

## Cool bypass switch for photovoltaic applications

### Features

- $I_F = 16\text{ A}$ ,  $V_R = 40\text{ V}$
- Very low forward voltage drop
- Very low reverse leakage current
- $175\text{ °C}$  operating junction temperature

### Applications

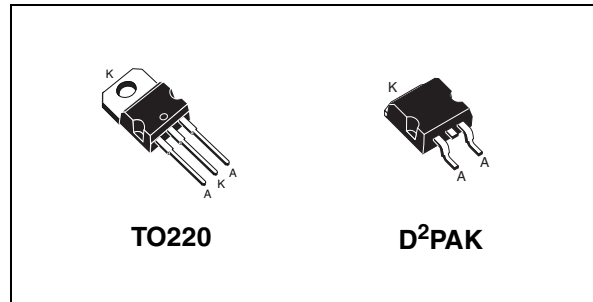
- Photovoltaic panels

### Description

The SPV1002 is a system-in-package solution for photovoltaic applications to perform cool bypass rectification similar to that of a conventional Schottky diode but with much lower forward voltage drop and reverse leakage current.

The device consists of a power MOSFET transistor which charges a capacitor during the OFF time, and drives its gate during the ON time using the charge previously stored in the capacitor.

The ON and OFF times are set to reduce the average voltage drop across the drain and source terminals, resulting in reduced power dissipation.



**Table 1. Device summary**

| Order codes  | Package             | Packaging     |
|--------------|---------------------|---------------|
| SPV1002D40   | D <sup>2</sup> PACK | Tube          |
| SPV1002T40   | TO220               | Tube          |
| SPV1002D40TR | D <sup>2</sup> PACK | Tape and reel |

# 1 Maximum ratings

## 1.1 Absolute maximum ratings

Table 2. Absolute maximum ratings

| Symbol     | Parameter                                                           | Range<br>[min, max] | Unit |
|------------|---------------------------------------------------------------------|---------------------|------|
| $V_R$      | Max DC reverse voltage                                              | 40                  | V    |
| $I_F$      | Max forward current                                                 | 16                  | A    |
| $I_{FSM}$  | Non repetitive peak surge (half-wave, single-phase, 60 Hz)          | 250                 | A    |
| ESD level  | Human body level                                                    | $\geq 8$ k          | V    |
| $R_{thJC}$ | Thermal resistance, junction-to-ambient (D <sup>2</sup> PAK, TO220) | 1.6                 | °C/W |
| $T_J$      | Junction temperature operating range                                | -40 to 175          | °C   |
| $T_{STG}$  | Storage temperature range                                           | -40 to 175          | °C   |

## 2 Electrical characteristics

**Table 3. Electrical characteristics**

| Symbol      | Parameter                | Test condition           |                      | Values |     |     | Unit    |
|-------------|--------------------------|--------------------------|----------------------|--------|-----|-----|---------|
|             |                          |                          |                      | Min    | Typ | Max |         |
| $V_{F,AVG}$ | AVG forward voltage drop | $I_F = 16A^{(1)}$        | $T_J = 25^{\circ}C$  | -      | 180 | -   | mV      |
|             |                          | $I_F = 8A^{(1)}$         | $T_J = 25^{\circ}C$  | -      | 110 | -   | mV      |
|             |                          |                          | $T_J = 125^{\circ}C$ | -      | 230 | -   | mV      |
| $I_R$       | Reverse leakage current  | $V_R = 40V$              | $T_J = 25^{\circ}C$  | -      | 1   | -   | $\mu A$ |
|             |                          |                          | $T_J = 125^{\circ}C$ | -      | 10  | -   | $\mu A$ |
| D           | TON/T ratio              | $I_F = 8A^{(1)}$         | $T_J = 25^{\circ}C$  | -      | 95% | -   | -       |
|             |                          |                          | $T_J = 125^{\circ}C$ | -      | 75% | -   | -       |
| $V_F$       | Forward voltage drop     | $I_F = 8A, T_{OFF}$      | $T_J = 25^{\circ}C$  | -      | 850 | -   | mV      |
|             |                          |                          | $T_J = 125^{\circ}C$ | -      | 600 | -   | mV      |
|             |                          | $I_F = 8A^{(1)}, T_{ON}$ | $T_J = 25^{\circ}C$  | -      | 60  | -   | mV      |
|             |                          |                          | $T_J = 125^{\circ}C$ | -      | 120 | -   | mV      |

