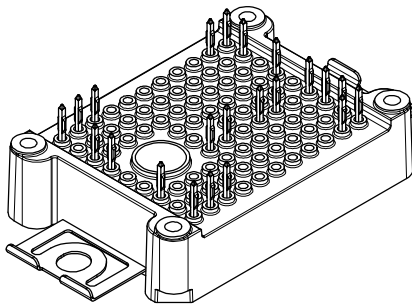
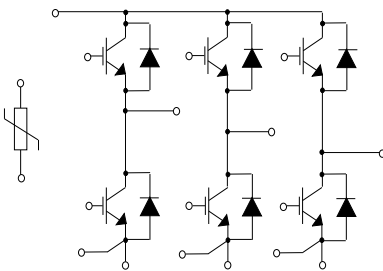


## ACEPACK™ 1 sixpack topology, 650 V, 50 A, trench gate field-stop M series IGBT with soft diode and NTC



ACEPACK™ 1



### Features

- ACEPACK™ 1 power module
  - DBC Cu Al<sub>2</sub>O<sub>3</sub> Cu
- Sixpack topology
  - 650 V, 50 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™ 1 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

A1P50S65M2-F

#### Product summary

<b>Order code</b>	A1P50S65M2-F
<b>Marking</b>	A1P50S65M2-F
<b>Package</b>	ACEPACK™ 1
<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 ( $V_{GE} = 0\text{ V}$ )	650	V
$I_C$	Continuous collector current ( $T_C = 100\text{ °C}$ )	50	A
$I_{CP}^{(1)}$	Pulsed collector current ( $t_p = 1\text{ ms}$ )	100	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total power dissipation of each IGBT ( $T_C = 25\text{ °C}$ , $T_J = 175\text{ °C}$ )	208	W
$T_{JMAX}$	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 2. Electrical characteristics of the IGBT**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$I_C = 1\text{ mA}$ , $V_{GE} = 0\text{ V}$	650			V
$V_{CE(sat)}$ (terminal)	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 50\text{ A}$ $V_{GE} = 15\text{ V}$ , $I_C = 50\text{ A}$ , $T_J = 150\text{ °C}$		1.95 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	$V_{GE} = 0\text{ V}$ , $V_{CE} = 650\text{ V}$			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			4150		pF
$C_{oes}$	Output capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,		170		pF
$C_{res}$	Reverse transfer capacitance	$V_{GE} = 0\text{ V}$		80		pF
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}$ , $I_C = 50\text{ A}$ , $V_{GE} = \pm 15\text{ V}$		150		nC
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 300\text{ V}$ , $I_C = 50\text{ A}$ ,		143		ns
$t_r$	Current rise time	$R_G = 6.8\ \Omega$ , $V_{GE} = \pm 15\text{ V}$ ,		16.5		ns
$E_{on}^{(1)}$	Turn-on switching energy	$di/dt = 2400\text{ A}/\mu\text{s}$		0.140		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 300\text{ V}$ , $I_C = 50\text{ A}$ ,		112		ns
$t_f$	Current fall time	$R_G = 6.8\ \Omega$ , $V_{GE} = \pm 15\text{ V}$ ,		149		ns
$E_{off}^{(2)}$	Turn-off switching energy	$dv/dt = 7600\text{ V}/\mu\text{s}$		1.45		mJ

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 300\text{ V}$ , $I_C = 50\text{ A}$ ,		148		ns
$t_r$	Current rise time	$R_G = 6.8\ \Omega$ , $V_{GE} = \pm 15\text{ V}$ ,		19.2		ns
$E_{on(1)}$	Turn-on switching energy	$di/dt = 2062\text{ A}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$		0.311		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 300\text{ V}$ , $I_C = 50\text{ A}$ ,		110		ns
$t_f$	Current fall time	$R_G = 6.8\ \Omega$ , $V_{GE} = \pm 15\text{ V}$ ,		221		ns
$E_{off(2)}$	Turn-off switching energy	$dv/dt = 5800\text{ V}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$		1.98		mJ
$t_{SC}$	Short-circuit withstand time	$V_{CC} \leq 360\text{ V}$ , $V_{GE} \leq 15\text{ V}$ , $T_{Jstart} \leq 150\text{ }^\circ\text{C}$	6			$\mu\text{s}$
$R_{THJ-c}$	Thermal resistance junction-to-case	Each IGBT		0.65	0.72	$^\circ\text{C}/\text{W}$
$R_{THC-h}$	Thermal resistance case-to-heatsink	Each IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot^\circ\text{C})$		0.79		$^\circ\text{C}/\text{W}$

