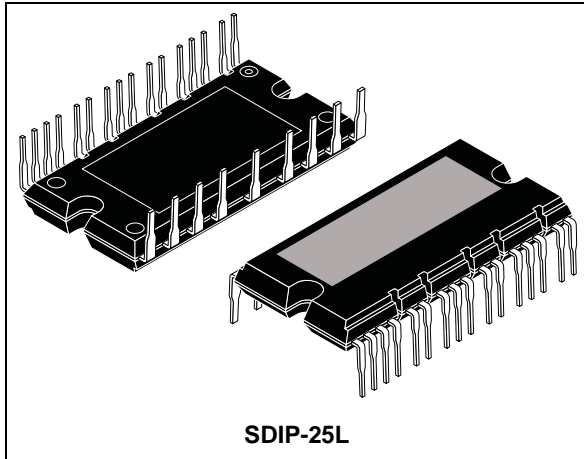


## SLLIMM™ small low-loss intelligent molded module IPM, 3-phase inverter, 10 A, 600 V short-circuit rugged IGBT

Datasheet - production data



### Features

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

### Applications

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

### 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.

**Table 1. Device summary**

Order code	Marking	Package	Packing
STGIPS10K60T-H	GIPS10K60T-H	SDIP-25L	Tube

# Contents

- 1 Internal block diagram and pin configuration ..... 3**
- 2 Electrical ratings ..... 5**
  - 2.1 Absolute maximum ratings ..... 5
  - 2.2 Thermal data ..... 6
- 3 Electrical characteristics ..... 7**
  - 3.1 Control part ..... 9
    - 3.1.1 NTC thermistor ..... 11
  - 3.2 Waveform definitions ..... 12
- 4 Applications information ..... 13**
  - 4.1 Recommendations ..... 14
- 5 Package information ..... 15**
  - 5.1 SDIP-25L package information ..... 15
  - 5.2 Packing information ..... 17
- 6 Revision history ..... 18**

# 1 Internal block diagram and pin configuration

Figure 1. Internal block diagram

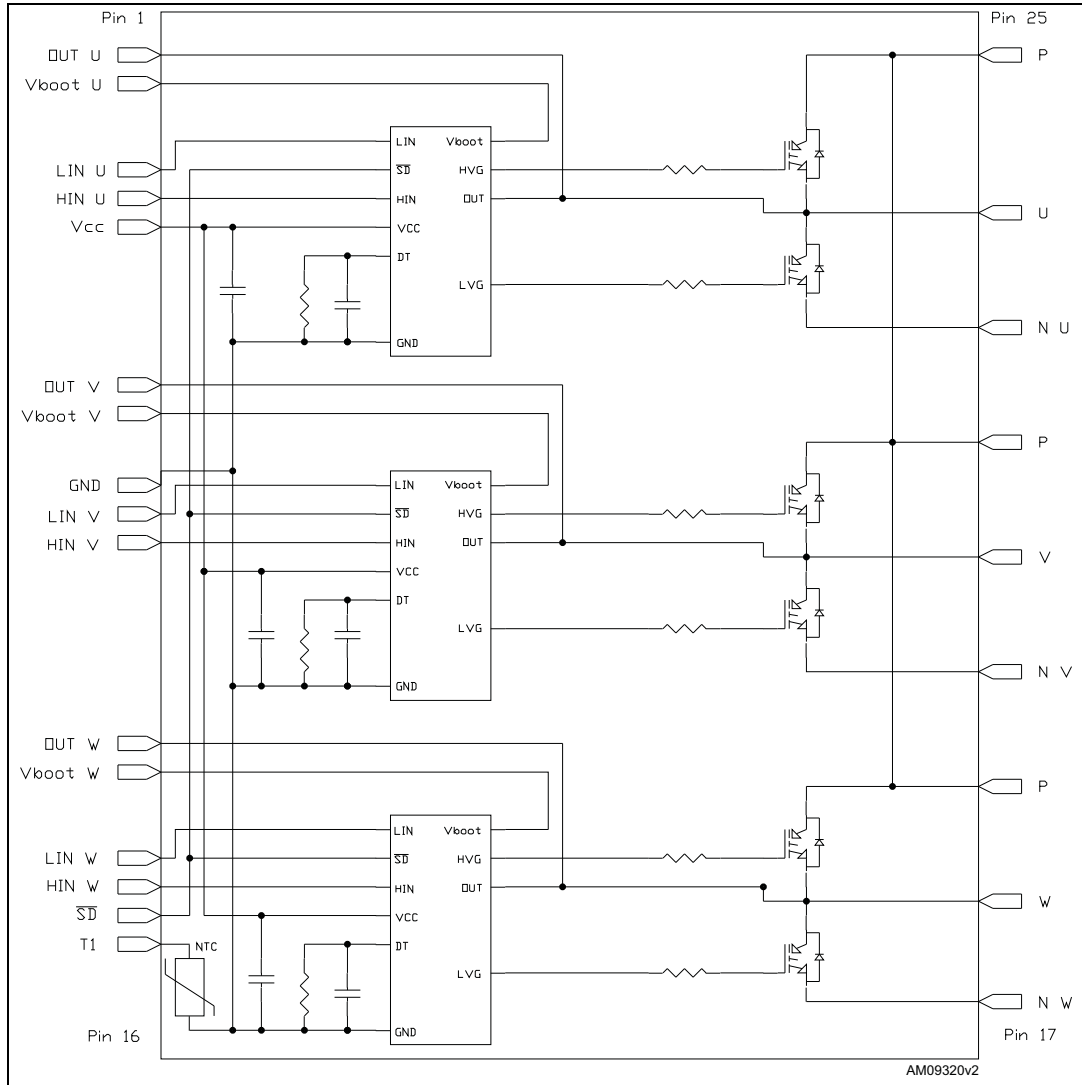
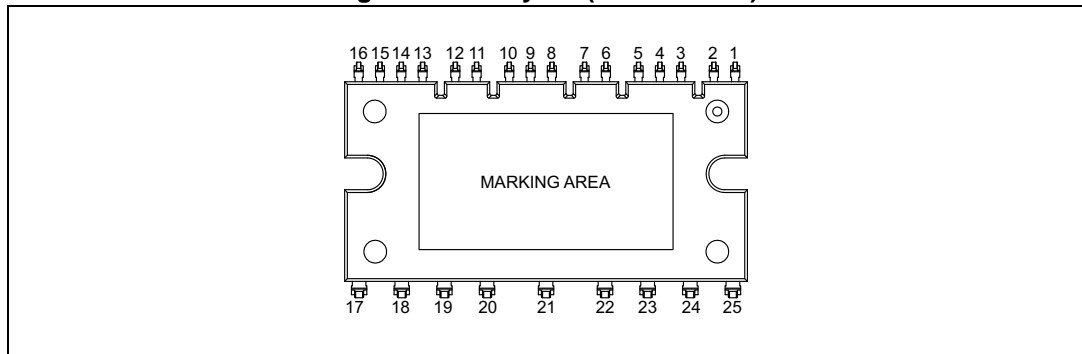


