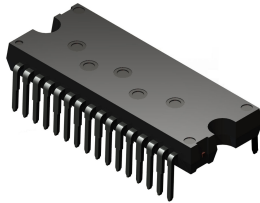
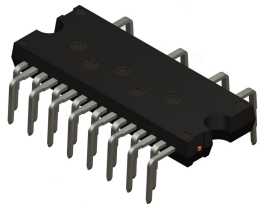


## SLLIMM-nano 2<sup>nd</sup> series IPM, 3 A, 600 V, 3-phase inverter bridge IGBT



N2DIP-26L type L



N2DIP-26L type Z



### Product status links

[STGIPQ3H60T-HL](#)

[STGIPQ3H60T-HZ](#)

### Product summary

#### Order code: STGIPQ3H60T-HL

|         |                  |
|---------|------------------|
| Marking | GIPQ3H60T-HL     |
| Package | N2DIP-26L type L |
| Packing | Tube             |

#### Order code: STGIPQ3H60T-HZ

|         |                  |
|---------|------------------|
| Marking | GIPQ3H60T-HZ     |
| Package | N2DIP-26L type Z |
| Packing | Tube             |

### Features

- IPM 3 A, 600 V, 3-phase IGBT inverter bridge including 3 control ICs for gate driving and freewheeling diodes
- 3.3 V, 5 V, 15 V TTL/CMOS input comparators with hysteresis and pull-down/pull-up resistors
- Internal bootstrap diode
- Optimized for low electromagnetic interference
- Undervoltage lockout
- $V_{CE(SAT)}$  negative temperature coefficient
- Shutdown function
- Interlocking function
- Op-amp for advanced current sensing
- Comparator for fault protection against overcurrent
- NTC (UL 1434 CA 2 and 4)
- Up to  $\pm 2$  kV ESD protection (HBM C = 100 pF, R = 1.5 k $\Omega$ )
- Isolation ratings of 1800 Vrms/min.
- UL recognition: UL 1557, file E81734

### Applications

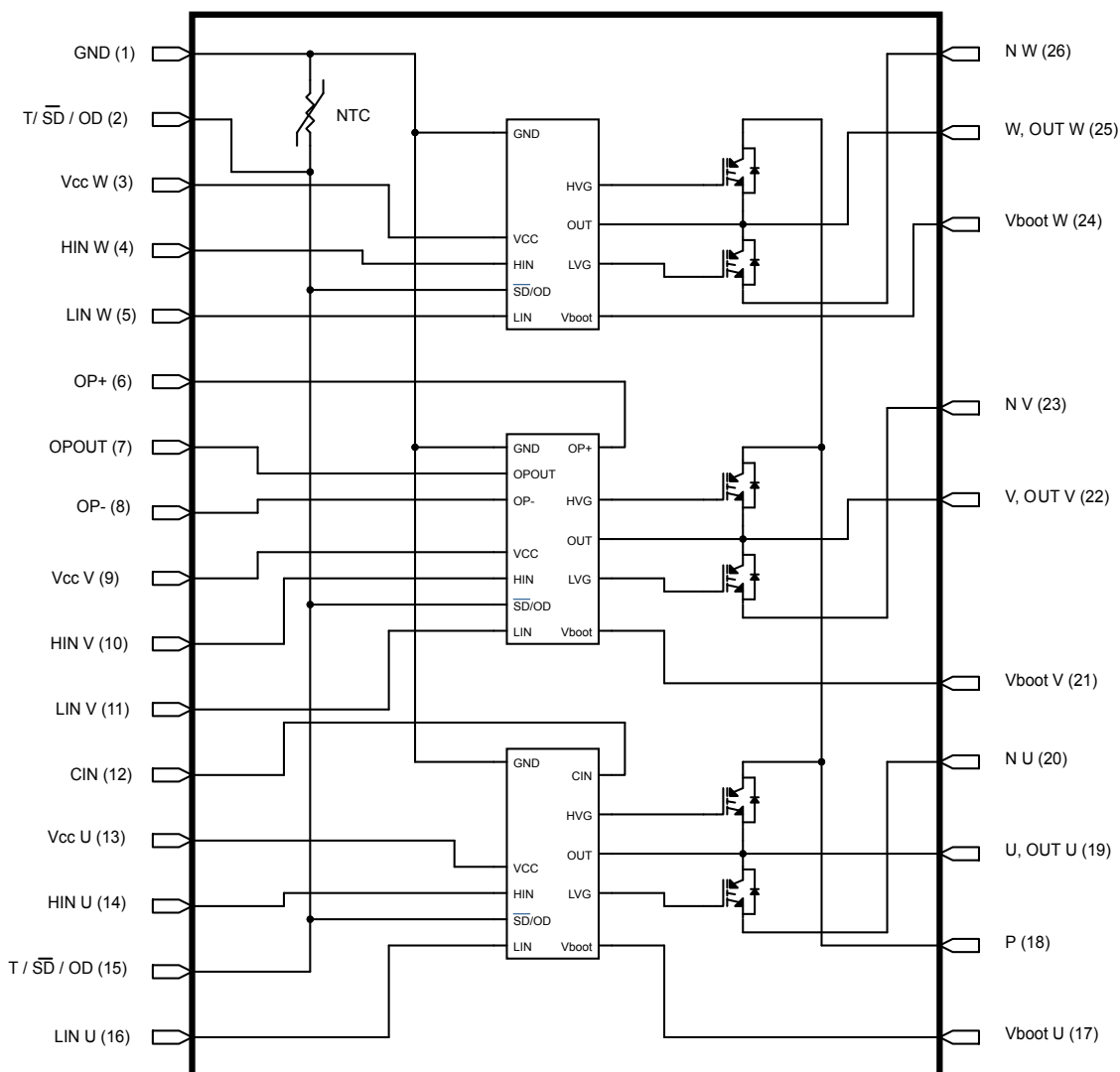
- 3-phase induction motor (ACIM)
- Dishwasher
- Fans
- Kitchen hoods
- PMSM / BLDC motor control
- Refrigerators and freezers

### Description

This second series of SLLIMM (small low-loss intelligent molded module) nano provides a compact, high-performance AC motor drive in a simple, rugged design. It is composed of six improved short-circuit rugged trench gate fieldstop 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 designed to allow a better and more easily screwed-on heat sink, and 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 a completely uncommitted operational amplifier and a comparator that can be used to design a fast and efficient protection circuit.

# 1 Internal schematic diagram and pin configuration

Figure 1. Internal schematic diagram

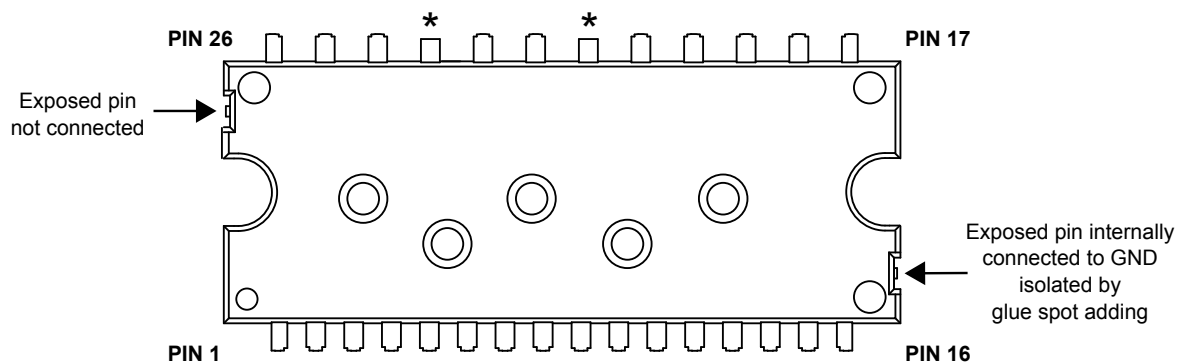


GIPG300720141542SMD

**Table 1. Pin description**

| Pin | Symbol                        | Description                                                                              |
|-----|-------------------------------|------------------------------------------------------------------------------------------|
| 1   | GND                           | Ground                                                                                   |
| 2   | T/ $\overline{\text{SD}}$ /OD | NTC thermistor terminal/shutdown logic input (active low)/open-drain (comparator output) |
| 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   | OP+                           | Op-amp non-inverting input                                                               |
| 7   | OP <sub>OUT</sub>             | Op-amp output                                                                            |
| 8   | OP-                           | Op-amp inverting input                                                                   |
| 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  | CIN                           | Comparator input                                                                         |
| 13  | V <sub>CC</sub> U             | Low-voltage power supply for V phase                                                     |
| 14  | HIN U                         | High-side logic input for V phase                                                        |
| 15  | T/ $\overline{\text{SD}}$ /OD | NTC thermistor terminal/shutdown logic input (active low)/open-drain (comparator output) |
| 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, OUT <sub>U</sub>           | 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, OUT <sub>V</sub>           | 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, OUT <sub>W</sub>           | W phase output                                                                           |
| 26  | N <sub>W</sub>                | Negative DC input for W phase                                                            |

