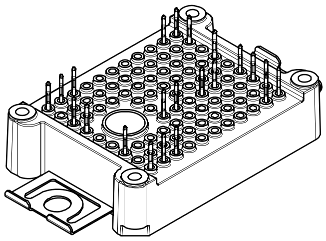
A1P35S12M3-F

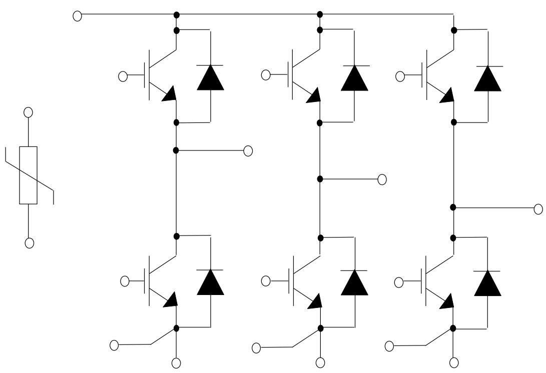
ACEPACK™ 1 - sixpack topology - 1200 V, 35 A trench gate field-stop IGBT M series, soft diode and NTC

Datasheet - production data



ACEPACK™ 1

Figure 1: Internal electrical schematic



Features

- ACEPACK™ 1 power module
  - DBC Cu Al_2O_3 Cu
- Sixpack topology
  - 1200 V, 35 A IGBTs and diodes
  - $V_{CE(sat)}$: 1.95 V @ I_C = 35 A
  - 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.

Table 1: Device summary

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

Contents

1 Electrical ratings

1.1 IGBT

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

Table 2: 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 °C)	35	A
I_{CP} (1)	Pulsed collector current	70	A
V_{GE}	Gate-emitter voltage	±20	V
P_{TOT}	Total power dissipation	250	W
T_{JMAX}	Maximum junction temperature	175	°C
T_{Jop}	Operative temperature range under switching conditions	-40 to 150	°C

Notes:

(1)Pulse width limited by maximum junction temperature.

Table 3: 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
$V_{CE(sat)}$	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}	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}	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

Notes:

(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

1.2 Diode

Table 4: 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	70	A
T_{JMAX}	Maximum junction temperature	175	°C
T_{Jop}	Operative temperature range under switching conditions	-40 to 150	°C

Notes:

(1)Pulse width limited by maximum junction temperature.

Table 5: Electrical characteristics of the diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	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
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-c}	Thermal resistance junction to case	Each diode	-	0.8	0.9	°C/W
R_{THc-h}	Thermal resistance case to heatsink	Each diode, λ_{grease} = 1 W/(m·°C)	-	0.75		°C/W

1.3 NTC

Table 6: NTC temperature sensor, considered as stand-alone

Symbol	Parameter	Test condition	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 2: NTC resistance vs. temperature

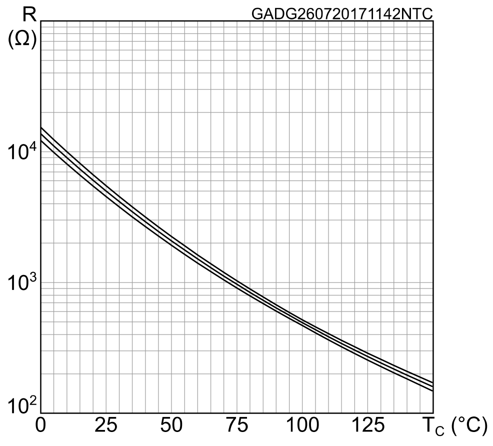
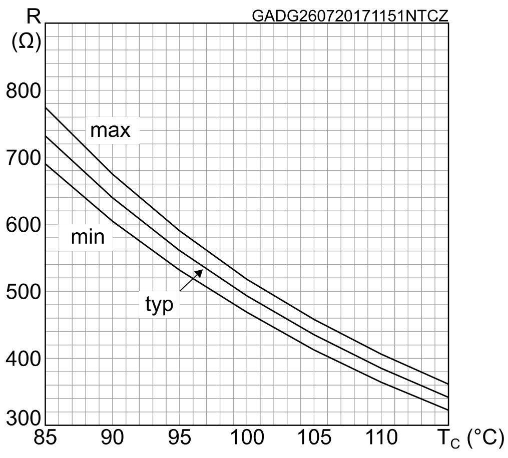


