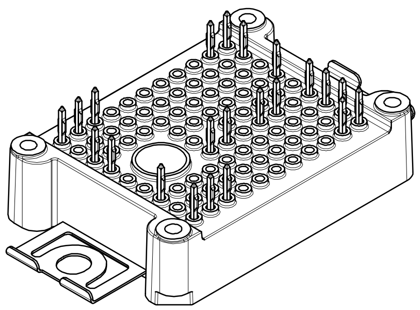
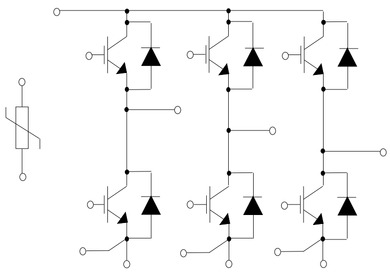
ACEPACK™ 1 sixpack topology, 1200 V, 35 A, trench gate field-stop M series IGBT with soft diode and NTC



ACEPACK™ 1



Features

- ACEPACK™ 1 power module
  - DBC Cu Al_2O_3 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-F

Product summary	
Order code	A1P35S12M3-F
Marking	A1P35S12M3-F
V_{CES}, I_C ratings	1200 V, 35 A
Package	ACEPACK™ 1
Packing	Press fit contact pins

1 Electrical ratings

1.1 IGBT

Limiting values at T_J = 25 °C, unless otherwise specified.

Table 1. Absolute maximum ratings of the IGBT

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0 V)	1200	V
I_C	Continuous collector current (T_C = 100 °C)	35	A
I_{CP} [1]	Pulsed collector current (t_p = 1 ms)	70	A
V_{GE}	Gate-emitter voltage	±20	V
P_{TOT}	Total power dissipation of each IGBT (T_C = 25 °C, T_J = 175 °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 mA, V_{GE} = 0 V	1200			V
$V_{CE(sat)}$ (terminal)	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C= 35 A		1.95	2.45	V
		V_{GE} = 15 V, I_C = 35 A, T_J = 150 °C		2.3		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA	5	6	7	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 1200 V			100	µA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ± 20 V			± 500	nA
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0 V		2154		pF
C_{oes}	Output capacitance			164		pF
C_{res}	Reverse transfer capacitance			86		pF
Q_g	Total gate charge	V_{CC} = 960 V, I_C = 35 A, V_{GE} = ±15 V		163		nC
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, I_C = 35 A, R_G = 10 Ω, V_{GE} = ±15 V, di/dt = 1900 A/µs		122		ns
t_r	Current rise time			17		ns
E_{on} [1]	Turn-on switching energy			1.21		mJ
$t_{d(off)}$	Turn-off delay time	V_{CC} = 600 V, I_C = 35 A, R_G = 10 Ω, V_{GE} = ±15 V, dv/dt = 7800 V/µs		142		ns
t_f	Current fall time			150		ns
E_{off} [2]	Turn-off switching energy			2.19		mJ