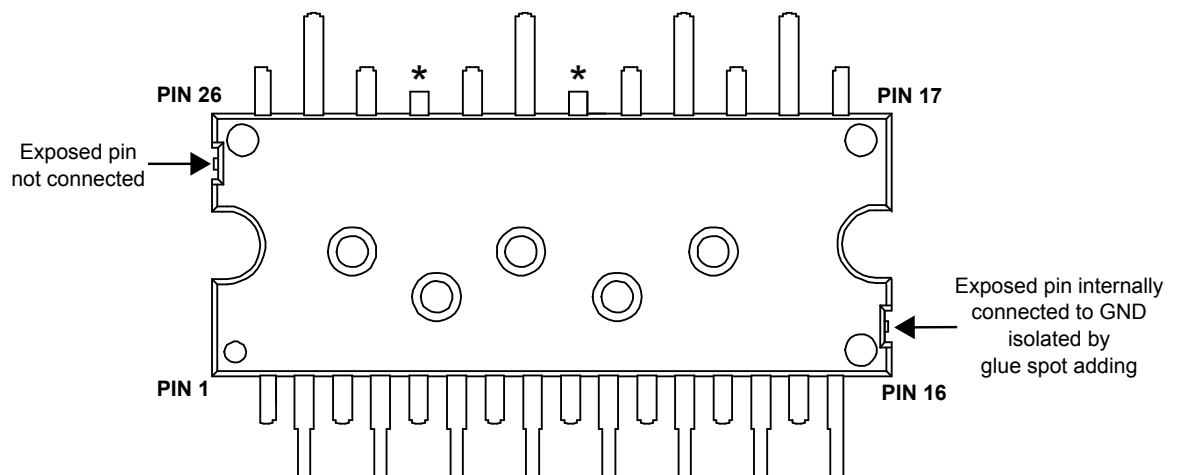
**Figure 2. Pin layout (top view) - N2DIP-26L type L**



\* Dummy pins internally connected to P (positive DC input)

GADG181220181209IG

**Figure 3. Pin layout (top view) - N2DIP-26L type Z**



\* Dummy pins internally connected to P (positive DC input)

GADG181220181216IG

## 2 Electrical ratings

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

### 2.1 Absolute maximum ratings

**Table 2. Inverter part**

| Symbol         | Parameter                                                           | Value | Unit |
|----------------|---------------------------------------------------------------------|-------|------|
| $V_{CES}$      | Collector-emitter voltage for each IGBT ( $V_{IN}^{(1)} = 0$ )      | 600   | V    |
| $I_C$          | Continuous collector current for each IGBT ( $T_C = 25\text{ °C}$ ) | 3     | A    |
| $I_{CP}^{(2)}$ | Peak collector current for each IGBT (less than 1 ms)               | 6     | A    |
| $P_{TOT}$      | Total power dissipation for each IGBT ( $T_C = 25\text{ °C}$ )      | 12.5  | W    |

1. Applied among  $HIN_x$ ,  $LIN_x$  and GND for  $x = U, V, W$
2. Pulse width limited by maximum junction temperature.

**Table 3. Control part**

| Symbol        | Parameter                                                      | Min.            | Max.             | Unit |
|---------------|----------------------------------------------------------------|-----------------|------------------|------|
| $V_{CC}$      | Low voltage power supply                                       | -0.3            | 21               | V    |
| $V_{boot}$    | Bootstrap voltage                                              | -0.3            | 620              | V    |
| $V_{OUT}$     | Output voltage applied among $OUT_U$ , $OUT_V$ , $OUT_W$ - GND | $V_{boot} - 21$ | $V_{boot} + 0.3$ | V    |
| $V_{CIN}$     | Comparator input voltage                                       | -0.3            | $V_{CC} + 0.3$   | V    |
| $V_{op+}$     | Op-amp non-inverting input                                     | -0.3            | $V_{CC} + 0.3$   | V    |
| $V_{op-}$     | Op-amp inverting input                                         | -0.3            | $V_{CC} + 0.3$   | V    |
| $V_{IN}$      | Logic input voltage applied among $HIN_x$ , $LIN_x$ and GND    | -0.3            | 15               | V    |
| $V_{T/SD/OD}$ | Open-drain voltage                                             | -0.3            | 15               | V    |
| $dV_{out}/dt$ | Allowed output slew rate                                       |                 | 50               | V/ns |

**Table 4. Total system**

| Symbol    | Parameter                                                                                            | Value      | Unit |
|-----------|------------------------------------------------------------------------------------------------------|------------|------|
| $V_{ISO}$ | Isolation withstand voltage applied to each pin and heat sink plate (AC voltage, $t = 60\text{ s}$ ) | 1800       | Vrms |
| $T_J$     | Power chip operating junction temperature                                                            | -40 to 150 | °C   |
| $T_C$     | Operating case temperature range                                                                     | -40 to 125 | °C   |

### 2.2 Thermal data

**Table 5. Thermal data**

| Symbol     | Parameter                                         | Value | Unit |
|------------|---------------------------------------------------|-------|------|
| $R_{thJC}$ | Thermal resistance, junction-to-case single IGBT  | 10    | °C/W |
|            | Thermal resistance, junction-to-case single diode | 15    |      |

### 3 Electrical characteristics

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

#### 3.1 Inverter part

**Table 6. Static**

| Symbol        | Parameter                                                     | Test conditions                                                                                | Min. | Typ. | Max. | Unit          |
|---------------|---------------------------------------------------------------|------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{CES}$     | Collector cut-off current ( $V_{IN}^{(1)} = 0$ "logic state") | $V_{CE} = 550\text{ V}$ , $V_{CC} = V_{Boot} = 15\text{ V}$                                    | -    |      | 250  | $\mu\text{A}$ |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage                          | $V_{CC} = V_{boot} = 15\text{ V}$ , $V_{IN}^{(1)} = 0$ to $5\text{ V}$ ,<br>$I_C = 1\text{ A}$ | -    | 2.15 | 2.6  | V             |
| $V_F$         | Diode forward voltage                                         | $V_{IN}^{(1)} = 0$ "logic state", $I_C = 1\text{ A}$                                           | -    | 1.35 | 1.8  | V             |

1. Applied among  $HIN_x$ ,  $LIN_x$  and  $G_{ND}$  for  $x = U, V, W$ .

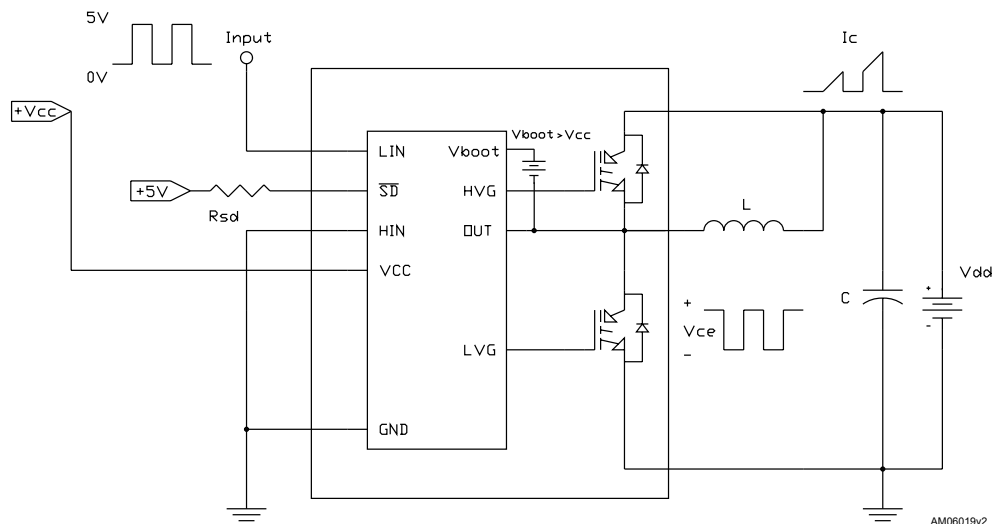
**Table 7. Inductive load switching time and energy**

