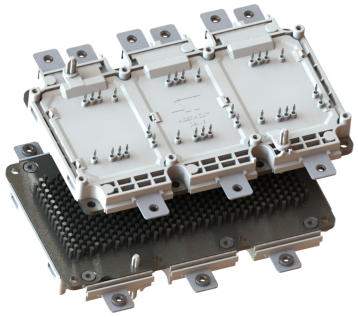
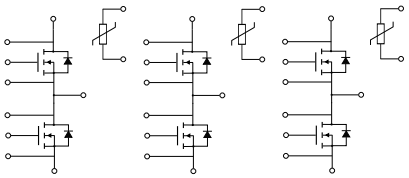
ADP480120W3-S

Datasheet

Automotive-grade ACEPACK DRIVE power module, sixpack topology 1200 V, 1.9 mΩ typ. SiC MOSFET gen.3 based



ACEPACK DRIVE



STPOWER

Product status link
ADP480120W3-S

Product summary	
Order code	ADP480120W3-S
Marking	ADP480120W3-S
Package	ACEPACK DRIVE
Leads type	Press-fit
Packing	Tray

Features

- AQG 324 qualified
- 1200 V blocking voltage
- 1.9 mΩ of typical $R_{DS(on)}$
- Maximum operating junction temperature T_J = 175 °C
- Very low switching energy
- Low inductive compact design for an higher power density
- Si_3N_4 AMB substrate to improve thermal performance
- SiC Power MOSFET chip sintered to substrate for improved lifetime
- 4.2 kV DC 1 s insulation
- Directly liquid cooled base plate with pin-fins
- Three integrated NTC temperature sensors
- Bus bars featuring self-clinching nuts

Application

- Main inverter (electric traction)

Description

The ACEPACK DRIVE is a compact sixpack module optimized for hybrid and electric vehicles traction inverters. This power module features switches based on 3rd generation silicon carbide Power MOSFETs, which are characterized by very low $R_{DS(on)}$, very limited switching losses and outstanding performances in synchronous rectification working mode. This ensures superb efficiency in the final application, saving battery recharging cycles.

A copper base plate with pin-fin base structure makes direct fluid cooling available for this power module minimizing thermal resistance.

A dedicated pin-out has been developed to get the best switching performances, and press-fit pins ensure an optimal connection with the driving board.

Moreover, the self-clinching nuts facilitate the connection with DC-link and motor tabs.

1 Electrical ratings

Table 1. Absolute maximum ratings of each switch

Symbol	Parameter	Value	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	1200	V
V_{GS}	Gate-source voltage	-10 to 22	V
	Gate-source voltage (recommended operating values)	-5 to 18	
I_D(1)	Continuous drain current at T_F = 75 °C (refer to T_J max = 175 °C, V_{GS} = 18 V)	488	A
I_{DM}(2)	Repetitive peak drain current	1000	A
P_{TOT}	Total power dissipation at T_F = 75 °C (refer to T_J max = 175 °C, V_{GS} = 18 V)	869	W
T_J	Operating junction temperature range under switching conditions	-40 to 175(3)	°C

1. *Specified by design, not tested in production.*
2. *Pulse width limited by maximum junction temperature.*
3. *Maximum baseplate temperature has to be always limited to 125 °C.*

Table 2. Thermal data of each switch

Symbol	Parameter	Min.	Typ.	Max.	Unit
R_{thJF}(1)	Thermal resistance, junction-to-fluid (flow rate = 10 LPM, T_F = 75 °C, single switch)	-	0.105	-	°C/W

1. *Simulated value considering 50% water/ 50% ethylene glycol cooling fluid. Refer to TN1412 "ACEPACK DRIVE assembly instructions" for water jacket design*

2 Electrical characteristics

T_J = 25 °C, unless otherwise specified.

