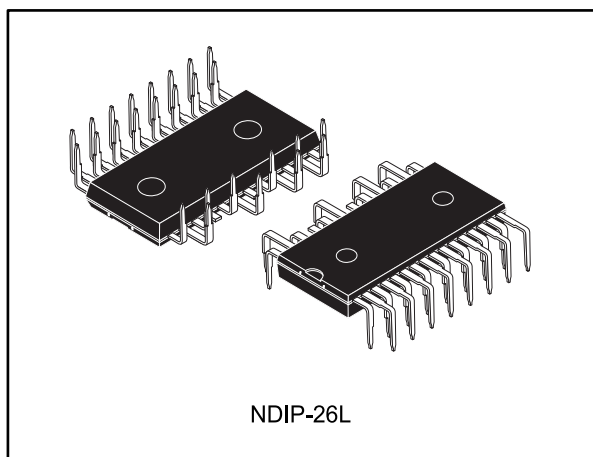


## SLLIMM™-nano small low-loss intelligent molded module IPM, 3 A, 600 V, 3-phase IGBT inverter bridge

Datasheet - production data



### Applications

- 3-phase inverters for motor drives
- Dish washers, refrigerator compressors, heating systems, air-conditioning fans, draining and recirculation pumps

### Description

This intelligent power module implements a compact, high performance AC motor drive in a simple, rugged design. It is composed of six IGBTs with freewheeling diodes and three half-bridge HVICs for gate driving, providing low electromagnetic interference (EMI) characteristics with optimized switching speed. The package is optimized for thermal performance and compactness in built-in motor applications, or other low power applications where assembly space is limited. This IPM includes an operational amplifier, completely uncommitted, and a comparator that can be used to design a fast and efficient protection circuit. SLLIMM™ is a trademark of STMicroelectronics.

### Features

- IPM 3 A, 600 V, 3-phase IGBT inverter bridge including control ICs for gate driving and freewheeling diodes
- Optimized for low electromagnetic interference
- $V_{CE(sat)}$  negative temperature coefficient
- 3.3 V, 5 V, 15 V CMOS/TTL inputs comparators with hysteresis and pull-down resistors
- Undervoltage lockout
- Internal bootstrap diode
- Interlocking function
- Optimized pinout for easy board layout
- 85 k $\Omega$  NTC for temperature control (UL1434 CA 2 and 4)

Table 1: Device summary

| Order code   | Marking    | Package  | Packing |
|--------------|------------|----------|---------|
| STGIPN3H60AT | GIPN3H60AT | NDIP-26L | Tube    |

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## Contents

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# 1 Internal schematic diagram and pin configuration

