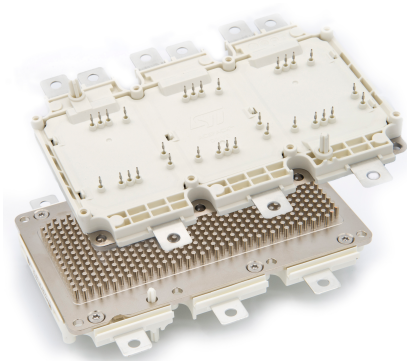
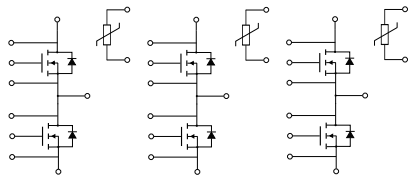



## Automotive-grade ACEPACK DRIVE power module, sixpack topology 1200 V, 1.9 mΩ typ. SiC MOSFET gen.3 based


**ACEPACK DRIVE**


### Features

- AQG 324 qualified 
- 1200 V blocking voltage
- 1.9 mΩ of typical  $R_{DS(on)}$
- Maximum operating junction temperature  $T_J = 175\text{ °C}$
- 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

### Application

- Main inverter (electric traction)

### Description

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

A copper base plate with pin-fin base structure make 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 will ensure optimal connection with driving board.


**Product status link**
[ADP480120W3](#)
**Product summary**

<b>Order code</b>	ADP480120W3
<b>Marking</b>	ADP480120W3
<b>Package</b>	ACEPACK DRIVE
<b>Leads type</b>	Press fit
<b>Packing</b>	Tray

# 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 $T_F = 75\text{ °C}$ (refer to $T_J \text{ max} = 175\text{ °C}$ , $V_{GS} = 18\text{ V}$ )	488	A
$I_{DM}^{(2)}$	Repetitive peak drain current	1000	A
$P_{TOT}$	Total power dissipation at $T_F = 75\text{ °C}$ (refer to $T_J \text{ max} = 175\text{ °C}$ , $V_{GS} = 18\text{ V}$ )	869	W
$T_J$	Operating junction temperature range under switching conditions	-40 to 175 <sup>(3)</sup>	°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, $T_F = 75\text{ °C}$ , 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

$T_J = 25\text{ °C}$ , 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	$V_{GS} = 18\text{ V}, I_D = 480\text{ A}$		1.90	2.60	mΩ
		$V_{GS} = 18\text{ V}, I_D = 480\text{ A}, T_J = 175\text{ °C}$		3.35		
		$V_{GS} = 18\text{ V}, I_D = -480\text{ A}$		1.70		
		$V_{GS} = 18\text{ V}, I_D = -480\text{ A}, T_J = 175\text{ °C}$		3.30		
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 50\text{ mA}$	1.9	3.1	4.4	V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}$			100	μA
		$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}, T_J = 150\text{ °C}^{(2)}$			2	mA
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}, V_{GS} = -10\text{ to }22\text{ V}$			2	μA
$C_{iss}$	Input capacitance	$V_{DS} = 800\text{ V}, f = 1\text{ MHz}, V_{GS} = 0\text{ V}$		37.42		nF
$C_{oss}$	Output capacitance			1.43		
$C_{riss}$	Reverse transfer capacitance			0.13		
$Q_g$	Total gate charge	$V_{DS} = 800\text{ V}, I_D = 480\text{ A},$ $V_{GS} = -5\text{ V to }18\text{ V}$		1258		nC
$Q_{gs}$	Gate-emitter charge			431		
$Q_{gd}$	Gate-collector charge			403		