Figure 3: NTC resistance vs. temperature, zoom



1.4 Package

Table 7: ACEPACK™ 1 package

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{isol}	Isolation voltage (AC voltage, t = 60 s)			2500	V
M_d	Screw mounting torque	40		80	Nm
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 lead resistance, terminal to chip		3.9		mΩ

2 Electrical characteristics curves

Figure 4: IGBT output characteristics (V_{GE} = 15 V)

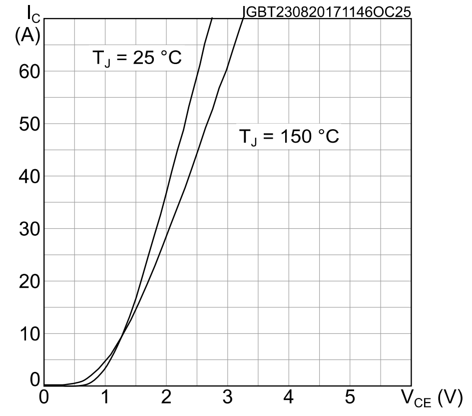


Figure 5: IGBT output characteristics (T_J = 150 °C)

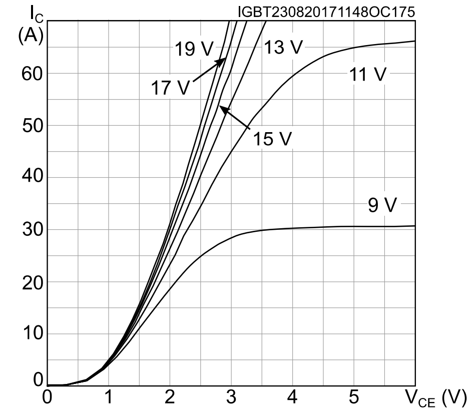


Figure 6: IGBT transfer characteristics (V_{CE} = 15 V)

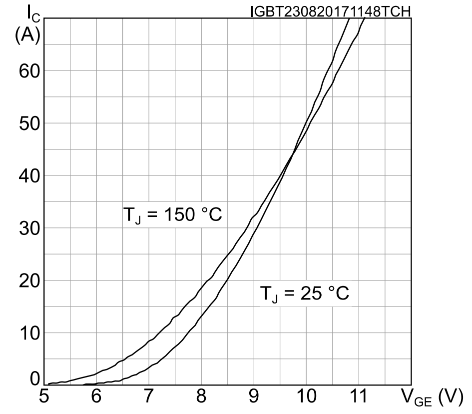


Figure 7: Switching energy vs. gate resistance

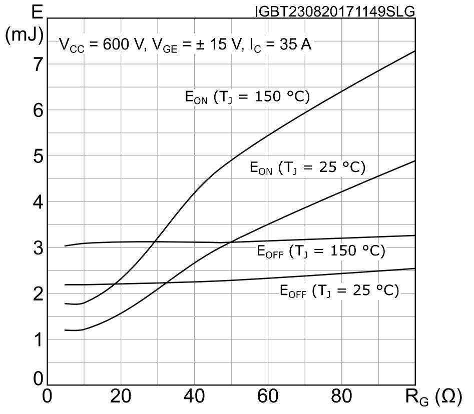


Figure 8: Switching energy vs. collector current

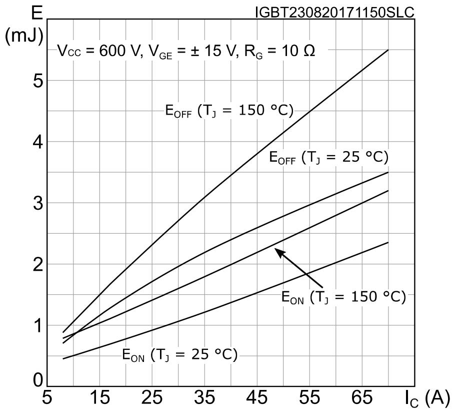


Figure 9: IGBT reverse biased safe operating area (RBSOA)