Figure 1: Internal schematic diagram

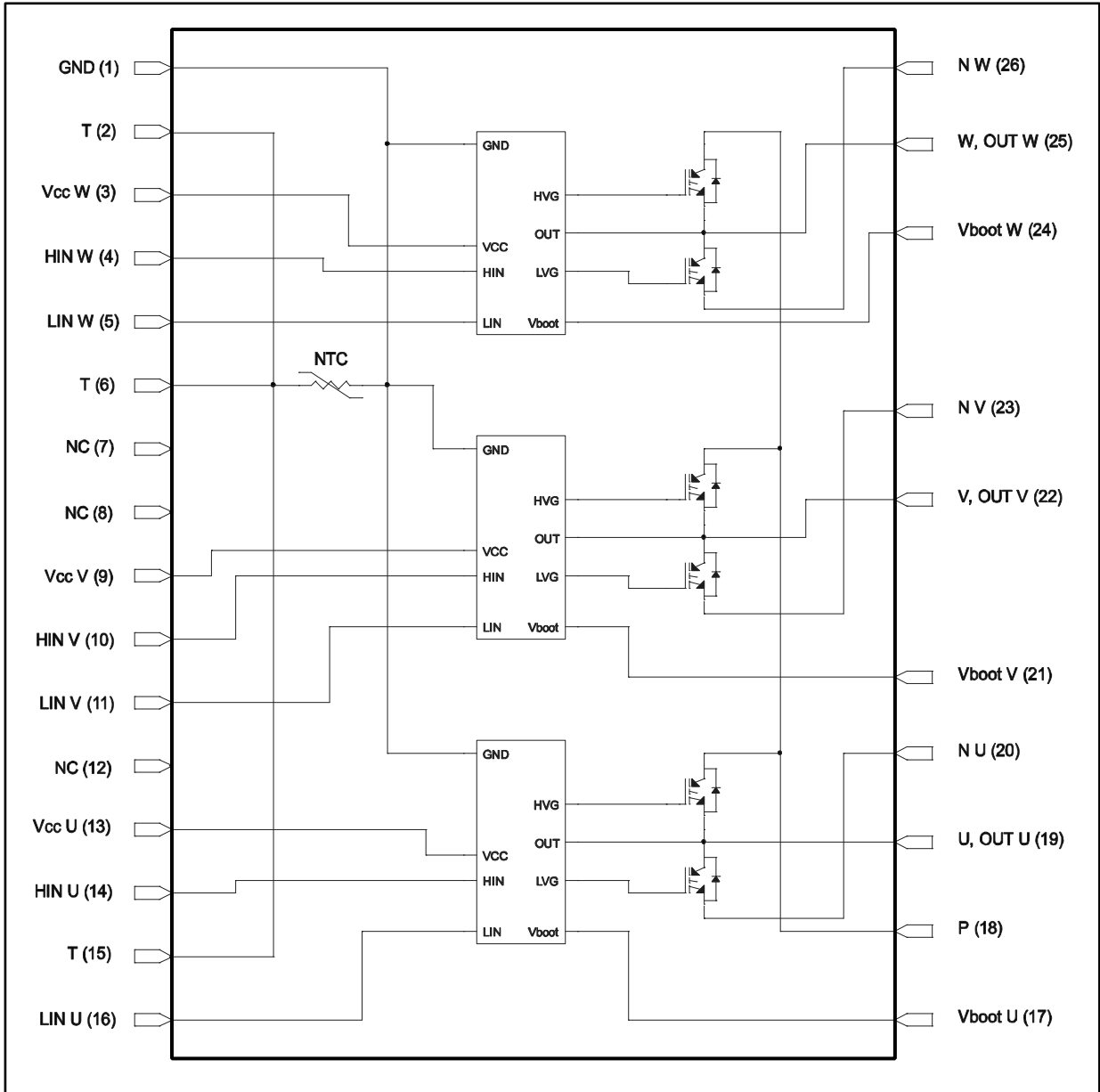
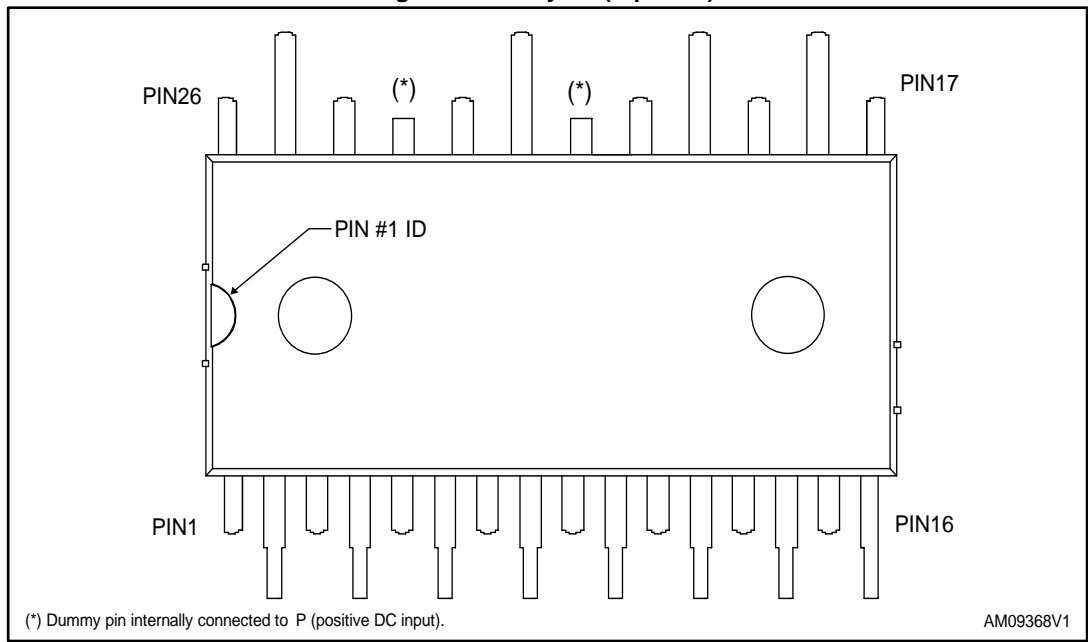


Table 2: Pin description

| Pin | Symbol              | Description                          |
|-----|---------------------|--------------------------------------|
| 1   | GND                 | Ground                               |
| 2   | T                   | NTC thermistor terminal              |
| 3   | V <sub>CC</sub> W   | Low voltage power supply W phase     |
| 4   | HIN W               | High side logic input for W phase    |
| 5   | LIN W               | Low side logic input for W phase     |
| 6   | T                   | NTC thermistor terminal              |
| 7   | NC                  | Not connected                        |
| 8   | NC                  | Not connected                        |
| 9   | V <sub>CC</sub> V   | Low voltage power supply V phase     |
| 10  | HIN V               | High side logic input for V phase    |
| 11  | LIN V               | Low side logic input for V phase     |
| 12  | NC                  | Not connected                        |
| 13  | V <sub>CC</sub> U   | Low voltage power supply for U phase |
| 14  | HIN U               | High side logic input for U phase    |
| 15  | T                   | NTC thermistor terminal              |
| 16  | LIN U               | Low side logic input for U phase     |
| 17  | V <sub>BOOT</sub> U | Bootstrap voltage for U phase        |
| 18  | P                   | Positive DC input                    |
| 19  | U                   | U phase output                       |
| 20  | N <sub>U</sub>      | Negative DC input for U phase        |
| 21  | V <sub>BOOT</sub> V | Bootstrap voltage for V phase        |
| 22  | V                   | V phase output                       |
| 23  | N <sub>V</sub>      | Negative DC input for V phase        |
| 24  | V <sub>BOOT</sub> W | Bootstrap voltage for W phase        |
| 25  | W                   | W phase output                       |
| 26  | N <sub>W</sub>      | Negative DC input for W phase        |

Figure 2: Pin layout (top view)