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, I_C = 35 A, R_G = 10 Ω, V_{GE} = ±15 V, di/dt = 1533 A/μs, T_J = 150 °C		124		ns
t_r	Current rise time			18		ns
E_{on}[(1)]	Turn-on switching energy			1.8		mJ
$t_{d(off)}$	Turn-off delay time	V_{CC} = 600 V, I_C = 35 A, R_G = 10 Ω, V_{GE} = ±15 V, dv/dt = 6700 V/μs, T_J = 150 °C		142		ns
t_f	Current fall time			256		ns
E_{off}[(2)]	Turn-off switching energy			3.1		mJ
t_{SC}	Short-circuit withstand time	V_{CC} ≤ 600 V, V_{GE} ≤ 15 V, T_{Jstart} ≤ 150 °C	10			μs
R_{THj-c}	Thermal resistance junction-to-case	Each IGBT		0.55	0.60	°C/W
R_{THc-h}	Thermal resistance case-to-heatsink	Each IGBT, λ_{grease} = 1 W/(m·°C)		0.70		°C/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 °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 °C	35	A
I_{FP}[(1)]	Pulsed forward current (t_p = 1 ms)	70	A
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 4. Electrical characteristics of the diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F (terminal)	Forward voltage	I_F = 35 A	-	2.95	4.1	V
		I_F = 35 A, T_J = 150 °C	-	2.3		
t_{rr}	Reverse recovery time	I_F = 35 A, V_R = 600 V, V_{GE} = ±15 V, di/dt = 1900 A/μs	-	140		ns
Q_{rr}	Reverse recovery charge		-	2.62		μC
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 A, V_R = 600 V, V_{GE} = ±15 V, di/dt = 1533 A/µs, T_J = 150 °C	-	350		ns
Q_{rr}	Reverse recovery charge		-	6.6		µC
I_{rrm}	Reverse recovery current		-	63		A
E_{rec}	Reverse recovery energy		-	3.2		mJ
$R_{THj\text{-}c}$	Thermal resistance junction-to-case	Each diode	-	0.8	0.9	°C/W
$R_{THc\text{-}h}$	Thermal resistance case-to-heatsink	Each diode, λ_{grease} = 1 W/(m·°C)	-	0.75		°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°C		5		kΩ
R_{100}	Resistance	T = 100°C		493		Ω
ΔR/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

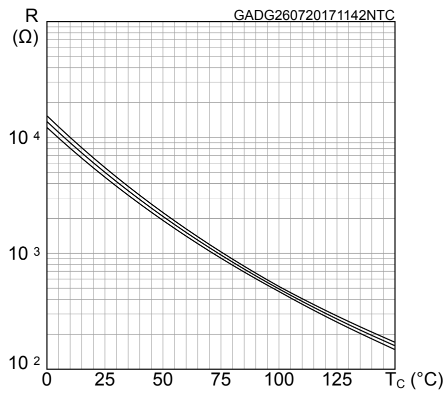
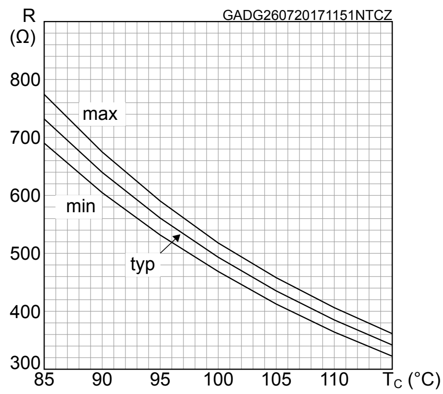


Figure 2. NTC resistance vs temperature, zoom



1.4 Package

Table 6. ACEPACK™ 1 package

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{isol}	Isolation voltage (AC voltage, t = 60 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)

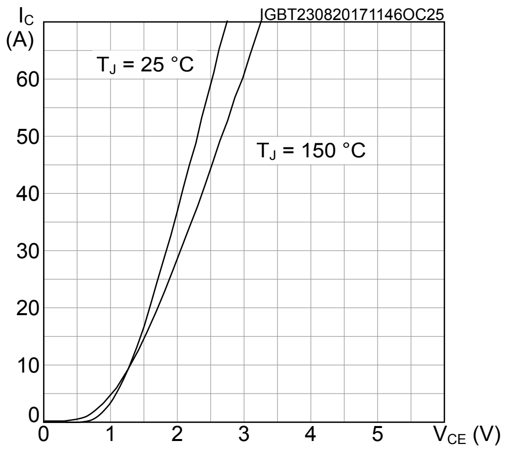


Figure 4. IGBT output characteristics (T_J = 150 °C, terminal)

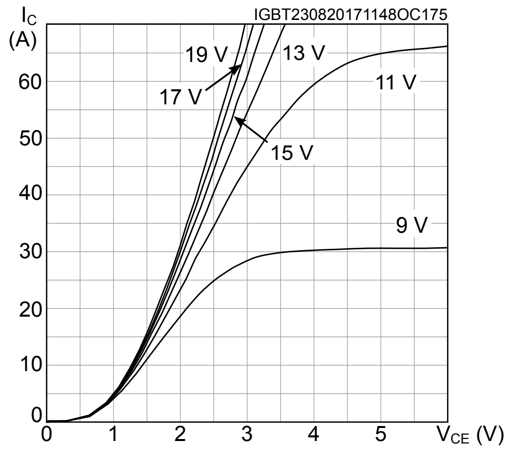


Figure 5. IGBT transfer characteristics (V_{CE} = 15 V, terminal)

