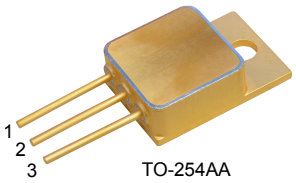
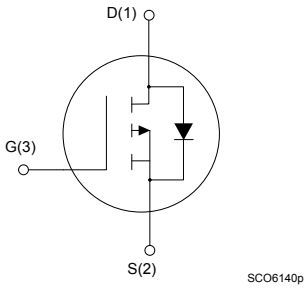
Rad-Hard 100 V, 34 A P-channel Power MOSFET



TO-254AA



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.

Product status link
STRH40P10

Product summary

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			100 krad
STRH40P10HYT				Solder dip	100 krad

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

1. *This rating is guaranteed at $T_J \geq 25$ °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 $R_{thj\text{-}case}$ + $R_{thc\text{-}s}$*
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 2. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case (maximum)	0.71	°C/W
$R_{thc\text{-}s}$	Thermal resistance case-sink (typical)	0.21	°C/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 °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
E_{AR}	Repetitive pulse avalanche energy (V_{DD} = 50 V, I_{AR} = 24 A, f = 100 KHz, T_J = 25 °C, duty cycle = 10%)	25	mJ
	Repetitive pulse avalanche energy (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

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

Table 4. Electrical characteristics (T_{amb} = 25 °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 V		100	nA
		V_{GS} = -20 V	-100		
		V_{GS} = 20 V, T_C = 125 °C		200	
		V_{GS} = -20 V, T_C = 125 °C	-200		
$V_{(BR)DSS}$ (1)	Drain-to-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	100		V
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 1 mA, T_C = -55 °C	2.3	5.2	V
		V_{DS} = V_{GS}, I_D = 1 mA	2.0	4.5	
		V_{DS} = V_{GS}, I_D = 1 mA, T_C = 125 °C	1.6	3.7	
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 12 V, I_D = 17 A		0.075	Ω
C_{iss}	Input capacitance	V_{DS} = 25 V, f = 1 MHz, V_{GS} = 0 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 V, I_D = 34 A, V_{GS} = 12 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 V, I_D = 17 A, R_G = 4.7 Ω, V_{GS} = 12 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 A, V_{GS} = 0 V		136	A
V_{SD} (4)	Forward on voltage	I_{SD} = 34 A, V_{GS} = 0 V		1.5	V
		I_{SD} = 34 A, V_{GS} = 0 V, T_c = 125 °C		1.25	V
t_{rr} (2)	Reverse recovery time	I_{SD} = 34 A, di/dt = 40 A/µs, V_{DD} = 12 V, TJ = 25 °C	276	414	ns

1. *This rating is guaranteed at T_J ≥ 25 °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 ≤ 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 V and V_{DS} = 0 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 °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 V	1.5	nA
		V_{GS} = -20 V	-1.5	
$V_{(BR)DSS}$	Drain-to-source breakdown voltage	V_{GS} = 0 V, 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} = 12 V, I_D = 17 A	-4% / +35%	Ω
Q_g	Total gate charge	V_{DS} = 50 V, I_G = 1 mA, V_{GS} = 12 V, I_{DS} = 34 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 V, I_{SD} = 34 A	±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