## 2 Electrical ratings

### 2.1 Absolute maximum ratings

Table 3: Inverter part

| Symbol                           | Parameter  | Value | Unit |
|----------------------------------|--|-------|------|
| V <sub>CES</sub>                 | Each IGBT collector emitter voltage (V <sub>IN</sub> <sup>(1)</sup> = 0) | 600   | V    |
| ± I <sub>C</sub> <sup>(2)</sup>  | Each IGBT continuous collector current at T <sub>C</sub> = 25°C          | 3     | A    |
| ± I <sub>CP</sub> <sup>(3)</sup> | Each IGBT pulsed collector current                                       | 18    | A    |
| P <sub>TOT</sub>                 | Each IGBT total dissipation at T <sub>C</sub> = 25°C                     | 8     | W    |

**Notes:**

(1) Applied between HIN<sub>i</sub>, LIN<sub>i</sub> and G<sub>ND</sub> 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 <sub>OUT</sub>     | Output voltage applied between OUT <sub>U</sub> , OUT <sub>V</sub> , OUT <sub>W</sub> - G <sub>ND</sub>     | V <sub>boot</sub> - 18 | V <sub>boot</sub> + 0.3 | V    |
| V <sub>CC</sub>      | Low voltage power supply  | - 0.3                  | 18                      | V    |
| V <sub>boot</sub>    | Bootstrap voltage   | - 0.3                  | 618                     | V    |
| V <sub>IN</sub>      | Logic input voltage applied between HIN <sub>i</sub> , LIN <sub>i</sub> and G <sub>ND</sub> for i = U, V, W | - 0.3                  | V <sub>CC</sub> + 0.3   | V    |
| ΔV <sub>OUT/dT</sub> | Allowed output slew rate  |                        | 50                      | V/ns |

Table 5: Total system

| Symbol           | Parameter   | Value      | Unit |
|------------------|---|------------|------|
| V <sub>ISO</sub> | Isolation withstand voltage applied between each pin and heatsink plate (AC voltage, t = 60 s.) | 1000       | V    |
| T <sub>j</sub>   | Power chips operating junction temperature range  | -40 to 150 | °C   |
| T <sub>C</sub>   | Module operation case temperature range   | -40 to 125 | °C   |

### 2.2 Thermal data

Table 6: Thermal data

| Symbol            | Parameter                           | Value | Unit |
|-------------------|-------------------------------------|-------|------|
| R <sub>thJA</sub> | Thermal resistance junction-ambient | 50    | °C/W |

### 3 Electrical characteristics

#### 3.1 Inverter part

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

Table 7: Static

| Symbol        | Parameter   | Test conditions  | Min. | Typ. | Max. | Unit          |
|---------------|---|--|------|------|------|---------------|
| $V_{CE(sat)}$ | Collector-emitter saturation voltage                          | $V_{CC} = V_{boot} = 15\text{ V}$ , $V_{IN}^{(1)} = 0\text{ to }5\text{ V}$ , $I_C = 1\text{ A}$                         | -    | 2.15 | 2.6  | V             |
|               |   | $V_{CC} = V_{boot} = 15\text{ V}$ , $V_{IN}^{(1)} = 0\text{ to }5\text{ V}$ , $I_C = 1\text{ A}$ , $T_J = 125\text{ °C}$ | -    | 1.65 |      |               |
| $I_{CES}$     | Collector-cut off current ( $V_{IN}^{(1)} = 0$ "logic state") | $V_{CE} = 550\text{ V}$ , $V_{CC} = V_{Boot} = 15\text{ V}$  | -    |      | 250  | $\mu\text{A}$ |
| $V_F$         | Diode forward voltage   | $V_{IN}^{(1)} = 0$ "logic state", $I_C = 1\text{ A}$   | -    |      | 1.7  | V             |

**Notes:**

<sup>(1)</sup>Applied between  $HIN_i$ ,  $LIN_i$  and  $G_{ND}$  for  $i = U, V, W$  ( $LIN$  inputs are active-low).

Table 8: Inductive load switching time and energy

| Symbol             | Parameter                 | Test conditions   | Min. | Typ. | Max. | Unit          |
|--------------------|---------------------------|---|------|------|------|---------------|
| $t_{on}^{(1)}$     | Turn-on time              | $V_{DD} = 300\text{ V}$ ,<br>$V_{CC} = V_{boot} = 15\text{ V}$ ,<br>$V_{IN}^{(2)} = 0\text{ to }5\text{ V}$ ,<br>$I_C = 1\text{ A}$<br>(see <a href="#">Figure 4: "Switching time definition"</a> ) | -    | 275  | -    | ns            |
| $t_{c(on)}^{(1)}$  | Crossover time (on)       |   | -    | 90   | -    |               |
| $t_{off}^{(1)}$    | Turn-off time             |   | -    | 890  | -    |               |
| $t_{c(off)}^{(1)}$ | Crossover time (off)      |   | -    | 125  | -    |               |
| $t_{rr}$           | Reverse recovery time     |   | -    | 50   | -    | $\mu\text{J}$ |
| $E_{on}$           | Turn-on switching energy  |   | -    | 18   | -    |               |
| $E_{off}$          | Turn-off switching energy | -   | 13   | -    |      |               |

**Notes:**

<sup>(1)</sup> $t_{ON}$  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.