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	650	V
$I_F$	Continuous forward current at ( $T_C = 100\text{ }^\circ\text{C}$ )	50	A
$I_{FP(1)}$	Pulsed forward current ( $t_p = 1\text{ ms}$ )	100	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
$V_F$ (terminal)	Forward voltage	$I_F = 50\text{ A}$	-	1.85	2.65	V
		$I_F = 50\text{ A}$ , $T_J = 150\text{ }^\circ\text{C}$	-	1.65		
$t_{rr}$	Reverse recovery time		-	142		ns
$Q_{rr}$	Reverse recovery charge	$I_F = 50\text{ A}$ , $V_R = 300\text{ V}$ ,	-	1.87		$\mu\text{C}$
$I_{rrm}$	Reverse recovery current	$V_{GE} = \pm 15\text{ V}$ , $di/dt = 2400\text{ A}/\mu\text{s}$	-	40		A
$E_{rec}$	Reverse recovery energy		-	0.41		mJ
$t_{rr}$	Reverse recovery time		-	260		ns
$Q_{rr}$	Reverse recovery charge	$I_F = 50\text{ A}$ , $V_R = 300\text{ V}$ ,	-	5.2		$\mu\text{C}$
$I_{rrm}$	Reverse recovery current	$V_{GE} = \pm 15\text{ V}$ , $di/dt = 2062\text{ A}/\mu\text{s}$ ,	-	58		A
$E_{rec}$	Reverse recovery energy	$T_J = 150\text{ }^\circ\text{C}$	-	1.32		mJ

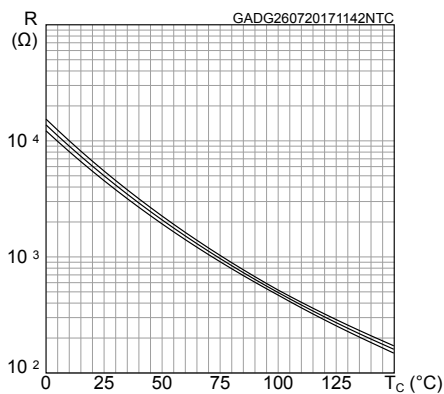
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$R_{THj-c}$	Thermal resistance junction-to-case	Each diode	-	1.0	1.1	°C/W
$R_{THc-h}$	Thermal resistance case-to-heatsink	Each diode, $\lambda_{grease} = 1 \text{ W/(m}\cdot\text{°C)}$	-	0.9		°C/W

### 1.3 NTC

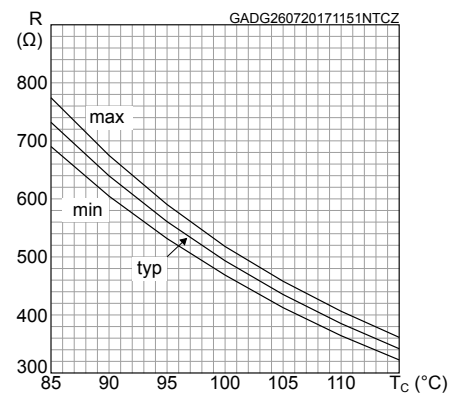
**Table 5. NTC temperature sensor, considered as stand-alone**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$R_{25}$	Resistance	$T = 25^\circ\text{C}$		5		k $\Omega$
$R_{100}$	Resistance	$T = 100^\circ\text{C}$		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	°C