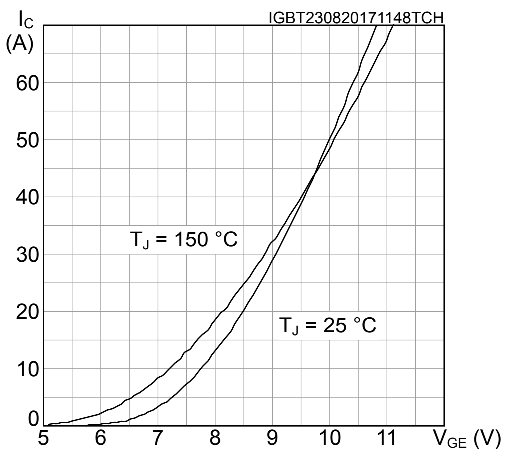


Figure 6. IGBT collector current vs case temperature

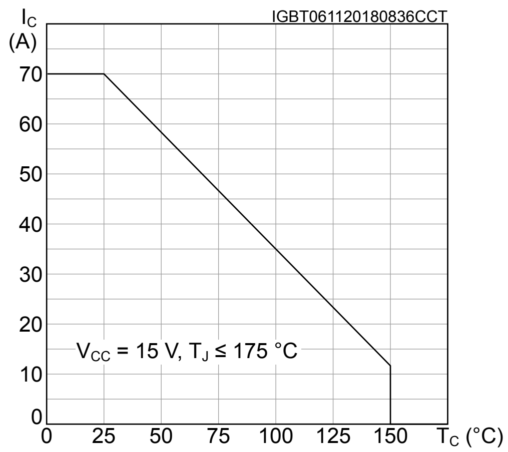


Figure 7. **Switching energy vs gate resistance**

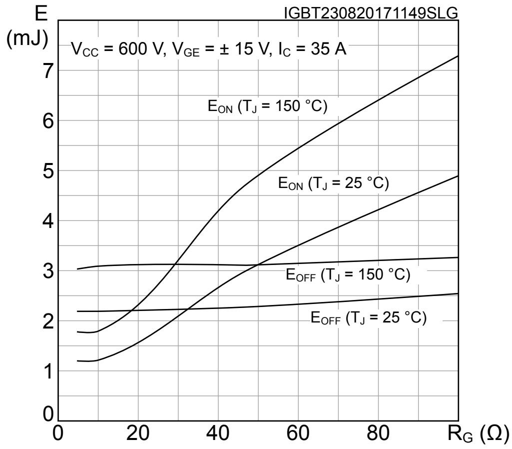


Figure 8. **Switching energy vs collector current**

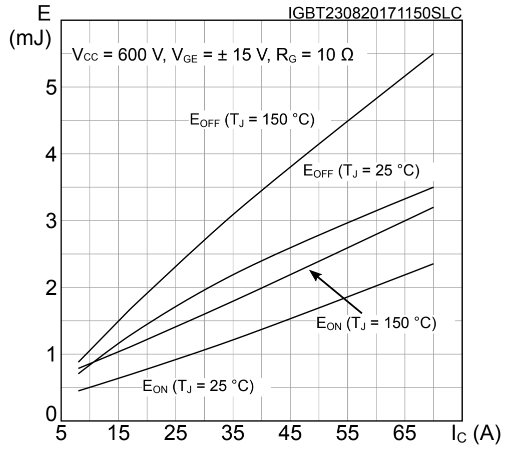


Figure 9. **IGBT reverse biased safe operating area (RBSOA)**

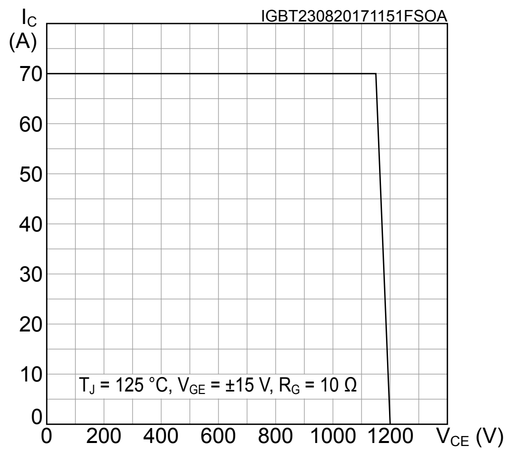


Figure 10. **Diode forward characteristics (terminal)**

