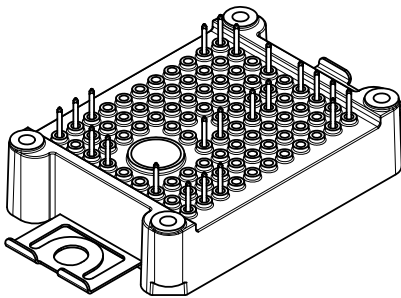
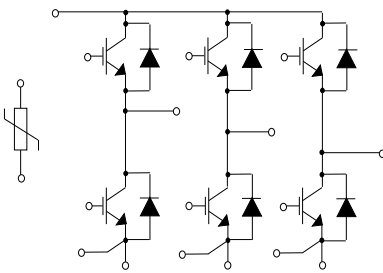


## ACEPACK™ 1 sixpack topology, 1200 V, 35 A, trench gate field-stop M series IGBT with soft diode and NTC


**ACEPACK™ 1**


### Features

- ACEPACK™ 1 power module
  - DBC Cu Al<sub>2</sub>O<sub>3</sub> Cu
- Sixpack topology
  - 1200 V, 35 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

A1P35S12M3

#### Product summary

<b>Order code</b>	A1P35S12M3
<b>Marking</b>	A1P35S12M3
<b>Package</b>	ACEPACK™ 1
<b>Leads type</b>	Solder 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 ( $V_{GE} = 0\text{ V}$ )	1200	V
$I_C$	Continuous collector current ( $T_C = 100\text{ °C}$ )	35	A
$I_{CP}^{(1)}$	Pulsed collector current ( $t_p = 1\text{ ms}$ )	70	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total power dissipation of each IGBT ( $T_C = 25\text{ °C}$ , $T_J = 175\text{ °C}$ )	250	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
$V_{CE(sat)}$ (terminal)	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 35\text{ A}$ $V_{GE} = 15\text{ V}$ , $I_C = 35\text{ A}$ , $T_J = 150\text{ °C}$		1.95 2.3	2.45	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	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$		2154		pF
$C_{oes}$	Output capacitance			164		pF
$C_{res}$	Reverse transfer capacitance			86		pF
$Q_g$	Total gate charge	$V_{CC} = 960\text{ V}$ , $I_C = 35\text{ A}$ , $V_{GE} = \pm 15\text{ V}$		163		nC
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 600\text{ V}$ , $I_C = 35\text{ A}$ , $R_G = 10\text{ }\Omega$ , $V_{GE} = \pm 15\text{ V}$ ,		122		ns
$t_r$	Current rise time			17		ns
$E_{on}^{(1)}$	Turn-on switching energy	$di/dt = 1900\text{ A}/\mu\text{s}$		1.21		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600\text{ V}$ , $I_C = 35\text{ A}$ , $R_G = 10\text{ }\Omega$ , $V_{GE} = \pm 15\text{ V}$ ,		142		ns
$t_f$	Current fall time			150		ns
$E_{off}^{(2)}$	Turn-off switching energy		$dv/dt = 7800\text{ V}/\mu\text{s}$		2.19	

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 600\text{ V}$ , $I_C = 35\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = \pm 15\text{ V}$ , $di/dt = 1533\text{ A}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$		124		ns
$t_r$	Current rise time			18		ns
$E_{on}^{(1)}$	Turn-on switching energy				1.8	
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600\text{ V}$ , $I_C = 35\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = \pm 15\text{ V}$ , $dv/dt = 6700\text{ V}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$		142		ns
$t_f$	Current fall time			256		ns
$E_{off}^{(2)}$	Turn-off switching energy				3.1	
$t_{SC}$	Short-circuit withstand time	$V_{CC} \leq 600\text{ V}$ , $V_{GE} \leq 15\text{ V}$ , $T_{Jstart} \leq 150\text{ }^\circ\text{C}$	10			$\mu\text{s}$
$R_{THj-c}$	Thermal resistance junction-to-case	Each IGBT		0.55	0.60	$^\circ\text{C}/\text{W}$
$R_{THc-h}$	Thermal resistance case-to-heatsink	Each IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot^\circ\text{C})$		0.70		$^\circ\text{C}/\text{W}$

