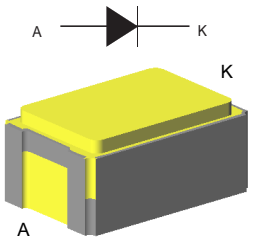
Aerospace 150 V, 6 A ultrafast rectifier in LCC-2B package



Leadless chip carrier 2 (LCC-2B)

Features

- Low forward voltage: V_F = 0.95 V at 6 A and +125 °C
- Very small conduction losses
- Ultrafast switchings, t_{rr} = 35 ns at -50 A/µs and T_j = 25 °C
- High thermal conductivity materials
- Surface mount hermetic package
- Radiation performance
  - 3 Mrad (Si) high dose rate
- ESCC qualified: detail specification 5101/013

Applications

- Satellite and spacecraft power systems
- Switch mode power supply
- Flyback or forward converter output rectification
- Free wheeling diode for DC motor chopper or 3-phase motor inverter
- Reverse polarity protection

Product status link
1N5811U

Product summary	
$I_{F(AV)}$	6 A
V_{RRM}	150 V
V_F(max.)	0.95 V
T_J(max.)	175 °C

Description

The 1N5811 is an ultrafast rectifier housed in the ceramic LCC-2B package. This surface mount package is hermetically sealed, and its footprint is fully compatible with industry standards, as such the D5B.

The 1N5811 rectifier is characterized in total ionizing dose at high dose rate 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 switching mode power supplies, high frequency DC-to-DC converters or low voltage step-down chopper drive to perform secondary rectification, free wheeling diode or reverse polarity protection.

1 Characteristics

Table 1. Absolute ratings (limiting values)

Symbol	Parameter		Value	Unit
V_{RRM}	Repetitive peak reverse voltage		150	V
V_{RWM} (1)	Peak working reverse voltage		150	V
$I_{F(RMS)}$	RMS forward current		10	A
$I_{F(AV)}$	Average forward current	$T_C \geq 136$ °C, $\delta = 0.5$	6	A
I_{FSM}	Non repetitive surge forward current(2)	t_p = 8.3 ms sinusoidal	105	A
		t_p = 10 ms sinusoidal	100	
T_{stg}	Storage temperature range		-65 to +175	°C
T_{op}	Operating temperature range (case temperature)		-65 to +175	°C
T_j	Maximum operating junction temperature		175	°C
T_{sol}	Maximum soldering temperature(3)		245	°C
ESD	Electro static discharge, air discharge, HBM model, class 3B		8	kV

1. *See Figure 1.*
2. *T_{amb} initial = 25°C*
3. *Maximum duration 5 s. The same package cannot be re-soldered until 3 minutes have elapsed after initial soldering.*

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

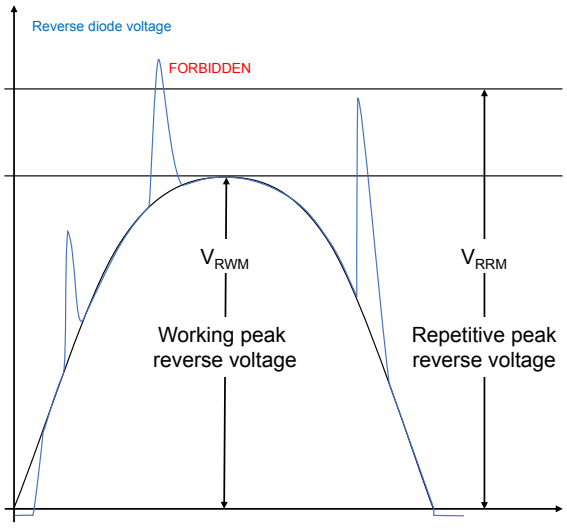


Table 2. Thermal parameters

Symbol	Parameter	Max. value	Unit
$R_{th(j-c)}$	Junction to case (DC) , mounted on infinite heat sink	6.5	°C/W

For more information, please refer to the application note:

- AN5088: Rectifiers thermal management, handling and mounting recommendation

Table 3. Static electrical characteristics

Symbol	Parameter	Test conditions		Max.	Unit
I_{RR} (1)	Reverse leakage current	T_j = -65 °C	V_R = 160 V	10	µA
		T_j = 25 °C		10	
		T_j = 25 °C	$V_R = V_{RWM}$	2	
		T_j = 125 °C		30	
V_F (2)	Forward voltage drop	T_j = 25 °C	I_F = 3 A	0.865	V
		T_j = -65 °C	I_F = 4 A	1.075	
		T_j = 25 °C		0.9	
		T_j = 125 °C		0.8	
		T_j = 25 °C	I_F = 6 A	0.955	

1. *Pulse test: t_p = 5 ms, δ < 2%, δ = duty cycle*
2. *Pulse test: t_p = 680 µs, δ < 2%*

Table 4. Dynamic characteristics

Symbol	Parameter	Test conditions		Max.	Unit
t_{RR}	Reverse recovery time	$I_F = I_R$ = 0.5 A, I_{RR} = 0.1 A, dI_F/dt = -100A/µs	T_j = 25 °C	30	ns
		I_F = 1 A, dI_F/dt = -50 A/µs, V_R = 30 V		35	
C_j	Total diode capacitance	V_R = 10 V, F = 1 MHz	T_j = 25 °C	60	pF
V_{FP}	Forward recovery voltage	I_F = 0.5 A	T_j = 25 °C	2.2	V
t_{FR}	Forward recovery time	I_F = 0.5 A, V_{FR} = 1.1 x V_F	T_j = 25 °C	15	ns

To evaluate the conduction losses, use the following equation:

$P = 0.68 \times I_{F(AV)} + 0.03 \times I_F{}^2{}_{(RMS)}$

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 on a power diode

1.1 Characteristics (curves)

Figure 2. Forward voltage drop versus forward current (typical values)

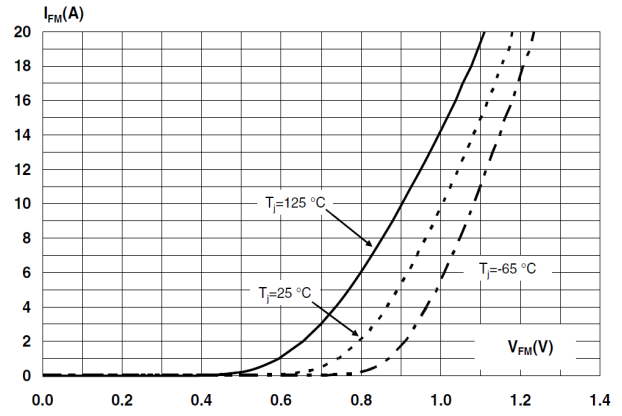


Figure 3. Forward voltage drop versus forward current (maximum values)

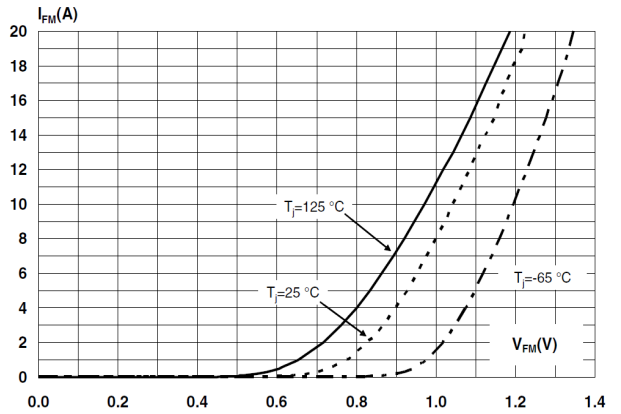


Figure 4. Reverse leakage current versus reverse voltage applied (typical values)