Table 3. Electrical characteristics of each switch

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$R_{DS(on)}$[1]	Static drain-source on-resistance	V_{GS} = 18 V, I_D = 480 A	-	1.90	2.60	mΩ
		V_{GS} = 18 V, I_D = 480 A, T_J = 175 °C	-	3.35	-	
		V_{GS} = 18 V, I_D = -480 A	-	1.70	-	
		V_{GS} = 18 V, I_D = -480 A, T_J = 175 °C	-	3.30	-	
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 50 mA	1.9	3.1	4.4	V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 1200 V	-	-	100	µA
		V_{GS} = 0 V, V_{DS} = 1200 V, T_J = 150 °C[2]	-	-	2	mA
I_{GSS}	Gate-body leakage current	V_{DS} = 0 V, V_{GS} = -10 to 22 V	-	-	±2	µA
C_{iss}	Input capacitance	V_{DS} = 800 V, f = 1 MHz, V_{GS} = 0 V	-	35.86	-	nF
C_{oss}	Output capacitance		-	1.56	-	
C_{rss}	Reverse transfer capacitance		-	0.06	-	
Q_g	Total gate charge	V_{DS} = 800 V, I_D = 480 A, V_{GS} = -5 V to 18 V	-	1258	-	nC
Q_{gs}	Gate-emitter charge		-	431	-	
Q_{gd}	Gate-collector charge		-	403	-	

1. *$R_{DS(on)}$ is referred to switch level.*
2. *Specified by design, not tested in production.*

Table 4. Switching energy of each switch

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
E_{on} (1)	Turn-on switching energy	V_{DD} = 800 V, V_{GS} = -5 to 18 V, R_{Gon} = 12 Ω, R_{Goff} = 12 Ω di/dt_{on} = 4.7 A/ns I_D = 480 A	-	44.4	-	mJ
		V_{DD} = 800 V, V_{GS} = -5 to 18 V, R_{Gon} = 12 Ω, R_{Goff} = 12 Ω di/dt_{on} = 5.9 A/ns I_D = 480 A, T_J = 175 °C	-	36.5	-	
E_{off}	Turn-off switching energy	V_{DD} = 800 V, V_{GS} = -5 to 18 V, R_{Gon} = 12 Ω, R_{Goff} = 12 Ω dv/dt_{off} = 8.1 V/ns I_D = 480 A	-	33.8	-	mJ
		V_{DD} = 800 V, V_{GS} = -5 to 18 V, R_{Gon} = 12 Ω, R_{Goff} = 12 Ω dv/dt_{off} = 8.9 V/ns I_D = 480 A, T_J = 175 °C	-	33	-	

1. *Using active Miller clamp circuit.*

Table 5. Source-drain diode characteristics of each switch

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{SD}	Forward on voltage drop	V_{GS} = -5 V, I_{SD} = 480 A	-	4.4	-	V
t_{rr}	Reverse recovery time	V_{DD} = 800 V, V_{GS} = -5 to 18 V R_{Gon} = 12 Ω, R_{Goff} = 12 Ω di/dt_{on} = 5.3 A/ns	-	150	-	ns
Q_{rr}	Reverse recovery charge		-	2.7	-	µC
I_{RRM}	Reverse recovery current		-	94	-	A
E_{rec}	Reverse recovery energy		-	0.3	-	mJ
t_{rr}	Reverse recovery time	V_{DD} = 800 V, V_{GS} = -5 to 18 V R_{Gon} = 12 Ω, R_{Goff} = 12 Ω di/dt_{on} = 6.3 A/ns T_J = 175 °C	-	133	-	ns
Q_{rr}	Reverse recovery charge		-	6	-	µC
I_{RRM}	Reverse recovery current		-	153	-	A
E_{rec}	Reverse recovery energy		-	1.4	-	mJ

Note: Values are calculated taking in account an active Miller clamp circuit.

