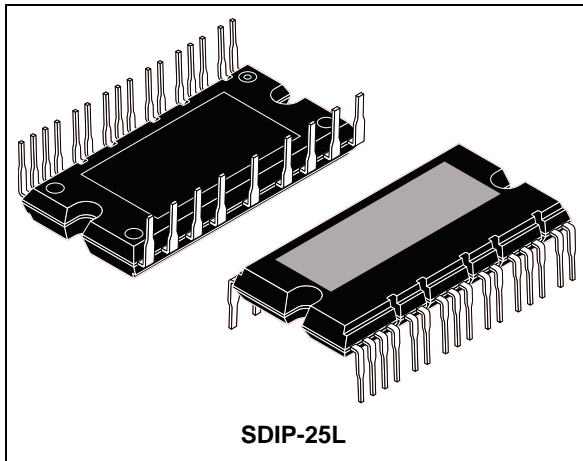


SLLIMM™ small low-loss intelligent molded module IPM, 3-phase inverter, 14 A, 600 V short-circuit rugged IGBT

Datasheet - production data



Applications

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

Features

- IPM 14 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 Ω NTC for temperature control
- UL Recognized: UL1557 file E81734

Table 1. Device summary

| Order code | Marking | Package | Packing |
|--------------|------------|----------|---------|
| STGIPS14K60T | GIPS14K60T | 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

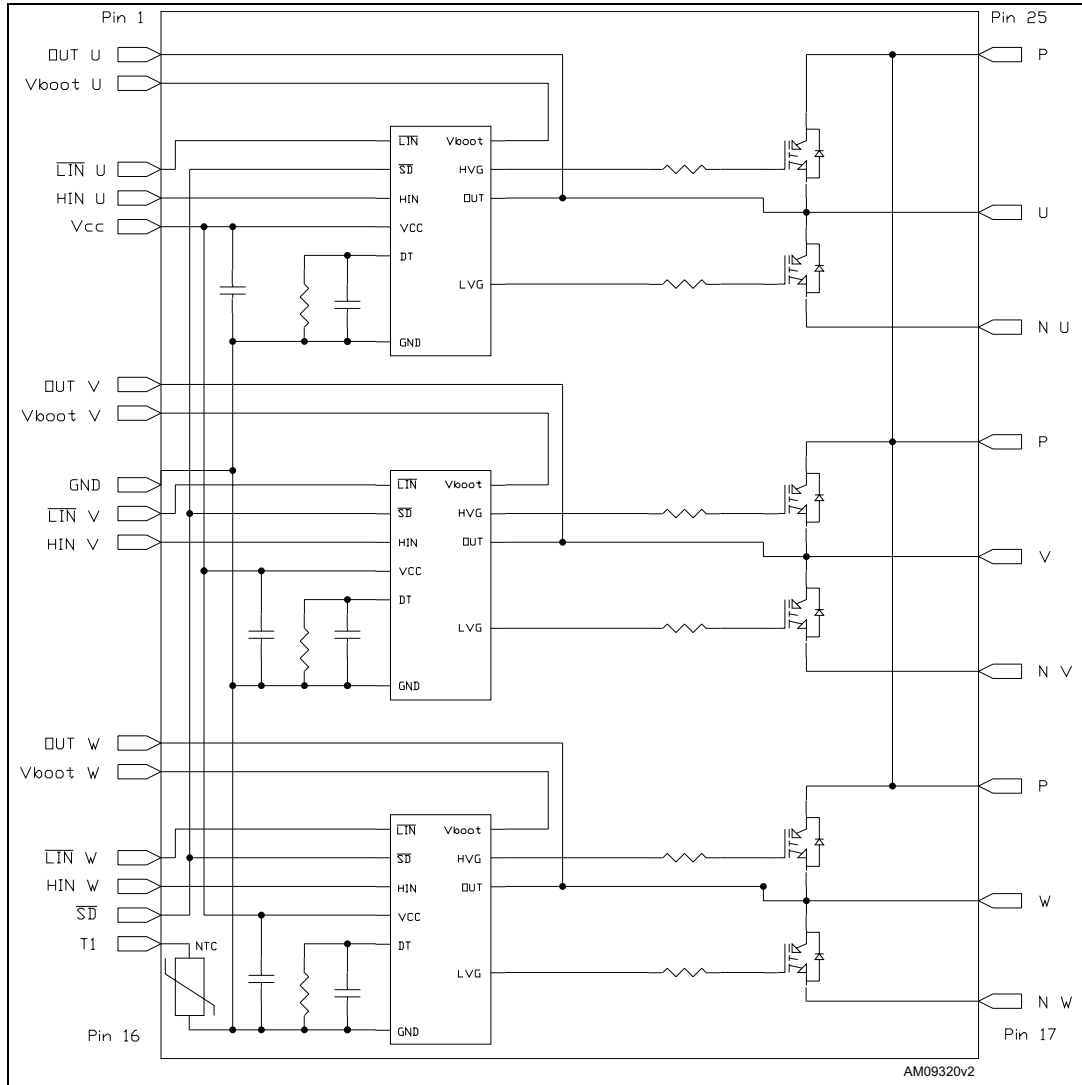
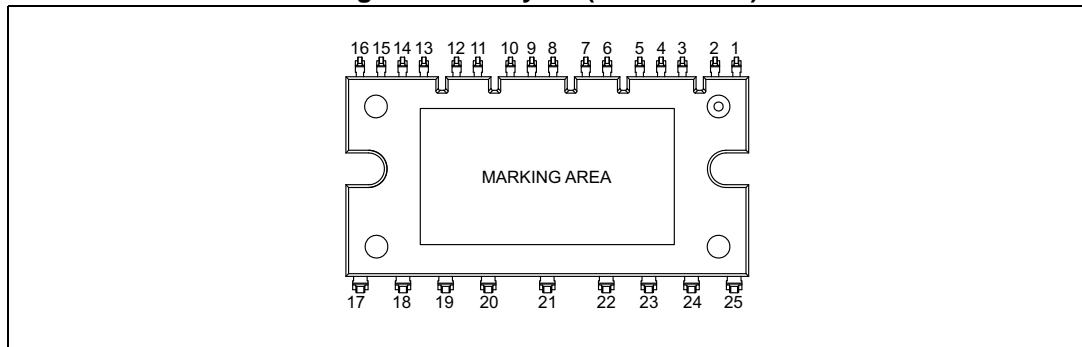