<sup>(2)</sup>Applied between  $HIN_i$ ,  $LIN_i$  and  $G_{ND}$  for  $i = U, V, W$  ( $LIN$  inputs are active-low).

Figure 3: Switching time test circuit

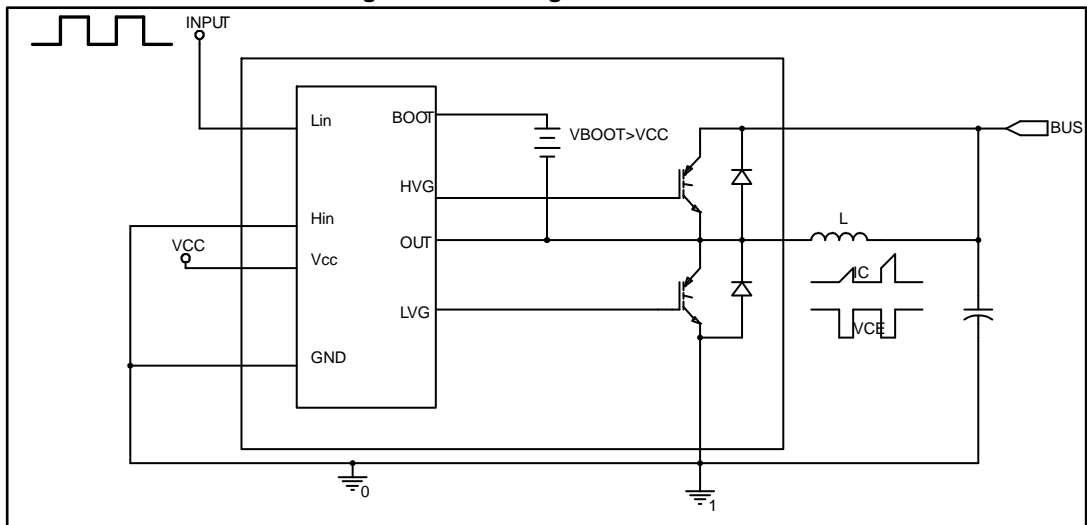
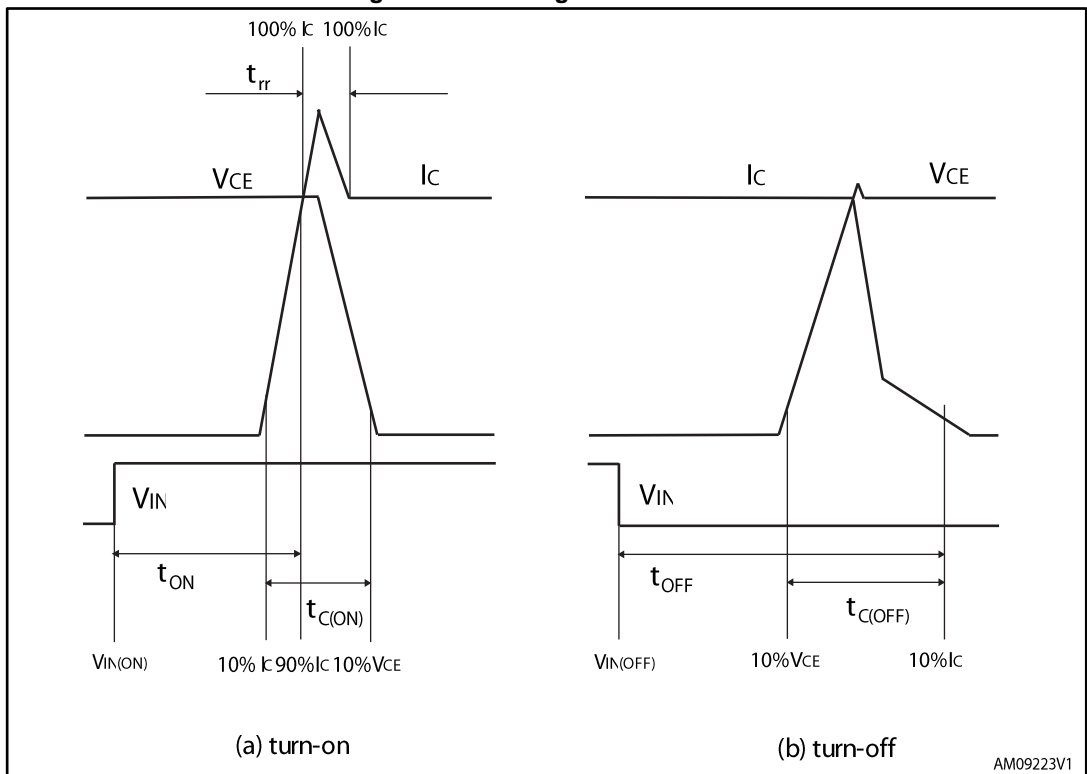


