

ACEPACK™ 1 converter inverter brake, 1200 V, 15 A trench gate field-stop IGBT M series, soft diode and NTC

Datasheet - production data

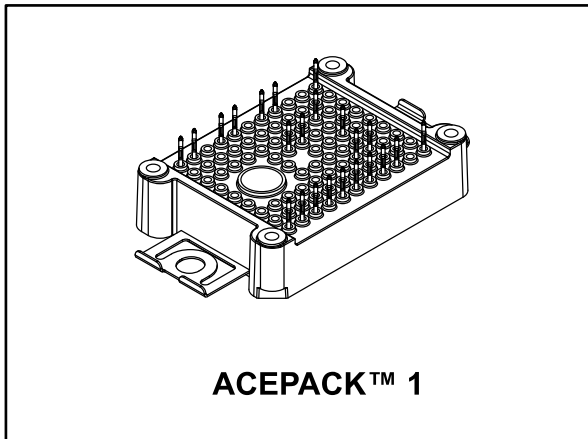
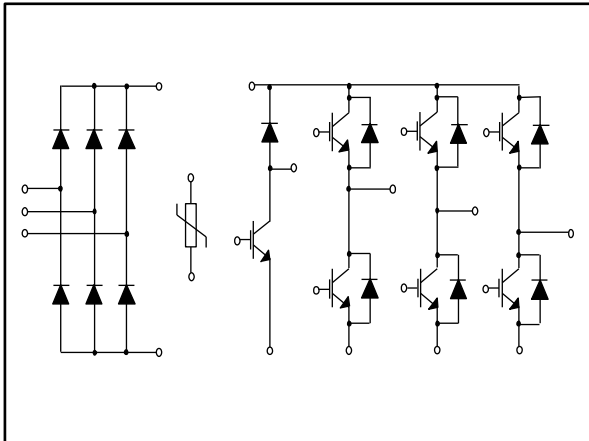


Figure 1: Internal electrical schematic



Features

- ACEPACK™ 1 power module
 - DBC Cu Al₂O₃ Cu
 - Press fit contact pins
- Converter inverter brake topology
 - 1600 V, very low drop rectifiers for converter
 - 1200 V, 15 A IGBTs and diodes
 - $V_{CE(sat)}$: 1.95 V @ $I_C = 15$ A
 - Soft and fast recovery diode
- Integrated NTC

Applications

- Inverters
- Motor drives

Description

This power module is a converter-inverter brake (CIB) topology in an ACEPACK™ 1 package with NTC, integrating the advanced trench gate field-stop technology 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	Package	Leads type
A1C15S12M3-F	A1C15S12M3-F	ACEPACK™ 1	Press fit contact pins

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1 Electrical ratings

1.1 Inverter stage

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

1.1.1 IGBTs

Table 2: Absolute maximum ratings of the IGBTs, inverter stage

Symbol	Description	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GE} = 0$)	1200	V
I_C	Continuous collector current at $T_c = 100\text{ °C}$	15	A
$I_{CP}^{(1)}$	Pulsed collector current ($t_P = 1\text{ ms}$)	30	A
V_{GE}	Gate-emitter voltage	± 20	V
P_{TOT}	Total power dissipation IGBT ($T_{JMAX} = 175\text{ °C}$)	142.8	W
T_{JMAX}	Maximum junction temperature	175	$^{\circ}\text{C}$
T_{Jop}	Operative temperature range under switching conditions	-40 to 150	$^{\circ}\text{C}$

Notes:

⁽¹⁾Pulse width limited by maximum junction temperature.

Table 3: Electrical characteristics of the IGBTs, inverter stage

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
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$, $I_C = 15\text{ A}$		1.95	2.45	V
		$V_{GE} = 15\text{ V}$, $I_C = 15\text{ A}$, $T_J = 150\text{ °C}$		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	μA
I_{GES}	Gate-emitter leakage current	$V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$			± 500	nA
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$		985		pF
C_{oes}	Output capacitance			118		pF
C_{res}	Reverse transfer capacitance			40		pF
Q_g	Total gate charge	$V_{CC} = 960\text{ V}$, $I_C = 15\text{ A}$, $V_{GE} = \pm 15\text{ V}$		71		nC
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 600\text{ V}$, $I_C = 15\text{ A}$, $R_G = 22\ \Omega$, $V_{GE} = \pm 15\text{ V}$, $di/dt = 820\text{ A}/\mu\text{s}$		120		ns
t_r	Current rise time			14.5		ns
$E_{on}^{(1)}$	Turn-on switching energy				0.59	

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600\text{ V}$, $I_C = 15\text{ A}$, $R_G = 22\ \Omega$, $V_{GE} = \pm 15\text{ V}$, $dv/dt = 8200\text{ V}/\mu\text{s}$;		115		ns
t_f	Current fall time			84		ns
$E_{off(2)}$	Turn-off switching energy			0.83		mJ
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 600\text{ V}$, $I_C = 15\text{ A}$, $R_G = 22\ \Omega$, $V_{GE} = \pm 15\text{ V}$, $di/dt = 690\text{ A}/\mu\text{s}$, $T_J = 150\text{ }^\circ\text{C}$		122		ns
t_r	Current rise time			17		ns
$E_{on(1)}$	Turn-on switching energy			1.08		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600\text{ V}$, $I_C = 15\text{ A}$, $R_G = 22\ \Omega$, $V_{GE} = \pm 15\text{ V}$, $dv/dt = 7000\text{ V}/\mu\text{s}$, $T_J = 150\text{ }^\circ\text{C}$		122		ns
t_f	Current fall time			146		ns
$E_{off(2)}$	Turn-off switching energy			1.06		mJ
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			μs
R_{THj-c}	Thermal resistance junction to case	each IGBT		0.95	1.05	$^\circ\text{C}/\text{W}$
R_{THc-h}	Thermal resistance case to heatsink	each IGBT $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot^\circ\text{C})$		0.90		$^\circ\text{C}/\text{W}$

Notes:

(1) Including the reverse recovery of the diode.