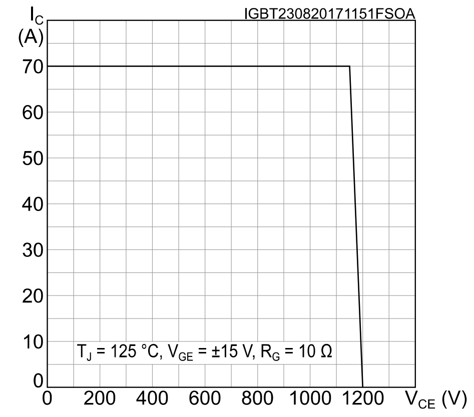


Figure 10: Diode forward characteristics

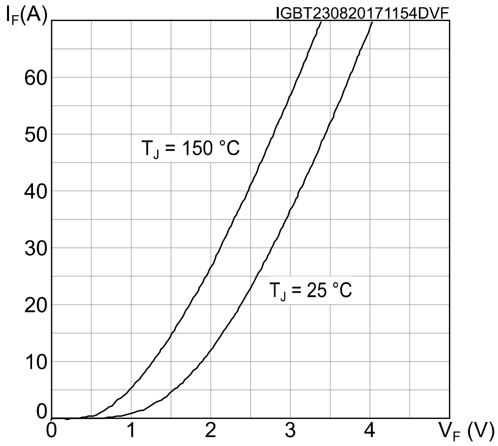


Figure 11: Diode reverse recovery energy vs. diode current slope

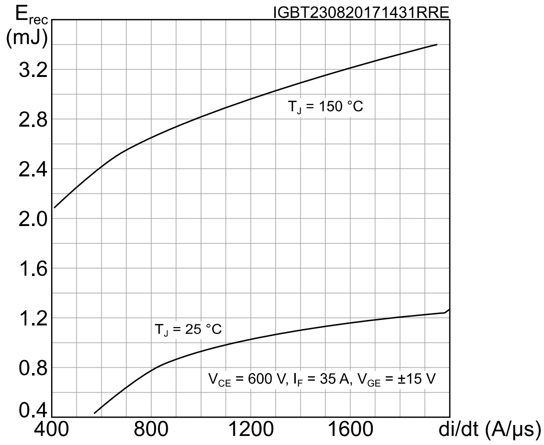


Figure 12: Diode reverse recovery energy vs. forward current

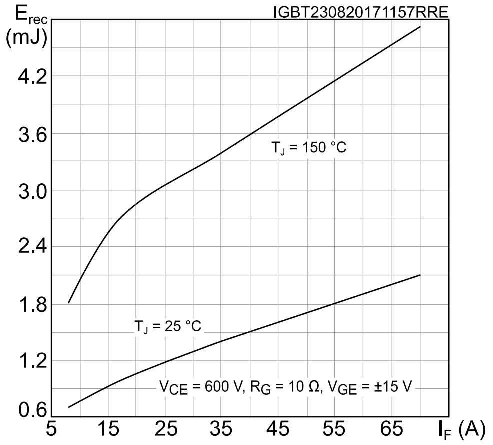


Figure 13: Diode reverse recovery energy vs. gate resistance

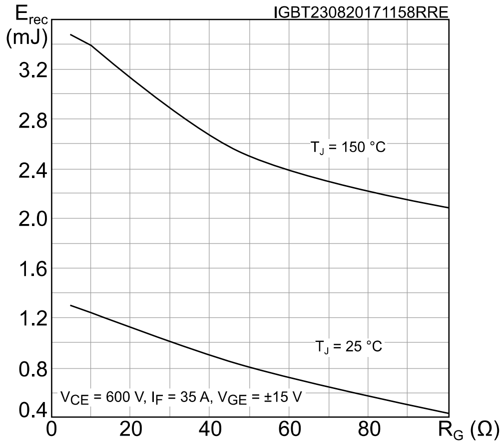


