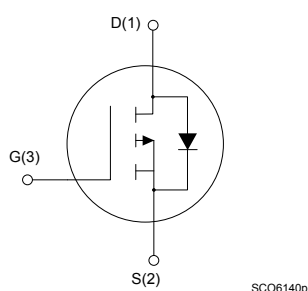
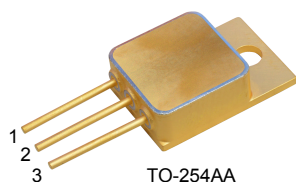


Rad-Hard 100 V, 34 A P-channel Power MOSFET



Features

V_{DS}	I_D	$R_{DS(on)}$ typ.	Q_g
100 V	34 A	60 mΩ	162 nC

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

Description

The STRH40P10 is a P-channel Power MOSFET developed with the Rad-Hard STripFET technology in TO-254AA hermetic package and qualified as per ESCC detail specification No. 5205/025.

Designed for satellite application, it sustains high level of total ionized dose (TID) and immunity to heavy ions effects. In case of discrepancies between this datasheet and the relevant agency specification, the latter takes precedence.

Device summary

Product status link
STRH40P10

Product summary					
Part number	Quality level	ESCC part number	Package	Lead finish	Radiation level
STRH40P10HY1	Engineering model	-	TO-254AA	Gold	-
STRH40P10HYG	ESCC flight	5205/025		Solder dip	100 krad
STRH40P10HYT					

Note: See [Table 8. Ordering information](#).

1 Electrical ratings

Note: For P-channel MOSFET voltage and current polarity is reversed.

Table 1. Absolute maximum ratings

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) at $T_{case} = 25\text{ }^{\circ}\text{C}$	34	A
	Drain current (continuous) at $T_{case} = 100\text{ }^{\circ}\text{C}$	21	A
$I_{DM}^{(4)}$	Drain current (pulsed)	136	A
$P_{TOT}^{(3)}$	Total power dissipation at $T_{case} = 25\text{ }^{\circ}\text{C}$	176	W
$dv/dt^{(5)}$	Peak diode recovery voltage slope	2.5	V/ns
T_{op}	Operating temperature range	-55 to 150	$^{\circ}\text{C}$
T_j	Max. operating junction temperature range	150	$^{\circ}\text{C}$

1. This rating is guaranteed at $T_j \geq 25\text{ }^{\circ}\text{C}$ (see Figure 9. Normalized $V_{(BR)DSS}$ vs temperature).
2. This value is guaranteed over the full range of temperature.
3. Rated according to the $R_{thj-case} + R_{thc-s}$
4. Pulse width limited by safe operating area.
5. $I_{SD} \leq 40\text{ A}$, $di/dt \leq 100\text{ A}/\mu\text{s}$, $V_{DD} = 80\% V_{(BR)DSS}$.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case (maximum)	0.71	$^{\circ}\text{C}/\text{W}$
R_{thc-s}	Thermal resistance case-sink (typical)	0.21	$^{\circ}\text{C}/\text{W}$

Table 3. Avalanche data

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max)	17	A
$E_{AS}^{(1)}$	Single pulse avalanche energy (starting $T_j = 25\text{ }^{\circ}\text{C}$, $I_D = 17\text{ A}$, $V_{DD} = 50\text{ V}$)	1133	mJ
E_{AS}	Single pulse avalanche energy (starting $T_j = 110\text{ }^{\circ}\text{C}$, $I_D = 17\text{ A}$, $V_{DD} = 50\text{ V}$)	332	mJ
E_{AR}	Repetitive pulse avalanche energy ($V_{DD} = 50\text{ V}$, $I_{AR} = 24\text{ A}$, $f = 100\text{ KHz}$, $T_j = 25\text{ }^{\circ}\text{C}$, duty cycle = 10%)	25	mJ
	Repetitive pulse avalanche energy ($V_{DD} = 50\text{ V}$, $I_{AR} = 17\text{ A}$, $f = 100\text{ KHz}$, $T_j = 110\text{ }^{\circ}\text{C}$, duty cycle = 10%)	8	

