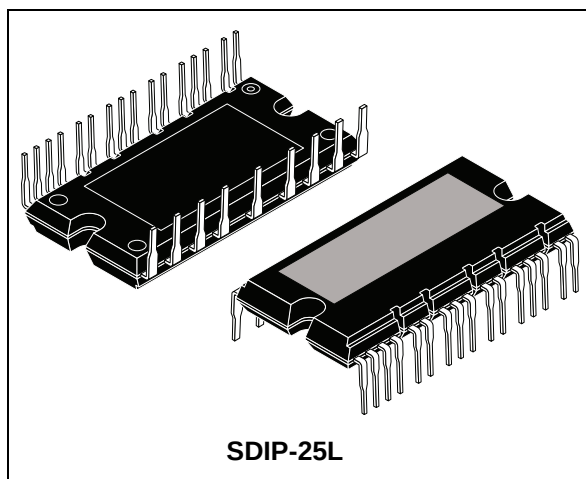


## SLLIMM™ small low-loss intelligent molded module IPM, 3-phase inverter, 10 A, 600 V short-circuit rugged IGBT

Datasheet - production data



### Applications

- 3-phase inverters for motor drives
- Home appliances, such as washing machines, refrigerators, air conditioners

### Description

This intelligent power module provides a compact, high performance AC motor drive in a simple, rugged design. Combining ST proprietary control ICs with the most advanced short-circuit-rugged IGBT system technology, this device is ideal for 3-phase inverters in applications such as home appliances and air conditioners. SLLIMM™ is a trademark of STMicroelectronics.

### Features

- IPM 10 A, 600 V, 3-phase IGBT inverter bridge including control ICs for gate driving and free-wheeling diodes
- Short-circuit rugged IGBT
- $V_{CE(sat)}$  negative temperature coefficient
- 3.3 V, 5 V, 15 V CMOS/TTL inputs comparators with hysteresis and pull-down resistor
- Undervoltage lockout
- Internal bootstrap diode
- Interlocking function
- DBC substrate leading to low thermal resistance
- Isolation rating of 2500 V<sub>rms</sub>/min
- 5 k $\Omega$  NTC thermistor for temperature control
- UL recognized: UL1557 file E81734

**Table 1. Device summary**

| Order code   | Marking    | Package  | Packing |
|--------------|------------|----------|---------|
| STGIPS10K60A | GIPS10K60A | SDIP-25L | Tube    |

## Contents

|          |                                                     |           |
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# 1 Internal block diagram and pin configuration

Figure 1. Internal block diagram

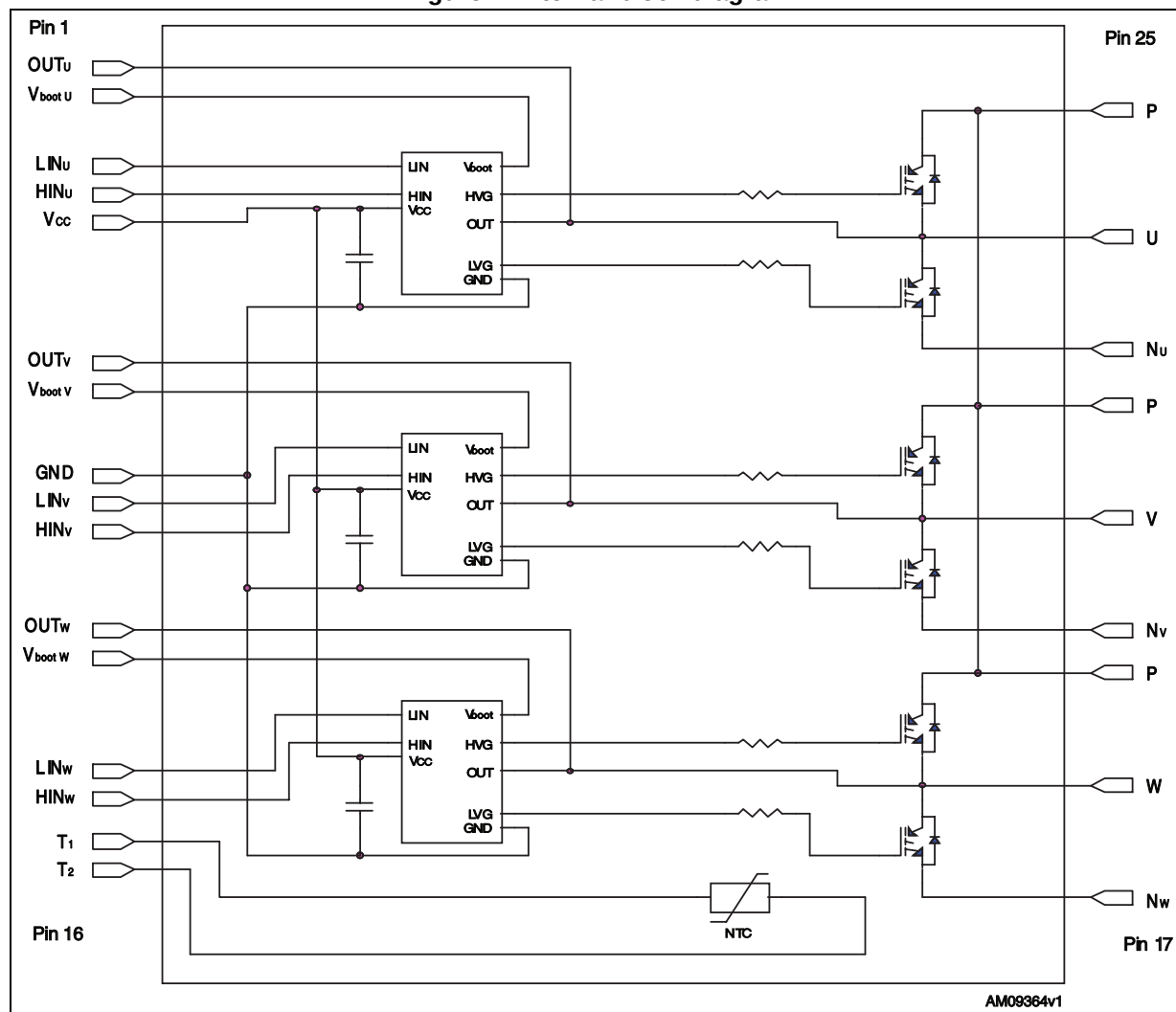
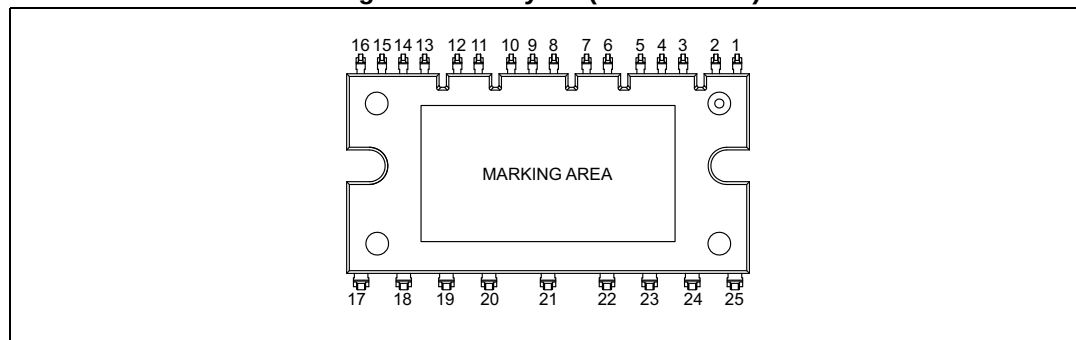