**Figure 1. NTC resistance vs temperature**



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



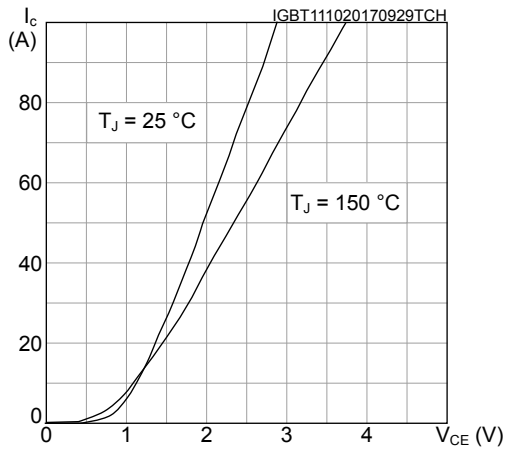
### 1.4 Package

**Table 6. ACEPACK™ 1 package**

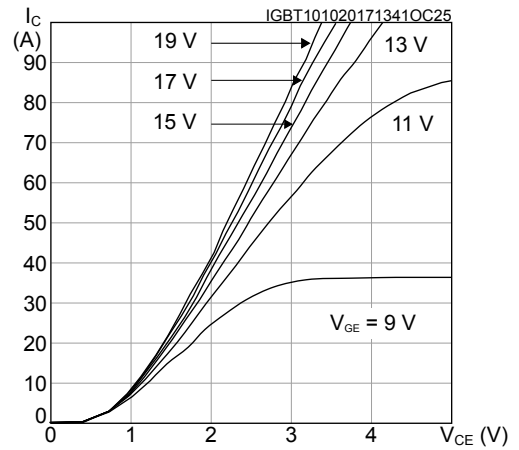
Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{isol}$	Isolation voltage (AC voltage, $t = 60 \text{ s}$ )			2500	Vrms
$T_{stg}$	Storage temperature	-40		125	°C
CTI	Comparative tracking index	200			
$L_s$	Stray inductance module P1 - EW loop		28.7		nH
$R_s$	Module single lead resistance, terminal-to-chip		3.9		m $\Omega$

## 2 Electrical characteristics (curves)

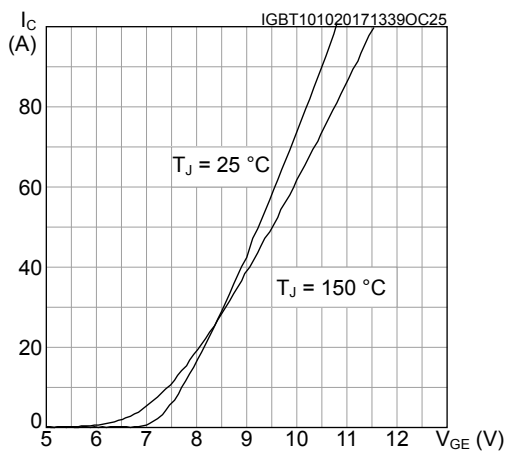
**Figure 3. IGBT output characteristics**  
( $V_{GE} = 15\text{ V}$ , terminal)



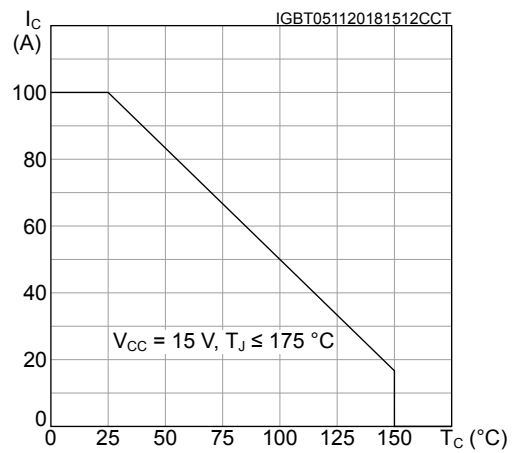
**Figure 4. IGBT output characteristics**  
( $T_J = 150\text{ °C}$ , terminal)



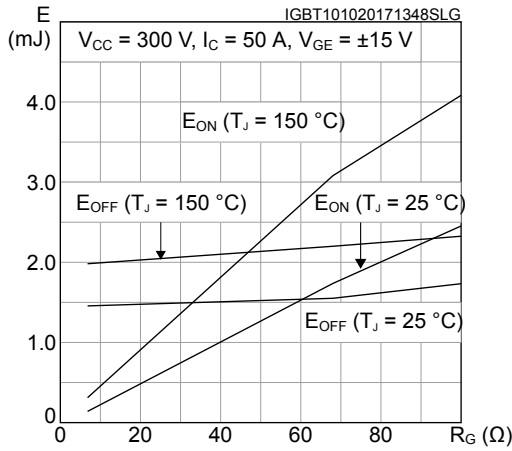
**Figure 5. IGBT transfer characteristics**  
( $V_{CE} = 15\text{ V}$ , terminal)



