A2C25S12M3

ACEPACK™ 2 converter inverter brake, 1200 V, 25 A trench gate field-stop IGBT M series, soft diode and NTC

Datasheet - preliminary data

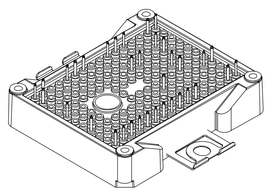
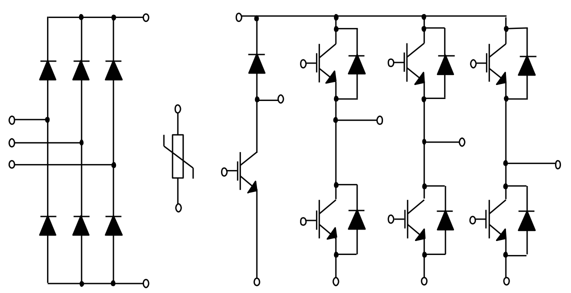


Figure 1: Internal electrical schematic



Features

- ACEPACK™ 2 power module
  - DBC Cu Al_2O_3 Cu
- Converter inverter brake topology
  - 1600 V, very low drop rectifiers for converter
  - 1200 V, 25 A IGBTs and diodes
  - $V_{CE(sat)}$: 1.95 V @ I_C = 25 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
A2C25S12M3	A2C25S12M3	ACEPACK™ 2	Solder contact pins

This is preliminary information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