Table 2. Pin description

| Pin | Symbol              | Description                            |
|-----|---------------------|----------------------------------------|
| 1   | OUT <sub>U</sub>    | High side reference output for U phase |
| 2   | V <sub>boot U</sub> | Bootstrap voltage for U phase          |
| 3   | LIN <sub>U</sub>    | Low side logic input for U phase       |
| 4   | HIN <sub>U</sub>    | High side logic input for U phase      |
| 5   | V <sub>CC</sub>     | Low voltage power supply               |
| 6   | OUT <sub>V</sub>    | High side reference output for V phase |
| 7   | V <sub>boot V</sub> | Bootstrap voltage for V phase          |
| 8   | GND                 | Ground                                 |
| 9   | LIN <sub>V</sub>    | Low side logic input for V phase       |
| 10  | HIN <sub>V</sub>    | High side logic input for V phase      |
| 11  | OUT <sub>W</sub>    | High side reference output for W phase |
| 12  | V <sub>boot W</sub> | Bootstrap voltage for W phase          |
| 13  | LIN <sub>W</sub>    | Low side logic input for W phase       |
| 14  | HIN <sub>W</sub>    | High side logic input for W phase      |
| 15  | T <sub>1</sub>      | NTC thermistor terminal 1              |
| 16  | T <sub>2</sub>      | NTC thermistor terminal 2              |
| 17  | N <sub>W</sub>      | Negative DC input for W phase          |
| 18  | W                   | W phase output                         |
| 19  | P                   | Positive DC input                      |
| 20  | N <sub>V</sub>      | Negative DC input for V phase          |
| 21  | V                   | V phase output                         |
| 22  | P                   | Positive DC input                      |
| 23  | N <sub>U</sub>      | Negative DC input for U phase          |
| 24  | U                   | U phase output                         |
| 25  | P                   | Positive DC input                      |

Figure 2. Pin layout (bottom view)



## 2 Electrical ratings

### 2.1 Absolute maximum ratings

Table 3. Inverter part

| Symbol             | Parameter                                                                                                                                            | Value | Unit          |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------|
| $V_{PN}$           | Supply voltage applied between P - $N_U$ , $N_V$ , $N_W$                                                                                             | 450   | V             |
| $V_{PN(surge)}$    | Supply voltage (surge) applied between P - $N_U$ , $N_V$ , $N_W$                                                                                     | 500   | V             |
| $V_{CES}$          | Each IGBT collector emitter voltage ( $V_{IN}^{(1)} = 0$ )                                                                                           | 600   | V             |
| $\pm I_C^{(2)}$    | Each IGBT continuous collector current at $T_C = 25^\circ\text{C}$                                                                                   | 10    | A             |
| $\pm I_{CP}^{(3)}$ | Each IGBT pulsed collector current                                                                                                                   | 20    | A             |
| $P_{TOT}$          | Each IGBT total dissipation at $T_C = 25^\circ\text{C}$                                                                                              | 33    | W             |
| $t_{scw}$          | Short-circuit withstand time, $V_{CE} = 0.5 V_{(BR)CES}$<br>$T_j = 125^\circ\text{C}$ , $V_{CC} = V_{boot} = 15\text{ V}$ , $V_{IN(1)} = 5\text{ V}$ | 5     | $\mu\text{s}$ |

1. Applied between  $HIN_i$ ,  $LIN_i$  and  $G_{ND}$  for  $i = U, V, W$ .
2. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

3. Pulse width limited by max junction temperature.

Table 4. Control part

| Symbol        | Parameter                                                                            | Min.            | Max              | Unit |
|---------------|--------------------------------------------------------------------------------------|-----------------|------------------|------|
| $V_{OUT}$     | Output voltage applied between $OUT_U$ , $OUT_V$ , $OUT_W$ - GND                     | $V_{boot} - 18$ | $V_{boot} + 0.3$ | V    |
| $V_{CC}$      | Low voltage power supply                                                             | - 0.3           | 18               | V    |
| $V_{boot}$    | Bootstrap voltage                                                                    | - 0.3           | 618              | V    |
| $V_{IN}$      | Logic input voltage applied between $HIN_i$ , $LIN_i$ and $G_{ND}$ for $i = U, V, W$ | - 0.3           | $V_{CC} + 0.3$   | V    |
| $dV_{OUT}/dt$ | Allowed output slew rate                                                             | 50              | 50               | V/ns |

Table 5. Total system

| Symbol    | Parameter                                                                                                   | Value      | Unit             |
|-----------|-------------------------------------------------------------------------------------------------------------|------------|------------------|
| $V_{ISO}$ | Isolation withstand voltage applied between each pin and heatsink plate (AC voltage, $t = 60\text{ sec.}$ ) | 2500       | V                |
| $T_J$     | Power chips operating junction temperature                                                                  | -40 to 150 | $^\circ\text{C}$ |
| $T_C$     | Module case operating temperature                                                                           | -40 to 125 | $^\circ\text{C}$ |

## 2.2 Thermal data

**Table 6. Thermal data**

| Symbol     | Parameter                                          | Value | Unit |
|------------|----------------------------------------------------|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case single IGBT max.  | 3.8   | °C/W |
|            | Thermal resistance junction-case single diode max. | 5.5   | °C/W |

### 3 Electrical characteristics

$T_j = 25^\circ\text{C}$  unless otherwise specified.