- $R_{DS(on)}$  is referred to switch level.
- 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	$V_{DD} = 800\text{ V}, V_{GS} = -5\text{ to }18\text{ V},$ $di/dt_{on} = 4.2\text{ A/ns}, R_G = 10\text{ Ω},$ $I_D = 480\text{ A}$	-	42.3	-	mJ
		$V_{DD} = 800\text{ V}, V_{GS} = -5\text{ to }18\text{ V},$ $di/dt_{on} = 5.5\text{ A/ns}, R_G = 10\text{ Ω},$ $I_D = 480\text{ A}, T_J = 175\text{ °C}$	-	32.8	-	
$E_{off}$	Turn-off switching energy	$V_{DD} = 800\text{ V}, V_{GS} = -5\text{ to }18\text{ V},$ $dv/dt_{off} = 5.9\text{ V/ns}, R_G = 8.2\text{ Ω},$ $I_D = 480\text{ A}$	-	41.6	-	mJ
		$V_{DD} = 800\text{ V}, V_{GS} = -5\text{ to }18\text{ V},$ $dv/dt_{off} = 7.8\text{ V/ns}, R_G = 8.2\text{ Ω},$ $I_D = 480\text{ A}, T_J = 175\text{ °C}$	-	38.5	-	

- 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	$V_{GS} = -5\text{ V}$ , $I_{SD} = 480\text{ A}$	-	4.4	-	V
$t_{rr}$	Reverse recovery time	$V_{DD} = 800\text{ V}$ , $V_{GS} = -5\text{ to }18\text{ V}$ , $R_G = 10\ \Omega$ , $di/dt_{on} = 4.2\text{ A/ns}$ , $I_{SD} = 480\text{ A}$	-	34	-	ns
$Q_{rr}$	Reverse recovery charge		-	2.5	-	$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	128	-	A
$E_{rec}$	Reverse recovery energy		-	0.52	-	mJ
$t_{rr}$	Reverse recovery time	$V_{DD} = 800\text{ V}$ , $V_{GS} = -5\text{ to }18\text{ V}$ , $R_G = 10\ \Omega$ , $di/dt_{on} = 5.5\text{ A/ns}$ , $I_{SD} = 480\text{ A}$ , $T_J = 175\text{ }^\circ\text{C}$	-	57	-	ns
$Q_{rr}$	Reverse recovery charge		-	6.6	-	$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	195	-	A
$E_{rec}$	Reverse recovery energy		-	1.96	-	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 stand-alone**

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

## 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 isolation (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	
$L_s$	Typical stray inductance drain to source module loop		10	nH
$R_s$	Typical module lead resistance, terminals to chip		0.5	m $\Omega$
$T_{stg}$	Storage temperature range		-40 to 125	$^{\circ}C$

## 5 Electrical characteristics (curves)

Figure 1. Typical output characteristics ( $T_J = -40\text{ }^\circ\text{C}$ )

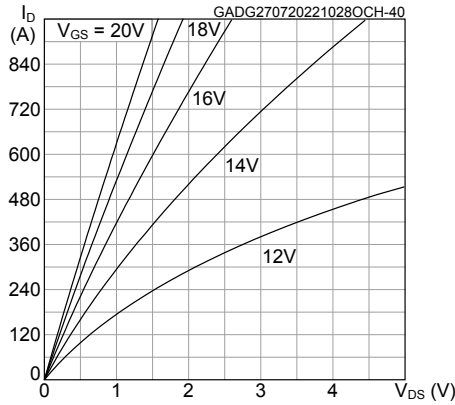


Figure 2. Typical output characteristics ( $T_J = 25\text{ }^\circ\text{C}$ )

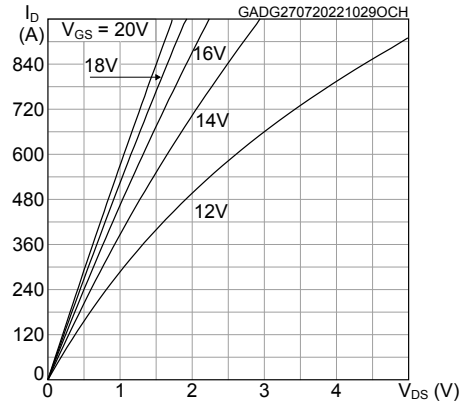


Figure 3. Typical output characteristics ( $T_J = 175\text{ }^\circ\text{C}$ )

