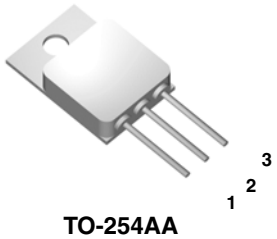
STRH40P10

Rad-Hard P-channel 100 V, 34 A Power MOSFET

Features

V_{BDSS}	I_D	$R_{DS(on)}$	Q_g
100 V	34 A	0.060 Ohm	162 nC

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



TO-254AA

Applications

- Satellite
- High reliability

Description

This P-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.

Figure 1. Internal schematic diagram

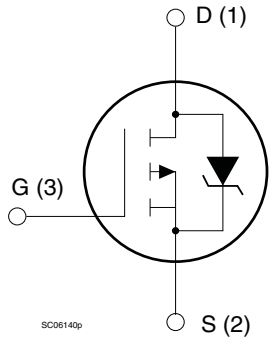


Table 1. Device summary

Part number	ESCC part number	Quality level	Package	Lead finish	Mass (g)	Temp. range	EPPL
STRH40P10HY1	-	Engineering model	TO-254AA	Gold	10	-55 to 150°C	-
STRH40P10HYG	TBD	ESCC flight					Target

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).

Note: For the P-channel MOSFET actual polarity of voltages and current has to be reversed.

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)	34	A
I_D (3)	Drain current (continuous) at T_C= 100 °C	21	A
I_{DM} (4)	Drain current (pulsed)	136	A
P_{TOT} (3)	Total dissipation	176	W
dv/dt (5)	Peak diode recovery voltage slope	2.5	V/ns
T_{stg}	Storage temperature	- 55 to 150	°C
T_J	Operating junction temperature		°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 ≤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 max	0.71	°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)	TBD	A
E_{AS} (1)	Single pulse avalanche energy (starting T_J=25 °C, I_D= 17 A, V_{DD}=50 V)	1133	mJ
E_{AS}	Single pulse avalanche energy (starting T_J=110 °C, I_D= 17 A, V_{DD}=50 V)	332	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%)	25	mJ
	Repetitive avalanche (V_{dd} = 50 V, I_{AR} = 17 A, f = 100 KHz, T_J = 110 °C, duty cycle = 10%)	8	

1. Maximum rating value.

2 Electrical characteristics

(T_C = 25 °C unless otherwise specified).

Note: For the P-channel MOSFET actual polarity of voltages and current has to be reversed.

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 = 17 A		0.060	0.075	Ω

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} C_{oss} (1) C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{GS} = 0, V_{DS} = 25 V, f=1 MHz	3710 510 204	4640 635 255	5570 760 306	pF pF pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-to-source charge Gate-to-drain (“Miller”) charge	V_{DD} = 50 V, I_D = 34 A, V_{GS}=12 V	130 14 32	162 18 40	194 22 48	nC nC nC
R_G(1)	Gate input resistance	f=1MHz gate DC bias=0 test signal level=20mV open drain		1.5		Ω

1. Not tested, guaranteed by process.

Table 7. Pre-irradiation switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 50 V, I_D = 17 A, R_G = 4.7 Ω, V_{GS} = 12 V	15	24	33	ns
t_r	Rise time		19	31	43	ns
$t_{d(off)}$	Turn-off-delay time		68	129	190	ns
t_f	Fall time		34	46	58	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)				34 136	A A
V_{SD} (3)	Forward on voltage	I_{SD} = 30 A, V_{GS} = 0		1.1		V
t_{rr} (4) Q_{rr} (4) I_{RRM} (4)	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 34 A, di/dt = 40 A/µs V_{DD}= 12 V, T_J = 25 °C	276	345 4.1 316	414	ns µC A
t_{rr} (4) Q_{rr} (4) I_{RRM} (4)	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 34 A, di/dt = 40 A/µs V_{DD}= 12 V, T_J = 150 °C		473 7.1 133		ns µC 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 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 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: + 20 V applied and V_{DS}= -100 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 100 K Rad(Si))