Contents

1 Electrical ratings

1.1 Inverter stage

Limiting values at T_j= 25 °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 °C	25	A
I_{CP}[(1)]	Pulsed collector current (t_P = 1 ms)	50	A
V_{GE}	Gate-emitter voltage	± 20	V
P_{TOT}	Total power dissipation IGBT (T_{JMAX} = 175 °C)	197	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 mA, V_{GE} = 0 V	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C= 25 A		1.95	2.45	V
		V_{GE} = 15 V, I_C = 25 A, T_J = 150 °C		2.3		V
$V_{GE(th)}$	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		1550		pF
C_{oes}	Output capacitance			130		pF
C_{res}	Reverse transfer capacitance			65		pF
Q_g	Total gate charge	V_{CC} = 960 V, I_C = 25 A, V_{GE} = ±15 V		80		nC
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, I_C = 25 A, R_G = 15 Ω, V_{GE} = ±15 V, di/dt = 1290 A/µs		109		ns
t_r	Current rise time			15.3		ns
E_{on} (1)	Turn-on switching energy			0.97		mJ
$t_{d(off)}$	Turn-off delay time	V_{CC} = 600 V, I_C = 25 A, R_G = 15 Ω, V_{GE} = ±15 V, dv/dt = 9600 V/µs		109		ns
t_f	Current fall time			132		ns
E_{off} (2)	Turn-off switching energy			1.36		mJ
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, I_C = 25 A, R_G = 15 Ω, V_{GE} = ±15 V, di/dt = 1274 A/µs, T_J = 150 °C		109		ns
t_r	Current rise time			16.2		ns
E_{on}	Turn-on switching energy			1.49		mJ
$t_{d(off)}$	Turn-off delay time	V_{CC} = 600 V, I_C = 25 A, R_G = 15 Ω, V_{GE} = ±15 V, dv/dt = 8200 V/µs, T_J = 150 °C		122		ns
t_f	Current fall time			216		ns
E_{off}	Turn-off switching energy			1.85		mJ
t_{SC}	Short-circuit withstand time	V_{CC} ≤ 600V, V_{GE} ≤ 15 V, T_{jstart} ≤ 150 °C	10			µs
R_{THj-c}	Thermal resistance junction to case	each IGBT		0.69	0.76	°C/W
R_{THc-h}	Thermal resistance case to heatsink	each IGBT, λ_{grease} = 1 W/(m·°C)		0.79		°C/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 °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 °C)	25	A
I_{FP}(1)	Pulsed forward current	50	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 = 25 A	-	2.95	4.1	V
		I_F = 25 A, T_J = 150 °C	-	2.3		
t_{rr}	Reverse recovery time	I_F = 25 A, V_R = 600 V, V_{GE} = ±15 V, di_F/dt = 1290 A/µs	-	190		ns
Q_{rr}	Reverse recovery charge		-	1.53		µC
I_{rrm}	Reverse recovery current		-	29		A
E_{rec}	Reverse recovery energy		-	0.74		mJ
t_{rr}	Reverse recovery time	I_F = 25 A, V_R = 600 V, V_{GE} = ±15 V, di_F/dt = 1274 A/µs, T_J = 150 °C	-	378		ns
Q_{rr}	Reverse recovery charge		-	4.43		µC
I_{rrm}	Reverse recovery current		-	41		A
E_{rec}	Reverse recovery energy		-	2.33		mJ
R_{THj-c}	Thermal resistance junction to case	Each diode	-	1.05	1.16	°C/W
R_{THc-h}	Thermal resistance case to heatsink	Each diode, λ_{grease} = 1 W/(m·°C)	-	0.85		°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)	25	A
I_{CP}[(1)]	Pulsed collector current	50	A
V_{GE}	Gate-emitter voltage	±20	V
P_{TOT}	Total power dissipation	197	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 mA, V_{GE} = 0 V	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 25 A		1.95		V
		V_{GE} = 15 V, I_C = 25 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		1550		pF
C_{oes}	Output capacitance			130		pF
C_{res}	Reverse transfer capacitance			65		pF
Q_g	Total gate charge	V_{CC} = 960 V, I_C = 25 A, V_{GE} = ±15 V		80		nC
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, I_C = 25 A, R_G = 15 Ω, V_{GE} = ±15 V, di/dt = 1290 A/µs		109		ns
t_r	Current rise time			15.3		ns
E_{on}(1)	Turn-on switching energy			0.97		mJ
$t_{d(off)}$	Turn-off delay time	V_{CC} = 600 V, I_C = 25 A, R_G = 15 Ω, V_{GE} = ±15 V, dv/dt = 9600 V/µs		109		ns
t_f	Current fall time			132		ns
E_{off}(2)	Turn-off switching energy			1.36		mJ
$t_{d(on)}$	Turn-on delay time	V_{CC} = 600 V, I_C = 25 A, R_G = 15 Ω, V_{GE} = ±15 V, di/dt = 1274 A/µs, T_J = 150 °C		109		ns
t_r	Current rise time			16.2		ns
E_{on}	Turn-on switching energy			1.49		mJ
$t_{d(off)}$	Turn-off delay time	V_{CC} = 600 V, I_C = 25 A, R_G = 15 Ω, V_{GE} = ±15 V, dv/dt = 8200 V/µs, T_J = 150 °C		122		ns
t_f	Current fall time			216		ns
E_{off}	Turn-off switching energy			1.85		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		0.69	0.76	°C/W
R_{THc-h}	Thermal resistance case to heatsink	Each IGBT, λ_{grease} = 1 W/(m·°C)		0.79		°C/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)	25	A
I_{FP}[(1)]	Pulsed forward current	50	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 = 25 A	-	2.95		V
		I_F = 25 A, T_J = 150 °C	-	2.3		
t_{rr}	Reverse recovery time	I_F = 25 A, V_R = 600 V, V_{GE} = ±15 V, di/dt = 1290 A/µs	-	190		ns
Q_{rr}	Reverse recovery charge		-	1.53		µC
I_{rrm}	Reverse recovery current		-	29		A
E_{rec}	Reverse recovery energy		-	0.74		mJ
t_{rr}	Reverse recovery time	I_F = 25 A, V_R = 600 V, V_{GE} = ±15 V, di/dt = 1274 A/µs, T_J = 150 °C	-	378		ns
Q_{rr}	Reverse recovery charge		-	4.43		µC
I_{rrm}	Reverse recovery current		-	41		A
E_{rec}	Reverse recovery energy		-	2.33		mJ
R_{THj-c}	Thermal resistance junction to case	Each diode	-	1.05	1.16	°C/W
R_{THc-h}	Thermal resistance case to heatsink	Each diode, λ_{grease} = 1 W/(m·°C)	-	0.85		°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	50	A
I_{FSM}	Forward surge current tp = 10 ms, T_C = 25 °C	450	A
	Forward surge current tp = 10 ms, T_C = 150 °C	365	
I^2t	tp = 10 ms, T_C = 25 °C	1012	A^2s
	tp = 10 ms, T_C = 150 °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 = 25 A	-	1.0	1.4	V
		I_F = 25 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	-	1.00	1.10	°C/W
R_{THc-h}	Thermal resistance case to heatsink	Each diode, λ_{grease} = 1 W/(m·°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 °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