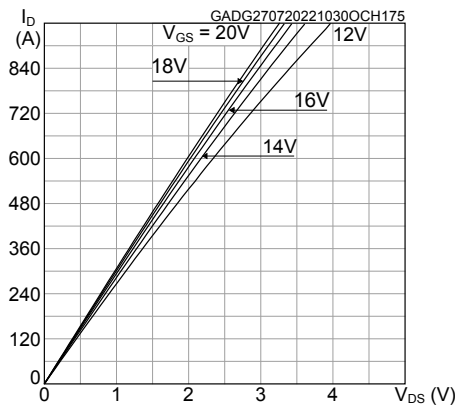


Figure 4. Typical reverse conduction characteristics ( $T_J = -40\text{ }^\circ\text{C}$ )

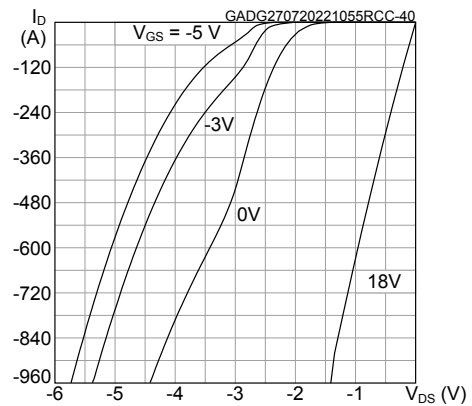


Figure 5. Typical reverse conduction characteristics ( $T_J = 25\text{ }^\circ\text{C}$ )

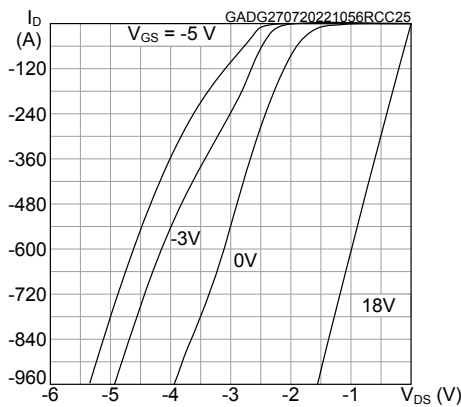


Figure 6. Typical reverse conduction characteristics ( $T_J = 175\text{ }^\circ\text{C}$ )

