

Power Modules

ST Offer for Power Modules

Brief Overview

March 21, 2018

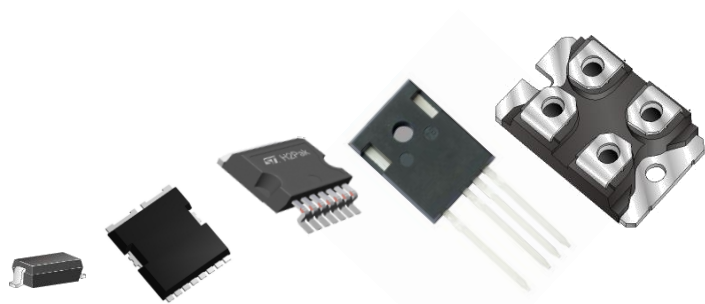


Power Transistor Division

Power Product Portfolio

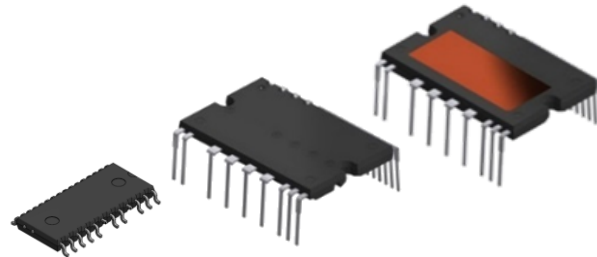
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From Discrete to Power Modules, ST leads the innovation



