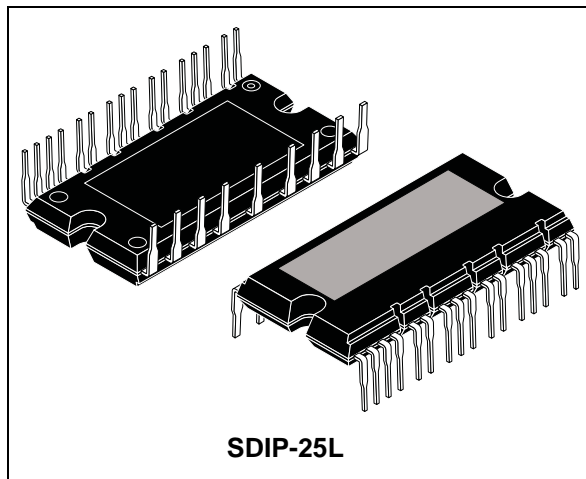


## SLLIMM™ (small low-loss intelligent molded module) IPM, 3-phase inverter - 10 A, 600 V short-circuit rugged IGBT

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
- Under-voltage lockout
- Internal bootstrap diode
- Interlocking function
- DBC substrate leading to low thermal resistance
- Isolation rating of 2500 Vrms/min.
- 5 k $\Omega$  NTC thermistor for temperature control
- UL recognized : UL1557 file E81734

**Table 1. Device summary**

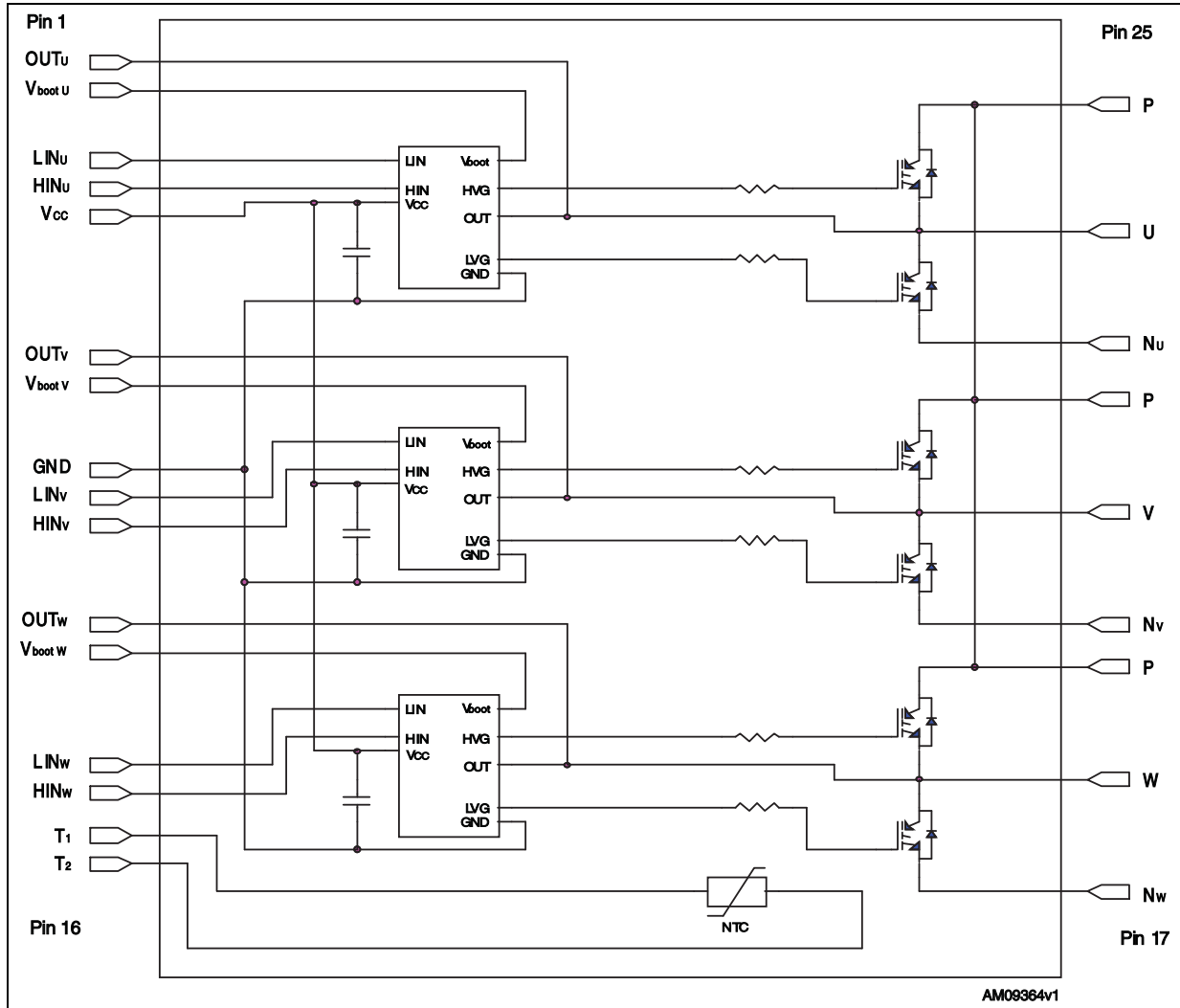
Order code	Marking	Package	Packaging
STGIPS10K60A	GIPS10K60A	SDIP-25L	Tube