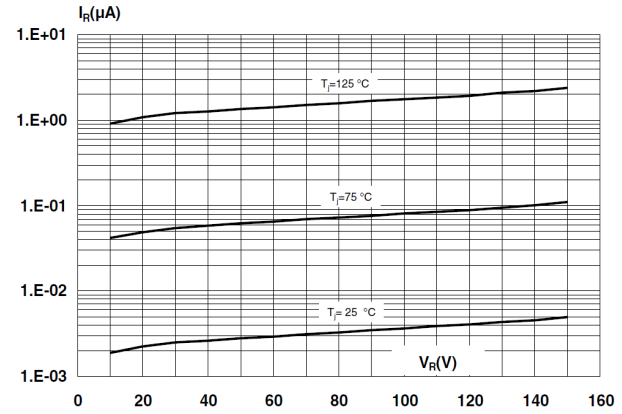


Figure 5. Relative variation of thermal impedance, junction to case, versus single square pulse duration

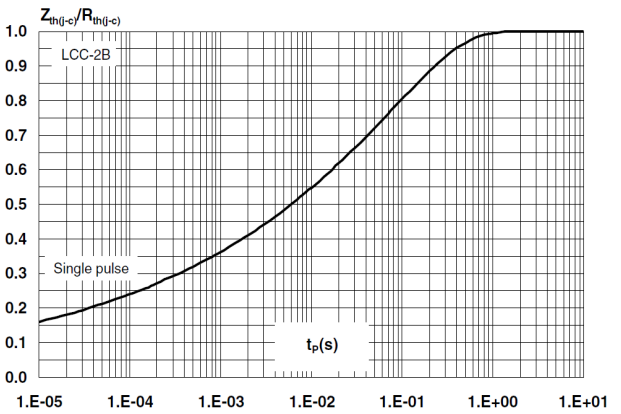


Figure 6. Reverse recovery time versus dI_F/dt (typical values)

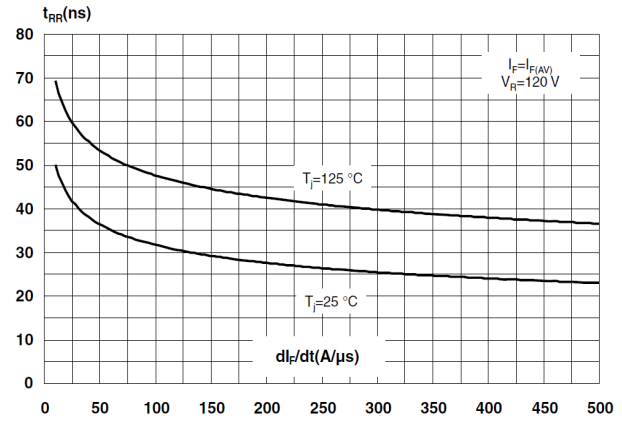
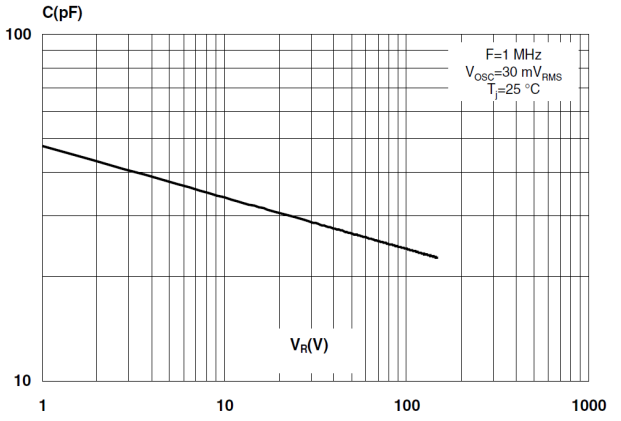


Figure 7. Junction capacitance versus reverse voltage applied (typical values)



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 worst case total ionisation dose for power rectifier is high dose rate. Consequently, the product has been charaterized at 620 krad(si)/h (high dose rate), as per ESCC 22900, on 15 packaged parts, 5 reverse biased, 5 forward biased and 5 unbiased.

