

ACEPACK™ 2 converter inverter brake, 1200 V, 35 A trench gate field-stop IGBT M series, soft diode and NTC

Datasheet - preliminary data

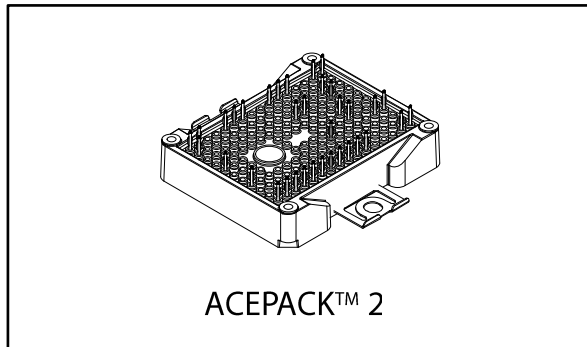
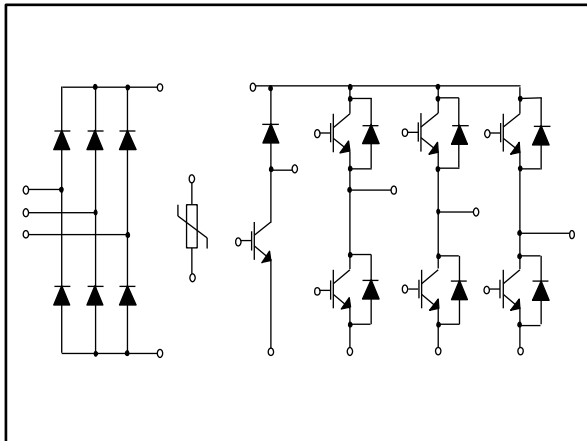


Figure 1: Internal electrical schematic



Features

- ACEPACK™ 2 power module
 - DBC Cu Al₂O₃ Cu
- Converter inverter brake topology
 - 1600 V, very low drop rectifiers for converter
 - 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
- Motor drives

Description

This power module is a converter-inverter brake (CIB) topology in an ACEPACK™ 2 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
A2C35S12M3-F	A2C35S12M3-F	ACEPACK™ 2	Press fit 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 $T_c = 100\text{ °C}$	35	A
$I_{CP}^{(1)}$	Pulsed collector current ($t_P = 1\text{ ms}$)	70	A
V_{GE}	Gate-emitter voltage	± 20	V
P_{TOT}	Total power dissipation IGBT ($T_{JMAX} = 175\text{ °C}$)	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 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	$V_{GE} = 15 \text{ V}, I_C = 35 \text{ A}$		1.95	2.45	V
		$V_{GE} = 15 \text{ V}, I_C = 35 \text{ A}, T_J = 150 \text{ }^\circ\text{C}$		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			2154		pF
C_{oes}	Output capacitance	$V_{CE} = 25 \text{ V}, f = 1 \text{ MHz}, V_{GE} = 0 \text{ V}$		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	$V_{CC} = 600 \text{ V}, I_C = 35 \text{ A}, R_G = 10 \text{ } \Omega, V_{GE} = \pm 15 \text{ V}, di/dt = 1460 \text{ A}/\mu\text{s}$		127		ns
t_r	Current rise time			18.5		ns
$E_{on}^{(1)}$	Turn-on switching energy			1.065		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600 \text{ V}, I_C = 35 \text{ A}, R_G = 10 \text{ } \Omega, V_{GE} = \pm 15 \text{ V}, dv/dt = 9000 \text{ V}/\mu\text{s};$		135		ns
t_f	Current fall time			133		ns
$E_{off}^{(2)}$	Turn-off switching energy			1.83		mJ
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 600 \text{ V}, I_C = 35 \text{ A}, R_G = 10 \text{ } \Omega, V_{GE} = \pm 15 \text{ V}, di/dt = 1424 \text{ A}/\mu\text{s}, T_J = 150 \text{ }^\circ\text{C}$		125		ns
t_r	Current rise time			20		ns
E_{on}	Turn-on switching energy			1.79		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600 \text{ V}, I_C = 35 \text{ A}, R_G = 10 \text{ } \Omega, V_{GE} = \pm 15 \text{ V}, dv/dt = 7500 \text{ V}/\mu\text{s}, T_J = 150 \text{ }^\circ\text{C}$		140		ns
t_f	Current fall time			224		ns
E_{off}	Turn-off switching energy			2.85		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		0.55	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		$^\circ\text{C}/\text{W}$

Notes:

(1) Including the reverse recovery of the diode.

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

1.1.2 Diode

Limiting values at $T_j = 25\text{ °C}$, 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 ($T_C = 100\text{ °C}$)	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, inverter stage

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward voltage	$I_F = 35\text{ A}$	-	2.95	4.1	V
		$I_F = 35\text{ A}, T_J = 150\text{ °C}$	-	2.3		
t_{rr}	Reverse recovery time	$I_F = 35\text{ A}, V_R = 600\text{ V},$ $V_{GE} = \pm 15\text{ V}, di_F/dt = 1460\text{ A}/\mu\text{s}$	-	200		ns
Q_{rr}	Reverse recovery charge		-	2.7		μC
I_{rrm}	Reverse recovery current		-	43		A
E_{rec}	Reverse recovery energy		-	1.1		mJ
t_{rr}	Reverse recovery time		$I_F = 35\text{ A}, V_R = 600\text{ V},$ $V_{GE} = \pm 15\text{ V}, di_F/dt = 1424\text{ A}/\mu\text{s},$ $T_J = 150\text{ °C}$	-	380	
Q_{rr}	Reverse recovery charge	-		6.8		μC
I_{rrm}	Reverse recovery current	-		60		A
E_{rec}	Reverse recovery energy	-		3.2		mJ
R_{THj-c}	Thermal resistance junction to case	Each diode	-	0.80	0.90	°C/W
R_{THc-h}	Thermal resistance case to heatsink	Each diode, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot\text{°C})$	-	0.75		°C/W

