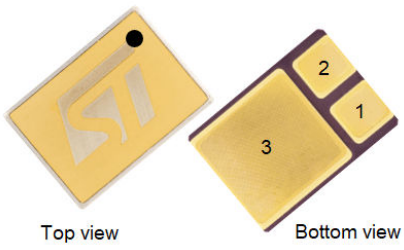
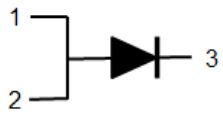
STTH60400HR

Datasheet

Rad-Hard 60 A - 400 V ultrafast rectifier



SMD1



Terminals 1 and 2: Anode
Terminals 3: cathode

Product status link
STTH60400HR

Product summary	
$I_{F(AV)}$	60 A
V_{RRM}	400 V
T_j(max)	175 °C
$V_{F(max)}$ at 60 A / 125 °C	1.15 V

Features

- Forward current: 60 A
- Repetitive peak reverse voltage: 400 V
- Low forward voltage drop: 1.15 V max. at 60 A and 125 °C
- Negligible switching losses
- High surge current capability: 500 A
- Ceramic hermetic package
- Tested radiation performance
  - TID: 1 Mrad(Si) high dose rate
  - SEE: no burn out at 60 MeV.cm²/mg
- ESCC qualified : detail specification 5103/032

Application

- Satellite and spacecraft power systems
- Switch mode power supply
- High voltage DC-DC converter output rectification
- Reverse polarity protection
- Redundancy OR-Ing power bus diode
- DC motor chopper or inverter free wheeling diode

Description

The STTH60400HR is a single monolithic rectifier assembled in an SMD1 hermetic package and tested in total dose at high dose rate and in single event effect to be used in Rad-Hard applications.

Its full planar technology allows superior performances and high reliability up to 175 °C junction temperature.

This diode is ESCC qualified, which makes it eligible for use in space programs. It is typically used in high frequency DC-to-DC converters or high voltage step-down regulator where it performs secondary rectification, redundancy OR-Ing, free wheeling diode or reverse polarity protection.

1 Characteristics

1.1 Absolute maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter		Value	Unit
V_{RRM}	Repetitive peak reverse voltage		400	V
V_{RWM}	Peak working reverse voltage		400	V
I_O (1)	Average output rectified current		60	A
I_{FSM} (2)	Forward surge current	t_p = 10 ms sinusoidal	500	A
T_{OP}	Operating temperature range (case temperature)		-65 to +175	°C
T_{stg}	Storage temperature range		-65 to +175	°C
T_{sol} (3)	Soldering temperature		+245	°C

1. *At $T_j \geq +29.2$ °C, derate linearly to 0 A at +175 °C.*
2. *At $T_{amb} \leq +25$ °C*
3. *Duration 5 seconds maximum with at least 3 minutes between consecutive temperature peaks.*

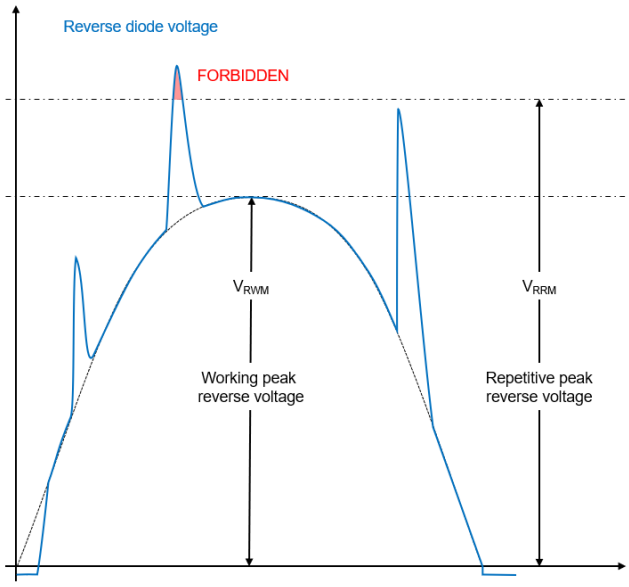
1.2 Thermal parameters

Table 2. Thermal parameters

Symbol	Parameter	Value	Unit
$R_{th(j-c)}$ (1)	Thermal resistance, junction to case	1.8	°C/W
$R_{th(j-a)}$	Thermal resistance, junction to ambient	55	°C/W

1. *Package mounted on infinite heatsink.*

Figure 1. V_{RRM} and V_{RWM} definition with their waveform



1.3 Electrical characteristics

Limiting value per diode unless otherwise specified.