Figure 4: Switching time definition





## 3.2 Control part

Table 9: Low voltage power supply ( $V_{CC} = 15\text{ V}$  unless otherwise specified)

| Symbol          | Parameter                             | Test conditions         | Min. | Typ. | Max. | Unit          |
|-----------------|---------------------------------------|-------------------------|------|------|------|---------------|
| $V_{CC\_thON}$  | Undervoltage turn-on threshold        |                         | 9.1  | 9.6  | 10.1 | V             |
| $V_{CC\_thOFF}$ | Undervoltage turn-off threshold       |                         | 7.9  | 8.3  | 8.8  | V             |
| $V_{CC\_hys}$   | Undervoltage hystereses               |                         | 0.9  |      |      | V             |
| $I_{qccu}$      | Undervoltage quiescent supply current | $V_{CC} < 7.9\text{ V}$ |      | 250  | 330  | $\mu\text{A}$ |
| $I_{qcc}$       | Quiescent current                     | $V_{CC} = 15\text{ V}$  |      | 350  | 450  | $\mu\text{A}$ |

Table 10: Bootstrapped voltage ( $V_{CC} = 15\text{ V}$  unless otherwise specified)

| Symbol            | Parameter                       | Test conditions          | Min. | Typ. | Max. | Unit          |
|-------------------|---------------------------------|--------------------------|------|------|------|---------------|
| $V_{boot\_thON}$  | Undervoltage turn-on threshold  |                          | 8.5  | 9.5  | 10.5 | V             |
| $V_{boot\_thOFF}$ | Undervoltage turn-off threshold |                          | 7.2  | 8.3  | 9.2  | V             |
| $V_{boot\_hys}$   | Undervoltage 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 11: Logic inputs ( $V_{CC} = 15\text{ V}$  unless otherwise specified)

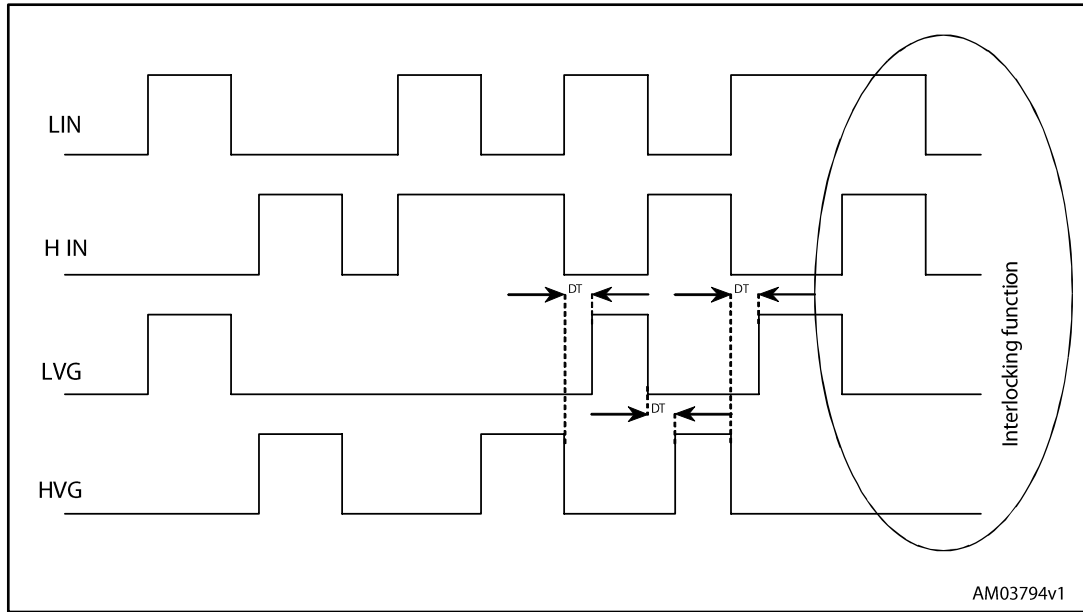
| Symbol   | Parameter                                     | Test conditions                       | Min. | Typ. | Max. | Unit          |
|----------|---|---------------------------------------|------|------|------|---------------|
| $V_{il}$ | Low level logic input voltage                 |                                       |      |      | 1.1  | V             |
| $V_{ih}$ | High level logic input voltage                |                                       | 1.8  |      |      | V             |
| $I_{il}$ | Low level logic input current <sup>(1)</sup>  | $V_{IN} = 0\text{ V}$ <sup>(1)</sup>  | -1   |      |      | $\mu\text{A}$ |
| $I_{ih}$ | High level logic input current <sup>(1)</sup> | $V_{IN} = 15\text{ V}$ <sup>(1)</sup> |      | 20   | 70   | $\mu\text{A}$ |
| $Dt$     | Dead time <sup>(2)</sup>                      |                                       |      | 320  |      | ns            |

### Notes:

<sup>(1)</sup>Applied between  $HIN_i$ ,  $LIN_i$  and  $G_{ND}$  for  $i = U, V, W$

<sup>(2)</sup>See [Figure 5: "Dead time and interlocking definition"](#)

Figure 5: Dead time and interlocking definition



3.2.1 NTC thermistor

Table 12: NTC thermistor

| Symbol | Parameter             | Test conditions     | Min. | Typ. | Max. | Unit |
|--------|-----------------------|---------------------|------|------|------|------|
| R25    | Resistance            | T = 25 °C           |      | 85   |      | kΩ   |
| R100   | Resistance            | T = 100 °C          |      | 5388 |      | Ω    |
| B      | B-constant            | T = 25 °C to 100 °C |      | 4092 |      | K    |
| T      | Operating temperature |                     | -25  |      | 125  | °C   |

