125 °C			100	
I_{GSS}	Gate body leakage current (V_{DS} = 0)	V_{GS} = 20 V V_{GS} = -20 V	-100		100	nA
		V_{GS} = 20 V, T_C = 125 °C V_{GS} = -20 V, T_C = 125 °C	-200		200	
BV_{DSS} (1)	Drain-to-source breakdown voltage	V_{GS} = 0, I_D = 1 mA	60			V
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 1 mA, T_C = -55 °C	2.2		5	V
		V_{DS} = V_{GS}, I_D = 1 mA	2		4.5	
		V_{DS} = V_{GS}, I_D = 1 mA, T_C = 125 °C	1.6		3.5	
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 12 V; I_D = 40 A		0.012	0.0135	Ω
		V_{GS} = 12 V; I_D = 40 A; T_C = 125 °C			0.024	

1. This rating is guaranteed @ $T_J \geq 25$ °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=1MHz	3900	4895	5900	pF
C_{oss}(1)	Output capacitance		860	1080	1300	pF
C_{rss}	Reverse transfer capacitance		300	407	470	pF
Q_g	Total gate charge	V_{DD} = 30 V, I_D = 40 A, V_{GS}=12 V	100	134.4	160	nC
Q_{gs}	Gate-to-source charge		18	24	30	nC
Q_{gd}	Gate-to-drain (“Miller”) charge		29	46.5	51	nC
R_G(2)	Gate input resistance	f=1MHz Gate DC bias=0 test signal level= 20 mV open drain	1.6	2	2.4	Ω

1. This value is guaranteed over the full range of temperature.
2. Not tested, guaranteed by process.

Table 7. Pre-irradation switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 30 V, I_D = 40 A, R_G = 4.7 Ω, V_{GS} = 12 V	16	28	40	ns
t_r	Rise time		60	115	260	ns
$t_{d(off)}$	Turn-off-delay time		50	86	120	ns
t_f	Fall time		60	69	160	ns

Table 8. Pre-irradiation source drain diode(1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (2)	Source-drain current Source-drain current (pulsed)				40 160	A A
V_{SD} (3)	Forward on voltage	I_{SD} = 40 A, V_{GS} = 0		1.1	1.5	V
		I_{SD} = 40 A, V_{GS} = 0, T_C = 125 °C			1.275	
t_{rr}(4)	Reverse recovery time	I_{SD} = 40 A, di/dt = 100 A/µs V_{DD}= 48 V, Tj = 25 °C	307	384	461	ns
Q_{rr}(4)	Reverse recovery charge			4.7		µC
I_{RRM}(4)	Reverse recovery current			24.6		A
t_{rr}(4)	Reverse recovery time	I_{SD} = 40 A, di/dt = 100 A/µs V_{DD}= 48 V, Tj = 150 °C	370	462.4	55	ns
Q_{rr}(4)	Reverse recovery charge			6.5		µC
I_{RRM}(4)	Reverse recovery current			28.3		A

1. Refer to *Figure 16: Source drain diode*.
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 STMicroelectronics Rad-Hard Power MOSFETs is extremely resistant to radiative environments. Every manufacturing lot is tested for total ionizing dose (irradiation done according to the ESCC 22900 specification, window 1.) using the TO-3 package. Both pre-irradiation and post-irradiation performance 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 168 hrs @ 100 °C anneal

Table 9. Post-irradiation on/off states @ T_J= 25 °C, (Co60 γ rays 50 K Rad(Si))

Symbol	Parameter	Test conditions	Drift values Δ	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	1.5 -1.5	nA
BV_{DSS}	Drain-to-source breakdown voltage	V_{GS} = 0, I_D = 1 mA	-15%	V
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 1 mA	-60%/ + 25%	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V; I_D = 40 A	±15 %	Ω

Table 10. Dynamic post-irradiation @ T_J= 25 °C, (Co60 γ rays 50 K Rad(Si))