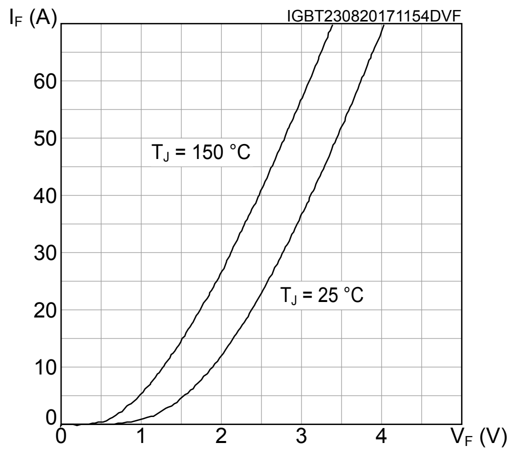


Figure 11. **Diode reverse recovery energy vs diode current slope**

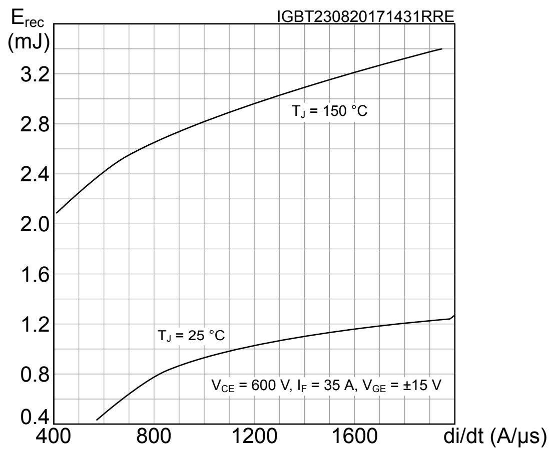


Figure 12. **Diode reverse recovery energy vs forward current**

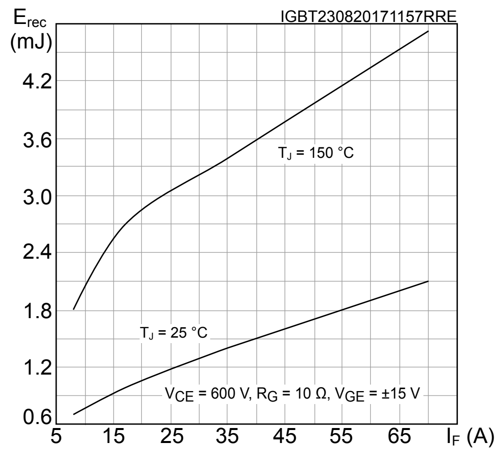


Figure 13. Diode reverse recovery energy vs gate resistance

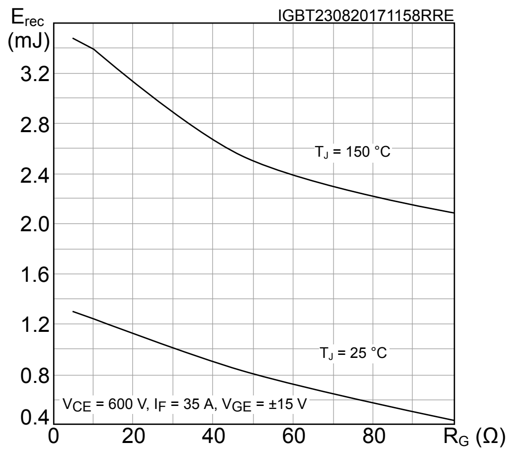


Figure 14. Inverter diode thermal impedance

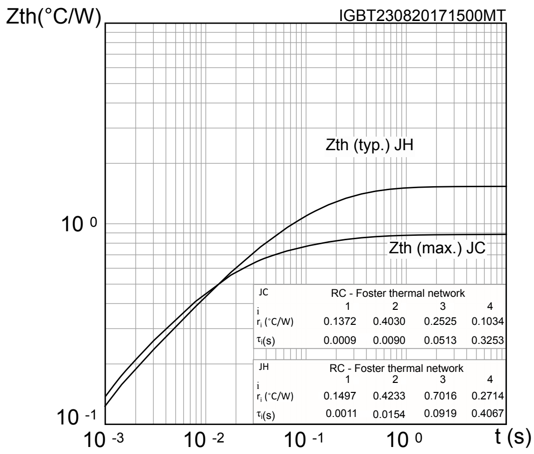
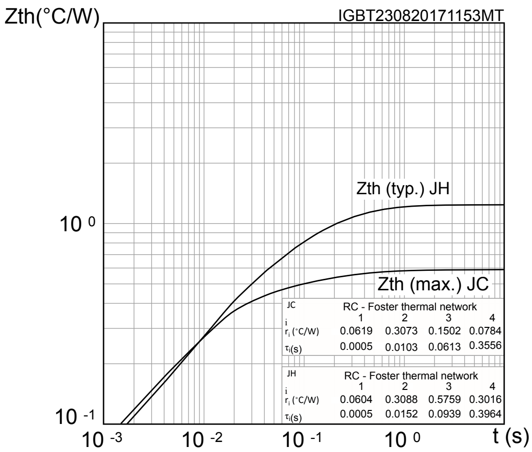