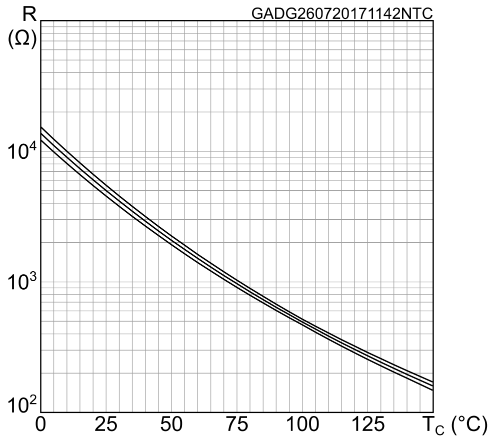
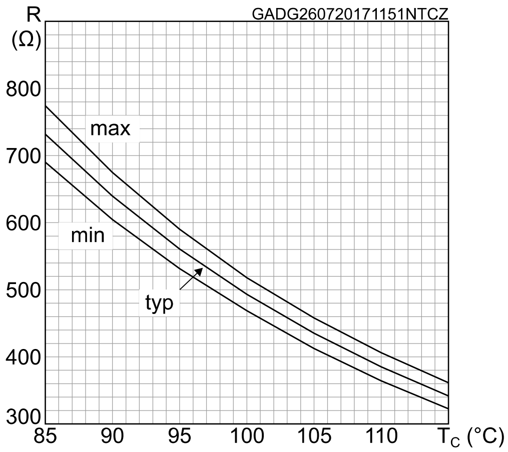


Figure 3: NTC resistance vs. temperature, zoom



1.5 Package

Table 13: ACEPACK™ 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 4: IGBT output characteristics (V_{GE} = 15 V)

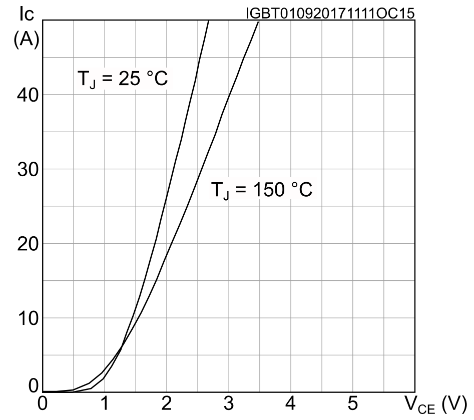


Figure 5: IGBT output characteristics (T_J = 150 °C)

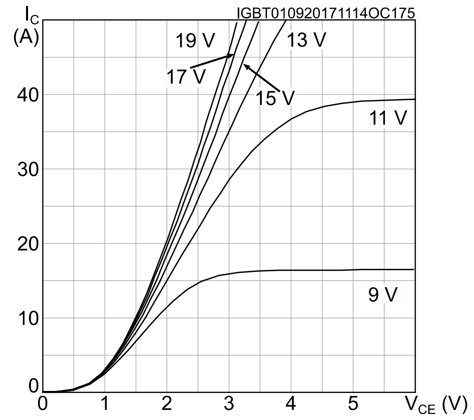


Figure 6: IGBT output characteristics (V_{CE} = 15 V)