Discrete & Drivers & SIP

Typical Power: 10 W ÷ 5 kW



SLLIMM™ IPM

Typical Power: 20 W ÷ 3 kW



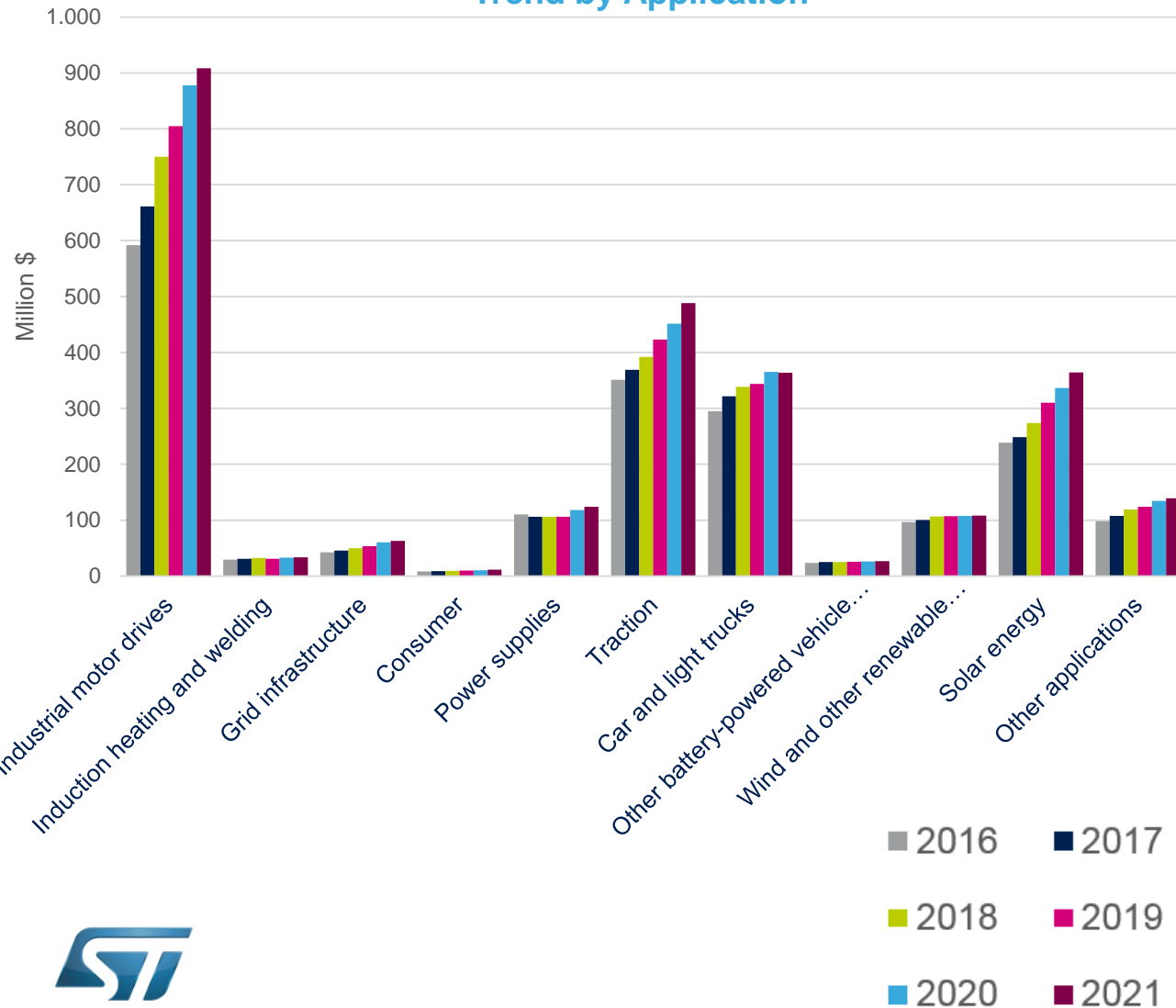
ACEPACK™ Power Modules

Typical Power: 3 kW ÷ 30 kW

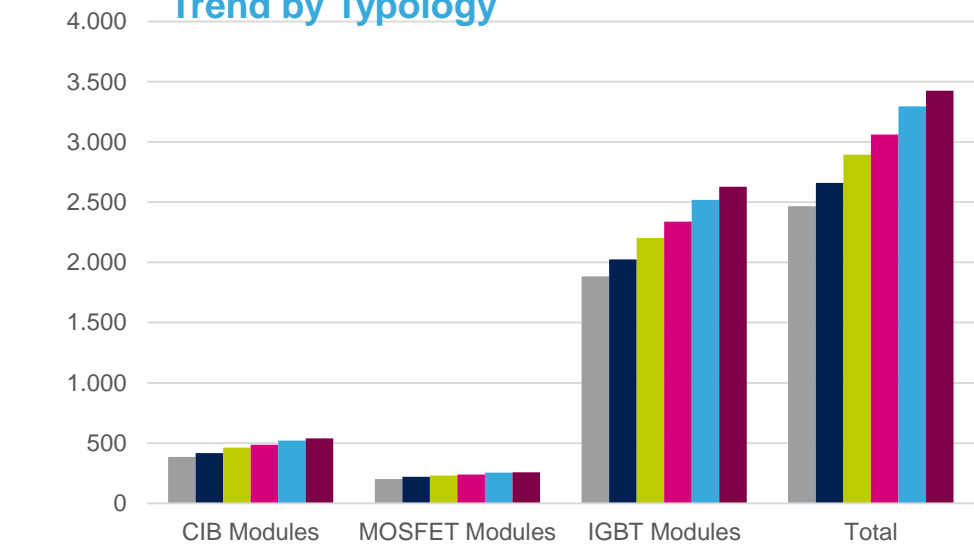


Module Market Trends 2016-2021

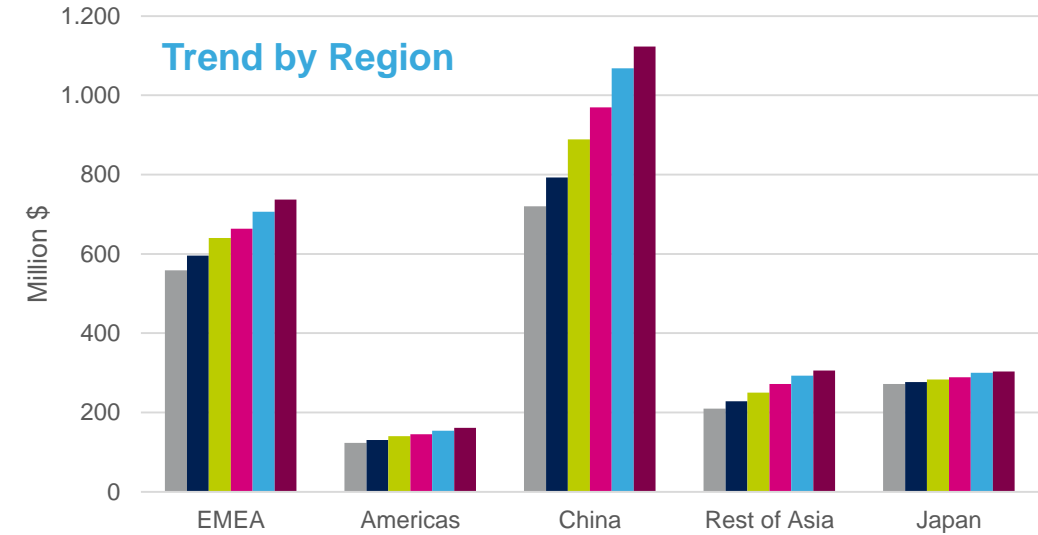
Trend by Application



Trend by Typology



Trend by Region



Adaptable, Compact and Easier PACKage

The best Power Module offer for Industrial Motor Control and more



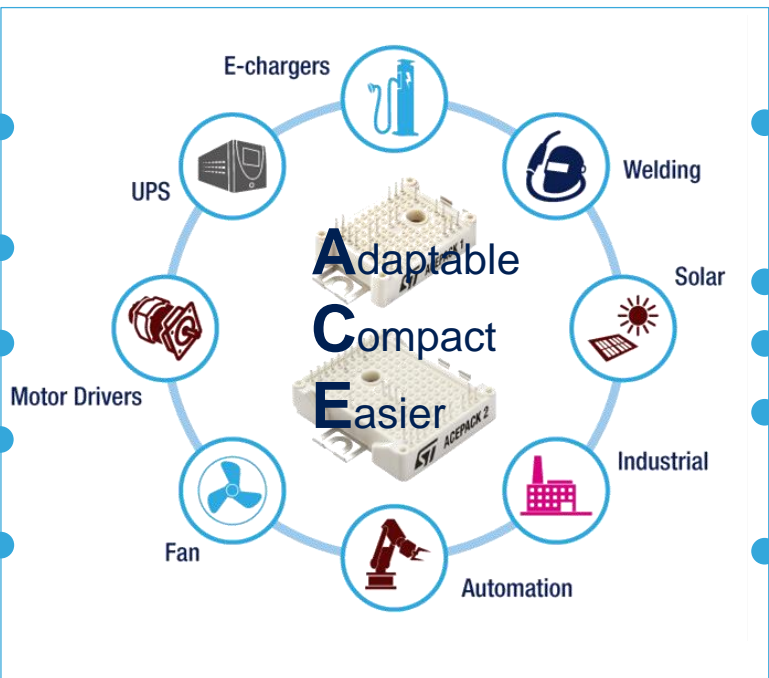
Power Modules for various applications

- Technology & Flexibility to address market needs
- 100% controlled by ST for silicon (SiC, MOSFET, IGBT and Diodes)
- Current level from 15 A to 75 A for power scalability
- 650 V and 1200 V



Features and Benefits

- Press FIT and solder pins options, configuration flexibility
- Up to 1200V breakdown voltage
- Integrated screw clamps
- All power switches in a module including NTC
- Several current ratings available



- Several configurations (CIB, 6pack, ..) available and low stray inductance
- High reliability and robustness, miniaturized power side board occupation
- Simplified and stable screwing
- Compact design and cost effective system approach
- Very high power density