Symbol	Parameter	Test conditions	Drift values Δ	Unit
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	80% BV_{Dss}	+1	µA
I_{GSS}	Gate body leakage current (V_{DS} = 0)	V_{GS} = 12 V V_{GS} = -12 V	1.5 -1.5	µA
BV_{DSS}	Drain-to-source breakdown voltage	V_{GS} = 0, I_D = 1 mA	+5%	V
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 1 mA	+150%	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 10 V; I_D = 20 A	-4% / +35%	Ω

Table 10. Dynamic post-irradiation @ T_J= 25 °C, (Co60 γ rays 100 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} = 20 A	-15% / +5%	nC
Q_{gs}	Gate-source charge		-5% / +200%	
Q_{gd}	Gate-drain charge		-10% / +100%	

1. Parameter not measured after irradiation but guaranteed by the results obtained during the evaluation phase that proves this parameter is directly correlated to the $V_{GS(th)}$ shift.

Table 11. Source drain diode post-irradiation @ T_J= 25 °C, (Co60 γ rays 100 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} = - 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 200 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:

  – no SEB
  – SEGR test produces the following SOA (see *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/cm²))	Energy (MeV)	Range (µm)	V_{DS} (V)				
				@V_{GS}=0	@V_{GS}= 2 V	@V_{GS}= 5 V	@V_{GS}= 10 V	@V_{GS}= 15 V
Kr	32	768	94	-	-60	-	-	-
		756	92	-	-	-	-	-20

Figure 2. Single event effect, SOA

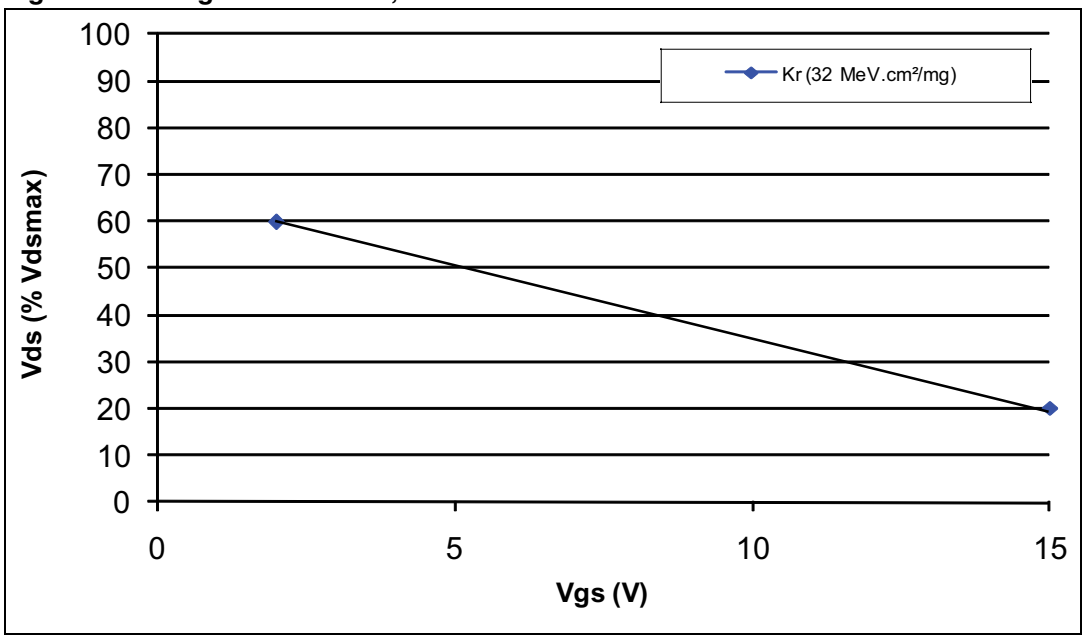
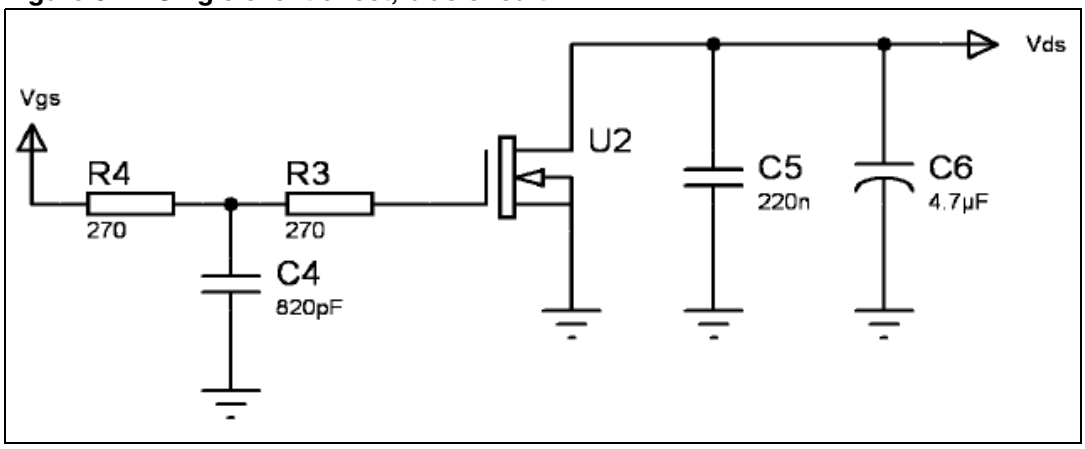