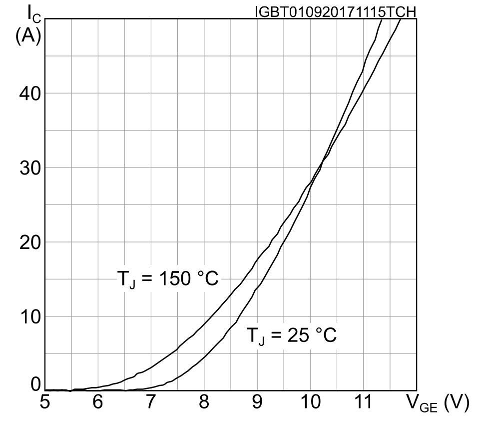


Figure 7: Switching energy vs gate resistance

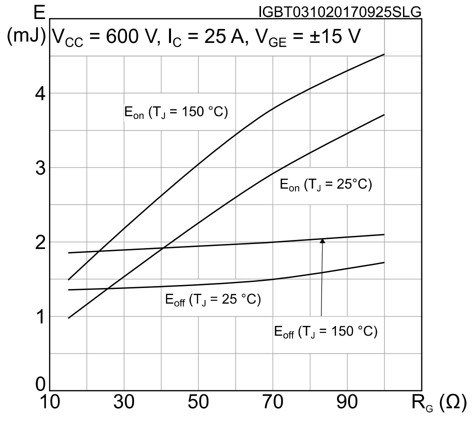


Figure 8: Switching energy vs collector current

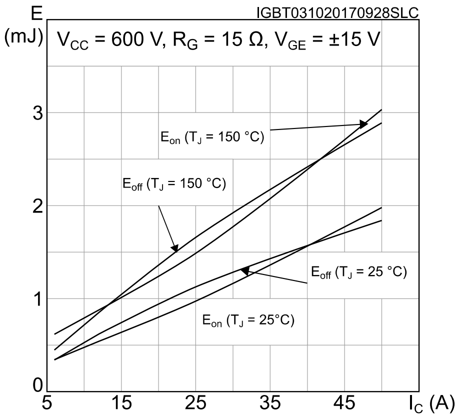


Figure 9: IGBT reverse biased safe operating area (R_{BSOA})