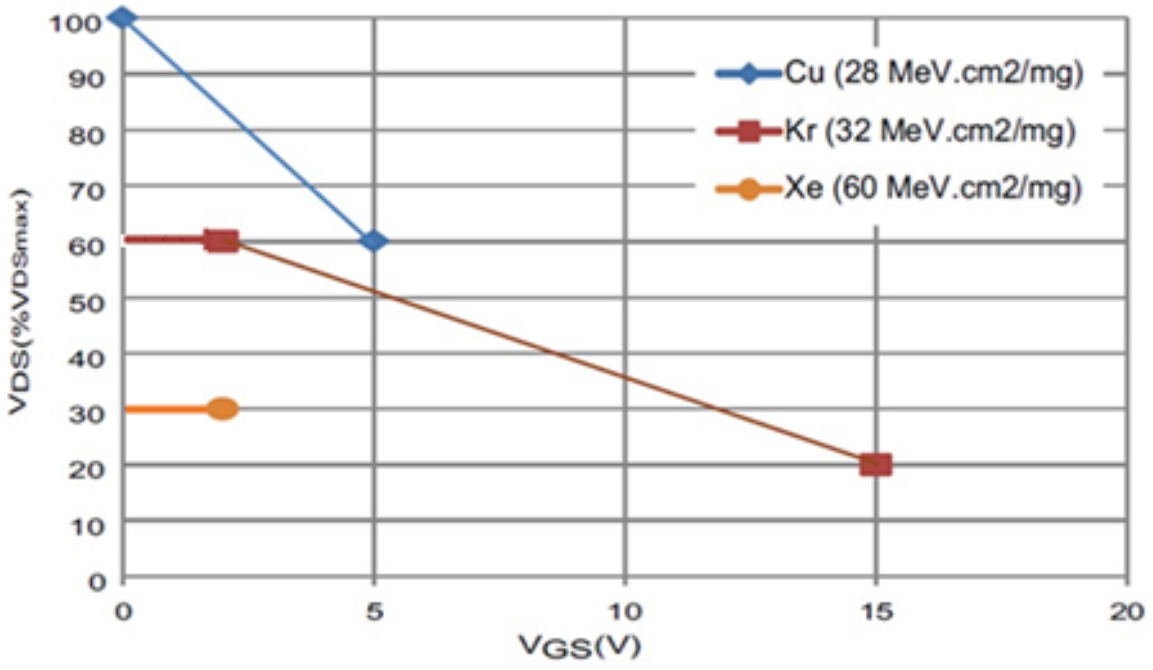
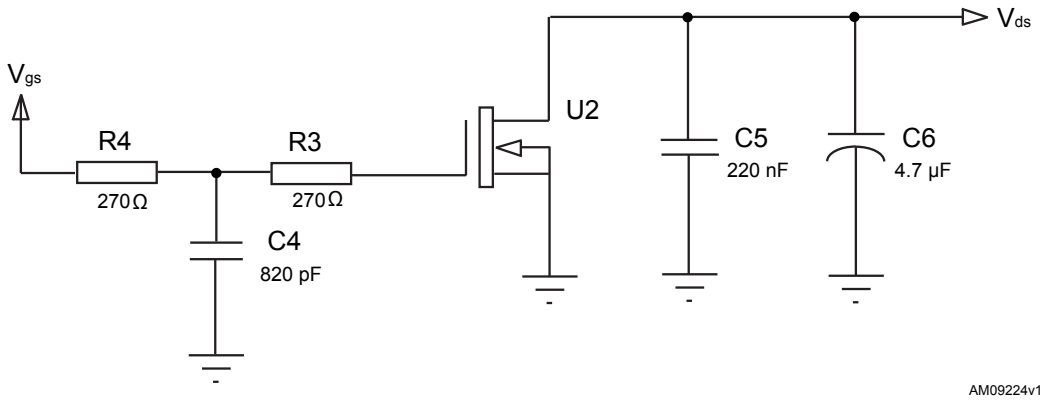