Symbol	Parameter	Test conditions	Drift values Δ	Unit
Q_g	Total gate charge	I_G = 1 mA, V_{GS} = 12 V, V_{DS} = 30 V, I_{DS} = 40 A	-5% / +50%	nC
Q_{gs}	Gate-source charge		±35 %	
Q_{gd}	Gate-drain charge		-5% / +110%	

Table 11. Source drain diode post-irradiation @ T_J= 25 °C, (Co60 γ rays 50 K Rad(Si))(1)

Symbol	Parameter	Test conditions	Drift values Δ.	Unit
V_{SD} (2)	Forward on voltage	I_{SD} = 40 A, V_{GS} = 0	± 5%	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 (irradiation per 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} = - 2 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 1 mA (during irradiation or during PIGS test) or if the fluence reaches 3e+5 ions/cm².

The results are:

– SEB immune at 60 MeV/mg/cm^2

– SEGR immune at 60 MeV/mg/cm^2 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	60	48	39	27	15
Xe	60	1217	89	30	30	-	-	-

Figure 2. Single event effect, SOA

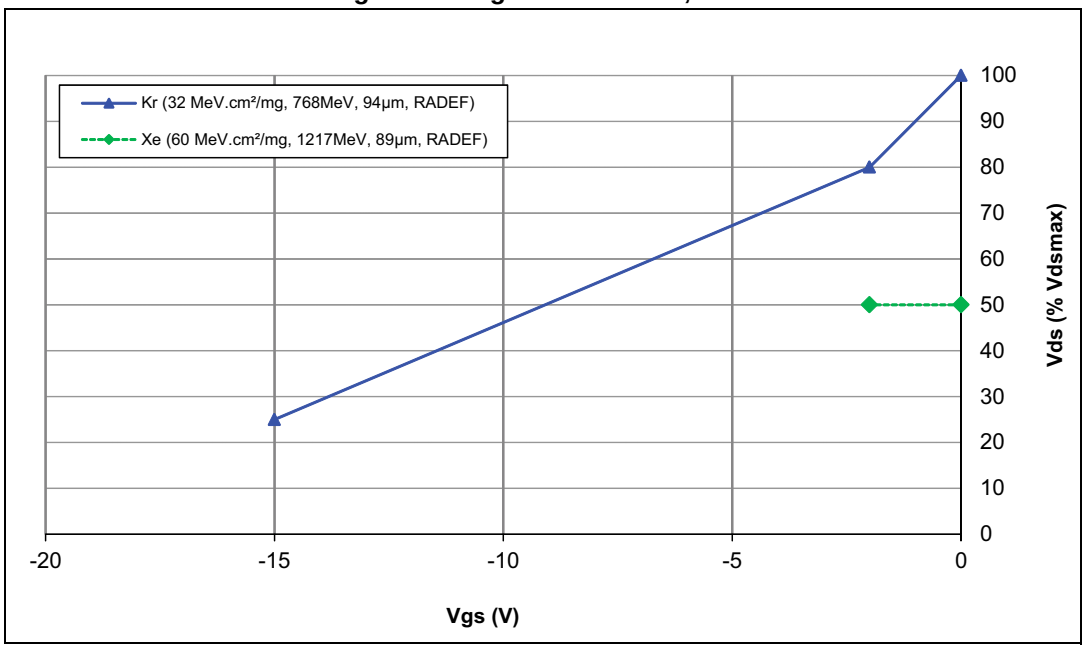
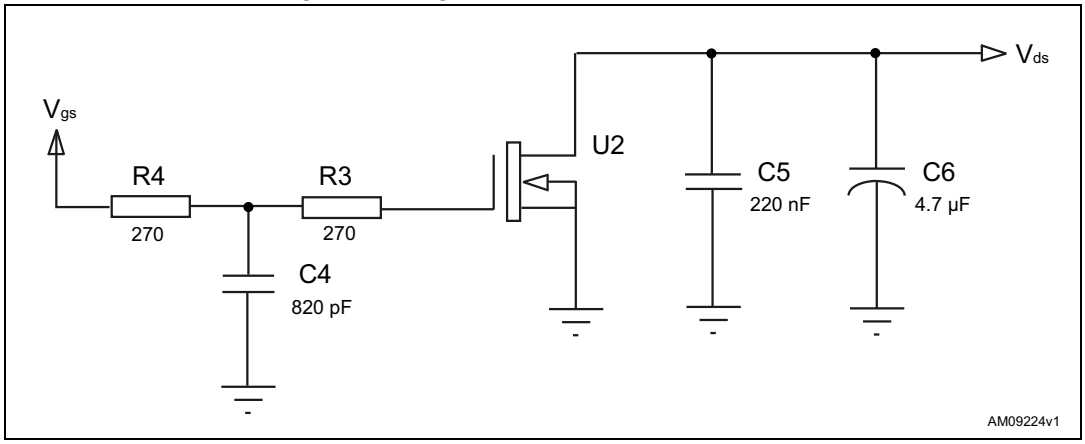