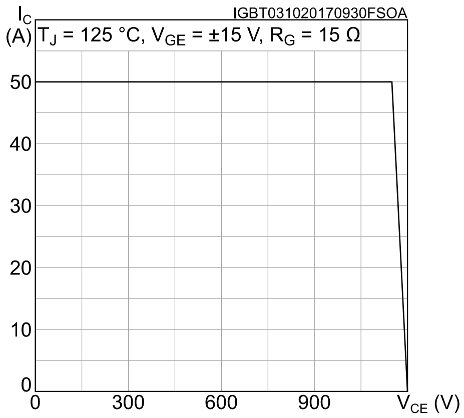


Figure 10: Diode forward characteristics

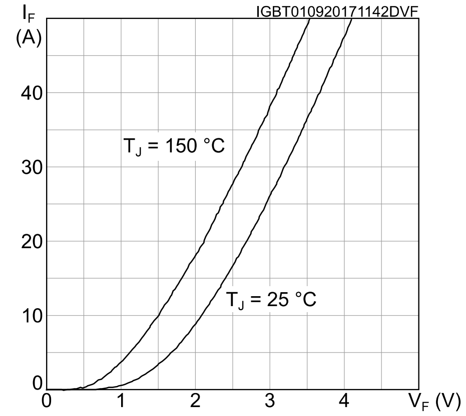


Figure 11: Diode reverse recovery energy vs diode current slope

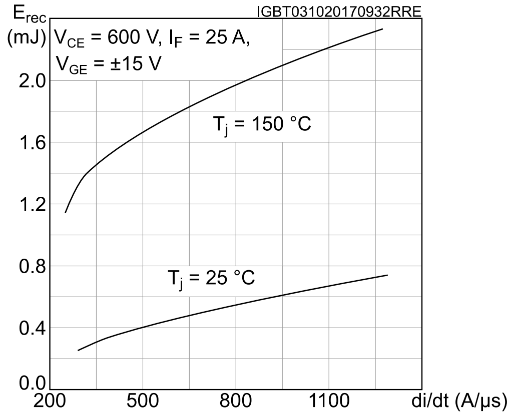


Figure 12: Diode reverse recovery energy vs forward current

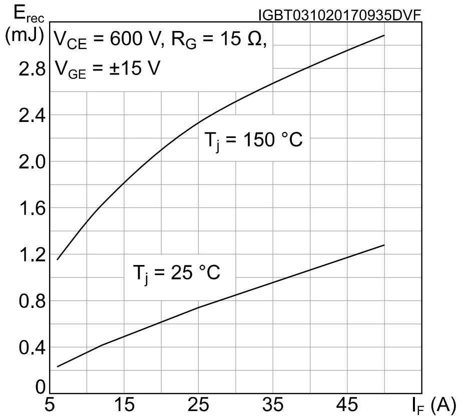


Figure 13: Diode reverse recovery energy vs gate resistance

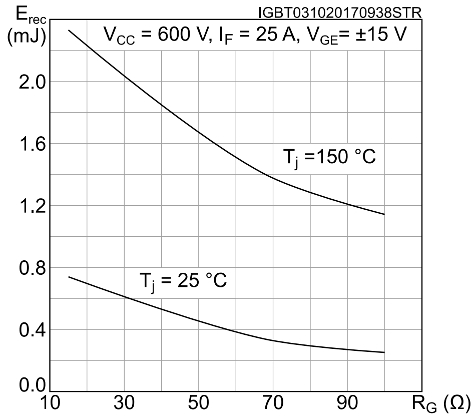


Figure 14: Converter diode forward characteristics

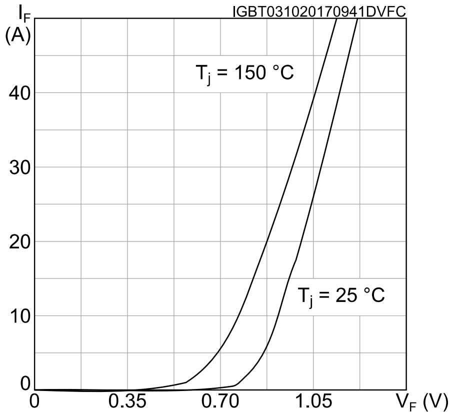


Figure 15: IGBT thermal impedance

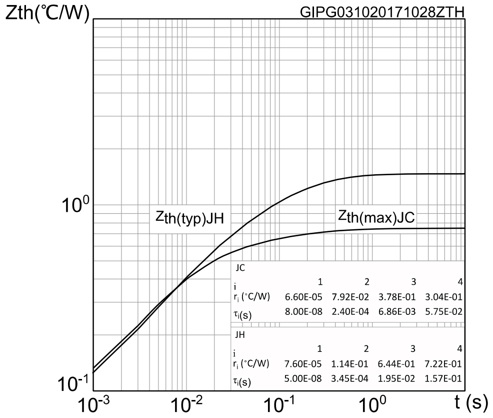
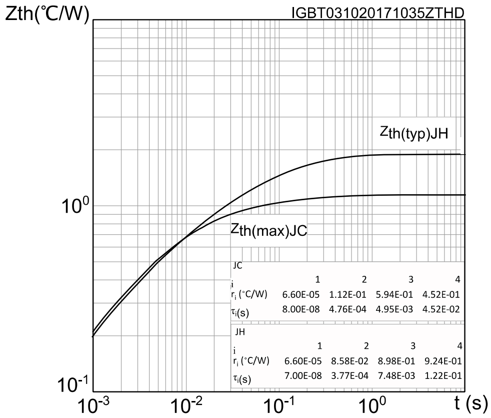