Table 2. Pin description

Pin n°	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	SD	Shut down logic input (active low)
16	T1	NTC thermistor terminal
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	$V_{boot} - 21$	$V_{boot} + 0.3$	V
$V_{CC}$	Low voltage power supply	- 0.3	21	V
$V_{boot}$	Bootstrap voltage	- 0.3	620	V
$V_{IN}$	Logic input voltage applied between $HIN$ , $LIN$ and GND	- 0.3	15	V
$V_{SD}$	Open drain voltage	- 0.3	15	V
$dV_{OUT}/dt$	Allowed output slew rate		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
$T_C$	Module case operation temperature	-40 to 125	$^\circ\text{C}$
$T_J$	Power chips operating junction temperature	-40 to 150	$^\circ\text{C}$

## 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<sub>J</sub> = 25 °C unless otherwise specified.

Table 7. Inverter part

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
V <sub>CE(sat)</sub>	Collector-emitter saturation voltage	V <sub>CC</sub> = V <sub>boot</sub> = 15 V, V <sub>IN</sub> <sup>(1)</sup> = 5 V, I <sub>C</sub> = 5 A	-	2.1	2.5	V
		V <sub>CC</sub> = V <sub>boot</sub> = 15 V, V <sub>IN</sub> <sup>(1)</sup> = 5 V, I <sub>C</sub> = 5 A, T <sub>J</sub> = 125 °C	-	1.8		
I <sub>CES</sub>	Collector-cut off current (V <sub>IN</sub> <sup>(1)</sup> = 0 "logic state")	V <sub>CE</sub> = 550 V V <sub>CC</sub> = V <sub>boot</sub> = 15 V	-		150	µA
V <sub>F</sub>	Diode forward voltage	(V <sub>IN</sub> <sup>(1)</sup> = 0 "logic state"), I <sub>C</sub> = 5 A	-		1.9	V
<b>Inductive load switching time and energy</b>						
t <sub>on</sub>	Turn-on time	V <sub>DD</sub> = 300 V, V <sub>CC</sub> = V <sub>boot</sub> = 15 V, V <sub>IN</sub> <sup>(1)</sup> = 0 ÷ 5 V I <sub>C</sub> = 5 A (see <a href="#">Figure 4</a> )	-	320	-	ns
t <sub>c(on)</sub>	Crossover time (on)		-	70	-	
t <sub>off</sub>	Turn-off time		-	430	-	
t <sub>c(off)</sub>	Crossover time (off)		-	135	-	
t <sub>rr</sub>	Reverse recovery time		-	130	-	
E <sub>on</sub>	Turn-on switching losses		-	65	-	µJ
E <sub>off</sub>	Turn-off switching losses		-	75	-	

1. Applied between HIN<sub>i</sub>, LIN<sub>i</sub> and GND for i = U, V, W.

Note: t<sub>ON</sub> and t<sub>OFF</sub> include the propagation delay time of the internal drive. t<sub>C(ON)</sub> and t<sub>C(OFF)</sub> are the switching time of IGBT itself under the internally given gate driving condition.