Figure 14: Inverter diode thermal impedance

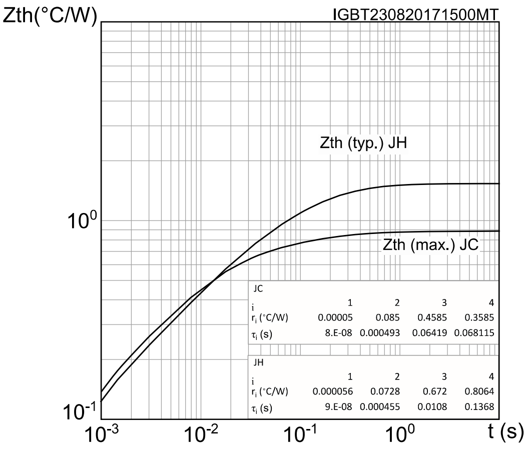
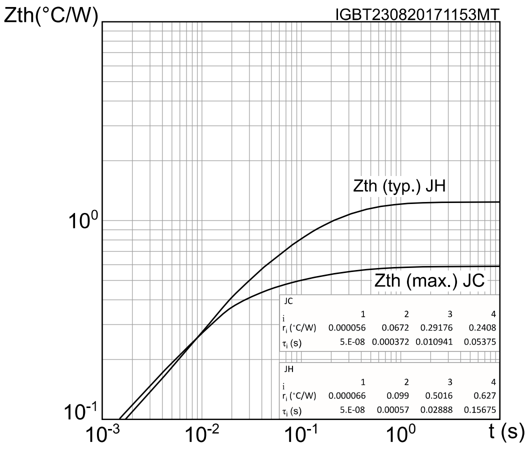


Figure 15: IGBT thermal impedance



3 Test circuits

Figure 16: Test circuit for inductive load switching

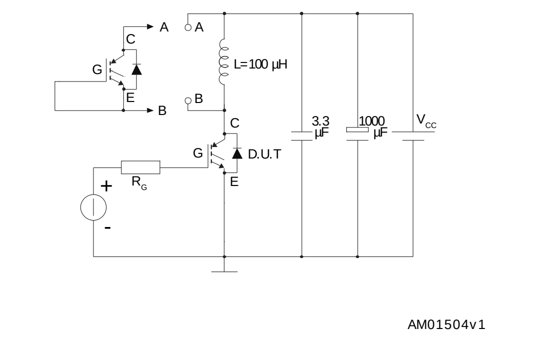


Figure 17: Gate charge test circuit

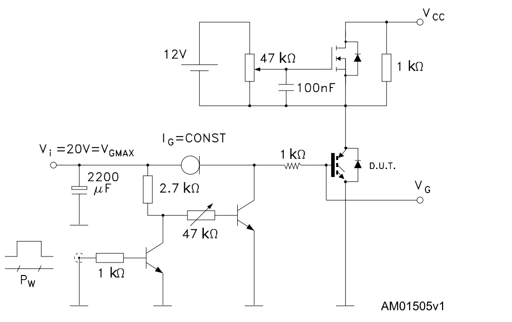


Figure 18: Switching waveform

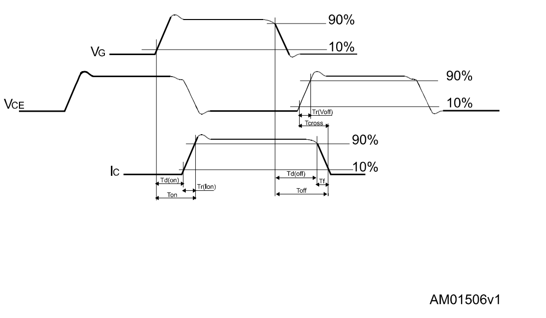
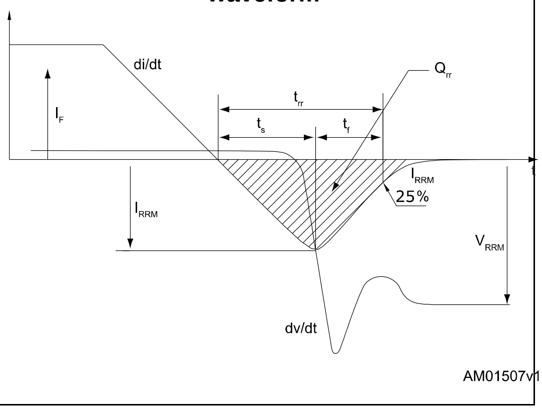


