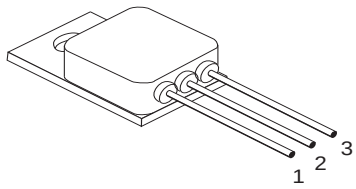
STRH12P10

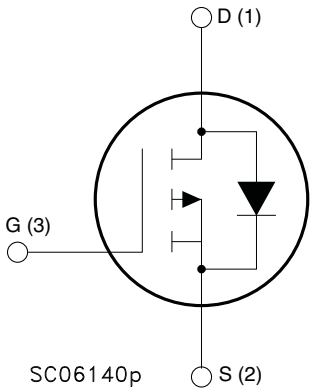
Rad-Hard 100 V, 12 A P-channel Power MOSFET

Datasheet - production data



TO-257AA

Figure 1. Internal schematic diagram



Features

V_{DSS}	I_D	$R_{DS(on)}$	Q_g
100V	12 A	265 mΩ	40 nC

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

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. 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
STRH12P10GY1	-	Engineering model	TO-257AA	Gold	10	-55 to 150 °C	-
STRH12P10GYG	5205/029/01	ESCC flight					Target
STRH12P10GYT	5205/029/02	ESCC flight		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

Table 2. Absolute maximum ratings (pre-irradiation)

Symbol	Parameter	Value	Unit
V_{DS}	Drain-source voltage (V_{GS} = 0)	100	V
V_{GS}	Gate-source voltage	±18	V
I_D (1)	Drain current (continuous) at T_C= 25°C	12	A
I_D (1)	Drain current (continuous) at T_C= 100°C	7.5	A
I_{DM} (2)	Drain current (pulsed)	48	A
P_{TOT} (1)	Total dissipation at T_C= 25°C	75	W
dv/dt (3)	Peak diode recovery voltage slope	2.4	V/ns
T_{stg}	Storage temperature	-55 to 150	°C
T_j	Max. operating junction temperature	150	°C

1. Rated according to the $R_{thj\text{-}case}$ + $R_{thc\text{-}s}$
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 12$ A, di/dt $\leq$ 36 A/μs, V_{DD} = 80%$V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case	1.47	°C/W
$R_{thc\text{-}s}$	Case-to-sink	0.2	°C/W

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_{j\ max}$)	6	A
E_{AS} (1)	Single pulse avalanche energy (starting T_j=25°C, I_D=I_{AR}, V_{DD}=50 V) @ 110 °C	112	mJ
E_{AR}	Repetitive avalanche (V_{DS}=50 V, I_{AR}=6 A, f=10 kHz, T_j= 25°C, Duty Cycle= 50%)	17	mJ
	(V_{DS}=50V, I_{AR}=6A, f=10 kHz, Tj= 110°C, Duty Cycle= 50%)	5.5	mJ

1. Maximum rating value.

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

2 Electrical characteristics

(T_{CASE} = 25°C unless otherwise specified)

2.1 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}= 16 V			100	nA
		V_{GS}= - 16 V	-100			nA
		V_{GS}= 16 V, T_c=125 dC			200	nA
		V_{GS}= -16 V, T_c=125 dC	-200			nA
BV_{DSS} (1)	Drain-source breakdown voltage	I_D = 1 mA, V_{GS} = 0 V	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 = 12 A		0.265	0.3	Ω

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

Table 6. Pre-irradiation dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
C_{iss} (1)	Input capacitance	V_{DS} = 25 V, f=1MHz, V_{GS}=0	940	1180	1410	pF
C_{oss}	Output capacitance		135	170	205	pF
C_{rss}	Reverse transfer capacitance		55	70	85	pF
Q_g	Total gate charge	V_{DD} = 50 V, I_D = 12 A, V_{GS}=12 V	32	40	48	nC
Q_{gs}	Gate-source charge		3.5	5	6.5	nC
Q_{gd}	Gate-drain charge		7	10	13	nC