Figure 2. Single event effect, bias circuit



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

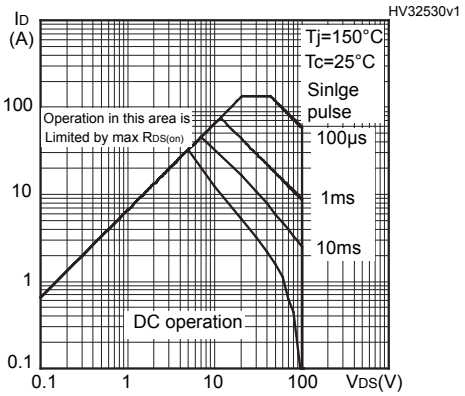


Figure 4. Thermal impedance

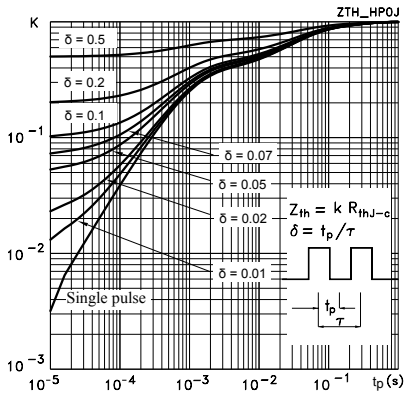


Figure 5. Output characteristics

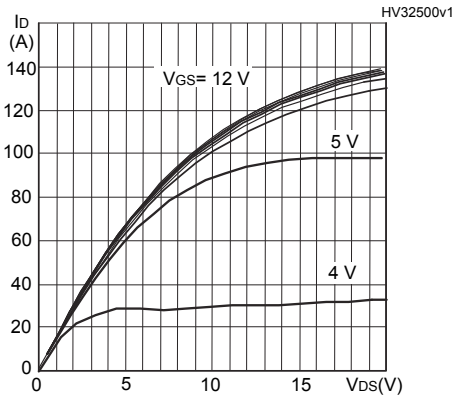


Figure 6. Transfer characteristics

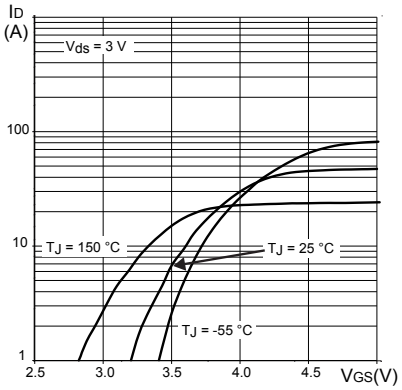


Figure 7. Gate charge vs gate-source voltage

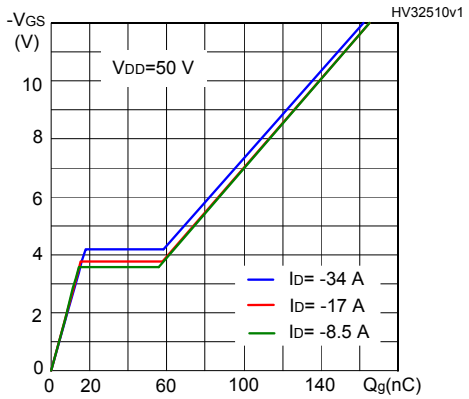


Figure 8. Capacitance variations

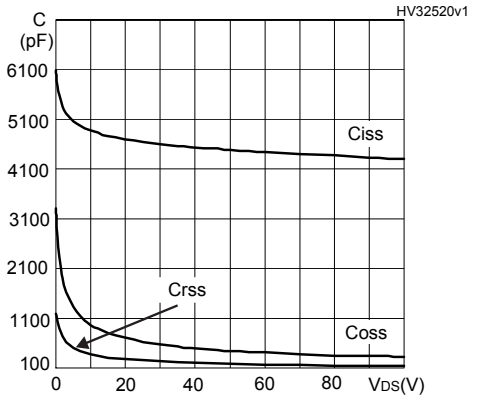


Figure 9. Normalized $V_{(BR)DSS}$ vs temperature

