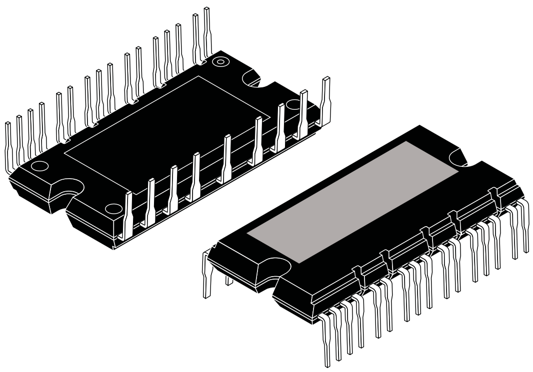
STGIPS10K60T-H

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

Datasheet - preliminary data



SDIP-25L

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
- Shut down function
- DBC substrate leading to low thermal resistance
- Isolation rating of 2500 Vrms/min
- 4.7 kΩ 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	Packaging
STGIPS10K60T-H	GIPS10K60T-H	SDIP-25L	Tube

This is preliminary information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

Contents

1 Internal block diagram and pin configuration

Figure 1. Internal block diagram

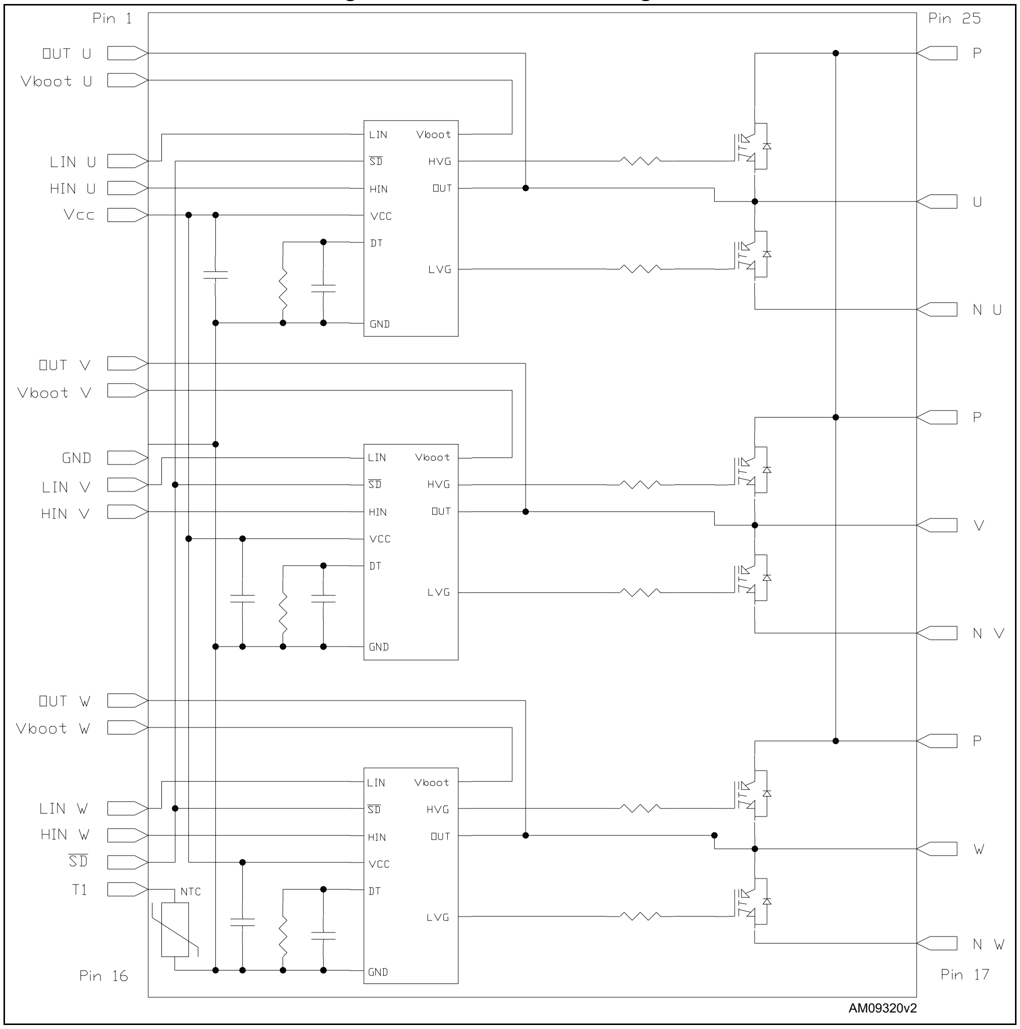
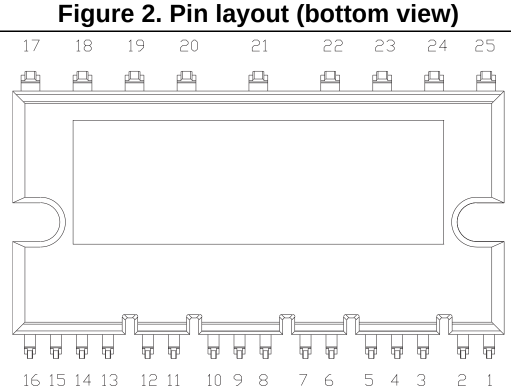