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

The following parameters are measured:

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

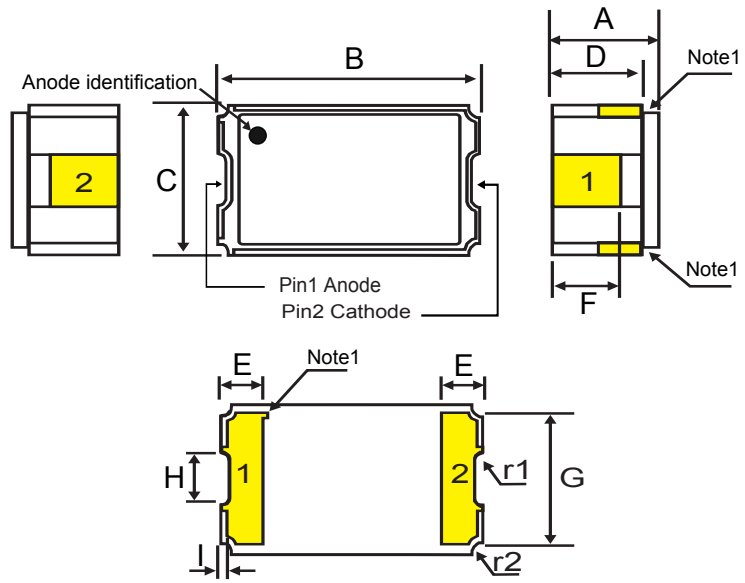
3 Package information

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.

3.1 LCC-2B package information

The LCC-2B package is available with two lead tinning versions : Gold plated or SnPb 63/37 solder dip leads. Its metallic lid is electrically floating and not connected to any pin. Connecting it to ground doesn't affect the electrical characteristics.

Figure 8. LCC-2B package outline



Note 1: The anode is identified by metalization in two top internal angles and the index mark.

Table 5. LCC-2B package mechanical data

Ref.	Dimensions					
	Millimeters			Inches (for reference only)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.04	2.23	2.42	0.080	0.088	0.095
B	5.27	5.40	5.60	0.207	0.213	0.220
C	3.49	3.62	3.76	0.137	0.143	0.150
D	1.71	1.90	2.09	0.067	0.075	0.082
E	0.48		0.71	0.019		0.028
F		1.4			0.055	
G		3.32			0.131	
H		1.82			0.072	
I		0.15			0.006	
r1		0.15			0.006	
r2		0.20			0.008	

Dimension data specified for the gold plated version and the solder dip version before tinning.

4 Ordering information

Table 6. **Ordering information**

Order code	ESCC detail specification	Quality level	Package	Lead finishing	Product marking	Mass	Base qty.	Packing
1N5811UB1	-	Engineering model	LCC-2B	Gold	1N5811UB1	180 mg	50	Wafle pack
1N5811U01B	5101/013/11	Flight model		Gold	510101311			
1N5811U02B	5101/013/12	Flight model		Solder dip	510101312			

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

5 Other information

5.1 Product marking description

Here below is described the marking of the package of both the engineering and flight models.

Figure 9. ESCC flight model marking outline

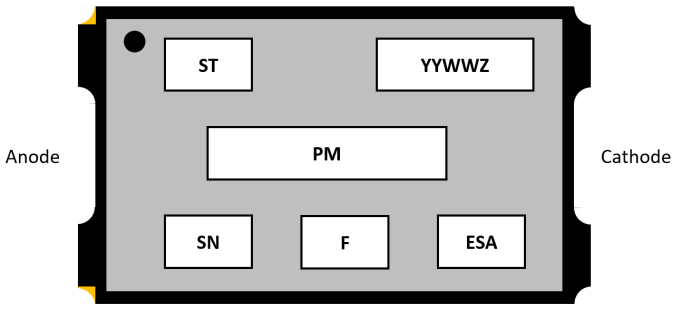


Table 7. ESCC flight model marking

Field	Description
ST	ST logo
YYWWZ	Date code and lot index in the week(1)
PM	Product marking
SN	Serialization number
F	Country of origin
ESA	ESA logo