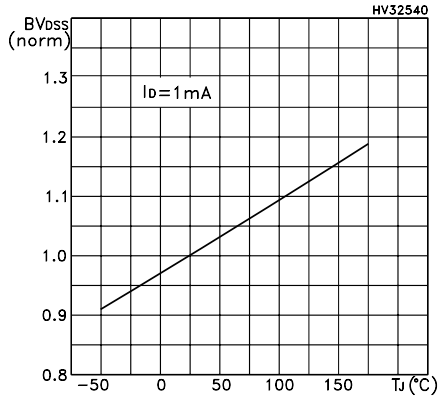


Figure 10. Static drain-source on-resistance

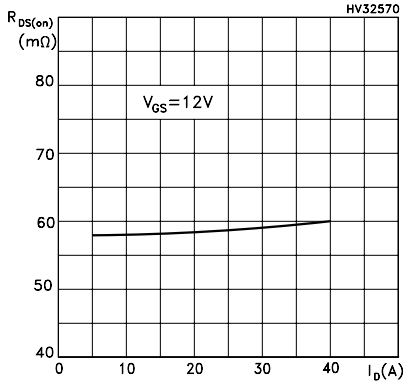


Figure 11. Normalized gate threshold voltage vs temperature

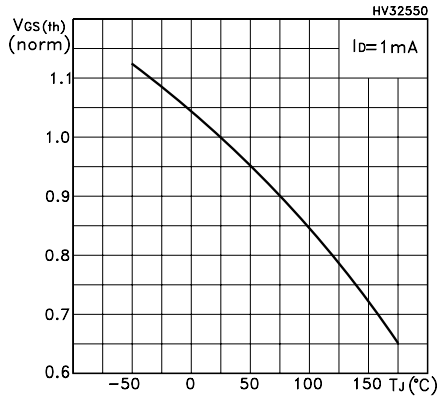


Figure 12. Normalized on-resistance vs temperature

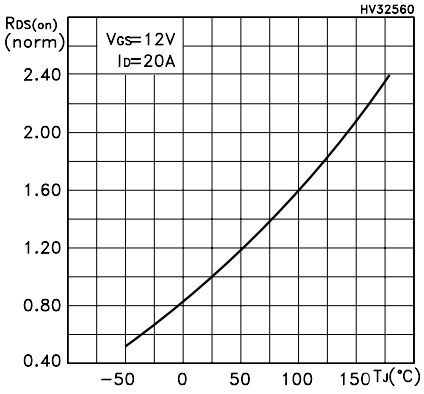
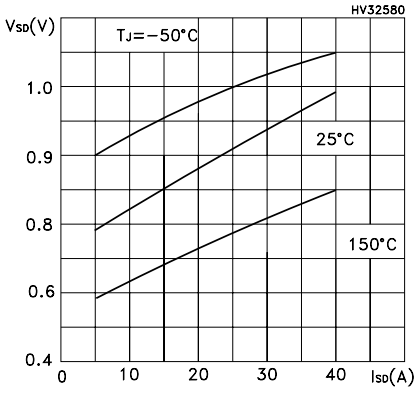
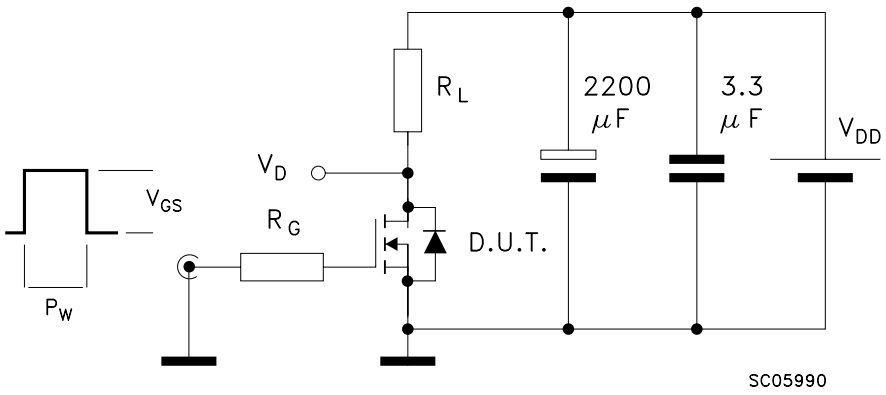


Figure 13. Source drain-diode forward characteristics



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**

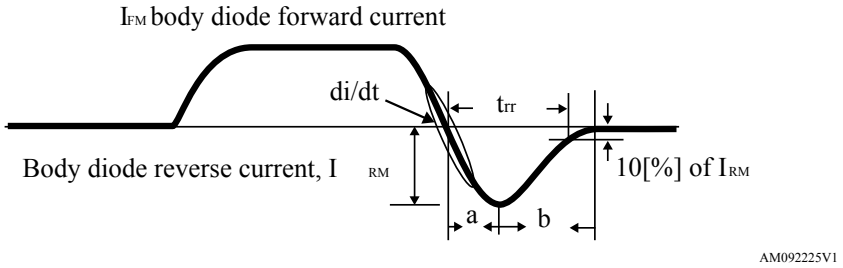
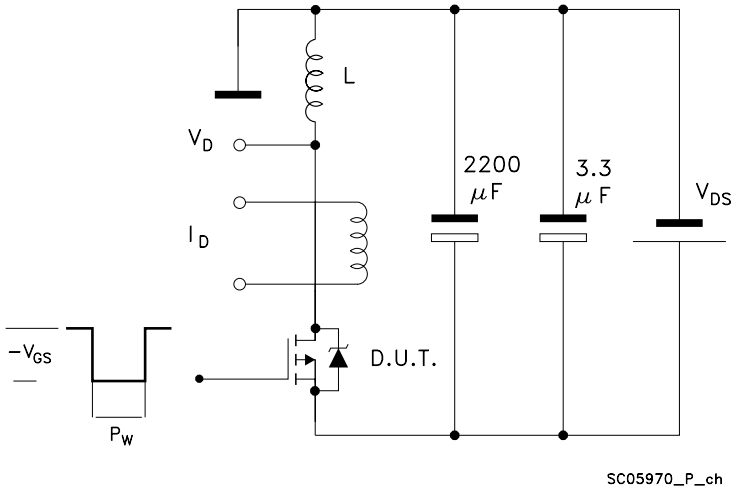