Figure 19: Diode reverse recovery waveform



4 Topology and pin description

Figure 20: Electrical topology and pin description

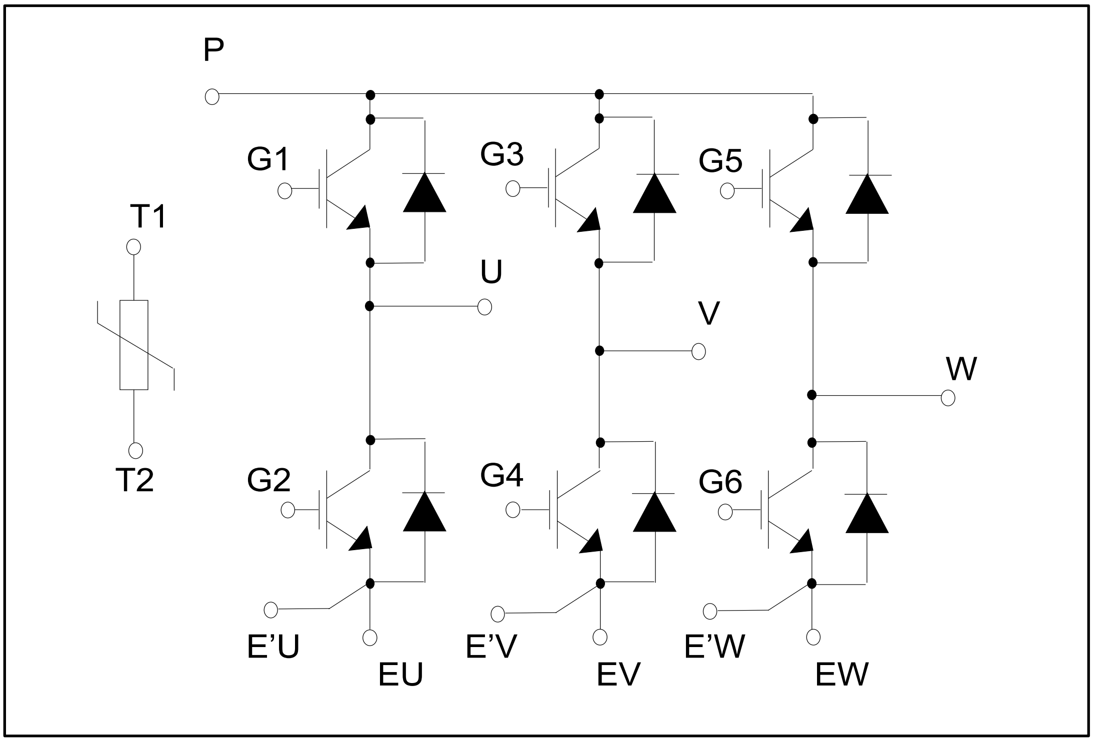
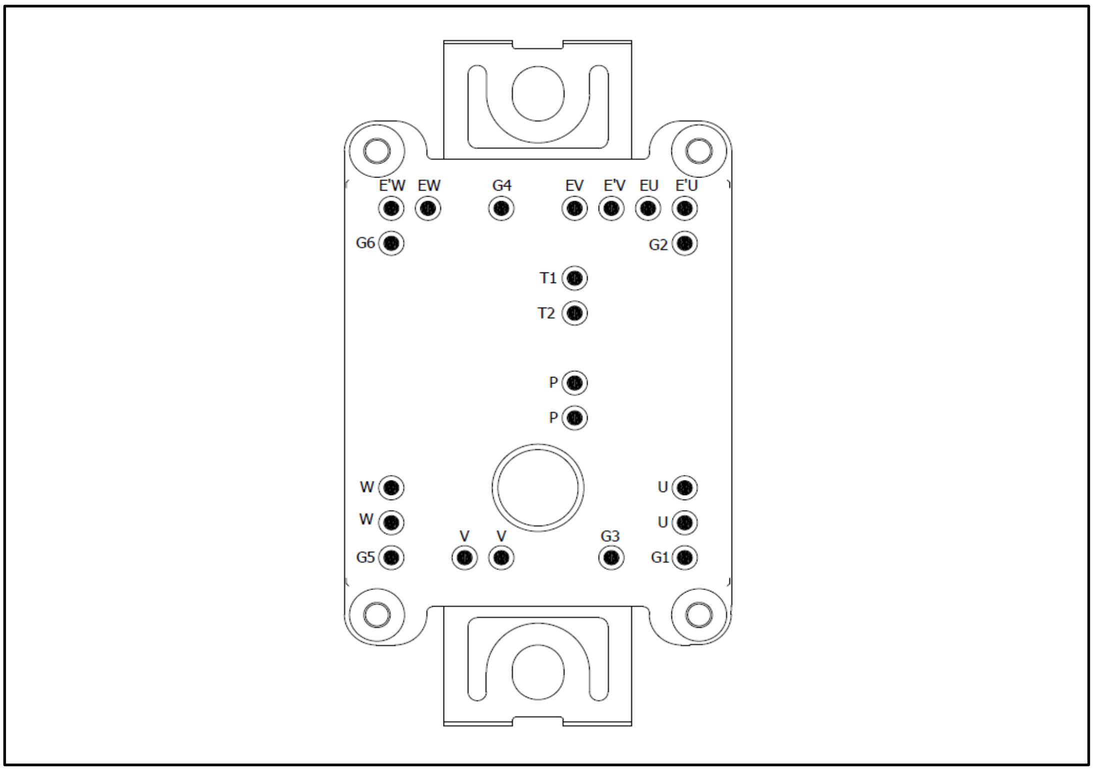