(2) Including also the tail of the collector current.

1.1.2 DiodeLimiting values at $T_J = 25\text{ }^\circ\text{C}$, unless otherwise specified.**Table 4: Absolute maximum ratings of the diode, inverter stage**

Symbol	Parameter	Value	Unit
V_{RRM}	Repetitive peak reverse voltage	1200	V
I_F	Continuous forward current at ($T_C = 100\text{ }^\circ\text{C}$)	15	A
$I_{FF(1)}$	Pulsed forward current	30	A
T_{JMAX}	Maximum junction temperature	175	$^\circ\text{C}$
T_{Jop}	Operative temperature range under switching conditions	-40 to 150	$^\circ\text{C}$

Notes:

(1) Pulse width limited by maximum junction temperature.

Table 5: Electrical characteristics of the diode, inverter stage

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
V _F	Forward voltage	I _F = 15 A	-	3.0	3.8	V	
		I _F = 15 A, T _J = 150 °C	-	2.1			
t _{rr}	Reverse recovery time	I _F = 15 A, V _R = 600 V, V _{GE} = ±15 V, di _F /dt = 820 A/μs	-	190		ns	
Q _{rr}	Reverse recovery charge		-	1.45		μC	
I _{rrm}	Reverse recovery current		-	23		A	
E _{rec}	Reverse recovery energy		-	0.55		mJ	
t _{rr}	Reverse recovery time		-	400		ns	
Q _{rr}	Reverse recovery charge	I _F = 15 A, V _R = 600 V, V _{GE} = ±15 V, di _F /dt = 690 A/μs, T _J = 150 °C	-	2.75		μC	
			I _{rrm}	Reverse recovery current	-	25	
E _{rec}	Reverse recovery energy		-	1.2		mJ	
R _{THj-c}	Thermal resistance junction to case		Each diode	-	1.60	1.75	°C/W
R _{THc-h}	Thermal resistance case to heatsink		Each diode, λ _{grease} = 1 W/(m·°C)	-	1.15		°C/W

1.2 Brake stage

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

1.2.1 IGBT

Table 6: Absolute maximum ratings of the IGBT, brake stage

Symbol	Parameter	Value	Unit
V _{CES}	Collector-emitter voltage (V _{GE} = 0)	1200	V
I _C	Continuous collector current (T _c = 100 °C)	15	A
I _{CP} ⁽¹⁾	Pulsed collector current	30	A
V _{GE}	Gate-emitter voltage	±20	V
P _{TOT}	Total power dissipation	142.8	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 7: Electrical characteristics of the IGBT, brake stage

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
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15 \text{ V}$, $I_C = 15 \text{ A}$		1.95	2.45	V
		$V_{GE} = 15 \text{ V}$, $I_C = 15 \text{ A}$, $T_J = 150 \text{ }^\circ\text{C}$		2.3		
$V_{GE(th)}$	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	μA
I_{GES}	Gate-emitter leakage current	$V_{CE} = 0 \text{ V}$, $V_{GE} = \pm 20 \text{ V}$			± 500	nA
C_{ies}	Input capacitance	$V_{CE} = 25 \text{ V}$, $f = 1 \text{ MHz}$, $V_{GE} = 0 \text{ V}$		985		pF
C_{oes}	Output capacitance			118		pF
C_{res}	Reverse transfer capacitance			40		pF
Q_g	Total gate charge	$V_{CC} = 960 \text{ V}$, $I_C = 15 \text{ A}$, $V_{GE} = \pm 15 \text{ V}$		71		nC
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 600 \text{ V}$, $I_C = 15 \text{ A}$, $R_G = 22 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $di/dt = 820 \text{ A}/\mu\text{s}$		120		ns
t_r	Current rise time			14.5		ns
$E_{on(1)}$	Turn-on switching energy			0.59		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600 \text{ V}$, $I_C = 15 \text{ A}$, $R_G = 22 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $dv/dt = 8200 \text{ V}/\mu\text{s}$;		115		ns
t_f	Current fall time			84		ns
$E_{off(2)}$	Turn-off switching energy			0.83		mJ
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 600 \text{ V}$, $I_C = 15 \text{ A}$, $R_G = 22 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $di/dt = 690 \text{ A}/\mu\text{s}$, $T_J = 150 \text{ }^\circ\text{C}$		122		ns
t_r	Current rise time			17		ns
E_{on}	Turn-on switching energy			1.08		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600 \text{ V}$, $I_C = 15 \text{ A}$, $R_G = 22 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $dv/dt = 7000 \text{ V}/\mu\text{s}$, $T_J = 150 \text{ }^\circ\text{C}$		122		ns
t_f	Current fall time			146		ns
E_{off}	Turn-off switching energy			1.06		mJ
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			μs
R_{THj-c}	Thermal resistance junction to case	Each IGBT		0.95	1.05	$^\circ\text{C}/\text{W}$
R_{THc-h}	Thermal resistance case to heatsink	Each IGBT, $\lambda_{grease} = 1 \text{ W}/(\text{m}\cdot^\circ\text{C})$		0.90		$^\circ\text{C}/\text{W}$

Notes:

(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

1.2.2 Diode

Table 8: Absolute maximum ratings of the diode, brake stage

Symbol	Parameter	Value	Unit
V _{RRM}	Repetitive peak reverse voltage	1200	V
I _F	Continuous forward current at (T _C = 100 °C)	15	A
I _{FP} ⁽¹⁾	Pulsed forward current	30	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 9: Electrical characteristics of the diode, brake stage