Table 2. Pin description

| Pin n° | Symbol | Description |
|--------|---------------------|--|
| 1 | OUT _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 $T_C = 25^\circ\text{C}$ | 14 | A |
| $\pm I_{CP}^{(3)}$ | Each IGBT pulsed collector current | 30 | A |
| P_{TOT} | Each IGBT total dissipation at $T_C = 25^\circ\text{C}$ | 42 | W |
| t_{scw} | Short circuit withstand time, $V_{CE} = 0.5 V_{(BR)CES}$ $T_J = 125^\circ\text{C}$, $V_{CC} = V_{boot} = 15\text{ V}$, $V_{IN}^{(1)} = 0 \div 5\text{ V}$ | 5 | μs |

1. Applied between HIN_i , \overline{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_{CIN} | Comparator input voltage | - 0.3 | $V_{CC} + 0.3$ | V |
| V_{boot} | Bootstrap voltage | - 0.3 | 620 | V |
| V_{IN} | Logic input voltage applied between HIN , \overline{LIN} and GND | - 0.3 | 15 | V |
| V_{SD} | SD 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 | 3 | °C/W |
| | Thermal resistance junction-case single diode | 5.5 | °C/W |

3 Electrical characteristics

$T_J = 25\text{ °C}$ unless otherwise specified.

Table 7. Inverter part

| Symbol | Parameter | Test conditions | Value | | | Unit |
|---|--|---|-------|------|------|---------------|
| | | | Min. | Typ. | Max. | |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{CC} = V_{boot} = 15\text{ V}$, $V_{IN}^{(1)} = 0 \div 5\text{ V}$, $I_C = 7\text{ A}$ | - | 2.1 | 2.5 | V |
| | | $V_{CC} = V_{boot} = 15\text{ V}$, $V_{IN}^{(1)} = 0 \div 5\text{ V}$, $I_C = 7\text{ A}$, $T_J = 125\text{ °C}$ | - | 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 | μA |
| V_F | Diode forward voltage | $V_{IN}^{(1)} = 0$ "logic state", $I_C = 7\text{ A}$ | - | | 2.1 | V |
| Inductive load switching time and energy | | | | | | |
| t_{on} | Turn-on time | $V_{DD} = 300\text{ V}$, $V_{CC} = V_{boot} = 15\text{ V}$, $V_{IN}^{(1)} = 0 \div 5\text{ V}$, $I_C = 7\text{ A}$ (see Figure 5) | - | 270 | - | ns |
| $t_{c(on)}$ | Crossover time (on) | | - | 130 | - | |
| t_{off} | Turn-off time | | - | 520 | - | |
| $t_{c(off)}$ | Crossover time (off) | | - | 140 | - | |
| t_{rr} | Reverse recovery time | | - | 130 | - | μJ |
| E_{on} | Turn-on switching losses | | - | 150 | - | |
| E_{off} | Turn-off switching losses | | - | 110 | - | |