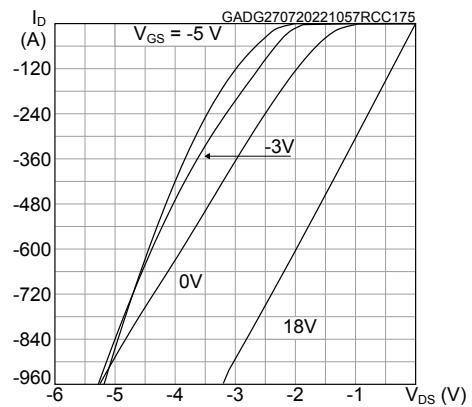


Figure 7. Typical transfer characteristics

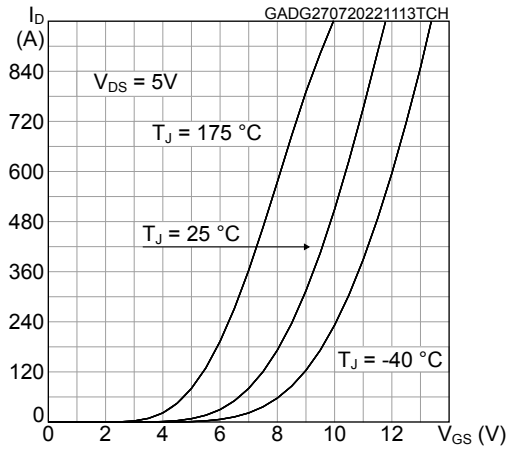


Figure 8. Normalized breakdown voltage vs temperature

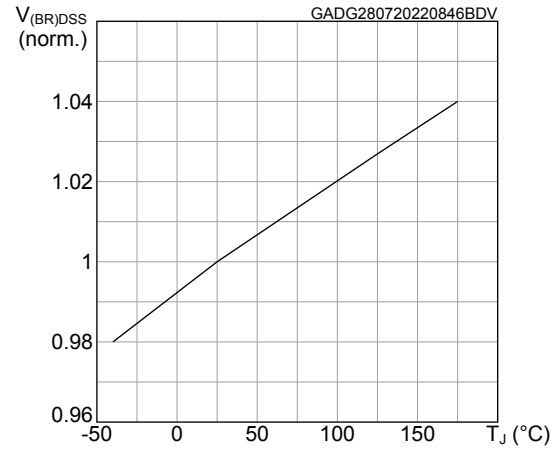


Figure 9. Typical switching energy vs drain current

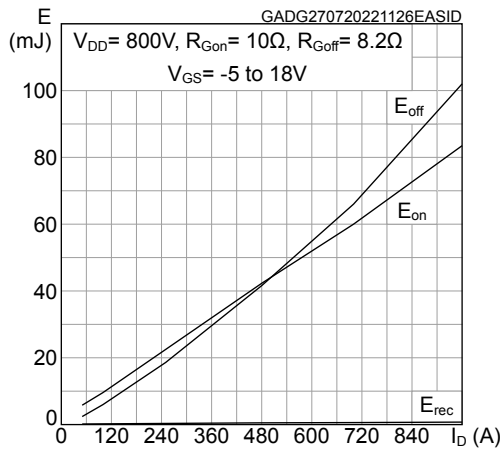


Figure 10. Typical switching energy vs gate resistance

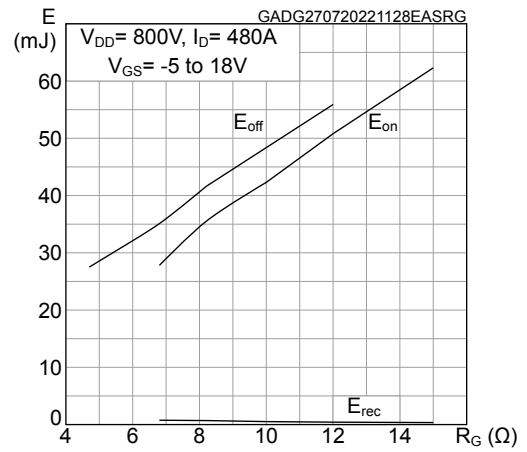