1. For correct power dissipation and heatsink sizing, please refer to [Figure 1](#), [4](#) and [5](#).

### 3 Device description

A photovoltaic panel consists of a series of PV cells. In optimal conditions, all the cells are equally irradiated and function at the same current level. However, during normal operation some cells may become partially shaded or obscured. These shaded cells limit the current generated by the fully irradiated cells and, in the extreme cases where these cells are totally obscured, the current flow is blocked.

In this case the shaded cells behave like a load, and the current generated from the fully irradiated cells produces overvoltages which can reach the breakdown threshold. This phenomenon, known as a “hot spot”, can cause overheating of the shaded cells and, in some cases, even permanent damage resulting in current leakage. To prevent hot spots, therefore, bypass diodes are connected in parallel to the cell strings.

The device described here has the same functionality as a Schottky diode, but with improved performance. It features very low forward voltage drop and reverse leakage current. It consists of a power MOSFET transistor which charges a capacitor during the OFF time, and drives its gate during the ON time using the charge previously stored in the capacitor. The ON and OFF times are set to reduce the average voltage drop across the drain and source terminals, resulting in reduced power dissipation.

Figure 1. Average forward power dissipation versus average forward current

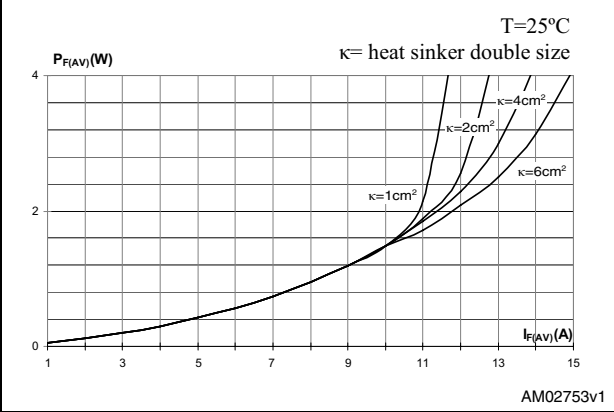


Figure 2. Forward voltage

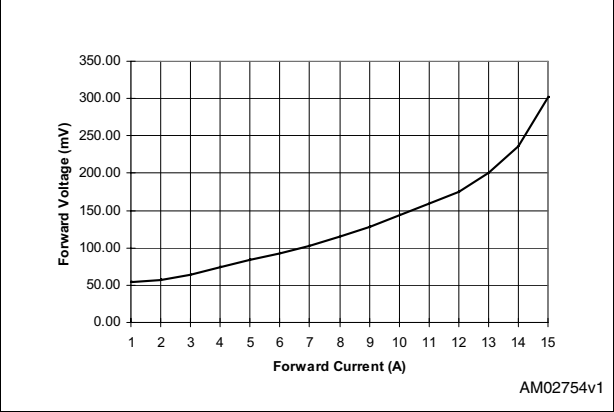


Figure 3. Reverse current

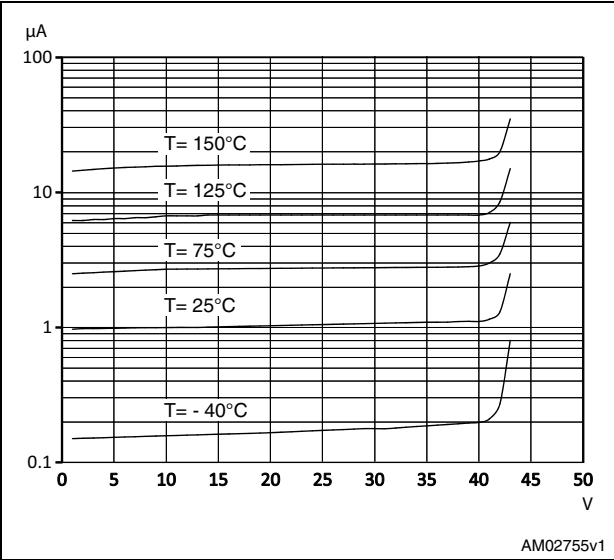


Figure 4. Average current versus ambient temperature

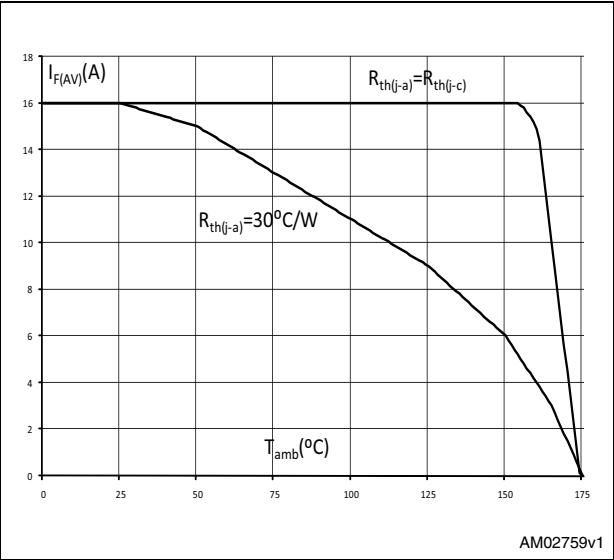
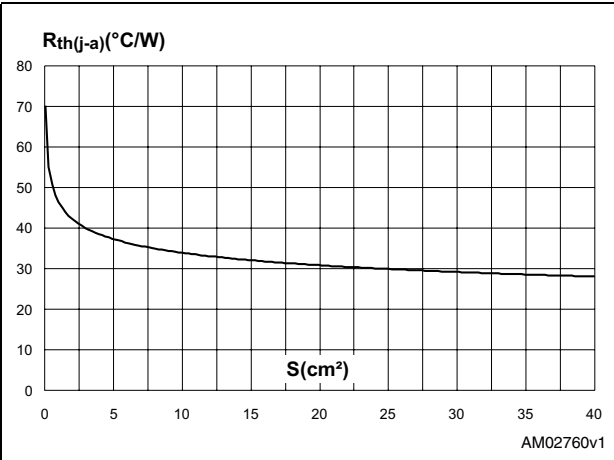


Figure 5. Thermal resistance junction-to-ambient vs copper surface under tab <sup>(1)</sup>



1. Epoxy printed board FR4, Cu = 35  $\mu m$

## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

**Table 4. TO-220 type A mechanical data**

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.70  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10    |       | 10.40 |
| e    | 2.40  |       | 2.70  |
| e1   | 4.95  |       | 5.15  |
| F    | 1.23  |       | 1.32  |
| H1   | 6.20  |       | 6.60  |
| J1   | 2.40  |       | 2.72  |
| L    | 13    |       | 14    |
| L1   | 3.50  |       | 3.93  |
| L20  |       | 16.40 |       |
| L30  |       | 28.90 |       |
| ØP   | 3.75  |       | 3.85  |
| Q    | 2.65  |       | 2.95  |