Figure 3. Switching time test circuit

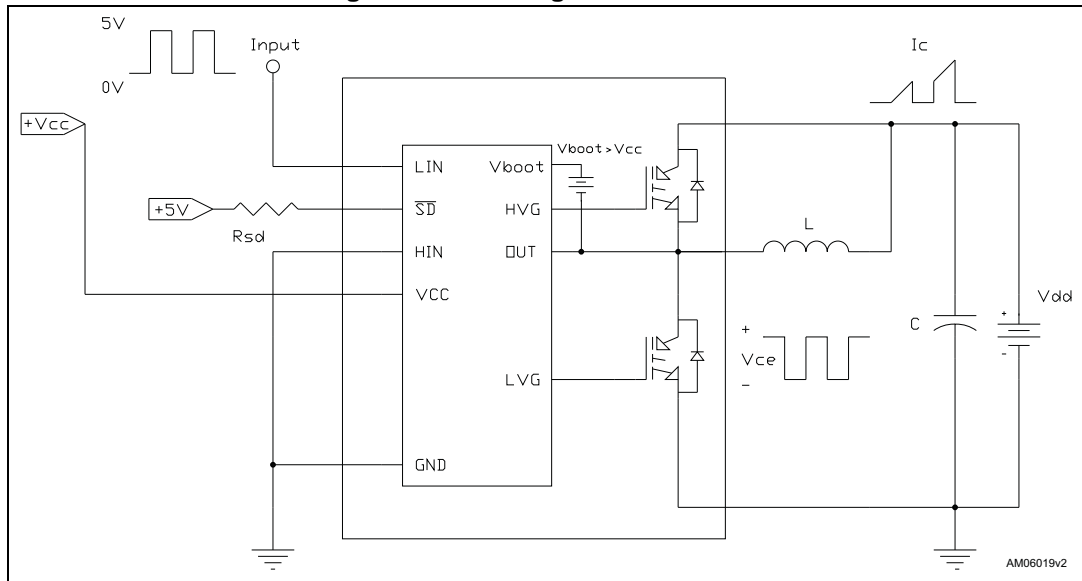
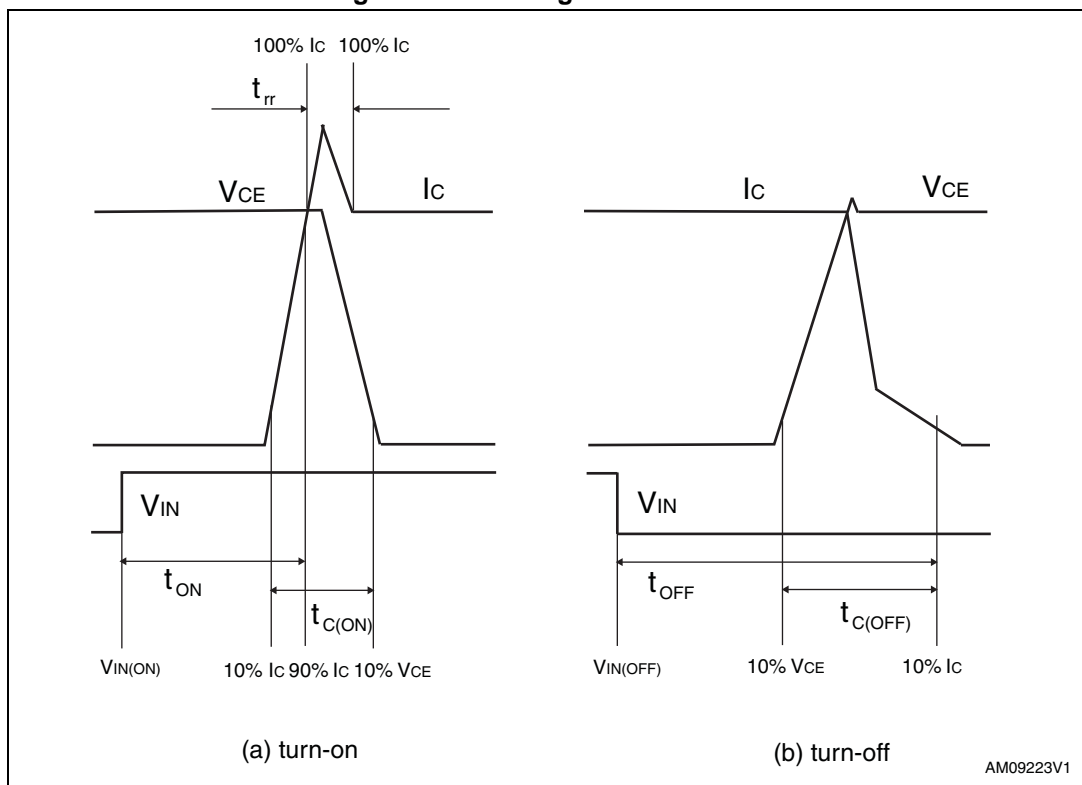


Figure 4. Switching time definition



Note: Figure 4 "Switching time definition" refers to HIN, LIN inputs (active high).