Table 2. Pin description

Pin n°	Symbol	Description
1	OUT_U	High side reference output for U phase
2	$V_{boot\ U}$	Bootstrap voltage for U phase
3	LIN_U	Low side logic input for U phase
4	HIN_U	High side logic input for U phase
5	V_{CC}	Low voltage power supply
6	OUT_V	High side reference output for V phase
7	$V_{boot\ V}$	Bootstrap voltage for V phase
8	GND	Ground
9	LIN_V	Low side logic input for V phase
10	HIN_V	High side logic input for V phase
11	OUT_W	High side reference output for W phase
12	$V_{boot\ W}$	Bootstrap voltage for W phase
13	LIN_W	Low side logic input for W phase
14	HIN_W	High side logic input for W phase
15	SD	Shut down logic input (active low)
16	T1	NTC thermistor terminal
17	N_W	Negative DC input for W phase
18	W	W phase output
19	P	Positive DC input
20	N_V	Negative DC input for V phase
21	V	V phase output
22	P	Positive DC input
23	N_U	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°C	10	A
$\pm I_{CP}$ (3)	Each IGBT pulsed collector current	20	A
P_{TOT}	Each IGBT total dissipation at T_C = 25°C	33	W
t_{scw}	Short-circuit withstand time, V_{CE} = 0.5 $V_{(BR)CES}$ T_j = 125 °C, V_{CC} = V_{boot}= 15 V, $V_{IN\ (1)}$= 5 V	5	µs

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
$V_{\overline{SD}}$	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 sec.)	2500	V
T_C	Module case operation temperature	-40 to 125	°C
T_J	Power chips operating junction temperature	-40 to 150	°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 °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 V, V_{IN}(1) = 5 V, I_C = 5 A	-	2.1	2.5	V
		$V_{CC} = V_{boot}$ = 15 V, V_{IN}(1) = 5 V, I_C = 5 A, T_j = 125 °C	-	1.8		
I_{CES}	Collector-cut off current (V_{IN}(1) = 0 "logic state")	V_{CE} = 550 V $V_{CC} = V_{boot}$ = 15 V	-		150	µA
V_F	Diode forward voltage	(V_{IN}(1) = 0 "logic state"), I_C = 5 A	-		1.9	V
Inductive load switching time and energy						
t_{on}	Turn-on time	V_{DD} = 300 V, $V_{CC} = V_{boot}$ = 15 V, V_{IN}(1) = 0 ÷ 5 V I_C = 5 A (see *Figure 4*)	-	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	-	µJ
E_{off}	Turn-off switching losses		-	75	-	