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit		
V _F	Forward voltage	I _F = 15 A	-	3.0	3.8	V		
		I _F = 15 A, T _J = 150 °C	-	2.1				
t _{rr}	Reverse recovery time	I _F = 15 A, V _R = 600 V, V _{GE} = ±15 V, di/dt = 820 A/μs	-	190		ns		
Q _{rr}	Reverse recovery charge		-	1.45		μC		
I _{rrm}	Reverse recovery current		-	23		A		
E _{rec}	Reverse recovery energy		-	0.55		mJ		
t _{rr}	Reverse recovery time	I _F = 15 A, V _R = 600 V, V _{GE} = ±15 V, di/dt = 690 A/μs, T _J = 150 °C	-	400		ns		
			Q _{rr}	Reverse recovery charge	-	2.75		μC
			I _{rrm}	Reverse recovery current	-	25		A
			E _{rec}	Reverse recovery energy	-	1.2		mJ
R _{THj-c}	Thermal resistance junction to case	Each diode	-	1.60	1.75	°C/W		
R _{THc-h}	Thermal resistance case to heatsink	Each diode, λ _{grease} = 1 W/(m·°C)	-	1.15		°C/W		

1.3 Converter stage

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

Table 10: Absolute maximum ratings of the bridge rectifiers

Symbol	Description	Value	Unit
V _{RRM}	Repetitive peak reverse voltage	1600	V
I _F	RMS forward current	30	A
I _{FSM}	Forward surge current t _p = 10 ms, T _C = 25 °C	315	A
	Forward surge current t _p = 10 ms, T _C = 150 °C	250	
I ² t	t _p = 10 ms, T _C = 25 °C	496	A ² s
	t _p = 10 ms, T _C = 150 °C	312	
T _{JMAX}	Maximum junction temperature	175	°C
T _{Jop}	Operative temperature range under switching conditions	-40 to 150	°C

Table 11: Electrical characteristics of the bridge rectifiers

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V _F	Forward voltage	I _F = 15 A	-	1.0	1.4	V
		I _F = 15 A, T _J = 150 °C	-	0.9		
I _R	Reverse current	T _J = 150 °C, V _R = 1600 V	-	1		mA
R _{THj-c}	Thermal resistance junction to case	Each diode	-	1.20	1.35	°C/W
R _{THc-h}	Thermal resistance case to heatsink	Each diode, λ _{grease} = 1 W/(m·°C)	-	1.15		°C/W

1.4 NTC

Table 12: 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

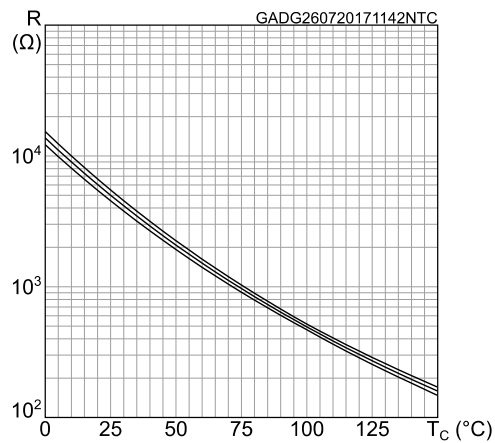
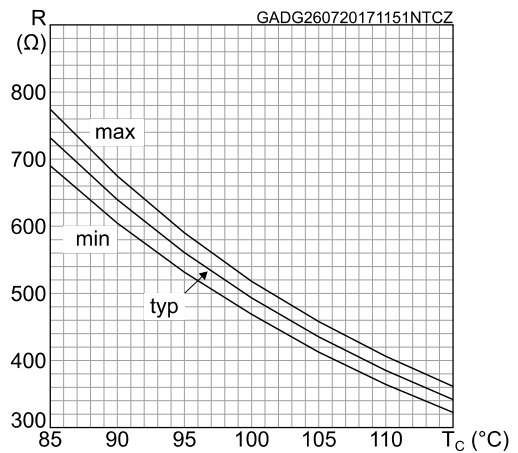