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 = 6 A, R_G = 4.7 Ω, V_{GS} = 12 V	5	9	13	ns
t_r	Rise time		7	19	31	ns
$t_{d(off)}$	Turn-off-delay time		18	30	42	ns
t_f	Fall time		3.5	7	10.5	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)				12 48	A A
V_{SD} (3)	Forward on voltage	I_{SD} = 12 A, V_{GS} = 0			1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 12 A, di/dt = 40 A/µs V_{DD}= 60 V, Tj = 25°C	178	218	258	ns
Q_{rr}	Reverse recovery charge		1700	2130	2560	nC
I_{RRM}	Reverse recovery current		14	19	24	A
t_{rr}	Reverse recovery time	I_{SD} = 12A, di/dt = 40 A/µs V_{DD}= 60 V, Tj = 150°C	225	280	335	ns
Q_{rr}	Reverse recovery charge		2650	3250	3950	nC
I_{RRM}	Reverse recovery current		18.5	23.5	28.5	A

1. Refer to the *Figure 14*.
2. Pulse width limited by safe operating area
3. Pulsed: pulse duration = 300µs, duty cycle 1.5%

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) for total ionizing dose according to the ESCC 22900 specification, window 1) and Single Event Effect according to the MIL-STD-750E TM1080 up to a fluency 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 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	nA
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 = 12 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} = 12 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
Cu	28	285	43	-100	-	-60	-	-
Xe	60	1217	89	-	-30	-	-	-

Figure 2. Single event effect, SOA

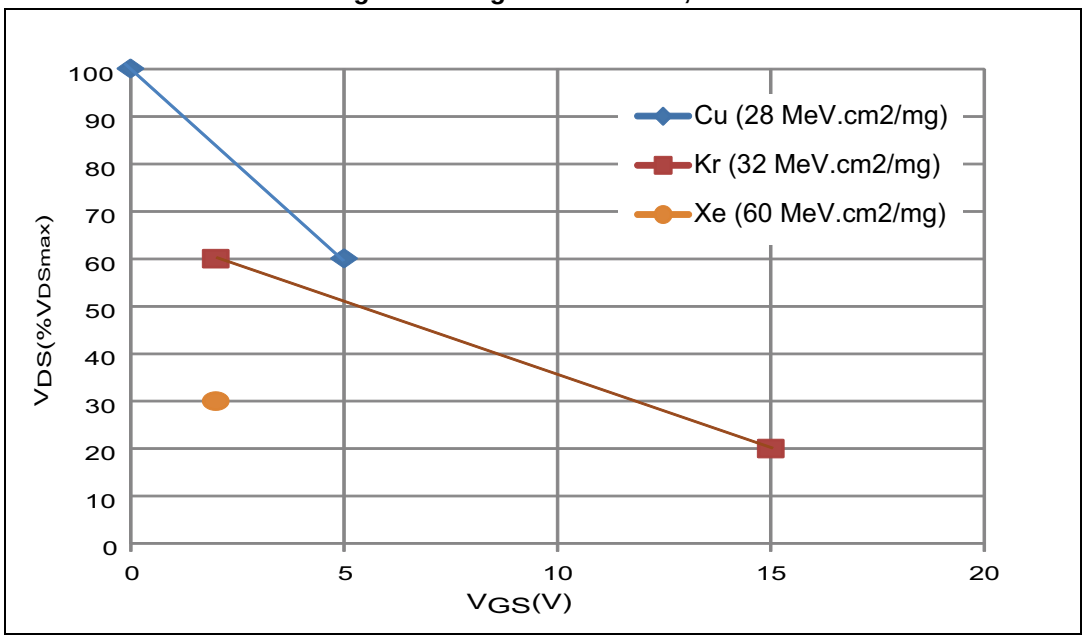
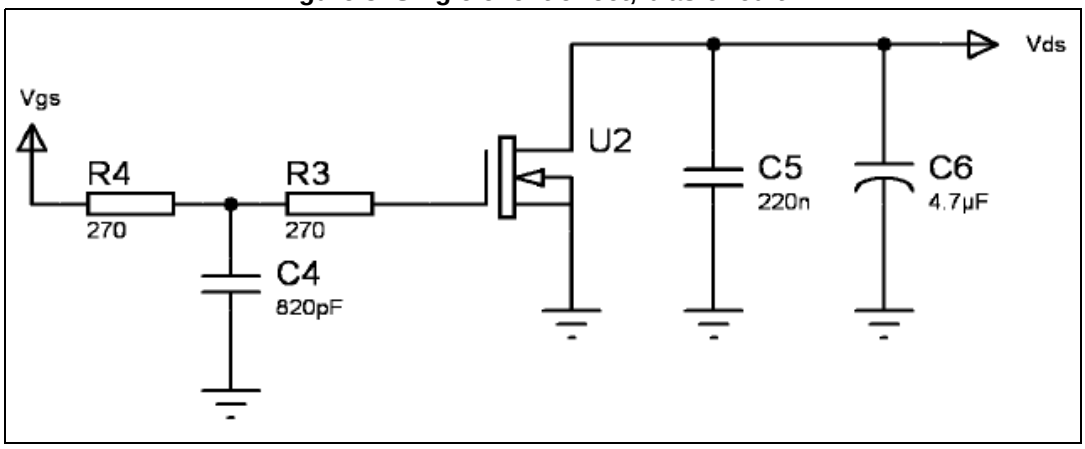


