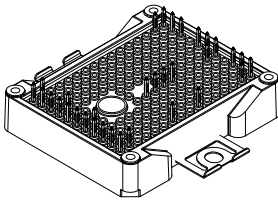
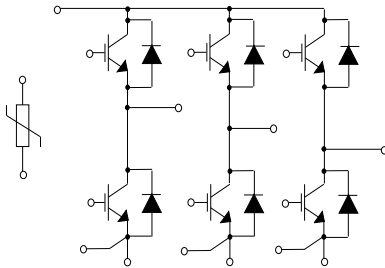


## ACEPACK™ 2 sixpack topology, 1200 V, 75 A trench gate field-stop IGBT M series, soft diode and NTC


**ACEPACK™ 2**


### Features

- ACEPACK™ 2 power module
  - DBC Cu Al<sub>2</sub>O<sub>3</sub> Cu
- Sixpack topology
  - 1200 V, 75 A IGBTs and diodes
  - Soft and fast recovery diode
- Integrated NTC

### Applications

- Inverters
- Industrial
- Motor drives

### Description

This power module is a sixpack topology in an ACEPACK™ 2 package with NTC, integrating the advanced trench gate field-stop technologies from STMicroelectronics. This new IGBT technology represents the best compromise between conduction and switching loss, to maximize the efficiency of any converter system up to 20 kHz.

#### Product status

A2P75S12M3-F

#### Product summary

|                   |                        |
|-------------------|------------------------|
| <b>Order code</b> | A2P75S12M3-F           |
| <b>Marking</b>    | A2P75S12M3-F           |
| <b>Package</b>    | ACEPACK™ 2             |
| <b>Leads type</b> | Press fit contact pins |

# 1 Electrical ratings

## 1.1 IGBT

Limiting values at  $T_J = 25\text{ °C}$ , unless otherwise specified.

**Table 1. Absolute maximum ratings of the IGBT**

| Symbol         | Parameter   | Value      | Unit |
|----------------|---|------------|------|
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0$ )  | 1200       | V    |
| $I_C$          | Continuous collector current ( $T_C = 100\text{ °C}$ )                                | 75         | A    |
| $I_{CP}^{(1)}$ | Pulsed collector current ( $t_p = 1\text{ ms}$ )                                      | 150        | A    |
| $V_{GE}$       | Gate-emitter voltage  | $\pm 20$   | V    |
| $P_{TOT}$      | Total power dissipation of each IGBT ( $T_C = 25\text{ °C}$ , $T_J = 175\text{ °C}$ ) | 454.5      | W    |
| $T_{JMAX}$     | Maximum junction temperature  | 175        | °C   |
| $T_{Jop}$      | Operating junction temperature range under switching conditions                       | -40 to 150 | °C   |

1. Pulse width limited by maximum junction temperature.

**Table 2. Electrical characteristics of the IGBT**

| Symbol                      | Parameter                            | Test conditions   | Min. | Typ.        | Max.      | Unit          |
|-----------------------------|--------------------------------------|---|------|-------------|-----------|---------------|
| $V_{(BR)CES}$               | Collector-emitter breakdown voltage  | $I_C = 1\text{ mA}$ , $V_{GE} = 0\text{ V}$   | 1200 |             |           | V             |
| $V_{CE(sat)}$<br>(terminal) | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 75\text{ A}$<br>$V_{GE} = 15\text{ V}$ , $I_C = 75\text{ A}$ ,<br>$T_J = 150\text{ °C}$                       |      | 1.95<br>2.3 | 2.3       | V             |
| $V_{GE(th)}$                | Gate threshold voltage               | $V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$   | 5    | 6           | 7         | V             |
| $I_{CES}$                   | Collector cut-off current            | $V_{GE} = 0\text{ V}$ , $V_{CE} = 1200\text{ V}$  |      |             | 100       | $\mu\text{A}$ |
| $I_{GES}$                   | Gate-emitter leakage current         | $V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$  |      |             | $\pm 500$ | nA            |
| $C_{ies}$                   | Input capacitance                    | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$   |      | 4700        |           | pF            |
| $C_{oes}$                   | Output capacitance                   |   |      | 350         |           | pF            |
| $C_{res}$                   | Reverse transfer capacitance         |   |      | 190         |           | pF            |
| $Q_g$                       | Total gate charge                    | $V_{CC} = 960\text{ V}$ , $I_C = 75\text{ A}$ , $V_{GE} = \pm 15\text{ V}$  |      | 350         |           | nC            |
| $t_{d(on)}$                 | Turn-on delay time                   | $V_{CC} = 600\text{ V}$ , $I_C = 75\text{ A}$ , $R_G = 10\ \Omega$ ,<br>$V_{GE} = \pm 15\text{ V}$ , $di/dt = 1900\text{ A}/\mu\text{s}$      |      | 198         |           | ns            |
| $t_r$                       | Current rise time                    |   |      | 32          |           | ns            |
| $E_{on}^{(1)}$              | Turn-on switching energy             |   |      | 3.59        |           | mJ            |
| $t_{d(off)}$                | Turn-off delay time                  | $V_{CC} = 600\text{ V}$ , $I_C = 75\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = \pm 15\text{ V}$ ,<br>$dv/dt = 6000\text{ V}/\mu\text{s}$ ; |      | 250         |           | ns            |
| $t_f$                       | Current fall time                    |   |      | 159         |           | ns            |
| $E_{off}^{(2)}$             | Turn-off switching energy            |   |      | 5.13        |           | mJ            |