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 at $T_C = 100\text{ }^\circ\text{C}$	35	A
$I_{FP}^{(1)}$	Pulsed forward current ( $t_p = 1\text{ ms}$ )	70	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	$I_F = 35\text{ A}$	-	2.95	4.1	V
		$I_F = 35\text{ A}$ , $T_J = 150\text{ }^\circ\text{C}$	-	2.3		
$t_{rr}$	Reverse recovery time	$I_F = 35\text{ A}$ , $V_R = 600\text{ V}$ , $V_{GE} = \pm 15\text{ V}$ , $di/dt = 1900\text{ A}/\mu\text{s}$	-	140		ns
$Q_{rr}$	Reverse recovery charge		-	2.62		$\mu\text{C}$
$I_{rrm}$	Reverse recovery current		-	54		A
$E_{rec}$	Reverse recovery energy		-	1.2		mJ

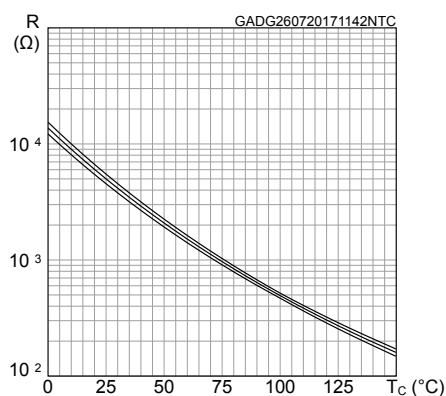
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{rr}$	Reverse recovery time	$I_F = 35\text{ A}$ , $V_R = 600\text{ V}$ , $V_{GE} = \pm 15\text{ V}$ , $di/dt = 1533\text{ A}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$	-	350		ns
$Q_{rr}$	Reverse recovery charge		-	6.6		$\mu\text{C}$
$I_{rrm}$	Reverse recovery current		-	63		A
$E_{rec}$	Reverse recovery energy		-	3.2		mJ
$R_{THj-c}$	Thermal resistance junction-to-case	Each diode	-	0.8	0.9	$^\circ\text{C}/\text{W}$
$R_{THc-h}$	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

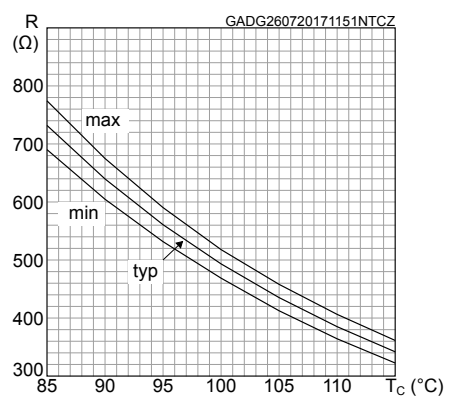
**Table 5. NTC temperature sensor, considered as stand-alone**

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

**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, $t = 60$ 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		mΩ

## 2 Electrical characteristics (curves)

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

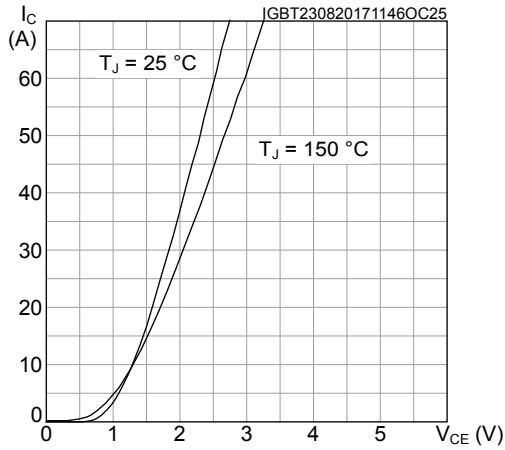


Figure 4. IGBT output characteristics ( $T_J = 150\text{ °C}$ , terminal)