Figure 15. IGBT thermal impedance



3 Test circuits

Figure 16. Test circuit for inductive load switching

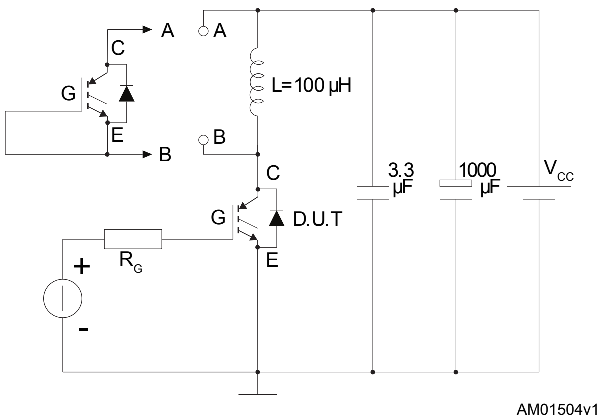


Figure 17. Gate charge test circuit

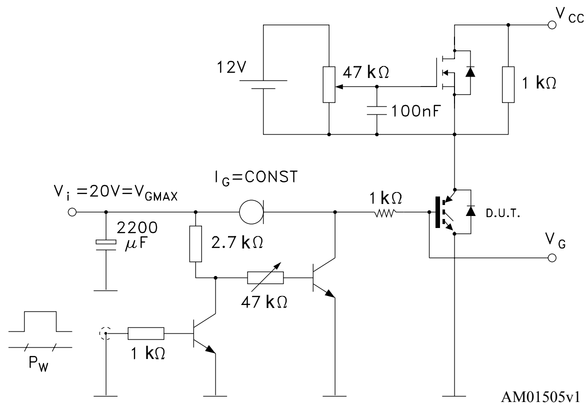


Figure 18. Switching waveform