### 3.1 Control part

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{CC\_hys}$	$V_{CC}$ UV hysteresis		1.2	1.5	1.8	V
$V_{CC\_thON}$	$V_{CC}$ UV turn ON threshold		11.5	12	12.5	V
$V_{CC\_thOFF}$	$V_{CC}$ UV turn OFF threshold		10	10.5	11	V
$I_{qccu}$	Undervoltage quiescent supply current	$V_{CC} = 10\text{ V}$ $\overline{SD} = 5\text{ V}; LIN = 0\text{ V};$ $H_{IN} = 0$			450	$\mu\text{A}$
$I_{qcc}$	Quiescent current	$V_{CC} = 15\text{ V}$ $\overline{SD} = 5\text{ V}; LIN = 0\text{ V}$ $H_{IN} = 0$			3.5	mA

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{BS\_hys}$	$V_{BS}$ UV hysteresis		1.2	1.5	1.8	V
$V_{BS\_thON}$	$V_{BS}$ UV turn ON threshold		11.1	11.5	12.1	V
$V_{BS\_thOFF}$	$V_{BS}$ UV turn OFF threshold		9.8	10	10.6	V
$I_{QBSU}$	Undervoltage $V_{BS}$ quiescent current	$V_{BS} = 9\text{ V}$ $\overline{SD} = 5\text{ V}; LIN = 0$ $H_{IN} = 5\text{ V}$		70	110	$\mu\text{A}$
$I_{QBS}$	$V_{BS}$ quiescent current	$V_{BS} = 15\text{ V}$ $\overline{SD} = 5\text{ V}; LIN = 0$ $H_{IN} = 5\text{ V}$		200	300	$\mu\text{A}$
$R_{DS(on)}$	Bootstrap driver on resistance	LVG ON		120		W

**Table 10. Logic inputs ( $V_{CC} = 15\text{ V}$  unless otherwise specified)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{il}$	Low logic level voltage		0.8		1.1	V
$V_{ih}$	High logic level voltage		1.9		2.25	V
$I_{HINh}$	HIN logic "1" input bias current	$H_{IN} = 15\text{ V}$	20	40	100	$\mu\text{A}$
$I_{HINl}$	HIN logic "0" input bias current	$H_{IN} = 0\text{ V}$			1	$\mu\text{A}$
$I_{LINh}$	LIN logic "1" input bias current	$LIN = 15\text{ V}$	20	40	100	$\mu\text{A}$
$I_{LINl}$	LIN logic "0" input bias current	$LIN = 0\text{ V}$			1	$\mu\text{A}$
$I_{SDh}$	$\overline{SD}$ logic "0" input bias current	$\overline{SD} = 15\text{ V}$	30	120	300	$\mu\text{A}$
$I_{SDl}$	$\overline{SD}$ logic "1" input bias current	$\overline{SD} = 0\text{ V}$			3	$\mu\text{A}$
Dt	Dead time	see <a href="#">Figure 9</a>		600		ns

Table 11. Shut down characteristics ( $V_{CC} = 15\text{ V}$  unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{sd}$	Shut down to high / low side driver propagation delay	$V_{OUT} = 0, V_{boot} = V_{CC}, V_{IN} = 0$ to $3.3\text{ V}$	50	125	200	ns

Table 12. Truth table

Condition	Logic input ( $V_I$ )			Output	
	SD	LIN	HIN	LVG	HVG
Shutdown enable half-bridge tri-state	L	X	X	L	L
Interlocking half-bridge tri-state	H	H	H	L	L
0 "logic state" half-bridge tri-state	H	L	L	L	L
1 "logic state" low side direct driving	H	H	L	H	L
1 "logic state" high side direct driving	H	L	H	L	H

Note: X: don't care

Figure 5. Maximum  $I_{C(RMS)}$  current vs. switching frequency <sup>(1)</sup>

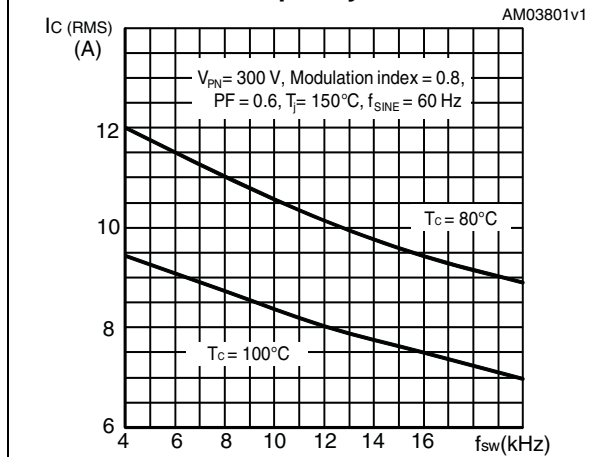
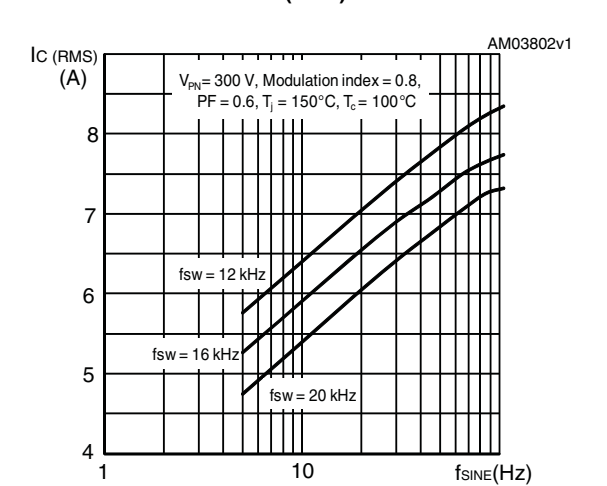