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# 1 Internal block diagram and pin configuration

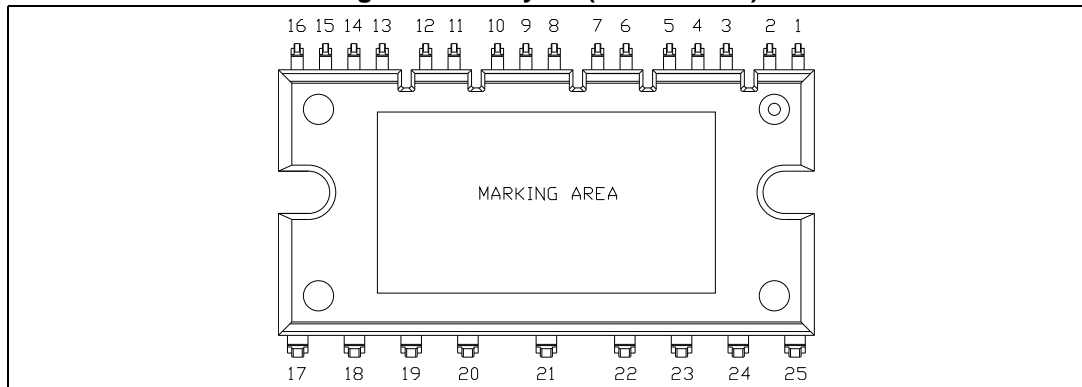
Figure 1. Internal block diagram



**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, $V_{CE} = 0.5 V_{(BR)CES}$ $T_j = 125^\circ\text{C}$ , $V_{CC} = V_{boot} = 15\text{ V}$ , $V_{IN(1)} = 5\text{ V}$	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.

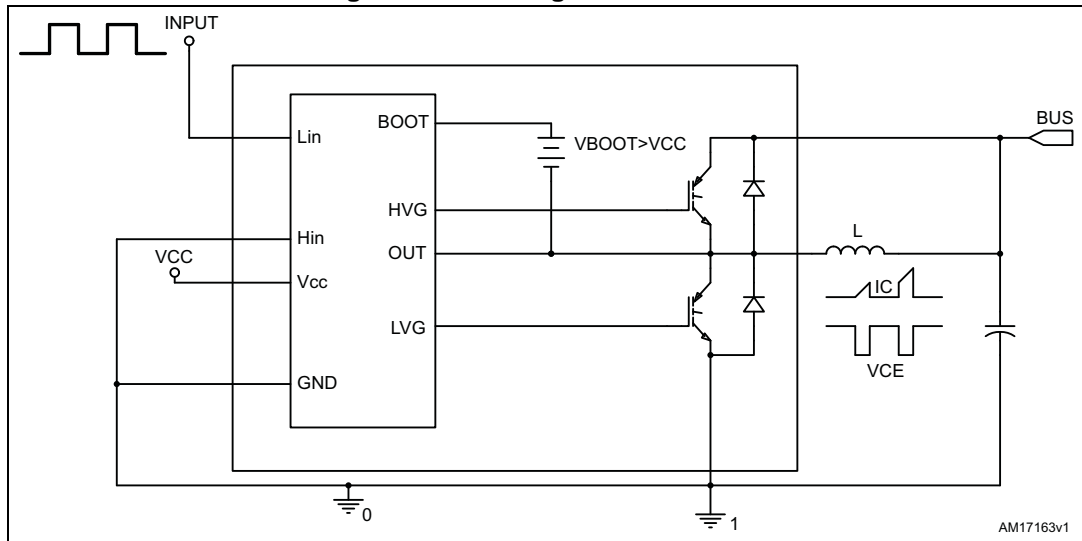
**Table 7. Inverter part**

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{CC} = V_{boot} = 15\text{ V}$ , $V_{IN}^{(1)} = 5\text{ V}$ , $I_C = 5\text{ A}$	-	2.1	2.5	V
		$V_{CC} = V_{boot} = 15\text{ V}$ , $V_{IN}^{(1)} = 5\text{ V}$ , $I_C = 5\text{ A}$ , $T_j = 125^\circ\text{C}$	-	1.8		
$I_{CES}$	Collector-cut off current ( $V_{IN}^{(1)} = 0$ "logic state")	$V_{CE} = 550\text{ V}$ $V_{CC} = V_{boot} = 15\text{ V}$	-		150	$\mu\text{A}$
$V_F$	Diode forward voltage	$V_{IN}^{(1)} = 0$ "logic state", $I_C = 5\text{ A}$	-		1.9	V
<b>Inductive load switching time and energy</b>						
$t_{on}$	Turn-on time	$V_{DD} = 300\text{ V}$ , $V_{CC} = V_{boot} = 15\text{ V}$ , $V_{IN}^{(1)} = 0 \div 5\text{ V}$ , $I_C = 5\text{ A}$ (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  $i = U, V, W$ .