1. Applied between HIN_i, LIN_i and GND 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

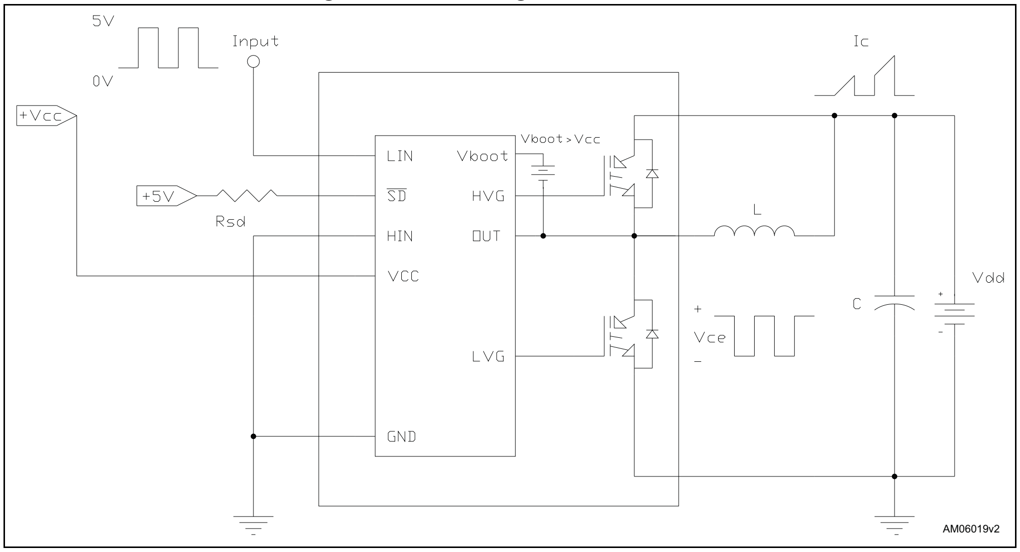
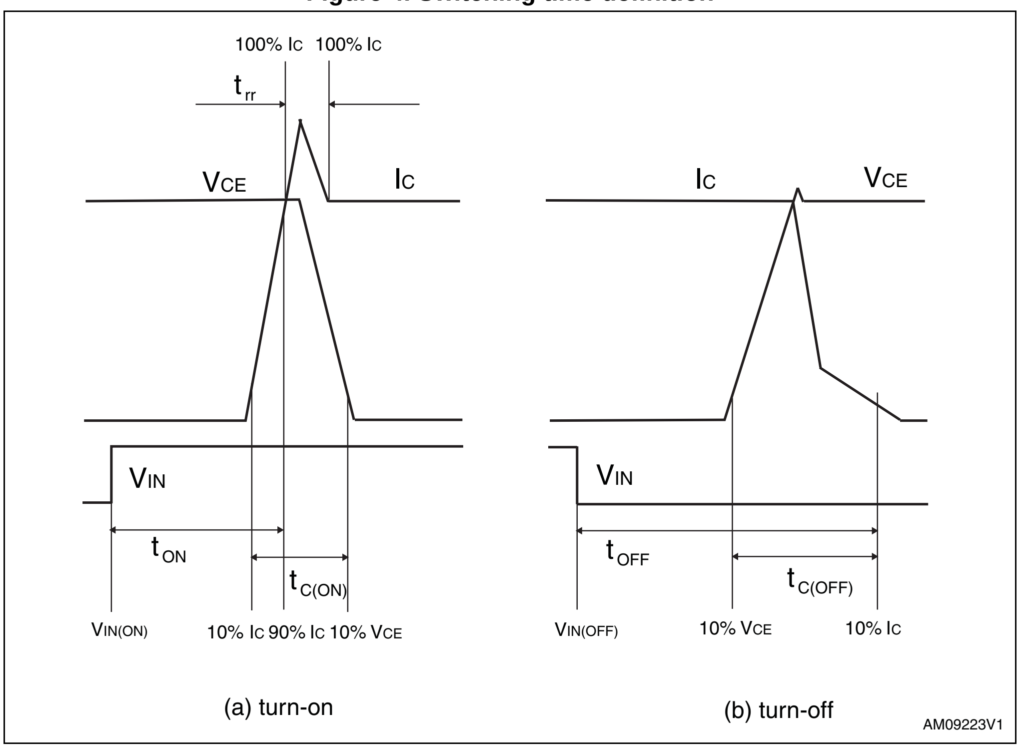


Figure 4. Switching time definition



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 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 V $\overline{SD}$ = 5 V; LIN = 0 V; H_{IN} = 0			450	µA
I_{qcc}	Quiescent current	V_{CC} = 15 V $\overline{SD}$ = 5 V; LIN = 0 V H_{IN} = 0			3.5	mA

Table 9. Bootstrapped voltage (V_{CC} = 15 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 V $\overline{SD}$ = 5 V; LIN = 0 HIN = 5 V		70	110	µA
I_{QBS}	V_{BS} quiescent current	V_{BS} = 15 V $\overline{SD}$ = 5 V; LIN = 0 HIN = 5 V		200	300	µA
$R_{DS(on)}$	Bootstrap driver on resistance	LVG ON		120		W

Table 10. Logic inputs (V_{CC} = 15 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	HIN = 15 V	20	40	100	µA
I_{HINl}	HIN logic “0” input bias current	HIN = 0 V			1	µA
I_{LINh}	LIN logic “1” input bias current	LIN = 15 V	20	40	100	µA
I_{LINl}	LIN logic “0” input bias current	LIN = 0 V			1	µA
I_{SDh}	$\overline{SD}$ logic “0” input bias current	$\overline{SD}$ = 15 V	30	120	300	µA
I_{SDl}	$\overline{SD}$ logic “1” input bias current	$\overline{SD}$ = 0 V			3	µA
Dt	Dead time	see *Figure 9*		600		ns