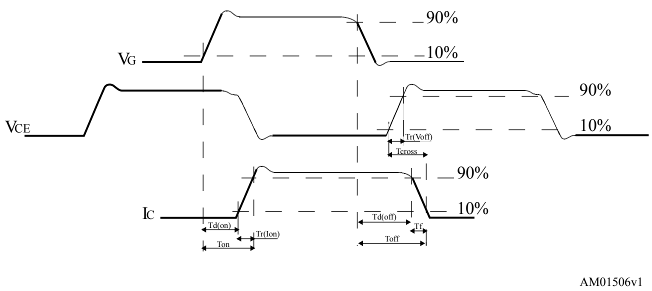
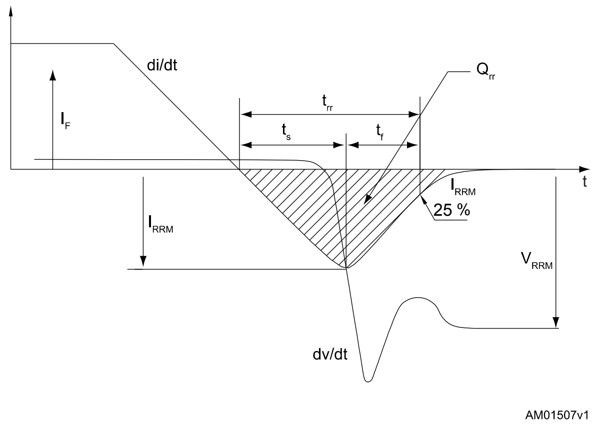


Figure 19. Diode reverse recovery waveform



4 Topology and pin description

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

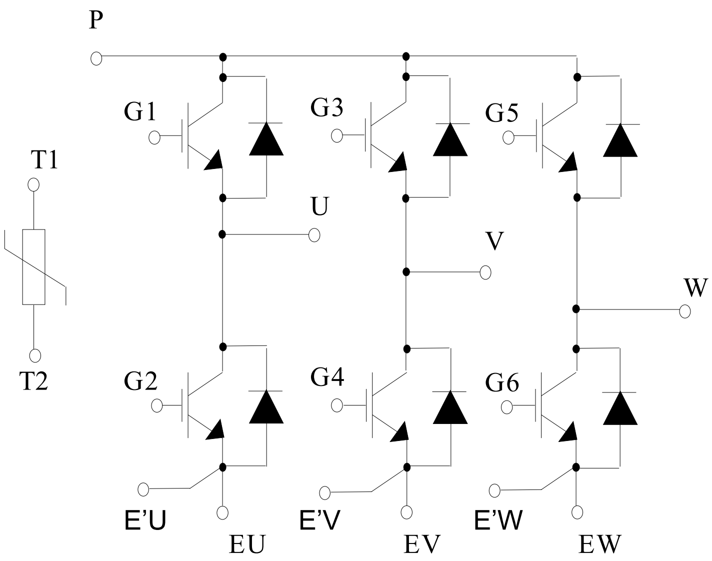
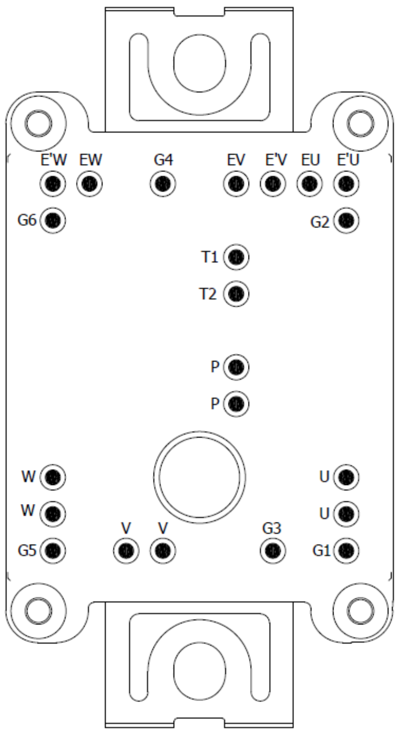