Table 3. Static electrical characteristics

Symbol	Parameter	MIL-STD-750 test method	Test conditions[1]		Min.	Max.	Unit
I_R	Reverse leakage current	4016	DC method, V_R = 400 V	T_j = 25 °C	-	20	µA
				T_j = 125 °C	-	200	
V_F [2]	Forward voltage drop	4011	I_F = 60 A	T_j = -55 °C	-	1.35	V
				T_j = 25 °C	-	1.30	
				T_j = 125 °C	-	1.15	

1. *Test performed with both anode terminals 2 and 3 tied together*
2. *Pulse width ≤ 680 µs, duty cycle ≤ 2%*

Table 4. Dynamic electrical characteristics

Symbol	Parameter	MIL-STD-750 test method	Test conditions		Min.	Typ.	Max.	Unit
C[1]	Junction capacitance	4001	T_j = 25 °C	V_R = 10 V, F = 1 MHz	-		250	pF
t_{rr}	Reverse recovery time	4031	T_j = 25 °C	I_F = 1 A, dIF/dt = -50 A/µs, V_R = 30 V	-		80	ns
t_{fr}[2]	Forward recovery time	4026	T_j = 25 °C	I_F = 60 A, V_{FR} = 2 V, dIF/dt = 100 A/µs	-	690		ns
V_{FP}	Forward recovery voltage	4026	T_j = 25 °C	I_F = 60 A, V_{FR} = 2 V, dIF/dt = 100 A/µs	-	3		V
I_{RM}	Reverse recovery current	4031	T_j = 125 °C	I_F = 20 A, dIF/dt = -200 A/µs, V_R = 160 V	-	19		A
Q_{RR}	Reverse recovery charges	4031			-	1400		nC
S_{factor}	Softness factor	4031			-	0.3		

1. *By default, guaranteed by sampling. Guaranteed by a 100% test in case the sampling acceptance criteria is not met.*
2. *Dynamic characteristics (t_{rr}, t_{fr}, V_{fr}, I_{RM}, S_{factor} and Q_{rr}) are guaranteed by design and characterization. They are not tested in production.*

For more information, please refer to the following application notes related to the power losses:

- AN604: Calculation of conduction losses in a power rectifier
- AN4021: Calculation of reverse losses in a power diode

1.4 Characteristics (curves)

Figure 2. Average forward power dissipation versus average forward current

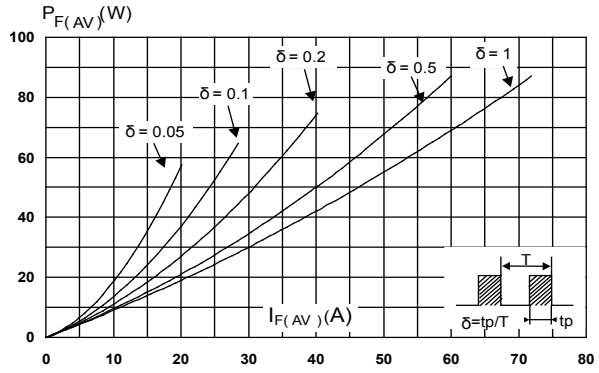


Figure 3. Forward voltage drop versus forward current (typical values)