Figure 6. TO-220 type A drawing

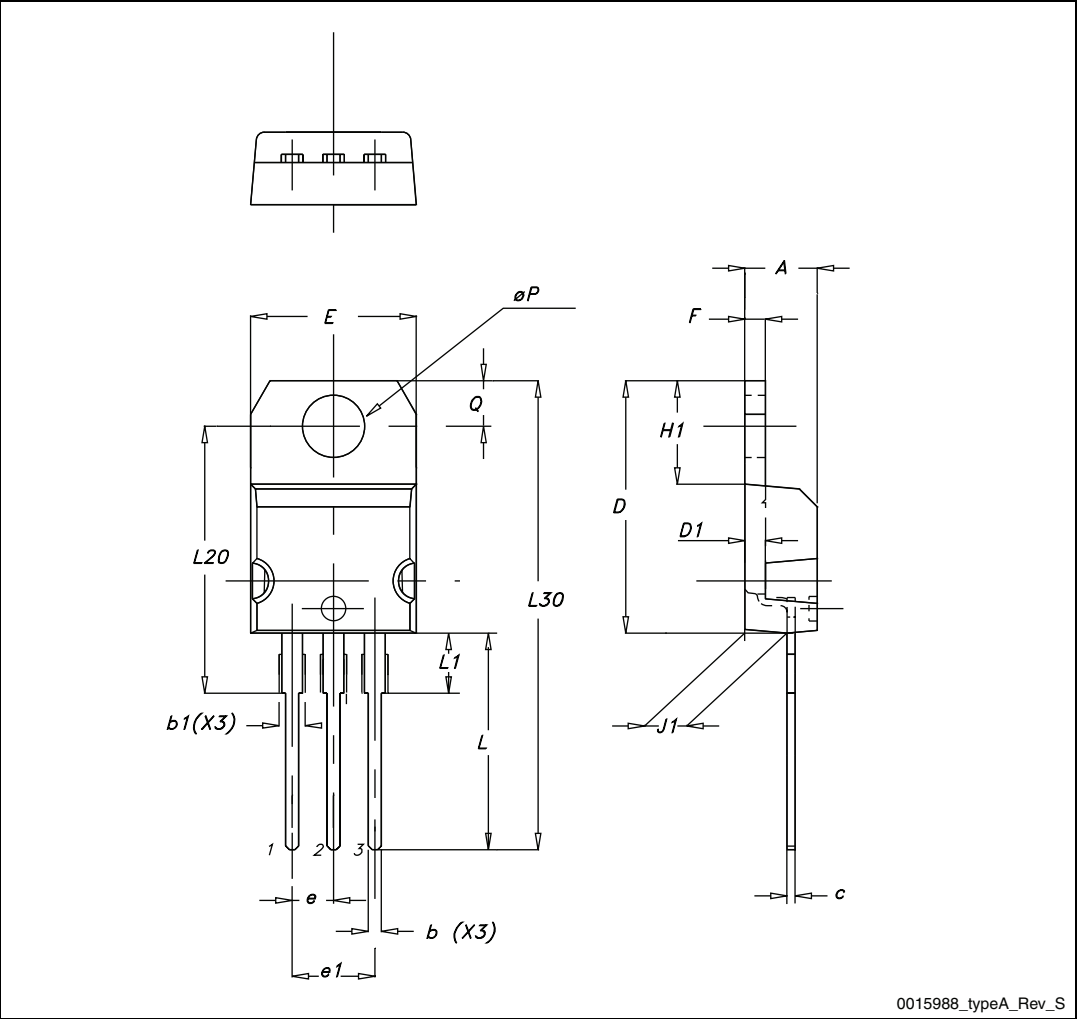
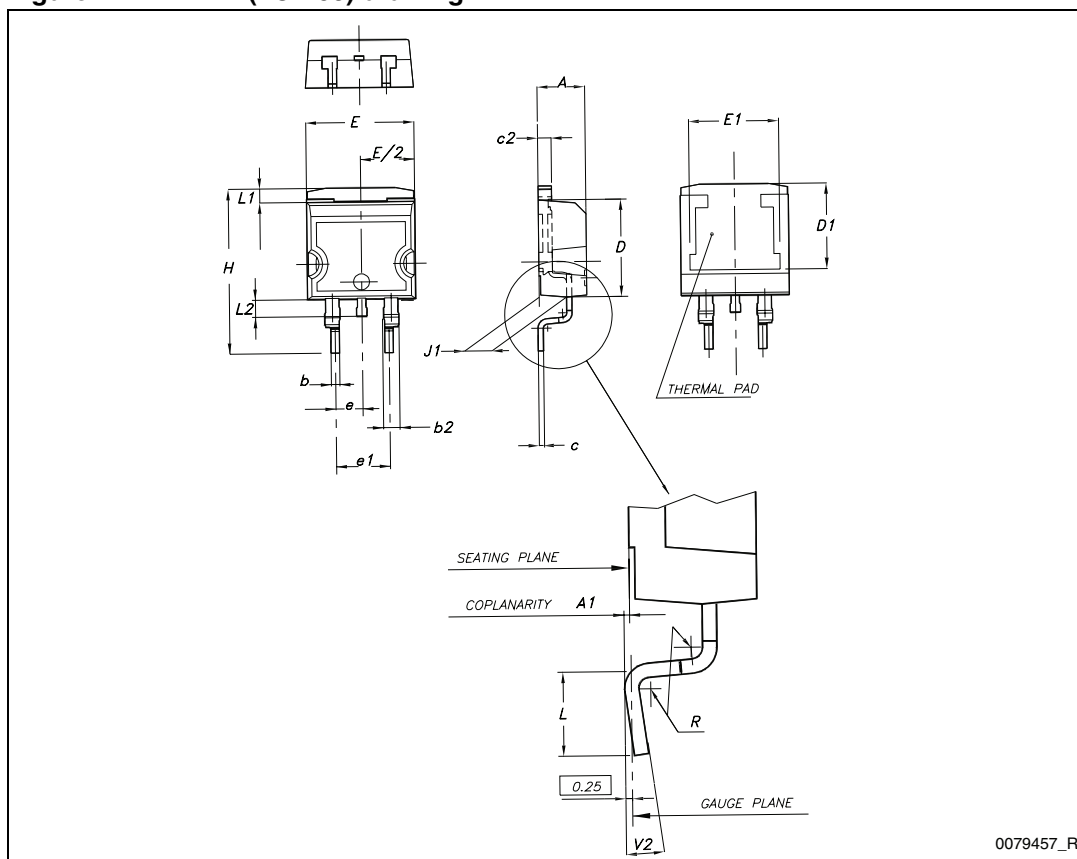