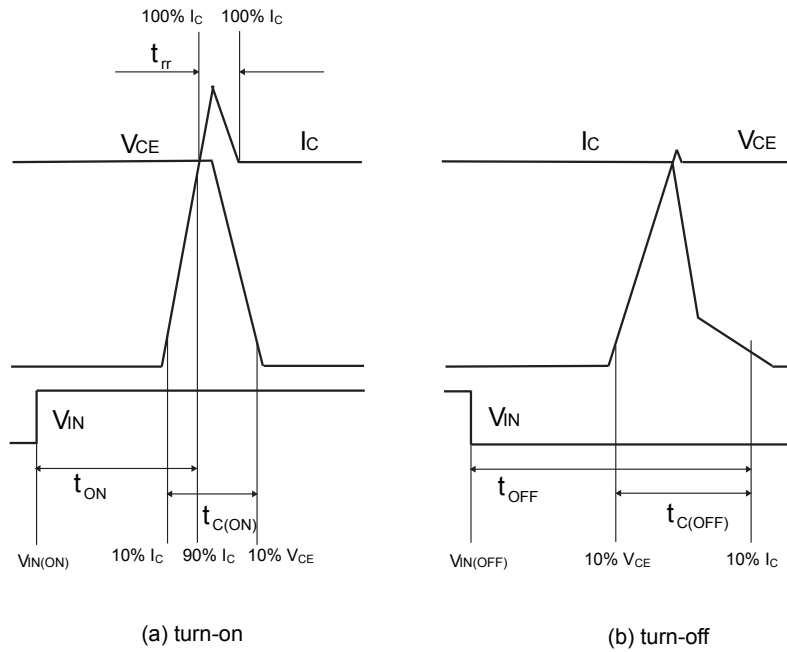
| Symbol             | Parameter                 | Test conditions                                                                                                                                                       | Min. | Typ. | Max. | Unit          |
|--------------------|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $t_{on}^{(1)}$     | Turn-on time              | $V_{DD} = 300\text{ V}$ , $V_{CC} = V_{boot} = 15\text{ V}$ ,<br>$V_{IN}^{(2)} = 0$ to $5\text{ V}$ , $I_C = 1\text{ A}$<br>(see Figure 5. Switching time definition) | -    | 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   | -    |               |

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

2. Applied among  $HIN_x$ ,  $LIN_x$  and  $G_{ND}$  for  $x = U, V, W$ .

**Figure 4. Switching time test circuit**



**Figure 5. Switching time definition**


AM09223V1

Figure 5. Switching time definition refers to HIN, LIN inputs (active high).

## 3.2 Control part

**Table 8. Low-voltage power supply**

| 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       | $V_{CC} = 10\text{ V}$ , $T/\overline{SD}/OD = 5\text{ V}$ ,<br>$LIN = HIN = CIN = 0\text{ V}$ |      |      | 150  | $\mu\text{A}$ |
| $I_{qcc}$       | Quiescent current                           | $V_{CC} = 10\text{ V}$ , $T/\overline{SD}/OD = 5\text{ V}$ ,<br>$LIN = HIN = CIN = 0\text{ V}$ |      |      | 1    | mA            |
| $V_{ref}$       | Internal comparator (CIN) reference voltage |                                                                                                | 0.51 | 0.54 | 0.56 | V             |

**Table 9. Bootstrapped voltage**

| 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 | $V_{BS} < 9\text{ V}$ , $T/\overline{SD}/OD = 5\text{ V}$ ,<br>$LIN = 0\text{ V}$ and $HIN = 5\text{ V}$ ,<br>$CIN = 0\text{ V}$ |      | 70   | 110  | $\mu\text{A}$ |
| $I_{QBS}$       | $V_{BS}$ quiescent current              | $V_{BS} = 15\text{ V}$ , $T/\overline{SD}/OD = 5\text{ V}$ ,<br>$LIN = 0\text{ V}$ and $HIN = 5\text{ V}$ ,<br>$CIN = 0$         |      | 150  | 210  | $\mu\text{A}$ |
| $R_{DS(on)}$    | Bootstrap driver on-resistance          | LVG ON                                                                                                                           |      | 120  |      | $\Omega$      |

**Table 10. Logic inputs**

| Symbol     | Parameter                                    | Test conditions                                                | Min. | Typ. | Max. | Unit          |
|------------|----------------------------------------------|----------------------------------------------------------------|------|------|------|---------------|
| $V_{il}$   | Low logic level voltage                      |                                                                |      |      | 0.8  | V             |
| $V_{ih}$   | High logic level voltage                     |                                                                | 2.25 |      |      | V             |
| $I_{HINh}$ | HIN logic "1" input bias current             | $HIN = 15\text{ V}$                                            | 20   | 40   | 100  | $\mu\text{A}$ |
| $I_{HINl}$ | HIN logic "0" input bias current             | $HIN = 0\text{ V}$                                             |      |      | 1    | $\mu\text{A}$ |
| $I_{LINl}$ | LIN logic "0" input bias current             | $LIN = 0\text{ V}$                                             |      |      | 1    | $\mu\text{A}$ |
| $I_{LINh}$ | LIN logic "1" input bias current             | $LIN = 15\text{ V}$                                            | 20   | 40   | 100  | $\mu\text{A}$ |
| $I_{SDh}$  | $\overline{SD}$ logic "0" input bias current | $\overline{SD} = 15\text{ V}$                                  | 210  | 350  | 477  | $\mu\text{A}$ |
| $I_{SDl}$  | $\overline{SD}$ logic "1" input bias current | $\overline{SD} = 0\text{ V}$                                   |      |      | 3    | $\mu\text{A}$ |
| $Dt$       | Dead time                                    | See Figure 10. Dead time and interlocking waveform definitions |      | 180  |      | ns            |

**Table 11. Op-amp characteristics**

| Symbol   | Parameter                         | Test conditions                                             | Min. | Typ. | Max. | Unit             |
|----------|-----------------------------------|-------------------------------------------------------------|------|------|------|------------------|
| $V_{io}$ | Input offset voltage              | $V_{ic} = 0\text{ V}$ , $V_o = 7.5\text{ V}$                |      |      | 6    | mV               |
| $I_{io}$ | Input offset current              | $V_{ic} = 0\text{ V}$ , $V_o = 7.5\text{ V}$                |      | 4    | 40   | nA               |
| $I_{ib}$ | Input bias current <sup>(1)</sup> |                                                             |      | 100  | 200  | nA               |
| $V_{OL}$ | Low level output voltage          | $R_L = 10\text{ k}\Omega$ to $V_{CC}$                       |      | 75   | 150  | mV               |
| $V_{OH}$ | High level output voltage         | $R_L = 10\text{ k}\Omega$ to GND                            | 14   | 14.7 |      | V                |
| $I_o$    | Output short-circuit current      | Source, $V_{id} = +1\text{ V}$ ; $V_o = 0\text{ V}$         | 16   | 30   |      | mA               |
|          |                                   | Sink, $V_{id} = -1\text{ V}$ ; $V_o = V_{CC}$               | 50   | 80   |      | mA               |
| SR       | Slew rate                         | $V_i = 1 - 4\text{ V}$ ; $C_L = 100\text{ pF}$ ; unity gain | 2.5  | 3.8  |      | V/ $\mu\text{s}$ |
| GBWP     | Gain bandwidth product            | $V_o = 7.5\text{ V}$                                        | 8    | 12   |      | MHz              |
| $A_{vd}$ | Large signal voltage gain         | $R_L = 2\text{ k}\Omega$                                    | 70   | 85   |      | dB               |
| SVR      | Supply voltage rejection ratio    | vs $V_{CC}$                                                 | 60   | 75   |      | dB               |
| CMRR     | Common mode rejection ratio       |                                                             | 55   | 70   |      | dB               |