| Symbol          | Parameter                           | Test conditions   | Min. | Typ. | Max. | Unit                      |
|-----------------|-------------------------------------|---|------|------|------|---------------------------|
| $t_{d(on)}$     | Turn-on delay time                  | $V_{CC} = 600\text{ V}$ , $I_C = 75\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = \pm 15\text{ V}$ ,<br>$di/dt = 1718\text{ A}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$ |      | 200  |      | ns                        |
| $t_r$           | Current rise time                   |   |      | 35   |      | ns                        |
| $E_{on}^{(1)}$  | Turn-on switching energy            |   |      |      | 6.28 |                           |
| $t_{d(off)}$    | Turn-off delay time                 | $V_{CC} = 600\text{ V}$ , $I_C = 75\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = \pm 15\text{ V}$ ,<br>$dv/dt = 4900\text{ V}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$ |      | 266  |      | ns                        |
| $t_f$           | Current fall time                   |   |      | 251  |      | ns                        |
| $E_{off}^{(2)}$ | Turn-off switching energy           |   |      |      | 7.7  |                           |
| $t_{SC}$        | Short-circuit withstand time        | $V_{CC} \leq 600\text{ V}$ , $V_{GE} \leq 15\text{ V}$ ,<br>$T_{Jstart} \leq 150\text{ }^\circ\text{C}$   | 10   |      |      | $\mu\text{s}$             |
| $R_{THj-c}$     | Thermal resistance junction-to-case | Each IGBT   |      | 0.30 | 0.33 | $^\circ\text{C}/\text{W}$ |
| $R_{THc-h}$     | Thermal resistance case-to-heatsink | Each IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot^\circ\text{C})$  |      | 0.60 |      | $^\circ\text{C}/\text{W}$ |

1. Including the reverse recovery of the diode.
2. Including the tail of the collector current.

## 1.2 Diode

Limiting values at  $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise specified.

**Table 3. Absolute maximum ratings of the diode**

| Symbol         | Parameter  | Value      | Unit             |
|----------------|--|------------|------------------|
| $V_{RRM}$      | Repetitive peak reverse voltage                                  | 1200       | V                |
| $I_F$          | Continuous forward current ( $T_C = 100\text{ }^\circ\text{C}$ ) | 75         | A                |
| $I_{FP}^{(1)}$ | Pulsed forward current ( $t_p = 1\text{ ms}$ )                   | 150        | A                |
| $T_{JMAX}$     | Maximum junction temperature                                     | 175        | $^\circ\text{C}$ |
| $T_{Jop}$      | Operating junction temperature range under switching conditions  | -40 to 150 | $^\circ\text{C}$ |

1. Pulse width limited by maximum junction temperature.

**Table 4. Electrical characteristics of the diode**

| Symbol              | Parameter                | Test conditions   | Min. | Typ. | Max. | Unit          |
|---------------------|--------------------------|---|------|------|------|---------------|
| $V_F$<br>(terminal) | Forward voltage          | $I_F = 75\text{ A}$   | -    | 2.95 | 4.1  | V             |
|                     |                          | $I_F = 75\text{ A}$ , $T_J = 150\text{ }^\circ\text{C}$   | -    | 2.3  |      |               |
| $t_{rr}$            | Reverse recovery time    | $I_F = 75\text{ A}$ , $V_R = 600\text{ V}$ ,<br>$V_{GE} = \pm 15\text{ V}$ ,<br>$di/dt = 1900\text{ A}/\mu\text{s}$ | -    | 200  |      | ns            |
| $Q_{rr}$            | Reverse recovery charge  |   | -    | 6.0  |      | $\mu\text{C}$ |
| $I_{rrm}$           | Reverse recovery current |   | -    | 78   |      | A             |
| $E_{rec}$           | Reverse recovery energy  |   | -    | 2.2  |      | mJ            |

