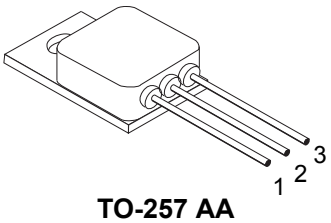
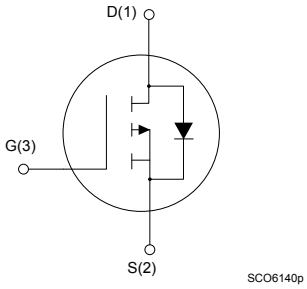
Rad-Hard 100 V, 12 A, P-channel Power MOSFET



TO-257 AA

The case is not connected to any lead



Features

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

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

Description

The STRH12P10 is a P-channel Power MOSFET able to operate under severe environment conditions and radiation exposure.

It provides high reliability performance and immunity to the total ionizing dose (TID) and single event effects (SEE).

Qualified as per ESCC detail specification No. 5205/029 and available in TO-257AA hermetic package, it is specifically recommended for space and harsh environment applications and suitable for in-Satellite power conversion, motor control and power switch circuits.

In case of discrepancies between this datasheet and the relevant agency specification, the latter takes precedence.

Product status link
STRH12P10

Device summary

Product summary					
Part numbers	Quality level	ESCC part number	Package	Lead finish	Radiation level
STRH12P10GY1	Engineering model	-	TO-257AA	Gold	-
STRH12P10GYG	ESCC flight	5205/029			100 krad
STRH12P10GYT				Solder dip	100 krad

Note: See Table 8 for ordering information.

1 Electrical ratings

T_C= 25 °C unless otherwise specified

Table 1. 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_{case} = 25 °C	12	A
	Drain current (continuous) at T_{case} = 100 °C	7.5	A
I_{DM}(2)	Drain current (pulsed)	48	A
P_{TOT}	Total power dissipation at T_{case} = 25 °C	75	W
dv/dt(3)	Peak diode recovery voltage slope	2.4	V/ns
T_{stg}	Storage temperature range	-55 to 150	°C
T_j	Max. operating junction temperature range	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} ≤ 12 A, di/dt ≤ 36 A/µs, V_{DD} = 80 %$V_{(BR)DSS}$.*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case max.	1.47	°C/W
$R_{thc\text{-}s}$	Thermal resistance case-sink typ.	0.20	°C/W

Table 3. 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) at 110 °C	112	mJ
E_{AR}	Repetitive pulse avalanche energy (V_{DS} = 50 V, I_{AR} = 6 A, f = 10 KHz, T_J = 25 °C, duty cycle = 50%)	17	mJ
	Repetitive pulse avalanche energy (V_{DS} = 50 V, I_{AR} = 6 A, f = 10 KHz, T_J = 110 °C, duty cycle = 50%)	5.5	mJ

1. *Maximum rating value.*

2 Electrical characteristics

For the P-channel MOSFET 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_{DS} = 80 V		10	µA
		V_{DS} = 80 V, T_C = 125 °C		100	
I_{GSS}	Gate body leakage current	V_{GS} = 16 V		100	nA
		V_{GS} = -16 V	-100		
		V_{GS} = 16 V, T_C = 125 °C		200	
		V_{GS} = -16 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	2.0	4.5	V
		V_{DS} = V_{GS}, I_D = 1 mA, T_C = 125 °C	1.6	3.8	
		V_{DS} = V_{GS}, I_D = 1 mA, T_C = -55 °C	2.2	5.2	
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 12 V, I_D = 12 A		0.30	Ω
		V_{GS} = 12 V, I_D = 12 A, T_C = 125 °C		0.6	
C_{iss} (2)	Input capacitance	V_{DS} = 25 V, f = 1 MHz, V_{GS} = 0 V	940	1410	pF
C_{oss} (2)	Output capacitance		135	205	pF
C_{rss} (2)	Reverse transfer capacitance		55	85	pF
Q_g	Total gate charge	V_{DD} = 50 V, I_D = 12 A, V_{GS} = 12 V	32	48	nC
Q_{gs}	Gate-to-source charge		3.5	6.5	nC
Q_{gd}	Gate-to-drain (“Miller”) charge		7	13	nC
$t_{d(on)}$	Turn-on delay time	V_{DD} = 50 V, I_D = 6 A, R_G = 4.7 Ω, V_{GS} = 12 V	5	15	ns
t_r	Rise time		7	31	ns
$t_{d(off)}$	Turn-off delay time		18	50	ns
t_f	Fall time		3.5	10.5	ns
V_{SD}	Forward on voltage	I_{SD} = 12 A, V_{GS} = 0 V		1.5	V
		I_{SD} = 12 A, V_{GS} = 0 V, T_C = 125 °C		1.25	
t_{rr}	Reverse recovery time	I_{SD} = 6 A, di/dt = 50 A/µs, V_{DD} = 50 V	178	310	ns