1. The direction of input current is out of the IC.



**Table 12. Sense comparator characteristics**

| Symbol        | Parameter                                                                 | Test conditions                                                      | Min. | Typ. | Max. | Unit             |
|---------------|---------------------------------------------------------------------------|----------------------------------------------------------------------|------|------|------|------------------|
| $I_{ib}$      | Input bias current                                                        | $V_{CIN} = 1\text{ V}$                                               | -    |      | 1    | $\mu\text{A}$    |
| $V_{od}$      | Open-drain low level output voltage                                       | $I_{od} = 3\text{ mA}$                                               | -    |      | 0.5  | V                |
| $R_{ON\_OD}$  | Open-drain low level output                                               | $I_{od} = 3\text{ mA}$                                               | -    | 166  |      | $\Omega$         |
| $R_{PD\_SD}$  | $\overline{SD}$ pull-down resistor <sup>(1)</sup>                         |                                                                      | -    | 125  |      | k $\Omega$       |
| $t_{d\_comp}$ | Comparator delay                                                          | T/ $\overline{SD}$ /OD pulled to 5 V through 100 k $\Omega$ resistor | -    | 90   | 130  | ns               |
| SR            | Slew rate                                                                 | $C_L = 180\text{ pF}$ , $R_{pu} = 5\text{ k}\Omega$                  | -    | 60   |      | V/ $\mu\text{s}$ |
| $t_{sd}$      | Shutdown to high-/low-side driver propagation delay                       | $V_{OUT} = 0$ , $V_{boot} = V_{CC}$ ,<br>$V_{IN} = 0$ to 3.3 V       | -    | 125  |      | ns               |
| $t_{isd}$     | Comparator triggering to high-/low-side driver turn-off propagation delay | Measured applying a voltage step from 0 V to 3.3 V to pin CIN        | -    | 200  |      |                  |

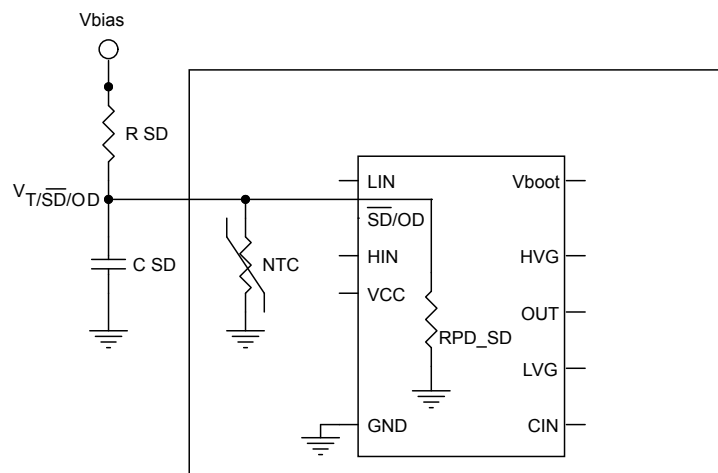
1. Equivalent values as a result of the resistances of three drivers in parallel.

**Table 13. Truth table**

| Conditions                               | Logic input ( $V_I$ )  |                  |                  | Output |     |
|------------------------------------------|------------------------|------------------|------------------|--------|-----|
|                                          | T/ $\overline{SD}$ /OD | LIN              | HIN              | LVG    | HVG |
| Shutdown enable half-bridge tri-state    | L                      | X <sup>(1)</sup> | X <sup>(1)</sup> | 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   |

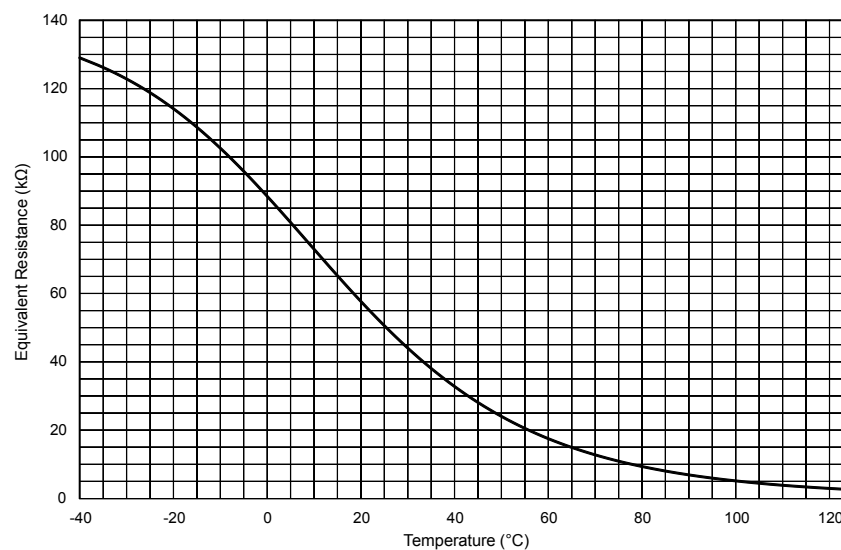
1. X: don't care.

### 3.2.1 NTC thermistor

**Figure 6. Internal structure of  $\overline{SD}$  and NTC**


RPD\_SD: equivalent value as result of resistances of three drivers in parallel.