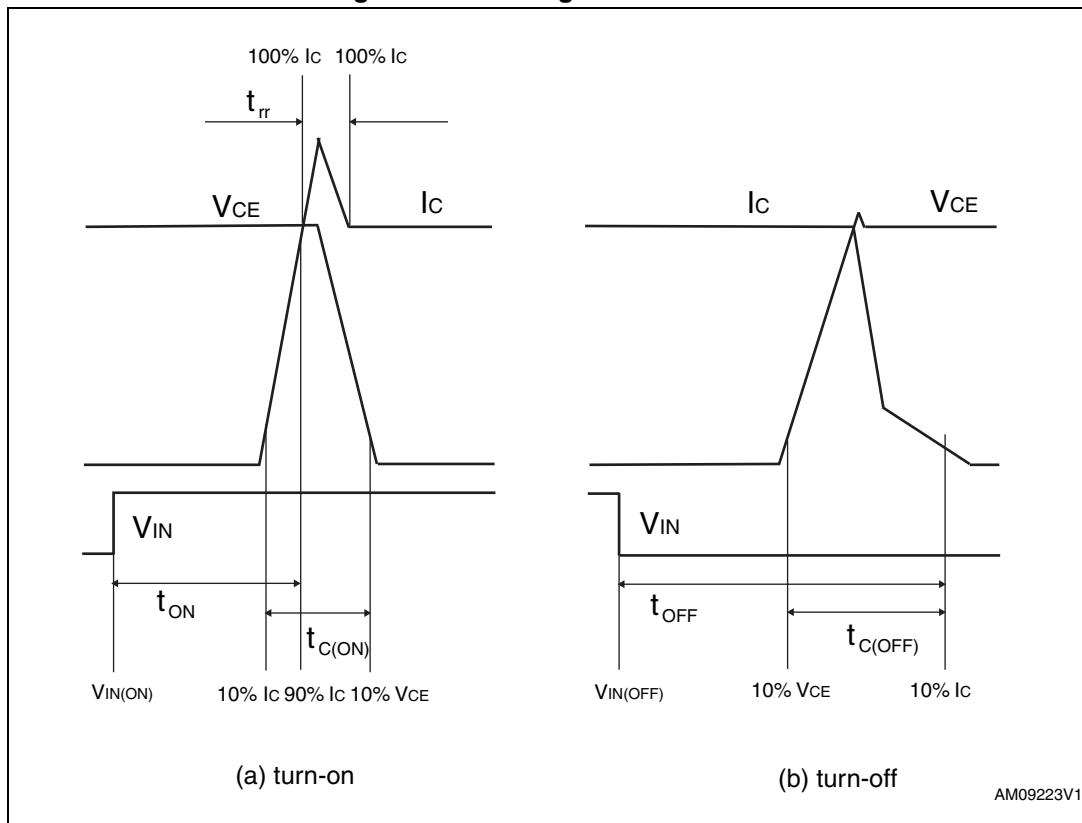
*Note:*  $t_{ON}$  and  $t_{OFF}$  include the propagation delay time of the internal drive.  $t_{C(ON)}$  and  $t_{C(OFF)}$  are the switching time of IGBT itself under the internally given gate driving condition.

Figure 3. Switching time test circuit



AM17163v1

Figure 4. Switching time definition



AM09223V1



### 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	$V_{IN}^{(2)} = 0$	-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

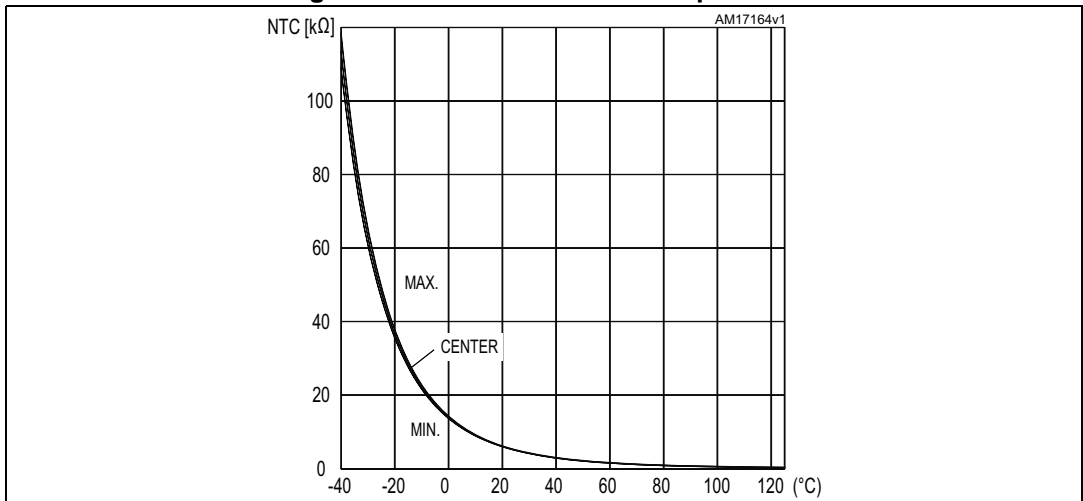


Figure 6. NTC resistance vs. temperature (zoom)