1. Applied between HIN_i , \overline{LIN}_i and G_{ND} for $i = U, V, W$ (\overline{LIN}_i inputs are active-low).

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

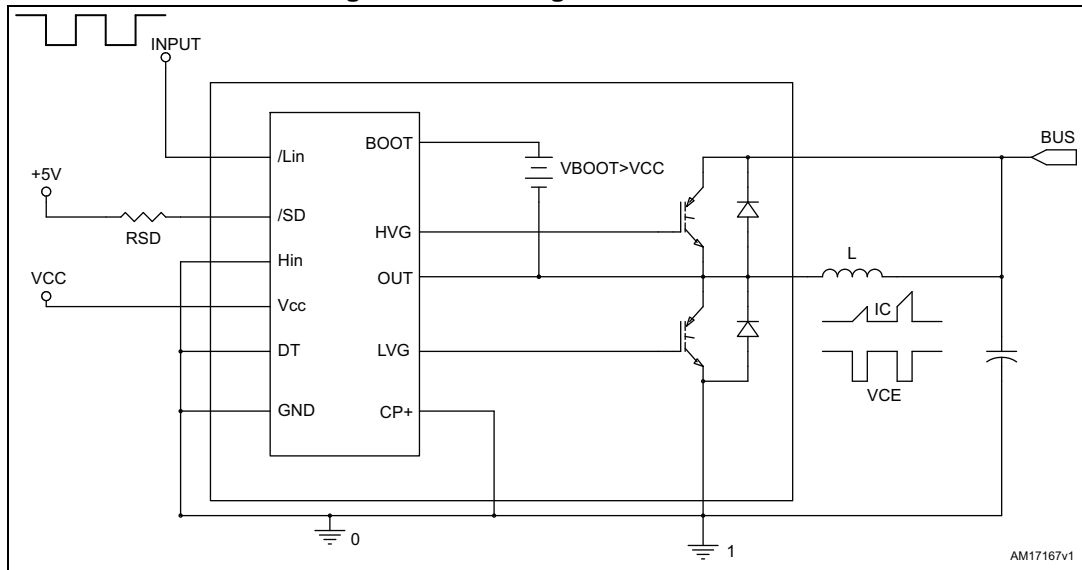
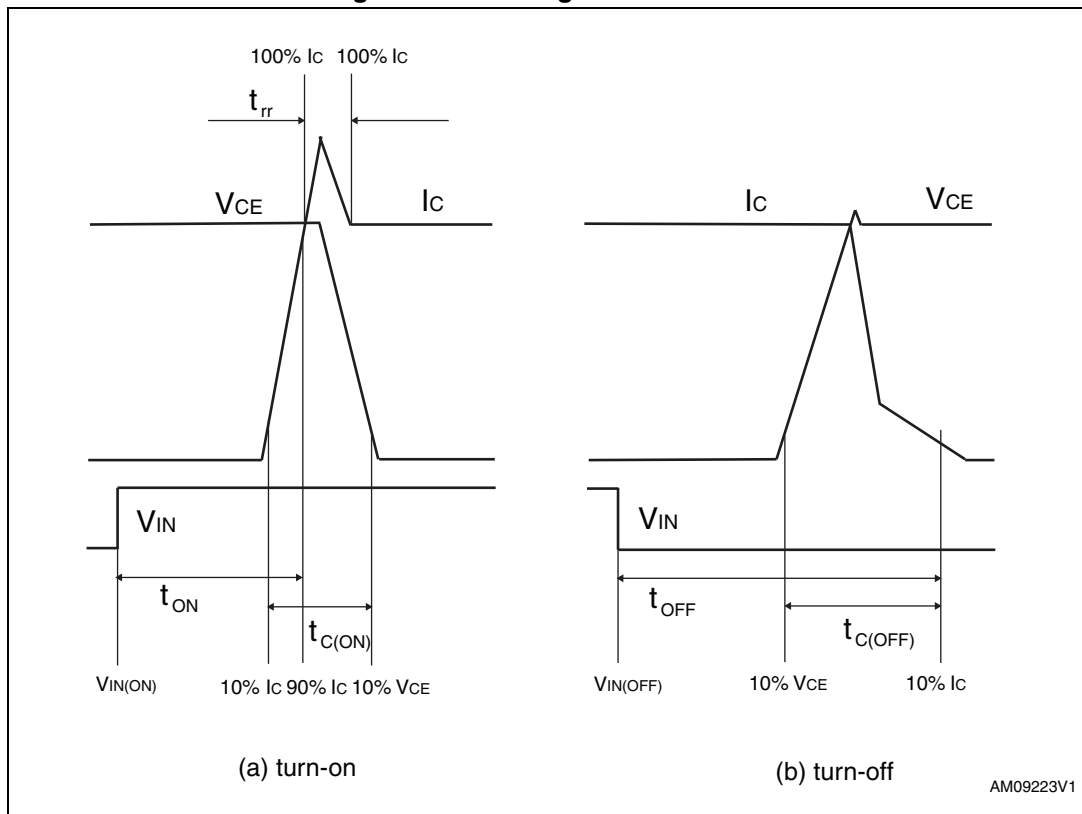


Figure 4. Switching time definition



Note: *Figure 4: Switching time definition* refers to H_{IN} inputs (active high). For \overline{L}_{IN} inputs (active low), V_{IN} polarity must be inverted for turn-on and turn-off.