Figure 16: Inverter diode thermal impedance



3 Test circuits

Figure 17: Test circuit for inductive load switching

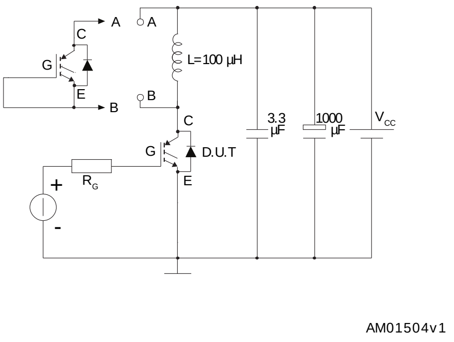


Figure 18: Gate charge test circuit

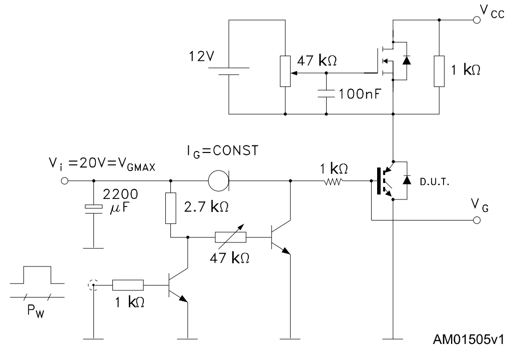


Figure 19: Switching waveform

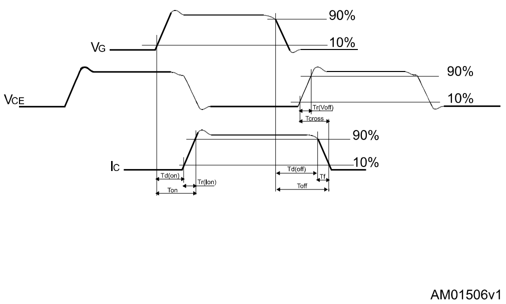
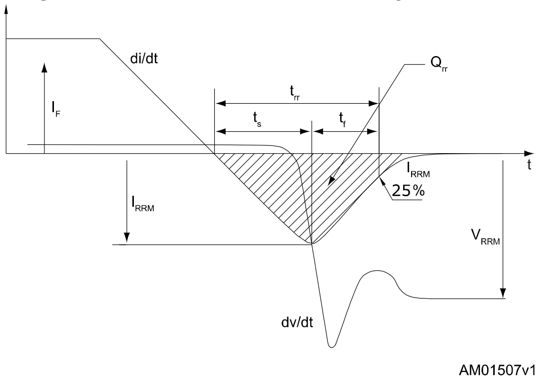