1.2 Brake stage

Limiting values at $T_j = 25\text{ °C}$, 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 ($T_c = 100\text{ °C}$)	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	$^{\circ}\text{C}$
T_{Jop}	Operative temperature range under switching conditions	-40 to 150	$^{\circ}\text{C}$

Notes:

⁽¹⁾Pulse width limited by maximum junction temperature.

Table 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	$V_{GE} = 15 \text{ V}$, $I_C = 35 \text{ A}$		1.95		V
		$V_{GE} = 15 \text{ V}$, $I_C = 35 \text{ A}$, $T_J = 150 \text{ }^\circ\text{C}$		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	$V_{CE} = 25 \text{ V}$, $f = 1 \text{ MHz}$, $V_{GE} = 0 \text{ V}$		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	$V_{CC} = 600 \text{ V}$, $I_C = 35 \text{ A}$, $R_G = 10 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $di/dt = 1460 \text{ A}/\mu\text{s}$		127		ns
t_r	Current rise time			18.5		ns
$E_{on(1)}$	Turn-on switching energy			1.065		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600 \text{ V}$, $I_C = 35 \text{ A}$, $R_G = 10 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $dv/dt = 9000 \text{ V}/\mu\text{s}$;		135		ns
t_f	Current fall time			133		ns
$E_{off(2)}$	Turn-off switching energy			1.83		mJ
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 600 \text{ V}$, $I_C = 35 \text{ A}$, $R_G = 10 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $di/dt = 1424 \text{ A}/\mu\text{s}$, $T_J = 150 \text{ }^\circ\text{C}$		125		ns
t_r	Current rise time			20		ns
E_{on}	Turn-on switching energy			1.79		mJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 600 \text{ V}$, $I_C = 35 \text{ A}$, $R_G = 10 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $dv/dt = 7500 \text{ V}/\mu\text{s}$, $T_J = 150 \text{ }^\circ\text{C}$		140		ns
t_f	Current fall time			224		ns
E_{off}	Turn-off switching energy			2.85		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		0.55	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		$^\circ\text{C}/\text{W}$

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 ($T_C = 100\text{ °C}$)	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 9: Electrical characteristics of the diode, brake stage

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward voltage	$I_F = 35\text{ A}$	-	2.95		V
		$I_F = 35\text{ A}, T_J = 150\text{ °C}$	-	2.3		
t_{rr}	Reverse recovery time	$I_F = 35\text{ A}, V_R = 600\text{ V}, V_{GE} = \pm 15\text{ V}, di/dt = 1460\text{ A}/\mu\text{s}$	-	200		ns
Q_{rr}	Reverse recovery charge		-	2.7		μC
I_{rrm}	Reverse recovery current		-	43		A
E_{rec}	Reverse recovery energy		-	1.1		mJ
t_{rr}	Reverse recovery time	$I_F = 35\text{ A}, V_R = 600\text{ V}, V_{GE} = \pm 15\text{ V}, di/dt = 1424\text{ A}/\mu\text{s}, T_J = 150\text{ °C}$	-	380		ns
	Reverse recovery charge		-	6.8		μC
	Reverse recovery current		-	60		A
	Reverse recovery energy		-	3.2		mJ
R_{THj-c}	Thermal resistance junction to case	Each diode	-	0.80	0.90	°C/W
R_{THc-h}	Thermal resistance case to heatsink	Each diode, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot\text{°C})$	-	0.95		°C/W

1.3 Converter stage

Limiting values at $T_j = 25\text{ °C}$, 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	70	A
I_{FSM}	Forward surge current $t_p = 10\text{ ms}$, $T_C = 25\text{ °C}$	450	A
	Forward surge current $t_p = 10\text{ ms}$, $T_C = 150\text{ °C}$	365	
I^2t	$t_p = 10\text{ ms}$, $T_C = 25\text{ °C}$	1012	A ² s
	$t_p = 10\text{ ms}$, $T_C = 150\text{ °C}$	666	
T_{JMAX}	Maximum junction temperature	175	°C
T_{Jop}	Operative temperature range under switching conditions	-40 to 150	°C