3 NTC

Table 6. Absolute maximum ratings for NTC temperature sensor, considered as standalone

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
R_{25}	Rated resistance	T = 25 °C	-	5.0	-	kΩ
R_{100}	Rated resistance	T = 100 °C	-	493	-	Ω
ΔR/R	Deviation of R_{100}		-5	-	+5	%
$B_{25/50}$	B-constant		-	3375	-	K
$B_{25/80}$			-	3411	-	K

4 ACEPACK DRIVE power module details

Table 7. Ratings for module

Symbol	Parameter		Value	Unit
V_{ISO}	Isolation voltage (f = 0 Hz, t = 1 s)		4.2	kV
	Internal isulation (class 1, IEC 61140)		Si_3N_4	
	Baseplate module material		Ni plated, Cu baseplate	
d_{creep}	Creepage distance	Terminal to heat sink	9.0	mm
		Terminal to terminal	9.0	
d_{clear}	Clearance distance	Terminal to heat sink	4.5	mm
		Terminal to terminal	4.5	
CTI	Comparative tracking index		>200	V
L_s	Typical stray inductance drain to source module loop		10	nH
R_s	Typical module lead resistance, terminals to chip		0.5	mΩ
T_{stg}	Storage temperature range		-40 to 125	°C

5 Electrical characteristics (curves)

Figure 1. Typical output characteristics (T_J = -40 °C)

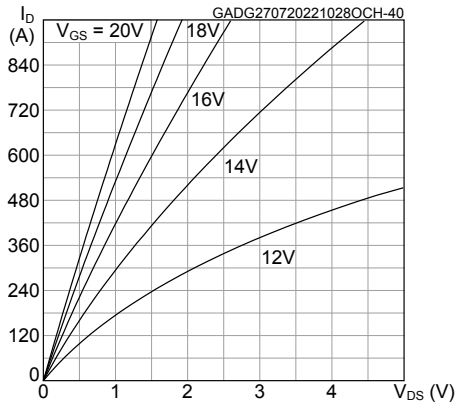


Figure 2. Typical output characteristics (T_J = 25 °C)

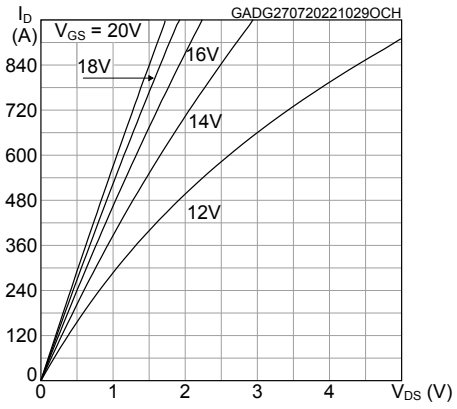


Figure 3. Typical output characteristics (T_J = 175 °C)

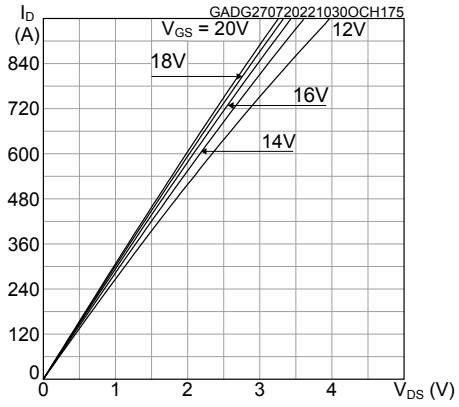


Figure 4. Typical reverse conduction characteristics (T_J = -40 °C)

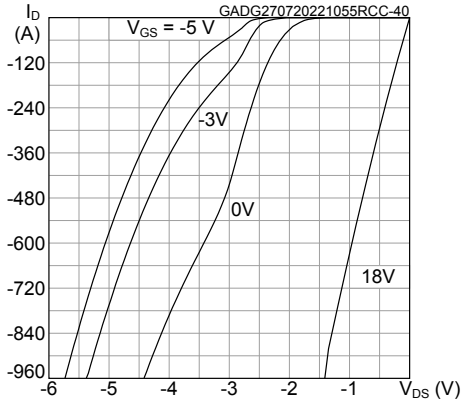


Figure 5. Typical reverse conduction characteristics (T_J = 25 °C)