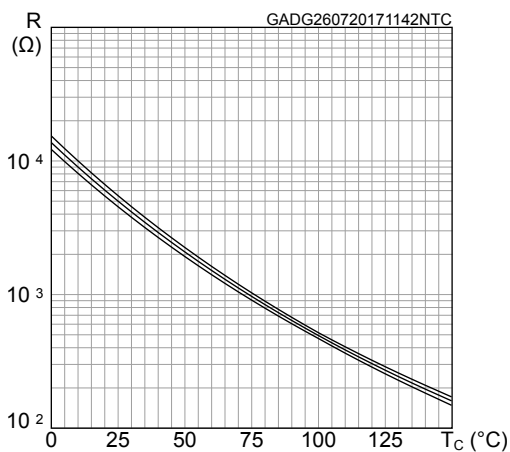
| Symbol      | Parameter                           | Test conditions  | Min. | Typ. | Max. | Unit                      |
|-------------|-------------------------------------|--|------|------|------|---------------------------|
| $t_{rr}$    | Reverse recovery time               | $I_F = 75\text{ A}$ , $V_R = 600\text{ V}$ ,<br>$V_{GE} = \pm 15\text{ V}$ ,<br>$di/dt = 1718\text{ A}/\mu\text{s}$ ,<br>$T_J = 150\text{ }^\circ\text{C}$ | -    | 500  |      | ns                        |
| $Q_{rr}$    | Reverse recovery charge             |  | -    | 12.5 |      | $\mu\text{C}$             |
| $I_{rrm}$   | Reverse recovery current            |  | -    | 90   |      | A                         |
| $E_{rec}$   | Reverse recovery energy             |  | -    | 5.2  |      | mJ                        |
| $R_{THj-c}$ | Thermal resistance junction-to-case | Each diode   | -    | 0.55 | 0.60 | $^\circ\text{C}/\text{W}$ |
| $R_{THc-h}$ | Thermal resistance case-to-heatsink | Each diode, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot^\circ\text{C})$  | -    | 0.75 |      | $^\circ\text{C}/\text{W}$ |

### 1.3 NTC

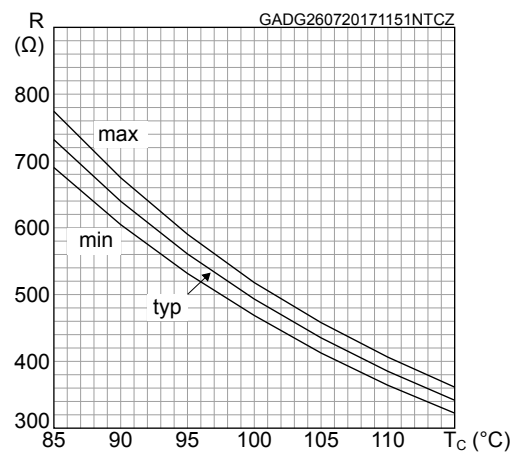
**Table 5. NTC temperature sensor, considered as stand-alone**

| Symbol       | Parameter                   | Test conditions                 | Min. | Typ. | Max. | Unit             |
|--------------|-----------------------------|---------------------------------|------|------|------|------------------|
| $R_{25}$     | Resistance                  | $T = 25\text{ }^\circ\text{C}$  |      | 5    |      | $\text{k}\Omega$ |
| $R_{100}$    | Resistance                  | $T = 100\text{ }^\circ\text{C}$ |      | 493  |      | $\Omega$         |
| $\Delta R/R$ | Deviation of $R_{100}$      |                                 | -5   |      | +5   | %                |
| $B_{25/50}$  | B-constant                  |                                 |      | 3375 |      | K                |
| $B_{25/80}$  | B-constant                  |                                 |      | 3411 |      | K                |
| T            | Operating temperature range |                                 | -40  |      | 150  | $^\circ\text{C}$ |