1. Maximum rating value.

2 Electrical characteristics

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

Table 4. Electrical characteristics ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Max.	Unit
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	80% BV_{DSS}		10	μA
I_{GSS}	Gate body leakage current	$V_{GS} = 20\text{ V}$		100	nA
		$V_{GS} = -20\text{ V}$	-100		
		$V_{GS} = 20\text{ V}, T_C = 125\text{ °C}$		200	
		$V_{GS} = -20\text{ V}, T_C = 125\text{ °C}$	-200		
$V_{(BR)DSS}^{(1)}$	Drain-to-source breakdown voltage	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	100		V
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 1\text{ mA}, T_C = -55\text{ °C}$	2.3	5.2	V
		$V_{DS} = V_{GS}, I_D = 1\text{ mA}$	2.0	4.5	
		$V_{DS} = V_{GS}, I_D = 1\text{ mA}, T_C = 125\text{ °C}$	1.6	3.7	
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 12\text{ V}, I_D = 17\text{ A}$		0.075	Ω
C_{iss}	Input capacitance	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}, V_{GS} = 0\text{ V}$	3710	5570	pF
$C_{oss}^{(2)}$	Output capacitance		510	760	pF
C_{rss}	Reverse transfer capacitance		204	306	pF
Q_g	Total gate charge	$V_{DD} = 50\text{ V}, I_D = 34\text{ A}, V_{GS} = 12\text{ V}$	130	194	nC
Q_{gs}	Gate-to-source charge		14	22	nC
Q_{gd}	Gate-to-drain ("Miller") charge		32	48	nC
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 50\text{ V}, I_D = 17\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 12\text{ V}$	15	33	ns
t_r	Rise time		19	43	ns
$t_{d(off)}$	Turn-off delay time		98	147	ns
t_f	Fall time		34	58	ns
$I_{SDM}^{(3)}$	Source-drain current (pulsed)	$I_{SD} = 34\text{ A}, V_{GS} = 0\text{ V}$		136	A
$V_{SD}^{(4)}$	Forward on voltage	$I_{SD} = 34\text{ A}, V_{GS} = 0\text{ V}$		1.5	V
		$I_{SD} = 34\text{ A}, V_{GS} = 0\text{ V}, T_C = 125\text{ °C}$		1.25	V
$t_{rr}^{(2)}$	Reverse recovery time	$I_{SD} = 34\text{ A}, di/dt = 40\text{ A}/\mu s, V_{DD} = 12\text{ V}, T_J = 25\text{ °C}$	276	414	ns

1. This rating is guaranteed at $T_J \geq 25\text{ °C}$ (see Figure 9. Normalized $V_{(BR)DSS}$ vs temperature).

2. Not tested in production, guaranteed by process.

3. Pulse width limited by safe operating area

4. Pulsed: pulse duration = 300 μs , duty cycle $\leq 1.52\%$

3 Radiation characteristics

This products is guaranteed in radiation as per ESCC 5205/025 and ESCC 22900 specification at 100 krad. Each lot tested in radiation is accepted according to the characteristics as per Table 5.

3.1 Total dose radiation (TID) testing

The bias with $V_{GS} = +15\text{ V}$ and $V_{DS} = 0\text{ V}$ is applied during irradiation exposure.

The parameters listed in Table 5 are measured:

- Before irradiation
- After irradiation
- After 24 hrs at room temperature
- after 168 hrs at 100 °C anneal

Table 5. Post-irradiation electrical characteristics ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Symbol	Parameter	Test conditions	Drift values Δ	Unit
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	80% $V_{(BR)DSS}$	+1	μA
I_{GSS}	Gate body leakage current	$V_{GS} = 20\text{ V}$	1.5	nA
		$V_{GS} = -20\text{ V}$	-1.5	
$V_{(BR)DSS}$	Drain-to-source breakdown voltage	$V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$	-15%	V
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 1\text{ mA}$	+150%	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 12\text{ V}$, $I_D = 17\text{ A}$	-4% / +35%	Ω
Q_g	Total gate charge	$V_{DS} = 50\text{ V}$, $I_G = 1\text{ mA}$, $V_{GS} = 12\text{ V}$, $I_{DS} = 34\text{ A}$	-15% / +5%	nC
Q_{gs}	Gate-to-source charge		-5% / +200%	
Q_{gd}	Gate-to-drain charge		-10% / +100%	
$V_{SD}^{(1)}$	Forward on voltage	$V_{GS} = 0\text{ V}$, $I_{SD} = 34\text{ A}$	$\pm 5\%$	V

1. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

3.2 Single event effect RBSOA

The STRH40P10 is extremely resistant under heavy ions exposure as per MIL-STD-750E, test method 1080, bias circuit of Figure 2.

