

### MAIN APPLICATIONS

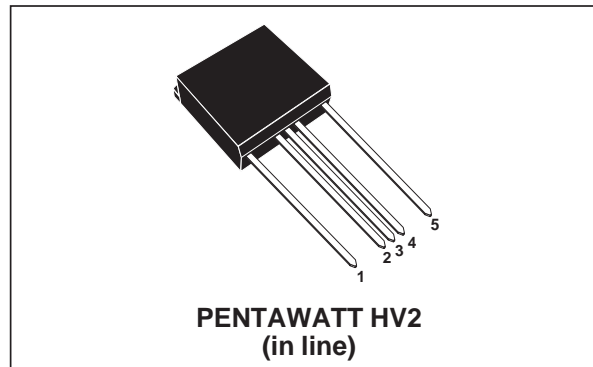
- HIGH POWER DENSITY ADAPTER
- HIGH END TV POWER SUPPLY
- OPENED FRAME SMPS

### FEATURES

- Inrush current limitation circuit for off-line power supply
- Dual non-sensitive unidirectional switches in a single package
- Suitable when space and efficiency are critical
- Active after short AC line drop out with a boost converter
- High repetitive forward and reverse off-state voltage (700V)

### BENEFITS

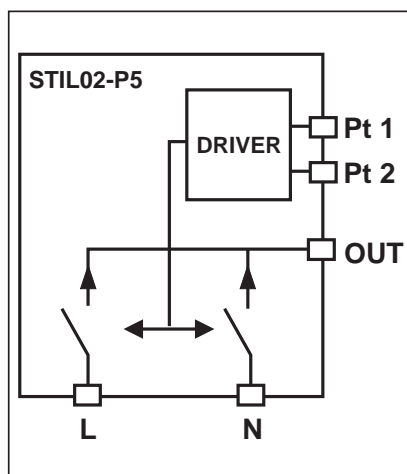
- Low consumption ( $I_{pt} = 20\text{mA}$ )
- High noise immunity:  
( $dV/dt > 500\text{V}/\mu\text{s}$  @  $T_j = 150^\circ\text{C}$ )
- Low reverse current losses
- Integrated pilot driver of the power switches
- Monolithic ASD<sup>TM</sup> planar technology for better robustness and reliability



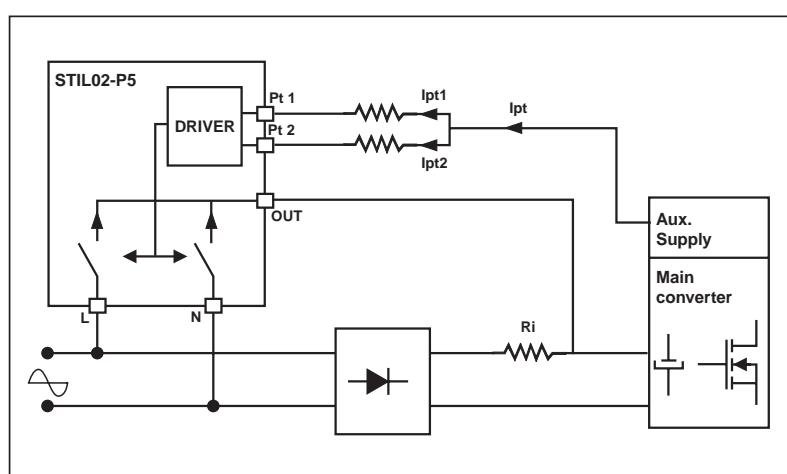
### PIN OUT DESCRIPTION

| Pin out designation | Description                  | Position |
|---------------------|------------------------------|----------|
| L                   | AC Line (switch1)            | 1        |
| Pt1                 | Pilot of power switch 1      | 2        |
| OUT                 | Output<br>(connected to Tab) | 3        |
| Pt2                 | Pilot of power switch 2      | 4        |
| N                   | AC Neutral (switch 2)        | 5        |

**Fig. A1:** Bloc Diagram.



**Fig. A2:** Basic connection.



## STIL02-P5

### Functional Description

The **STIL02** is connected in parallel with the bridge diode and the inrush power resistor  $R_i$  (fig. A2). During start up, the two unidirectional **ASD**<sup>TM</sup> power switches of the STIL02 are opened. The inrush current flows through the diodes of the bridge and the external inrush power resistor  $R_i$ . Since the main converter turns ON, the auxiliary power supply coupled with the main transformer, supplies the energy required to close the two power switches of the STIL02. At the normal state, the two bottom diodes of the bridge rectifier and the two unidirectional switches of the STIL02 rectify the AC line current.