Figure 3. Single event effect, bias circuit(a)



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

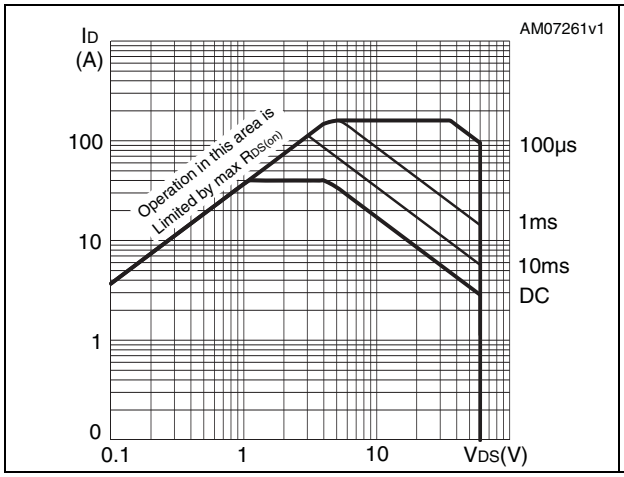


Figure 5. Thermal impedance

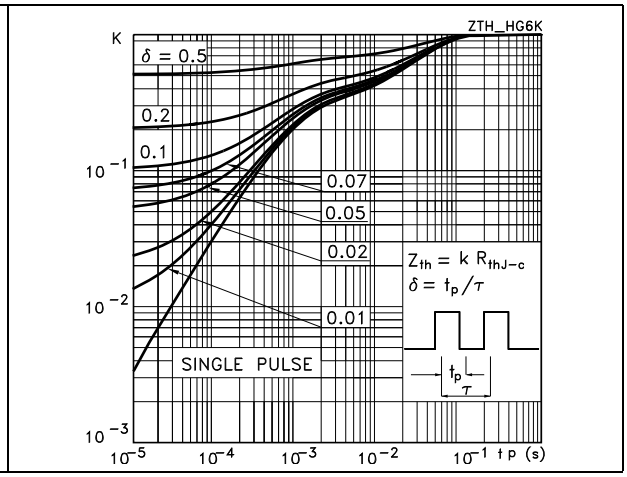


Figure 6. Output characteristics