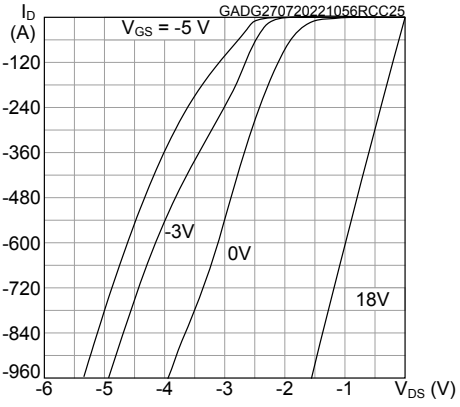


Figure 6. Typical reverse conduction characteristics (T_J = 175 °C)

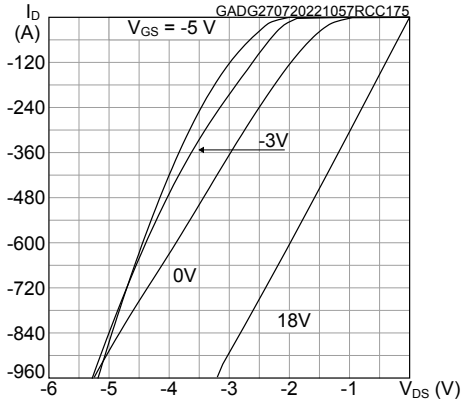


Figure 7. Typical transfer characteristics

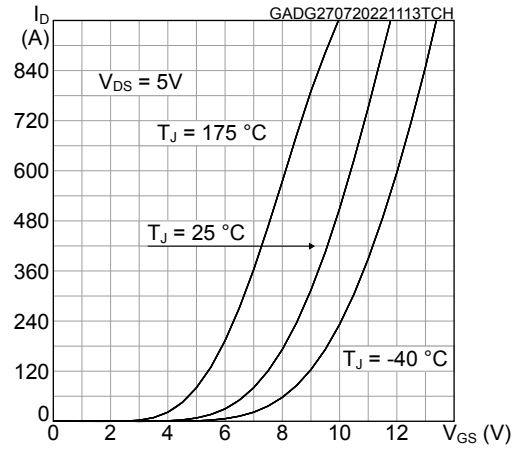


Figure 8. Normalized breakdown voltage vs temperature

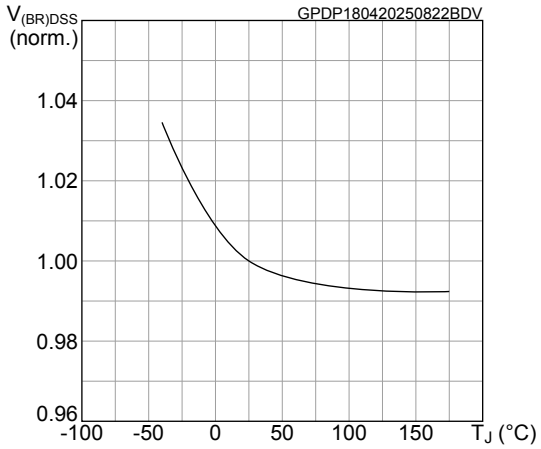


Figure 9. Typical switching energy vs drain current