Figure 3: NTC resistance vs. temperature, zoom

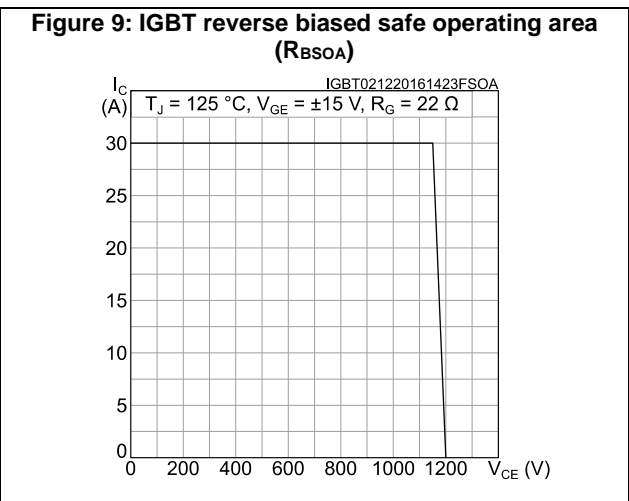
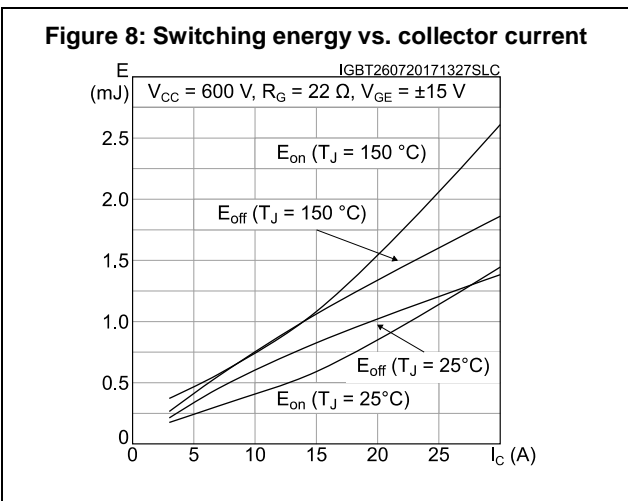
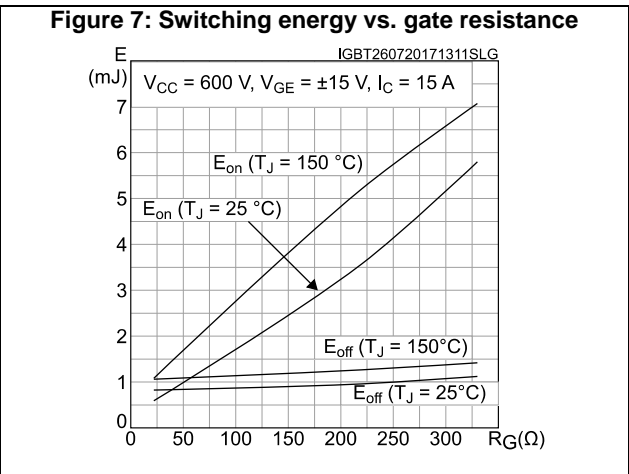
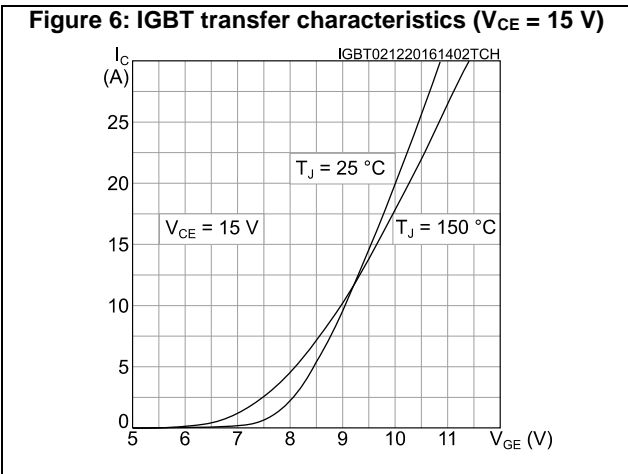
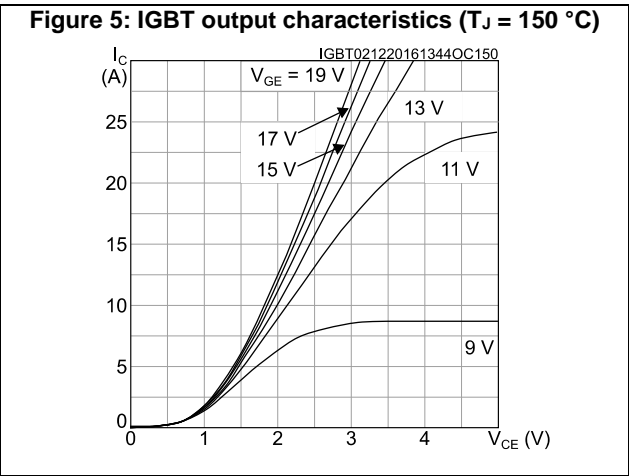
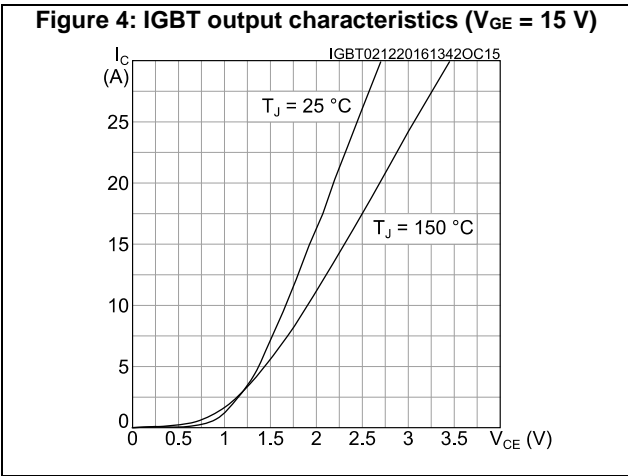