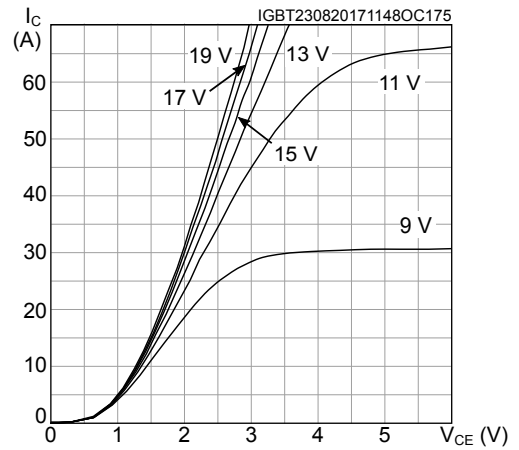


Figure 5. IGBT transfer characteristics ( $V_{CE} = 15V$ , terminal)

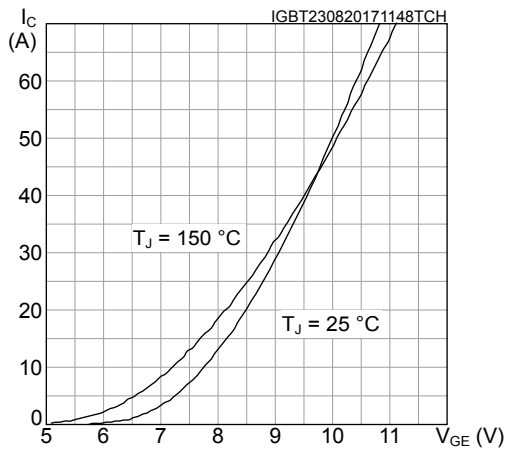
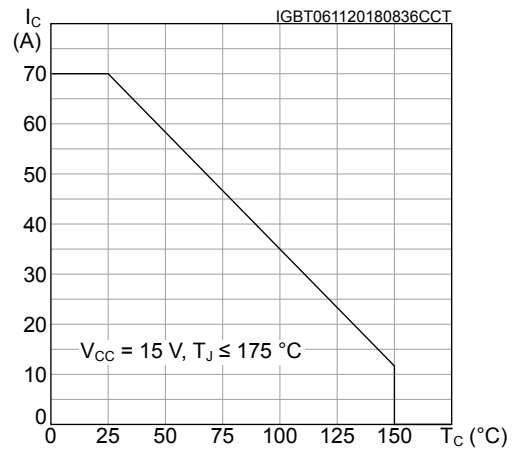
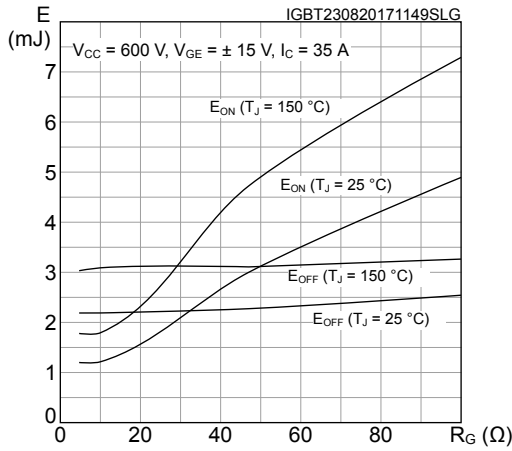


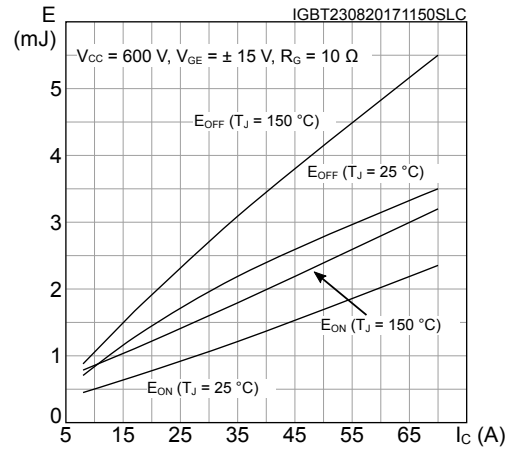
Figure 6. IGBT collector current vs case temperature