Figure 3. Single event effect, bias circuit(a)



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

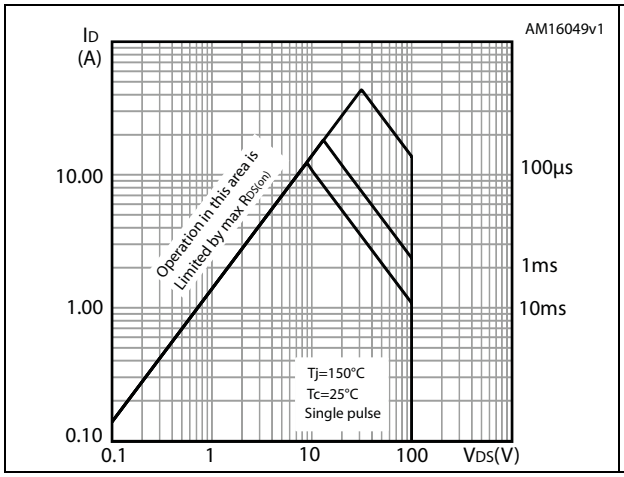


Figure 5. Thermal impedance

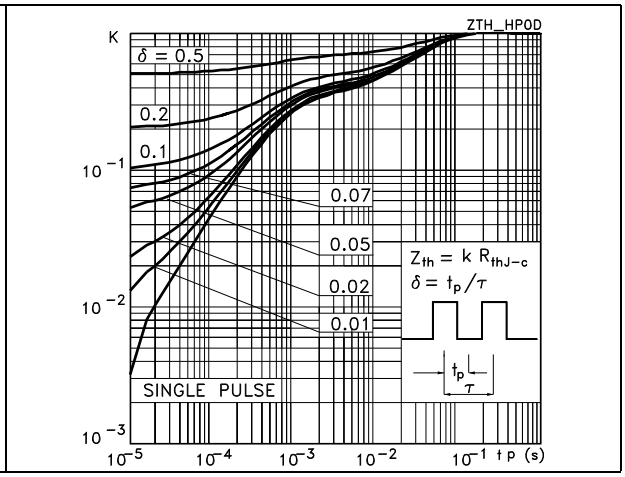


Figure 6. Output characteristics

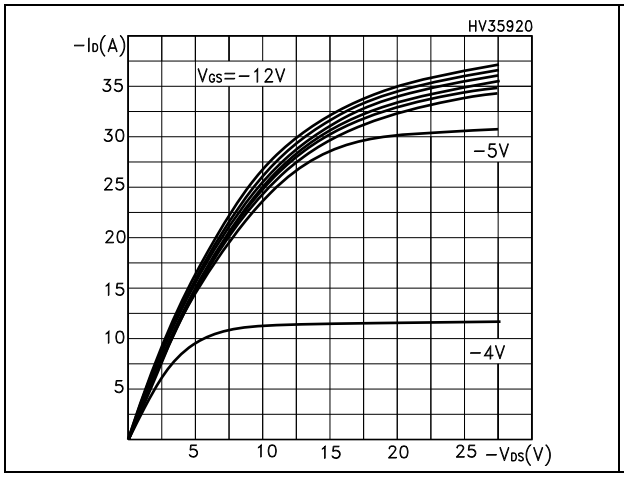


Figure 7. Transfer characteristics