Table 7. Inverter part

| Symbol                                          | Parameter                                                        | Test conditions                                                                                                                                                   | Value |      |      | Unit          |
|-------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|------|---------------|
|                                                 |                                                                  |                                                                                                                                                                   | Min.  | Typ. | Max. |               |
| $V_{CE(sat)}$                                   | Collector-emitter saturation voltage                             | $V_{CC} = V_{boot} = 15\text{ V}$ ,<br>$V_{IN}^{(1)} = 5\text{ V}$ ,<br>$I_C = 5\text{ A}$                                                                        | -     | 2.1  | 2.5  | V             |
|                                                 |                                                                  | $V_{CC} = V_{boot} = 15\text{ V}$ ,<br>$V_{IN}^{(1)} = 5\text{ V}$ ,<br>$I_C = 5\text{ A}$ , $T_j = 125^\circ\text{C}$                                            | -     | 1.8  |      |               |
| $I_{CES}$                                       | Collector-cut off current<br>( $V_{IN}^{(1)} = 0$ "logic state") | $V_{CE} = 550\text{ V}$<br>$V_{CC} = V_{boot} = 15\text{ V}$                                                                                                      | -     |      | 150  | $\mu\text{A}$ |
| $V_F$                                           | Diode forward voltage                                            | $V_{IN}^{(1)} = 0$ "logic state",<br>$I_C = 5\text{ A}$                                                                                                           | -     |      | 1.9  | V             |
| <b>Inductive load switching time and energy</b> |                                                                  |                                                                                                                                                                   |       |      |      |               |
| $t_{on}$                                        | Turn-on time                                                     | $V_{DD} = 300\text{ V}$ ,<br>$V_{CC} = V_{boot} = 15\text{ V}$ ,<br>$V_{IN}^{(1)} = 0 \div 5\text{ V}$ ,<br>$I_C = 5\text{ A}$<br>(see <a href="#">Figure 4</a> ) | -     | 320  | -    | ns            |
| $t_{c(on)}$                                     | Crossover time (on)                                              |                                                                                                                                                                   | -     | 70   | -    |               |
| $t_{off}$                                       | Turn-off time                                                    |                                                                                                                                                                   | -     | 430  | -    |               |
| $t_{c(off)}$                                    | Crossover time (off)                                             |                                                                                                                                                                   | -     | 135  | -    |               |
| $t_{rr}$                                        | Reverse recovery time                                            |                                                                                                                                                                   | -     | 130  | -    |               |
| $E_{on}$                                        | Turn-on switching losses                                         |                                                                                                                                                                   | -     | 65   | -    | $\mu\text{J}$ |
| $E_{off}$                                       | Turn-off switching losses                                        |                                                                                                                                                                   | -     | 75   | -    |               |

1. Applied between  $HIN_i$ ,  $LIN_i$  and  $G_{ND}$  for  $i = U, V, W$ .

Note:  $t_{ON}$  and  $t_{OFF}$  include the propagation delay time of the internal drive.  $t_{C(ON)}$  and  $t_{C(OFF)}$  are the switching time of IGBT itself under the internally given gate driving condition.

Figure 3. Switching time test circuit

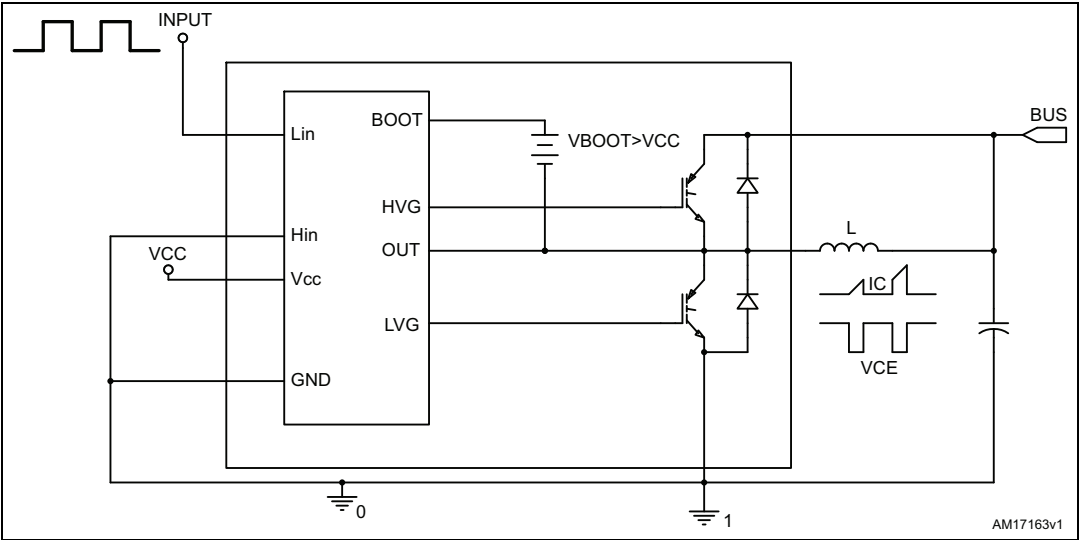
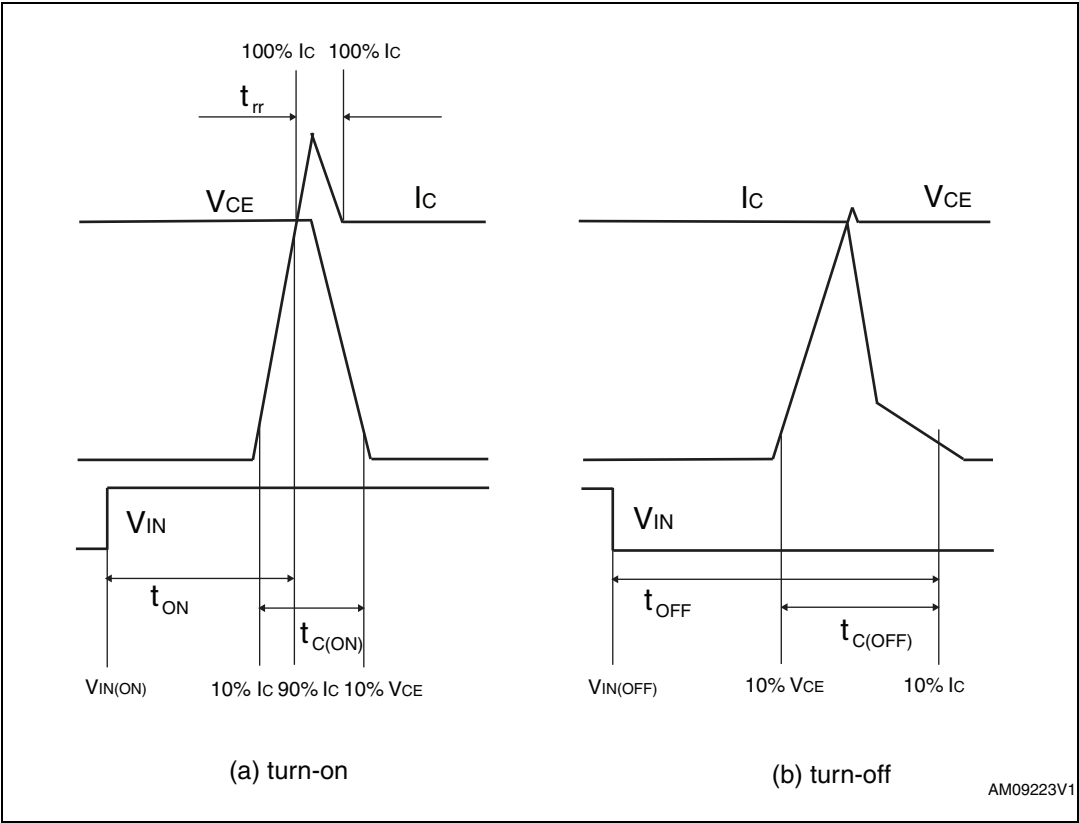