When the STIL02 is used with a PFC boost converter, the inrush current circuit remains active after a short AC line dropout (see fig. A5). In that configuration, since the AC line disappears, the PFC controller and the auxiliary power supply of the STIL turns OFF. The two switches of the STIL are opened. The output bulk capacitor  $C_b$  is discharging and it is providing the energy to the main converter. When the AC line recovers, the two switches remain opened and recharging inrush current of the capacitor  $C_b$  is deviated and limited through the resistor  $R_i$ . When the capacitor is charged, the PFC turns ON again and the two switches of the STIL switch ON.

More details on the design and operation of the driver circuit of figure A5 can be found in the application note "**AN1600 - STIL: Inrush Current Limitation Device for Off-Line Power Converter**".

### ABSOLUTE MAXIMUM RATINGS (Limiting value)

| Symbol                   | Parameter  |   | Value       | Unit             |
|--------------------------|--|---|-------------|------------------|
| $V_{Dout}$<br>$V_{Rout}$ | Repetitive forward ( $V_{Dout}$ ) and reverse ( $V_{Rout}$ ) off-state voltage                       | $T_j$ (min) to<br>$T_j$ (max)                         | 700         | V                |
| $I_{out(AV)}$            | Average on state current at the OUT terminal (180° conduction angle for the internal power switches) | $T_j = 150^\circ\text{C}$                             | 2           | A                |
| $I_{out(RMS)}$           | RMS on state current at the OUT terminal (180° conduction angle for the internal power switches)     | $T_j = 150^\circ\text{C}$                             | 2.2         | A                |
| $I_{TSM}$                | Non repetitive surge peak on-state current ( $T_j$ initial = 25°C)                                   | $t_p = 10\text{ms}$<br>sinusoidal                     | 65          | A                |
| $I^2t$                   | $I^2t$ value - rating for fusing   | $t_p = 10\text{ms}$                                   | 21          | A <sup>2</sup> s |
| $dl_{out}/dt$            | Critical rate of rise of on state current<br>$I_{pt1} + I_{pt2} = 20\text{mA}$                       | $T_j = 25^\circ\text{C}$<br>$T_j = 150^\circ\text{C}$ | 100<br>-    | A/ $\mu\text{s}$ |
| $T_{stg}$                | Storage temperature range  |   | -40 to +150 | °C               |
| $T_j$                    | Junction temperature range   |   | 0 to +150   | °C               |

### THERMAL PARAMETERS

| Symbol        | Parameter                               | Value | Unit |
|---------------|---|-------|------|
| $R_{th(j-c)}$ | Junction to case                        | 2     | °C/W |
| $R_{th(j-a)}$ | Junction to ambient (minimum footprint) | 60    |      |