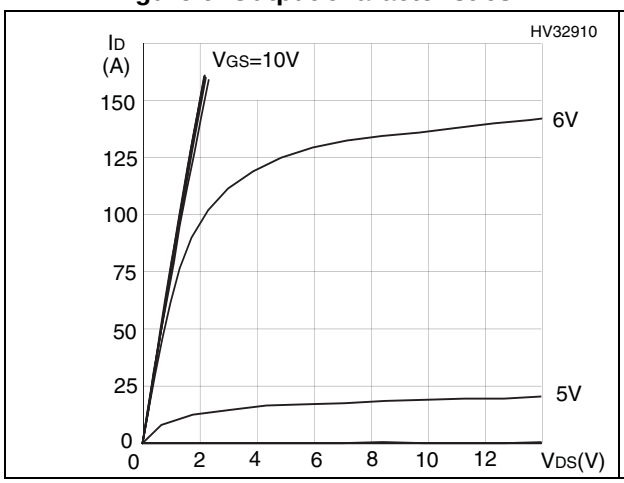


Figure 7. Transfer characteristics

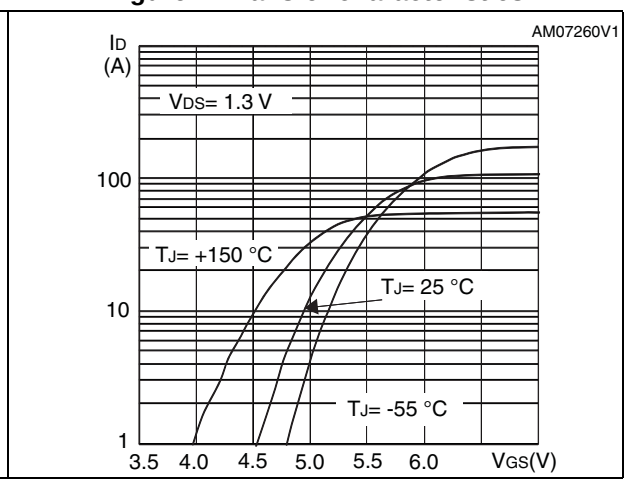


Figure 8. Gate charge vs gate-source voltage

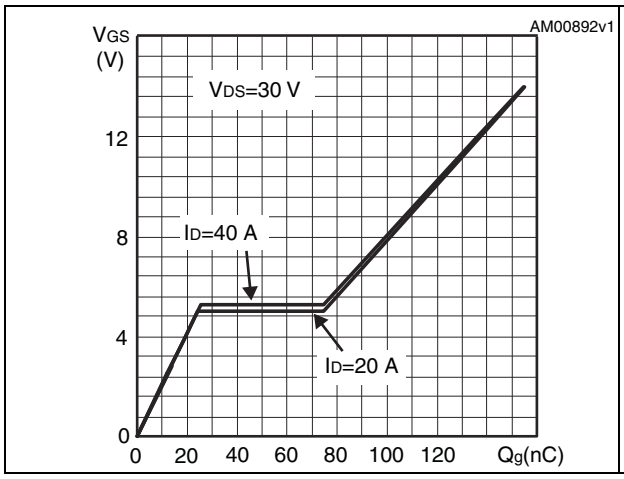


Figure 9. Capacitance variations