Figure 4. Switching time definition





### 3.1 Control part

**Table 8. Low supply voltage ( $V_{CC} = 15\text{ V}$  unless otherwise specified)**

| Symbol        | Parameter                              | Test conditions         | Min. | Typ. | Max. | Unit |
|---------------|----------------------------------------|-------------------------|------|------|------|------|
| $V_{CCthON}$  | Under voltage turn on threshold        |                         | 9.1  | 9.6  | 10.1 | V    |
| $V_{CCthOFF}$ | Under voltage turn off threshold       |                         | 7.9  | 8.3  | 8.8  | V    |
| $V_{CChys}$   | Under voltage hystereses               |                         | 0.9  |      |      | V    |
| $I_{qccu}$    | Under voltage quiescent supply current | $V_{CC} < 7.9\text{ V}$ |      | 0.75 | 1.2  | mA   |
| $I_{qcc}$     | Quiescent current                      | $V_{CC} = 15\text{ V}$  |      | 1    | 1.5  | mA   |

**Table 9. Bootstrap supply ( $V_{CC} = 15\text{ V}$  unless otherwise specified)**

| Symbol            | Parameter                        | Test conditions          | Min. | Typ. | Max. | Unit          |
|-------------------|----------------------------------|--------------------------|------|------|------|---------------|
| $V_{boot\_thON}$  | Under voltage turn on threshold  |                          | 8.5  | 9.5  | 10.5 | V             |
| $V_{boot\_thOFF}$ | Under voltage turn off threshold |                          | 7.2  | 8.3  | 9.2  | V             |
| $V_{boot\_hys}$   | Under voltage hystereses         |                          | 0.9  |      |      | V             |
| $I_{qboot}$       | Quiescent current                |                          |      |      | 250  | $\mu\text{A}$ |
| $R_{DS(on)}$      | Bootstrap driver on resistance   | $V_{CC} > 12.5\text{ V}$ |      | 125  |      | $\Omega$      |

**Table 10. Logic input <sup>(1)</sup> ( $V_{CC} = 15\text{ V}$  unless otherwise specified)**

| Symbol   | Parameter                      | Test conditions              | Min. | Typ. | Max. | Unit          |
|----------|--------------------------------|------------------------------|------|------|------|---------------|
| $V_{il}$ | Low level logic input voltage  |                              |      |      | 1.1  | V             |
| $V_{ih}$ | High level logic input voltage |                              | 1.8  |      |      | V             |
| $I_{il}$ | Low level logic input current  | $V_{IN}^{(2)} = 0\text{ V}$  | -1   |      |      | $\mu\text{A}$ |
| $I_{ih}$ | High level logic input current | $V_{IN}^{(1)} = 15\text{ V}$ |      | 20   | 70   | $\mu\text{A}$ |

1. See [Figure 9: Dead time and interlocking definition](#).

2. Applied between  $HIN_i$ ,  $LIN_i$  and  $G_{ND}$  for  $i = U, V, W$

3.1.1 NTC thermistor

Table 11. NTC thermistor

| Symbol           | Parameter             | Test conditions    | Min. | Typ. | Max. | Unit. |
|------------------|-----------------------|--------------------|------|------|------|-------|
| R <sub>25</sub>  | Resistance            | T = 25 °C          |      | 5    |      | kΩ    |
| R <sub>125</sub> | Resistance            | T = 125 °C         |      | 300  |      | Ω     |
| B                | B-constant            | T = 25 °C to 85 °C |      | 3340 |      | K     |
| T                | Operating temperature |                    | -40  |      | 125  | °C    |

Equation 1: resistance variation vs. temperature

$$R(T) = R_{25} \cdot e^{B\left(\frac{1}{T} - \frac{1}{298}\right)}$$

Where T are temperatures in Kelvin.