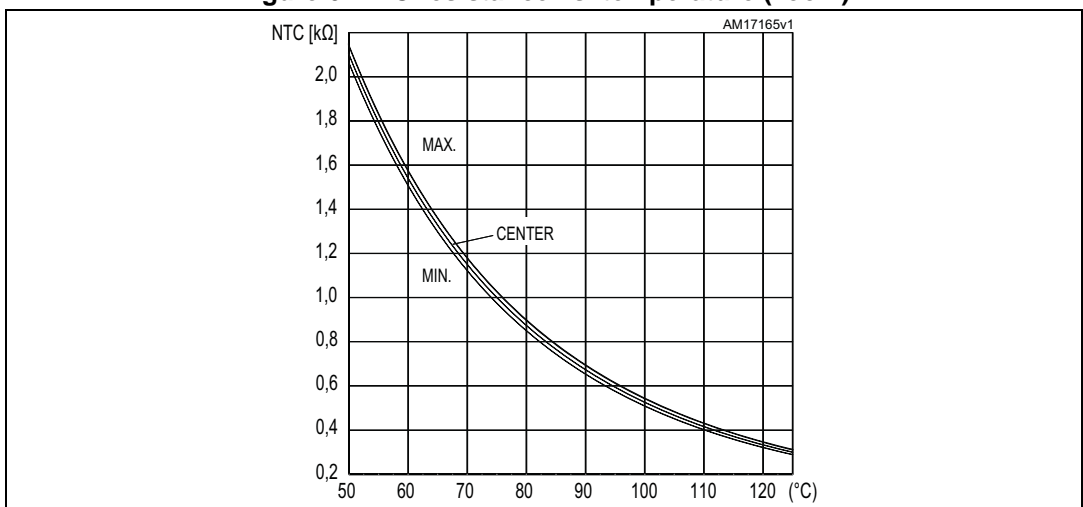


Figure 7. Maximum  $I_{C(RMS)}$  current vs. switching frequency <sup>(1)</sup>

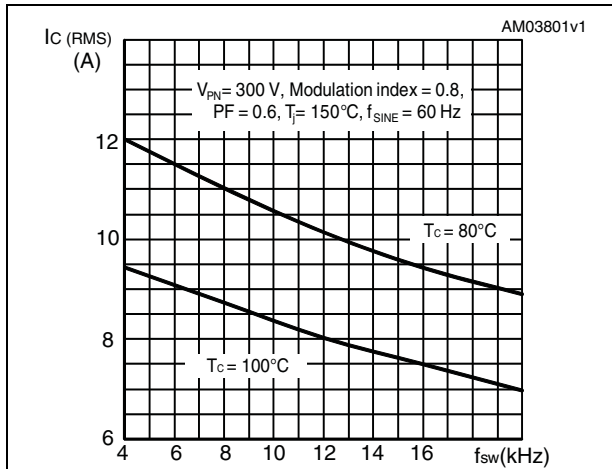
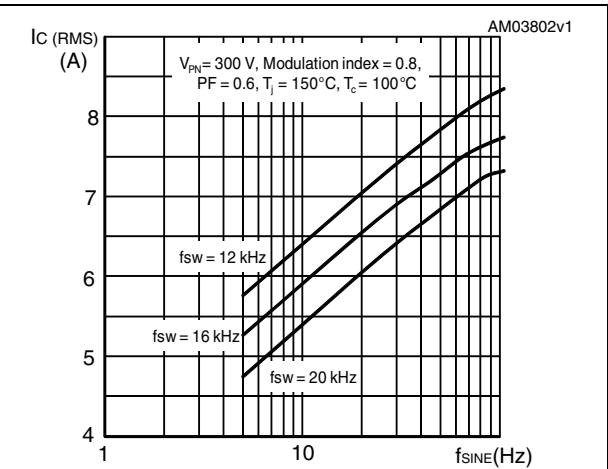
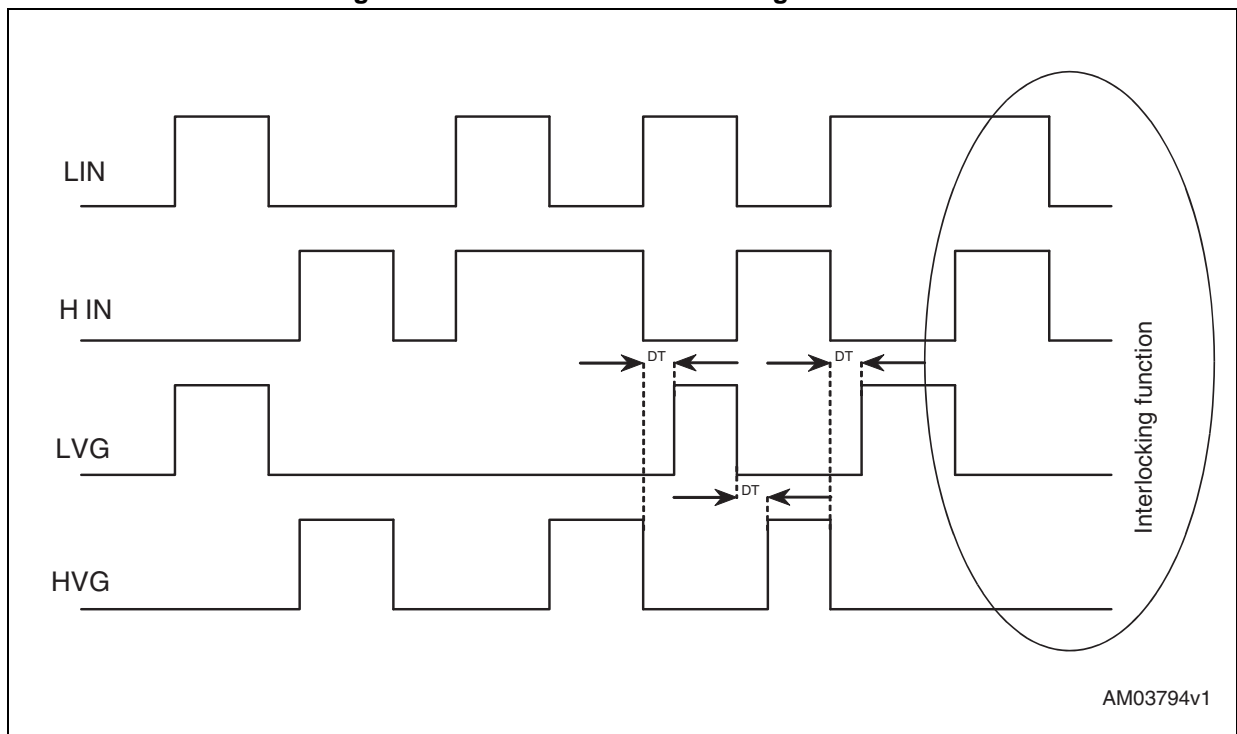