Figure 21: Package top view with sixpack pinout

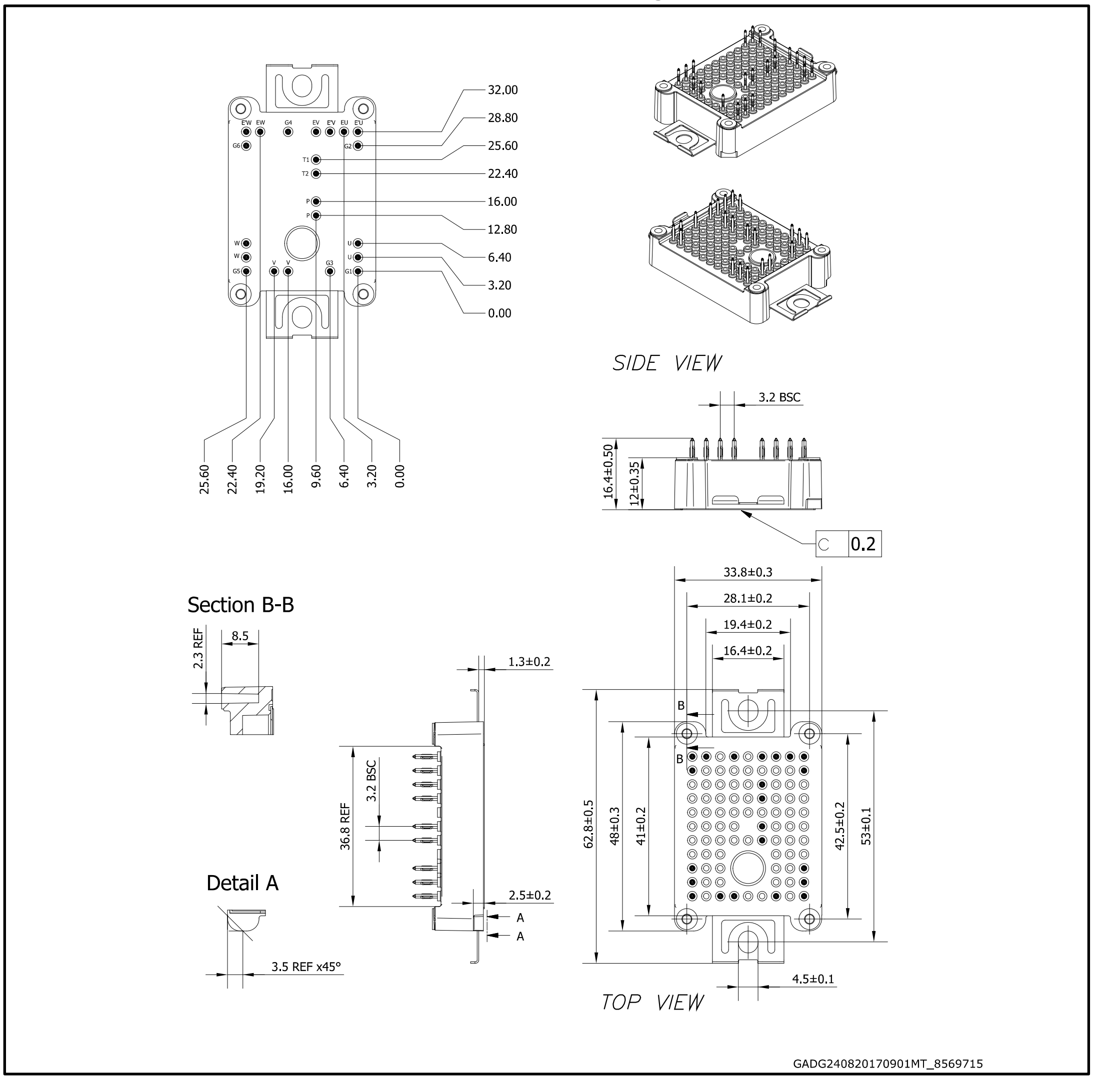


5 Package information

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.