**Figure 7. Equivalent resistance (NTC//R<sub>PD\_SD</sub>)**



**Figure 8. Equivalent resistance (NTC//R<sub>PD\_SD</sub>) zoom**

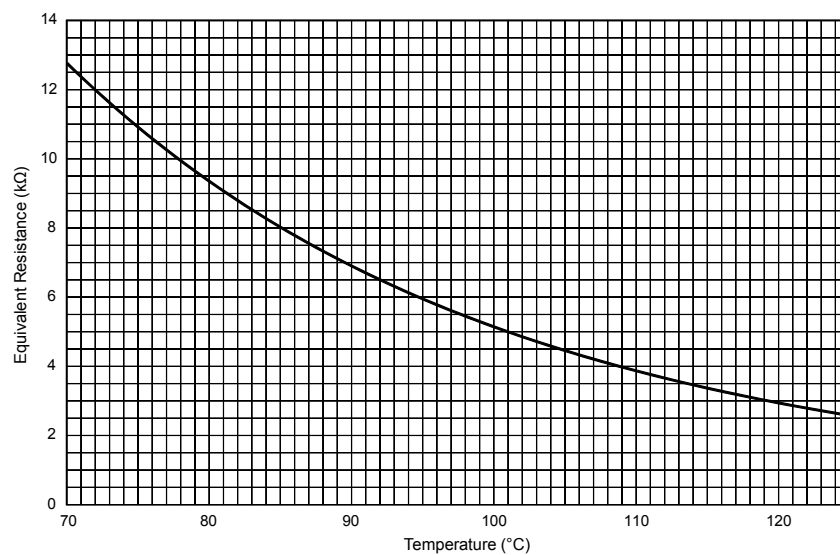
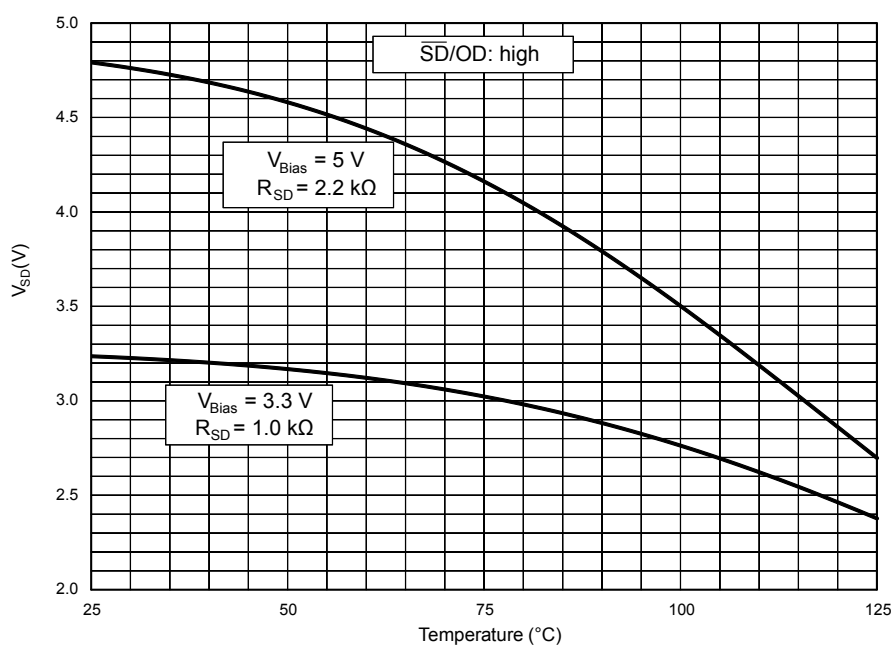
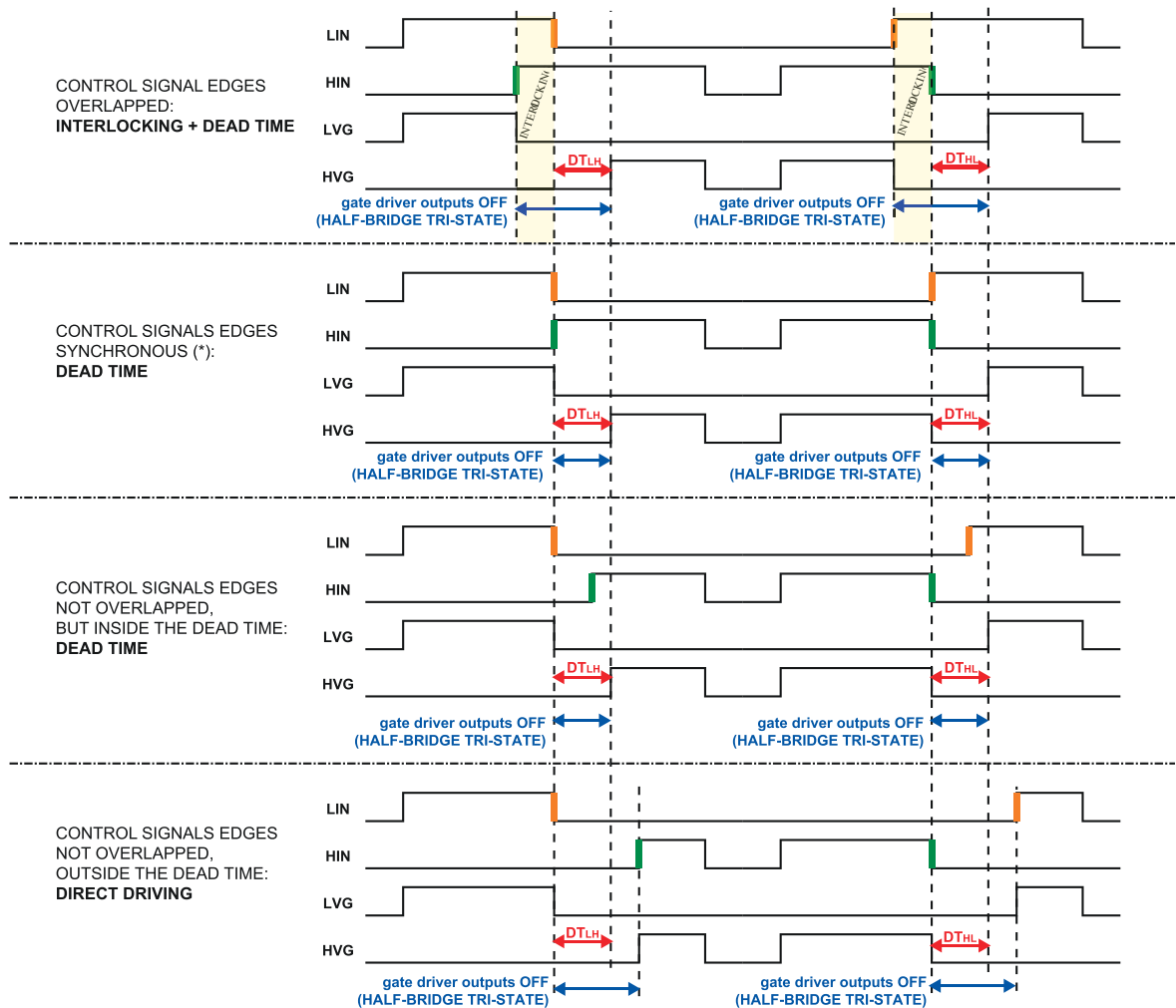


Figure 9. Voltage of T/SD/OD pin according to NTC temperature



### 3.3 Waveform definitions

**Figure 10. Dead time and interlocking waveform definitions**



## 4 Shutdown function

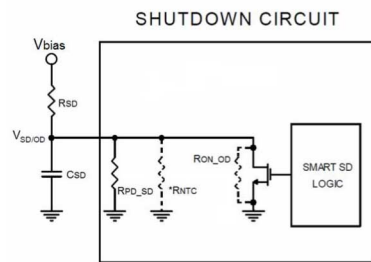
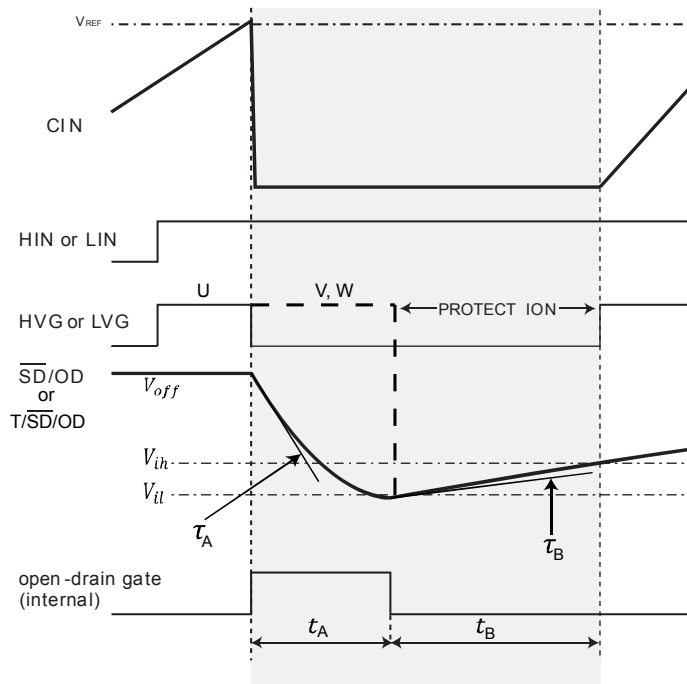
The device is equipped with three half-bridge IC gate drivers and integrates a comparator for fault detection. The comparator has an internal voltage reference  $V_{REF}$  connected to the inverting input, while the non-inverting input pin (CIN) can be connected to an external shunt resistor for current monitoring.

Since the comparator is embedded in the U IC gate driver, in case of fault it disables directly the U outputs, whereas the shutdown of V and W IC gate drivers depends on the RC value of the external SD circuitry, which fixes the disabling time.

For an effective design of the shutdown circuit, please refer to Application note AN4966.

**Figure 11. Shutdown timing waveforms**

GADG250120171515FSR



$$t_A \cong \tau_A \cdot \ln \left( \frac{V_{off} - V_{on}}{V_{il} - V_{on}} \right), \quad t_B \cong \tau_B \cdot \ln \left( \frac{V_{il} - V_{off}}{V_{ih} - V_{off}} \right)$$

$$\tau_A = (R_{ON\_OD} // R_{SD} // R_{PD\_SD} // R_{NTC}) \cdot C_{SD} \cong R_{ON\_OD} \cdot C_{SD}$$

$$\tau_B = (R_{SD} // R_{PD\_SD} // R_{NTC}) \cdot C_{SD}$$

$$V_{on} = \frac{R_{ON\_OD} // R_{PD\_SD} // R_{NTC}}{(R_{ON\_OD} // R_{PD\_SD} // R_{NTC}) + R_{SD}} \cdot V_{bias}$$

$$\cong \frac{R_{ON\_OD}}{R_{ON\_OD} + R_{SD}} \cdot V_{bias}$$

$$V_{off} = \frac{R_{PD\_SD} // R_{NTC}}{(R_{PD\_SD} // R_{NTC}) + R_{SD}} \cdot V_{bias}$$