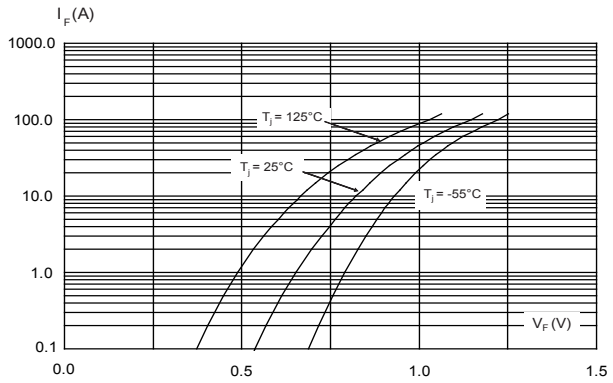


Figure 4. Forward voltage drop versus forward current (maximum values)

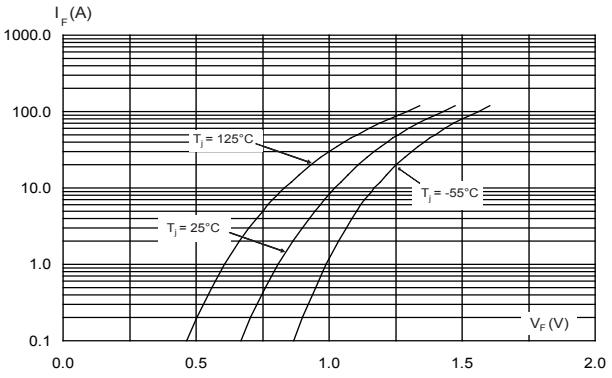


Figure 5. Relative variation of thermal impedance junction to case versus square pulse duration

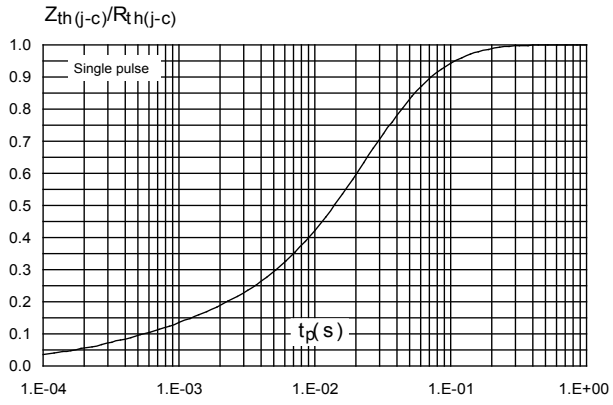


Figure 6. Peak reverse recovery current versus dI_F/dt (typical values)

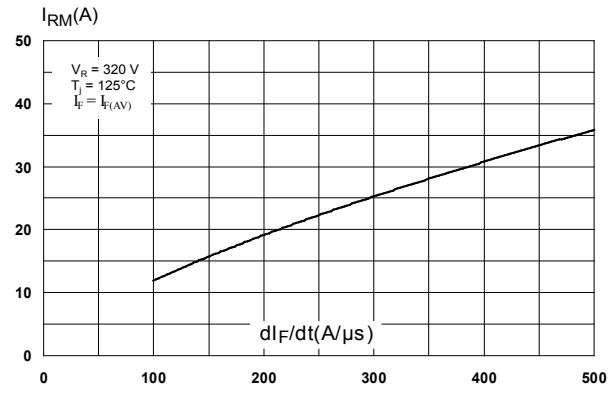


Figure 7. Reverse recovery time versus dI_F/dt (typical values)

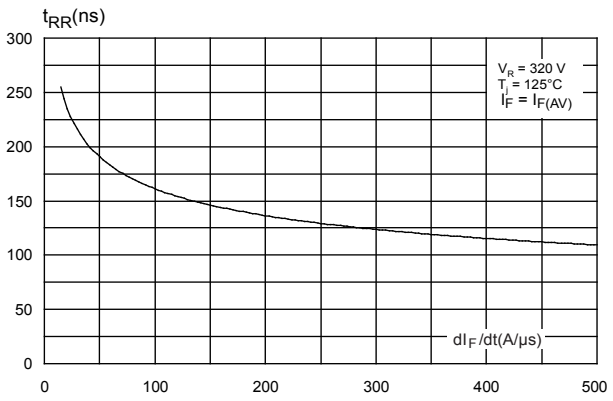


Figure 8. Reverse recovery charges versus dI_F/dt (typical values)