## ELECTRICAL CHARACTERISTICS

| Symbol                                       | Parameter  | Test conditions  | Min.                   | Typ. | Max. | Unit |   |
|--|--|--|------------------------|------|------|------|---|
| I <sub>pt1</sub><br>+<br>I <sub>pt2</sub>    | Driver trigger current   | V <sub>Dout</sub> = 12V (DC)<br>R <sub>L</sub> = 30Ω<br>t <sub>p</sub> = 380μs | T <sub>j</sub> = 0°C   | 12   | 20   | mA   |   |
|  |  |  | T <sub>j</sub> = 25°C  |      | 10   |      |   |
| V <sub>D</sub> (pt1)<br>V <sub>D</sub> (pt2) | Direct pilot trigger voltage   | V <sub>Dout</sub> = 12V (DC)<br>R <sub>L</sub> = 30Ω                           | T <sub>j</sub> = 0°C   | 0.6  | 0.85 | 1    | V |
|  |  |  | T <sub>j</sub> = 25°C  |      | 0.8  | 0.95 |   |
|  |  |  | T <sub>j</sub> = 150°C | 0.2  | 0.45 |      |   |
| V <sub>R</sub> (pt1)<br>V <sub>R</sub> (pt2) | Peak reverse driver voltage  |  | T <sub>j</sub> = 25°C  | 8    |      | V    |   |
| dV <sub>Dout</sub> /dt                       | Dynamic voltage rising   | Linear slope up to<br>V <sub>Dout</sub> = 470V                                 | T <sub>j</sub> = 150°C | 500  |      | V/μs |   |
| I <sub>Rout</sub> (off)                      | Max reverse current without driver current                             | V <sub>Rout</sub> = 700V<br>I <sub>pt1</sub> = I <sub>pt2</sub> = open         | T <sub>j</sub> = 25°C  |      | 5    | μA   |   |
|  |  |  | T <sub>j</sub> = 150°C |      | 300  | μA   |   |
| I <sub>Rout</sub> (on)                       | Max reverse current with driver current                                | V <sub>Rout</sub> = 400V<br>I <sub>pt1</sub> = I <sub>pt2</sub> = 10mA         | T <sub>j</sub> = 150°C |      | 300  | μA   |   |
| V <sub>t0</sub>                              | Threshold direct voltage for one power switch                          | I <sub>out(AV)</sub> = 2A  | T <sub>j</sub> = 150°C | 0.7  | 0.8  | V    |   |
| R <sub>d</sub>                               | Dynamic direct resistance for one power switch                         | I <sub>out(AV)</sub> = 2A  | T <sub>j</sub> = 150°C | 70   | 100  | mΩ   |   |
| V <sub>F</sub>                               | Maximum instantaneous direct forward voltage drop for one power switch | I <sub>out(AV)</sub> = 2A  | T <sub>j</sub> = 150°C | 0.9  | 1.1  | V    |   |

## Power losses calculations

When the input current is sinusoidal, the conducted power losses can be calculated by using the following formula:

$$P = V_{T0} \cdot I_{out(av)} + R_d \frac{(I_{out(av)} \times \pi)^2}{8}$$

If the output average current is 2Amps, V<sub>T0</sub> and R<sub>d</sub> of the electrical characteristics table can be used. For different output current please refer to the application note **AN1600** that provides guidelines to estimate the correct values of V<sub>T0</sub> and R<sub>d</sub>.

## LIGHTNING SURGE IMMUNITY (IEC61000-4-5)

During lightning surge transient voltage across the AC line, over current and over voltage stress are applied on all the components of the power supply. The STIL02 can sustain a maximum peak surge current of **500A as defined by the combine waveform generator (8/20μs waveform as shown in fig. A3 and A4).**

## Special recommendations for the lightning surge immunity:

- 1 - Check that the **maximum peak surge current** in the STIL stays below the limit specified above.
- 2 - Check that **no over voltages are applied** on the STIL and the bridge diode.
- 3 - In order to reduce the dynamic current stress (dI<sub>out</sub>/dt) through the structure of the STIL02, it is recommended to connect a differential mode choke coil in front of the STIL and the bridge diode.

More details and design guidelines are provided in the application note "**AN1600 - STIL: Inrush Current Limitation Device for Off-Line Power Converter**".

Fig. A3: Surge test condition.

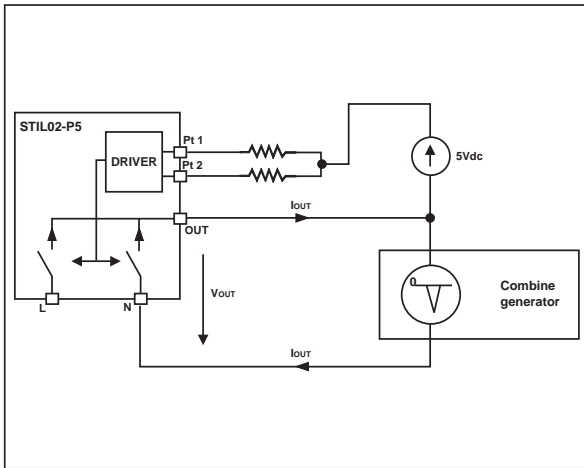


Fig. A4: Surge current waveform.