Figure 20: Diode reverse recovery waveform



4 Topology and pin description

Figure 21: Electrical topology and pin description

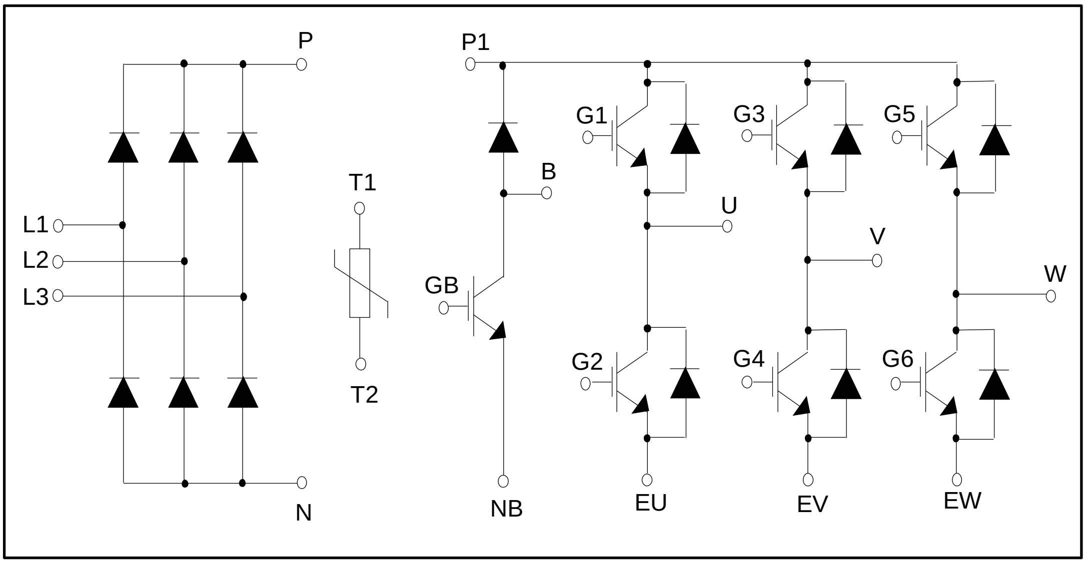
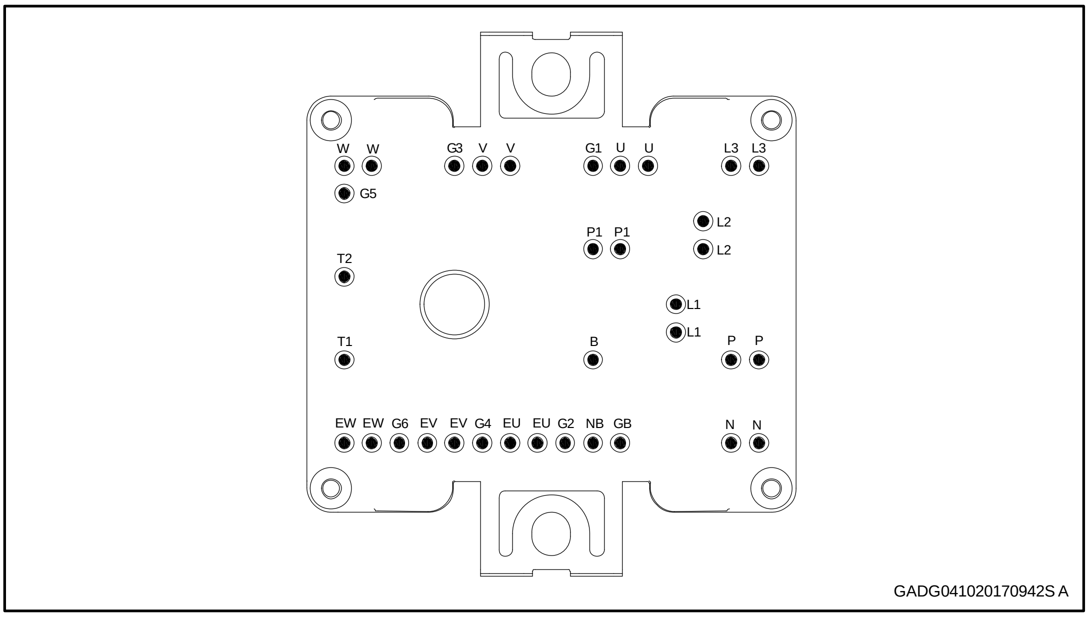