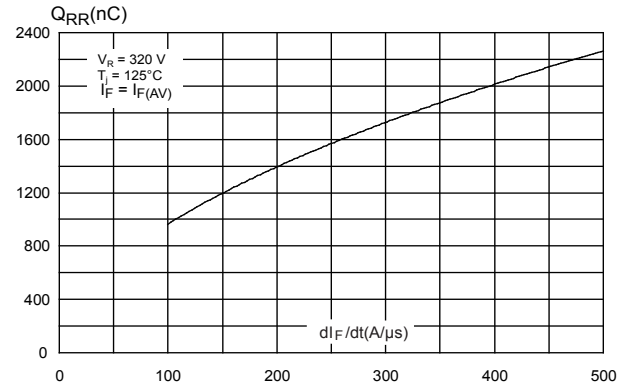


Figure 9. Reverse recovery softness factor versus dI_F/dt (typical values)

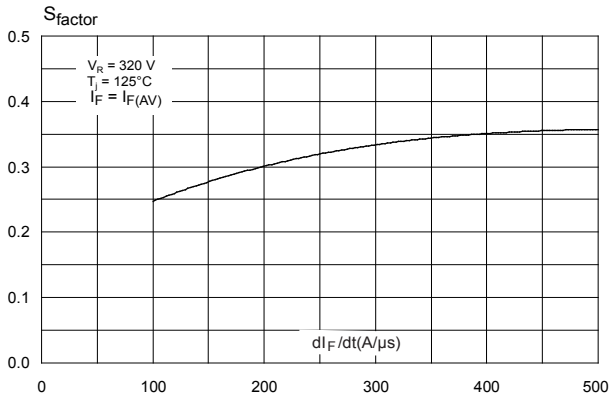


Figure 10. Relative variations of dynamic parameters versus junction temperature

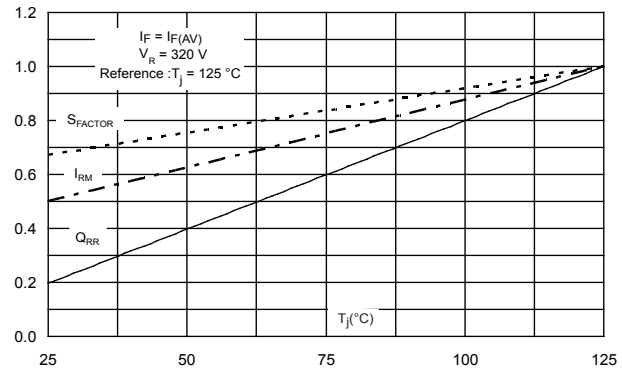


Figure 11. Transient peak forward voltage versus dIF/dt (typical values)

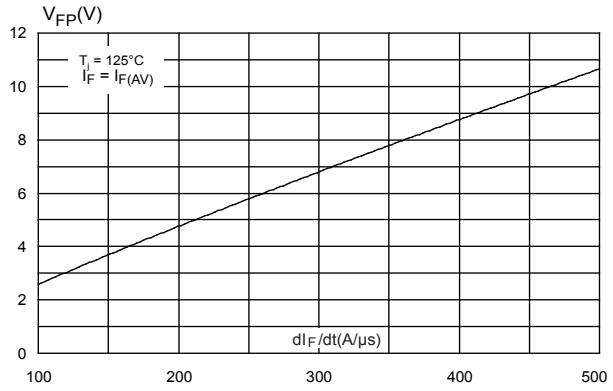


Figure 12. Forward recovery time versus dI_F/dt (typical values)