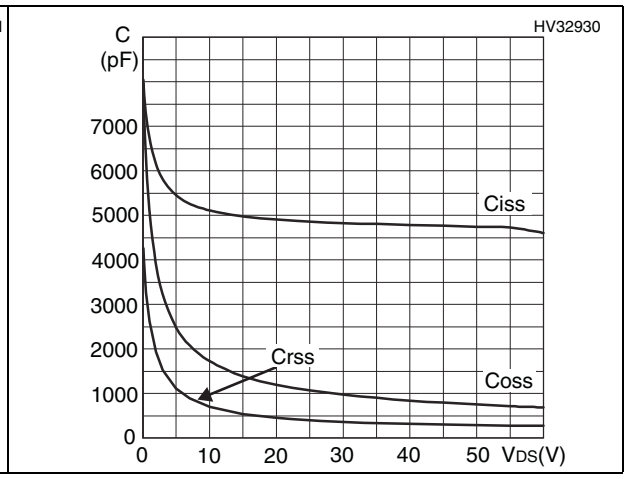


Figure 10. Normalized BV_{DSS} vs temperature

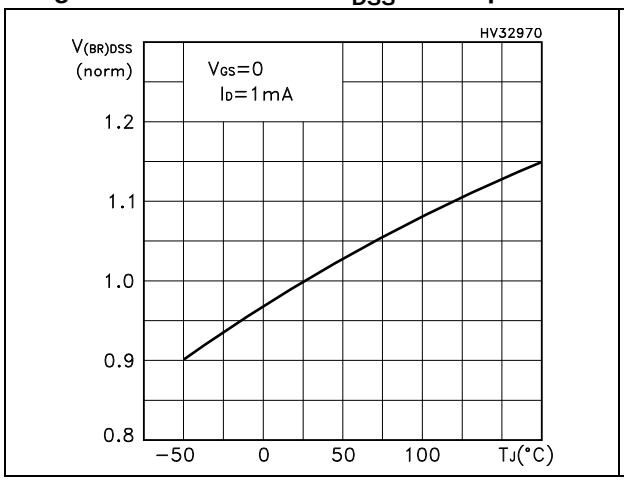


Figure 11. Static drain-source on-resistance

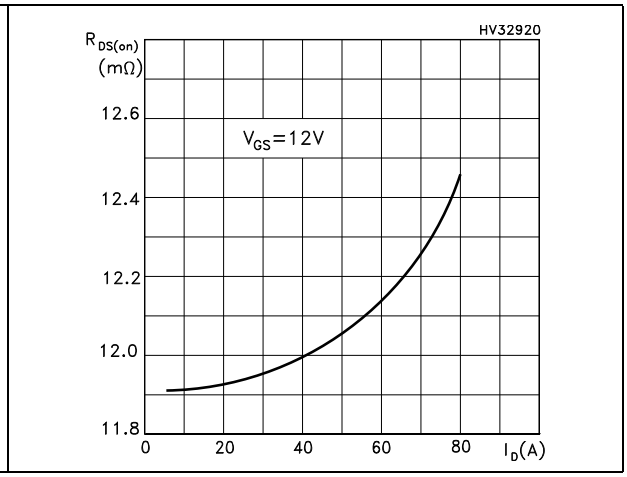