**Figure 1. NTC resistance vs temperature**



**Figure 2. NTC resistance vs temperature, zoom**



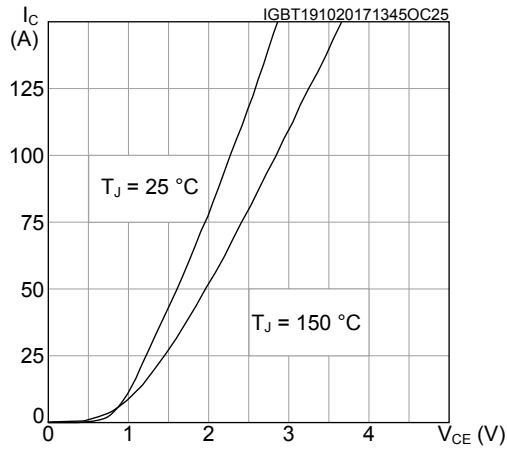
## 1.4 Package

**Table 6. ACEPACK™ 2 package**

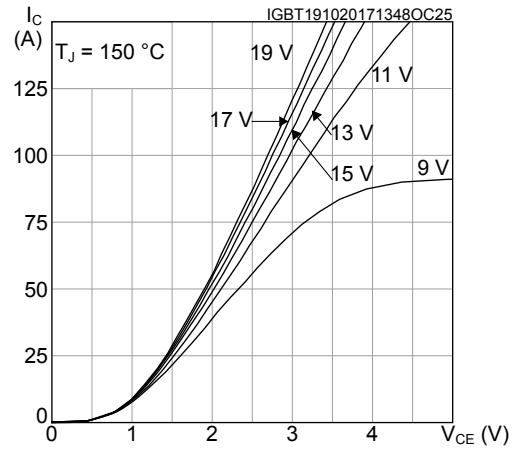
| Symbol            | Parameter                                       | Min. | Typ. | Max. | Unit |
|-------------------|---|------|------|------|------|
| V <sub>isol</sub> | Isolation voltage (AC voltage, t = 60 s)        |      |      | 2500 | V    |
| T <sub>stg</sub>  | Storage temperature                             | -40  |      | 125  | °C   |
| CTI               | Comparative tracking index                      | 200  |      |      |      |
| L <sub>s</sub>    | Stray inductance module P1 - EW loop            |      | 33.5 |      | nH   |
| R <sub>s</sub>    | Module single lead resistance, terminal to chip |      | 3.6  |      | mΩ   |

## 2 Electrical characteristics curves

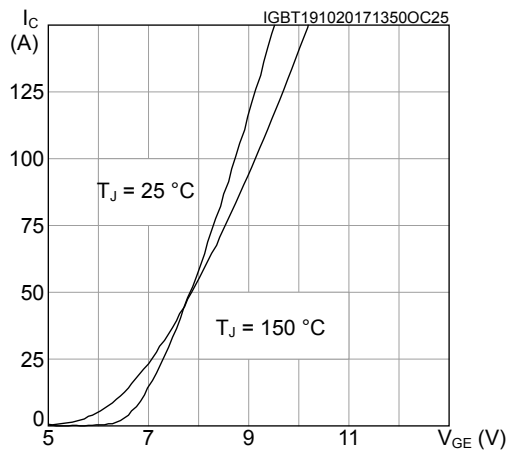
**Figure 3. IGBT output characteristics**  
( $V_{GE} = 15\text{ V}$ , terminal)



**Figure 4. IGBT output characteristics**  
( $T_J = 150\text{ °C}$ , terminal)



**Figure 5. IGBT transfer characteristics**  
( $V_{CE} = 15\text{ V}$ , terminal)



**Figure 6. Switching energy vs gate resistance**

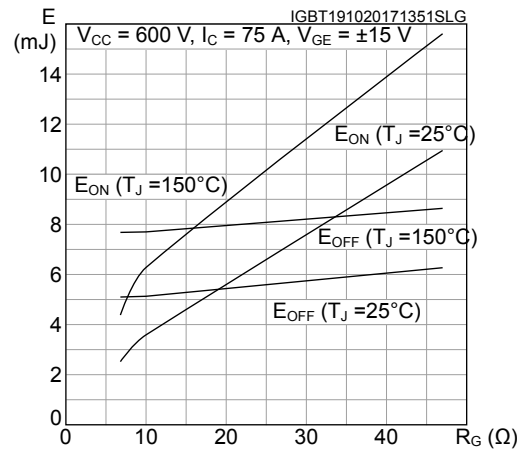


Figure 7. Switching energy vs collector current

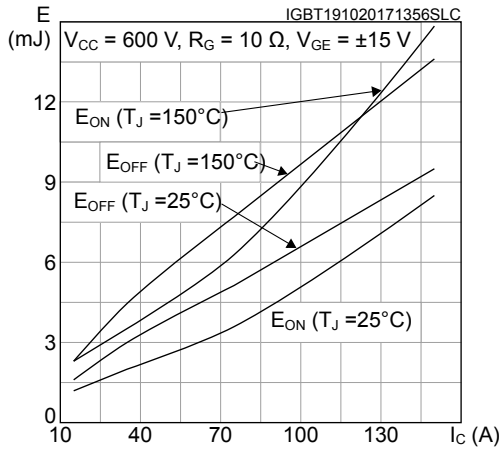


Figure 8. IGBT reverse biased safe operating area (RBSOA)