SEB and SEGR tests are performed with a fluence of $3e+5$ ions/cm² with the following acceptance criteria:

- 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.

Table 6. Single Event Effects (SEB and SEGR) RBSOA

Ion	Let (Mev/(mg/cm ²))	Energy (MeV)	Range (μm)
Kr	32	768	94
		756	92
Cu	28	285	43
Xe	60	1217	89

Figure 1. Single event effect, SOA

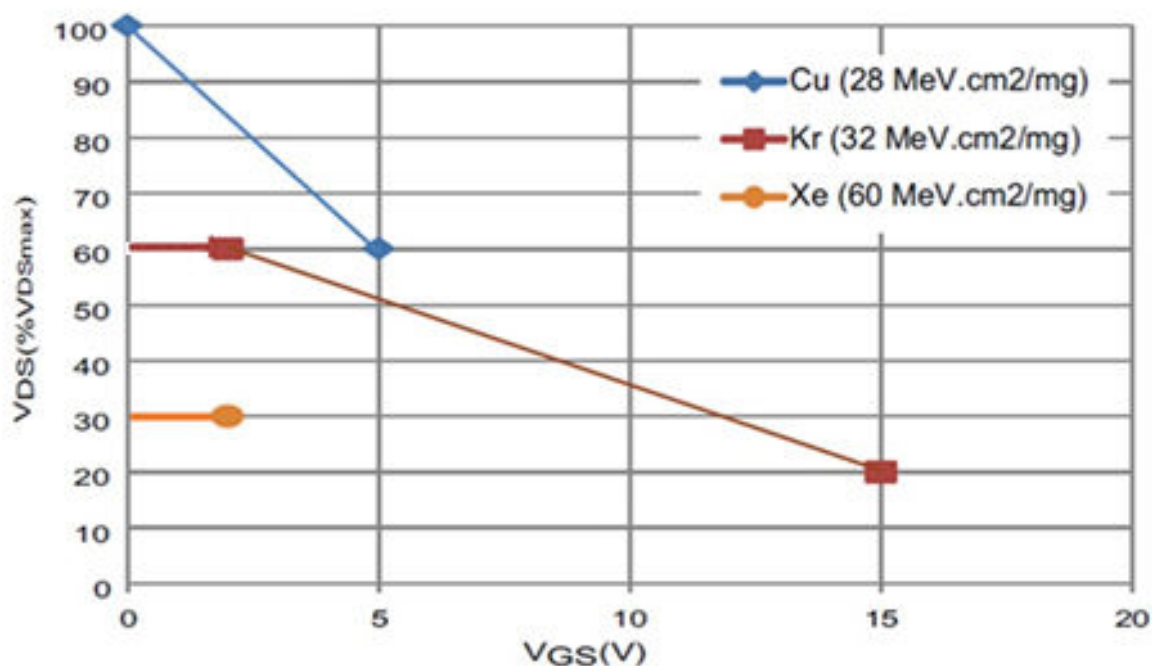
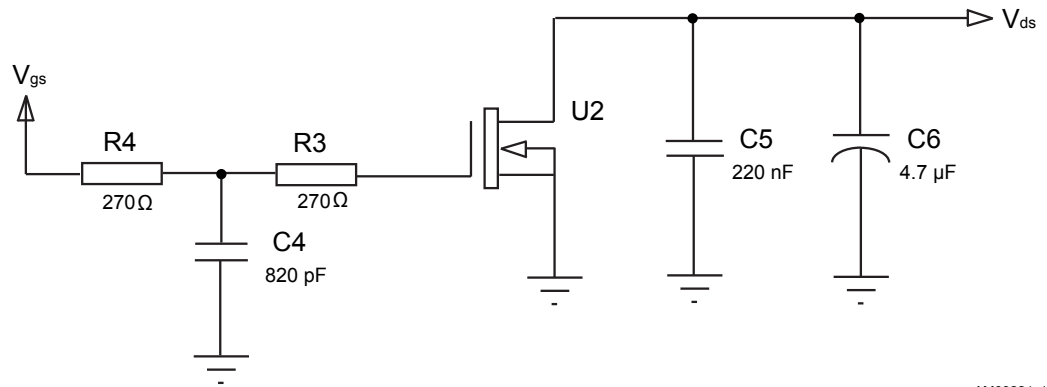


Figure 2. Single event effect, bias circuit



AM09224v1

Note: Bias condition during radiation refer to [Table 6. Single Event Effects \(SEB and SEGR\) RBSOA](#).