Figure 3. Single event effect, bias circuit[a]



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

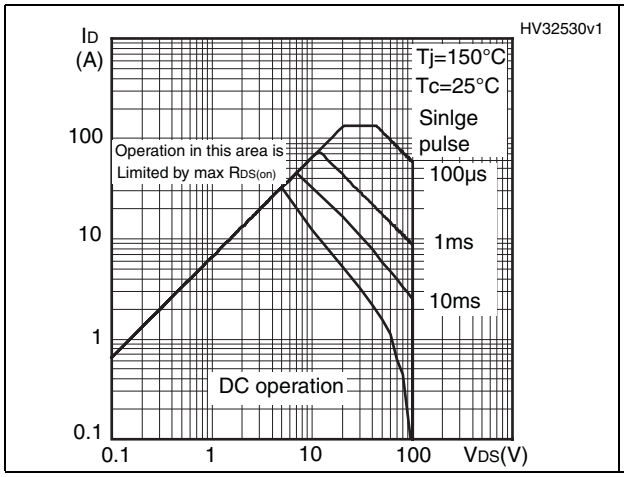


Figure 5. Thermal impedance

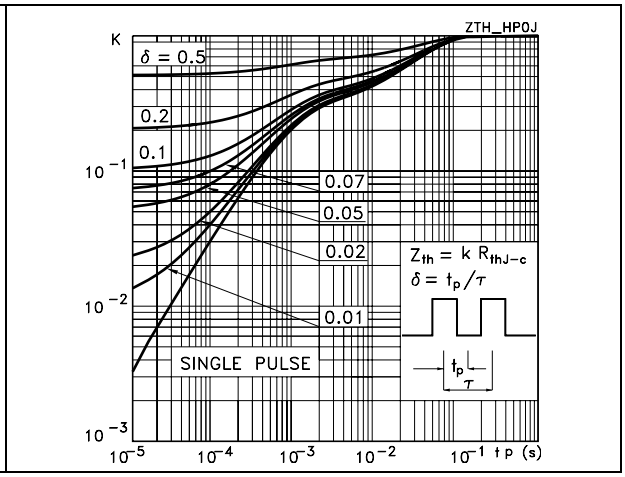


Figure 6. Output characteristics