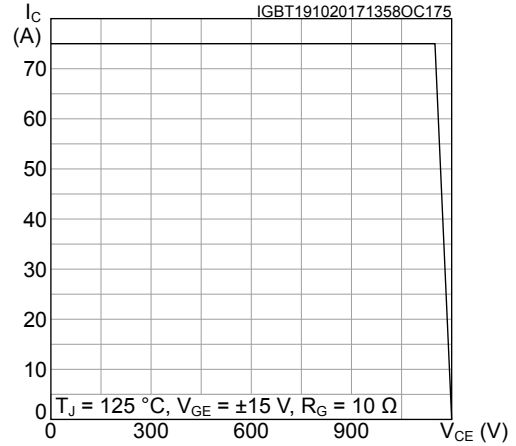


Figure 9. Diode forward characteristics (terminal)

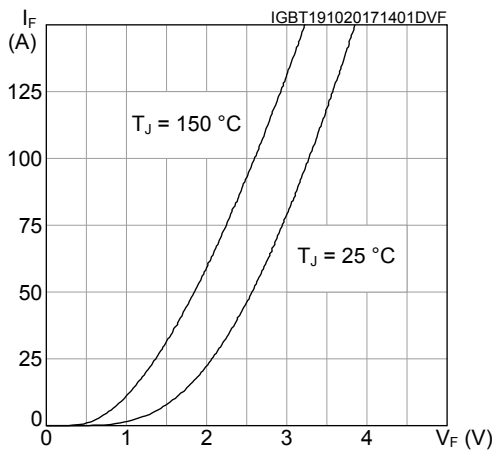


Figure 10. Diode reverse recovery energy vs diode current slope

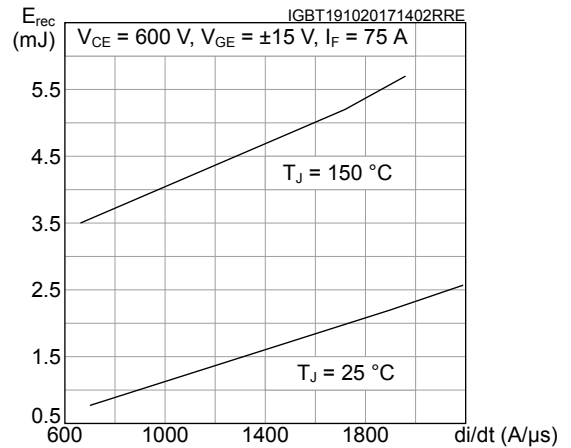


Figure 11. Diode reverse recovery energy vs forward current

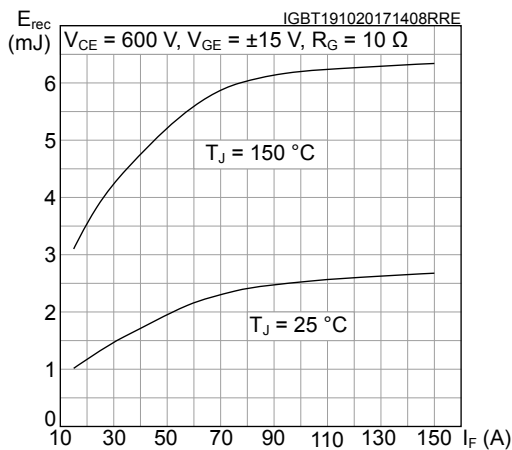


Figure 12. Diode reverse recovery energy vs gate resistance

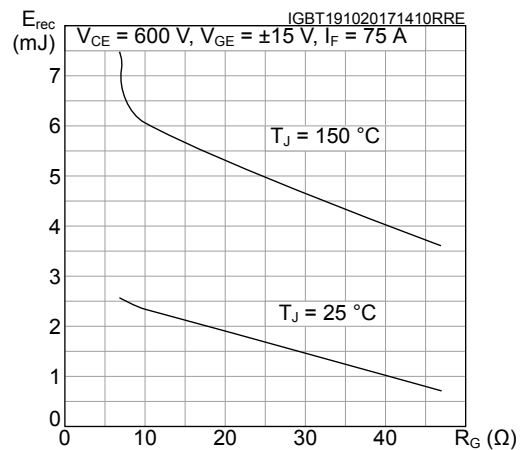


Figure 13. IGBT thermal impedance

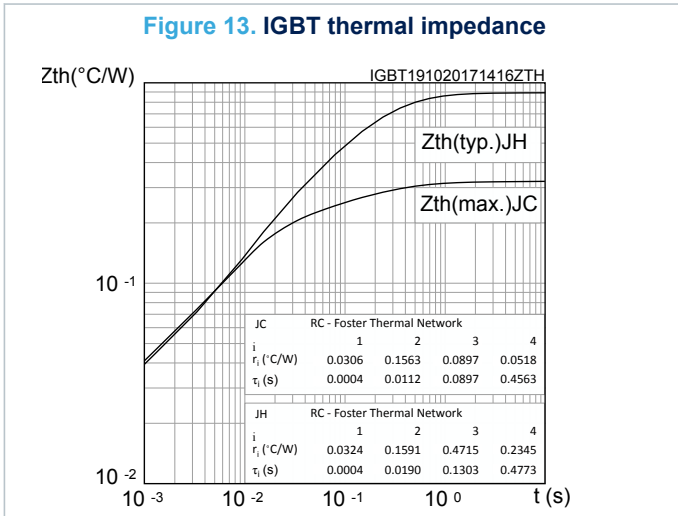
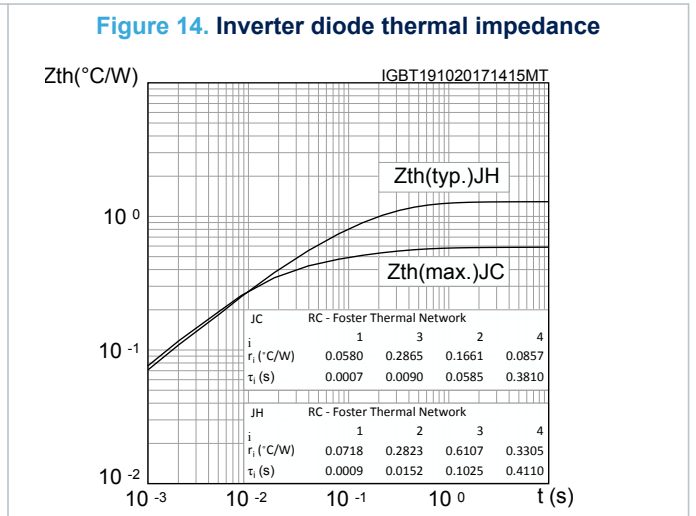
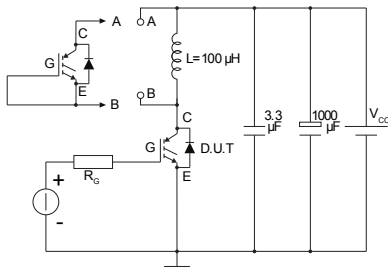