Figure 5. NTC resistance vs. temperature

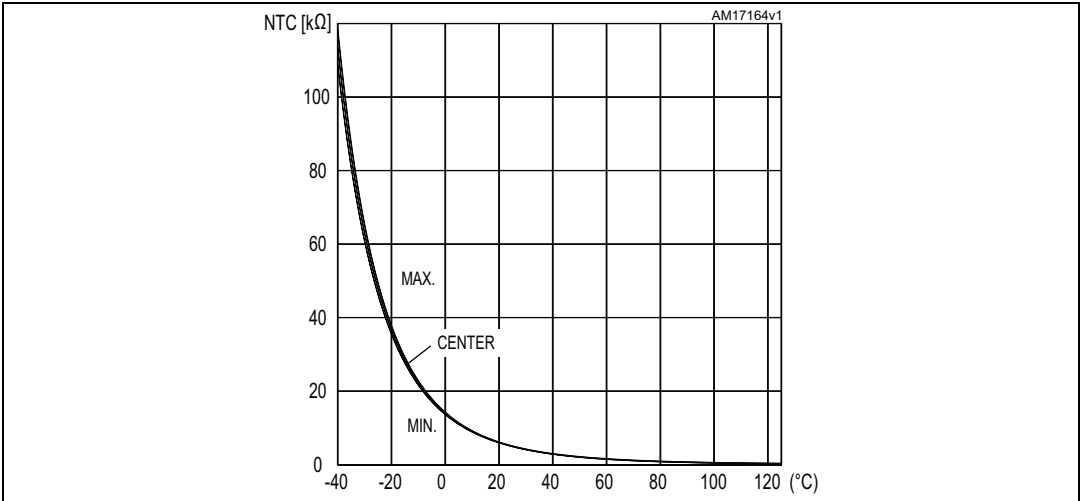
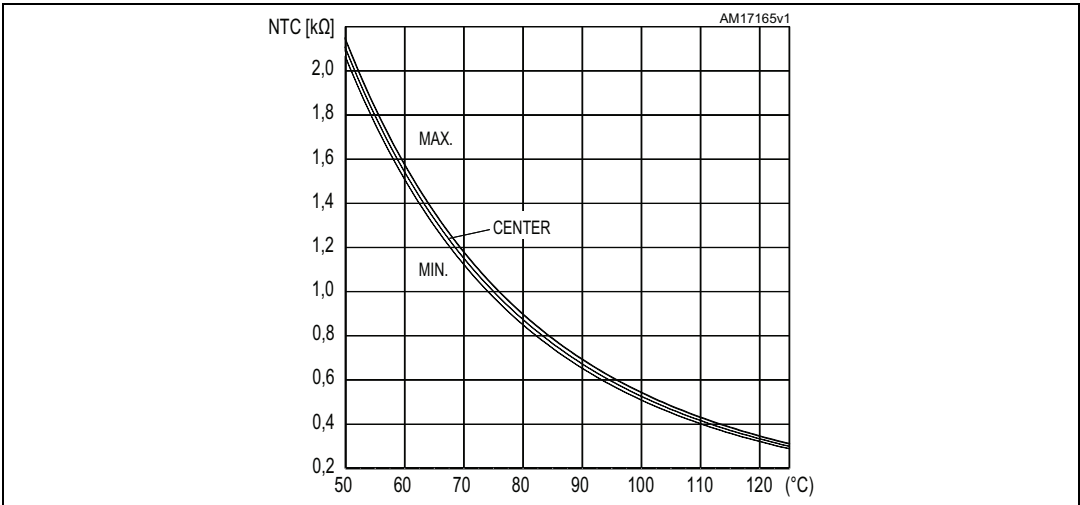
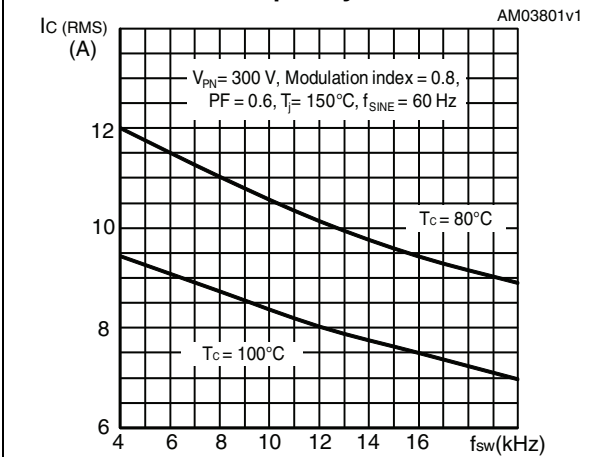


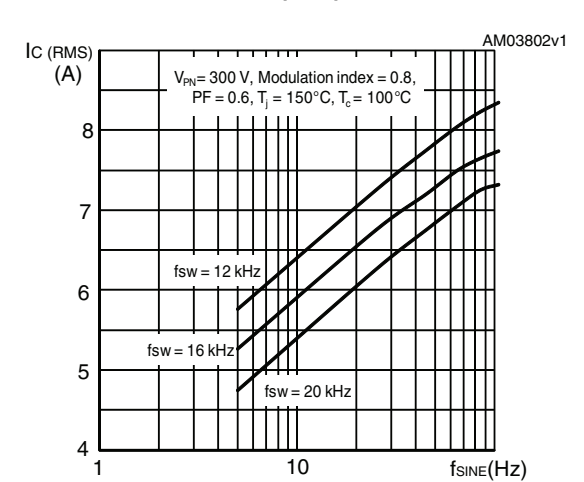
Figure 6. NTC resistance vs. temperature (zoom)