Table 11. Shut down characteristics (V_{CC} = 15 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 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 (1)

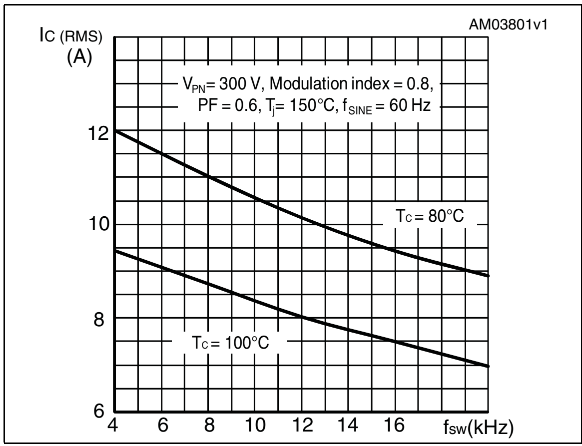
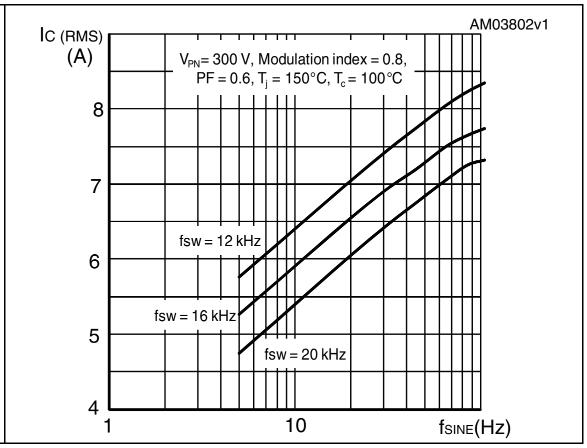


Figure 6. Maximum $I_{C(RMS)}$ current vs. f_{SINE} (1)



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_{25}	Resistance	T = 25°C		4.7		kΩ
R_{125}	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

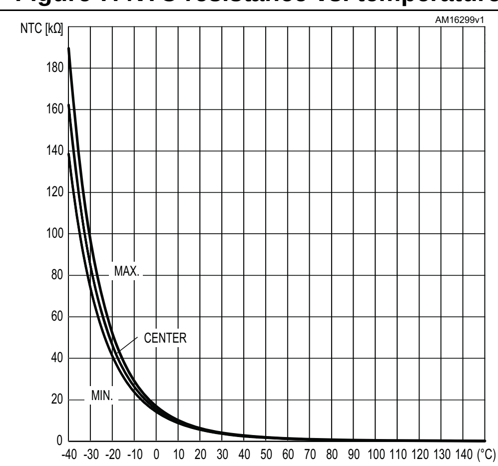
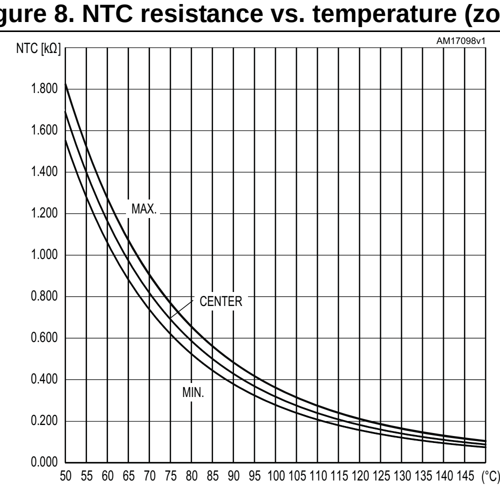
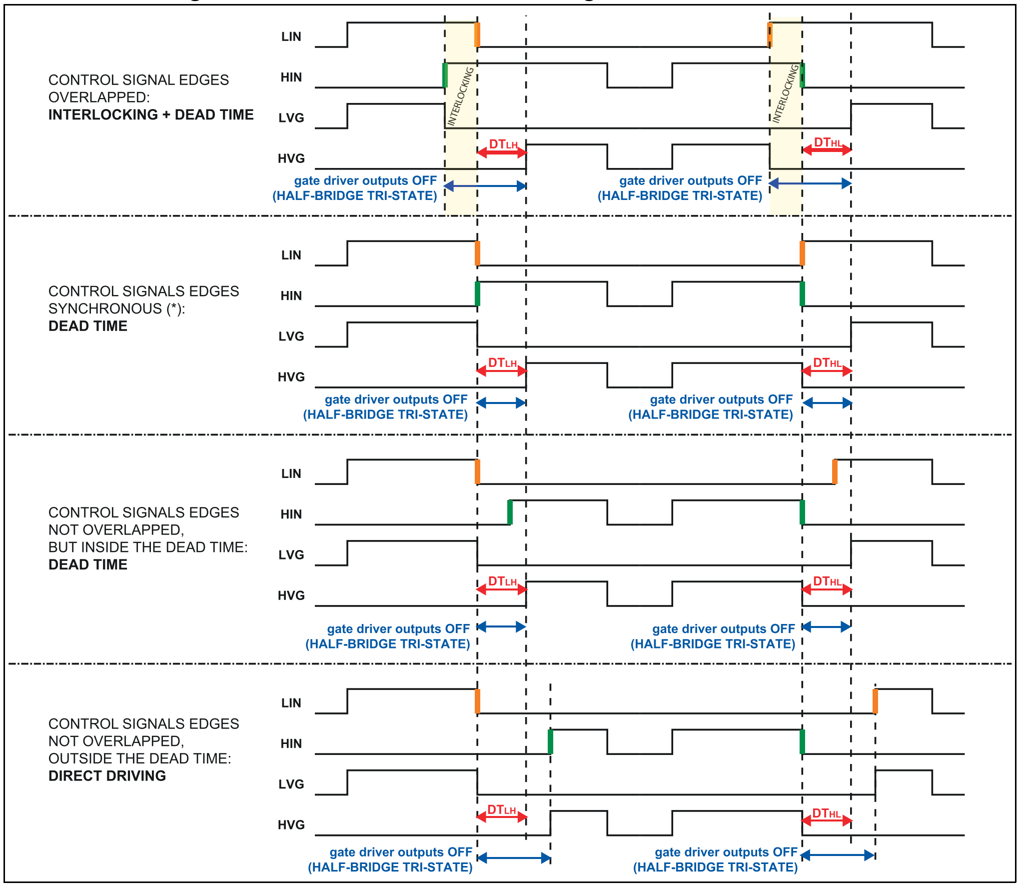