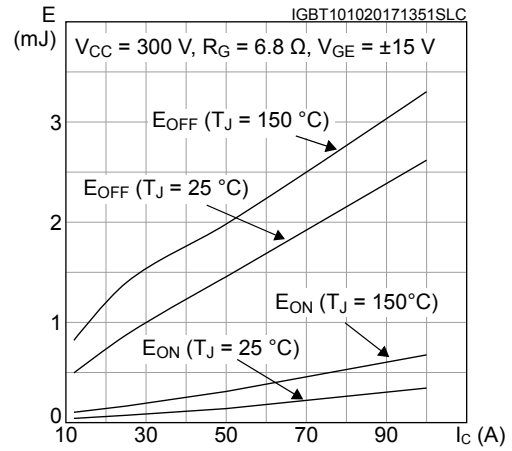
**Figure 6. IGBT collector current vs case temperature**



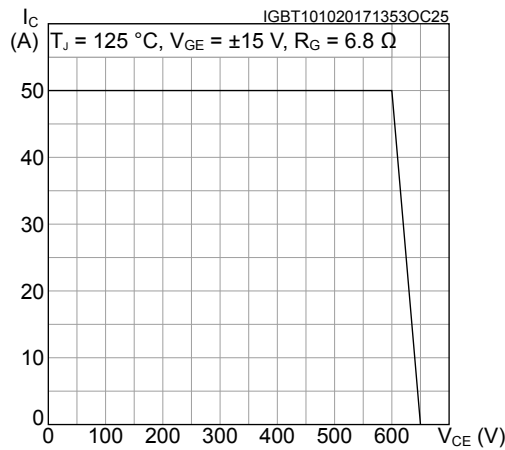
**Figure 7. Switching energy vs gate resistance**



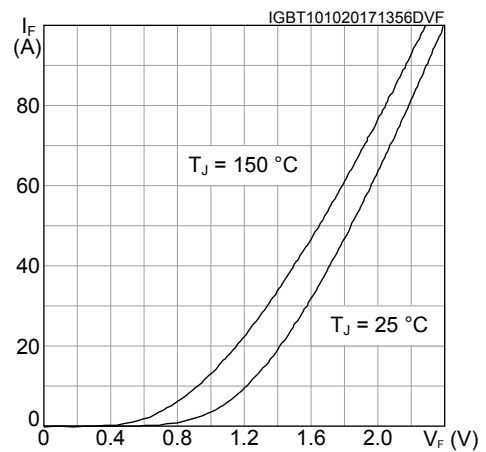
**Figure 8. Switching energy vs collector current**



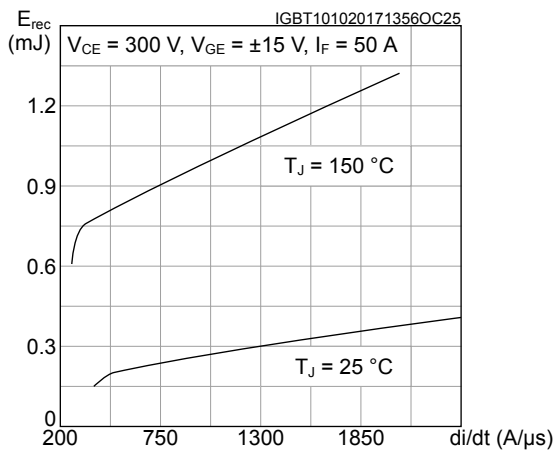
**Figure 9. IGBT reverse biased safe operating area (RBSOA)**