1. *This rating is guaranteed at T_J ≤ 25 °C (see Figure 9. Normalized $V_{(BR)DSS}$ vs temperature).*
2. *Not tested, guaranteed by process.*

3 Radiation characteristics

The STRH12P10 is guaranteed in radiation for single event effects (SEE) as per ESCC25100 and total ionizing dose (TID) as per ESCC 22900.

3.1 Total dose radiation (TID) testing

Each lot is tested in radiation and accepted according to the parameters of Table 5 at the following conditions.

- V_{GS} = - 15 V and V_{DS} = 0 V applied during irradiation exposure.
- 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	Min.	Max.	Unit
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 80 V		10	µA
I_{GSS}	Gate body leakage current	V_{GS} = 16 V		100	nA
		V_{GS} = -16 V	-100		
$V_{(BR)DSS}$	Drain-to-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	80		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		0.3	Ω
V_{SD} (1)	Forward on voltage	V_{GS} = 0 V, I_{SD} = 12 A		1.5	V

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

3.2 Single event effect SOA

Single event burnout (SEB) and single event gate rupture (SEGR) are performed according to MIL-STD-750E, method 1080, using bias circuit shown in Figure 2. Single event effect, bias circuit, at the following conditions.

- Fluence of 3e+5 ions/cm
- 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. The test is halted as soon as the gate current reaches 100 nA during irradiation or during post irradiation gate stress (PIGS) or if the fluence reaches 3e+5 ions/cm².

Table 6. Single event effect (SEE), safe operating area (SOA)

Ion	Let (Mev/(mg/cm²))	Energy (MeV)	Range (µm)
Kr	32	768	94
		756	92
Cu	28	285	43
Xe	60	1217	89

Figure 1. Single event effect, SOA

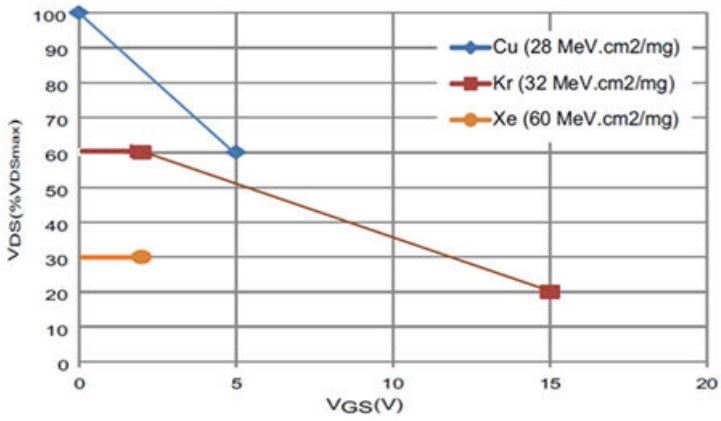
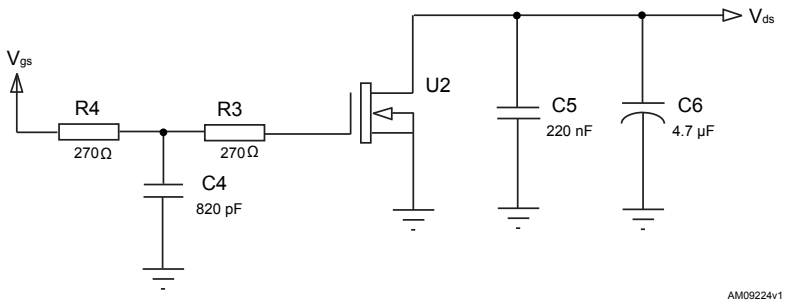