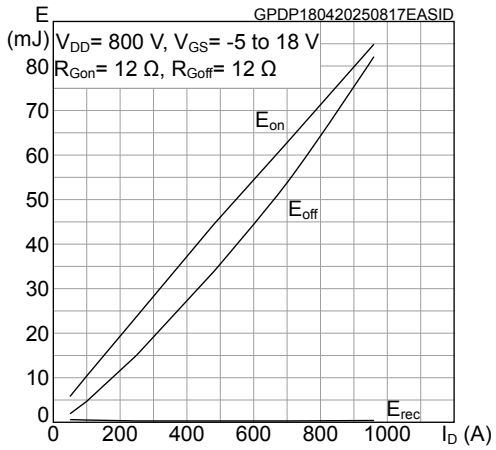


Figure 10. Typical switching energy vs gate resistance

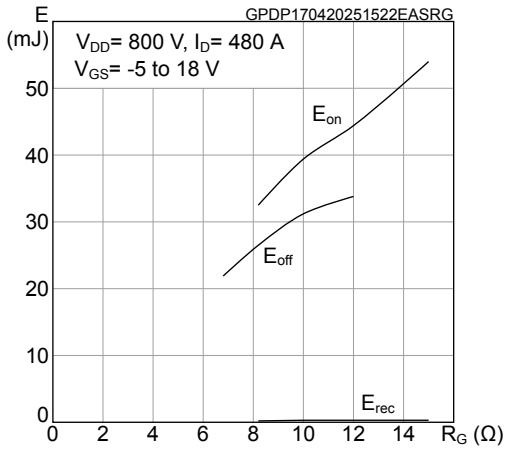


Figure 11. Typical switching energy vs temperature

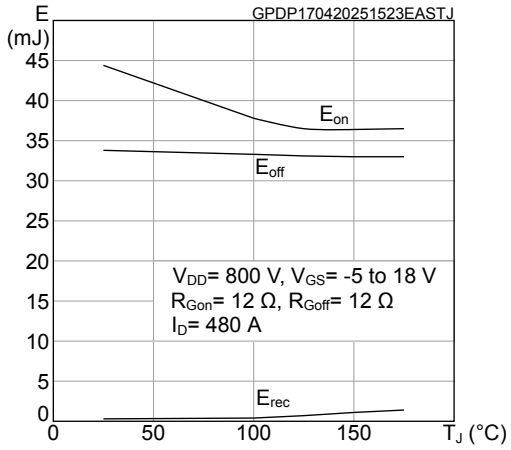


Figure 12. Typical switching energy vs bus voltage

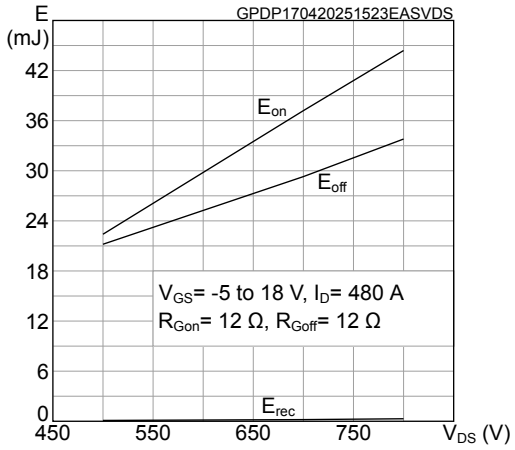


Figure 13. Typical capacitance characteristics