Figure 6. Maximum  $I_{C(RMS)}$  current vs.  $f_{SINE}$  <sup>(1)</sup>



1. Simulated curves refer to typical IGBT parameters and maximum  $R_{thJC}$ .

3.1.1 NTC thermistor

Table 13. NTC thermistor

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit.
R <sub>25</sub>	Resistance	T = 25°C		4.7		kΩ
R <sub>125</sub>	Resistance	T = 125°C		160		Ω
B	B-constant	T = 25°C to 85°C		3950		K
T	Operating temperature		-40		150	°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 Kelvins

Figure 7. NTC resistance vs. temperature

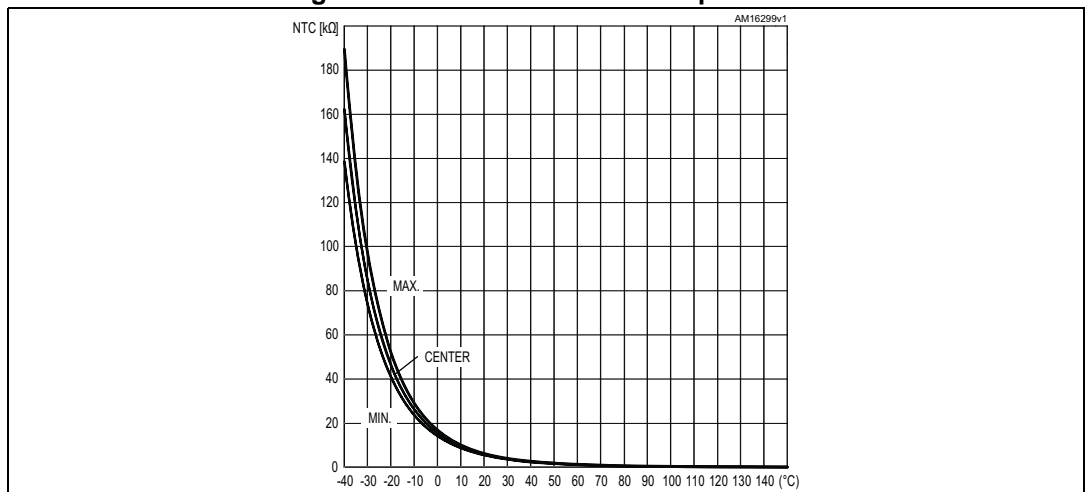
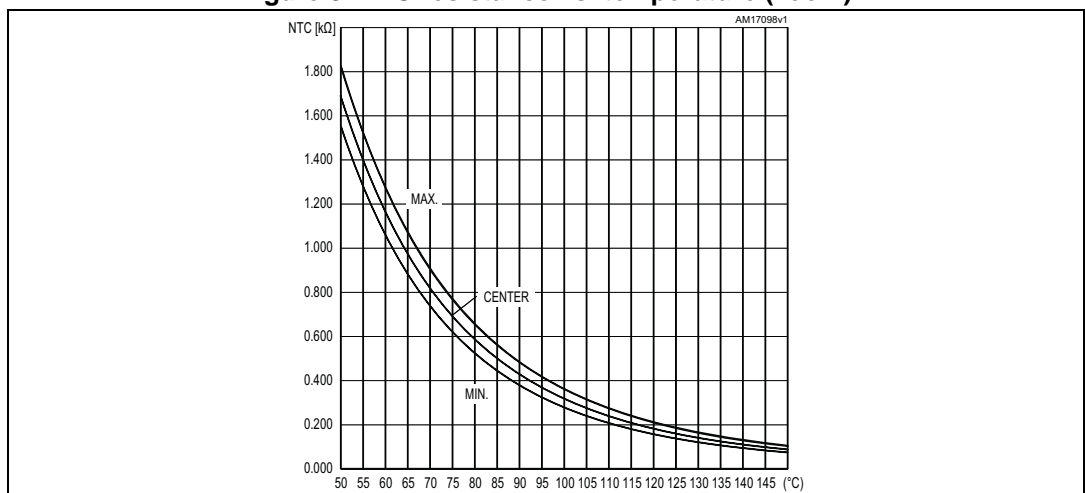
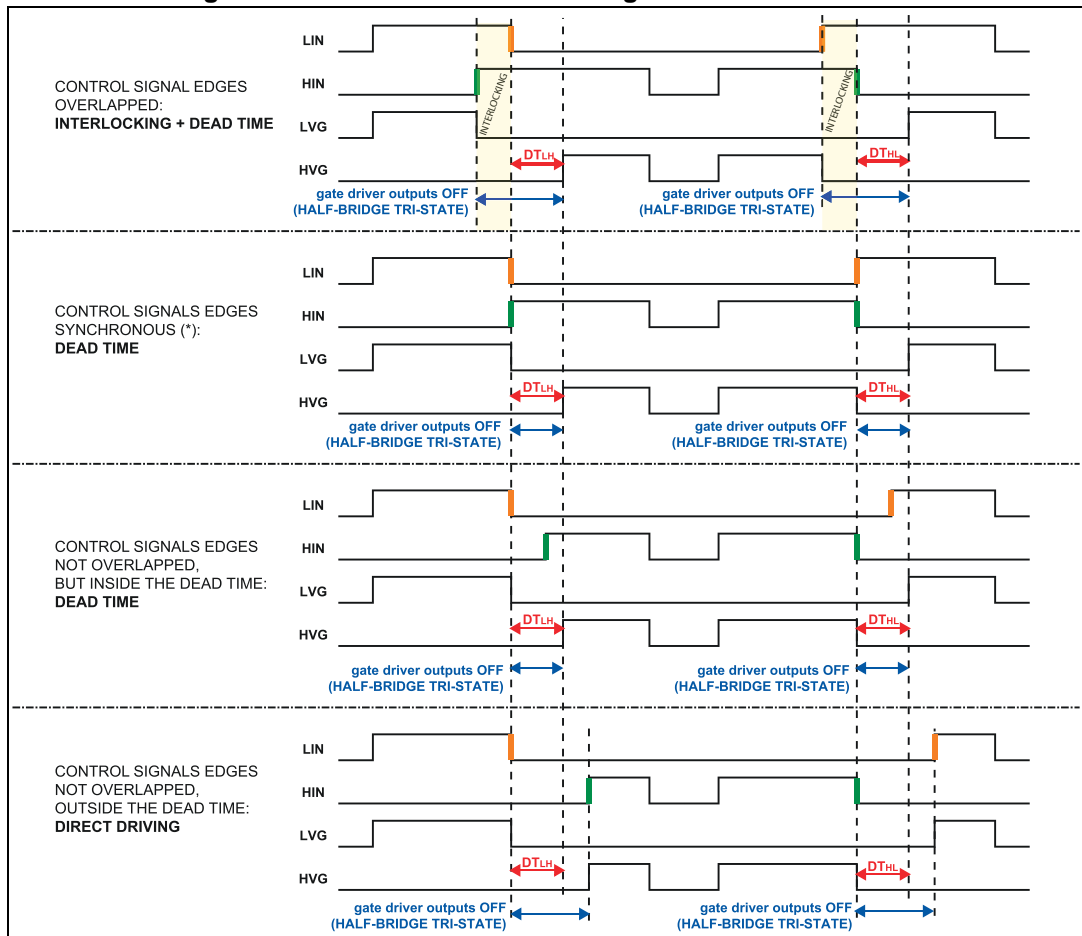