Figure 2. Single event effect, bias circuit



4 Electrical characteristics (curves)

Figure 3. Safe operating area

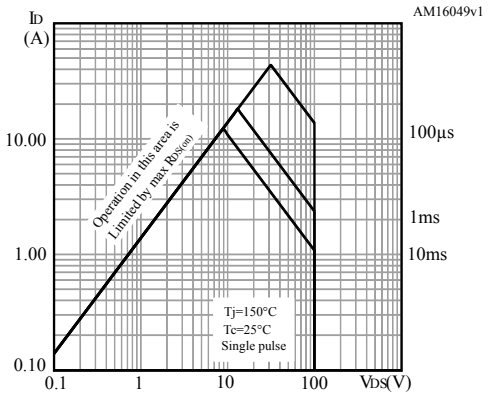


Figure 4. Thermal impedance

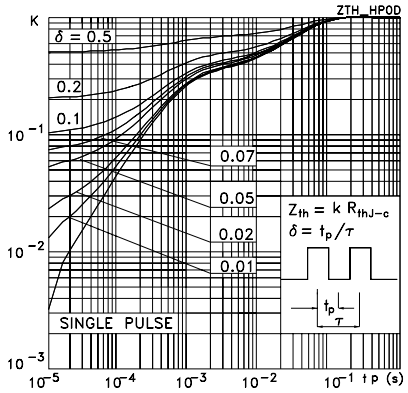


Figure 5. Output characteristics

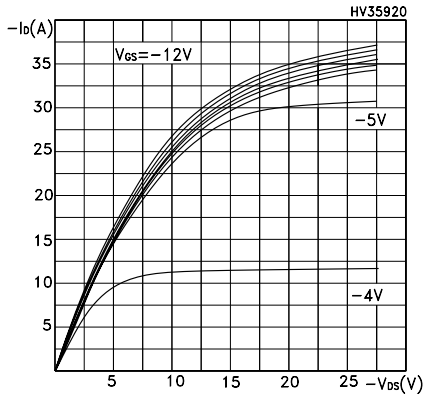


Figure 6. Transfer characteristics

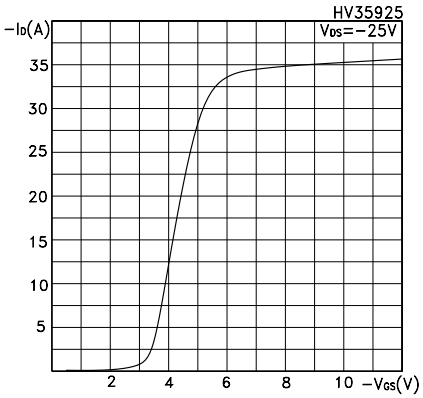


Figure 7. Gate charge vs gate-source voltage

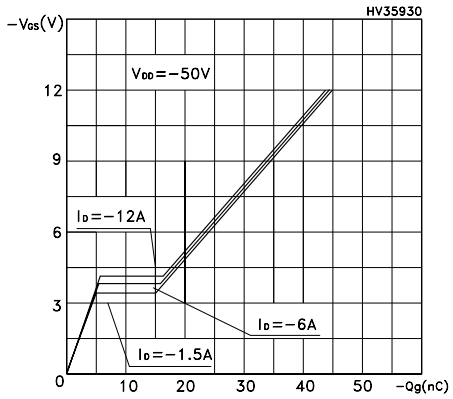


Figure 8. Capacitance variations