1.5 Package

Table 13: 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



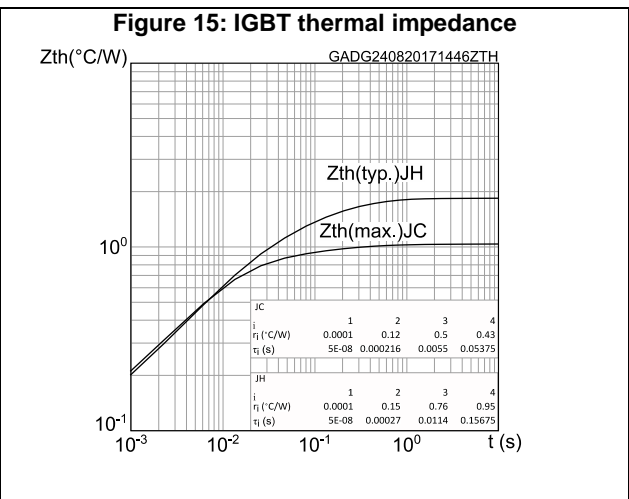
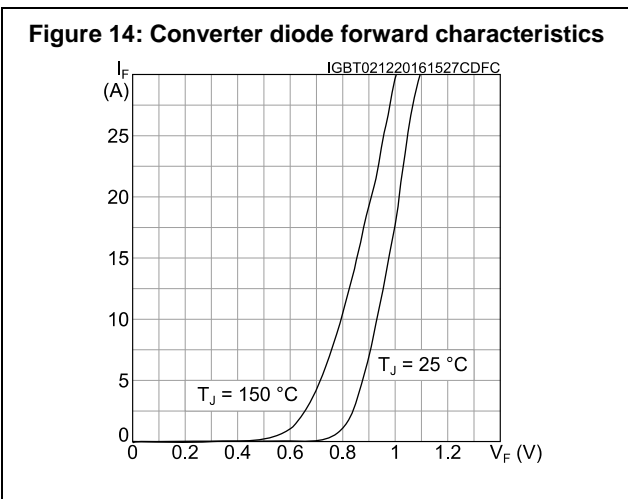
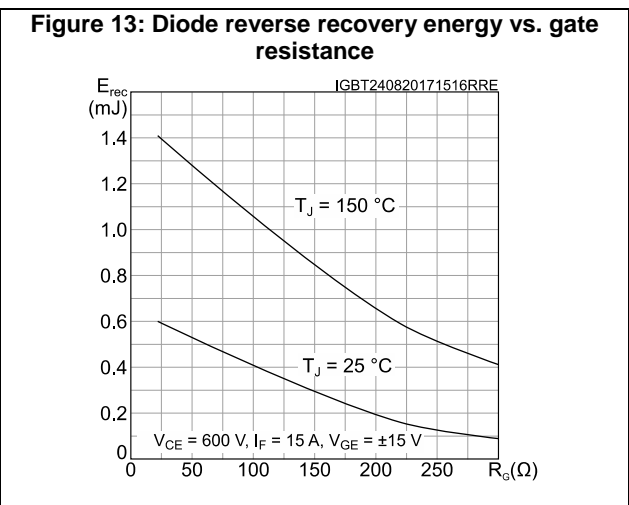
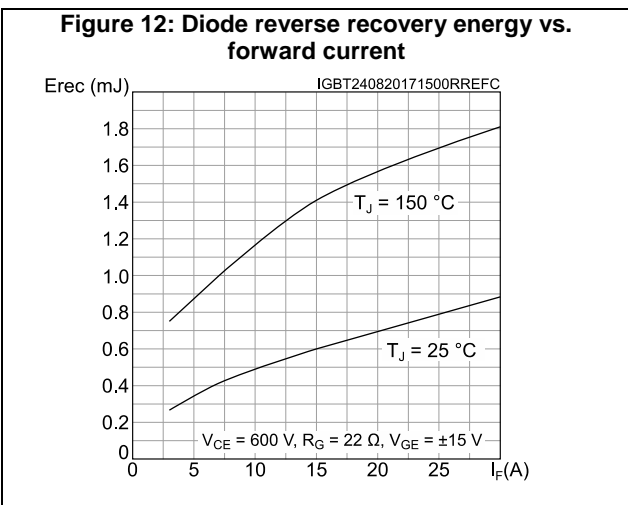
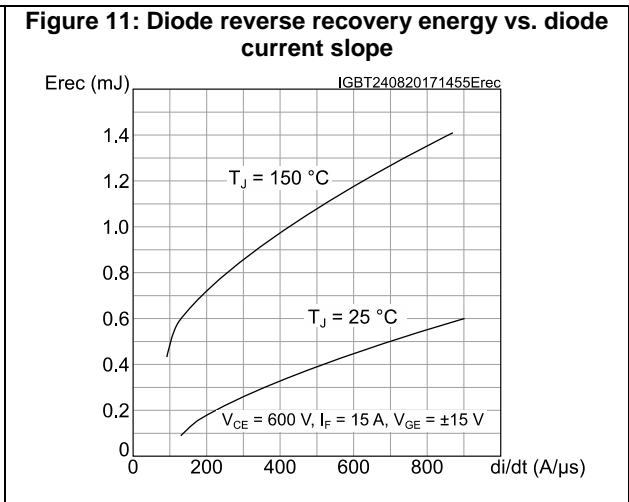
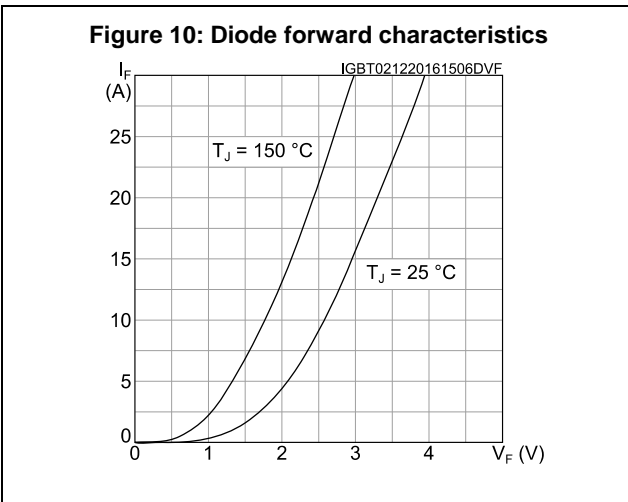
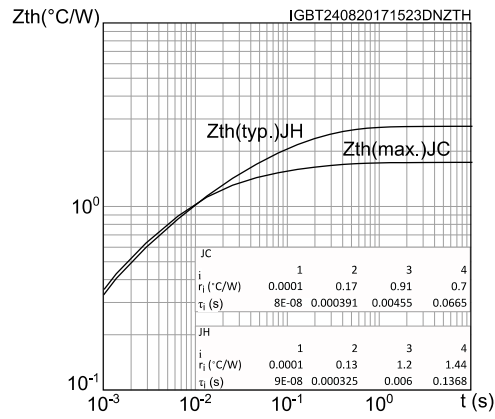
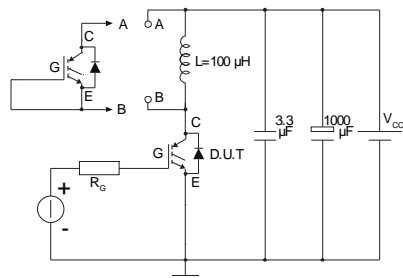