Figure 14. Inverter diode thermal impedance

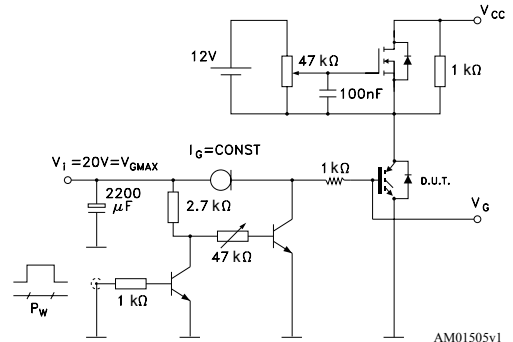




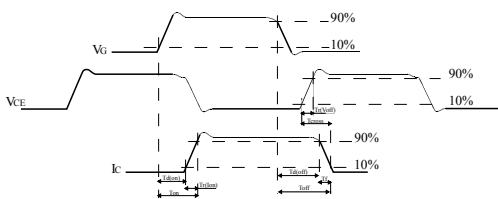
### 3 Test circuits

**Figure 15. Test circuit for inductive load switching**


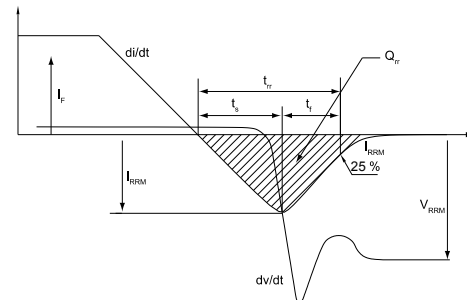
AM01504v1

**Figure 16. Gate charge test circuit**


AM01505v1

**Figure 17. Switching waveform**


AM01506v1