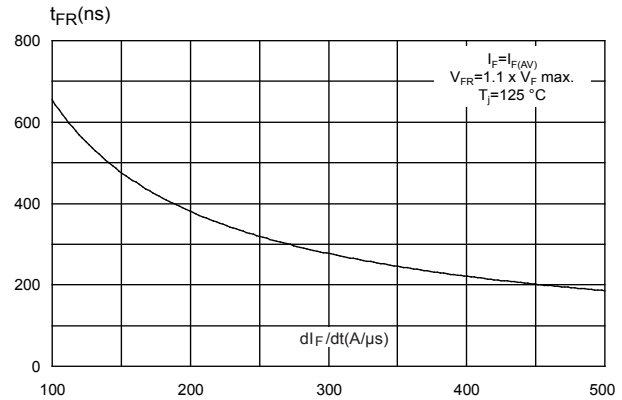
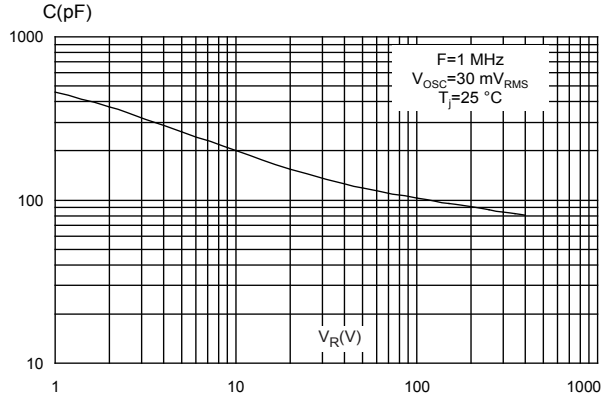


Figure 13. Junction capacitance versus applied reverse voltage (typical values)



2 Radiation

The technology of the STMicroelectronics Rad-Hard rectifier's diodes is intrinsically highly resistant to radiative environments. For further information refer the ECSS-Q-ST-60-15C1 Radiation hardness assurance standard.

The product radiation hardness assurance is supported by a total ionisation dose (TID) characterization, at high dose rate, and a single effect event (SEE) characterization during the product development.

2.1 Total ionisation dose

The total ionizing dose tests relevant to power rectifier are done at high dose rate on 10 parts housed in SMD1, 5 biased and 5 unbiased.

The irradiation is done according to the ESCC 22900 specification, standard window.

Both pre-irradiation and post-irradiation performances are tested using the same circuitry and test conditions for a direct comparison can be done (T_{amb} = 22 ±3 °C unless otherwise specified).

The following parameters are measured :

- Before irradiation
- After irradiation (target 3 Mrad(Si))
- After 24 hrs at room temperature
- After 168-hour of annealing at 100 °C

2.2 Single event effect

The single event effect (SEE) relevant to power rectifiers are characterized, i.e. the single event burnout (SEB).

The tests are performed as per ESCC 25100, each one on 3 pieces from 1 wafer at room temperature.

The accept/reject criteria are :

- SEB (destructive mode):
  The diode is reverse biased during irradiation. The test is stopped as soon as a SEB occurs or when the reverse leakage current is above the specification or when the overall fluence on the component reaches 1E7 heavy ion / cm².
- PIST (post-irradiation stress) test:
  After the irradiation, a stress is applied to the diode in order to reveal any latent damage on the irradiated devices.
  The reverse voltage value is increased from 0 V to 100% of V_{RRM} and then decreased from 100% of the V_{RRM} to 0 V. At each step, the reverse leakage current value is measured.