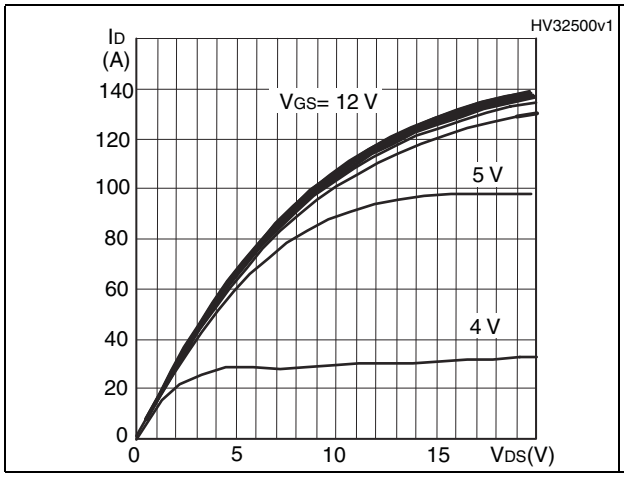


Figure 7. Transfer characteristics

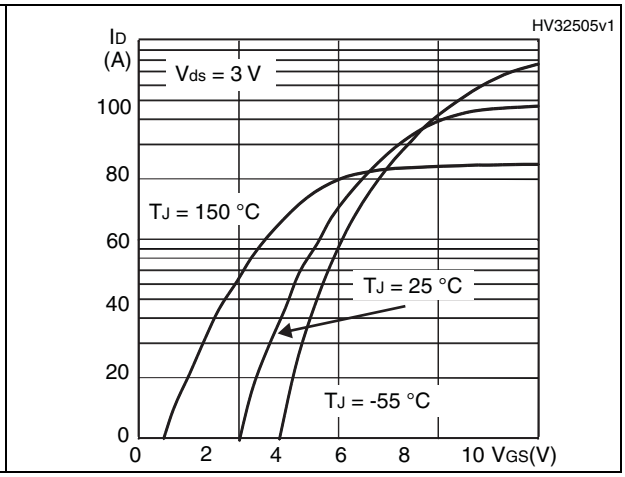


Figure 8. Gate charge vs gate-source voltage

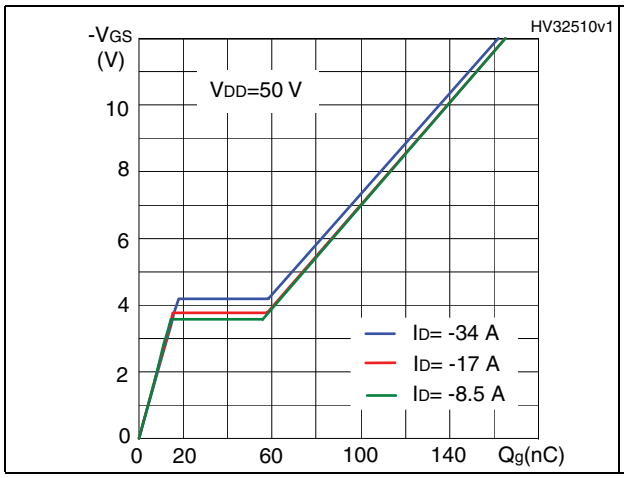


Figure 9. Capacitance variations