Figure 22: Package top view with CIB pinout

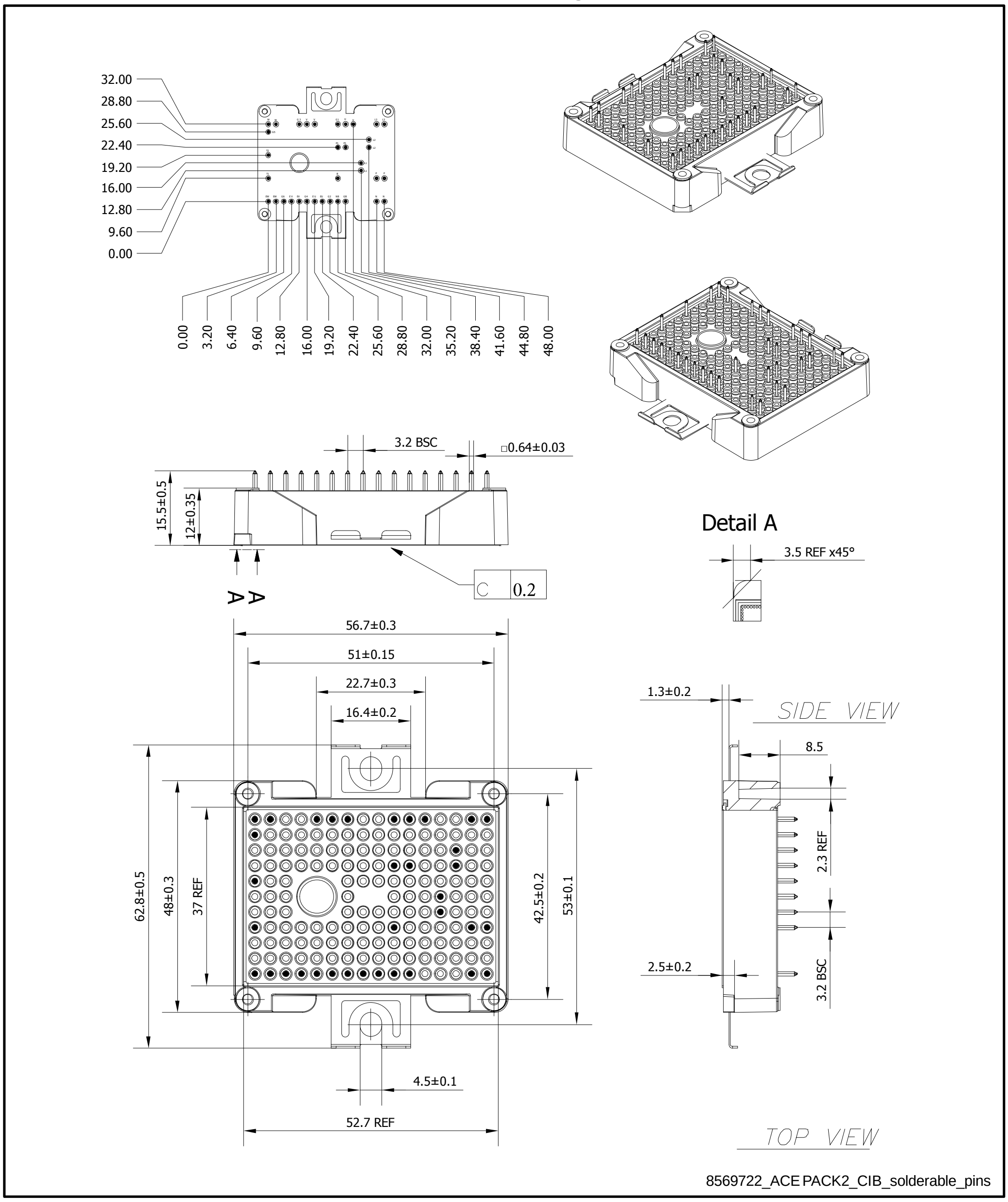


5 Package information

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 solder pins package information

Figure 23: ACEPACK™ 2 CIB 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.

6 Revision history

Table 14: Document revision history

Date	Revision	Changes
02-Oct-2017	1	Initial release.