Table 5. Radiation hardness assurance summary

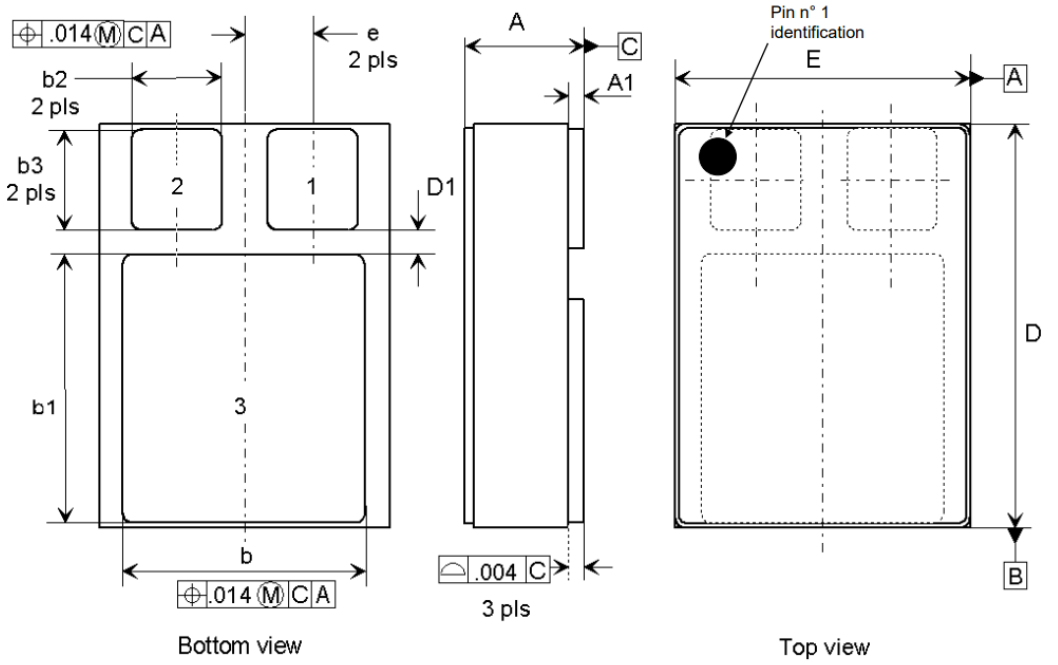
Type	Conditions	Result
Total ionisation dose	High dose rate 5 biased + 5 unbiased	Immune up to 3 Mrad(Si)
Single Effect Burnout	LET= 60 MeV.cm²/mg V_{cc}: 100% x V_{RRM}	No burnout

3 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.

3.1 SMD1 package information

Figure 14. **SMD1 package outline**



Ref POA 7449118 v7.0

Table 6. **SMD1 package mechanical data**

Symbols	Dimansions (mm)		
	Min.	Typ.	Max.
A	3.3		3.61
A1	0.25		0.51
b	9.4		9.65
b1	10.41		10.67
b2	3.43		3.68
b3	3.86		4.11
D	15.75		16
D1	0.76		
E	11.3		11.56
e		2.67 BSC	

4 Ordering information

Table 7. **Ordering information**

Order code	ESCC detailed specification	Quality level	Package	Lead finishing	Product marking	Mass	Base qty	Packing
STTH60400SA1	-	Engineering model	SMD1	Gold	STTH60400SA1	1.84g	1	Strip pack
STTH60400SAG	5103/032/01	Flight model			510303201			
STTH60400SAT	5103/032/02	Flight model		Solder dip	510303202			

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

5 Other information

5.1 Product marking and traceability

Figure 15. **Product marking outline, flight model top view**

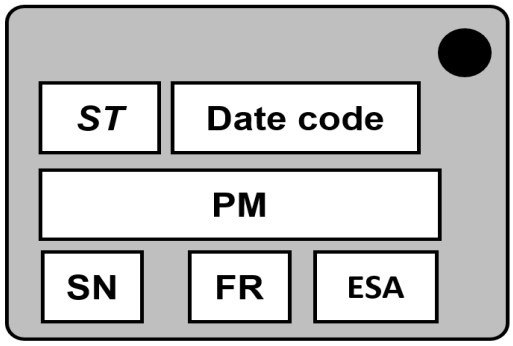


Figure 16. **Product marking outline, engineering model top view**

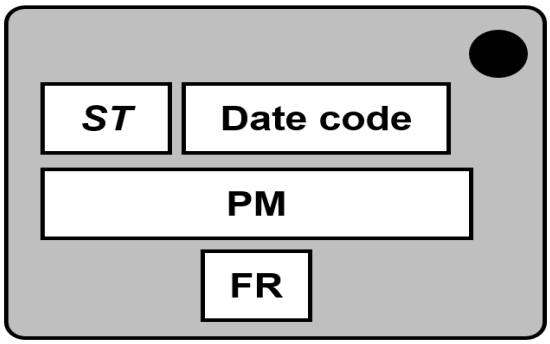


Table 8. **Product marking description**

Field	Model	Description
ST	Engineering and flight	Standard ST logo
PM	Engineering	Product part number
	Flight	ESCC part number
Date code	Engineering	3yywwN(1)
	Flight	yywwN(2)
SN	Flight	Serialization number
ESA	Flight	ESA logo
FR	Engineering and flight	Country of origin

1. *yy= year ; ww = week ; N = alfa-numeric digit for lot of week; 3 = EM type*
2. *yy= year ; ww = week ; N = alfa-numeric digit for lot of week*

Note: Black dot marks terminal 1 position underneath.