Figure 21. **Package top view with sixpack pinout**

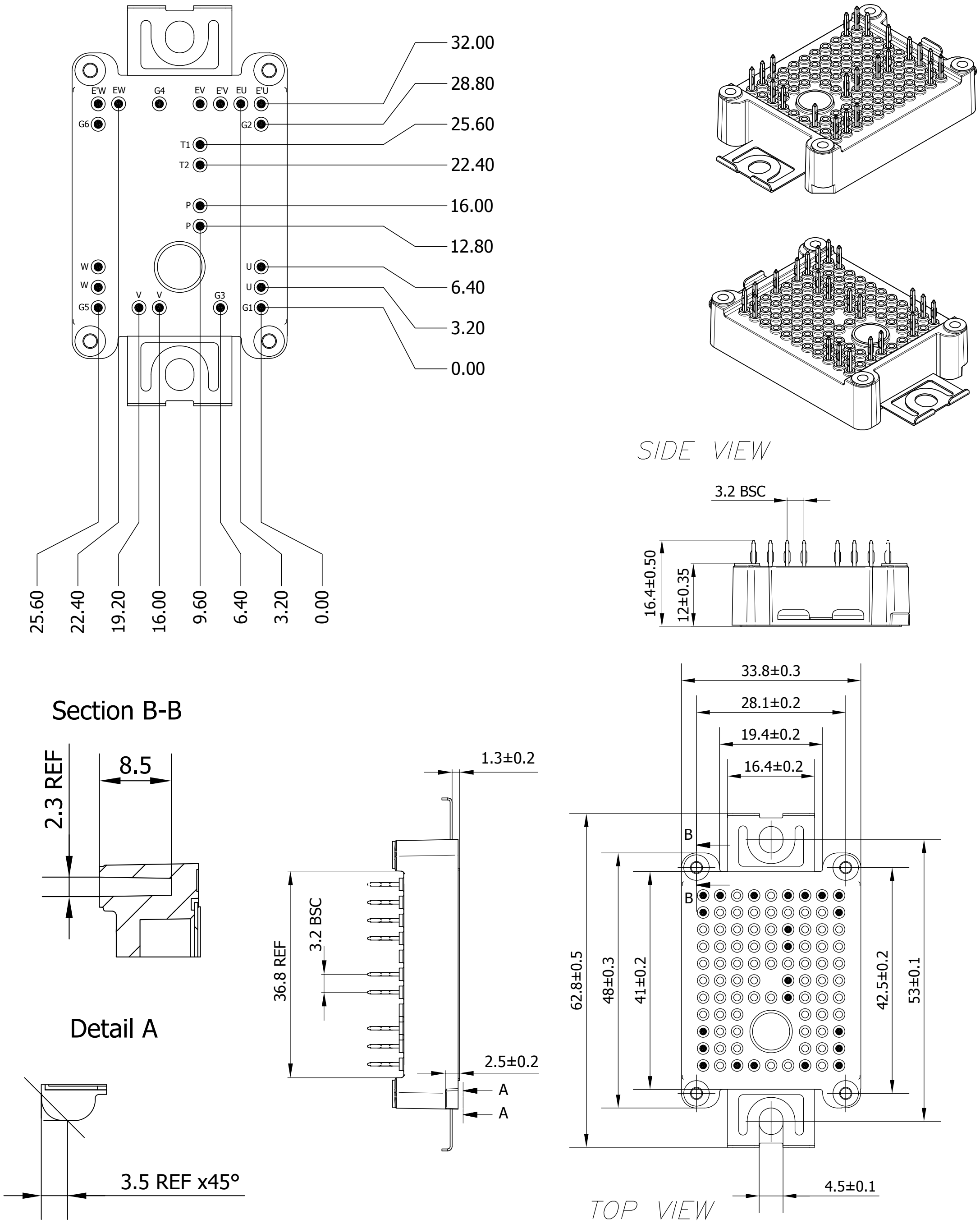


5 Package information

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. 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)