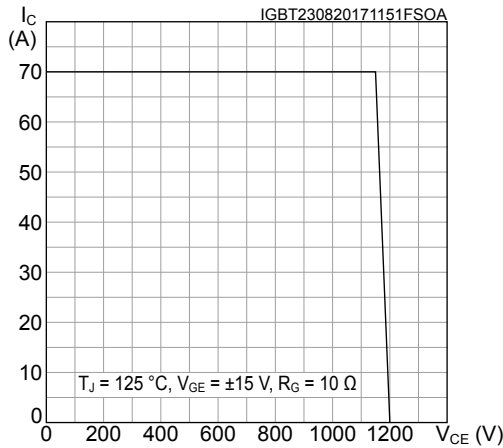
**Figure 7. Switching energy vs gate resistance**



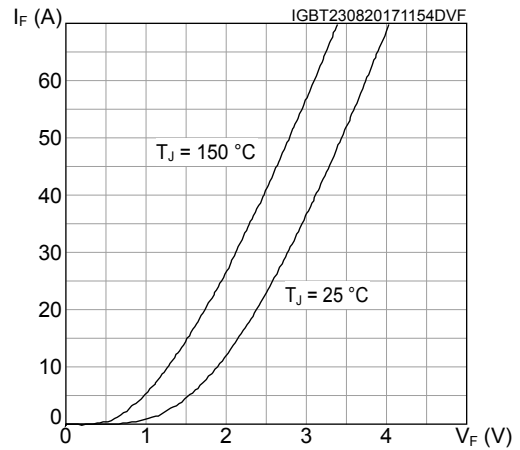
**Figure 8. Switching energy vs collector current**



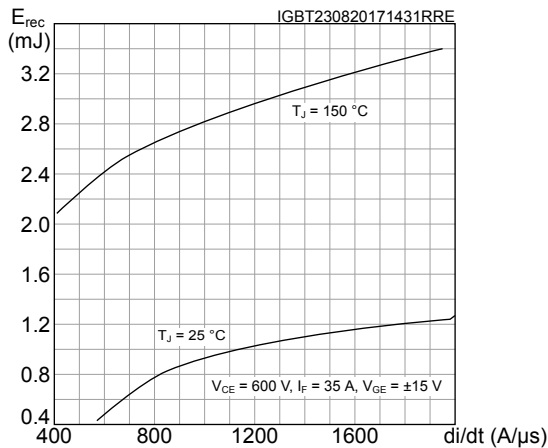
**Figure 9. IGBT reverse biased safe operating area (RBSOA)**