4 Electrical characteristics (curves)

Figure 3. Safe operating area

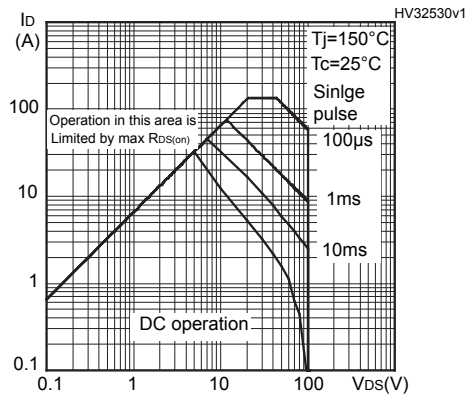


Figure 4. Thermal impedance

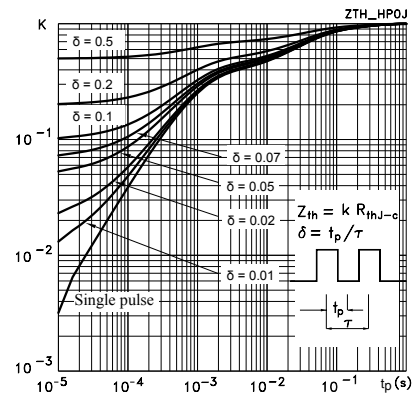


Figure 5. Output characteristics

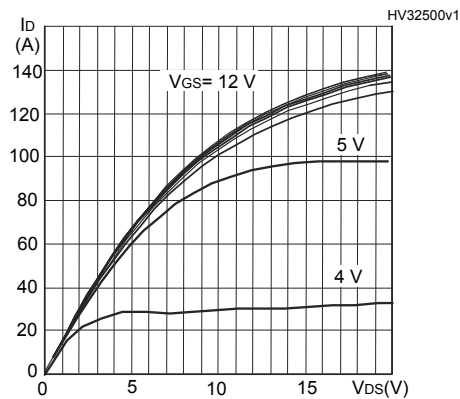


Figure 6. Transfer characteristics

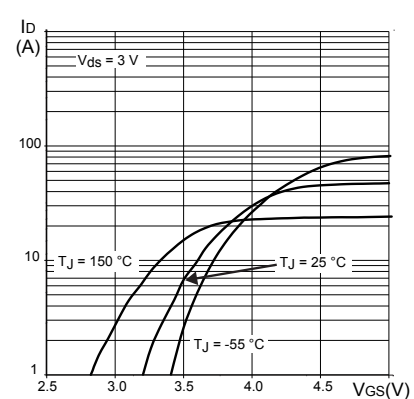


Figure 7. Gate charge vs gate-source voltage

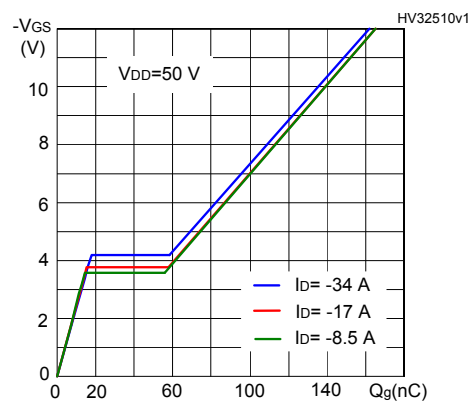


Figure 8. Capacitance variations