Figure 16: Inverter diode thermal impedance



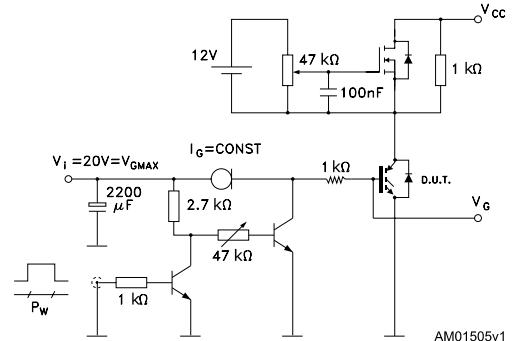
3 Test circuits

Figure 17: Test circuit for inductive load switching



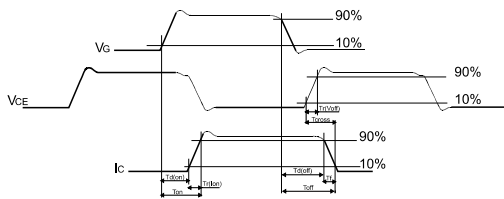
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Figure 18: Gate charge test circuit



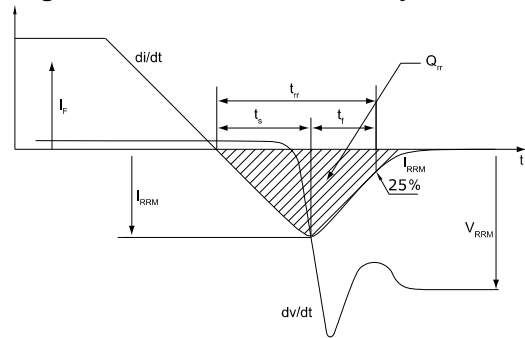
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Figure 19: Switching waveform



AM01506v1

Figure 20: Diode reverse recovery waveform



AM01507v1

4 Topology and pin description

Figure 21: Electrical topology and pin description

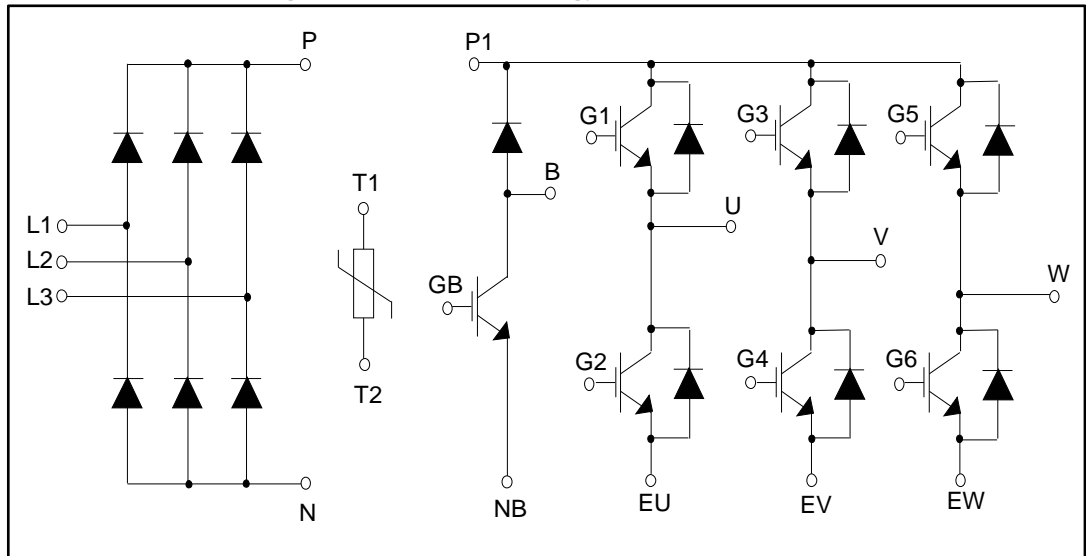
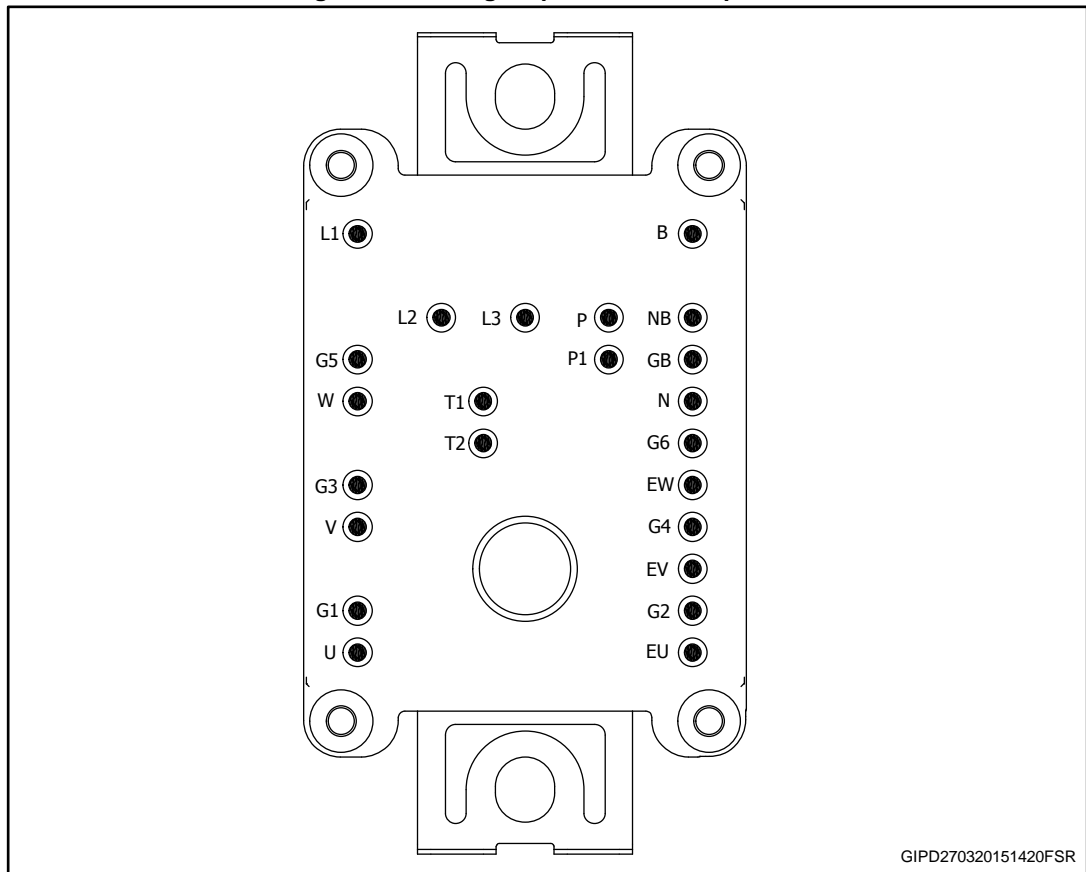