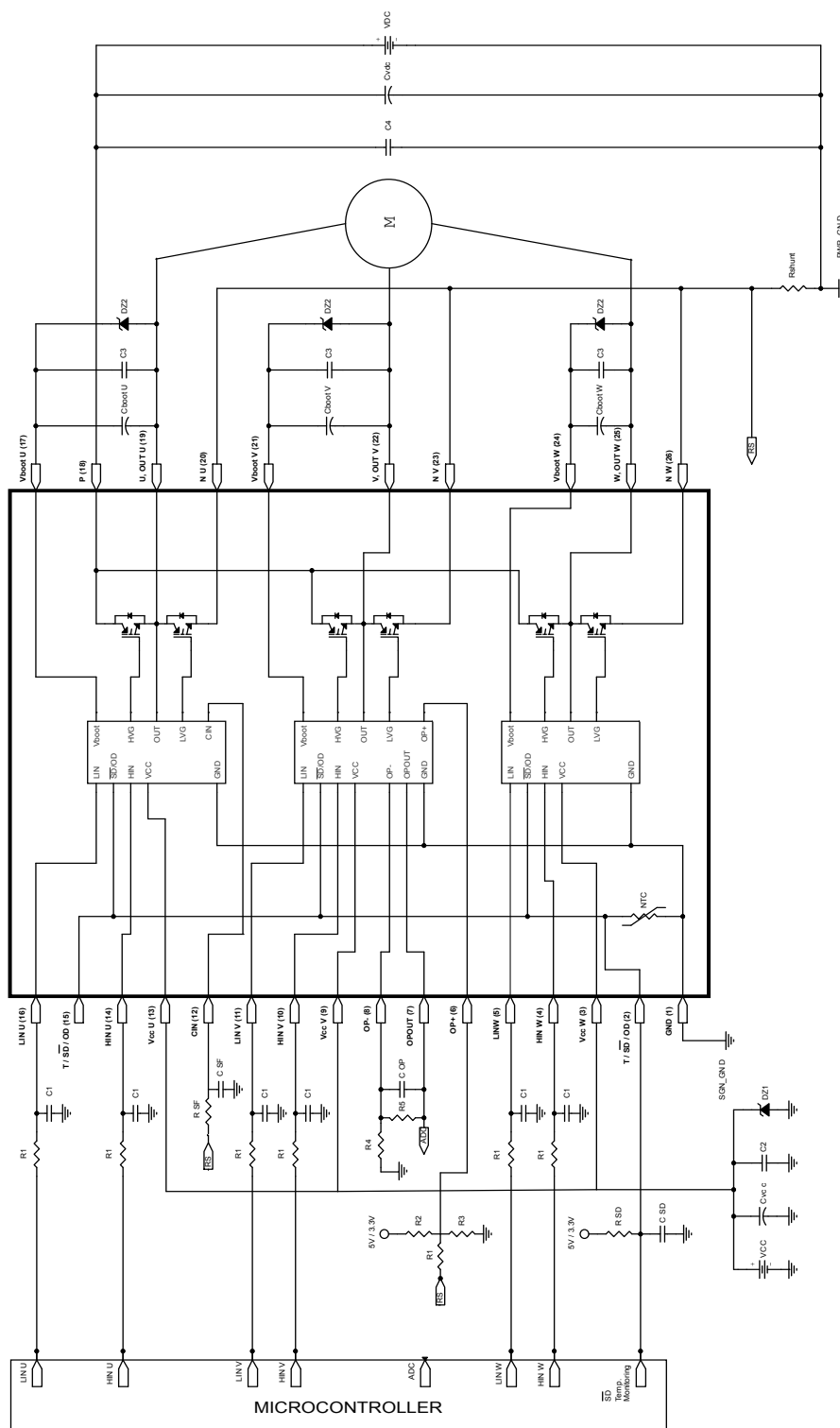
$R_{SD}$  and  $C_{SD}$  external circuitry must be designed to ensure  $V_{on} < V_{il}$  &  $V_{off} > V_{ih}$

Please refer to AN4966 for further details.

\*  $R_{NTC}$  to be considered only when the NTC is internally connected to the T/SD/OD pin.

## 5 Application circuit example

**Figure 12. Application circuit example**



GAD250720161156FSR

Application designers are free to use a different scheme according to the specifications of the device.

## 5.1 Guidelines

- Input signals HIN, LIN are active high logic. A 375 k $\Omega$  (typ.) pull-down resistor is built-in for each input. To avoid input signal oscillation, the wiring of each input should be as short as possible, and the use of RC filters ( $R_1$ ,  $C_1$ ) on each input signal is suggested. The filters should be with a time constant of about 100 ns and placed as close as possible to the IPM input pins.
- The use of a bypass capacitor  $C_{VCC}$  (aluminum or tantalum) can reduce the transient circuit demand on the power supply. Also, to reduce any high-frequency switching noise distributed on the power lines, a decoupling capacitor  $C_2$  (100 to 220 nF, with low ESR and low ESL) should be placed as close as possible to the  $V_{CC}$  pin and in parallel with the bypass capacitor.
- The use of an RC filter ( $R_{SF}$ ,  $C_{SF}$ ) is recommended to prevent protection circuit malfunction. The time constant ( $R_{SF} \times C_{SF}$ ) should be set to 1  $\mu$ s and the filter must be placed as close as possible to the  $C_{IN}$  pin.
- The  $\overline{SD}$  is an input/output pin (open-drain type if it is used as output). A built-in thermistor NTC is internally connected between the  $\overline{SD}$  pin and GND. The voltage  $V_{SD}$ -GND decreases as the temperature increases, due to the pull-up resistor  $R_{SD}$ . In order to keep the voltage always higher than the high-level logic threshold, the pull-up resistor should be set to 1 k $\Omega$  or 2.2 k $\Omega$  for 3.3 V or 5 V MCU power supply, respectively. The capacitor  $C_{SD}$  of the filter on  $\overline{SD}$  should be fixed no higher than 3.3 nF in order to assure the  $\overline{SD}$  activation time  $\tau_A \leq 500$  ns. Besides, the filter should be placed as close as possible to the  $\overline{SD}$  pin.
- The decoupling capacitor  $C_3$  (from 100 to 220 nF, ceramic with low ESR and low ESL), in parallel with each  $C_{boot}$ , filters high-frequency disturbance. Both  $C_{boot}$  and  $C_3$  (if present) should be placed as close as possible to the U, V, W and  $V_{boot}$  pins. Bootstrap negative electrodes should be connected to U, V, W terminals directly and separated from the main output wires.
- To avoid overvoltage on the  $V_{CC}$  pin, a Zener diode (Dz1) can be used. Similarly on the  $V_{boot}$  pin, a Zener diode (Dz2) can be placed in parallel with each  $C_{boot}$ .
- The use of the decoupling capacitor  $C_4$  (100 to 220 nF, with low ESR and low ESL) in parallel with the electrolytic capacitor  $C_{Vdc}$  is useful to prevent surge destruction. Both capacitors  $C_4$  and  $C_{Vdc}$  should be placed as close as possible to the IPM ( $C_4$  has priority over  $C_{Vdc}$ ).
- By integrating an application-specific type HVIC inside the module, direct coupling to the MCU terminals without an opto-couplers is possible.
- Low-inductance shunt resistors have to be used for phase leg current sensing.
- In order to avoid malfunctions, the wiring on N pins, the shunt resistor and  $P_{WR\_GND}$  should be as short as possible.
- The connection of  $SGN\_GND$  to  $PWR\_GND$  on one point only (close to the shunt resistor terminal) can reduce the impact of power ground fluctuation.

These guidelines ensure the specifications of the device for application designs. For further details, please refer to the relevant application note.

**Table 14. Recommended operating conditions**

| Symbol     | Parameter                          | Test conditions                                                                            | Min. | Typ. | Max. | Unit         |
|------------|------------------------------------|--------------------------------------------------------------------------------------------|------|------|------|--------------|
| $V_{PN}$   | Supply voltage                     | Applied among P-Nu, Nv, Nw                                                                 |      | 300  | 500  | V            |
| $V_{CC}$   | Control supply voltage             | Applied to $V_{CC}$ -GND                                                                   | 13.5 | 15   | 18   | V            |
| $V_{BS}$   | High-side bias voltage             | Applied to $V_{BOOTx}$ -OUT for x = U, V, W                                                | 13   |      | 18   | V            |
| $t_{dead}$ | Blanking time to prevent arm-short | For each input signal                                                                      | 1.5  |      |      | $\mu$ s      |
| $f_{PWM}$  | PWM input signal                   | -40 $^{\circ}$ C < $T_C$ < 100 $^{\circ}$ C<br>-40 $^{\circ}$ C < $T_J$ < 125 $^{\circ}$ C |      |      | 25   | kHz          |
| $T_C$      | Operating case temperature         |                                                                                            |      |      | 100  | $^{\circ}$ C |