Figure 12. Normalized gate threshold voltage vs temperature

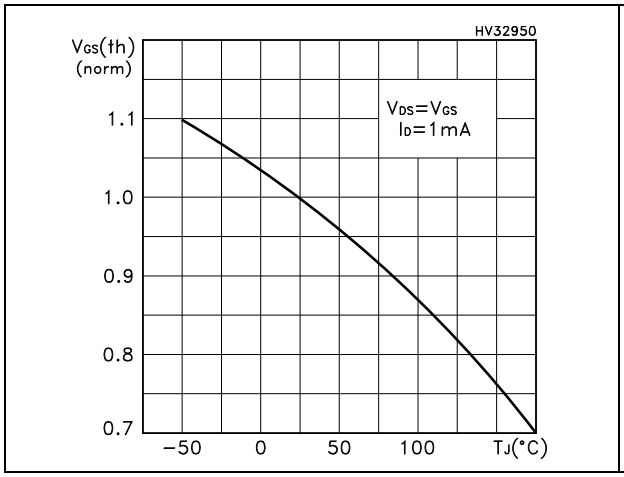


Figure 13. Normalized on resistance vs temperature

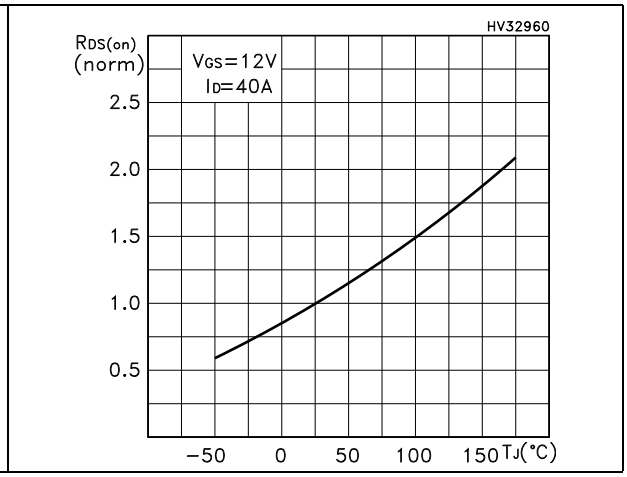
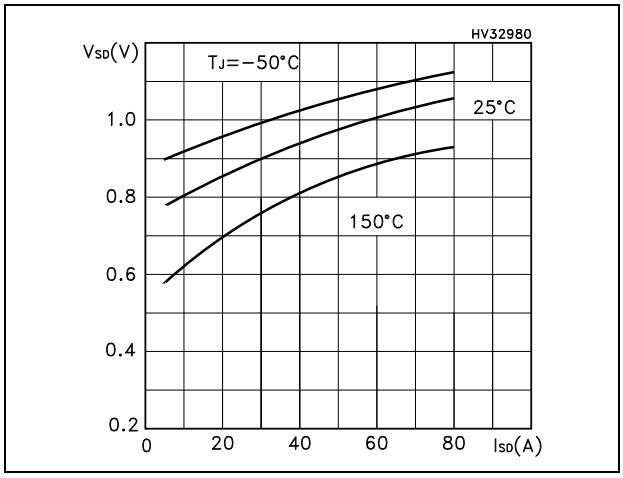
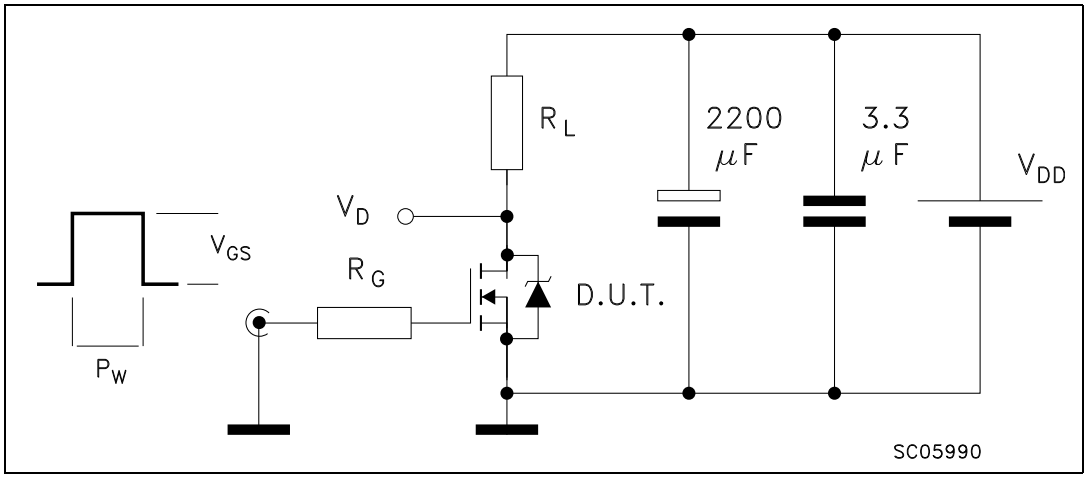