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

Where T are temperatures in Kelvins

Figure 6: NTC resistance vs. temperature

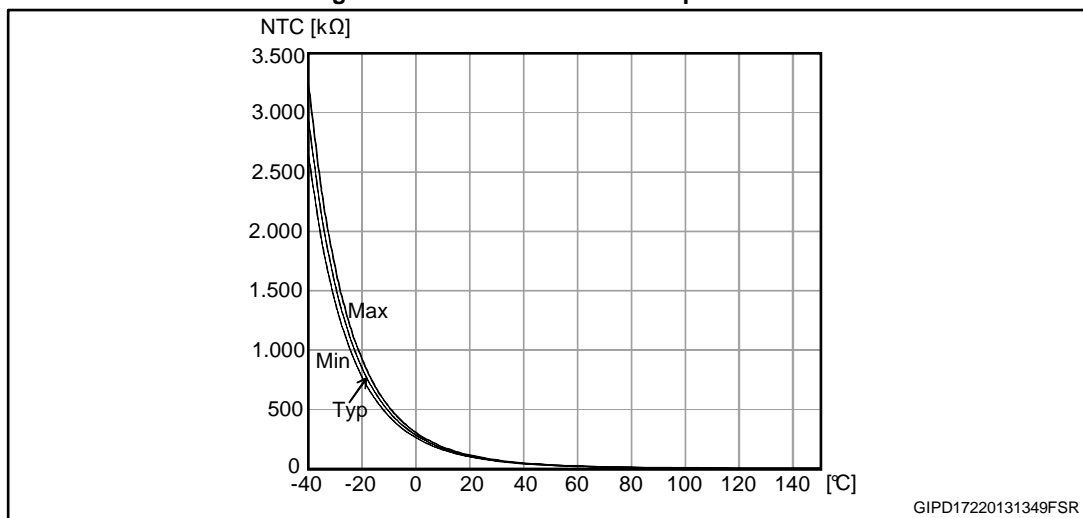
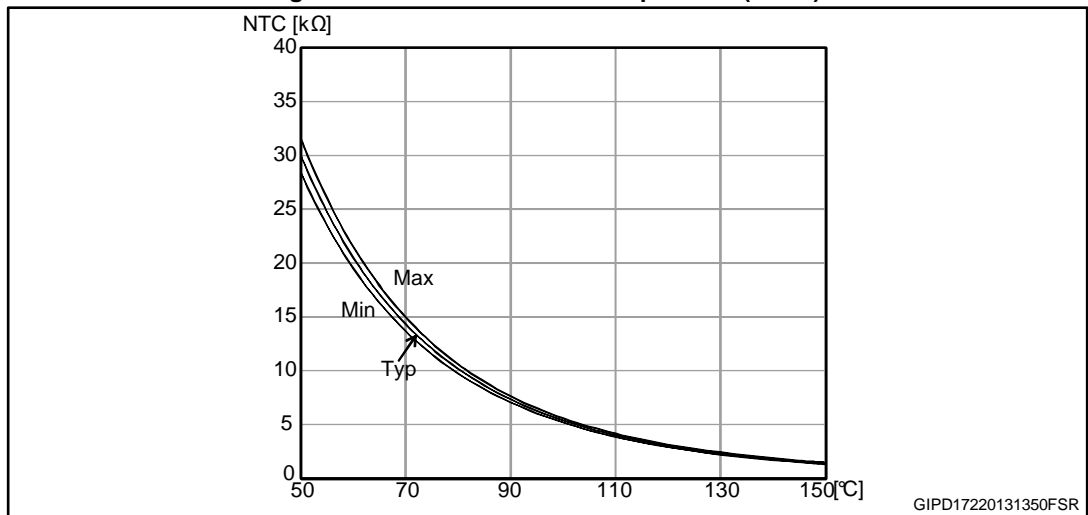


Figure 7: NTC resistance vs. temperature (zoom)





## 4.1 Guidelines

- Input signals HIN, LIN are active-high logic. A 500 k $\Omega$  (typ.) pull-down resistor is built-in for each input. To prevent input signal oscillation, the wiring of each input should be as short as possible and the use of RC filters (R1, C1) on each input signal is suggested. The filters should be done with a time constant of about 100ns and must be placed as close as possible to the IPM input pins.
- The bypass capacitor Cvcc (aluminum or tantalum) is recommended to reduce the transient circuit demand on the power supply. In addition, a decoupling capacitor C2 (from 100 to 220 nF, ceramic with low ESR) is suggested, to reduce high frequency switching noise distributed on the power supply lines. It must be placed as close as possible to each Vcc pin and in parallel to the bypass capacitor.
- The use of RC filter (RSF, CSF) for current monitoring is recommended to improve noise immunity. The filter must be placed as close as possible to the microcontroller or to the Op-amp.
- The decoupling capacitor C3 (from 100 to 220 nF, ceramic with low ESR), in parallel to each C<sub>boot</sub>, is recommended in order to filter high frequency disturbances.
- The Zener diodes DZ1 between the Vcc pins and GND and in parallel to each Cboot is suggested in order to prevent overvoltage.
- The decoupling capacitor C4 (from 100 to 220 nF, ceramic with low ESR) in parallel to the electrolytic capacitor Cvdc is recommended, in order to prevent surge destruction. Both capacitors C4 and Cvdc should be placed as close as possible to the IPM (C4 has priority over Cvdc).
- By integrating an application-specific type HVIC inside the module, direct coupling to the MCU terminals without an opto-coupler is possible.
- Low inductance shunt resistors should be used for phase leg current sensing.
- In order to avoid malfunctions, the wiring between N pins, the shunt resistor and PWR\_GND should be as short as possible.
- It is recommended to connect SGN\_GND to PWR\_GND at only one point (near the terminal of shunt resistor), in order to avoid any malfunction due to power ground fluctuation.