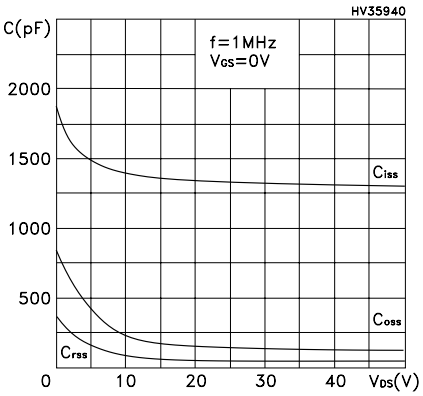


Figure 9. Normalized $V_{(BR)DSS}$ vs temperature

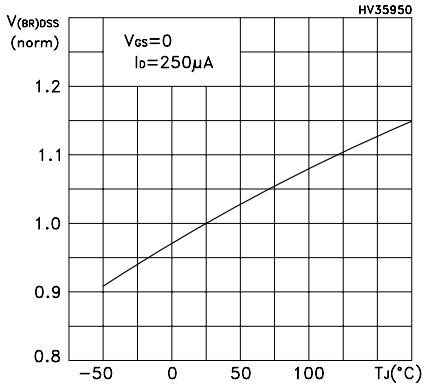


Figure 10. Static drain-source on-resistance

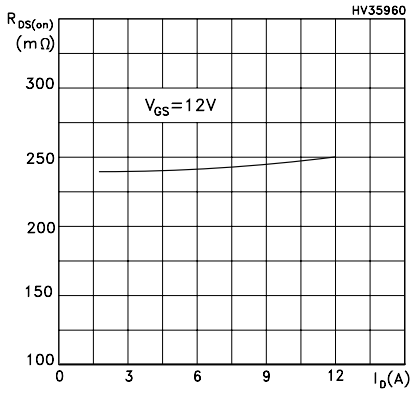


Figure 11. Normalized gate threshold voltage vs temperature

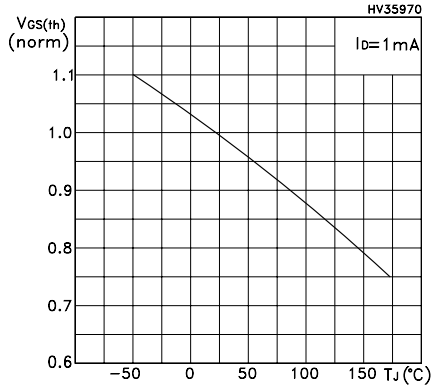


Figure 12. Normalized on-resistance vs temperature

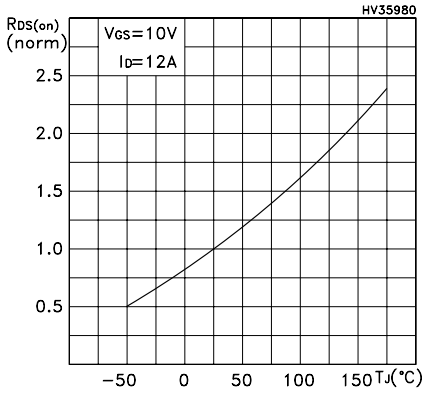
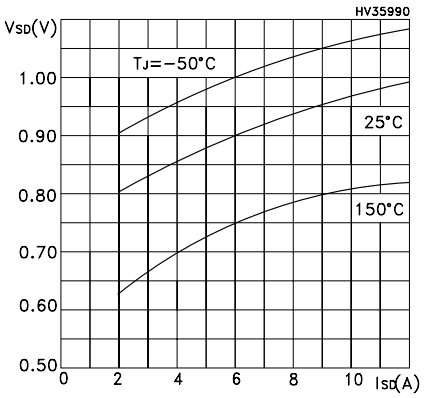
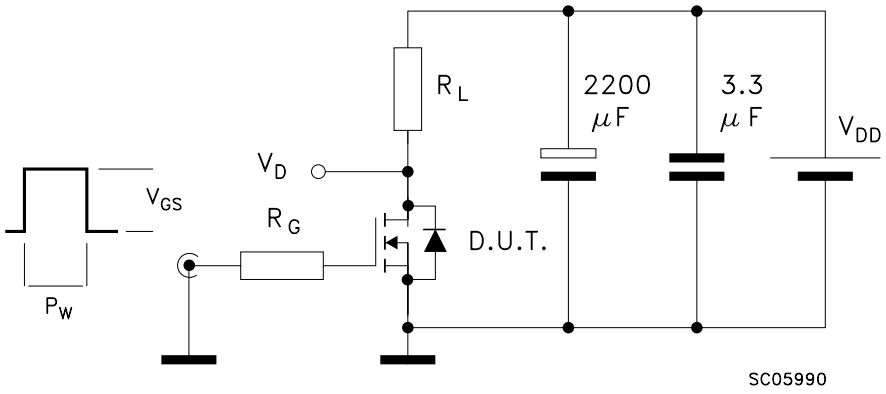