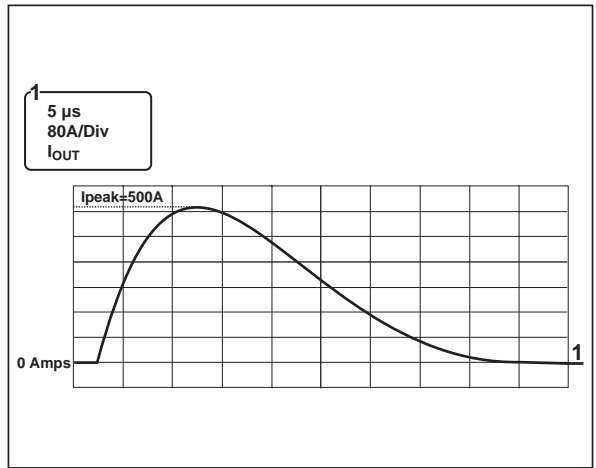
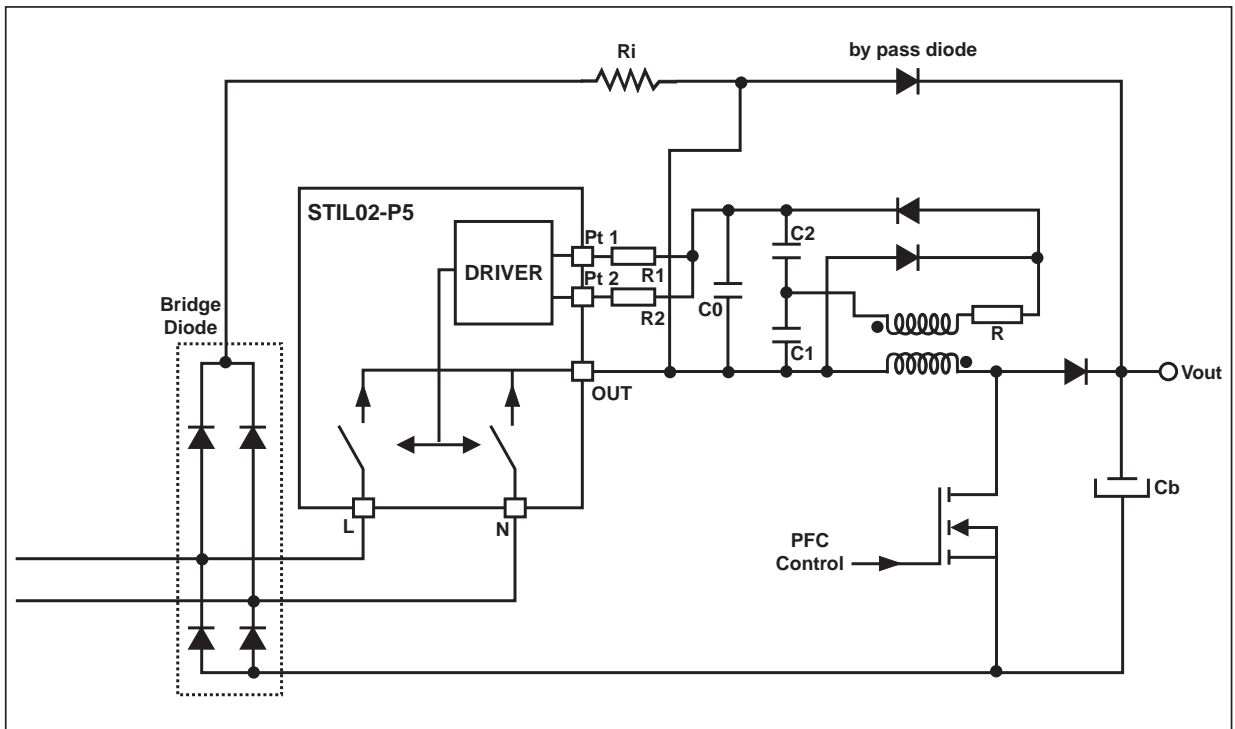
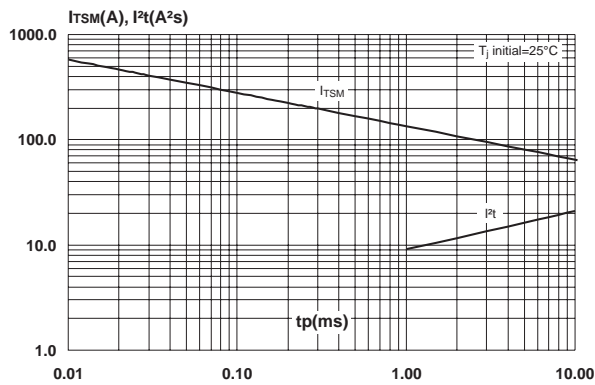