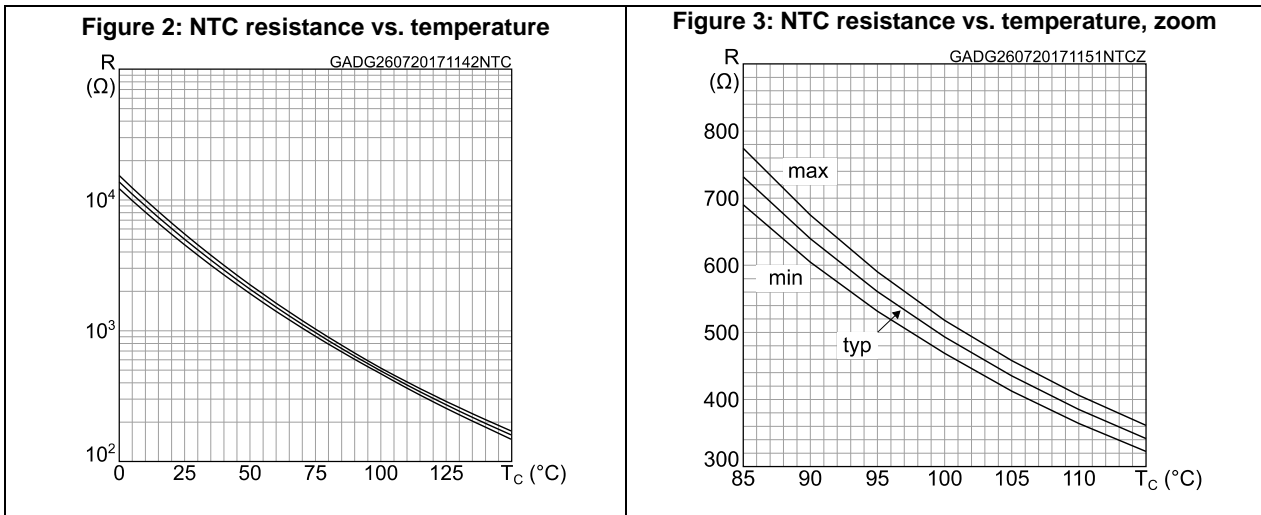
Table 11: Electrical characteristics of the bridge rectifiers

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward voltage	$I_F = 35\text{ A}$	-	1.0	1.4	V
		$I_F = 35\text{ A}$, $T_J = 150\text{ °C}$	-	0.9		
I_R	Reverse current	$T_J = 150\text{ °C}$, $V_R = 1600\text{ V}$	-	1		mA
R_{THj-c}	Thermal resistance junction to case	Each diode	-	1.00	1.10	°C/W
R_{THc-h}	Thermal resistance case to heatsink	Each diode, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot\text{°C})$	-	0.95		°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	$T = 25\text{ °C}$		5		k Ω
R_{100}	Resistance	$T = 100\text{ °C}$		493		Ω
$\Delta R/R$	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