**Figure 18. Diode reverse recovery waveform**


AM01507v1

## 4 Topology and pin description

Figure 19. Electrical topology and pin description

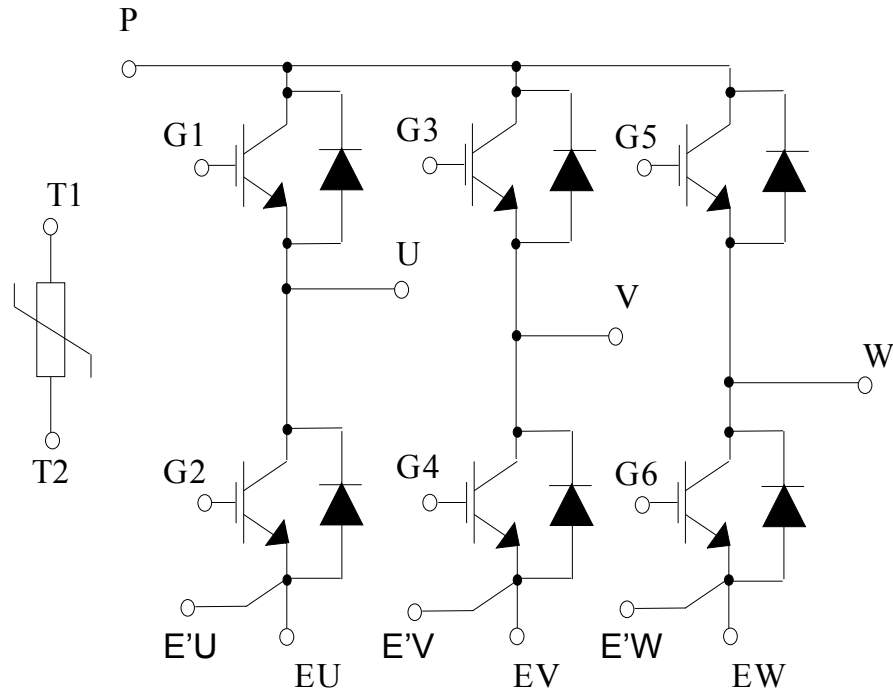
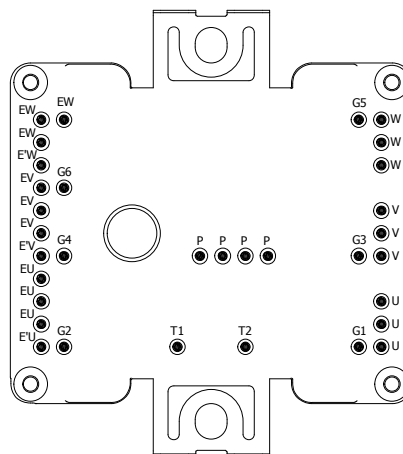


Figure 20. Package top view with sixpack pinout

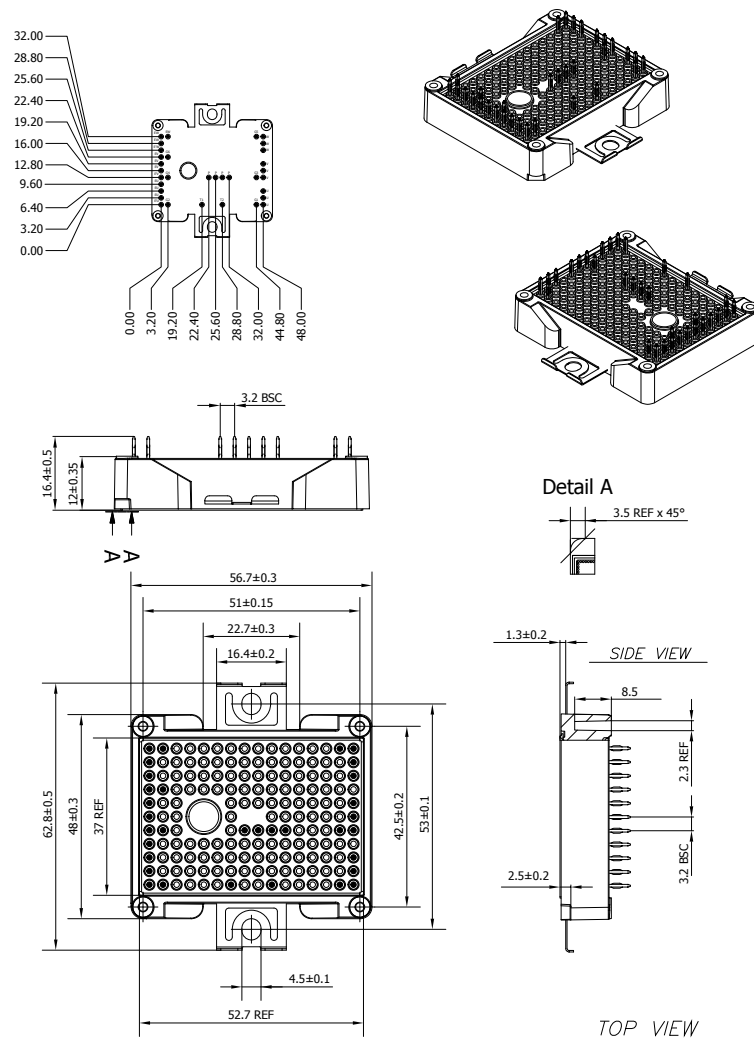


## 5 Package information

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.