Figure 22: Package top view with CIB pinout



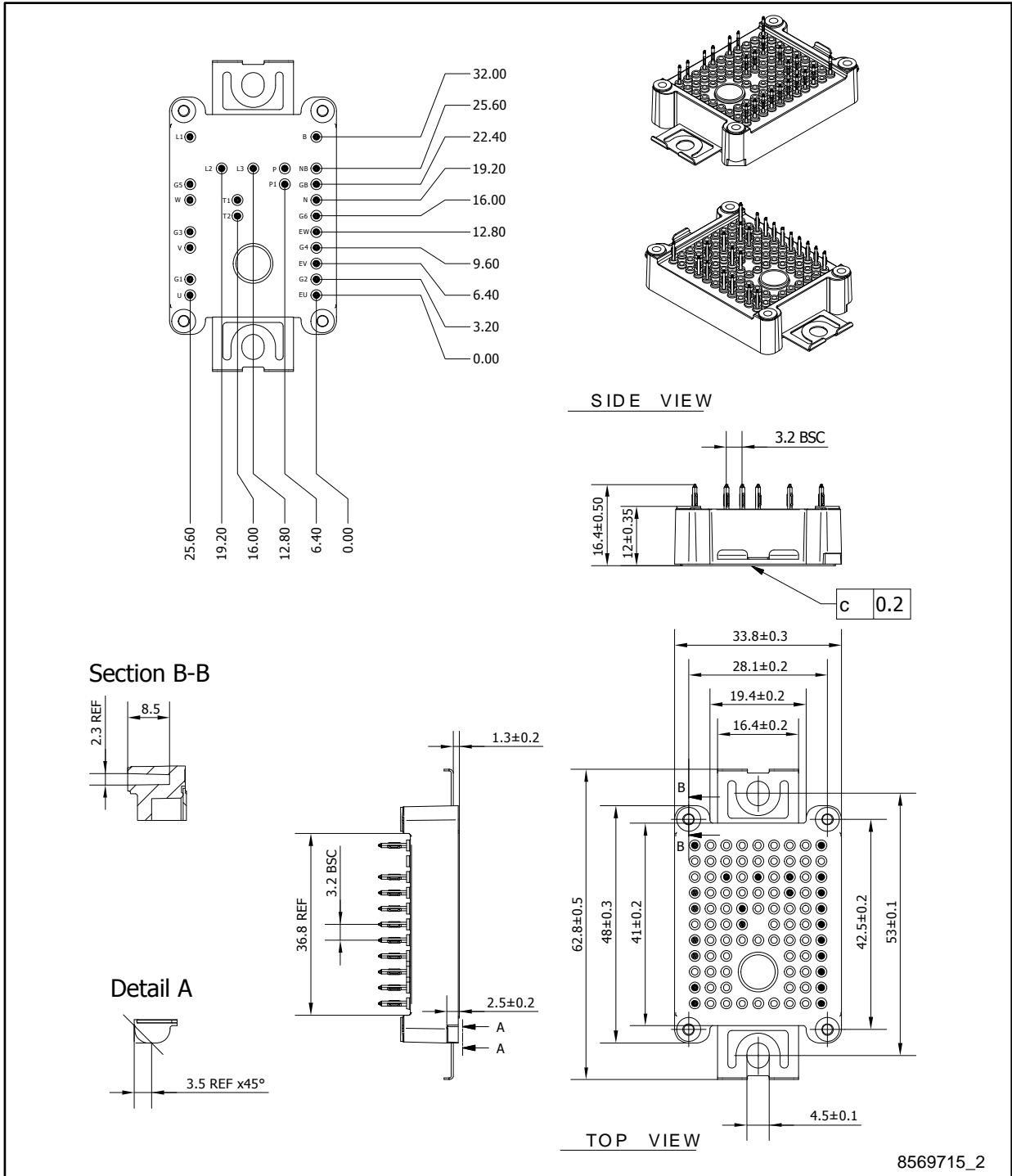
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5 Package information

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.