**Figure 7. Maximum  $I_{C(RMS)}$  current vs. switching frequency <sup>(1)</sup>**

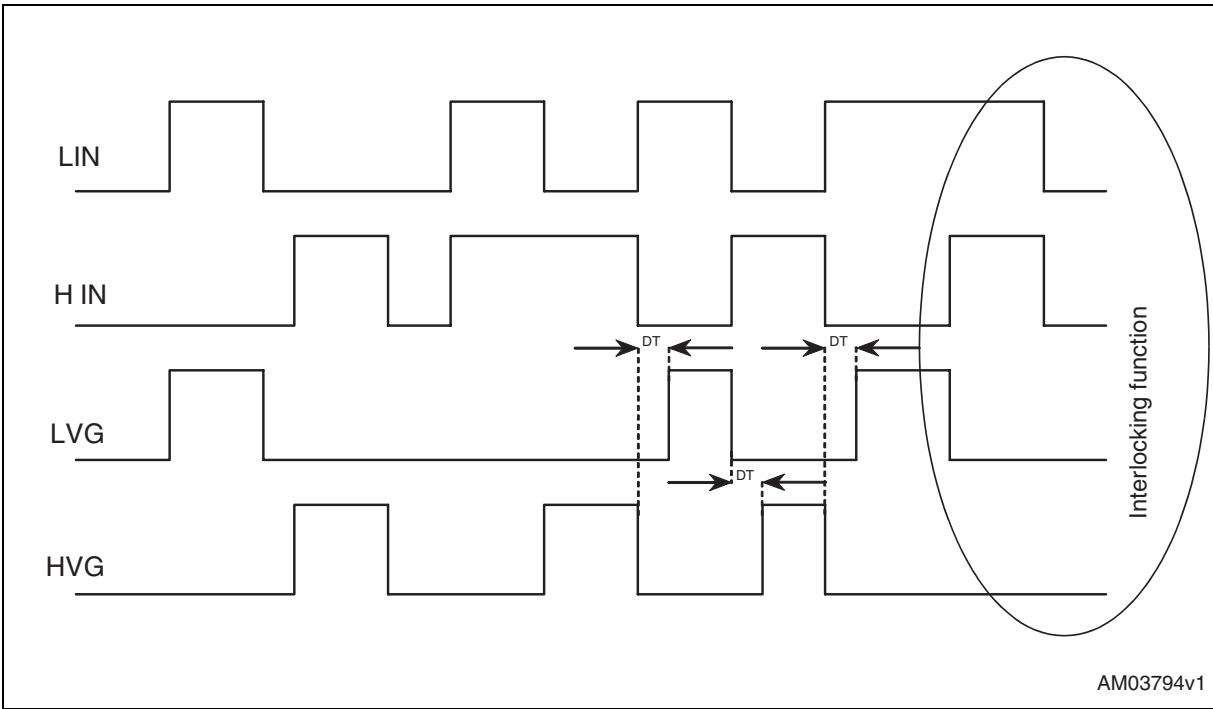


**Figure 8. Maximum  $I_{C(RMS)}$  current vs.  $f_{SINE}$  <sup>(1)</sup>**



1. Simulated curves refer to typical IGBT parameters and maximum  $R_{thj-c}$ .

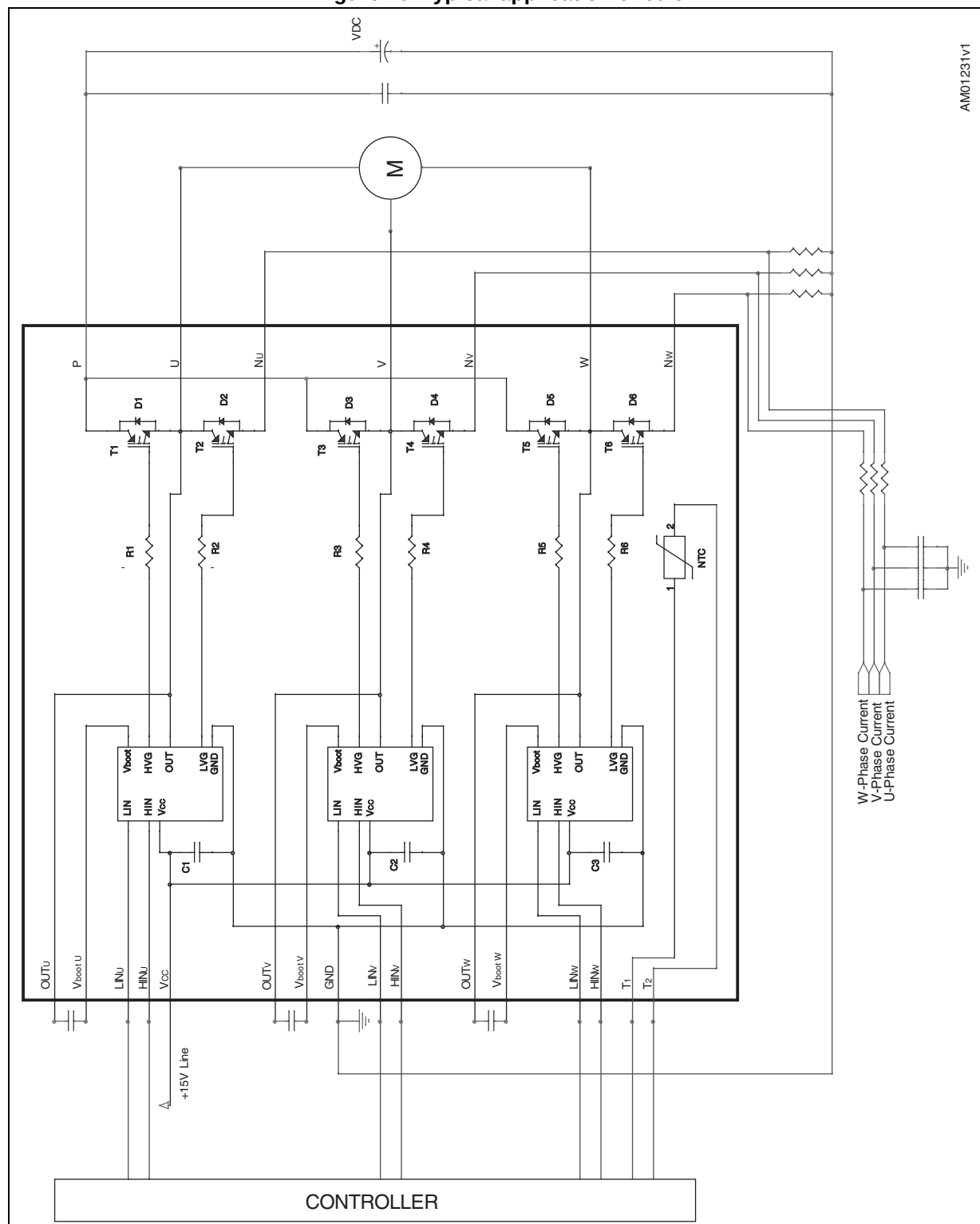
**Figure 9. Dead time and interlocking definition**



Minimum recommended dead time (DT) between low and high side logic input: 1  $\mu\text{s}$ .

## 4 Application information

**Figure 10. Typical application circuit**



## 4.1 Recommendations

- Input signal HIN,LIN are active-high logic. A 500 k $\Omega$  (typ.) pull down resistor is built-in for each high side input. If an external RC filter is used, for noise immunity, pay attention to the variation of the input signal level.
- To prevent the input signals oscillation, the wiring of each input should be as short as possible.
- By integrating an application specific type HVIC inside the module, direct coupling to MCU terminals without any opto-coupler is possible.
- Each capacitor should be located as nearby the pins of IPM as possible.
- Low inductance shunt resistors should be used for phase leg current sensing.
- Electrolytic bus capacitors should be mounted as close to the module bus terminals as possible. Additional high frequency ceramic capacitor mounted close to the module pins will further improve performance.