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 | $V_{CC} = 10\text{ V}$ $\overline{SD} = 5\text{ V}; \overline{LIN} = 5\text{ V};$ $H_{IN} = 0$ | | | 450 | μA |
| I_{qcc} | Quiescent current | $V_{CC} = 15\text{ V}$ $\overline{SD} = 5\text{ V}; \overline{LIN} = 5\text{ V}$ $H_{IN} = 0$ | | | 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 | $V_{BS} < 9\text{ V}$ $\overline{SD} = 5\text{ V}; \overline{LIN}$ and $H_{IN} = 5\text{ V}$ | | 70 | 110 | μA |
| I_{QBS} | V_{BS} quiescent current | $V_{BS} = 15\text{ V}$ $\overline{SD} = 5\text{ V}; \overline{LIN}$ and $H_{IN} = 5\text{ V}$ | | 200 | 300 | μA |
| $R_{DS(on)}$ | Bootstrap driver on resistance | LVG ON | | 120 | | Ω |

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 | $H_{IN} = 15\text{ V}$ | 110 | 175 | 260 | μA |
| I_{HINl} | HIN logic "0" input bias current | $H_{IN} = 0\text{ V}$ | | | 1 | μA |
| I_{LINl} | \overline{LIN} logic "1" input bias current | $\overline{LIN} = 0\text{ V}$ | 3 | 6 | 20 | μA |
| I_{LINh} | \overline{LIN} logic "0" input bias current | $\overline{LIN} = 15\text{ V}$ | | | 1 | μA |
| I_{SDh} | \overline{SD} logic "0" input bias current | $\overline{SD} = 15\text{ V}$ | 30 | 120 | 300 | μA |
| I_{SDl} | \overline{SD} logic "1" input bias current | $\overline{SD} = 0\text{ V}$ | | | 3 | μA |
| Dt | Dead time | see Figure 9 | | 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 | $V_{OUT} = 0, V_{boot} = V_{CC}, V_{IN} = 0 \text{ to } 3.3\text{ V}$ | 50 | 125 | 200 | ns |

Table 12. Truth table

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

Note: X: don't care

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

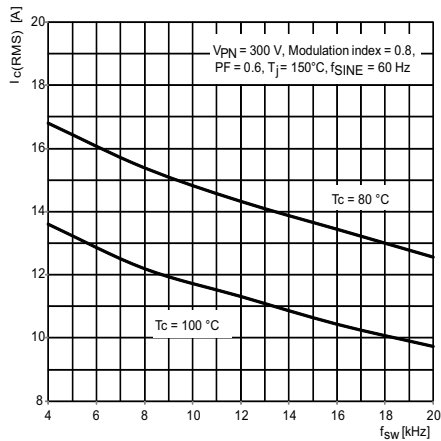
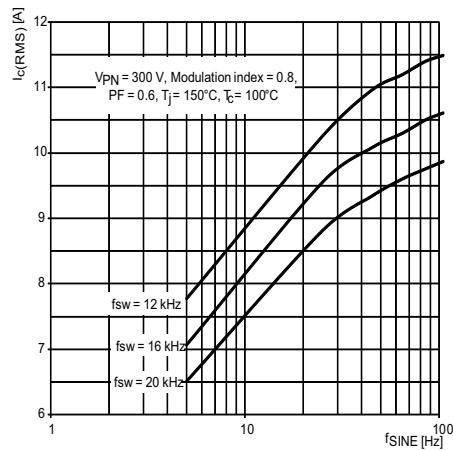