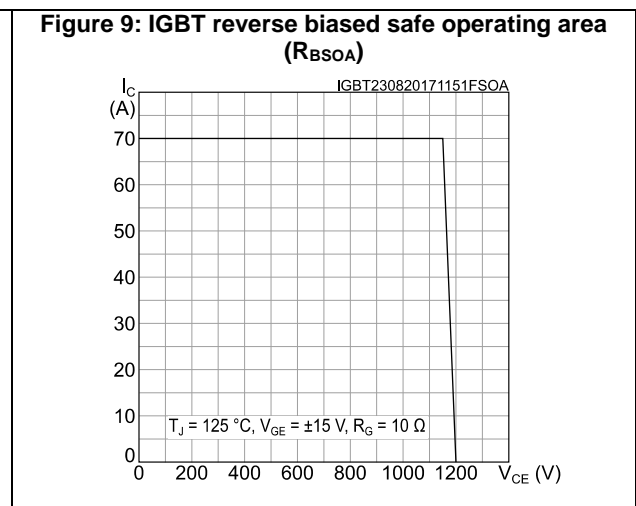
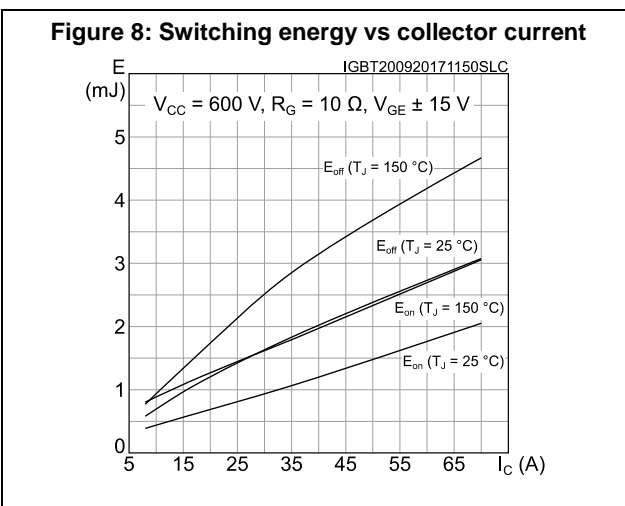
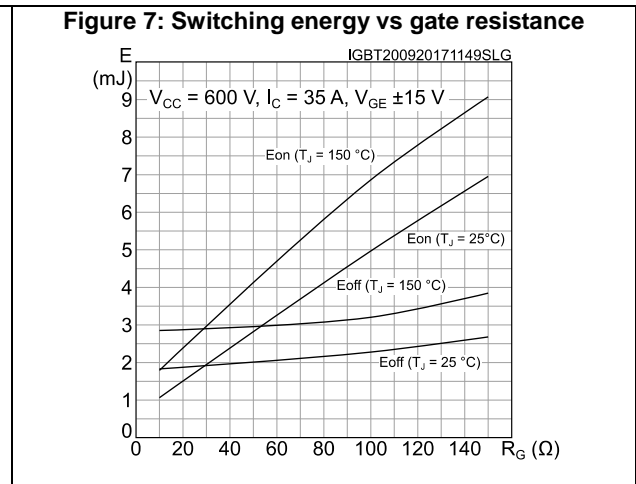
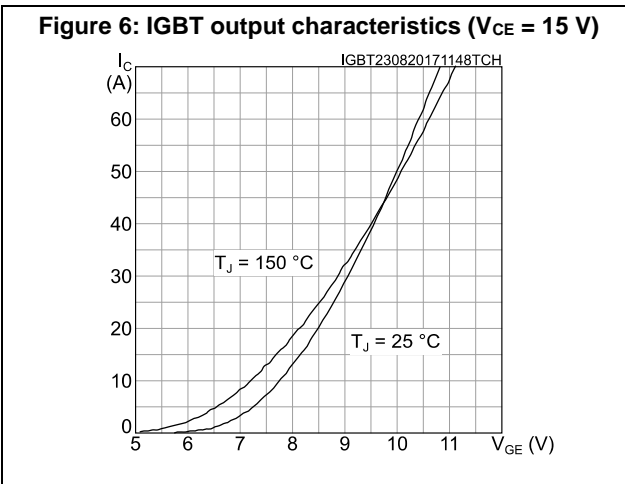
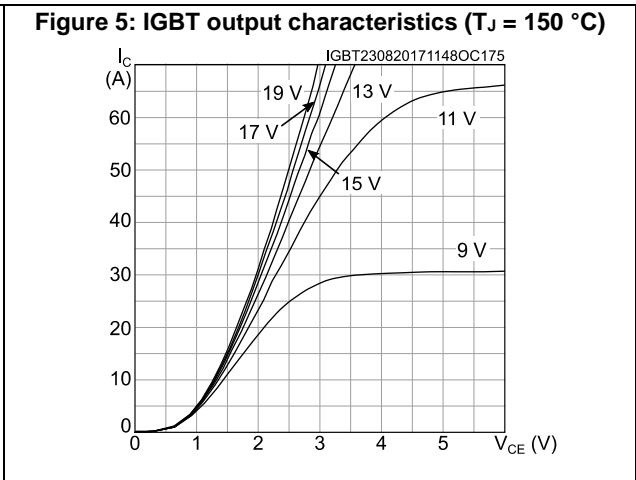
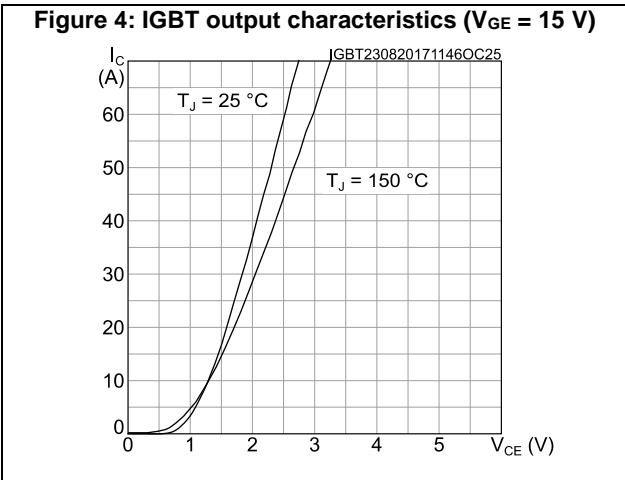


1.5 Package

Table 13: ACEPACK™ 2 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		33.5		nH
R _s	Module lead resistance, terminal to chip		3.6		mΩ