Figure 8. NTC resistance vs. temperature (zoom)



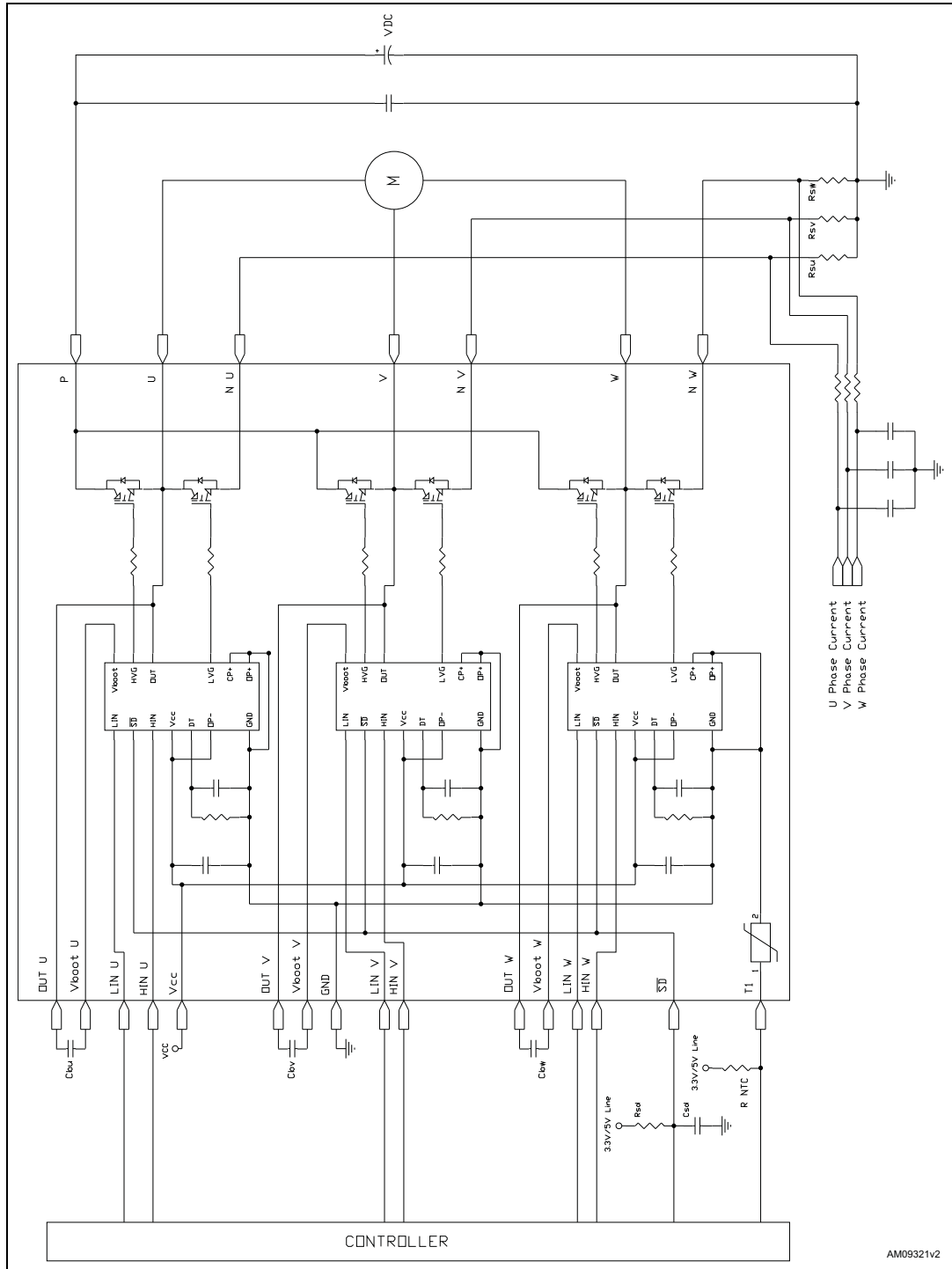
### 3.2 Waveform definitions

Figure 9. Dead time and interlocking waveform definitions



# 4 Applications information

Figure 10. Typical application circuit



## 4.1 Recommendations

- Input signals HIN, LIN are active high logic. A 375 k $\Omega$  (typ.) pull down resistor is built-in for each 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.
- The  $\overline{\text{SD}}$  signal should be pulled up to 5 V / 3.3 V with an external resistor.

**Table 14. Recommended operating conditions**

Symbol	Parameter	Conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{PN}$	Supply voltage	Applied between P-Nu, Nv, Nw		300	400	V
$V_{CC}$	Control supply voltage	Applied between $V_{CC}$ -GND	13.5	15	18	V
$V_{BS}$	High side bias voltage	Applied between $V_{BOOTi}$ - $OUT_i$ for $i = U, V, W$	13		18	V
$t_{dead}$	Blanking time to prevent arm-short	For each input signal	1			$\mu\text{s}$
$f_{PWM}$	Pwm input signal	-40°C < $T_c$ < 100°C -40°C < $T_j$ < 125°C			20	kHz
$T_c$	Case operation temperature				100	°C

For further details refer to AN3338.