Figure 6. Maximum $I_{C(RMS)}$ current vs. f_{SINE} ⁽¹⁾



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

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

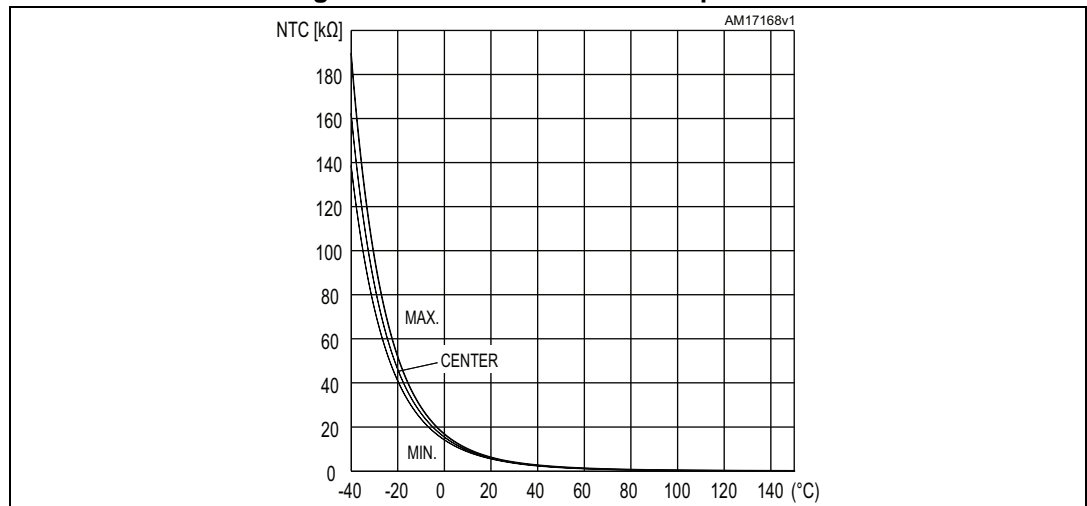
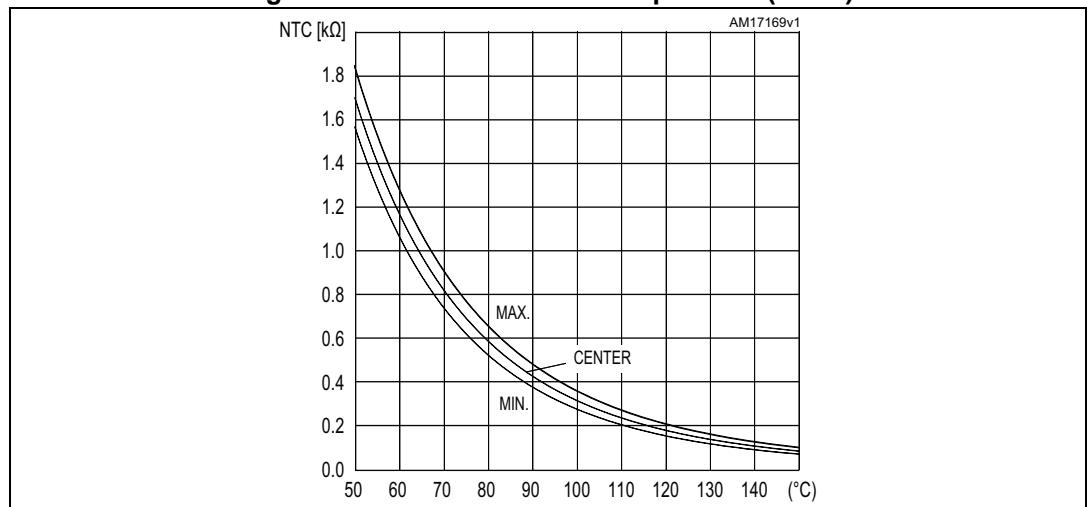
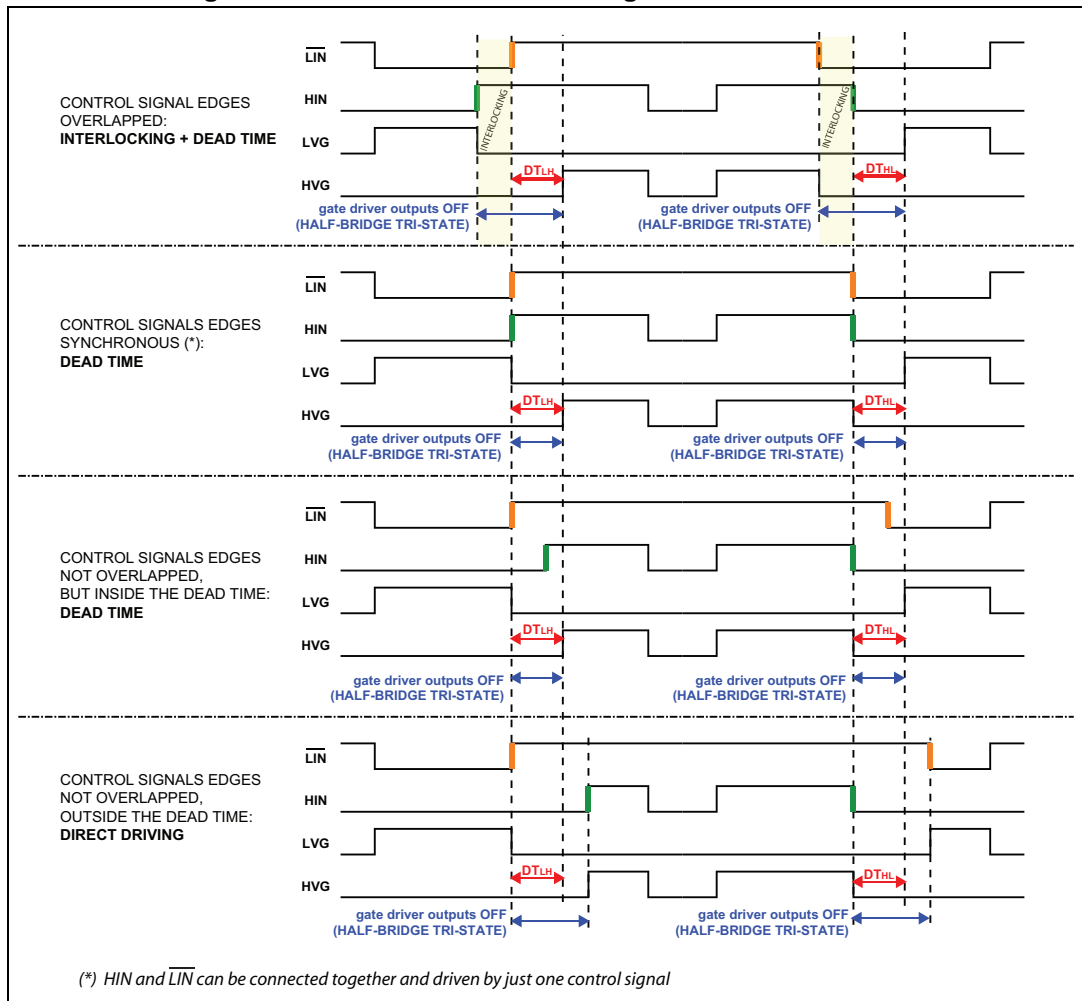