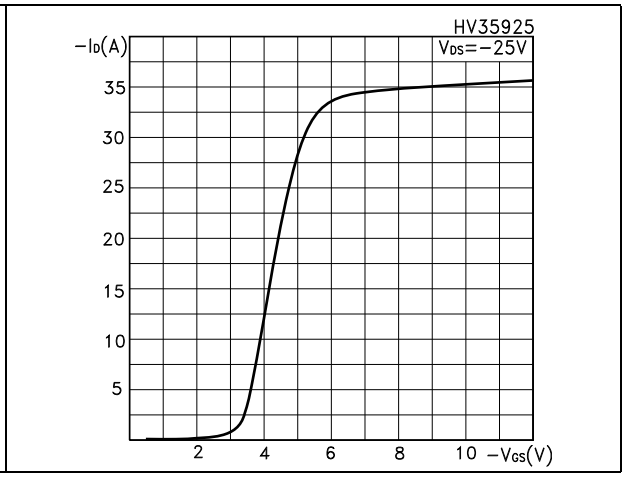


Figure 8. Gate charge vs gate-source voltage

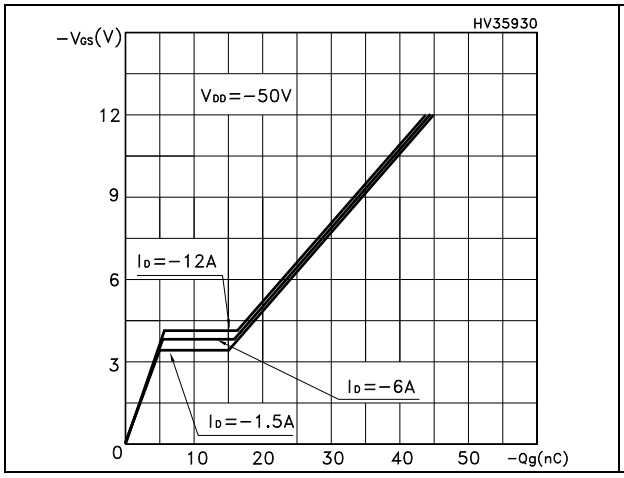


Figure 9. Capacitance variations

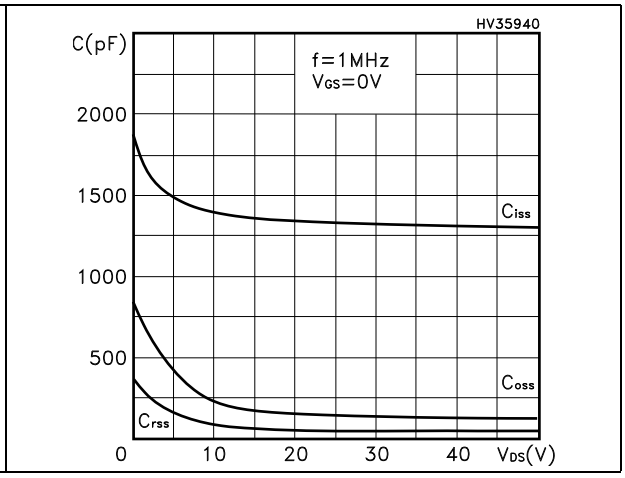


Figure 10. Normalized BV_{DSS} vs temperature

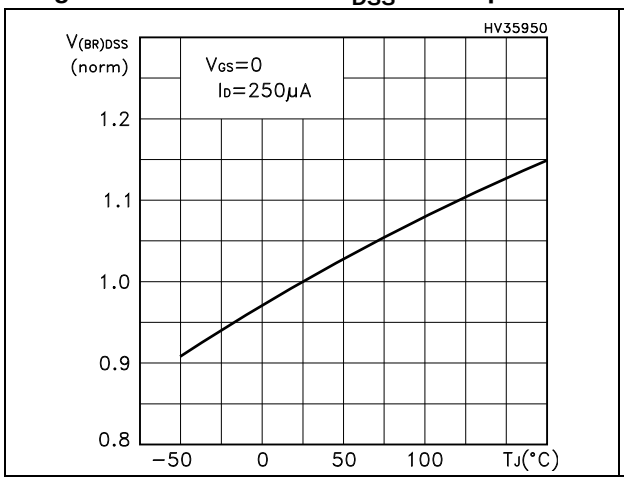


Figure 11. Static drain-source on resistance