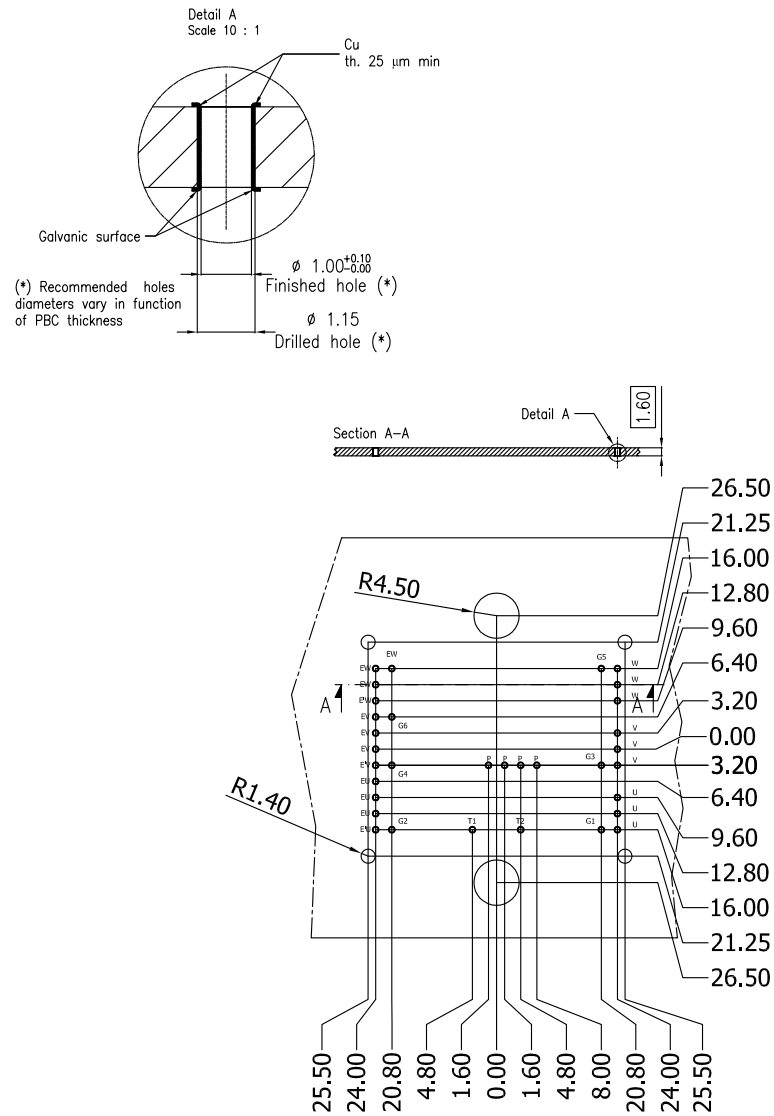
### 5.1 ACEPACK™ 2 sixpack press fit contact pins package information

Figure 21. ACEPACK™ 2 sixpack press fit contact pins package outline (dimensions are in mm)



8569722 rev.4

- The lead size includes the thickness of the lead plating material.
- Dimensions do not include mold protrusion.
- Package dimensions do not include any eventual metal burrs.

**Figure 22. ACEPACK™ 2 sixpack press fit contact pins recommended PCB holes layout (dimension are in mm)**


8569722 rev.4

## Revision history

**Table 7. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 19-May-2016 | 1        | Initial release.   |
| 24-May-2016 | 2        | Updated <i>Table 5: "Electrical characteristics of the diode"</i> .  |
| 24-Oct-2017 | 3        | Updated <i>Section 1: "Electrical ratings"</i> , <i>Section 2: "Electrical characteristics curves"</i> and <i>Section 5: "Package information"</i> .<br>Minor text changes.  |
| 20-Mar-2018 | 4        | Removed maturity status indication from cover page. The document status is production data.<br>Updated features in cover page, <a href="#">Section 1.1 IGBT</a> , <a href="#">Section 1.2 Diode</a> , <a href="#">Section 1.4 Package</a> , <a href="#">Section 2 Electrical characteristics curves</a> and <a href="#">Section 5.1 ACEPACK™ 2 sixpack press fit contact pins package information</a> .<br>Minor text changes. |

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