**Table 12. Recommended operating conditions**

| Symbol            | Parameter                          | Conditions                                                           | Min. | Typ. | Max. | Unit    |
|-------------------|------------------------------------|----------------------------------------------------------------------|------|------|------|---------|
| V <sub>PN</sub>   | Supply Voltage                     | Applied between P-Nu, Nv, Nw                                         |      | 300  | 400  | V       |
| V <sub>CC</sub>   | Control supply voltage             | Applied between V <sub>CC</sub> -GND                                 | 12   | 15   | 17   | V       |
| V <sub>BS</sub>   | High side bias voltage             | Applied between V <sub>BOOTi</sub> -OUT <sub>i</sub> for i = U, V, W | 11.5 |      | 17   | V       |
| t <sub>dead</sub> | Blanking time to prevent Arm-short | For each input signal                                                | 1    |      |      | $\mu$ s |
| f <sub>PWM</sub>  | PWM input signal                   | -40°C < T <sub>c</sub> < 100°C<br>-40°C < T <sub>j</sub> < 125°C     |      |      | 20   | kHz     |
| T <sub>C</sub>    | Case operation temperature         |                                                                      |      |      | 100  | °C      |

Refer to AN3338 for further details.

## 5 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](http://www.st.com). ECOPACK is an ST trademark.

Please refer to dedicated technical note TN0107 for mounting instructions.

### 5.1 SDIP-25L package information

Figure 11. SDIP-25L package outline

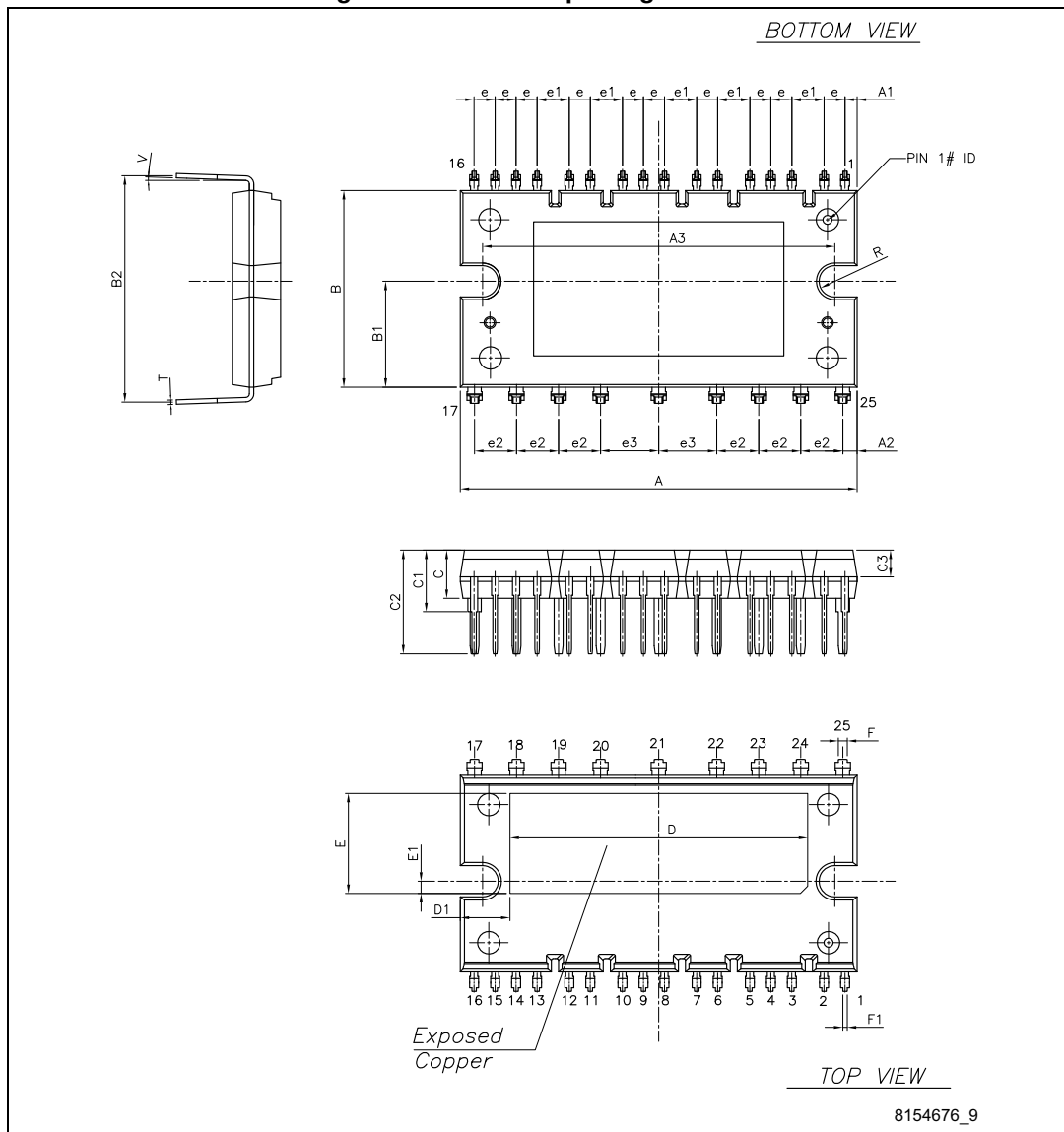
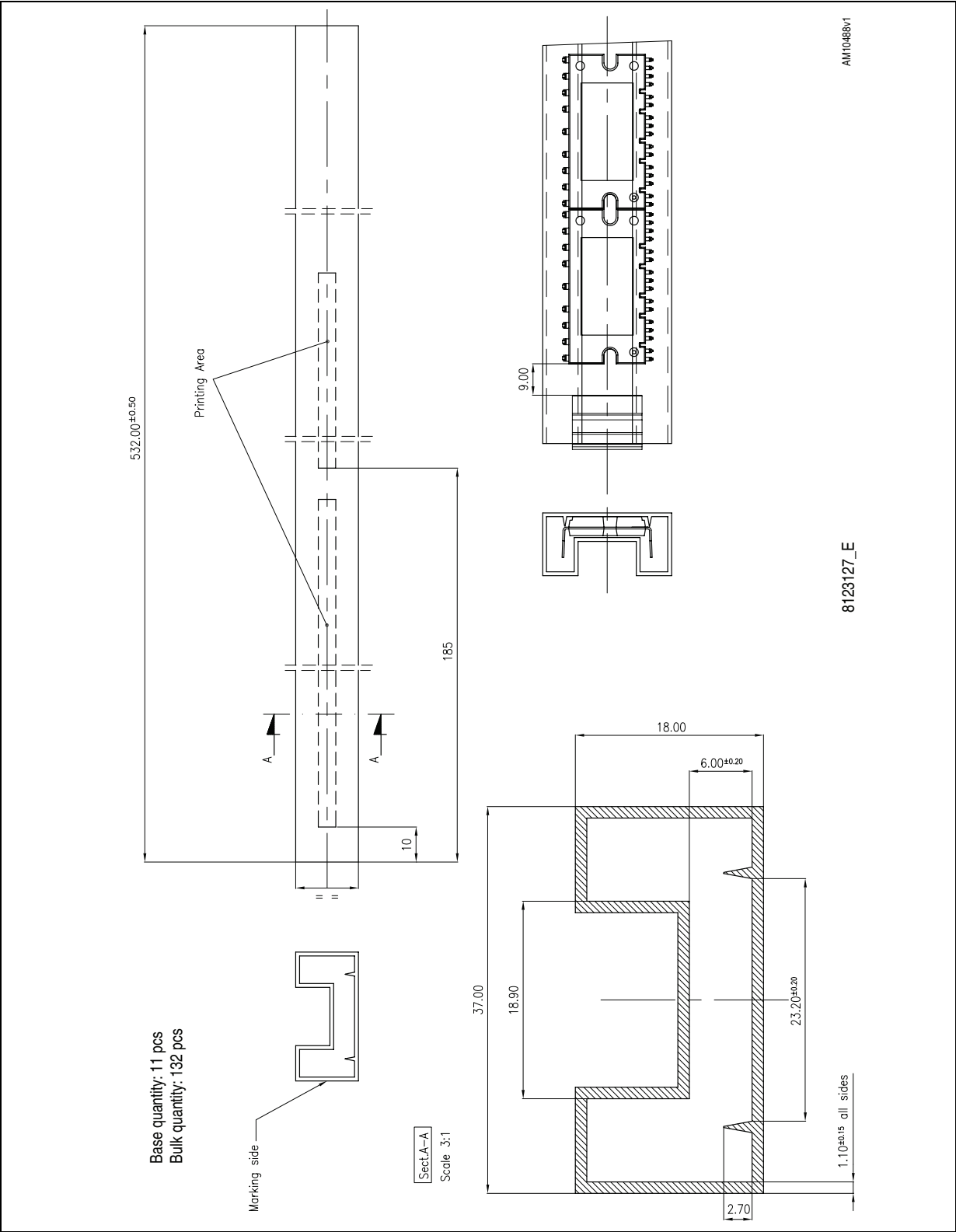