## 6 Electrical characteristics (curves)

Figure 13. Output characteristics

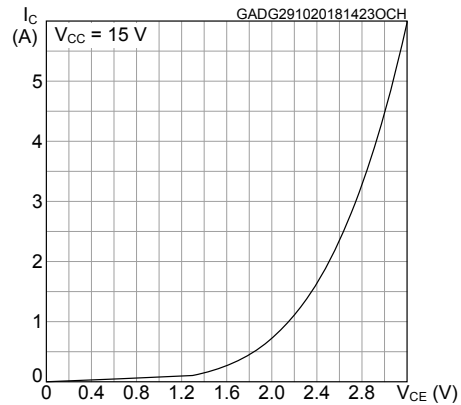


Figure 14.  $V_{ce(sat)}$  vs collector current

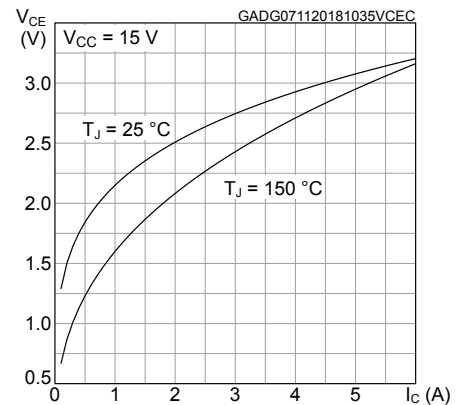


Figure 15.  $I_C$  vs case temperature

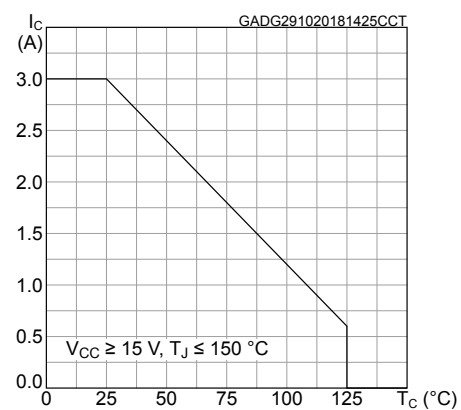


Figure 16. Diode  $V_F$  vs forward current

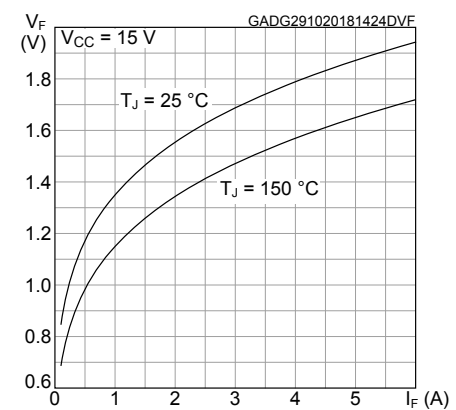


Figure 17.  $E_{on}$  switching energy vs collector current

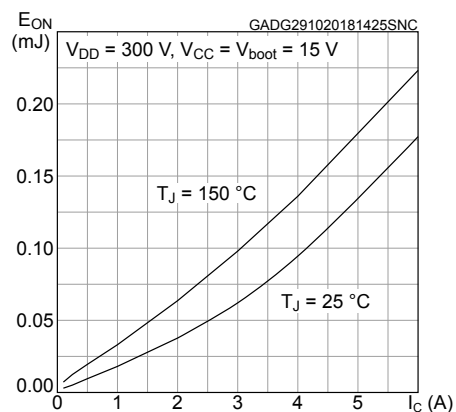


Figure 18.  $E_{off}$  switching energy vs collector current

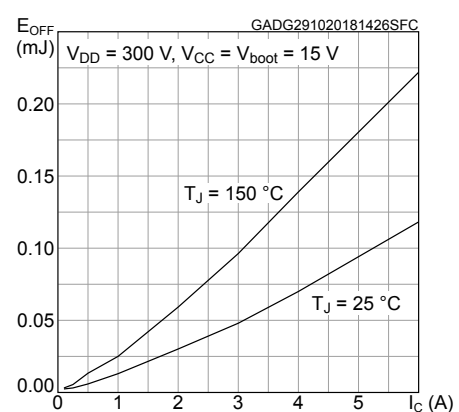
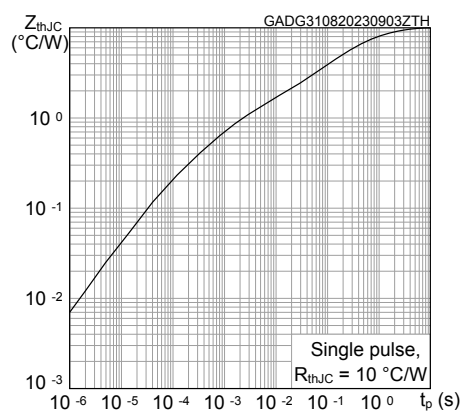




Figure 19. Maximum transient thermal impedance for IGBT

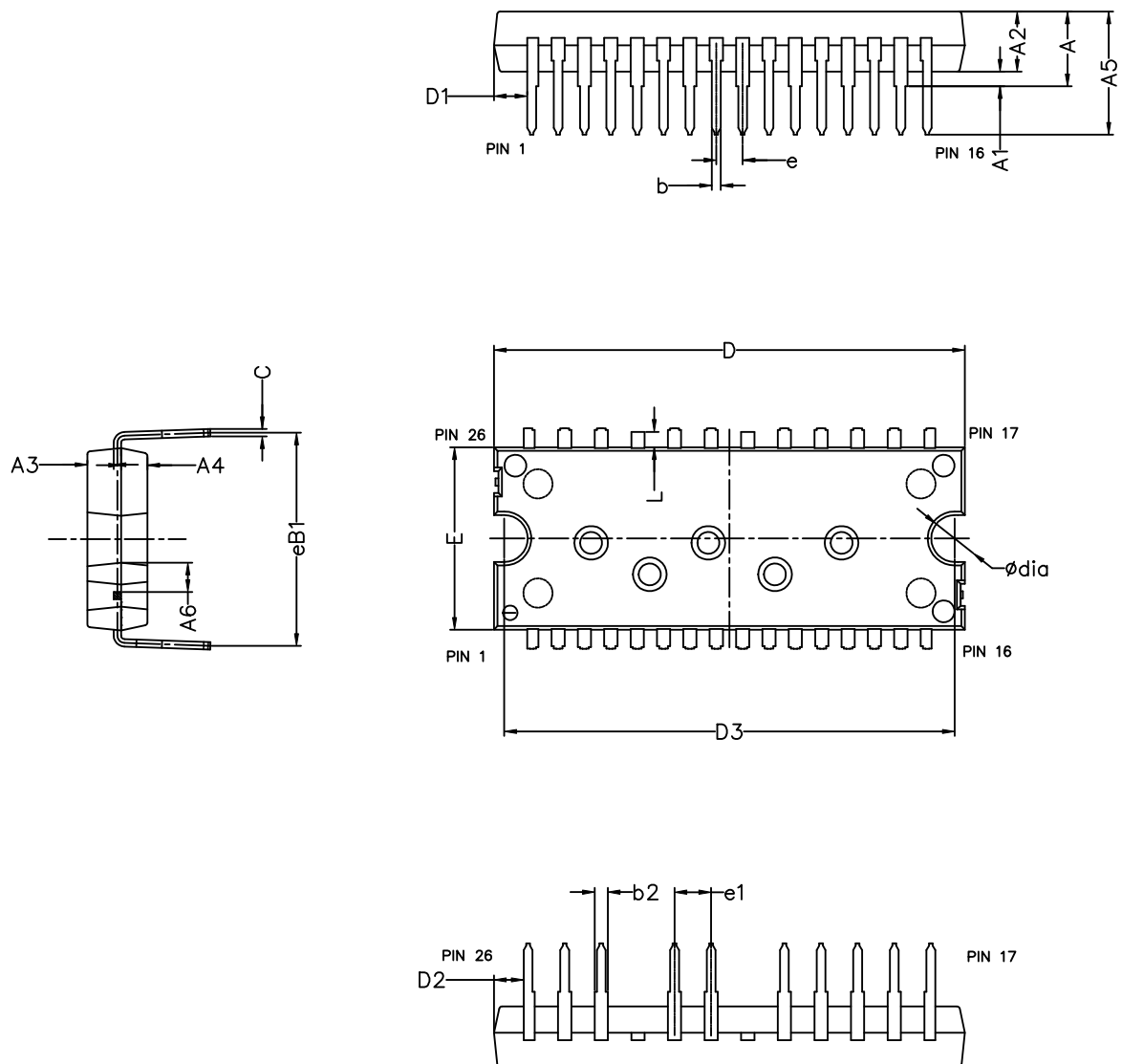


## 7 Package information

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.