Figure 14. Source drain-diode forward characteristics



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

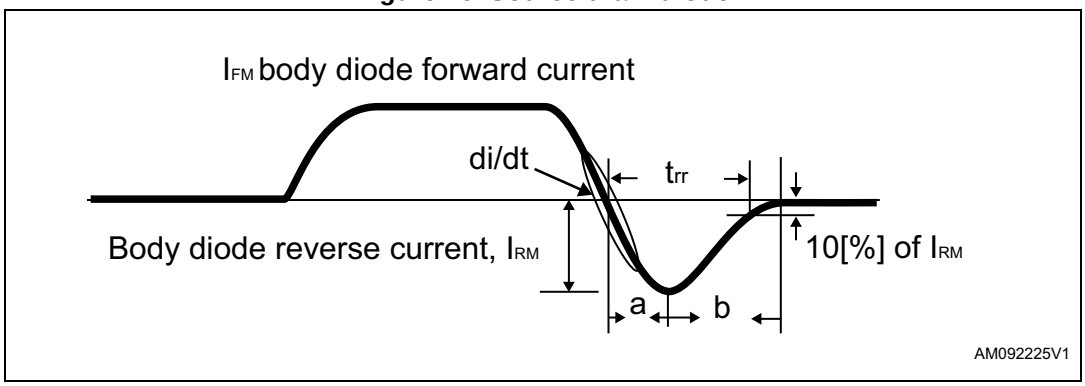
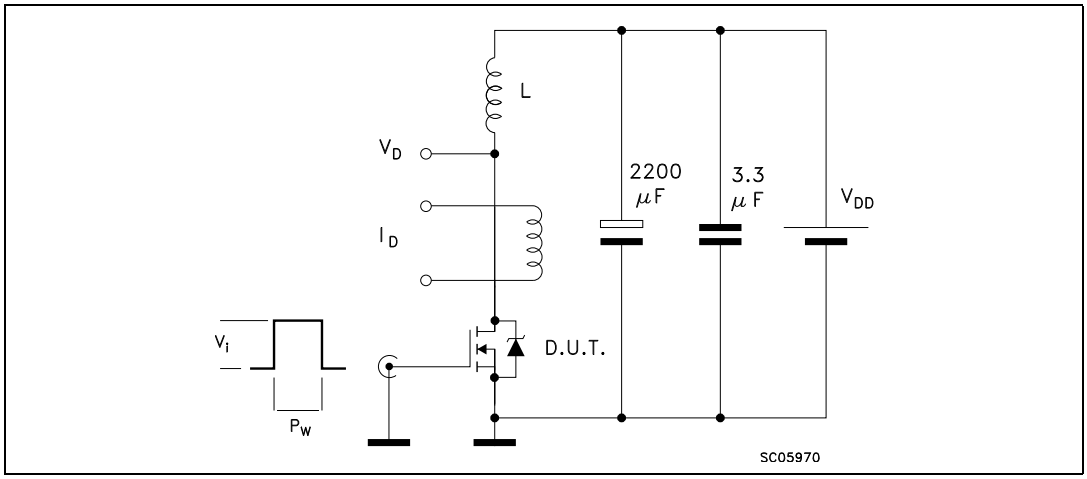


Figure 17. Unclamped inductive load test circuit (single pulse and repetitive)