These guidelines are useful for application design to ensure the specifications of the device. For further details, please refer to the relevant application note AN4043.

**Table 13: Recommended operating conditions**

| Symbol            | Parameter                          | Test conditions   | Min. | Typ. | Max. | Unit    |
|-------------------|------------------------------------|---|------|------|------|---------|
| V <sub>PN</sub>   | Supply voltage                     | Applied between P-Nu, Nv, Nw  |      | 300  | 500  | 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><br>for i = U, V, W | 11.5 |      | 17   | V       |
| t <sub>dead</sub> | Blanking time to prevent Arm-short | For each input signal   | 1.5  |      |      | $\mu$ 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      |      |      | 25   | kHz     |
| T <sub>C</sub>    | Case operation temperature         |   |      |      | 100  | °C      |

## 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.

### 5.1 NDIP-26L type C package information

Figure 9: NDIP-26L type C package outline

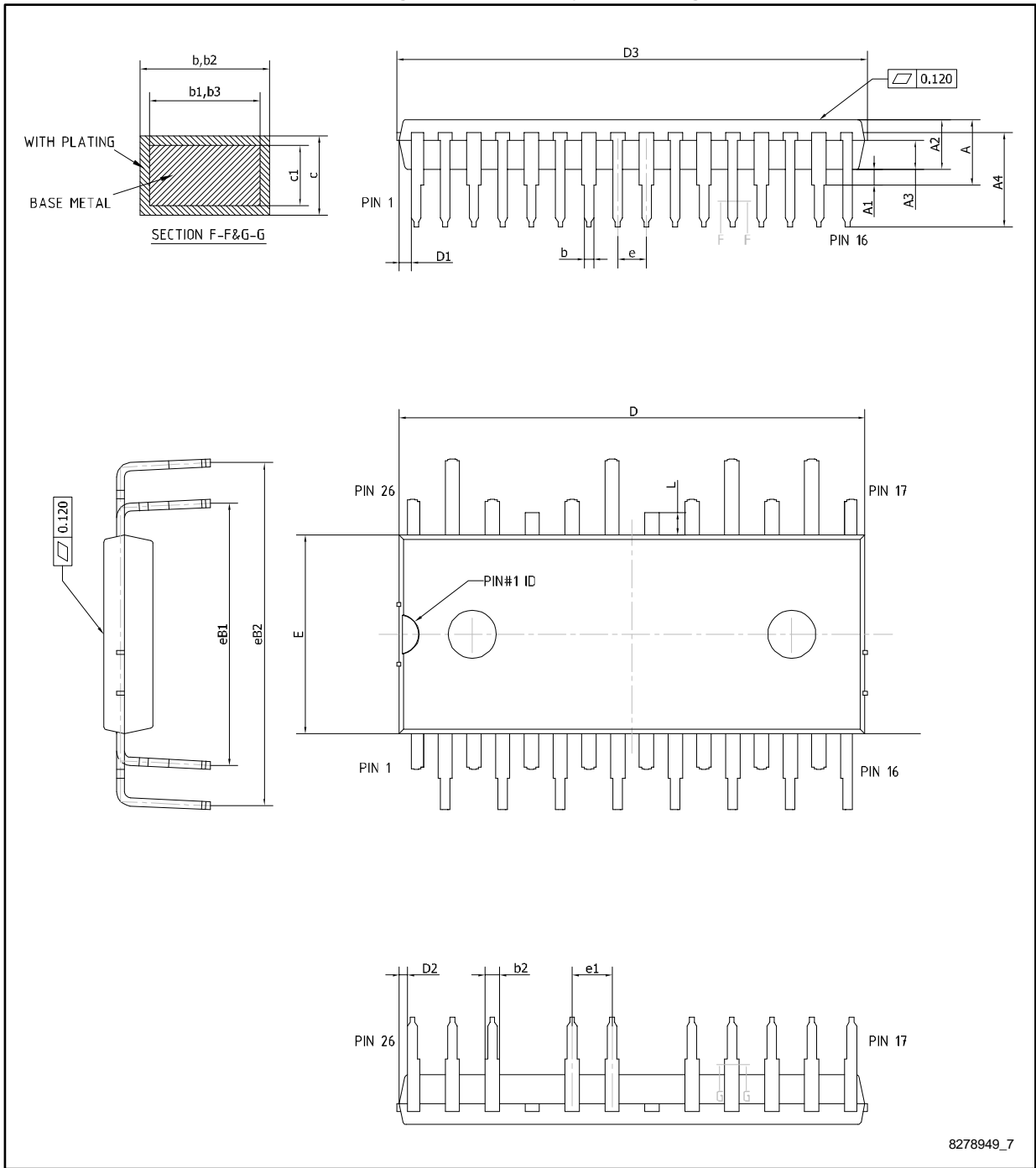


Table 14: NDIP-26L type C mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    |       |       | 4.40  |
| A1   | 0.80  | 1.00  | 1.20  |
| A2   | 3.00  | 3.10  | 3.20  |
| A3   | 1.70  | 1.80  | 1.90  |