Figure 13. Source drain-diode forward characteristics



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**

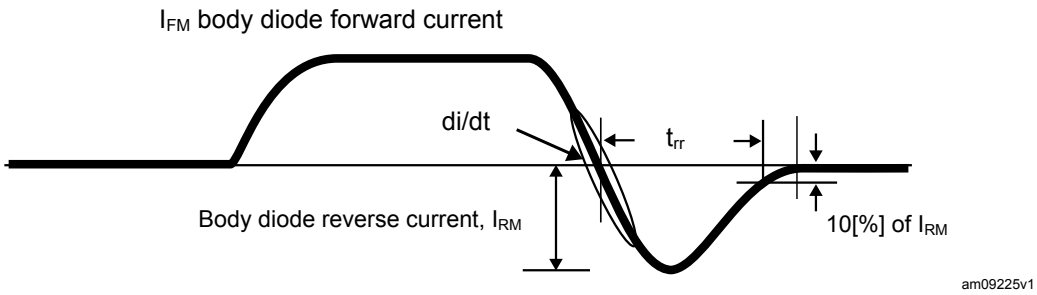
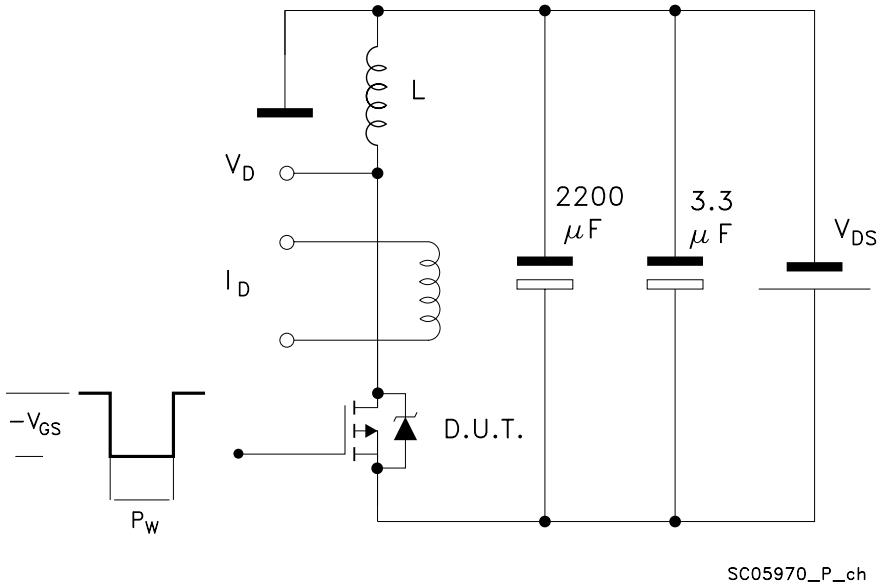


Figure 16. **Unclamped inductive load test circuit (single pulse and repetitive)**