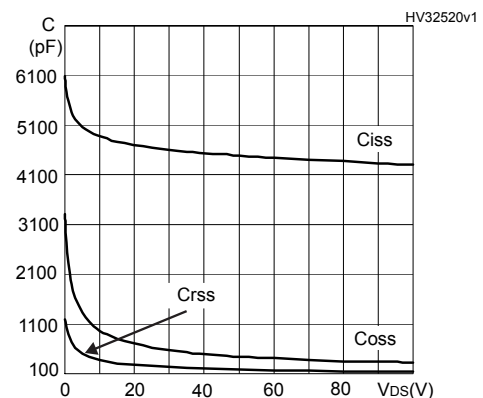


Figure 9. Normalized $V_{(BR)DSS}$ vs temperature

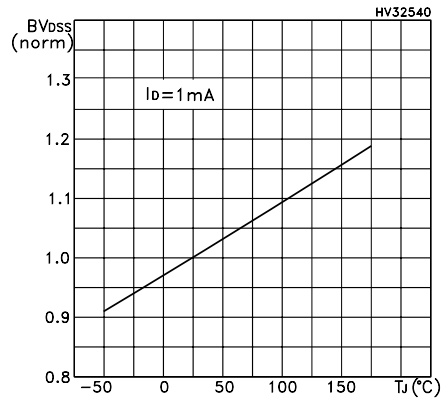


Figure 10. Static drain-source on-resistance

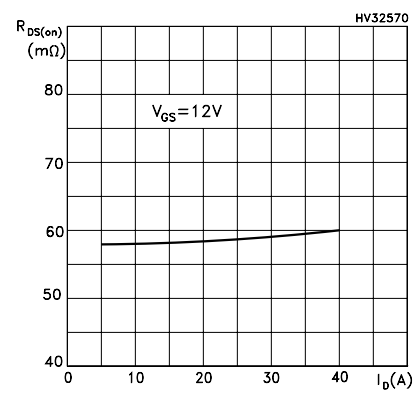


Figure 11. Normalized gate threshold voltage vs temperature

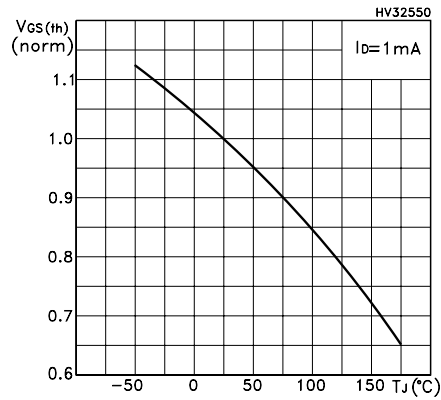


Figure 12. Normalized on-resistance vs temperature

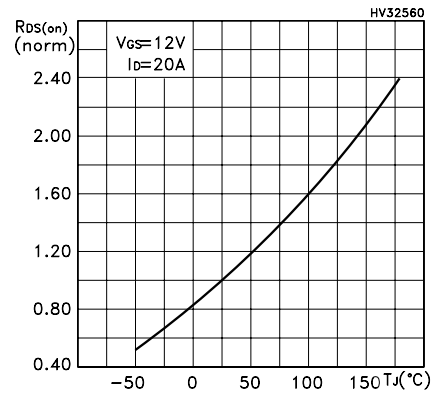
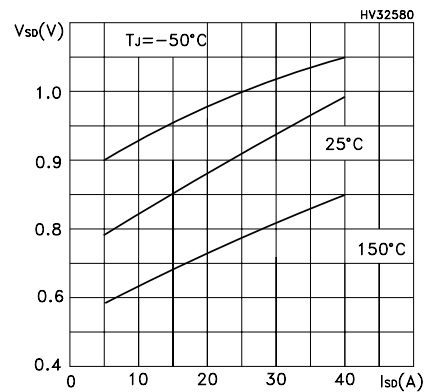
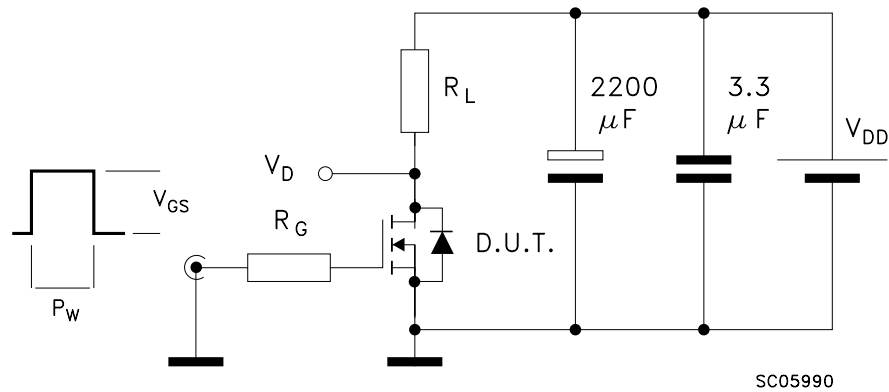