### 7.1 N2DIP-26L type L package information

**Figure 20. N2DIP-26L type L package outline**



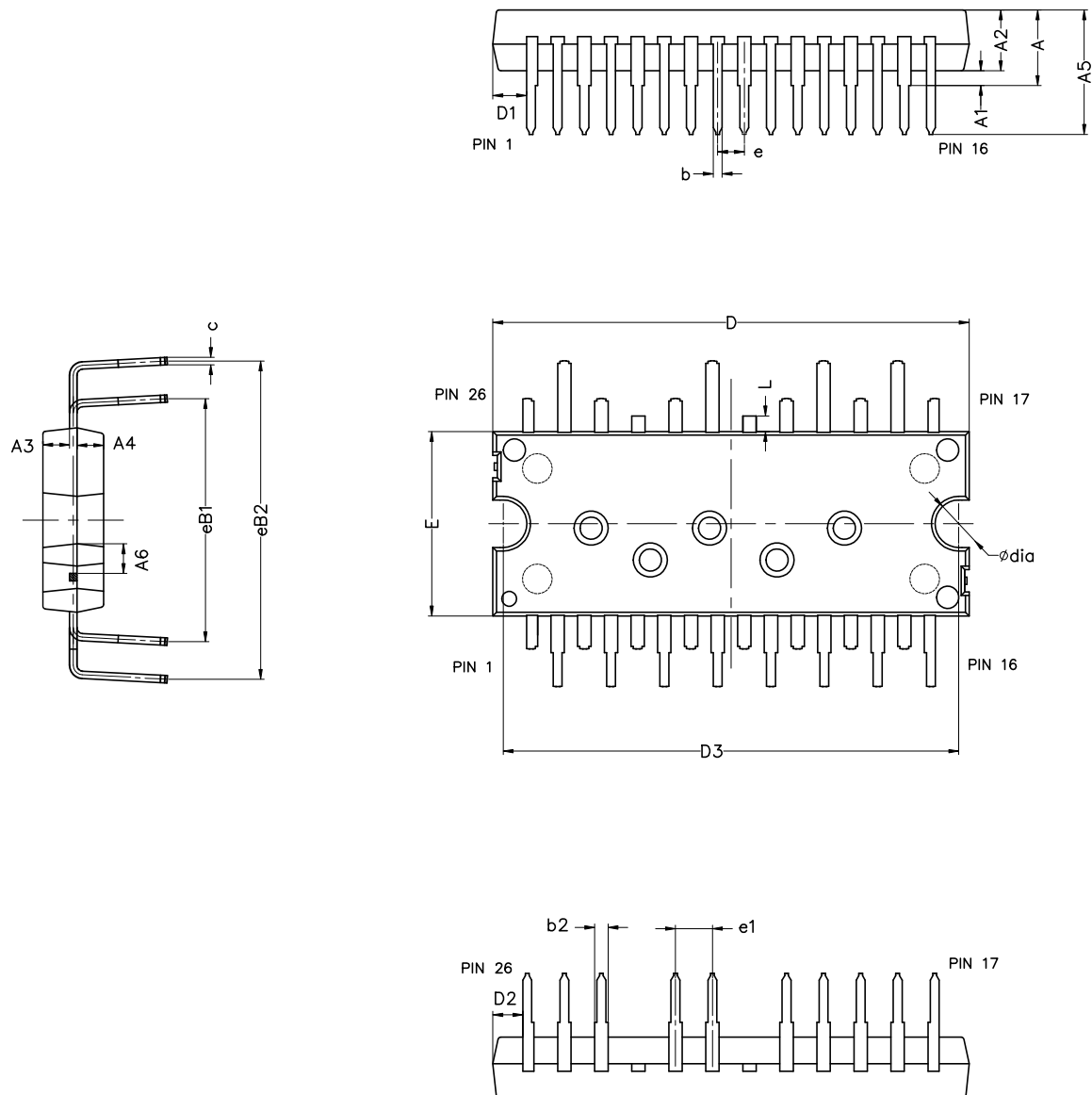
8558322\_typeL\_rev3

**Table 15. N2DIP-26L type L mechanical data**

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.80  | 5.10  | 5.40  |
| A1   | 0.80  | 1.00  | 1.20  |
| A2   | 4.00  | 4.10  | 4.20  |
| A3   | 1.70  | 1.80  | 1.90  |
| A4   | 1.70  | 1.80  | 1.90  |
| A5   | 8.10  | 8.40  | 8.70  |
| A6   | 1.75  |       |       |
| b    | 0.53  |       | 0.72  |
| b2   | 0.83  |       | 1.02  |
| c    | 0.46  |       | 0.59  |
| D    | 32.05 | 32.15 | 32.25 |
| D1   | 2.10  |       |       |
| D2   | 1.85  |       |       |
| D3   | 30.65 | 30.75 | 30.85 |
| E    | 12.35 | 12.45 | 12.55 |
| e    | 1.70  | 1.80  | 1.90  |
| e1   | 2.40  | 2.50  | 2.60  |
| eB1  | 14.25 | 14.55 | 14.85 |
| L    | 0.85  | 1.05  | 1.25  |
| Dia  | 3.10  | 3.20  | 3.30  |

## 7.2 N2DIP-26L type Z package information

Figure 21. N2DIP-26L type Z package outline



8558322\_typeZ\_rev3

**Table 16. N2DIP-26L type Z mechanical data**

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.80  | 5.10  | 5.40  |
| A1   | 0.80  | 1.00  | 1.20  |
| A2   | 4.00  | 4.10  | 4.20  |
| A3   | 1.70  | 1.80  | 1.90  |
| A4   | 1.70  | 1.80  | 1.90  |
| A5   | 8.10  | 8.40  | 8.70  |
| A6   | 1.75  |       |       |
| b    | 0.53  |       | 0.72  |
| b2   | 0.83  |       | 1.02  |
| c    | 0.46  |       | 0.59  |
| D    | 32.05 | 32.15 | 32.25 |
| D1   | 2.10  |       |       |
| D2   | 1.85  |       |       |
| D3   | 30.65 | 30.75 | 30.85 |
| 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    | 0.85  | 1.05  | 1.25  |
| Dia  | 3.10  | 3.20  | 3.30  |



## Revision history

**Table 17. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 25-Nov-2014 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 27-May-2015 | 2        | Text and formatting changes throughout document. On cover page: - updated Features - added N2DIP-26L type Z silhouette - renamed N2DIP-26L type L silhouette and package name (was N2DIP-26L) - renamed N2DIP-26L type Z package name (was N2DIP-26L). In Section 2: <i>Absolute maximum ratings</i> : - updated Table 3: <i>Inverter parts</i> . In Section 2.1: <i>Thermal data</i> : - updated Table 6: <i>Thermal data</i> . In Section 3: <i>Electrical characteristics</i> : - updated Table 7: <i>Inverter parts</i> |
| 06-Jul-2015 | 3        | Updated Table 8: <i>Low voltage power supply</i> , Table 9: <i>Bootstrapped voltage</i> , Table 10: <i>Logic inputs</i> and Table 12: <i>Sense comparator characteristics</i> . Minor text changes.                                                                                                                                                                                                                                                                                                                         |
| 31-Jul-2015 | 4        | Document status promoted from preliminary to production data.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 21-Mar-2017 | 5        | Modified Figure 2: "Switching time test circuit" and Figure 4: "Internal structure of SD and NTC".<br>Minor text changes.                                                                                                                                                                                                                                                                                                                                                                                                   |
| 12-Nov-2018 | 6        | Updated package silhouette on cover page.<br>Updated Section 2.1 <i>Absolute maximum ratings</i> , Section 3.2 <i>Control part</i> , Section 4 <i>Shutdown function</i> and Section 5.1 <i>Guidelines</i> .<br>Added Section 6 <i>Electrical characteristics (curves)</i> .<br>Updated Section 7 <i>Package information</i> .<br>Minor text changes                                                                                                                                                                         |
| 06-Mar-2019 | 7        | Updated Section 1 <i>Internal schematic diagram and pin configuration</i> and Figure 11. <i>Shutdown timing waveforms</i> .<br>Minor text changes                                                                                                                                                                                                                                                                                                                                                                           |
| 25-Aug-2022 | 8        | Modified Applications on cover page<br>Modified Table 5. Thermal data<br>Minor text changes.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 01-Sep-2023 | 9        | Updated Features on cover page.<br>Updated Table 2. Inverter part, Table 4. Total system and Figure 19. Maximum transient thermal impedance for IGBT.                                                                                                                                                                                                                                                                                                                                                                       |

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