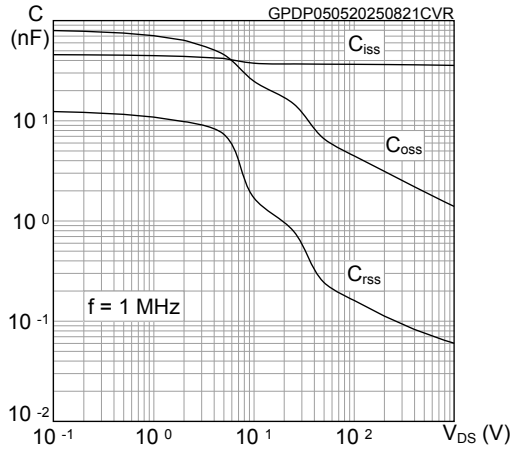


Figure 14. Typical gate charge characteristics

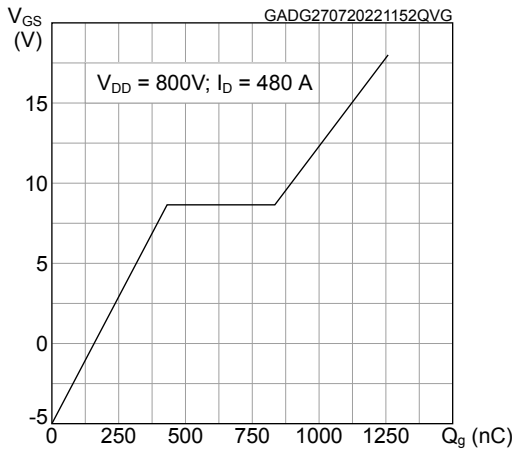


Figure 15. Typical transient thermal impedance

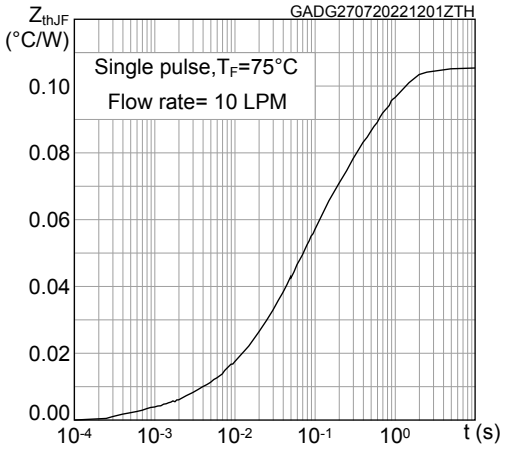


Figure 16. Typical thermal resistance vs flow rate

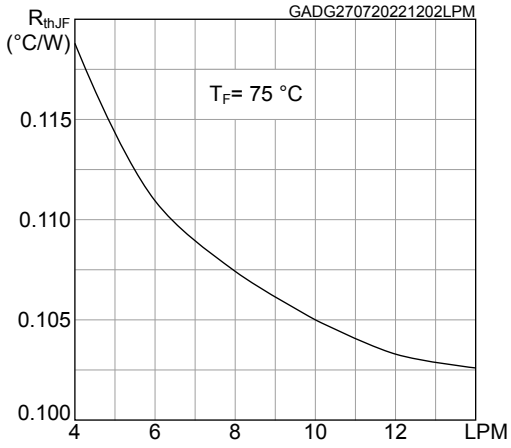
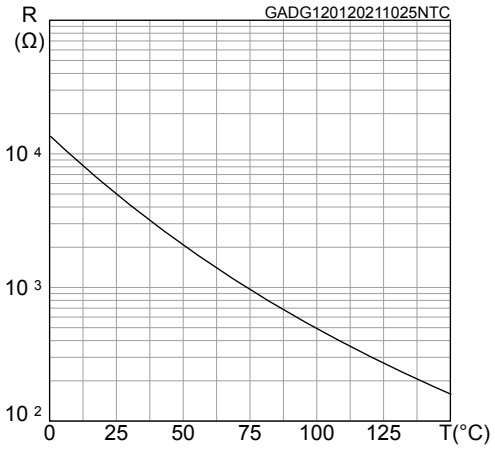