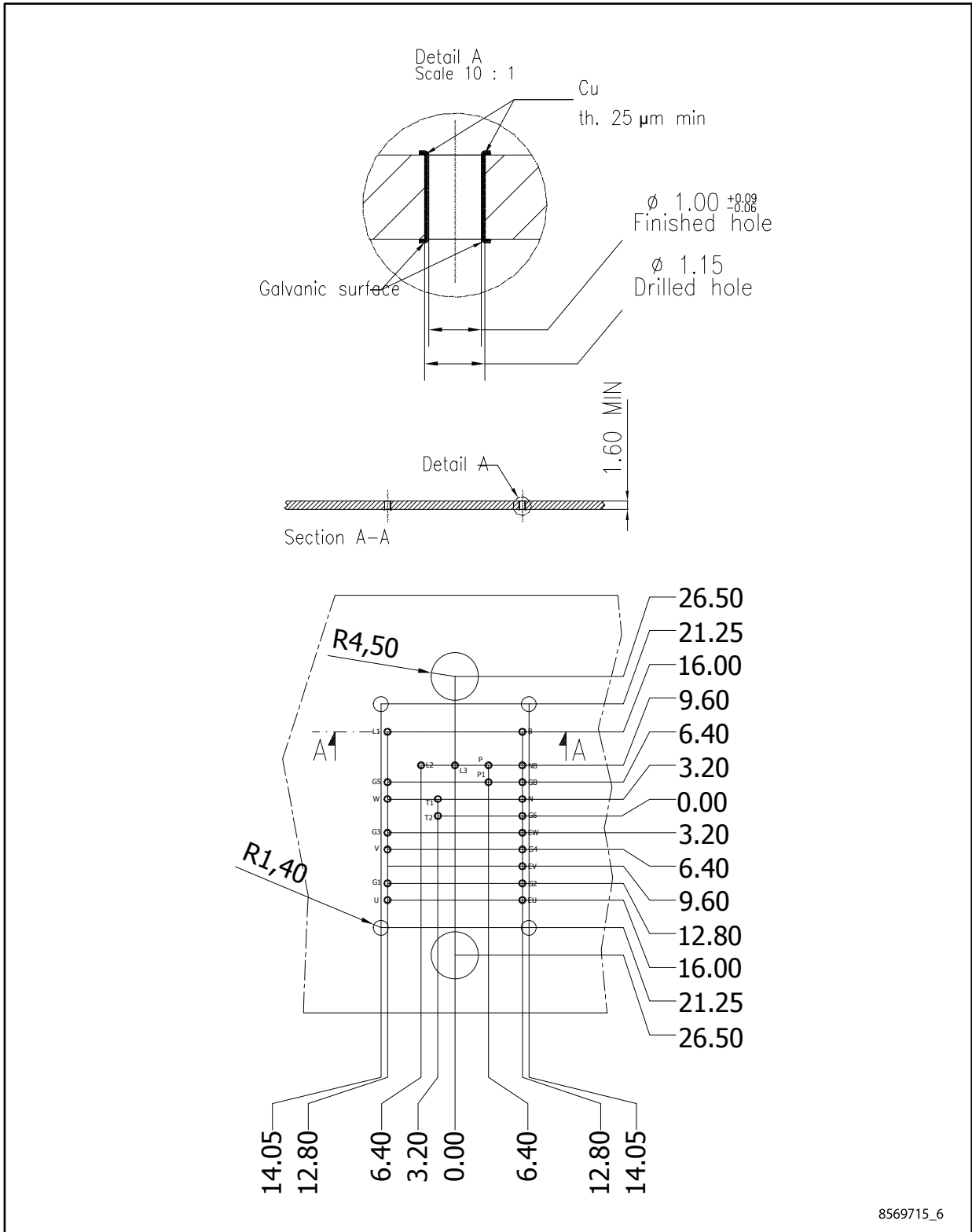
5.1 ACEPACK™ 1 CIB press fit pins package information

Figure 23: ACEPACK™ 1 CIB press fit package outline



- 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 24: ACEPACK™ 1 CIB press fit recommended PCB holes layout



8569715_6

6 Revision history

Table 14: Document revision history

Date	Revision	Changes
01-Feb-2016	1	Initial release.
03-Feb-2016	2	Updated <i>Table 3: "Electrical characteristics of the IGBTs, inverter stage"</i> . Minor text changes.
28-Jul-2017	3	Product status changed from preliminary to production data. Added <i>Electrical characteristics curves</i> . Minor text changes.
30-Aug-2017	4	Updated <i>Table 3: "Electrical characteristics of the IGBTs, inverter stage"</i> , <i>Table 5: "Electrical characteristics of the diode, inverter stage"</i> , <i>Table 7: "Electrical characteristics of the IGBT, brake stage"</i> , <i>Table 5: "Electrical characteristics of the diode, inverter stage"</i> , <i>Table 11: "Electrical characteristics of the bridge rectifiers"</i> , <i>Section 2: "Electrical characteristics curves"</i> . Minor text changes.
05-Oct-2017	5	Updated <i>Table 13: "ACEPACK™ 1 package"</i> , <i>Figure 15: "IGBT thermal impedance"</i> , <i>Figure 16: "Inverter diode thermal impedance"</i> and <i>Section 5.1: "ACEPACK™ 1 CIB press fit pins package information"</i> . Minor text changes.

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