Figure 11. Typical switching energy vs temperature

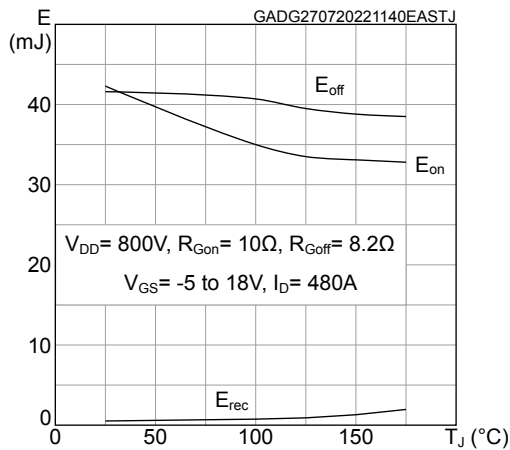
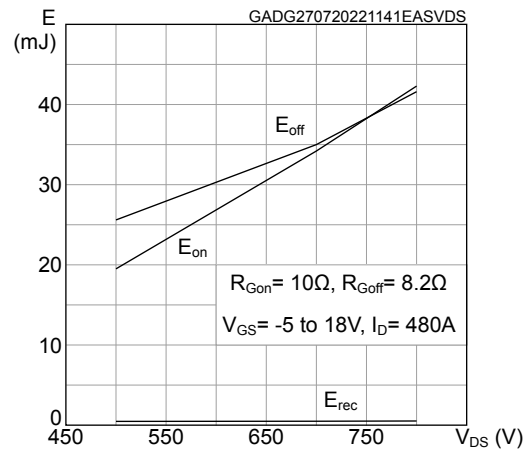
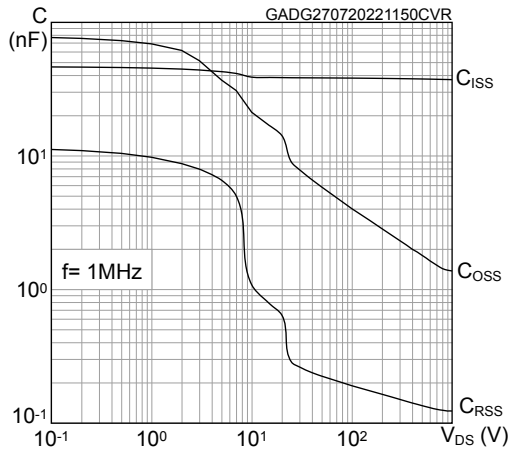


Figure 12. Typical switching energy vs bus voltage

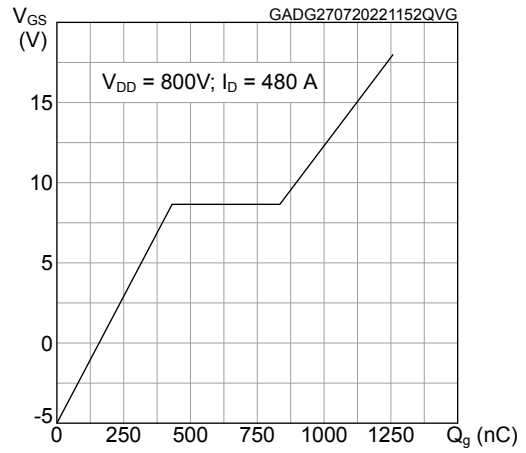




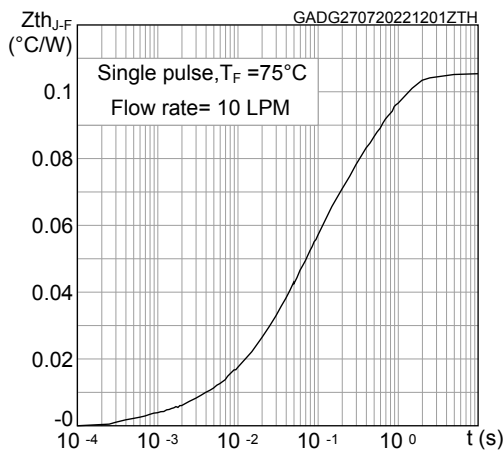
**Figure 13. Typical capacitance characteristics**



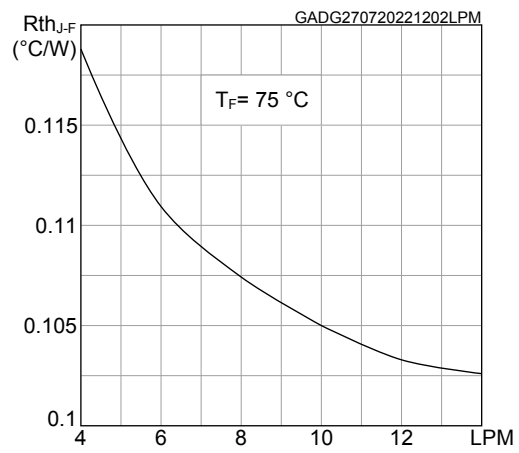
**Figure 14. Typical gate charge characteristics**