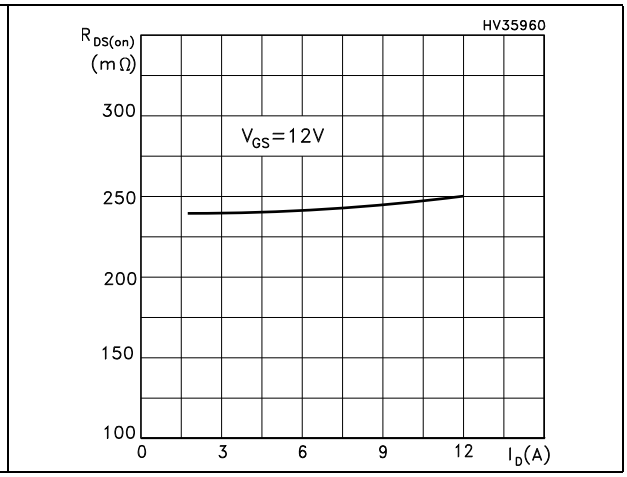


Figure 12. Normalized gate threshold voltage vs temperature

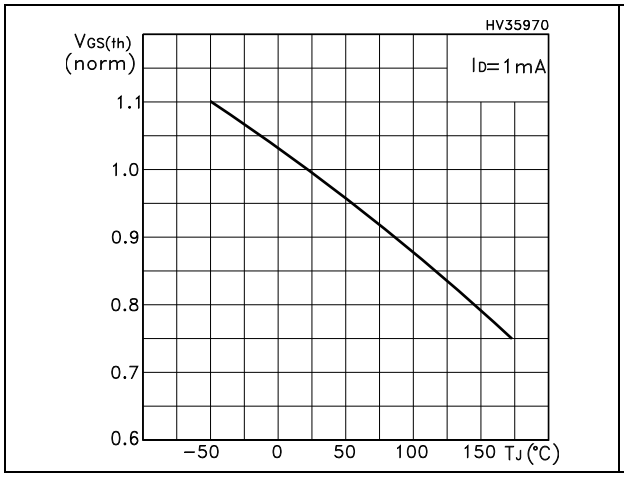


Figure 13. Normalized on resistance vs temperature

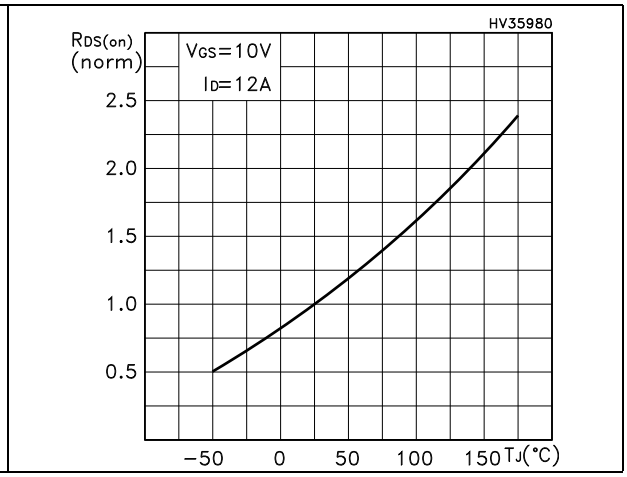
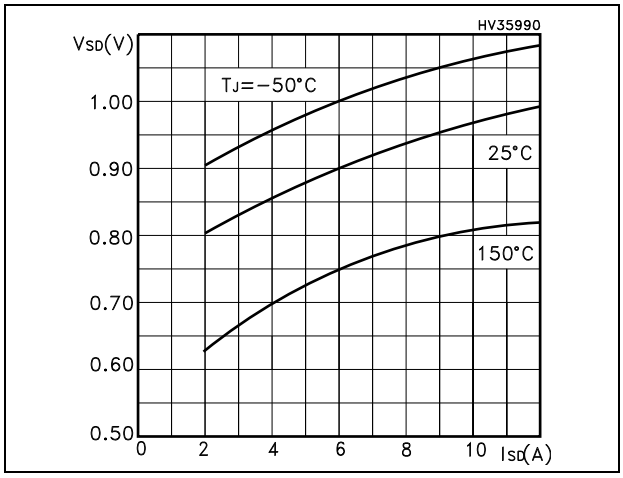
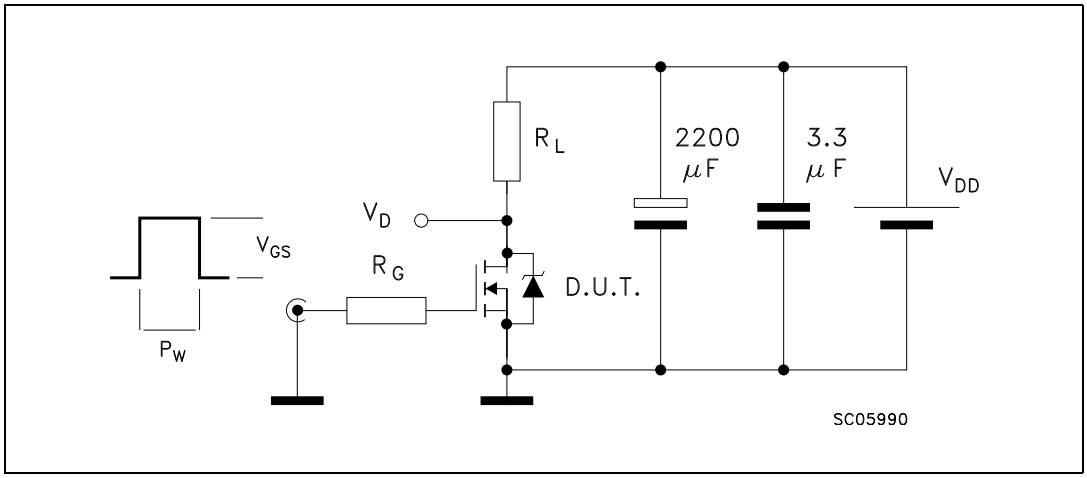