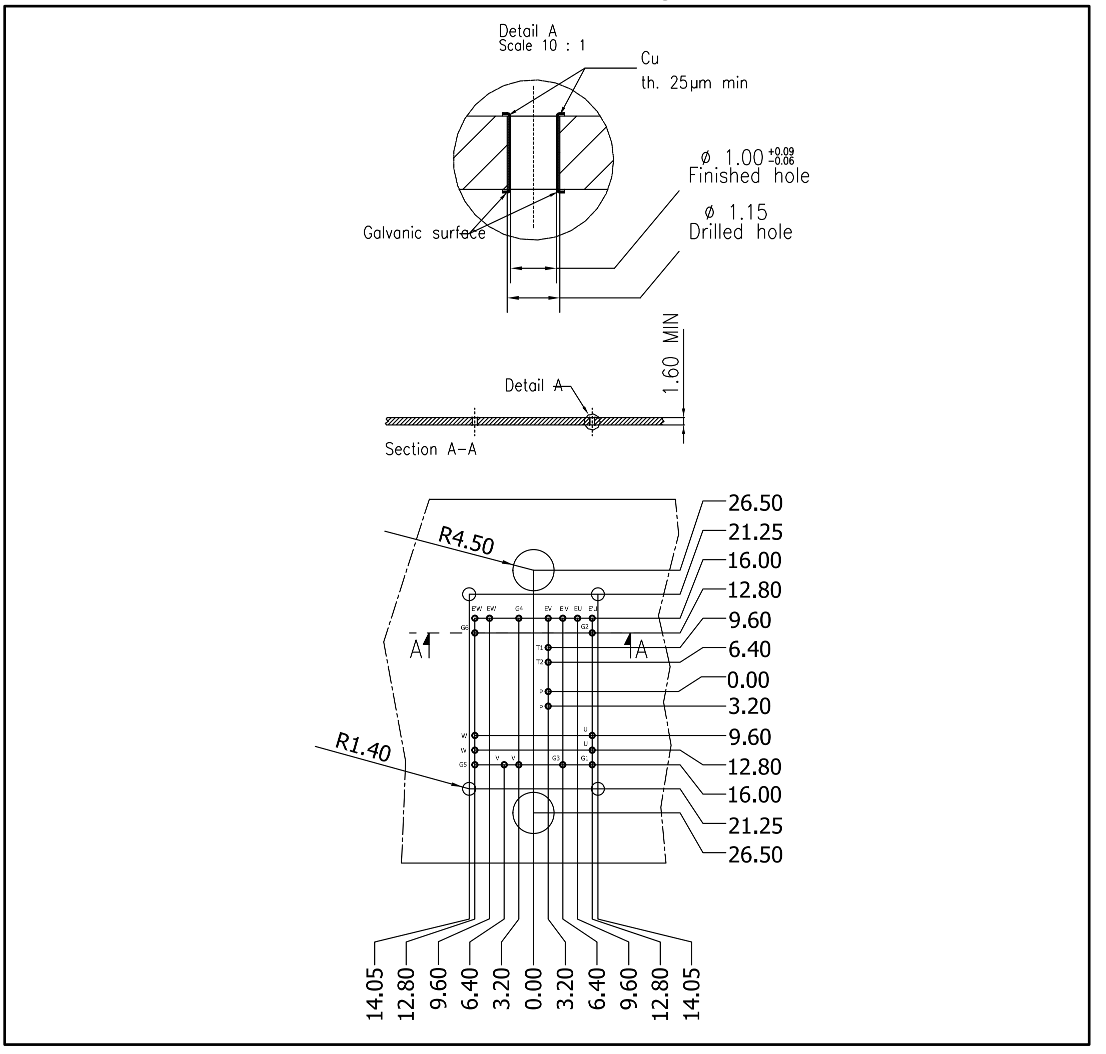
5.1 ACEPACK™ 1 sixpack press fit pins package information

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



- 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 package outline (dimension are in mm)



6 Revision history

Table 8: 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.