Figure 8. Maximum  $I_{C(RMS)}$  current vs.  $f_{SINE}$  <sup>(1)</sup>



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

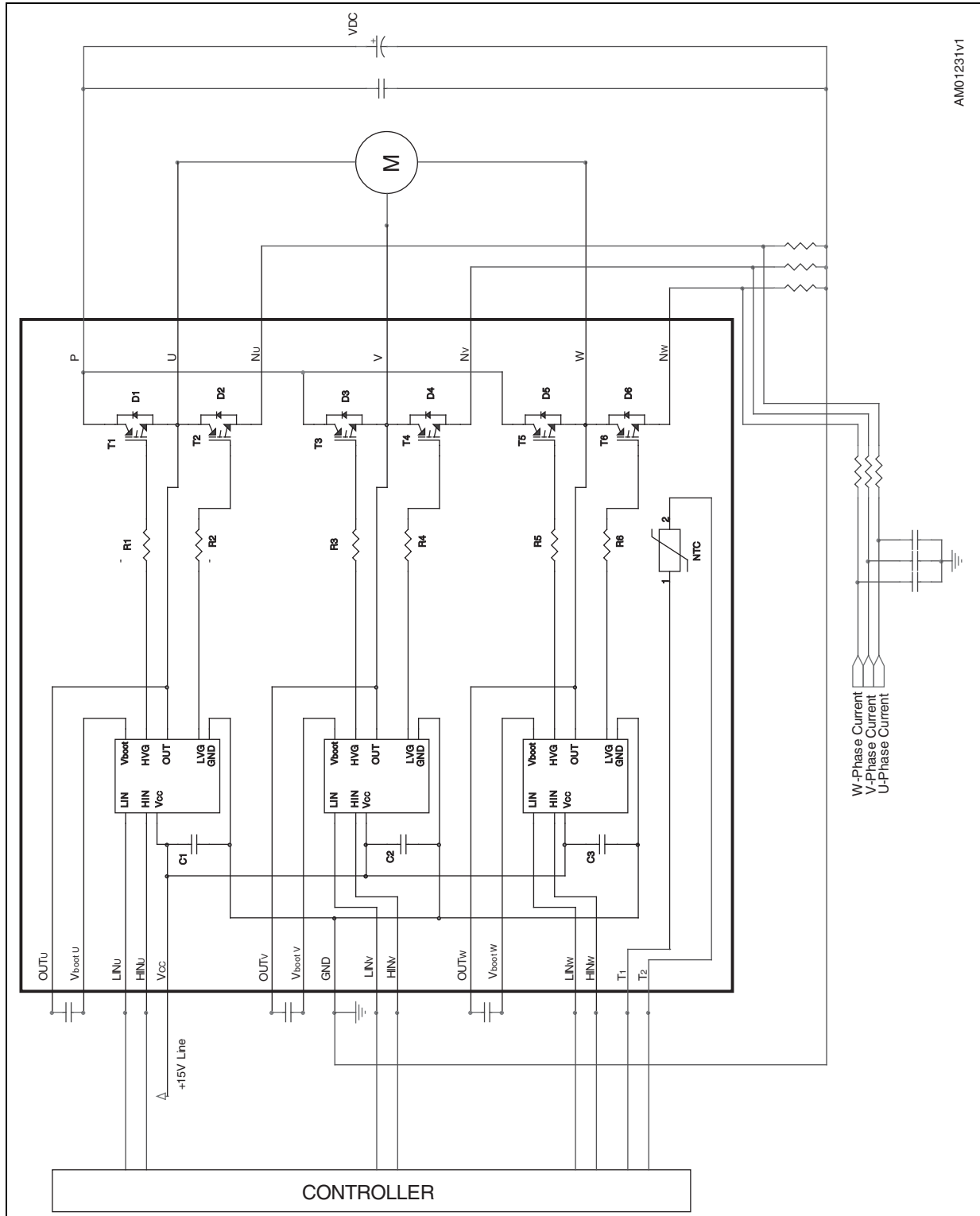
Figure 9. Dead time and interlocking definition