Figure 14. Source drain-diode forward characteristics



5 Test circuit

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

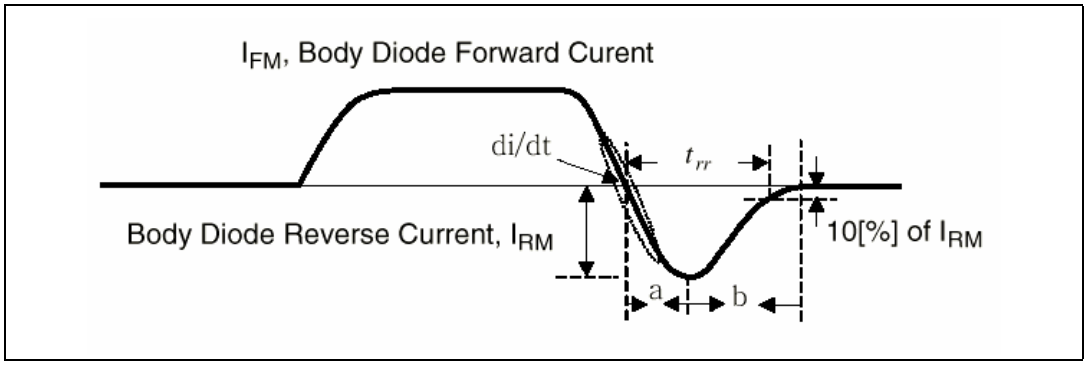
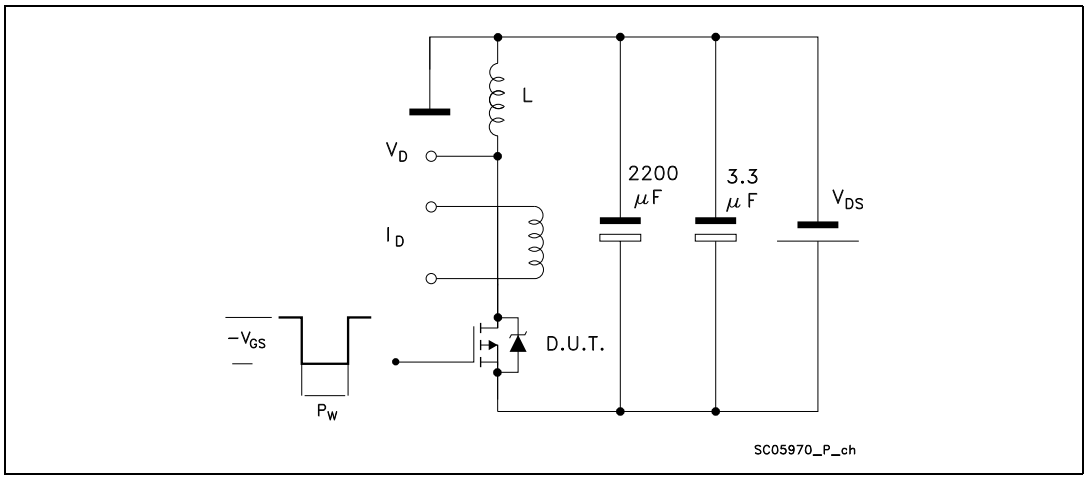


Figure 17. Unclamped inductive load test circuit (single pulse and repetitive)



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.