1. *YY = two-digit year, WW = two-digit week, Z = lot week index.*

Figure 10. Engineering model marking outline

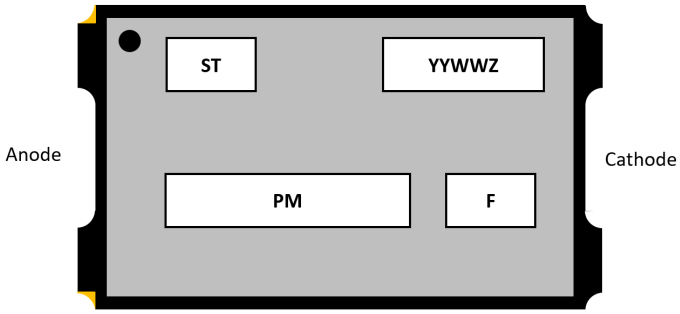


Table 8. Engineering model marking

Field	Description
ST	ST logo
YYWWZ	Date code and lot index in the week(1)
PM	Product marking
F	Country of origin

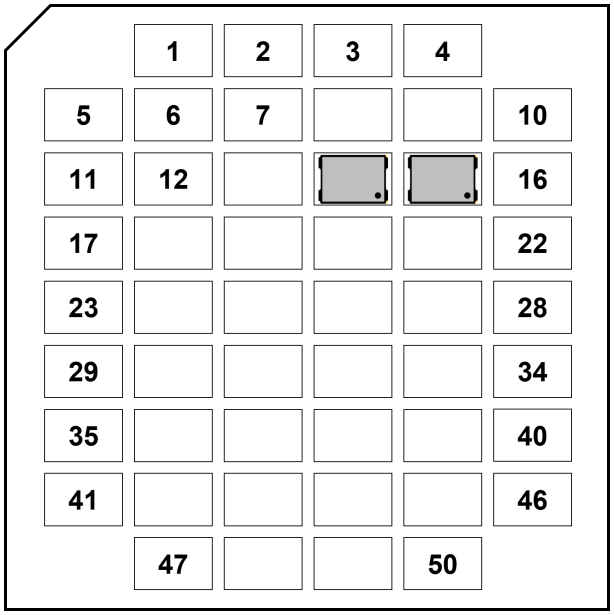
1. *YY = two-digit year, WW = two-digit week, Z = lot week index.*

5.2 Packing information

The 1N5811U versions are delivered in a 50-position, 50 x 50 mm² waffle pack consecutively populated from position 1.

The Figure 11 shows how to identify position 1, the orientation of the product in the waffle pack.

Figure 11. 1N5811 waffle pack outline



The diode anode is on the right pin of the device, and the anode identification dot is orientated at the opposite of the waffle pack truncated corner.

5.3 Documentation

In the Table 9 is a summary of the documentation provided with each type of products.

Table 9. 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 part number • Quantity delivered • Date code • Reference data sheet • Reference to TN1181 on engineering models • ST Rennes assembly lot ID
Flight model	Certificate of conformance including : • Customer name • Customer purchase order number • ST sales order number and item • ST part number • Quantity delivered • Date code • Serial numbers • Diffusion line (plant + wafer size) • Diffusion run (wafer lot number) and wafer ID • Reference of the applicable ESCC qualification maintenance lot • Reference to the ESCC detail specification • ST Rennes assembly lot ID number

Revision history

Table 10. **Document revision history**

Date	Revision	Changes
27-Jul-2009	1	First issue.
25-Mar-2010	2	Updated ESCC status in *Features* and added footnote to *Table 3*.
8-Nov-2013	3	Updated *Table 1*, *Table 5* and *Table 7* and inserted *Other information*.
04-Dec-2015	4	Updated *Table 7* and reformatted to current standard.
16-Oct-2023	5	Updated *features*, *description*, and *Section 5 Other information*. Added *application* and *Packing information*. Minor text changes.
14-Nov-2024	6	Updated Figure 8.

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