6 Package information

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-257AA package information

Figure 17. TO-257AA package outline

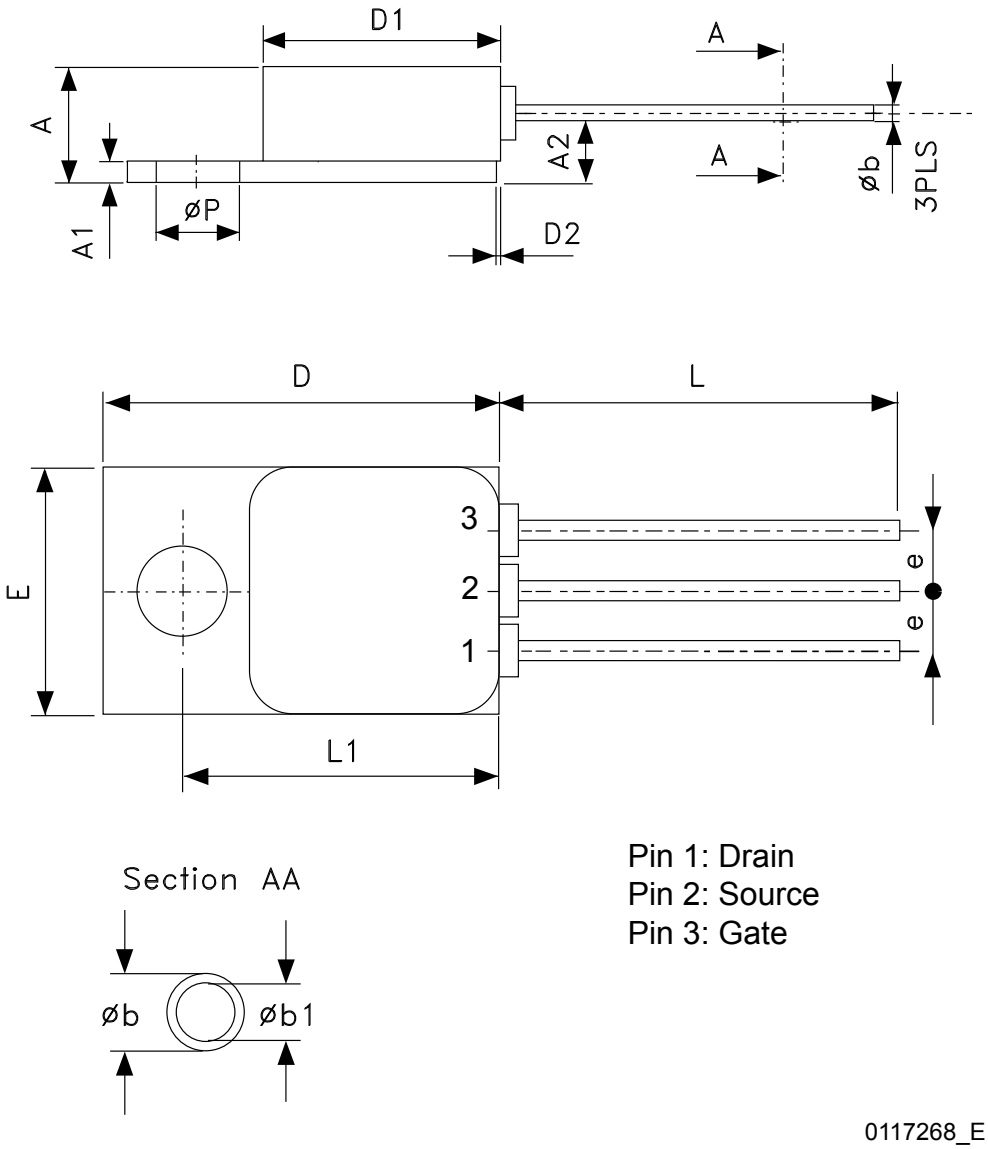


Table 7. **TO-257AA package mechanical data**

Symbols	Dimensions (mm)			Dimensions (inches)		
	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	15.24		16.51	0.600		0.650
L1	13.39		13.64	0.527		0.537
P	3.56		3.81	0.140		0.150

Note: The case is not connected to any lead.

7 Order codes

Table 8. Ordering information

Part number	Agency specification	Screening option	Radiation level	Package	Weight	Lead finish	Marking[1]	Packing
STRH12P10GY1		Engineering model	-	TO-257AA	5 g	Gold	STRH12P10GY1 + BeO	Strip pack
STRH12P10GYG	5205/029/01	ESCC flight	100 krad				520502901R + BeO	
STRH12P10GYT	5205/029/02		100 krad			Solder dip	520502902R + 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 the specific conditions for products in die form.

8 Other information

Table 9. Traceability and documentation

Screening type	Date code[1]	Radiation level	Documentation
Engineering model	3yywwN	-	Certificate of conformance
Flight model	yywwN	100 krad	Certificate of conformance ESCC qualification maintenance lot reference Radiation verification test (RVT) report at 25/50 /70/100 krad at 0.1 rad/s.

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

Revision history

Table 10. **Document revision history**

Date	Version	Changes
07-Oct-2011	1	First release.
24-Jun-2013	2	Document status promoted form preliminary data to production data. – Modified: *Figure 1* – Modified: EAS, EAR parameter and values in *Table 4* – Modified: IGSS, and added note 1 in *Table 5* – Added: note 1 in *Table 6* – Modified: trr, qrr and IRRM parameter in *Table 8* – Modified: RDS(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*.
19-Jan-2015	5	– Updated *Table 13.: TO-257AA mechanical data* – Minor text changes
02-May-2019	6	Updated *Table 7. Pre-irradiation source drain diode* and *Table 4. Preirradiation on/off states*. Minor text changes
29-Feb-2020	7	Updated *Table 10* and *TO-257 AA package information*.
21-Jan-2021	8	Updated *Product summary*, *Table 4*, *Table 5*, *Table 6*, *Figure 1*, *Table 8* and *Table 10*.
05-May-2022	9	Updated *features* in cover page. Updated *Table 4. Electrical characteristics (Tamb = 25 °C unless otherwise specified)*, *Section 3 Radiation characteristics*, *Section 3.1 Total dose radiation (TID) testing*, *Section 3.2 Single event effect RBSOA* and *Traceability information*. Minor text changes.
15-Oct-2024	10	Updated Table 4, and Table 5.