Figure 16. **Unclamped inductive load test circuit (single pulse and repetitive)**

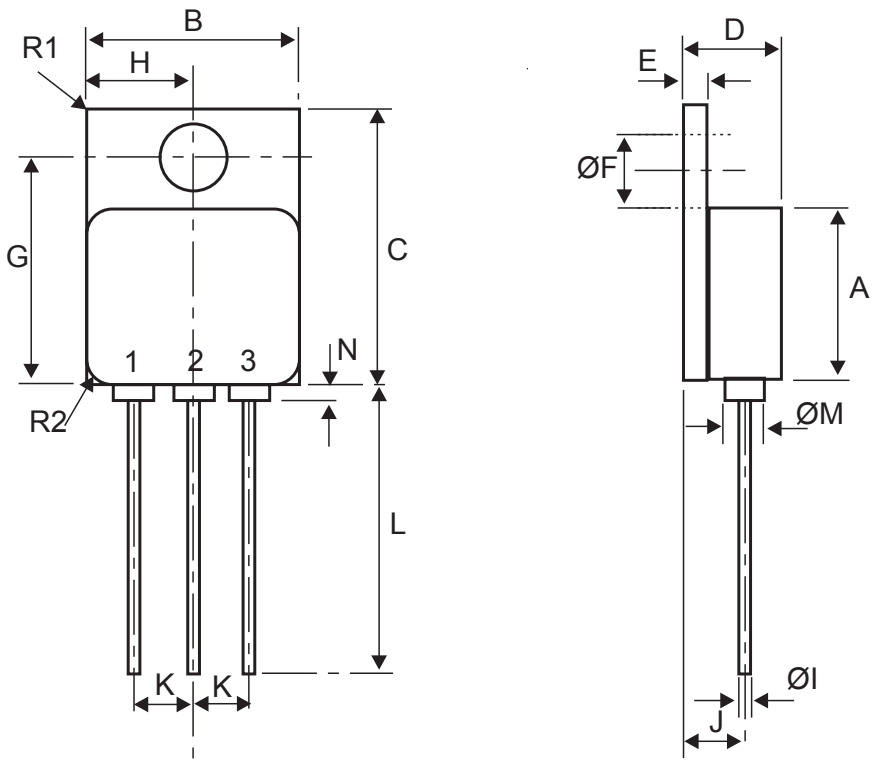


6 Package information

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: STlogo, 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 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	Modified: Description Minor text changes
12-Dec-2012	7	Updated features in cover page. Updated Table 5, Table 8, Table 9, Table 10, Table 11 and Table 15.
17-Dec-2012	8	Updated Table 8: Pre-irradation source drain diode. Minor text changes.
13-Jun-2013	9	Updated Table 7: Pre-irradation switching times and Table 8: Pre-irradation source drain diode. Minor text changes.
09-Sep-2013	10	Updated Table 1. Minor text changes.
27-Sep-2013	11	Updated IAR value in Table 4: Avalanche characteristics.
17-Dec-2013	12	Total dose radiation testing parameters changed in Section 3: Radiation characteristics.
25-Aug-2014	13	Updated Figure 7: Transfer characteristics.
19-Dec-2016	14	Updated Table 7: Pre-irradiation switching times and Table 8: Pre-irradiation source drain diode.
12-Jul-2019	15	Updated Table 4. Minor text changes.
30-Nov-2020	16	Updated Table 1, Table 4, Table 5, Table 6 and Table 8. Minor text changes.
15-Jun-2021	17	Updated Description and Figure 4.