**Figure 10. Diode forward characteristics (terminal)**



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



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

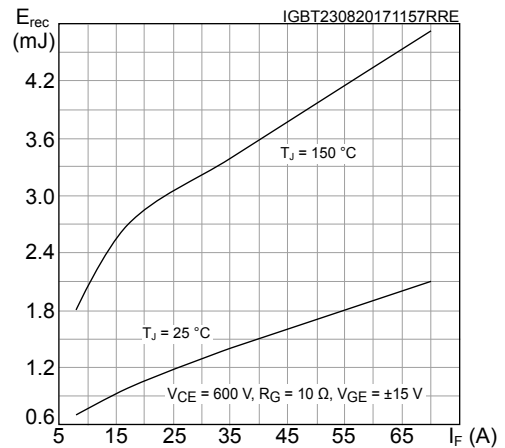


Figure 13. Diode reverse recovery energy vs gate resistance

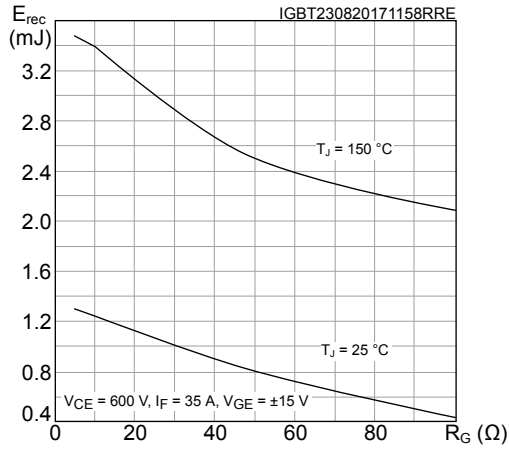


Figure 14. Inverter diode thermal impedance

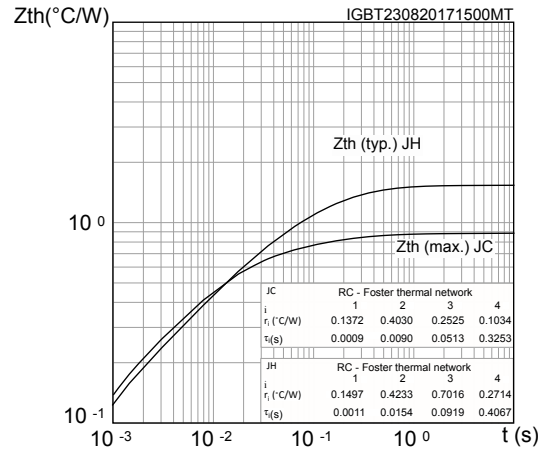
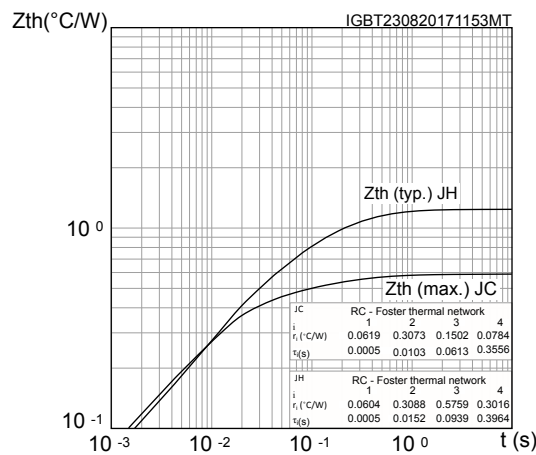
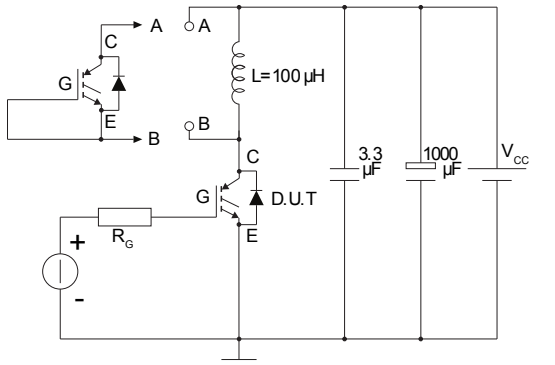
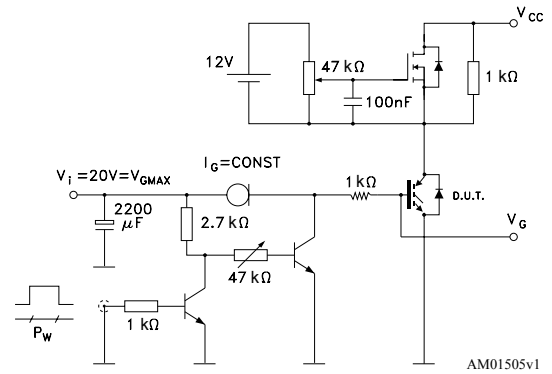
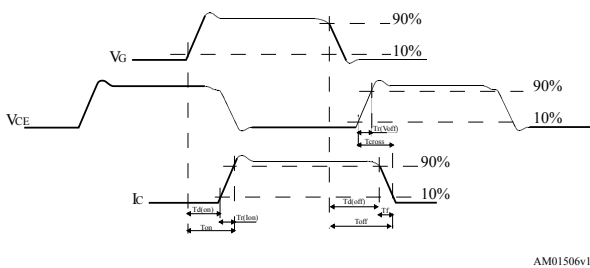
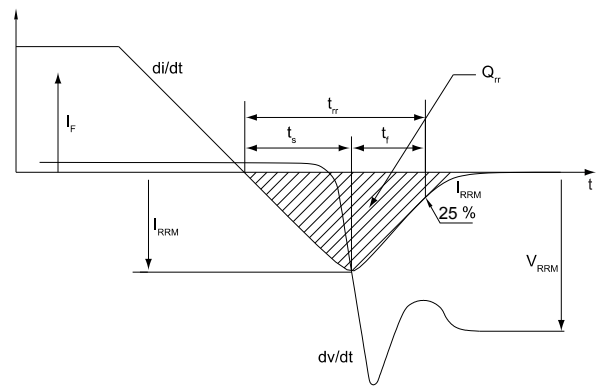