**Figure 10. Diode forward characteristics**



**Figure 11. Diode reverse recovery energy vs diode current slope**



**Figure 12. Diode reverse recovery energy vs forward current**

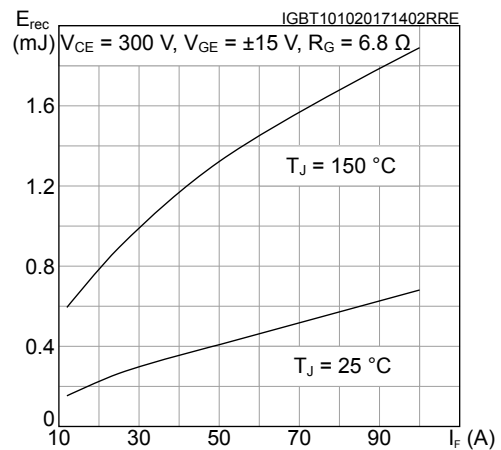


Figure 13. Diode reverse recovery energy vs gate resistance

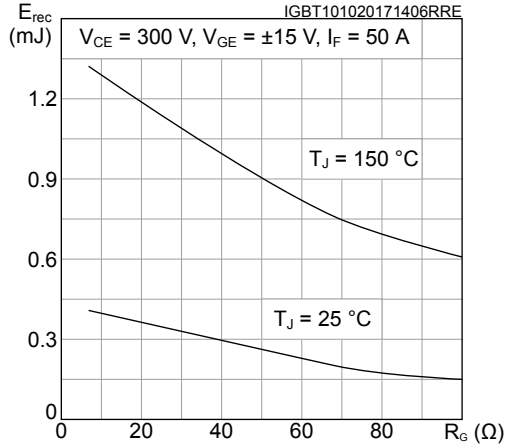