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 -40°C < T <sub>j</sub> < 125°C			20	kHz
T <sub>C</sub>	Case operation temperature				100	°C

For further details refer to AN3338.

## 5 Package mechanical data

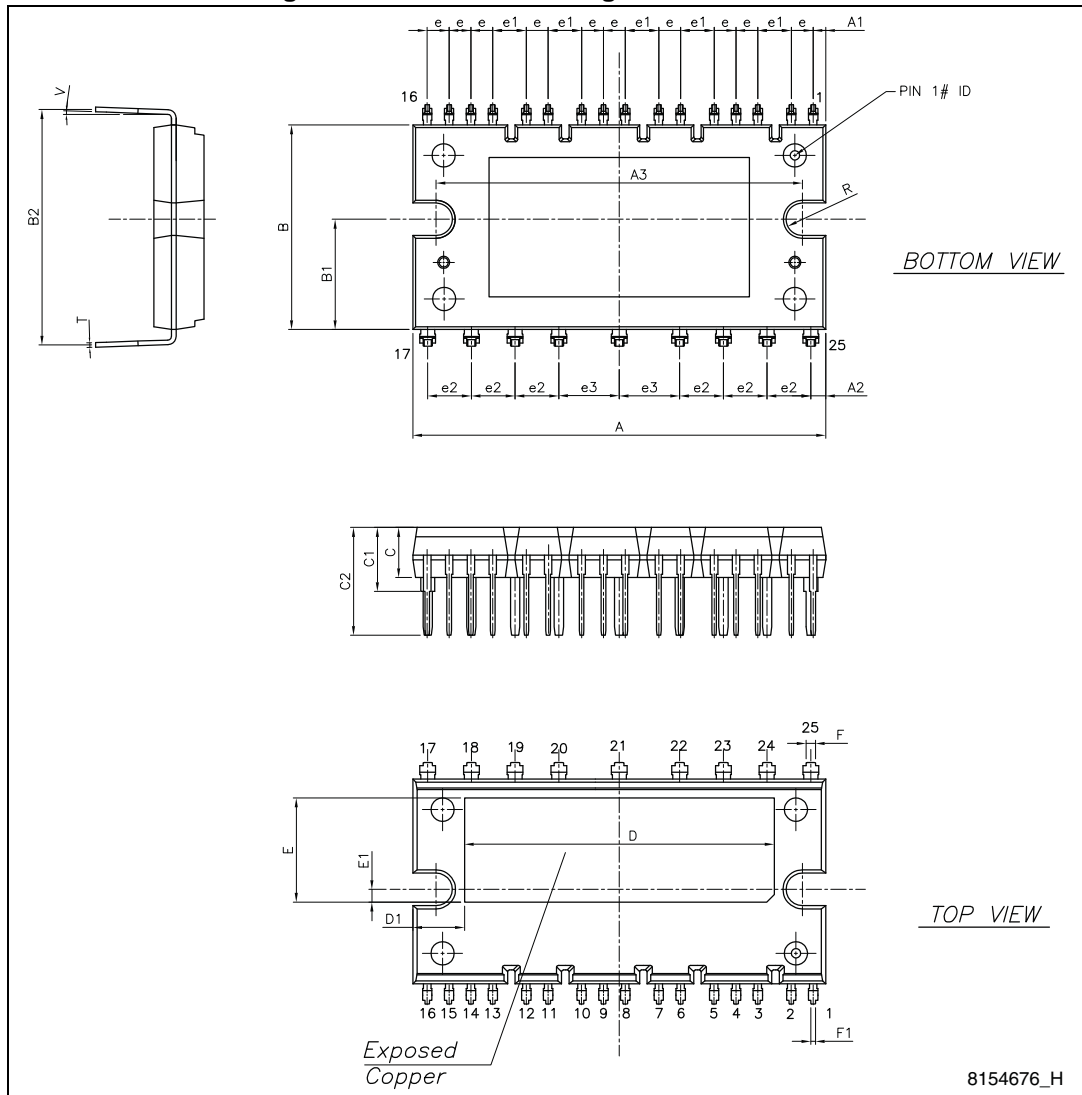
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK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