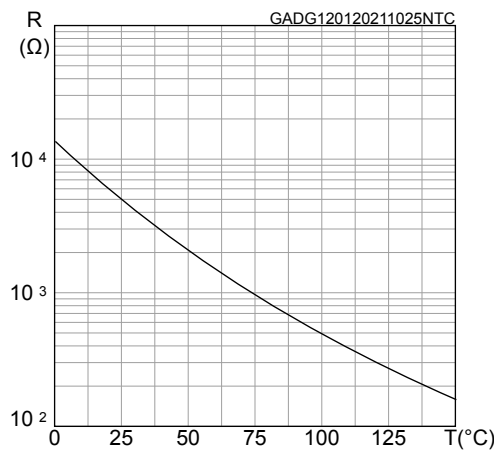
**Figure 15. Typical transient thermal impedance**



**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

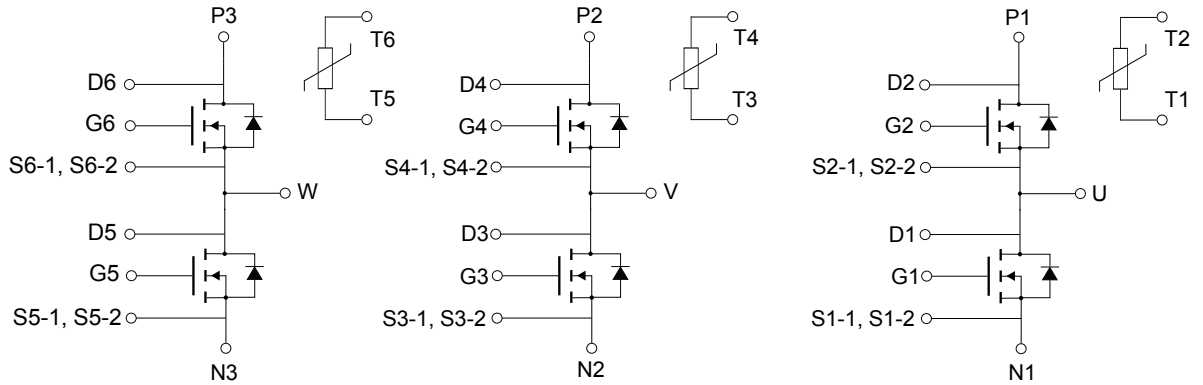
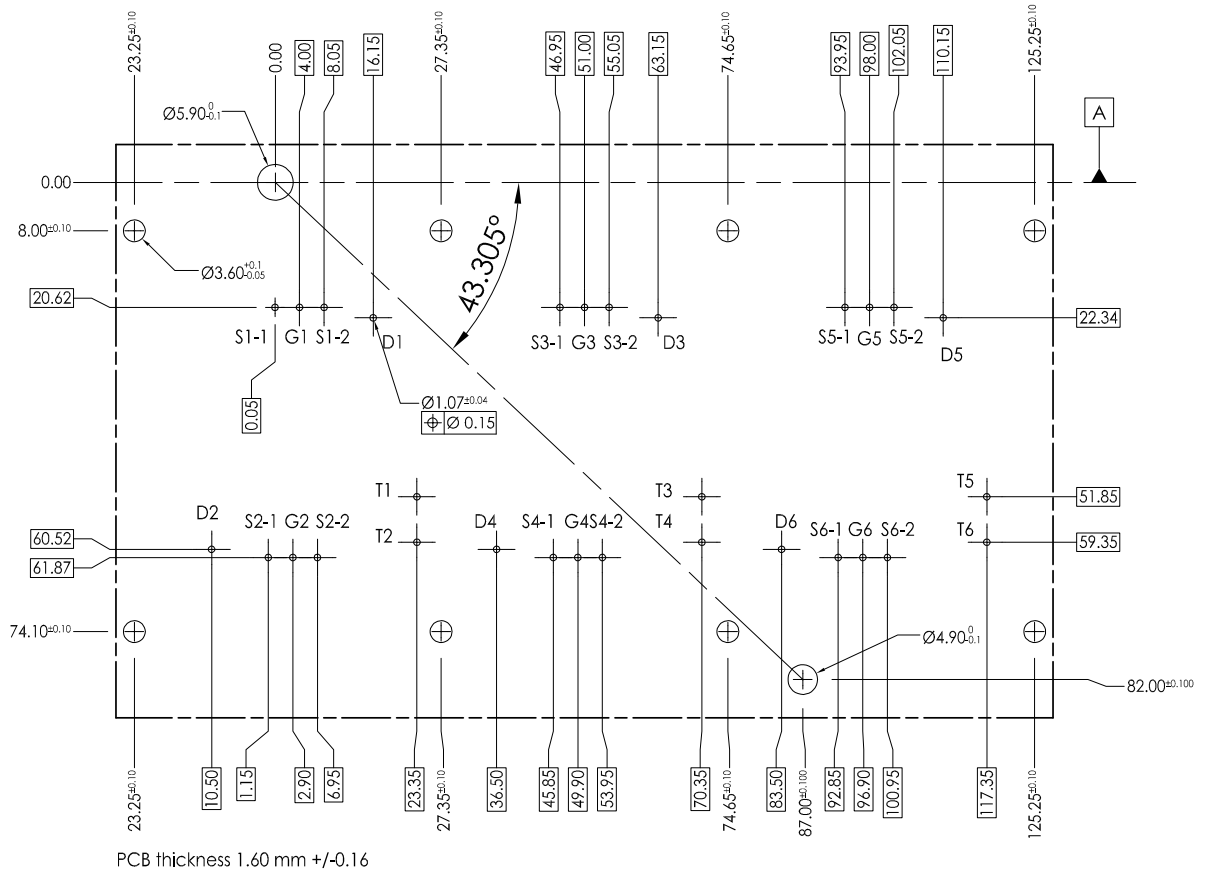