Figure 14. Inverter diode thermal impedance

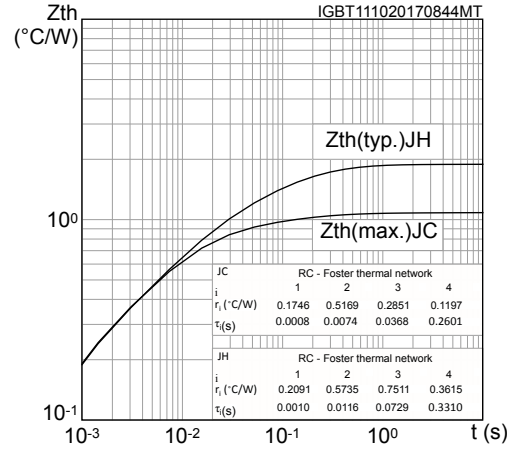
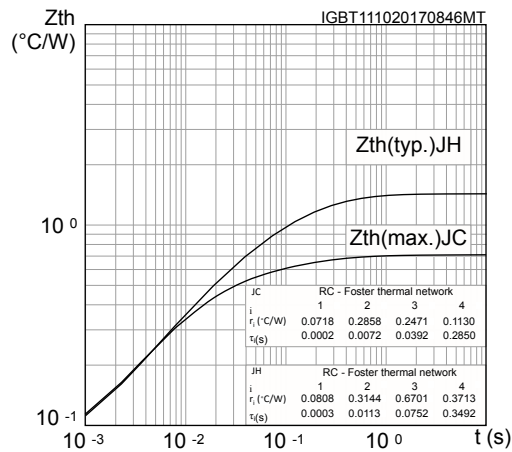
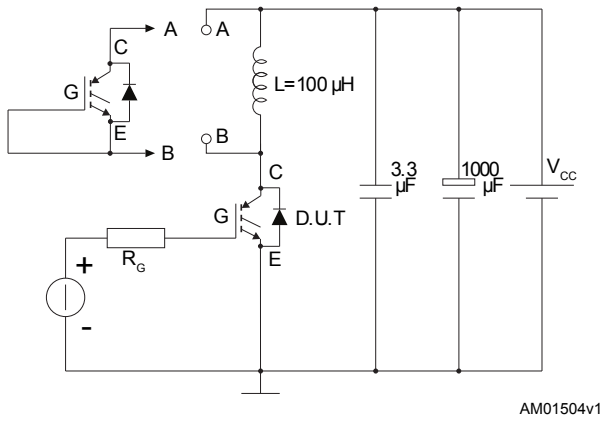
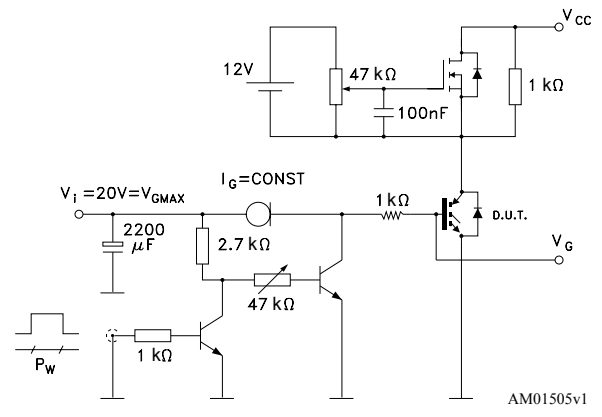
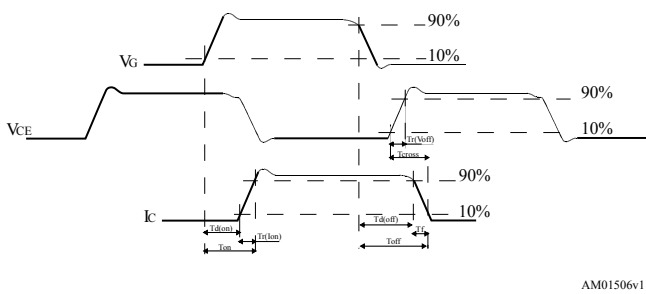
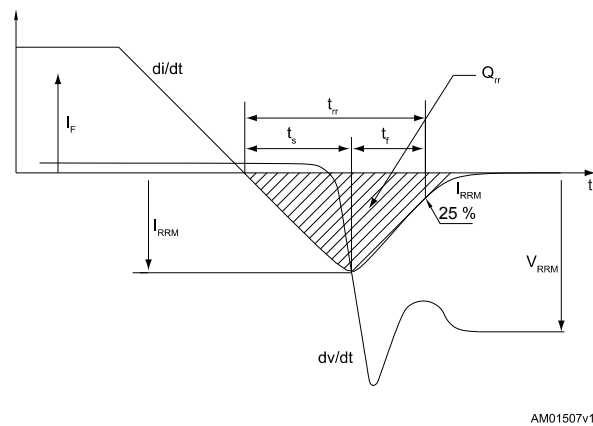