Table 5. D<sup>2</sup>PAK (TO-263) mechanical data

| Dim. | mm   |      |       |
|------|------|------|-------|
|      | Min. | Typ. | Max.  |
| A    | 4.40 |      | 4.60  |
| A1   | 0.03 |      | 0.23  |
| b    | 0.70 |      | 0.93  |
| b2   | 1.14 |      | 1.70  |
| c    | 0.45 |      | 0.60  |
| c2   | 1.23 |      | 1.36  |
| D    | 8.95 |      | 9.35  |
| D1   | 7.50 |      |       |
| E    | 10   |      | 10.40 |
| E1   | 8.50 |      |       |
| e    |      | 2.54 |       |
| e1   | 4.88 |      | 5.28  |
| H    | 15   |      | 15.85 |
| J1   | 2.49 |      | 2.69  |
| L    | 2.29 |      | 2.79  |
| L1   | 1.27 |      | 1.40  |
| L2   | 1.30 |      | 1.75  |
| R    |      | 0.4  |       |
| V2   | 0°   |      | 8°    |

Figure 7. D<sup>2</sup>PAK (TO-263) drawing

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## 5 Revision history

**Table 6. Document revision history**

| Date        | Revision | Changes                                                    |
|-------------|----------|------------------------------------------------------------|
| 16-May-2011 | 1        | Initial release                                            |
| 16-Jun-2011 | 2        | – Added D <sup>2</sup> PAK package<br>– Minor text changes |
| 17-Nov-2011 | 3        | Updated <a href="#">Figure 3</a>                           |

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