Figure 13. Source drain-diode forward characteristics



5 Test circuits

Figure 14. Switching times test circuit for resistive load



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

Figure 15. Source drain diode waveform

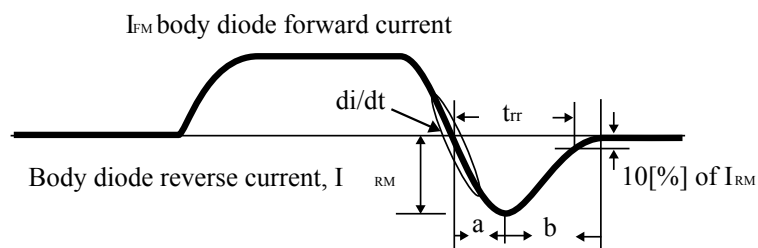
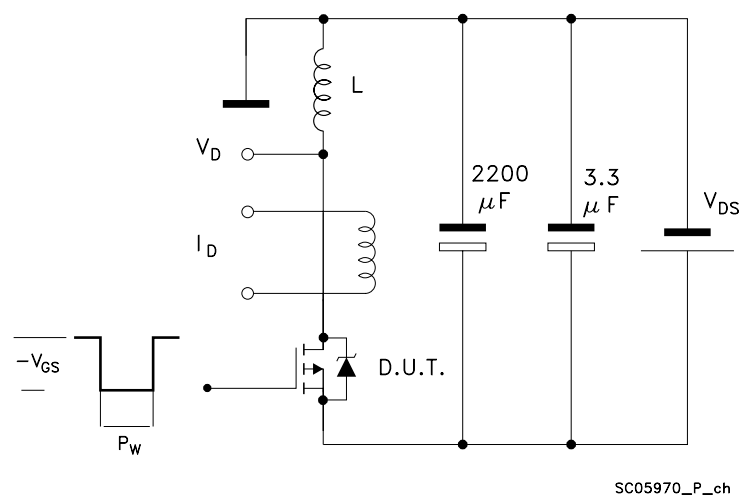


Figure 16. Unclamped inductive load test circuit (single pulse and repetitive)

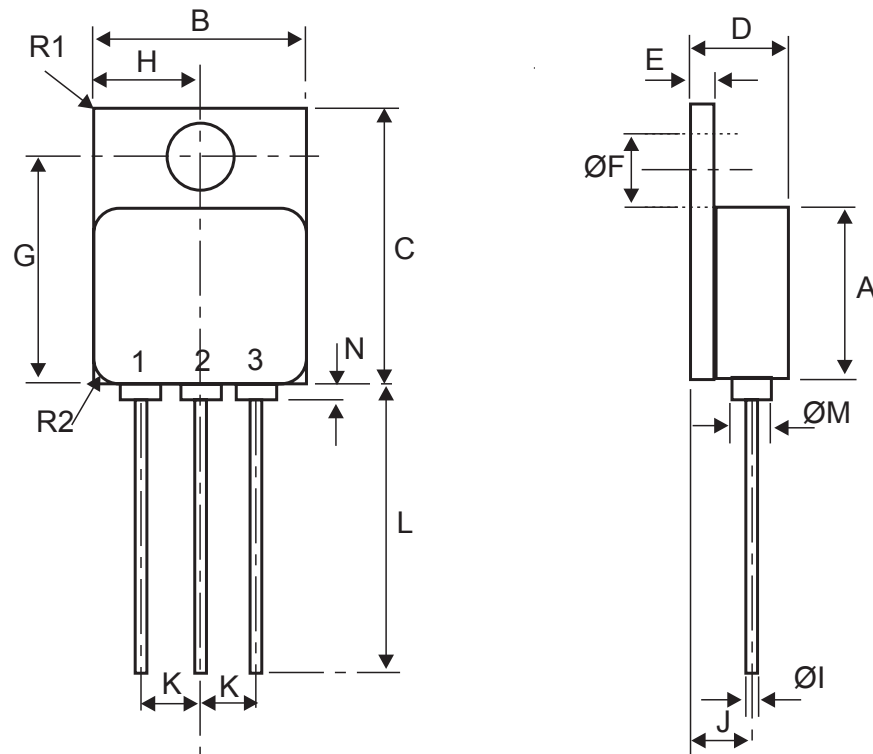


6 Package information

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.