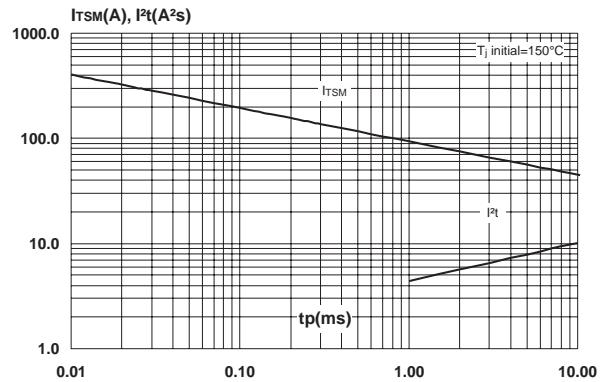
Fig. A5: Basic connection with a PFC Boost preregulator.



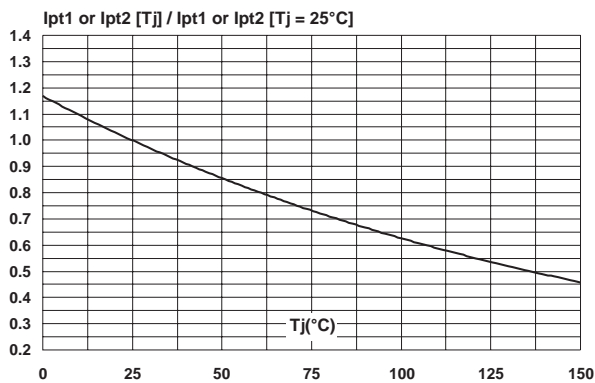
**Fig. 1-1:** Non repetitive surge peak on-state current (sinusoidal pulse) and corresponding value of  $I^2t$ .



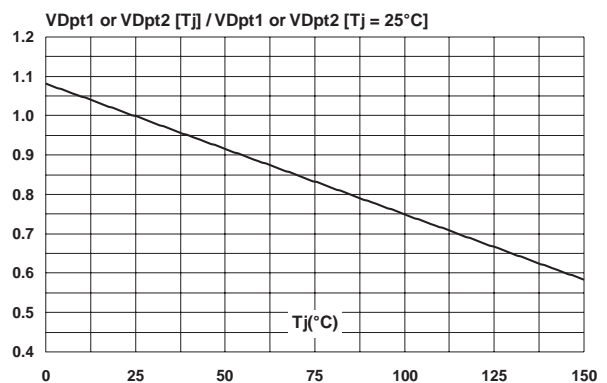
**Fig. 1-2:** Non repetitive surge peak on-state current (sinusoidal pulse) and corresponding value of  $I^2t$ .



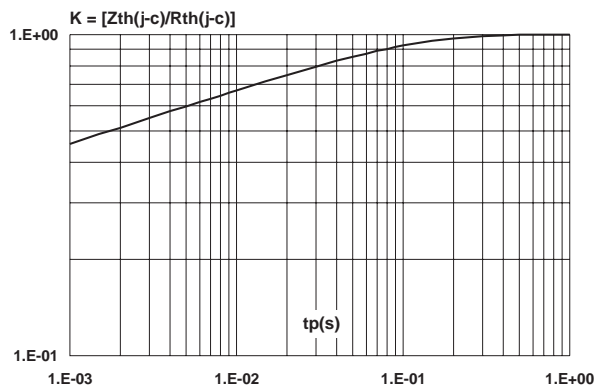
**Fig. 2:** Relative variation of driver trigger current versus junction temperature (typical values).