Table 13. SDIP-25L mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 43.90 | 44.40 | 44.90 |
| A1   | 1.15  | 1.35  | 1.55  |
| A2   | 1.40  | 1.60  | 1.80  |
| A3   | 38.90 | 39.40 | 39.90 |
| B    | 21.50 | 22.00 | 22.50 |
| B1   | 11.25 | 11.85 | 12.45 |
| B2   | 24.83 | 25.23 | 25.63 |
| C    | 5.00  | 5.40  | 6.00  |
| C1   | 6.50  | 7.00  | 7.50  |
| C2   | 11.20 | 11.70 | 12.20 |
| C3   | 2.90  | 3.00  | 3.10  |
| e    | 2.15  | 2.35  | 2.55  |
| e1   | 3.40  | 3.60  | 3.80  |
| e2   | 4.50  | 4.70  | 4.90  |
| e3   | 6.30  | 6.50  | 6.70  |
| D    |       | 33.30 |       |
| D1   |       | 5.55  |       |
| E    |       | 11.20 |       |
| E1   |       | 1.40  |       |
| F    | 0.85  | 1.00  | 1.15  |
| F1   | 0.35  | 0.50  | 0.65  |
| R    | 1.55  | 1.75  | 1.95  |
| T    | 0.45  | 0.55  | 0.65  |
| V    | 0°    |       | 6°    |

5.2 Packing information

Figure 12. SDIP-25L packing information





## 6 Revision history

**Table 14. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16-Apr-2009 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 11-May-2009 | 2        | Added <a href="#">Figure 7</a> and <a href="#">Figure 8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 17-Jul-2009 | 3        | Reduced $V_{CE(sat)}$ value on <a href="#">Table 7</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 06-Apr-2010 | 4        | Document promoted from preliminary data to datasheet.<br>Inserted <a href="#">Figure 3: Switching time test circuit</a> and <a href="#">Table 12: Recommended operating conditions</a> .<br>Updated <a href="#">Table 5: Total system</a> , <a href="#">Table 6: Thermal data</a> , <a href="#">Table 7: Inverter part</a> , <a href="#">Figure 5: NTC resistance vs. temperature</a> , <a href="#">Figure 7: Maximum IC(RMS) current vs. switching frequency</a> , <a href="#">Figure 8: Maximum IC(RMS) current vs. fSINE (1)</a> and <a href="#">Section 5: Package information</a> . |
| 15-Jun-2010 | 5        | Updated <a href="#">Table 7: Inverter part</a> .<br>Minor text changes to improve readability.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 17-Nov-2010 | 6        | Updated <a href="#">Table 3</a> , <a href="#">5</a> , <a href="#">11</a> and <a href="#">12</a> .<br>Modified <a href="#">Figure 7</a> and <a href="#">Figure 8</a> .                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 07-Mar-2011 | 7        | Updated title with SLLIMM™ in cover page, added SDIP-25L tube dimensions <a href="#">Figure 12 on page 16</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 04-Nov-2011 | 8        | Updated title with SLLIMM™ (small low-loss intelligent molded module) IPM, 3-phase inverter - 10 A, 600 V short-circuit rugged IGBT in cover page and SDIP-25L mechanical data <a href="#">Table 13 on page 14</a> , <a href="#">Figure 11 on page 14</a> .                                                                                                                                                                                                                                                                                                                              |
| 28-Aug-2012 | 9        | Modified: Min. and Max. value <a href="#">Table 4 on page 5</a> .<br>Updated: <a href="#">Table 13 on page 14</a> , <a href="#">Figure 11 on page 14</a> and <a href="#">Figure 12 on page 16</a> .<br>Added: <a href="#">Figure 13 on page 17</a> .                                                                                                                                                                                                                                                                                                                                     |
| 02-May-2013 | 10       | Modified: <a href="#">Figure 3 on page 8</a> and <a href="#">Figure 5 on page 10</a> .<br>Added: <a href="#">Figure 6 on page 10</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 13-Apr-2015 | 11       | Text edits and formatting changes throughout document<br>Updated <a href="#">Figure 2: Pin layout (bottom view)</a><br>Updated <a href="#">Section 5: Package information</a>                                                                                                                                                                                                                                                                                                                                                                                                            |

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