5.2 Packing information

Figure 17. **Strip pack view, label side**

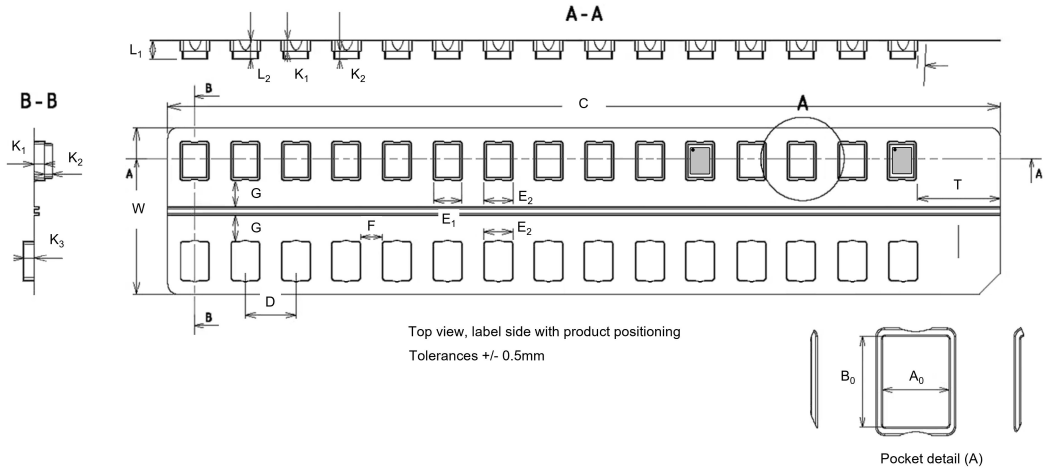


Table 9. **Strip pack dimension data**

Strip pack typical dimension (mm)														
A0	B0	C	D	E1	E2	F	G	K1	K2	K3	L1	L2	T	W
11.70	16.10	400.00	24.30	13.50	14.00	10.30	12.50	5.00	3.80	5.00	9.10	8.80	40.00	80.00

5.3 Documentation

In the Table 10 is a summary of the documentation provided with each type of products. Further quality information on engineering model product is also available in the technical note TN1181.

Table 10. Documentation provided for each type of product

Quality level	Documentation
Engineering model	Certificate of conformance including : • Customer name • Customer purchase order number • ST sales order number and item • ST commercial product code • Quantity delivered • Date code • Reference data sheet • Reference to TN1181 on engineering models • ST Rennes assembly lot ID number
Flight model	Certificate of conformance including : • Customer name • Customer purchase order number • ST sales order number and item • ST commercial product code • Quantity delivered • Date code • Serial numbers • Wafer diffusion plant location and wafer size • Wafer diffusion lot ID number and wafer ID number • Reference of the applicable ESCC qualification maintenance lot • Reference to the ESCC detail specification • ST Rennes assembly lot ID number

Revision history

Table 11. **Document revision history**

Date	Revision	Changes
07-Mar-2017	1	First issue.
21-Jul-2017	2	Updated Table 2: "Absolute ratings" and Table 5: "Dynamic electrical characteristics". Added Section 1.1: "Characteristics (curves)".
03-Jun-2020	3	Updated Section Product status / summary and Table 7. Minor text changed.
14-Apr-2023	4	Updated Features, Table 1, Section 2.1 Total ionisation dose, Section 2.2 Single event effect, Figure 14, Table 7, and Section 5.3 Documentation. Added Applications, Figure 1. V_{RRM} and V_{RWM} definition with their waveform, and Section 5.2 Packing information.