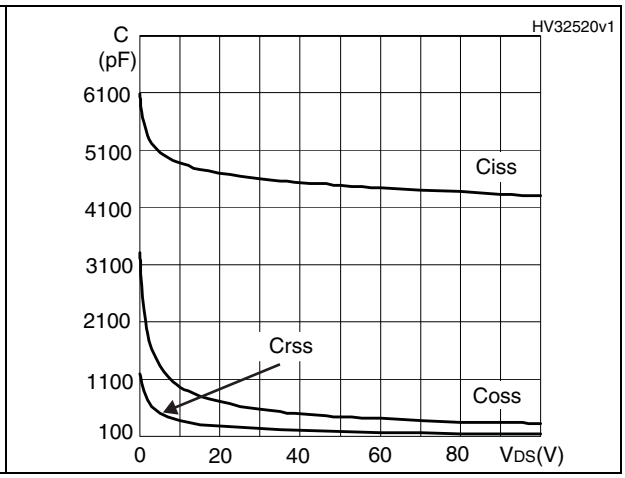


Figure 10. Normalized BV_{DSS} vs temperature

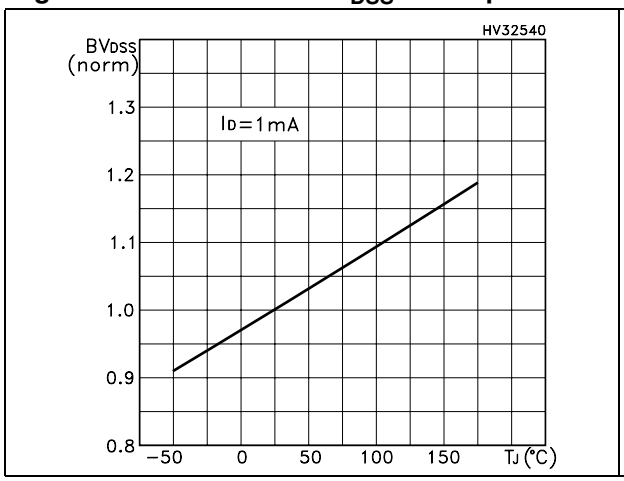


Figure 11. Static drain-source on resistance

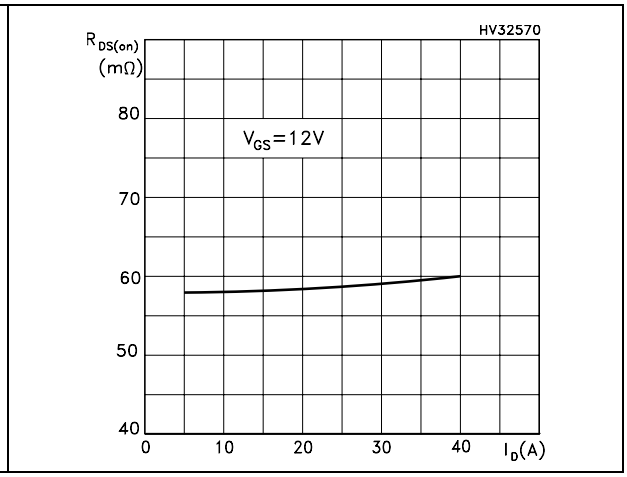