Figure 19. ACEPACK DRIVE PCB drawing (dimensions are in mm.)



DM00518615\_PCB\_Rev5

## **7** Package information

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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](http://www.st.com). ECOPACK is an ST trademark.



## Revision history

**Table 8. Document revision history**

Date	Version	Changes
03-Jun-2021	1	First release.
28-Jul-2022	2	<p>Removed <i>Section 1.1 Inverter switch inserted</i> and updated <i>Table 1. Absolute maximum ratings - MOSFET</i> added <i>Table 2. Thermal data of each switch under Section 1 Electrical ratings</i>.</p> <p>Inserted and updated <i>Table 3. Electrical characteristics of each switch</i>, added <i>Table 4. Switching energy of each switch under Section 2 Electrical characteristics</i>.</p> <p>Updated <i>Table 6. Absolute maximum ratings for NTC temperature sensor, considered as stand-alone</i>.</p> <p>Inserted <i>Section 5 Electrical characteristics (curves)</i>.</p>
13-Oct-2022	3	<p>Updated <i>Table 1. Absolute maximum ratings of each switch</i> and <i>Table 2. Thermal data of each switch</i>.</p> <p>Updated <i>Table 3. Electrical characteristics of each switch</i> and <i>Table 5. Source-drain diode characteristics of each switch</i>.</p>

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## Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>2</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>3</b>
<b>3</b>	<b>NTC</b> .....	<b>5</b>
<b>4</b>	<b>ACEPACK DRIVE power module details</b> .....	<b>6</b>
<b>5</b>	<b>Electrical characteristics (curves)</b> .....	<b>7</b>
<b>6</b>	<b>Topology, pin description and positioning</b> .....	<b>10</b>
<b>7</b>	<b>Package information</b> .....	<b>11</b>
	<b>7.1 ACEPACK DRIVE package information</b> .....	<b>12</b>
	<b>Revision history</b> .....	<b>13</b>

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