2 Electrical characteristics curves



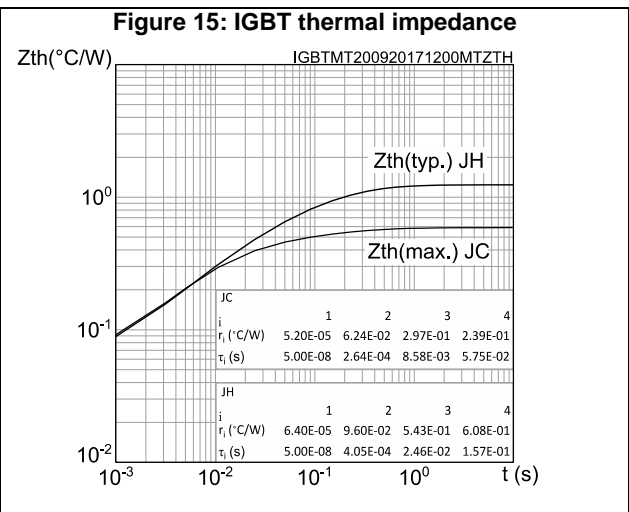
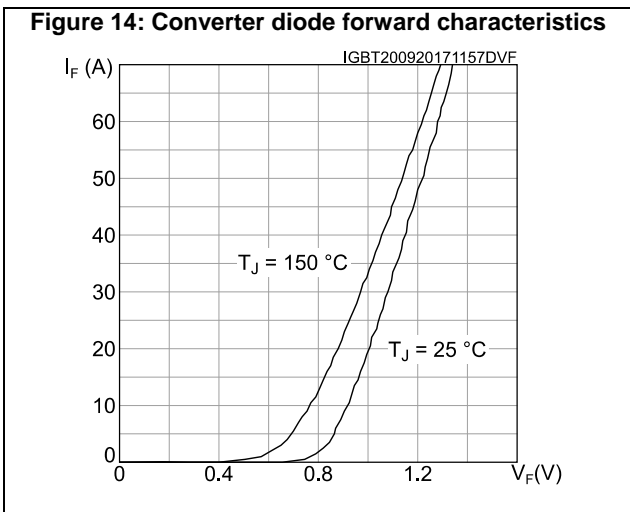
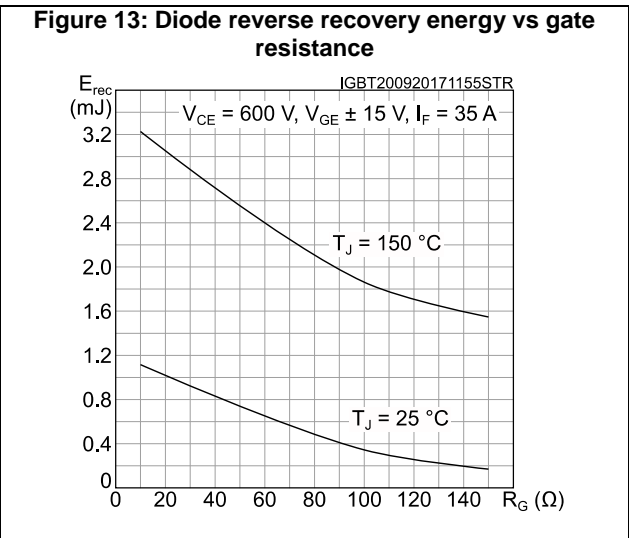
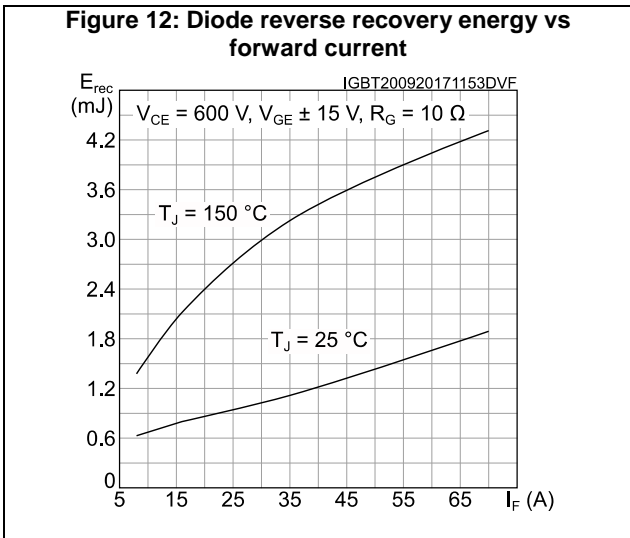