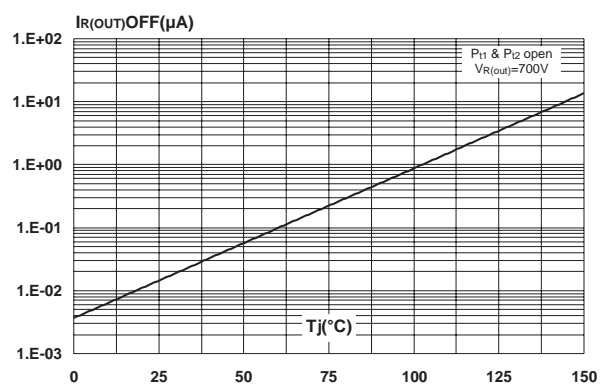
**Fig. 3:** Relative variation of direct pilot voltage versus junction temperature (typical values).



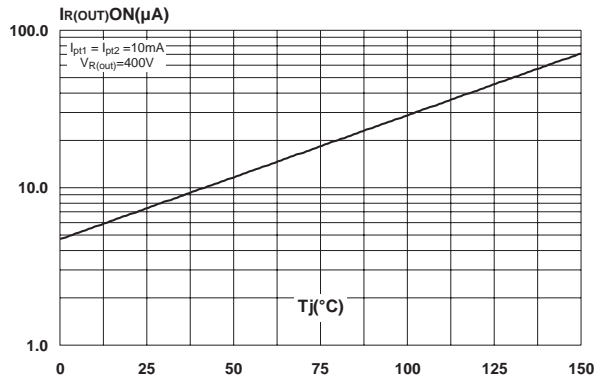
**Fig. 4:** Relative variation of thermal impedance junction to case versus pulse duration.



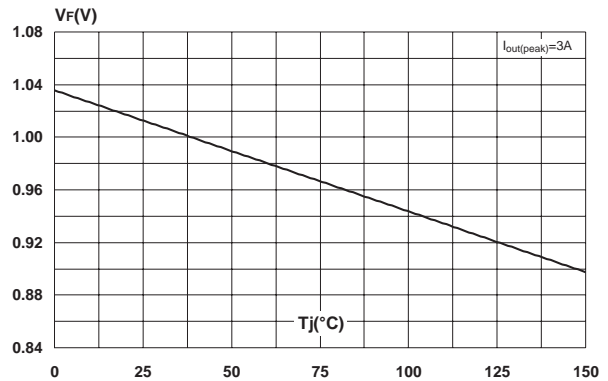
**Fig. 5-1:** Reverse current versus junction temperature without driver current (typical values).



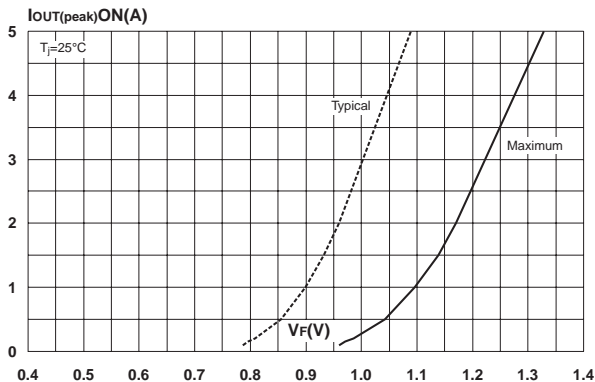
**Fig. 5-2:** Reverse current versus junction temperature with driver current (typical values).



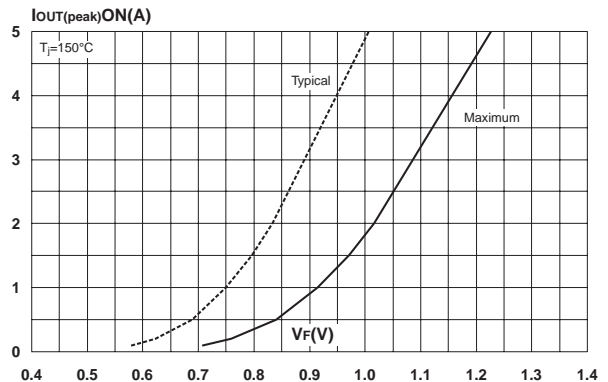
**Fig. 6:** Forward voltage drop for one power switch versus junction temperature at the peak forward current (typical values).