Figure 15. IGBT thermal impedance



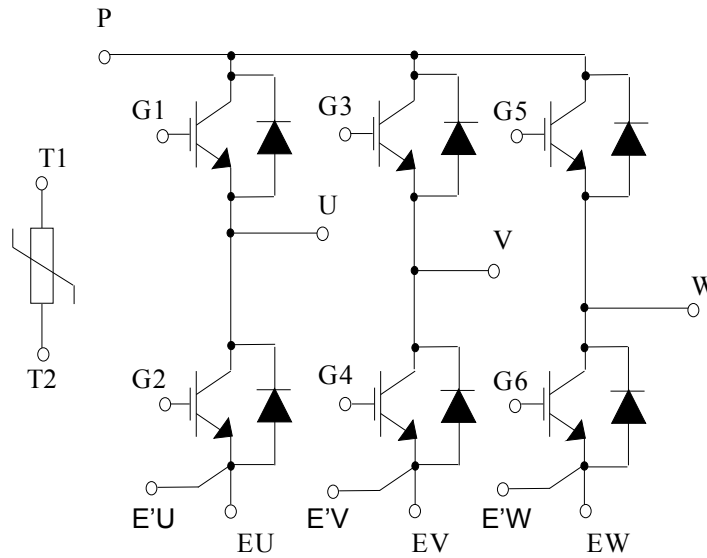
### 3 Test circuits

**Figure 16. Test circuit for inductive load switching**

**Figure 17. Gate charge test circuit**

**Figure 18. Switching waveform**

**Figure 19. Diode reverse recovery waveform**


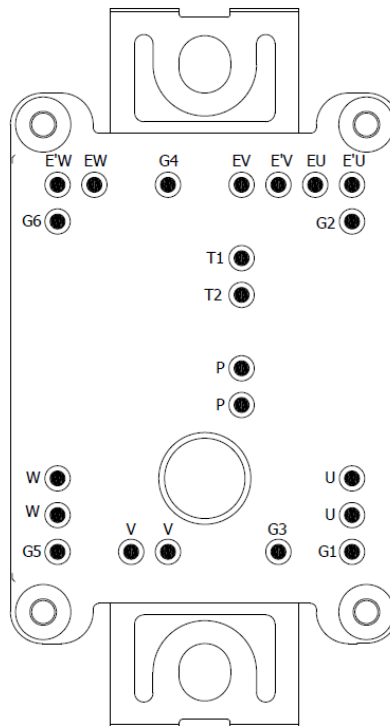


## 4 Topology and pin description

**Figure 20. Electrical topology and pin description**



**Figure 21. Package top view with sixpack pinout**



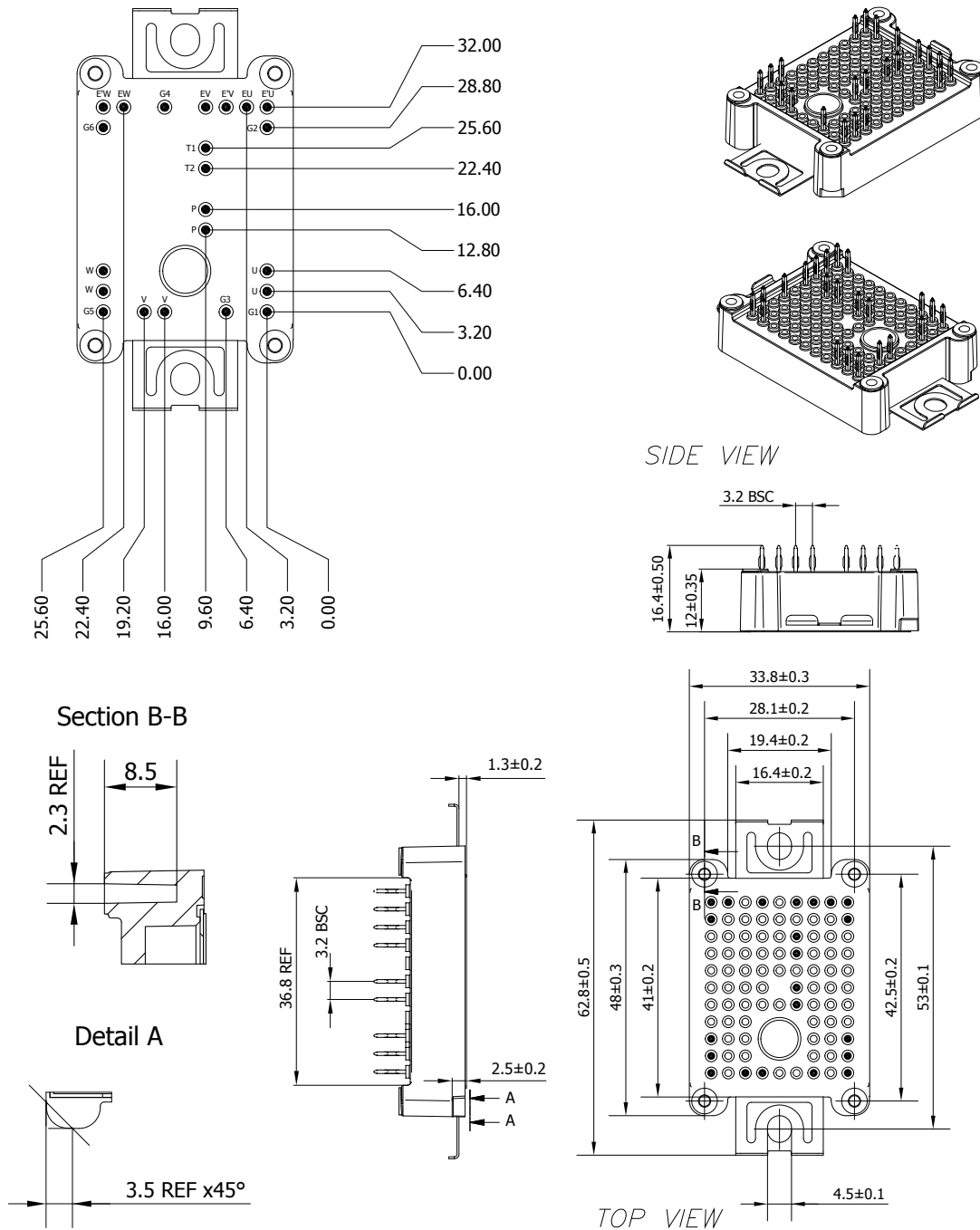
## **5** Package information

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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.