Figure 12. Normalized gate threshold voltage vs temperature

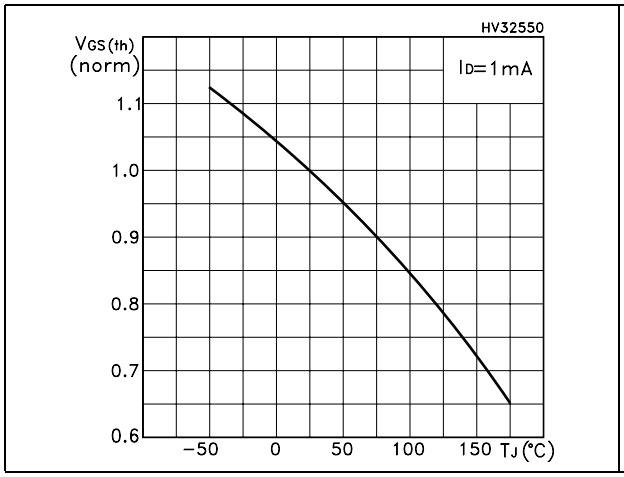


Figure 13. Normalized on resistance vs temperature

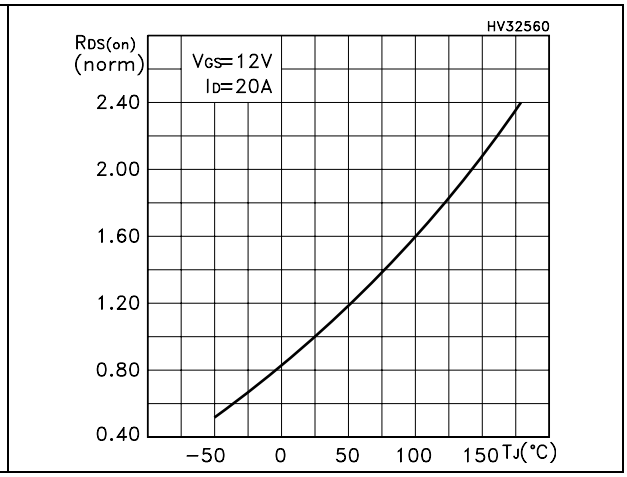
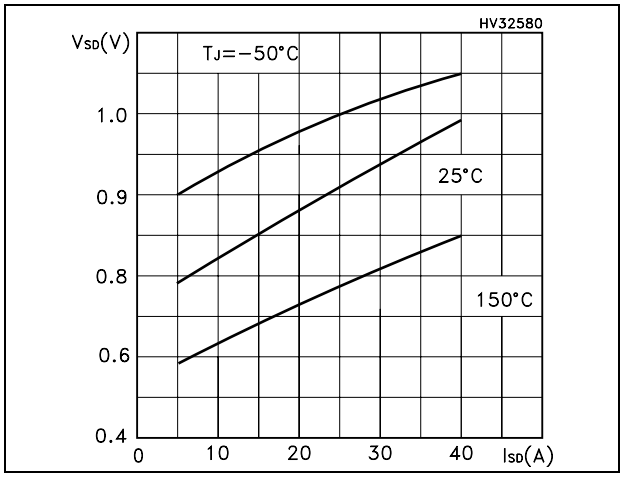
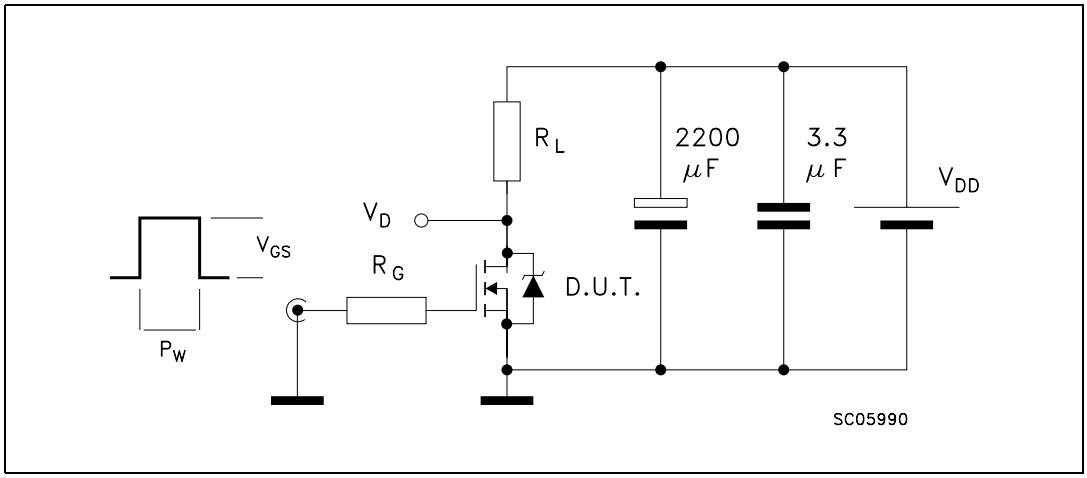