6.1 TO-254AA package information

Figure 17. TO-254AA package outline



The TO-254-AA is a metallic package. It is not connected to any pin nor to the inside die.

0005824 rev13

Table 7. TO-254AA package mechanical data

Symbols	Dimensions (mm)			Dimension (inches)		
	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	6.30		6.70	0.248		0.264
E	1.00		1.35	0.039		0.054
ØF	3.50		3.90	0.137		0.154
G	16.89		17.40	0.665		0.685
H		6.86			0.270	
ØI	0.89		1.14	0.035		0.045
J		3.81			0.150	
K		3.81			0.150	
L	12.95		14.50	0.510		0.571
ØM		3.05			0.120	
N			0.71			0.028
R1			1.00			0.039
R2		1.65			0.065	

7 Order codes

Table 8. Ordering information

Part number	Agency specification	Quality level	Radiation level	Package	Weight	Lead finish	Marking ⁽¹⁾	Packing
STRH40P10HY1		Engineering model	-	TO-254AA	10 g	Gold	STRH40P10HY1 + BeO	Strip pack
STRH40P10HYG	5205/025/01	ESCC flight	100 krad				520502501R + BeO	
STRH40P10HYT	5205/025/02		100 krad			Solder dip	520502502R + BeO	

1. Specific marking only. The full marking includes in addition: For the Engineering Models: ST logo, date code; country of origin (FR). For ESCC flight parts: ST logo, date code, country of origin (FR), ESA logo, serial number of the part within the assembly lot.

Contact ST sales office for information about specific conditions for products in die form.

8 Other information

8.1 Traceability information

Date code information is described in the table below.

Table 9. Date codes

Model	Date code ⁽¹⁾
EM	3yywwN
ESCC	yywwN

1. yy = year, ww = week number, N = lot index in the week.

8.2 Documentation

Table 10. Documentation provided for each type of product

Quality level	Radiation level	Documentation
Engineering model	-	Certificate of conformance
ESCC	100 krad	Certificate of conformance ESCC qualification maintenance lot reference Radiation data at 25 / 50 / 70 / 100 krad at 0.1 rad / s.

Revision history

Table 11. Document revision history

Date	Version	Changes
23-Dec-2010	1	First release.
02-Feb-2011	2	Updated <i>Figure 1</i> .
03-May-2011	3	Updated <i>Figure 1</i> .
22-Jun-2011	4	Updated <i>features</i> on coverpage.
25-Jul-2011	5	Updated order codes in <i>Table 1: Device summary</i> and <i>Table 14: Ordering information</i> . Minor text changes
09-Nov-2011	6	Modified: <i>Description</i> Minor text changes
12-Dec-2012	7	Updated <i>features</i> in cover page. Updated <i>Table 5</i> , <i>Table 8</i> , <i>Table 9</i> , <i>Table 10</i> , <i>Table 11</i> and <i>Table 15</i> .
17-Dec-2012	8	Updated <i>Table 8: Pre-irradiation source drain diode</i> . Minor text changes.
13-Jun-2013	9	Updated <i>Table 7: Pre-irradiation switching times</i> and <i>Table 8: Pre-irradiation source drain diode</i> . Minor text changes.
09-Sep-2013	10	Updated <i>Table 1</i> . Minor text changes.
27-Sep-2013	11	Updated IAR value in <i>Table 4: Avalanche characteristics</i> .
17-Dec-2013	12	Total dose radiation testing parameters changed in <i>Section 3: Radiation characteristics</i> .
25-Aug-2014	13	Updated <i>Figure 7: Transfer characteristics</i> .
19-Dec-2016	14	Updated <i>Table 7: Pre-irradiation switching times</i> and <i>Table 8: Pre-irradiation source drain diode</i> .
12-Jul-2019	15	Updated <i>Table 4</i> . Minor text changes.
30-Nov-2020	16	Updated <i>Table 1</i> , <i>Table 4</i> , <i>Table 5</i> , <i>Table 6</i> and <i>Table 8</i> .
15-Jun-2021	17	Updated <i>Description</i> and <i>Figure 4</i> .
08-Apr-2024	18	Updated <i>Table 5</i> .

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