Figure 8. NTC resistance vs. temperature (zoom)



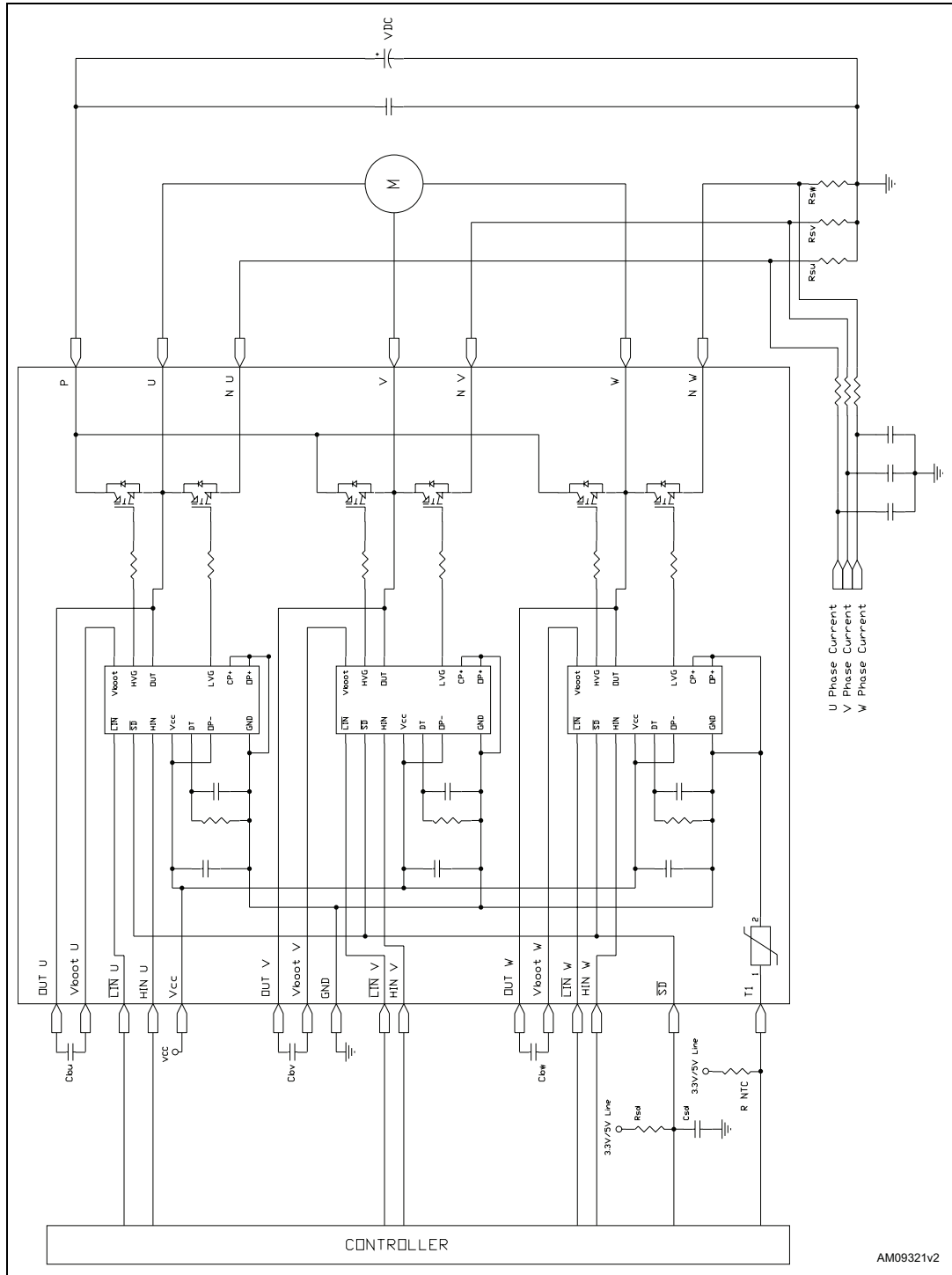
3.2 Waveform definitions

Figure 9. Dead time and interlocking waveform definitions



4 Applications information

Figure 10. Typical application circuit



4.1 Recommendations

- Input signal HIN is active high logic. A 85 kΩ (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.
- Input signal /LIN is active low logic. A 720 kΩ (typ.) pull-up resistor, connected to an internal 5 V regulator through a diode, is built-in for each low side input.
- 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 _{BOOT} -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 |

Note: 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. 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