Figure 18. TO-257AA drawing

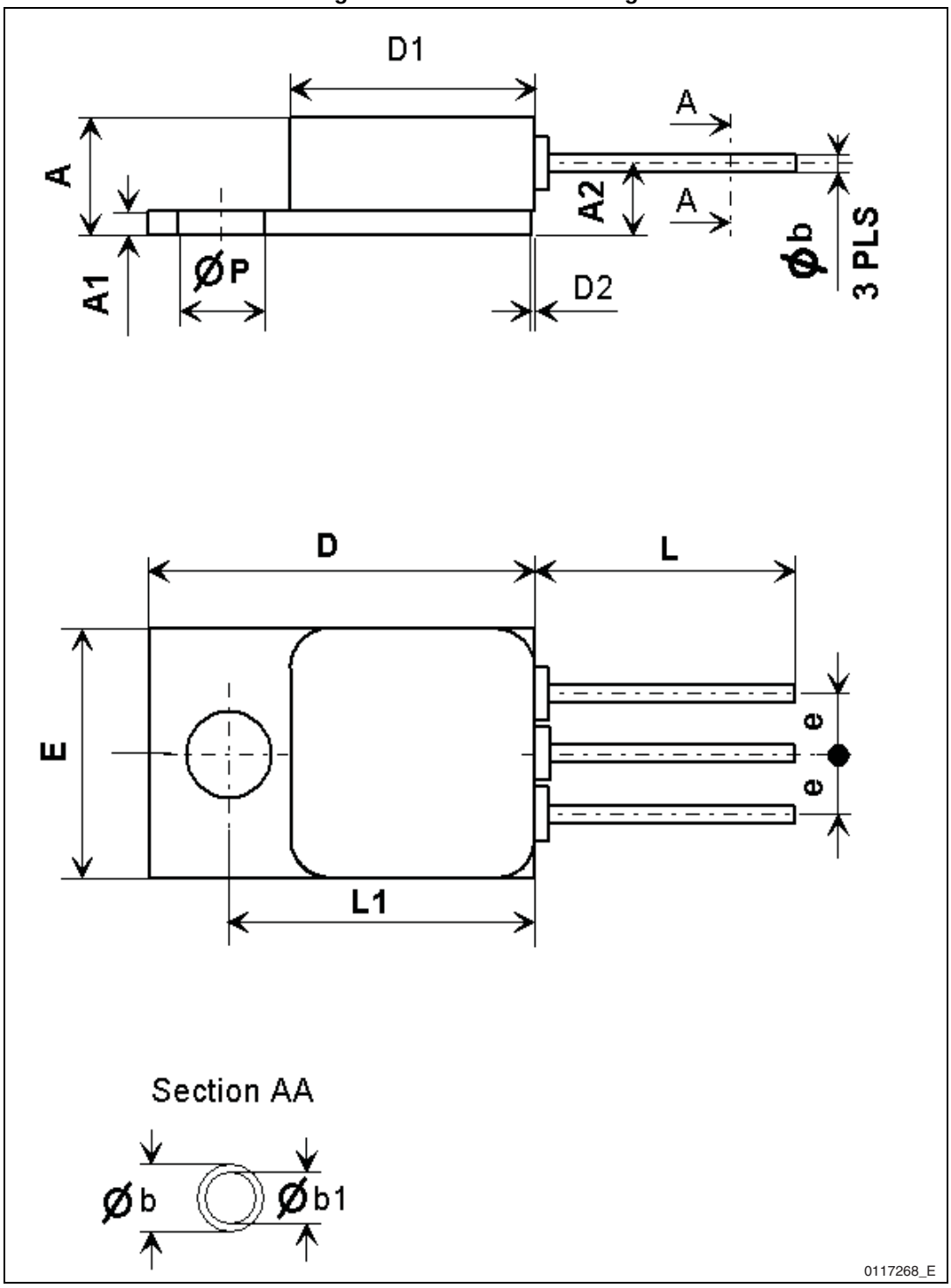


Table 13. TO-257AA mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.83		5.08	0.190		0.200
A1	0.89		1.14	0.035		0.045
A2		3.05			0.120	
b	0.64		1.02	0.025		0.040
b1	0.64	0.76	0.89	0.025	0.030	0.035
D	16.38		16.89	0.645		0.665
D1	10.41		10.92	0.410		0.430
D2			0.97			0.038
e		2.54			0.100	
E	10.41		10.67	0.410		0.420
L	12.70		19.05	0.500		0.750
L1	13.39		13.64	0.527		0.537
P	3.56		3.81	0.140		0.150

7 Order codes

Table 14. Ordering information

Order code	ESCC part number	Quality level	EPPL	Package	Lead finish	Marking	Packing
STRH12P10GY1	-	Engineering model	-	TO-257AA	Gold	STRH12P10GY1 + BeO	Strip pack
STRH12P10GYG	5205/029/01	ESCC flight	Target			520502901R + BeO	
STRH12P10GYT	5205/029/02		-		Solder dip	520502902R + 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.

8 Shipping details

8.1 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

8.2 Documentation

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

Table 15. Documentation provide for each type of product

Quality level	Radiation level	Documentation
Engineering model	-	-
ESCC flight	100 krad	Certificate of conformance, radiation verification test report

9 Revision history

Table 16. Document revision history

Date	Revision	Changes
07-Oct-2011	1	First release.
24-Jun-2013	2	Document status promoted form preliminary data to production data. – Modified: *Figure 1* – Modified: E_{AS}, E_{AR} parameter and values in *Table 4* – Modified: I_{GSS}, and added note *1* in *Table 5* – Added: note *1* in *Table 6* – Modified: t_{rr}, q_{rr} and I_{RRM} parameter in *Table 8* – Modified: $R_{DS(on)}$ test conditions in *Table 9*, the entire test conditions in *Table 10* – Modified: *Figure 4*
25-Nov-2013	3	– Modified: package drawing and *Figure 1*.
18-Dec-2013	4	– Updated *Table 1: Device summary* and *Table 14: Ordering information*. – Updated *Section : Total dose radiation (TID) testing*.

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