Technology & Flexibility to Address Market Needs

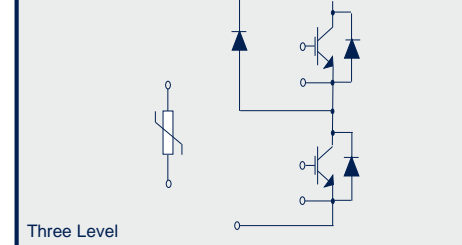
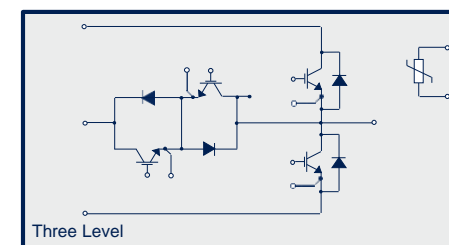
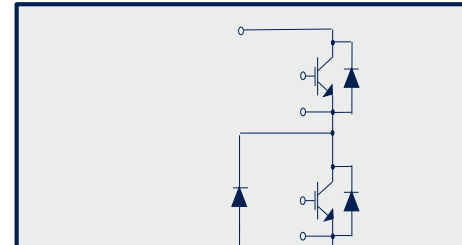
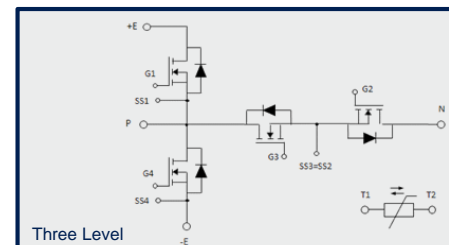
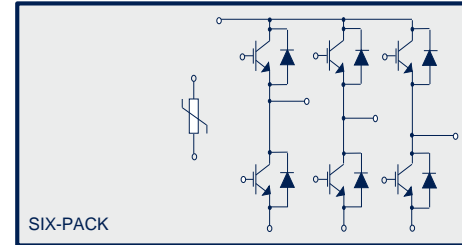
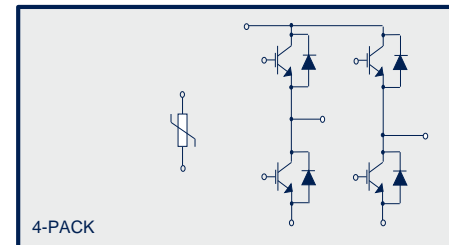
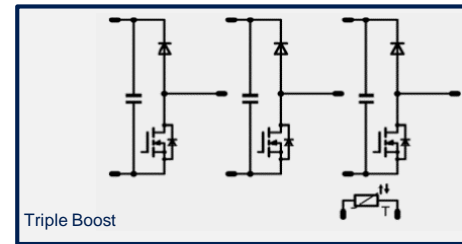
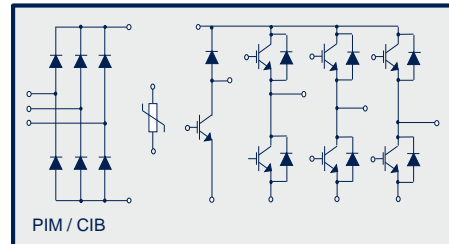
Main Features

- Compact module concept
- Configuration flexibility
- Press FIT and solder pins options
- High power density
- Reliable and easy mounting system
- Integrated temperature sensor available
- Low stray inductance module design
- PCB layout design
- High reliability and quality
- RoHS-compliant modules

ST Power Switch capability

- IGBTs
- HV MOSFETs
- Diodes
- Bridge Rectifier Diodes
- Silicon Carbide MOSFETs
- Silicon Carbide Diodes
- SCR....etc.

Main Topologies can be addressed in ACEPACK



ACEPACK 1
 6-PACK 25-35A, 1200V
 6-pack 50A, 650V
 CIB 15A, 1200V

- Air Conditioning
- Motor drives
- Servo drives
- UPS
- (H)EV



ACEPACK 2
 6-PACK 75A, 1200V
 CIB 25-35A, 1200VV
 CIB 50A, 650V

- Air Conditioning
- Motor drives
- Auxiliary Inverters

ACEPACK

Nomenclature



Module Type
 A1 = ACEPACK™ 1
 A2 = ACEPACK™ 2

Internal Main Configuration
 T = 12-Pack
 P = Sixpack (3 phase Full Bridge)
 C = Converter inverter Brake (CIB)
 H = Half Bridge
 U = Three Level
 TB = Triple Boost