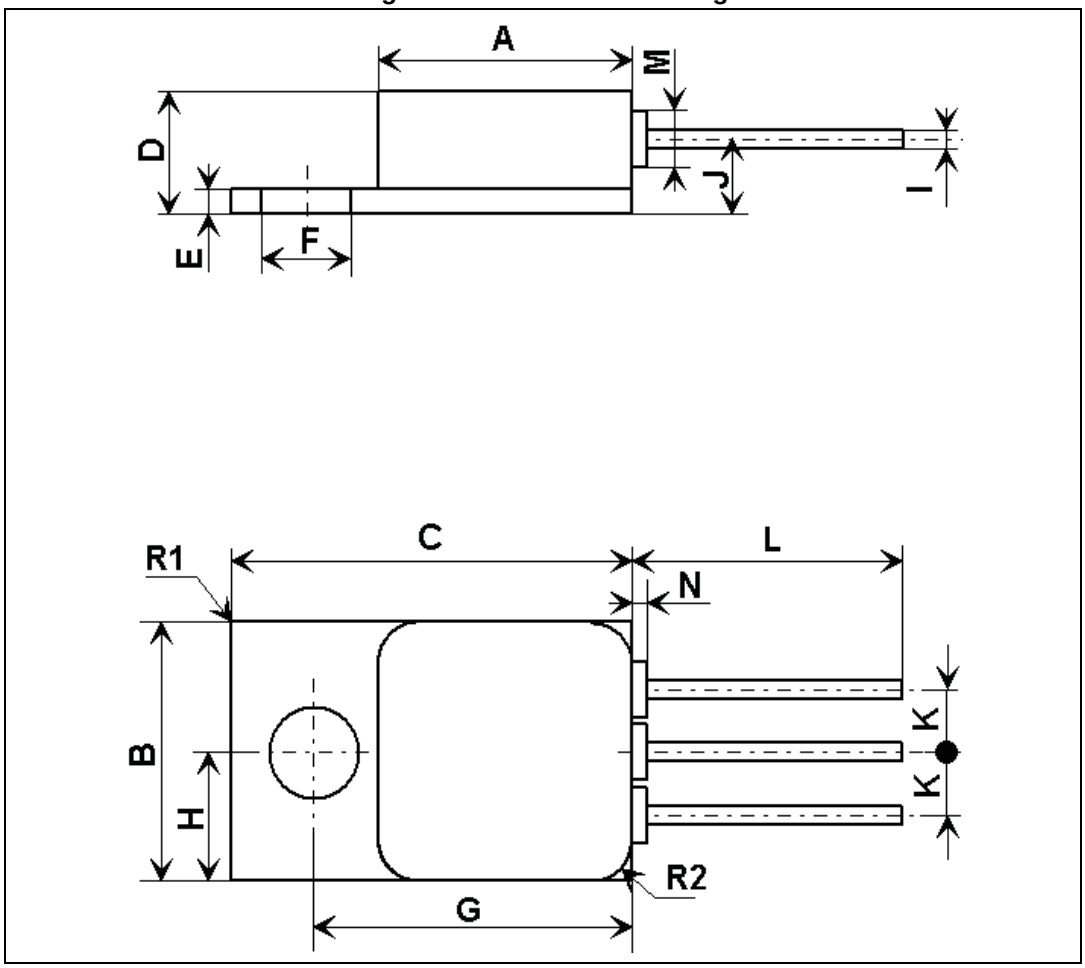
6 Package mechanical data

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 drawing



7 Order codes

Table 14. Ordering information

Order codes	ESCC part number	Quality level	EPPL	Package	Lead finish	Marking	Packing
STRH100N6HY1	-	Engineer model	-	TO-254AA	Gold	STRH100N6FSY1 + BeO	Strip pack
STRH100N6HYG	5205/022/01	ESCC flight	Target			520502201F + BeO	
STRH100N6HYT	5205/022/02		-		Solder dip	520502202F + 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	50Krad	Certificate of conformance radiation verification test report

8 Revision history

Table 16. Document revision history

Date	Revision	Changes
04-Jan-2011	1	First release.
27-Jul-2011	2	Updated order codes in Table 1: Device summary and Table 14: Ordering information. Minor text changes.
09-Nov-2011	3	Updated dynamic values on Table 6: Pre-irradation dynamic and Table 7: Pre-irradation switching times.
27-Feb-2013	4	Corrected ID value on: – Features – Table 2: Absolute maximum ratings (pre-irradiation) – Table 5: Pre-irradation on/off states – Table 6: Pre-irradation dynamic – Table 8: Pre-irradation source drain diode – Table 9: Post-irradiation on/off states @ TJ= 25 °C, (Co60 g rays 70 K Rad(Si)) – Table 10: Dynamic post-irradiation @ TJ= 25 °C, (Co60 g rays 70 K Rad(Si)) – Table 11: Source drain diode post-irradiation @ TJ= 25 °C, (Co60 g rays 70 K Rad(Si))
02-Jul-2013	5	Updated Table 1: Device summary and Table 14: Ordering information. Added Chapter 7.1: Other information.
16-Dec-2013	6	Modified: Description Minor text changes
16-Dec-2015	7	Updated features in cover page. Updated *Table 5*, *Table 8*, *Table 9*, *Table 10*, *Table 11* and *Table 15*.