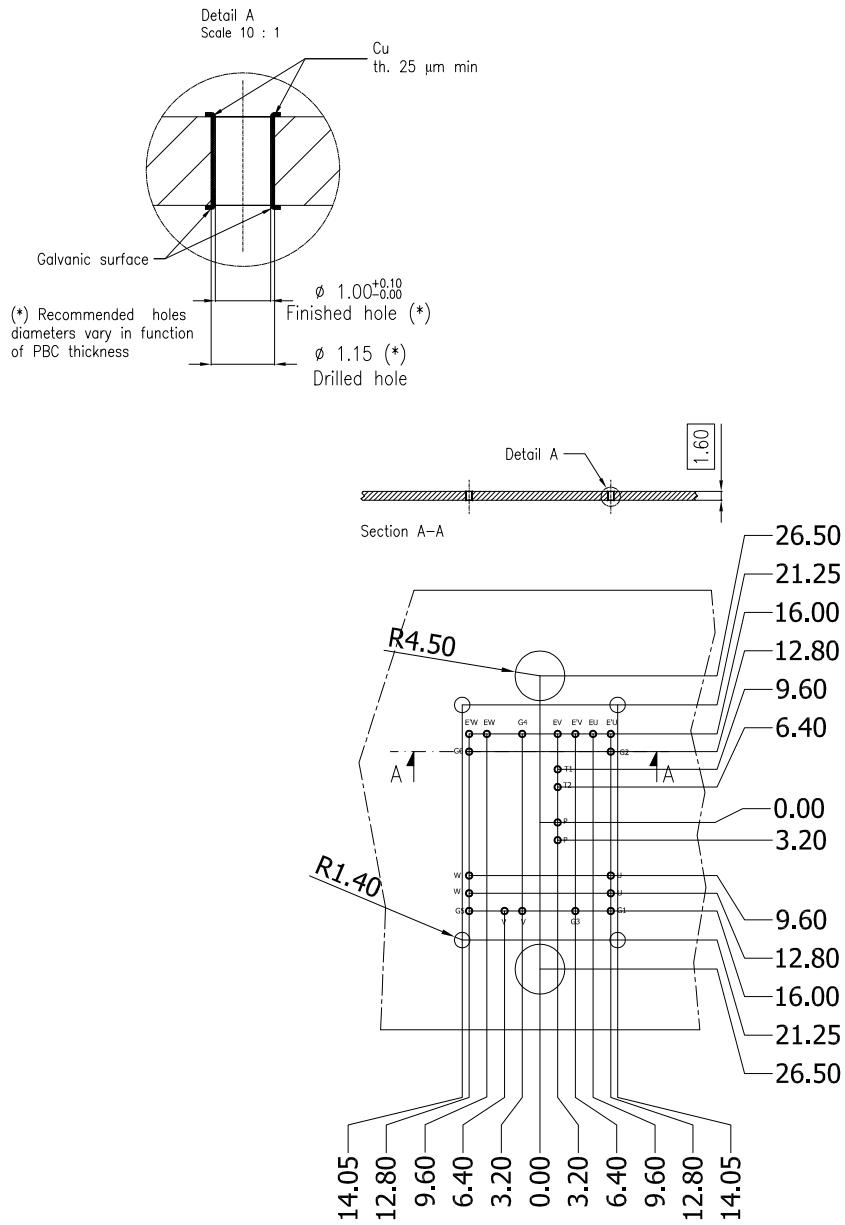
## 5.1 ACEPACK™ 1 sixpack press fit pins package information

**Figure 22. ACEPACK™ 1 sixpack press fit pins package outline (dimensions are in mm)**



GADG260220181307MT\_8569715\_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 23. ACEPACK™ 1 sixpack press fit pins recommended PCB holes layout (dimensions are in mm)**


GADG260220181409MT\_8569715\_4

## Revision history

**Table 7. Document revision history**

Date	Revision	Changes
11-Oct-2017	1	Initial release.
01-Mar-2018	2	Removed maturity status indication from cover page. The document status is production data. Updated silhouette in cover page, <i>Figure 13. Inverter diode thermal impedance</i> , <i>Figure 14. IGBT thermal impedance</i> and <i>Section 5.1 ACEPACK™ 1 sixpack press fit pins package information</i> . Minor text changes.
14-Nov-2018	3	Added <a href="#">Figure 6. IGBT collector current vs case temperature</a> . Minor text changes

## Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>2</b>
1.1	IGBT .....	2
1.2	Diode .....	3
1.3	NTC.....	4
1.4	Package .....	4
<b>2</b>	<b>Electrical characteristics (curves)</b> .....	<b>5</b>
<b>3</b>	<b>Test circuits</b> .....	<b>8</b>
<b>4</b>	<b>Topology and pin description</b> .....	<b>9</b>
<b>5</b>	<b>Package information</b> .....	<b>10</b>
5.1	ACEPACK™ 1 sixpack press fit pins package information .....	11
	<b>Revision history</b> .....	<b>13</b>

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