Figure 8. NTC resistance vs. temperature (zoom)



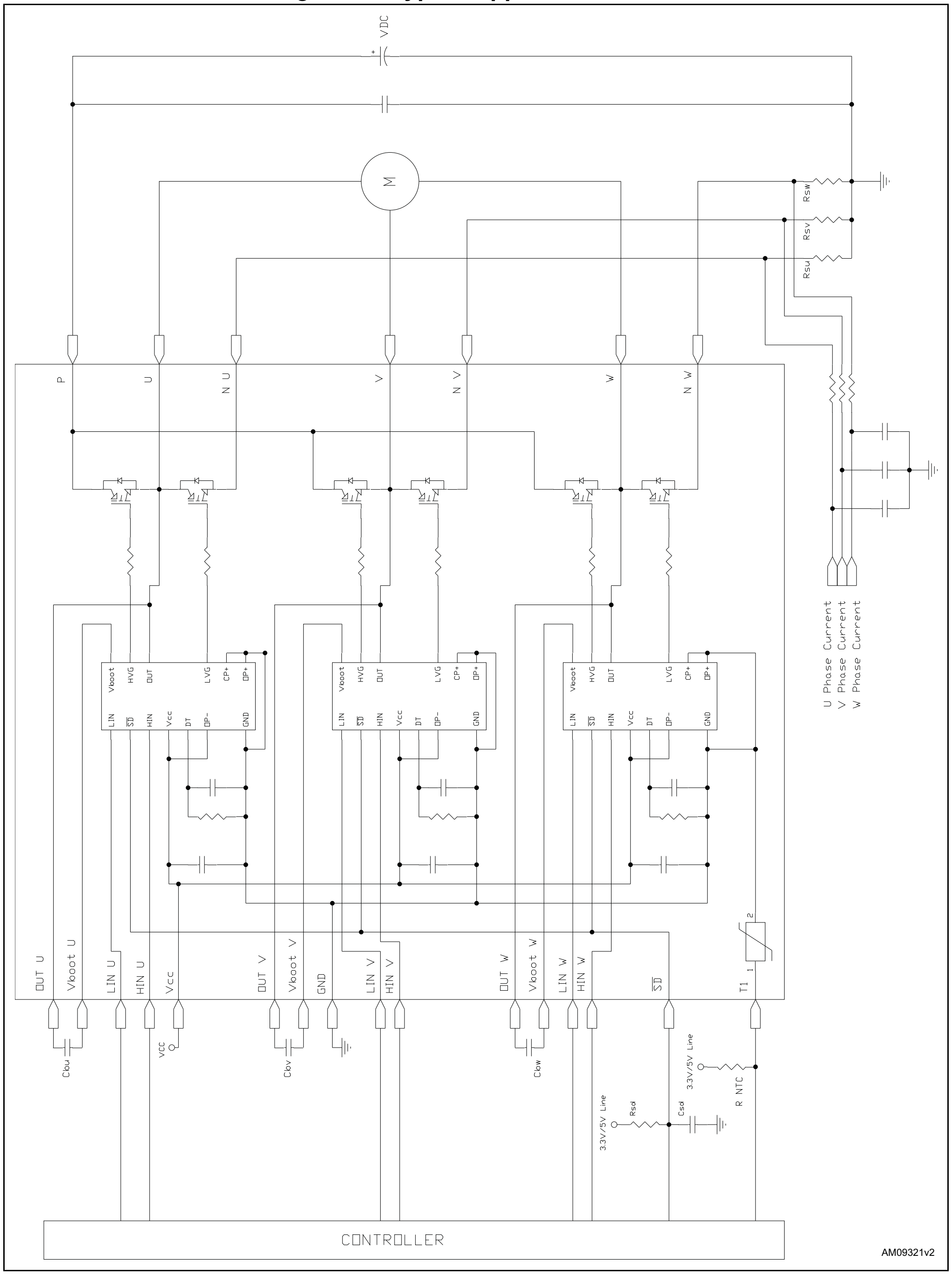
3.2 Waveforms definitions

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 kΩ (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 $\overline{SD}$ 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			µs
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 mechanical data

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. ECOPACK® is an ST trademark.

Please refer to dedicated technical note TN0107 for mounting instructions.

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
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