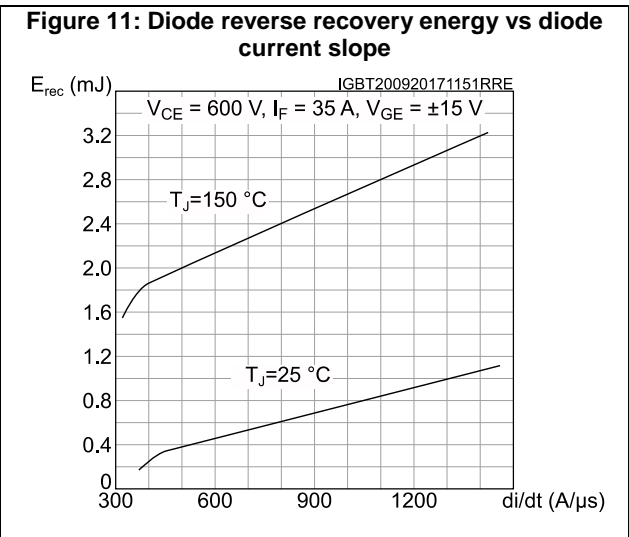
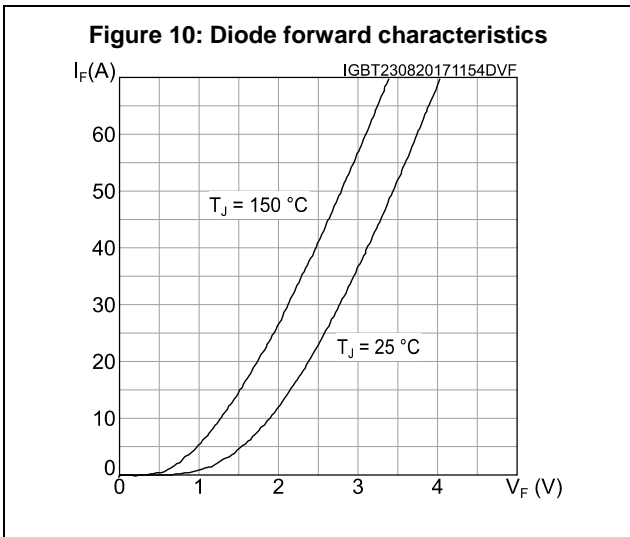
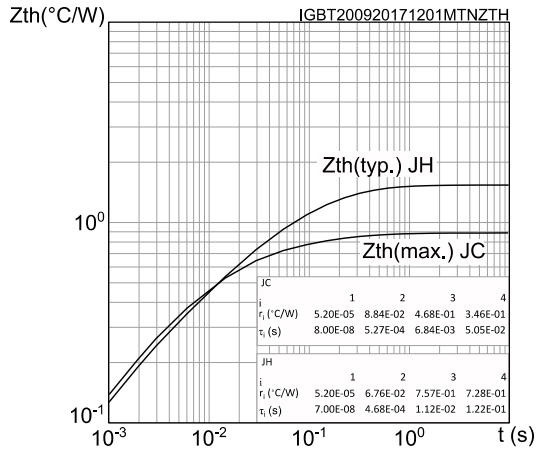
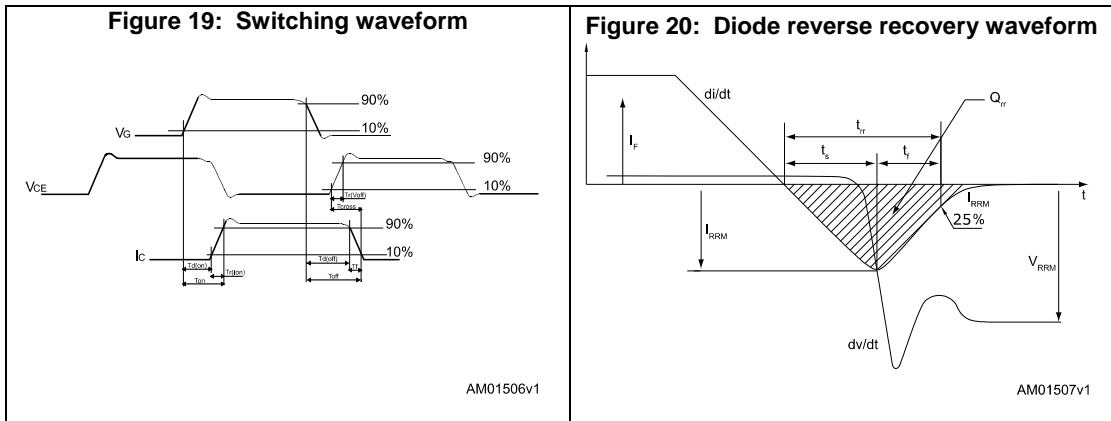
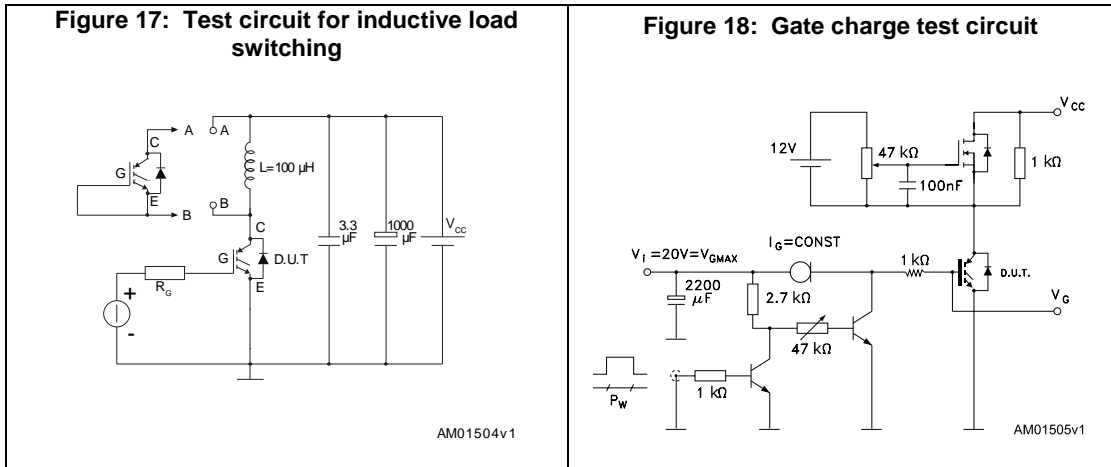