Figure 15. IGBT thermal impedance





### 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

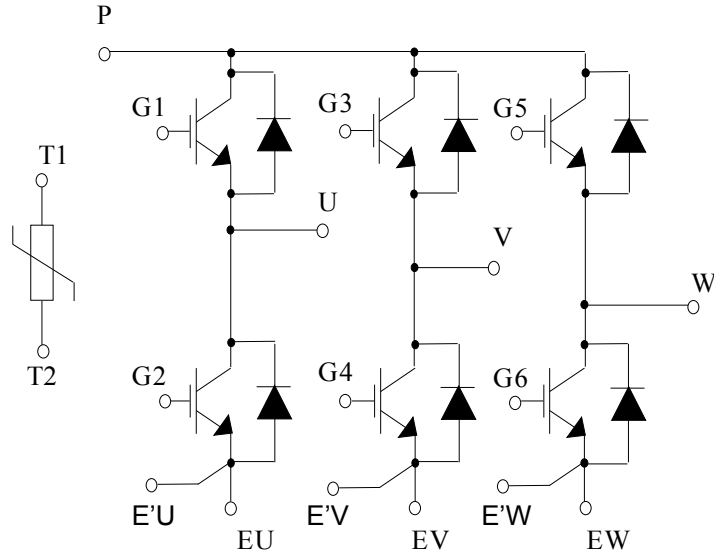
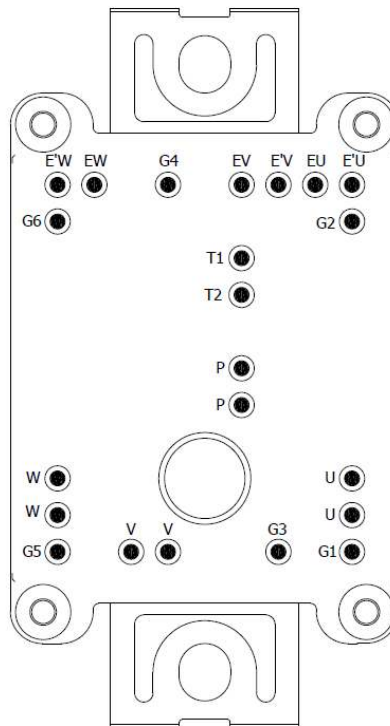