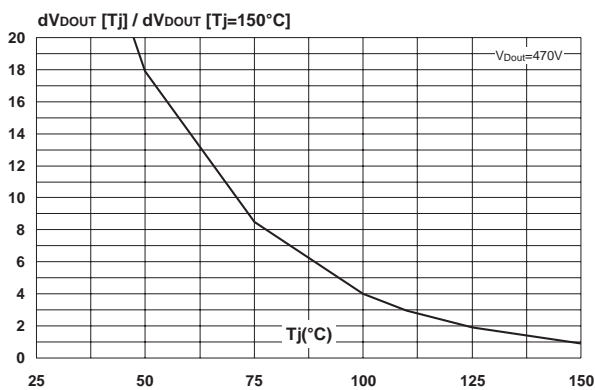
**Fig. 7-1:** Peak forward voltage drop versus peak forward output current for one power switch at  $T_j=25^{\circ}C$  (typical and maximal values).

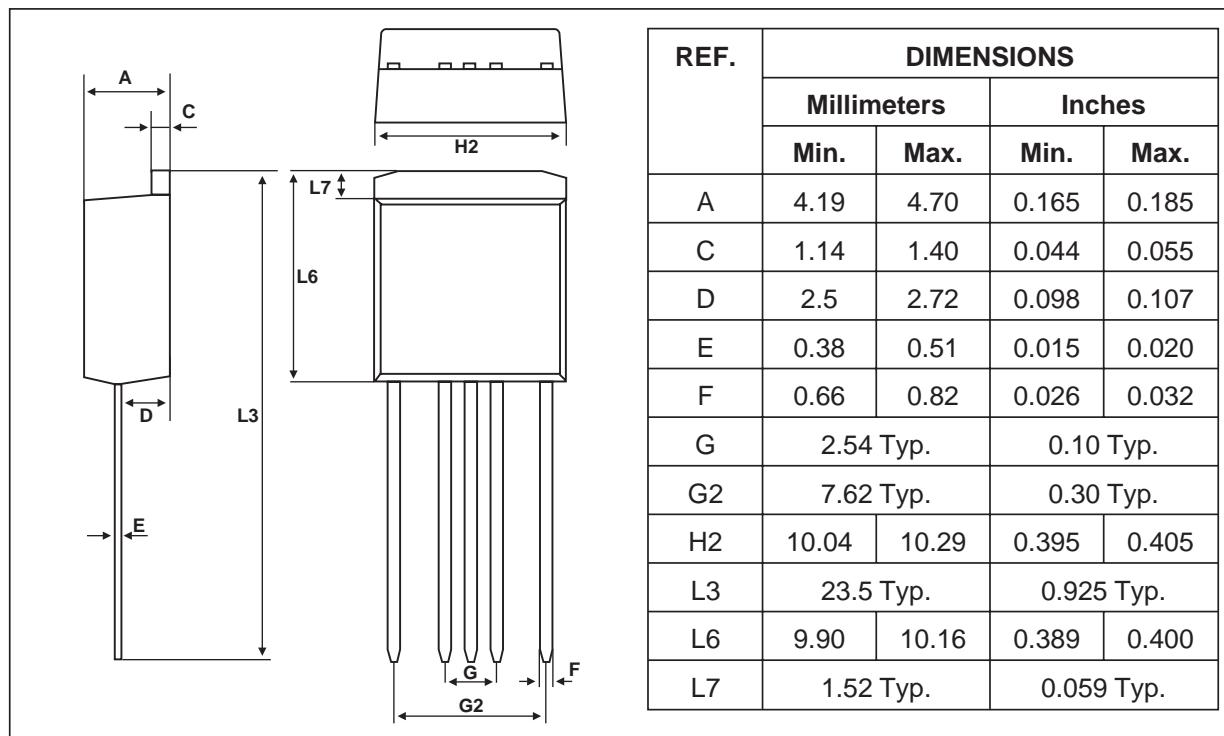


**Fig. 7-2:** Peak forward voltage drop versus peak forward output current for one power switch at  $T_j=150^{\circ}C$  (typical and maximum values).



**Fig. 8:** Relative variation of  $dV/dt$  immunity versus junction temperature (typical values).



**PACKAGE MECHANICAL DATA**  
 PENTAWATT HV2 (in line)


| Order code | Marking | Package                 | Weight | Delivery mode | Base qty |
|------------|---------|-------------------------|--------|---------------|----------|
| STIL02-P5  | STIL02  | PENTAWATT HV2 (in line) | 1.9 g. | Tube          | 50       |

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