| A4   | 5.70  | 5.90  | 6.10  |
| b    | 0.53  |       | 0.72  |
| b1   | 0.52  | 0.60  | 0.68  |
| b2   | 0.83  |       | 1.02  |
| b3   | 0.82  | 0.90  | 0.98  |
| c    | 0.46  |       | 0.59  |
| c1   | 0.45  | 0.50  | 0.55  |
| D    | 29.05 | 29.15 | 29.25 |
| D1   | 0.50  | 0.77  | 1.00  |
| D2   | 0.35  | 0.53  | 0.70  |
| D3   |       |       | 29.55 |
| E    | 12.35 | 12.45 | 12.55 |
| e    | 1.70  | 1.80  | 1.90  |
| e1   | 2.40  | 2.50  | 2.60  |
| eB1  | 16.10 | 16.40 | 16.70 |
| eB2  | 21.18 | 21.48 | 21.78 |
| L    | 1.24  | 1.39  | 1.54  |



### 5.2 NDIP-26L packing information

Figure 10: NDIP-26L tube dimensions (dimensions are in mm)

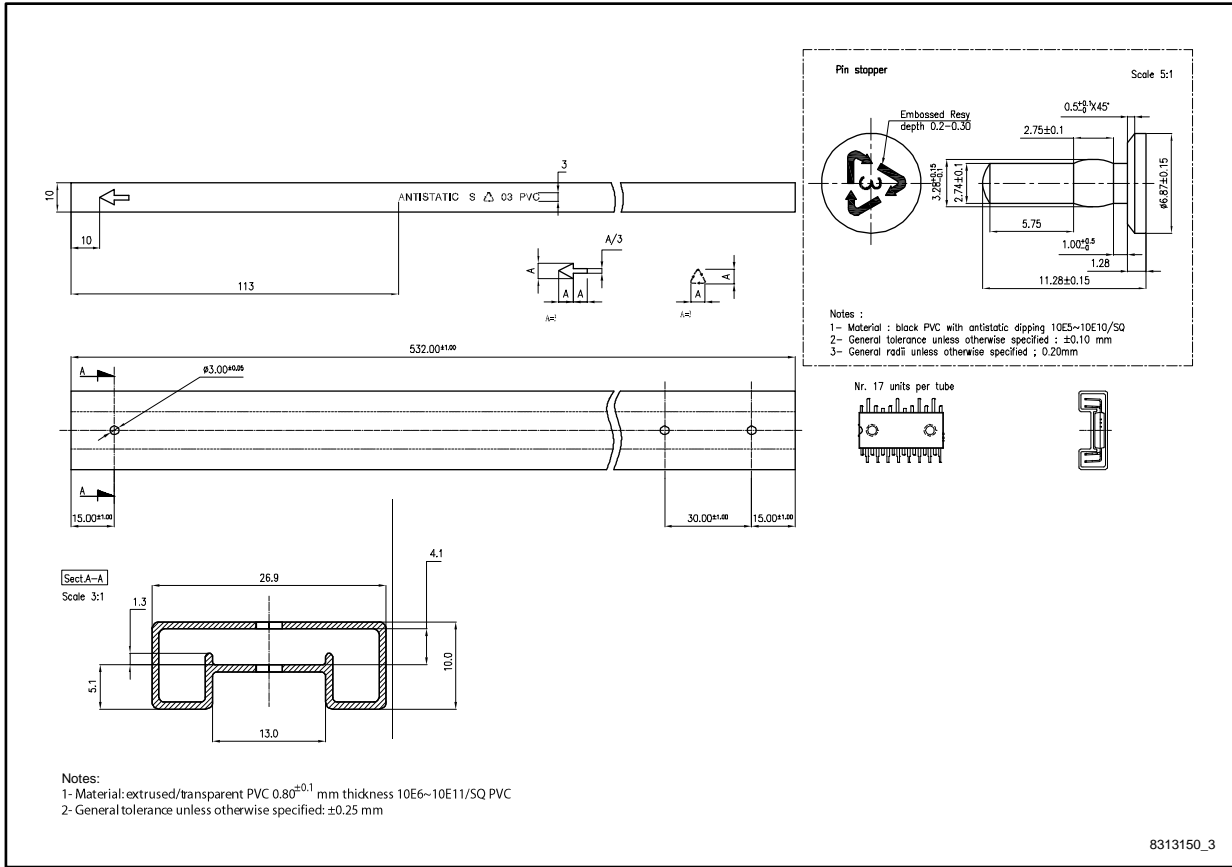


Table 15: Shipping details

| Parameter     | Value   |
|---------------|---------|
| Base quantity | 17 pcs  |
| Bulk quantity | 476 pcs |

## 6 Revision history

Table 16: Document revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| 30-Sep-2014 | 1        | Initial release.   |
| 13-Sep-2016 | 2        | Updated <a href="#">Section 5.1: "NDIP-26L type C package information"</a> and <a href="#">Section 5.2: "NDIP-26L packing information"</a><br>Minor text changes |

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(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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