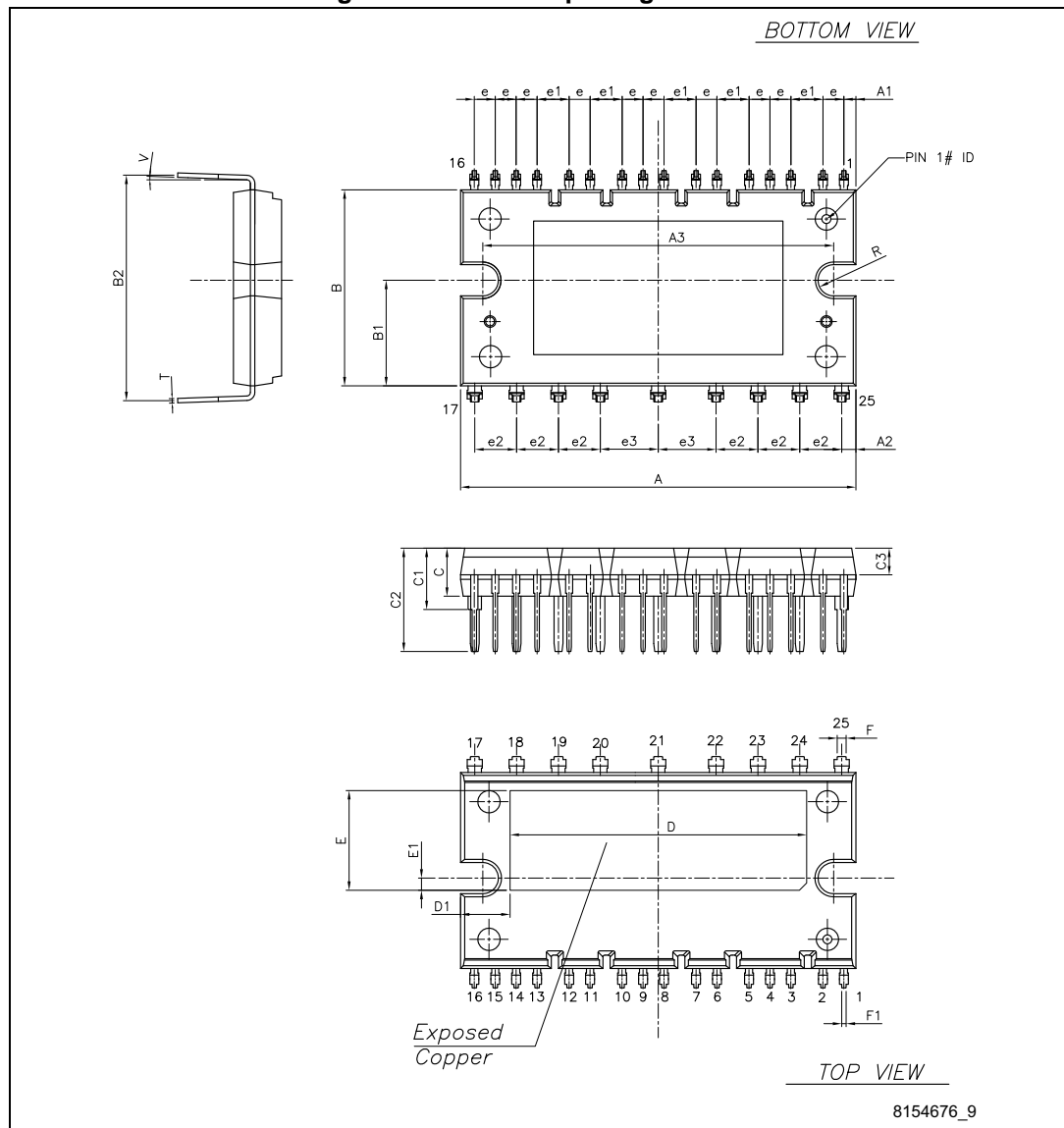
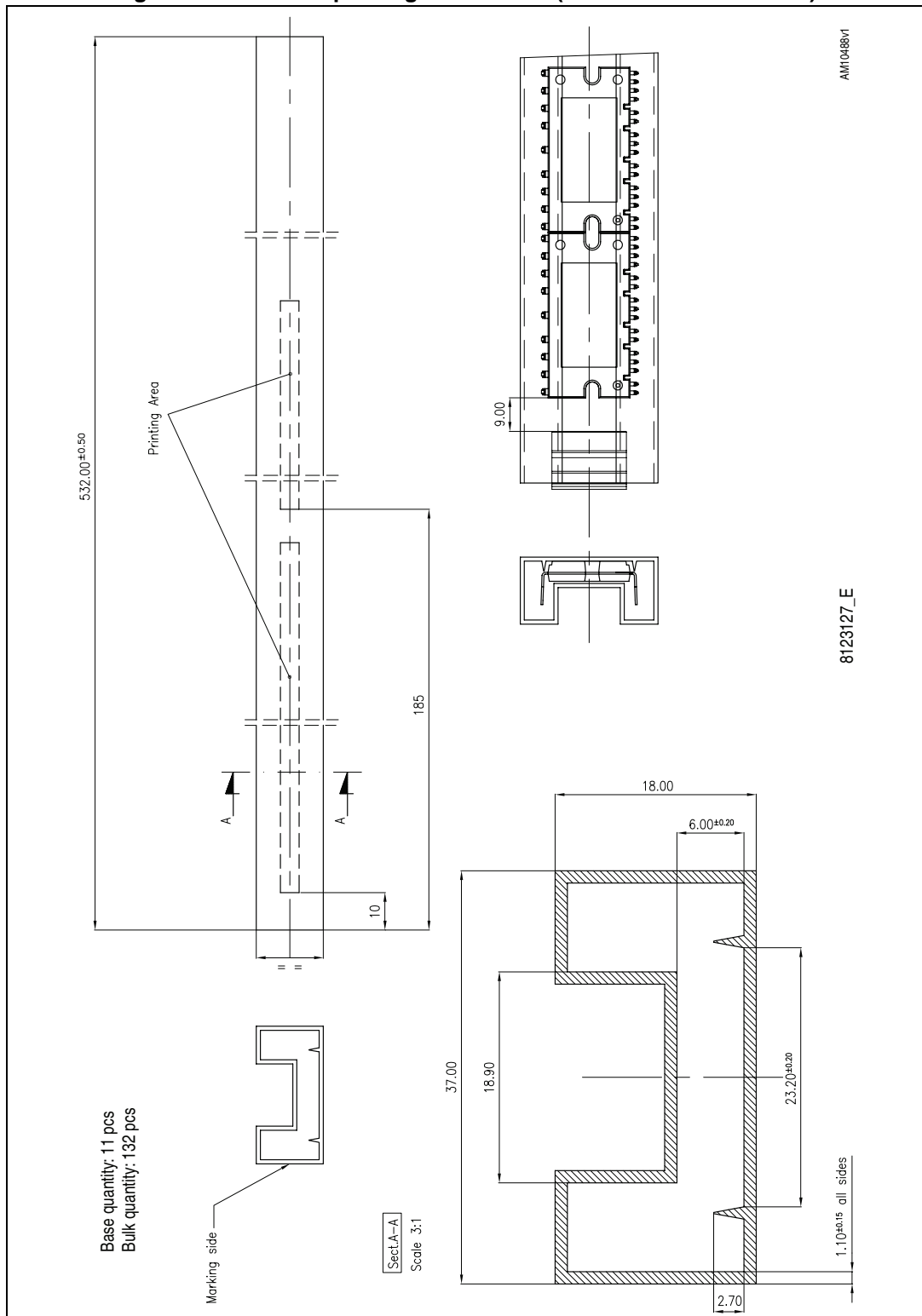


Table 15. SDIP-25L mechanical data

| 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 (dimensions are in mm.)



6 Revision history

Table 16. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 07-Mar-2011 | 1 | Initial release. |
| 14-Sep-2011 | 2 | Update Section 3.1.1 on page 11 . |
| 28-Aug-2012 | 3 | Modified: Min. and Max. value Table 4 on page 5 . Updated: Table 15 on page 15 , Figure 11 on page 15 , Figure 12 on page 17 . Added: Figure 13 on page 18 . |
| 15-May-2013 | 4 | Modified: description pin 15 Table 2 on page 4 and V_{SD} parameter Table 4 on page 5 . |
| 15-Apr-2015 | 5 | Text edits and formatting changes throughout document Updated Figure 2: Pin layout (bottom view) Updated Section 5: Package information |

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