Figure 17. Typical NTC resistance vs temperature



6 Topology, pin description and positioning

Figure 18. **Topology, pin description and positioning**

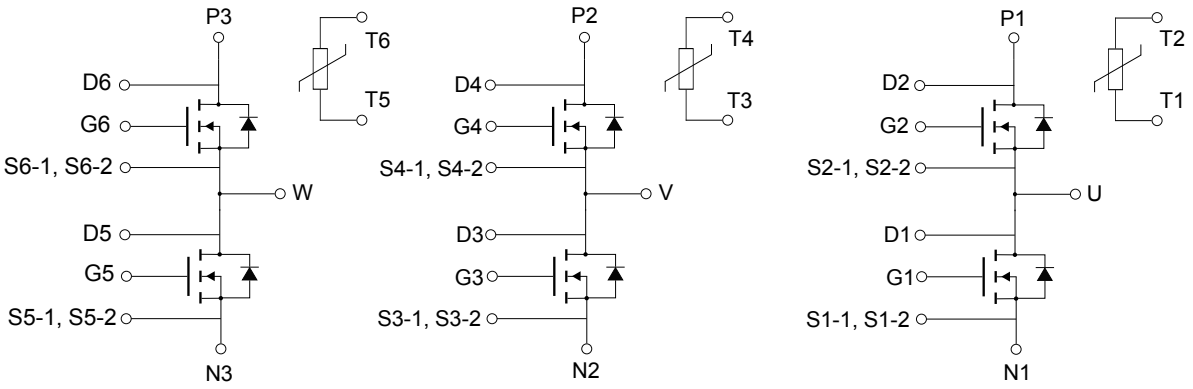
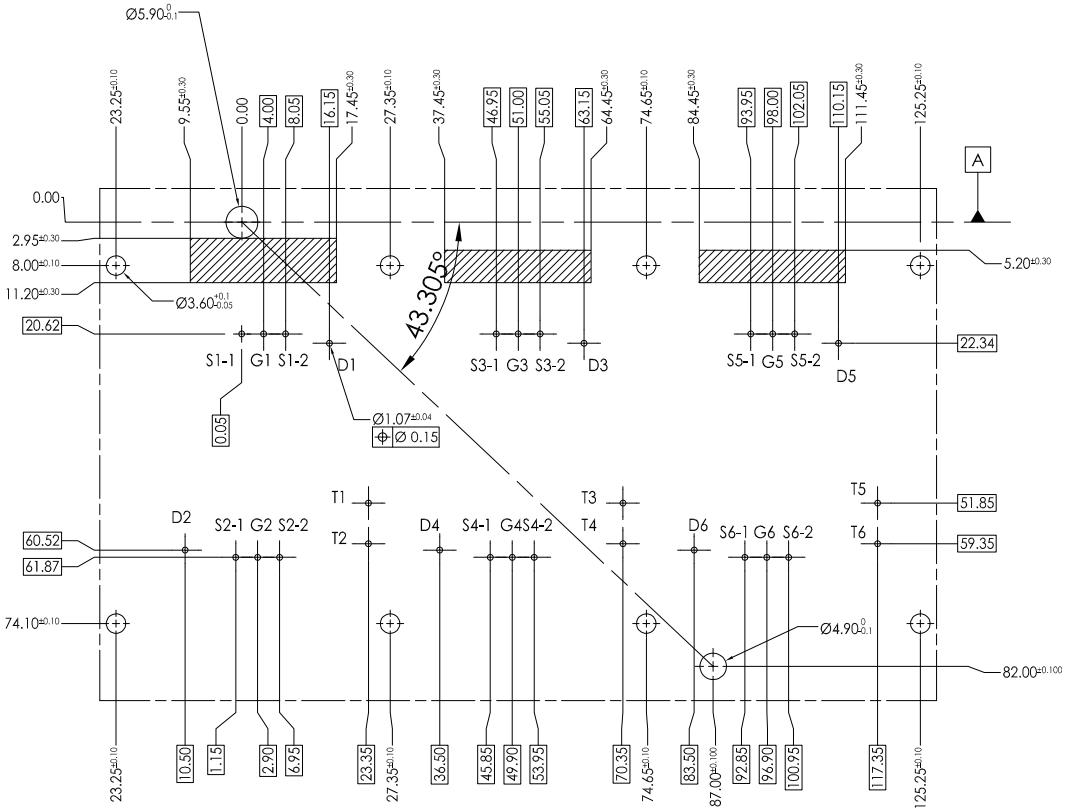