Figure 16: Inverter diode thermal impedance



3 Test circuits



4 Topology and pin description

Figure 21: Electrical topology and pin description

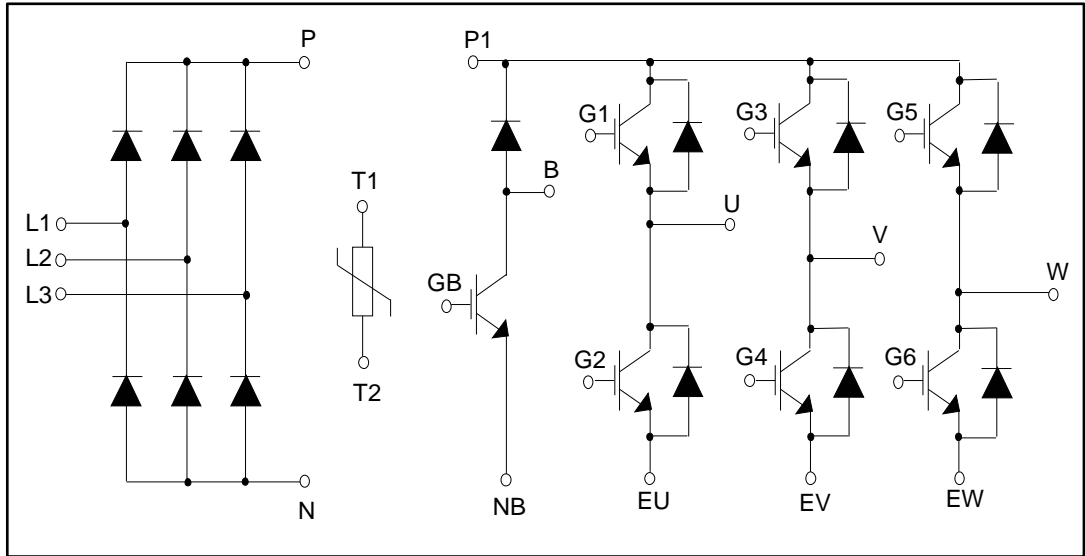
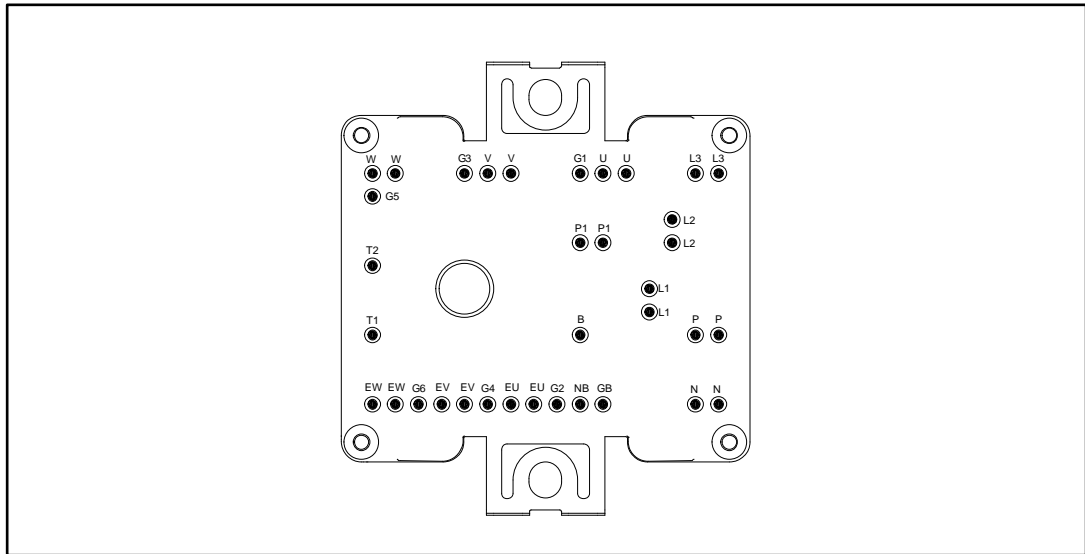