Current Indication (DC) for IGBT
 RDS(on)max for MOSFET
 RDS(on)typ for SiC

Diode Features
 S = Soft diode
 W = SiC Diode

Additional Options
 F = Press Fit
 C = Capacitor inside

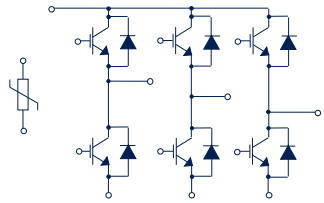
Technology gen.

Series
 H = High Speed IGBTs
 V = Very Fast IGBTs
 M = Low Loss IGBTs
 S = Low V_{CESAT} IGBTs
 W = SiC MOSFET
 M5 = MDMESH V

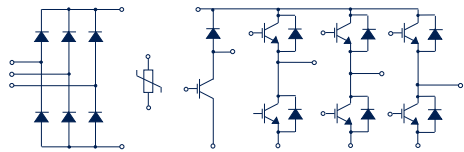
Breakdown Voltage
 2 digits: value ÷ by 100 or by 10.

ACEPACK Module for Motor Control

Standard products in MP (solder and press fit pins)



Six-Pack + NTC



CIB + NTC



ACEPACK™ 1

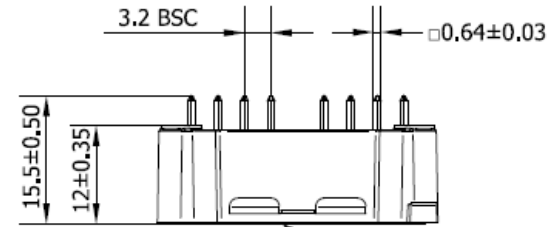
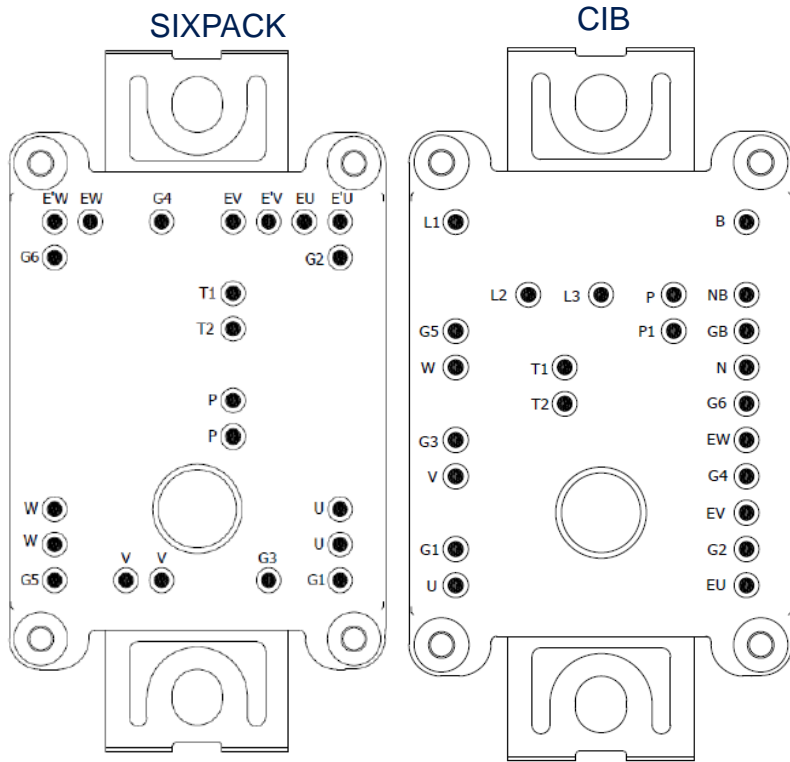
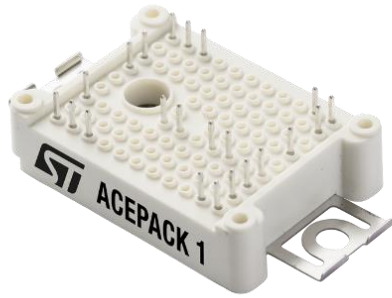
Part Number	Topology	BV _{CES}	I _C rating
A1P25S12M3/-F	Six-Pack	1200V	25A
A1P35S12M3/-F			35A
A1C15S12M3/-F	Converter Inverter Brake	1200V	15A
A1P50S65M2/-F	Six-Pack	650V	50A