Figure 14. Source drain-diode forward characteristics



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

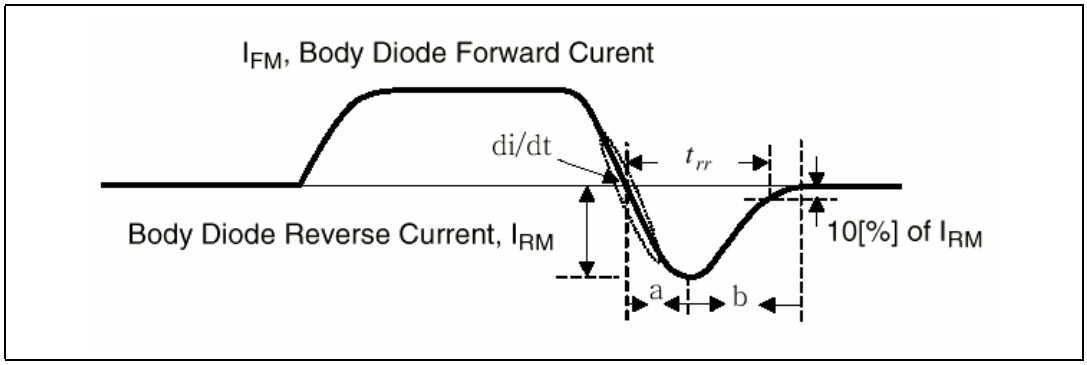
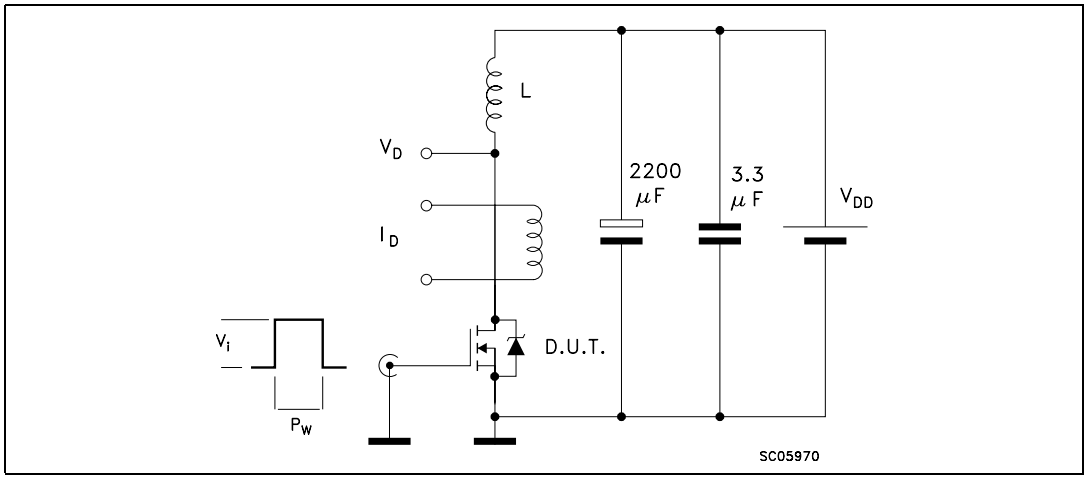


Figure 17. Unclamped inductive load test circuit (single pulse and repetitive)