Please refer to dedicated technical note TN0107 for mounting instructions.

**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
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°

Figure 11. SDIP-25L drawing dimensions data



8154676\_H

Figure 12. Packaging specifications of SDIP-25L package

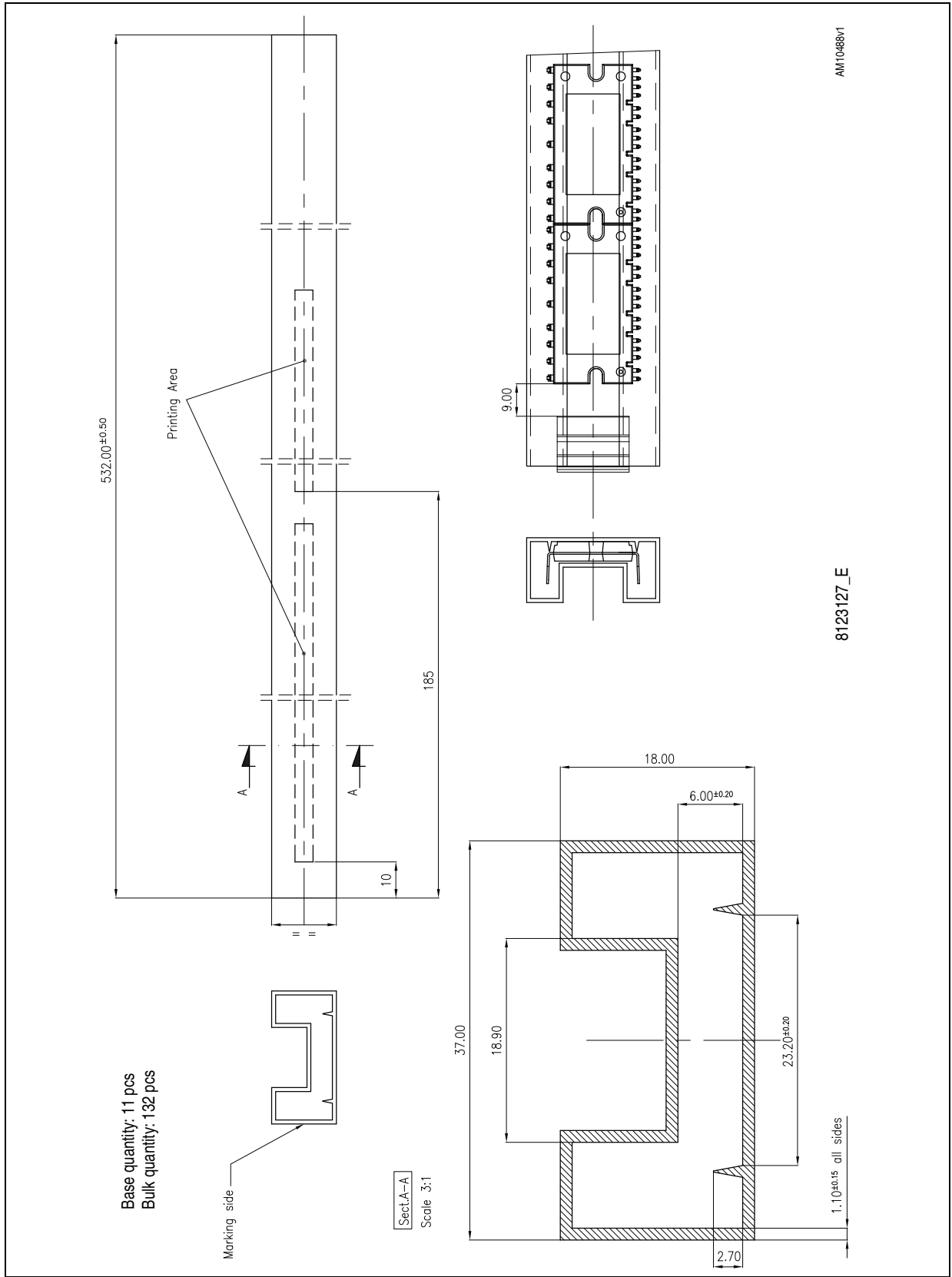
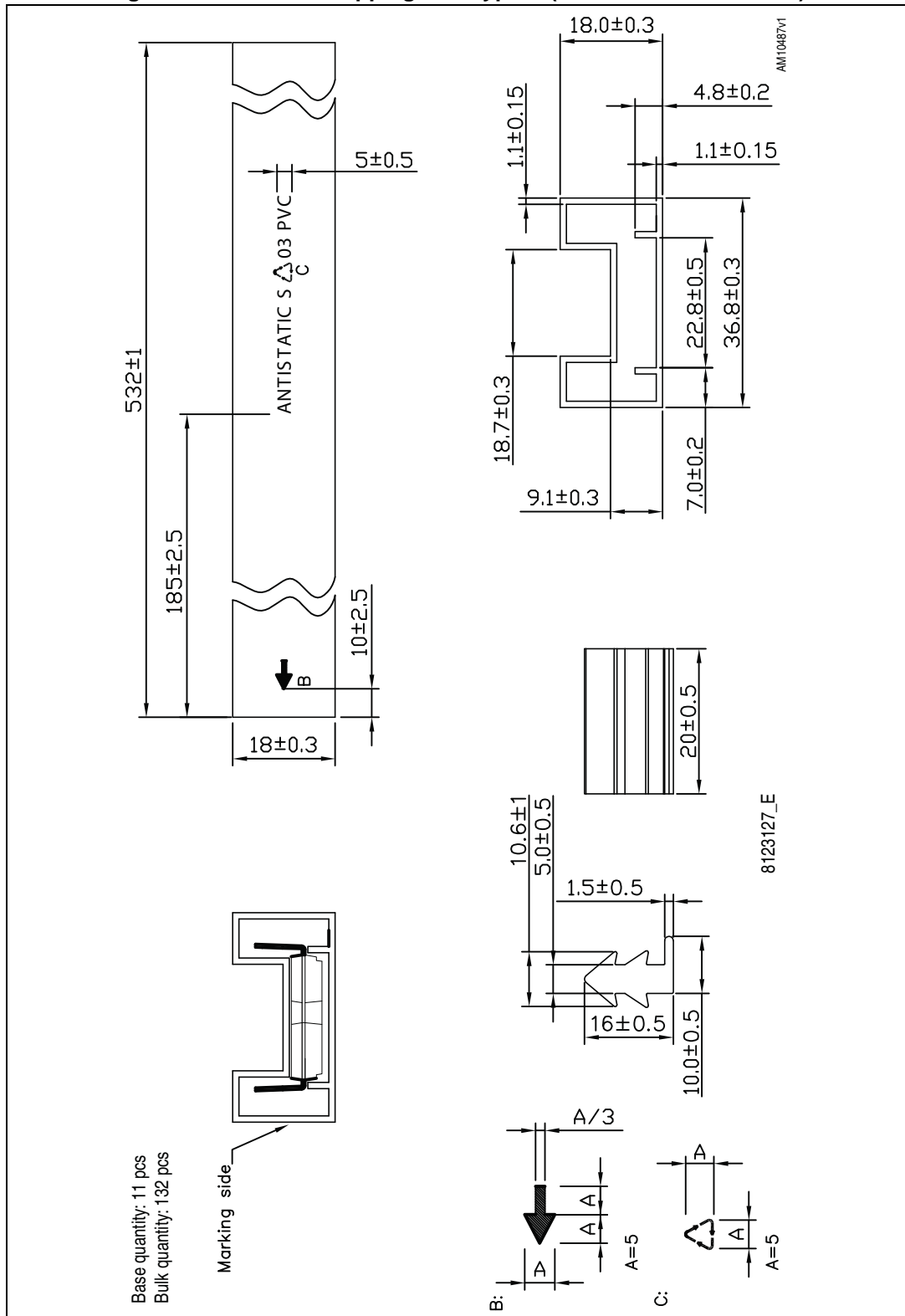




Figure 13. SDIP-25L shipping tube type B (dimensions are in mm.)



## 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. Inserted <a href="#">Figure 3: Switching time test circuit</a> and <a href="#">Table 12: Recommended operating conditions</a> . 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 mechanical data</a> .
15-Jun-2010	5	Updated <a href="#">Table 7: Inverter part</a> . 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> . 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 15</a> .
28-Aug-2012	9	Modified: Min. and Max. value <a href="#">Table 4 on page 5</a> . Updated: <a href="#">Table 13 on page 14</a> , <a href="#">Figure 11 on page 15</a> and <a href="#">Figure 12 on page 16</a> . 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> . Added: <a href="#">Figure 6 on page 10</a> .

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