## 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

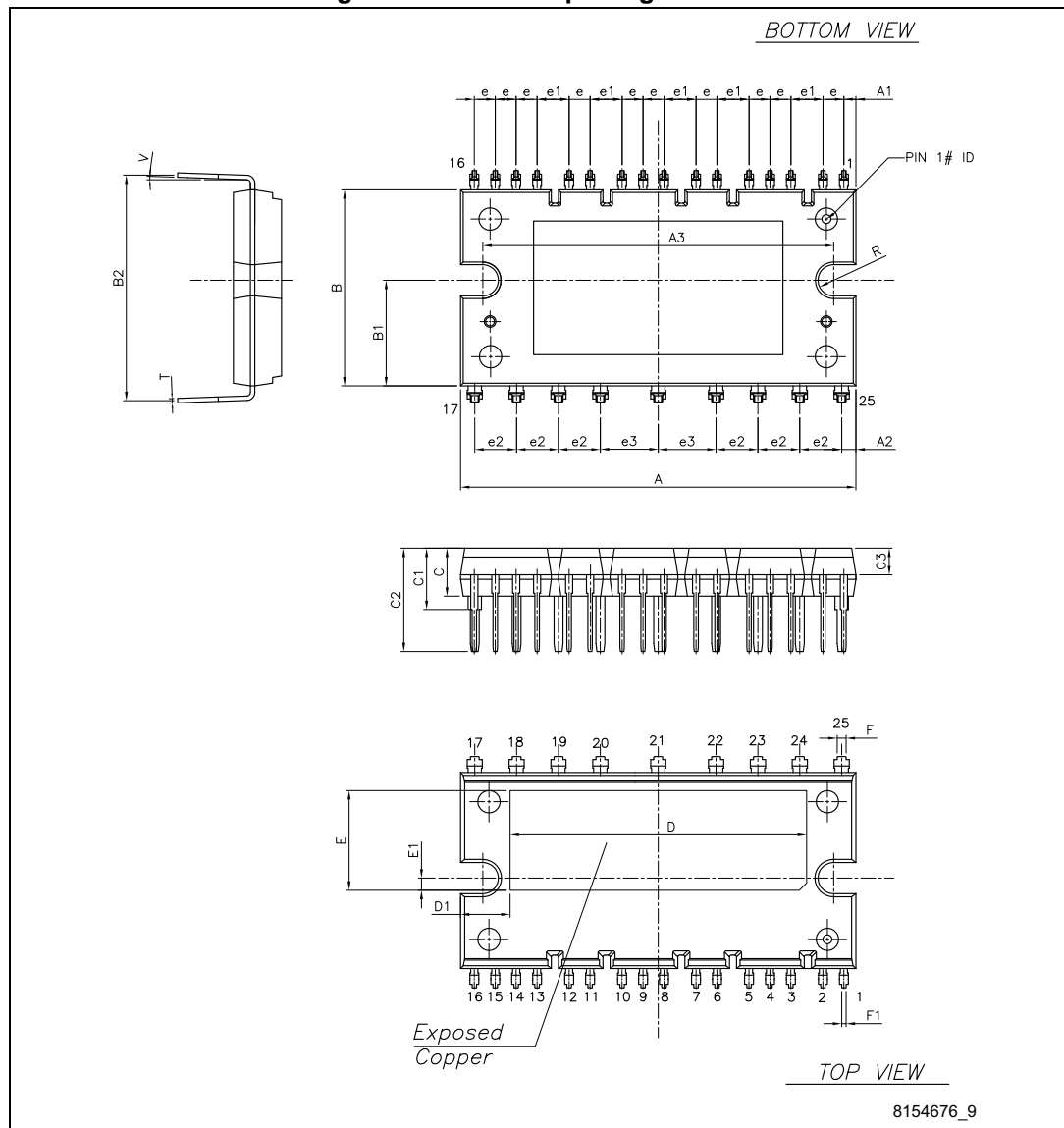


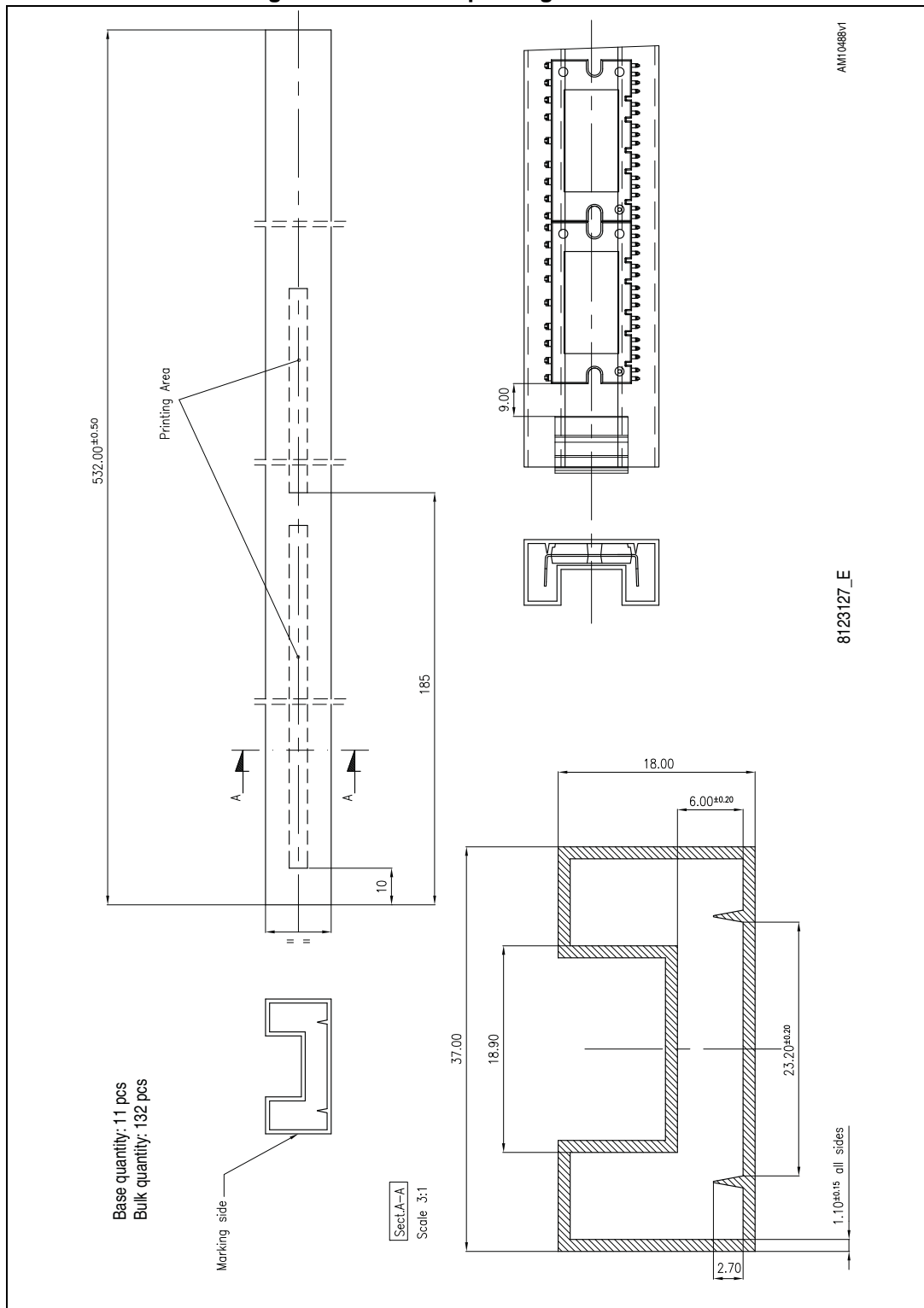
Table 15. SDIP-25L mechanical data

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 16. Document revision history

Date	Revision	Changes
18-Jan-2013	1	Initial release.
15-Feb-2013	2	Added Inductive load typical value <a href="#">Table 7 on page 7</a> and <a href="#">Figure 8 on page 11</a> . Modified <a href="#">Figure 3 on page 8</a> and <a href="#">Figure 7 on page 11</a> .
05-Mar-2013	3	Modified <a href="#">Figure 7</a> and <a href="#">Figure 8 on page 11</a> .
15-Apr-2014	4	Document status changed from preliminary to production data. Updated <a href="#">Figure 2: Pin layout (bottom view)</a> .
14-Apr-2015	5	Text edits and formatting changes throughout document Updated <a href="#">Figure 2: Pin layout (bottom view)</a> Updated <a href="#">Section 5: Package information</a>

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