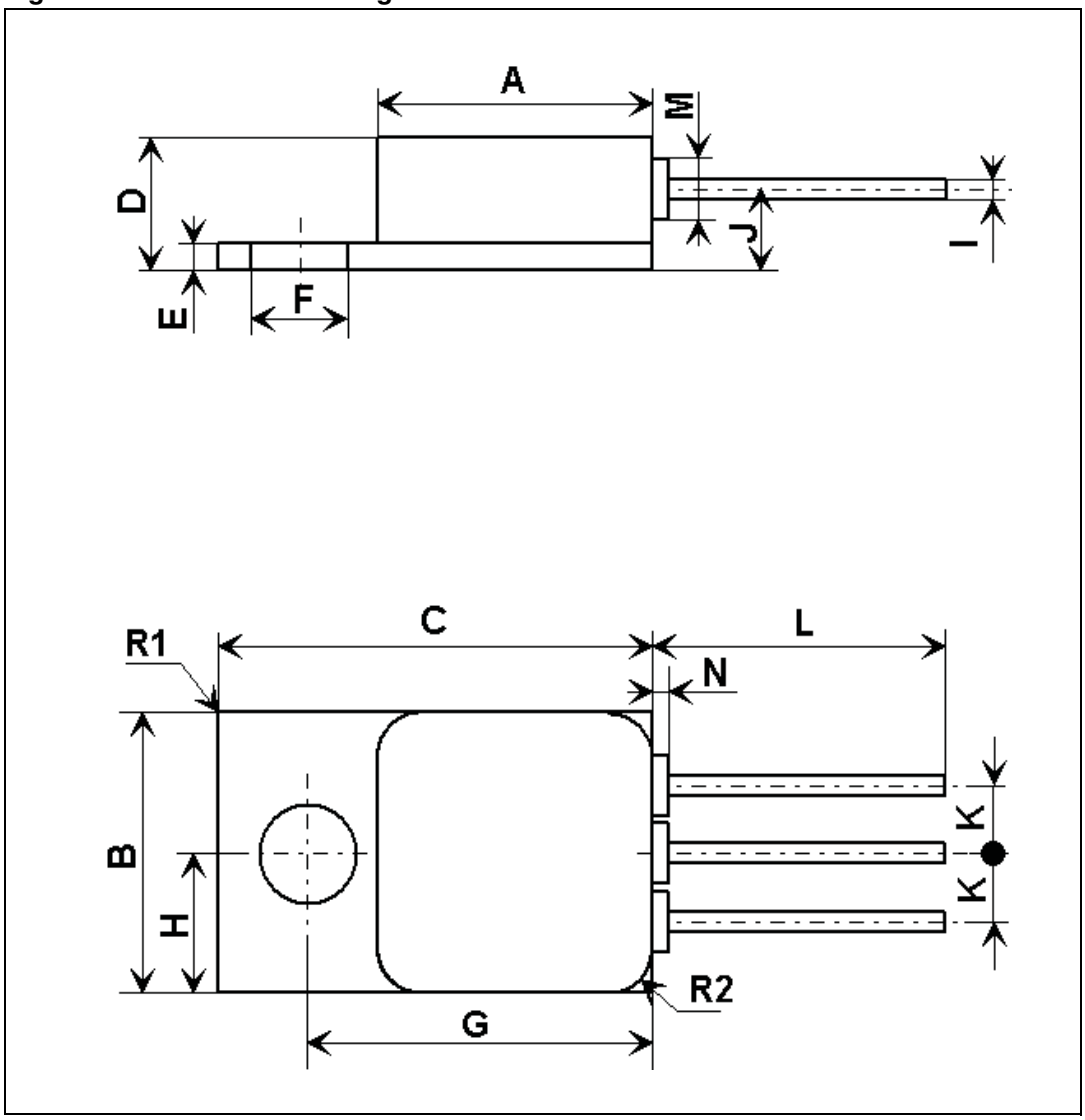
6 Package mechanical data

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 code	ESCC part number	Quality level	EPPL	Package	Lead finish	Marking	Packing
STRH40P10HY1	-	Engineering model	-	TO-254AA	Gold	TBD	Strip pack
STRH40P10HYG	TBD	ESCC flight	Target				

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

8 Revision history

Table 15. Document revision history

Date	Revision	Changes
23-Dec-2010	1	First release.
02-Feb-2011	2	Updated *Figure 1*.
03-May-2011	3	Updated *Figure 1*.
22-Jun-2011	4	Updated features on coverpage.
25-Jul-2011	5	Updated order codes in *Table 1: Device summary* and *Table 14: Ordering information*. Minor text changes.
09-Nov-2011	6	Updated dynamic values on *Table 6: Pre-irradiation dynamic*, *Table 7: Pre-irradiation switching times* and *Table 8: Pre-irradiation source drain diode*.

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