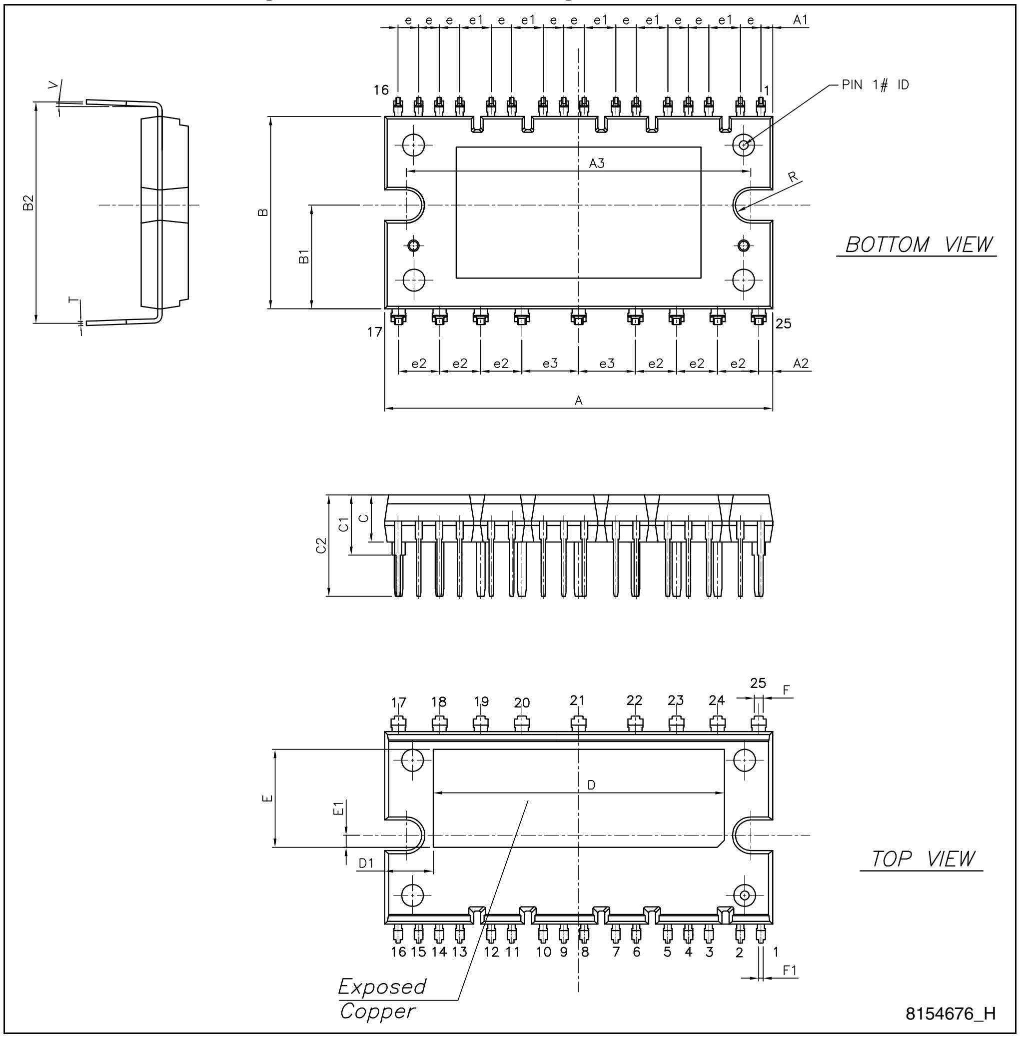


Figure 12. Packaging specifications of SDIP-25L package

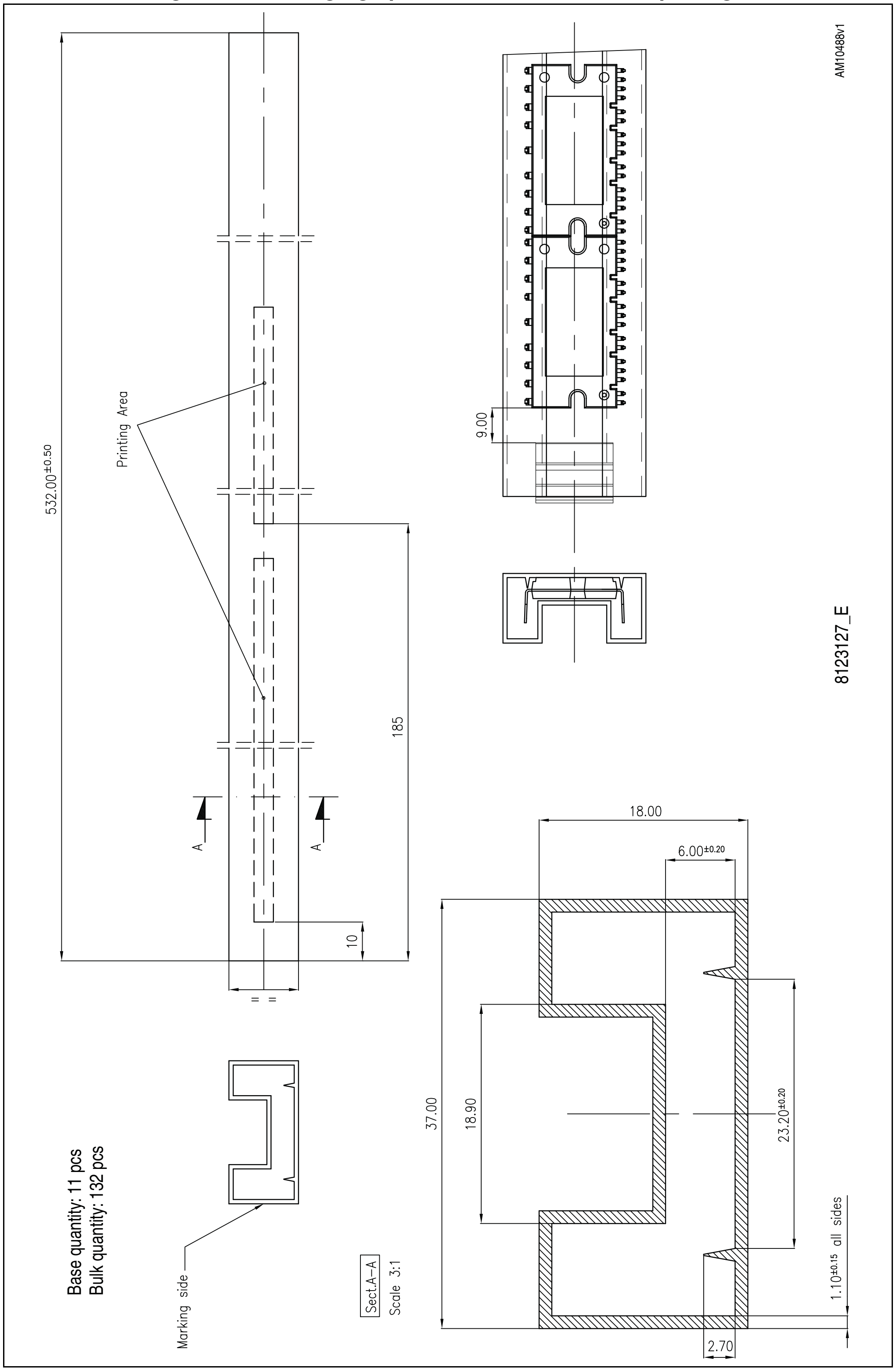
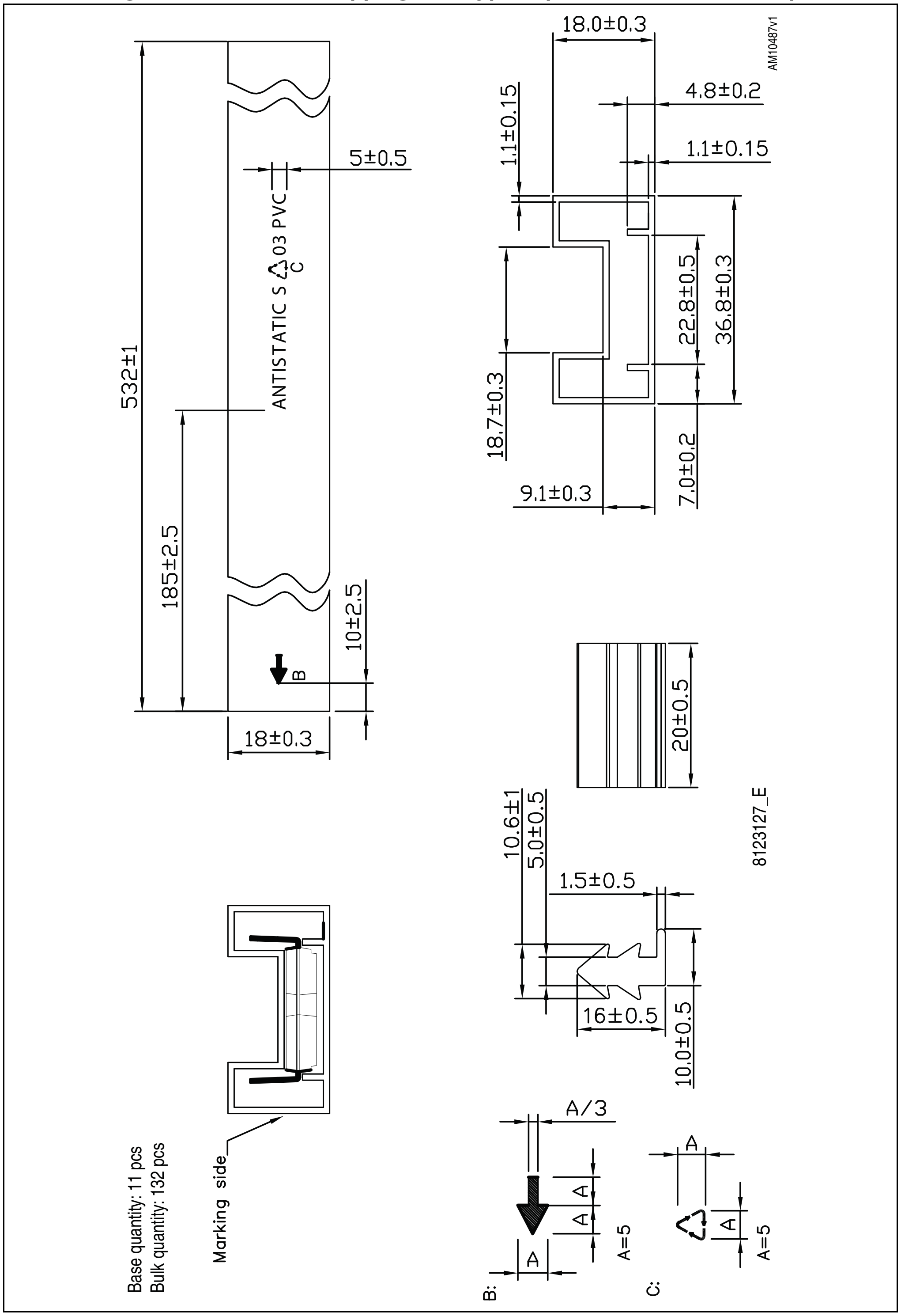


Figure 13. SDIP-25L shipping tube type B (dimensions are in mm.)



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 *Table 7 on page 7* and *Figure 8 on page 11*. Modified *Figure 3 on page 8* and *Figure 7 on page 11*.
05-Mar-2013	3	Modified *Figure 7* and *Figure 8 on page 11*.

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