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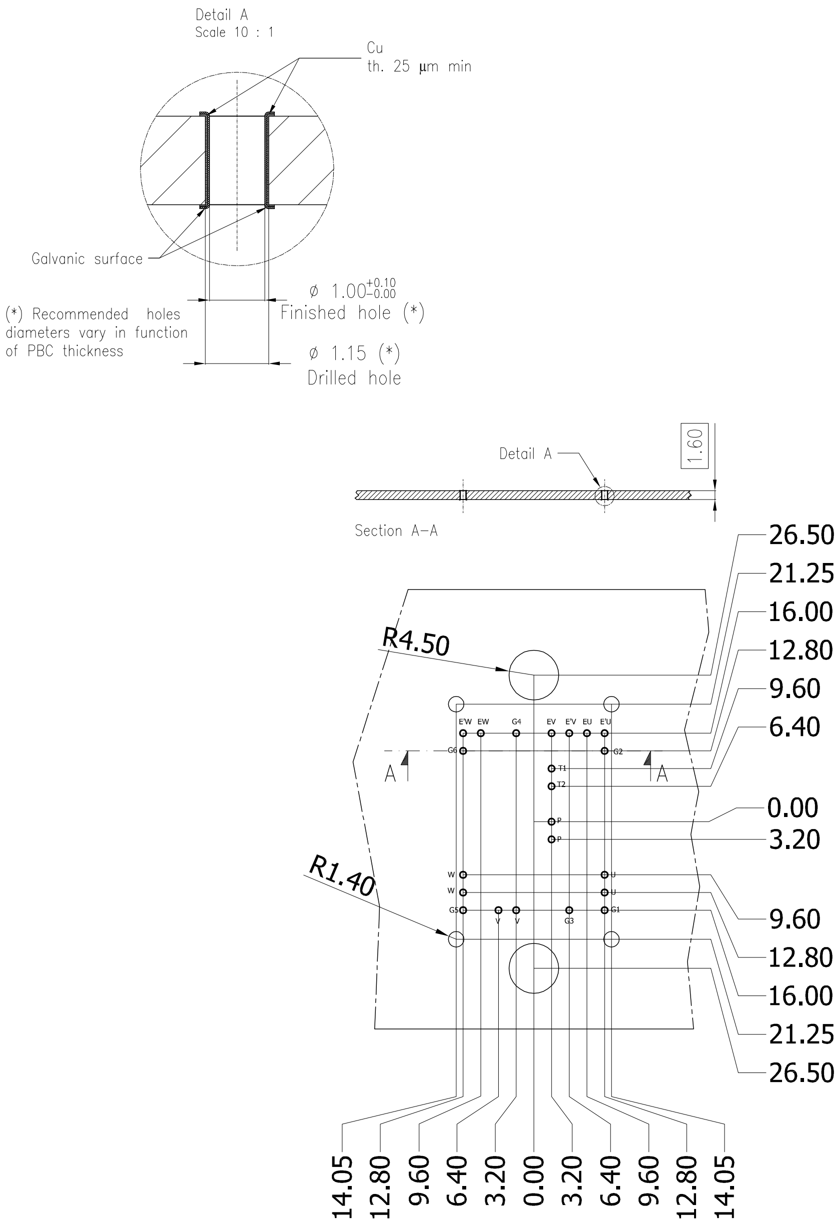
- The lead size includes the thickness of the lead plating material.
- Dimensions do not include mold protrusion.
- Package dimensions do not include any eventual metal burrs.

Figure 23. ACEPACK™ 1 sixpack press fit pins recommended PCB holes layout (dimensions are in mm)



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Revision history

Table 7. **Document revision history**

Date	Revision	Changes
04-May-2016	1	Initial release.
24-Aug-2017	2	Updated title, features, description and Table 1: "Device summary" in cover page. Updated Section 1: "Electrical ratings". Added Section 2: "Electrical characteristics curves", Section 3: "Test circuits", Section 4: "Topology and pin description" and Section 5: "Package information". Minor text changes.
03-Oct-2017	3	Updated Table 7: "ACEPACK™ 1 package" and Section 2: "Electrical characteristics curves". Minor text changes.
02-Mar-2018	4	Removed maturity status indication from cover page. The document status is production data. Updated silhouette in cover page and *Section 5.1 ACEPACK™ 1 sixpack press fit pins package information*. Minor text changes.
14-Nov-2018	5	Added Figure 6. IGBT collector current vs case temperature. Minor text changes

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Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:
moschip.ru
moschip.ru_4
moschip.ru_6
moschip.ru_9