Figure 22: Package top view with CIB pinout

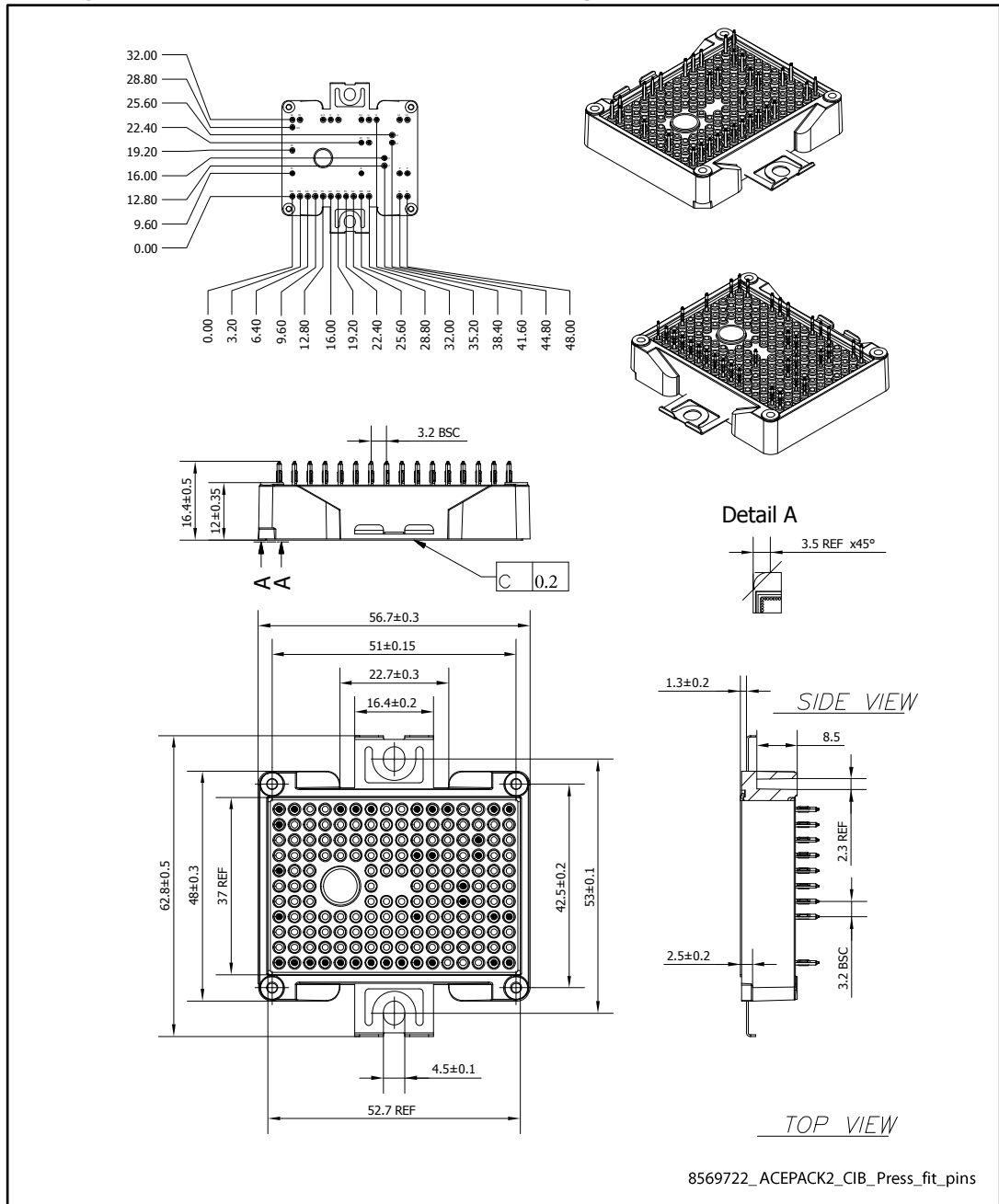


5 Package information

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.

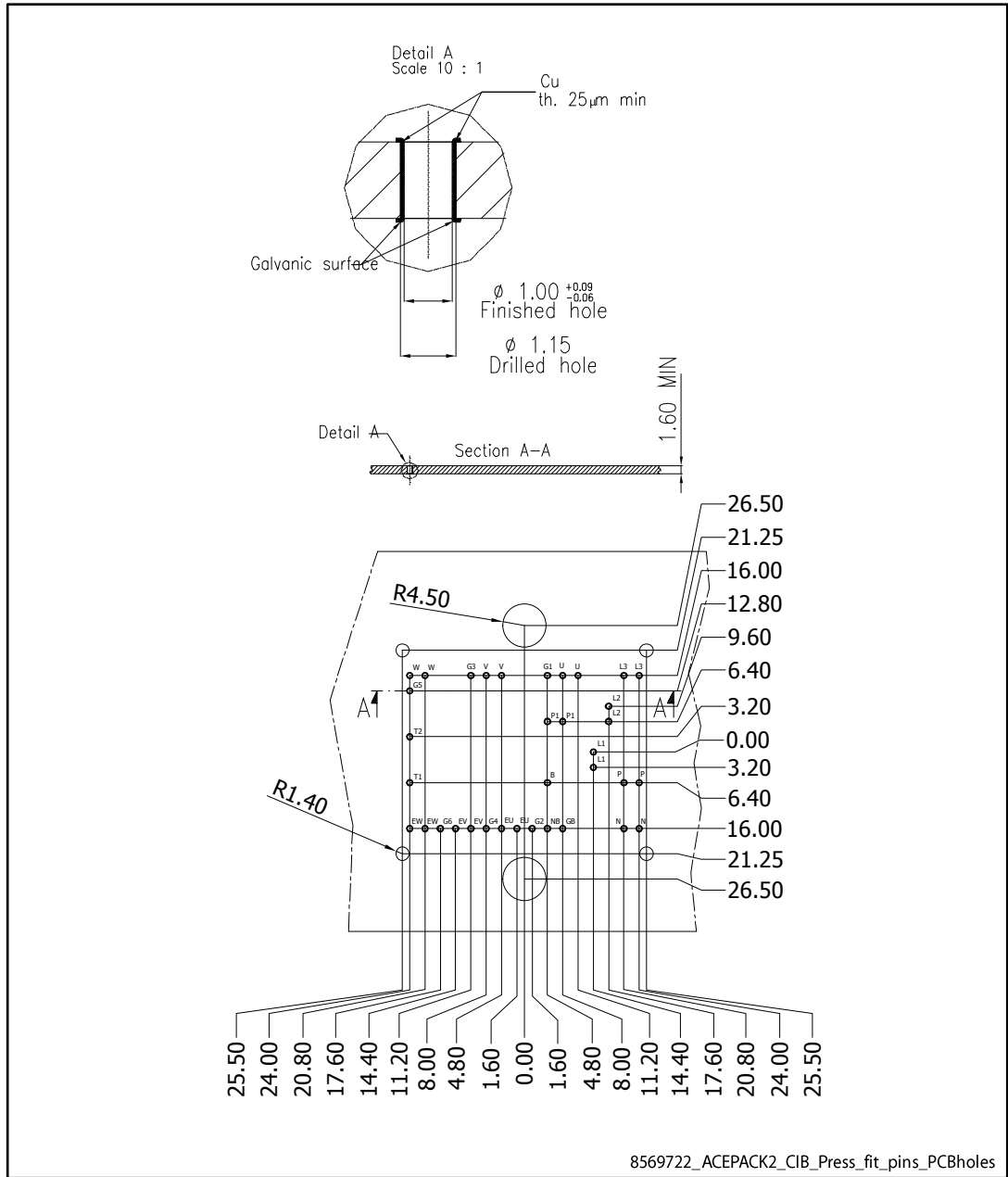
5.1 ACEPACK™ 2 CIB press fit pins package information

Figure 23: ACEPACK™ 2 CIB 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 24: ACEPACK™ 2 CIB press fit pins recommended PCB holes layout



6 Revision history

Table 14: Document revision history

Date	Revision	Changes
03-May-2016	1	Initial release.
22-Sep-2017	2	Updated title, features and description in cover page. Updated Table 1: "Device summary" , Section 1: "Electrical ratings" , Section 2: "Electrical characteristics curves" , Section 4: "Topology and pin description" and Section 5: "Package information" . Minor text changes.

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