Figure 19. **ACEPACK DRIVE PCB drawing (dimensions are in mm.)**



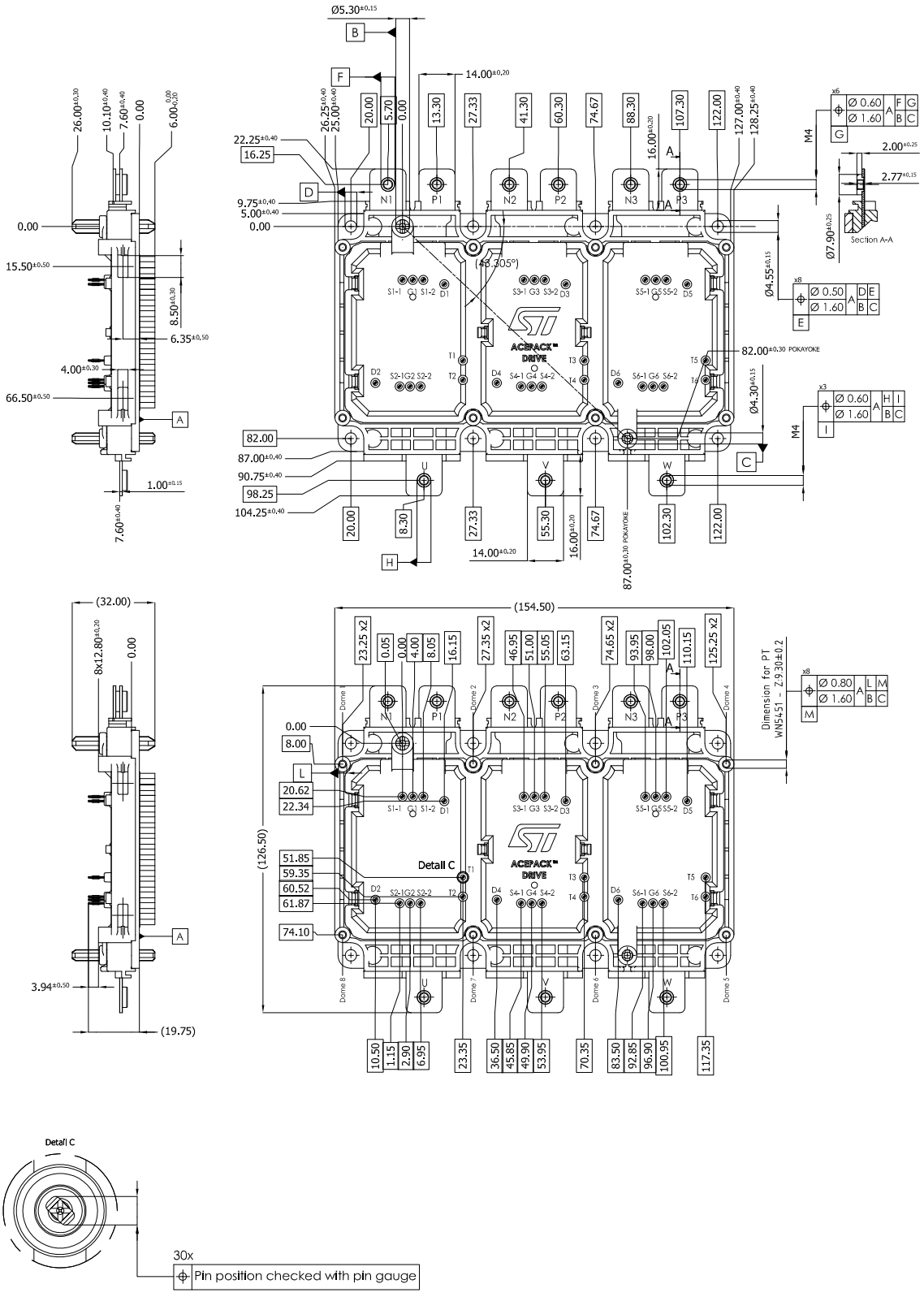
DM00518615_PCB_Rev8

7 Package information

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.

7.1 ACEPACK DRIVE package information

Figure 20. ACEPACK DRIVE short tab with self-clinching nuts package outline (dimensions are in mm.)



DM00518615_Rev8_self-clinching nuts

Revision history

Table 8. **Document revision history**

Date	Revision	Changes
13-Mar-2023	1	First release.
16-May-2023	2	Modified *Features* and *Description*.
05-May-2025	3	Updated *Table 3. Electrical characteristics of each switch*, *Table 4. Switching energy of each switch*, *Figure 8. Normalized breakdown voltage vs temperature*, *Figure 9. Typical switching energy vs drain current*, *Figure 10. Typical switching energy vs gate resistance*, *Figure 11. Typical switching energy vs temperature*, *Figure 12. Typical switching energy vs bus voltage* and *Figure 13. Typical capacitance characteristics*.
20-May-2025	4	Updated Table 4. Switching energy of each switch.

Contents

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