Figure 21. Package top view with sixpack pinout



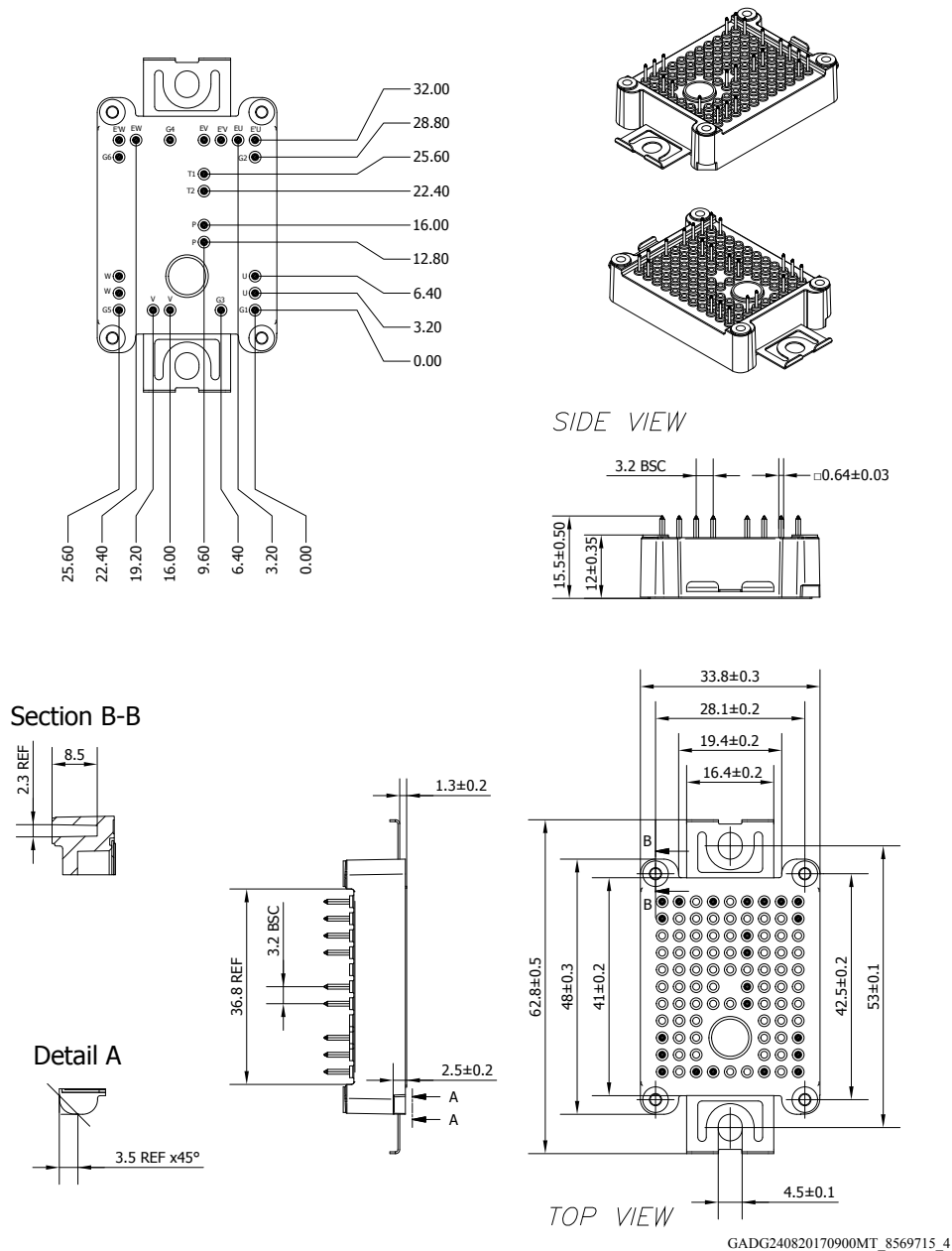
## **5** Package information

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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 solder pins package information

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



- 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.

## Revision history

**Table 7. Document revision history**

Date	Revision	Changes
02-May-2016	1	Initial release.
24-Aug-2017	2	Updated title, features, description and <i>Table 1: "Device summary"</i> in cover page. Updated <i>Section 1: "Electrical ratings"</i> . Added <i>Section 2: "Electrical characteristics curves"</i> , <i>Section 3: "Test circuits"</i> , <i>Section 4: "Topology and pin description"</i> and <i>Section 5: "Package information"</i> . Minor text changes.
02-Oct-2017	3	Document status promoted from preliminary data to production data. Updated <i>Table 7: "ACEPACK™ 1 package"</i> and <i>Section 2: "Electrical characteristics curves"</i> . Minor text changes.
16-Feb-2018	4	Updated features and removed maturity status indication from cover page. Updated <i>Figure 13. Inverter diode thermal impedance</i> and <i>Figure 14. IGBT thermal impedance</i> . Updated <i>Figure 21. ACEPACK™ 1 sixpack solder pins package outline (dimensions are in mm)</i> . Minor text changes
14-Nov-2018	5	Added <a href="#">Figure 6. IGBT collector current vs case temperature</a> . Minor text changes

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