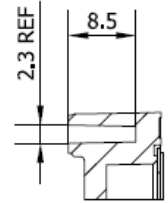
ACEPACK™ 2

Part Number	Topology	BV _{CES}	I _C rating
A2C25S12M3/-F	Converter Inverter Brake	1200V	25A
A2C35S12M3/-F			35A
A2P75S12M3/-F	Six-Pack	1200V	75A
A2C50S65M2/-F	Converter Inverter Brake	650V	50A

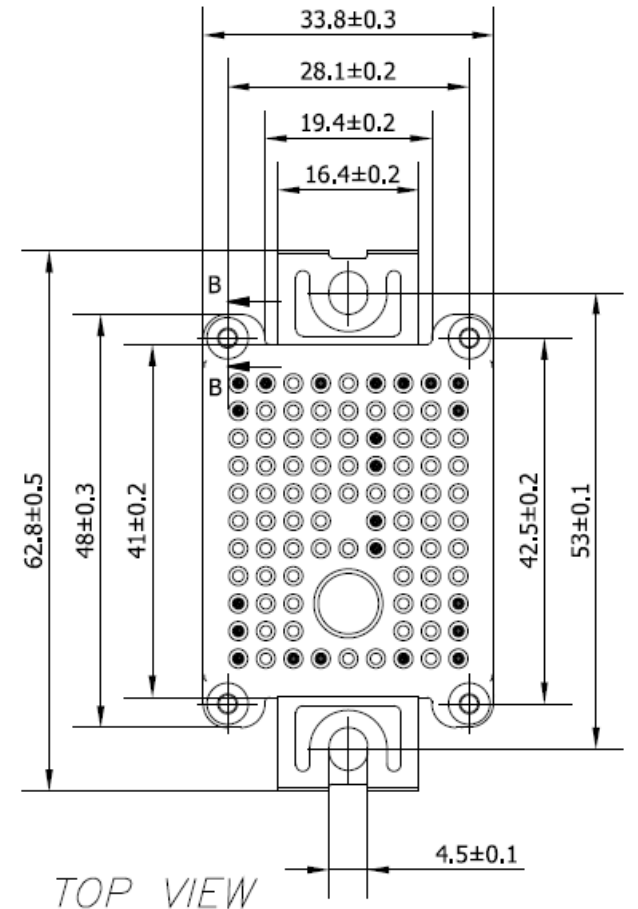
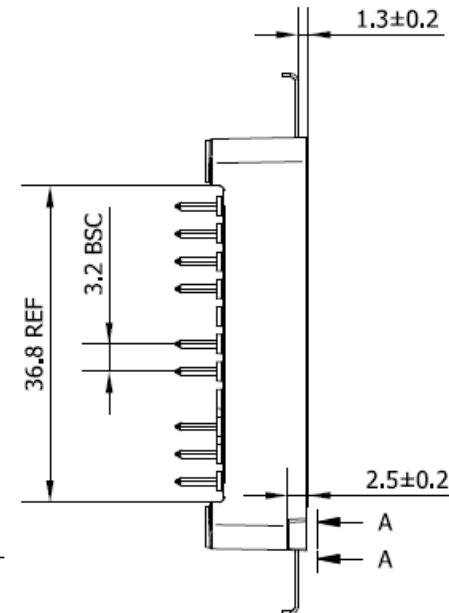
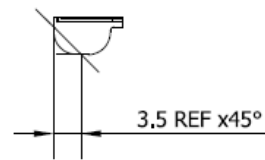
ACEPACK 1 Package



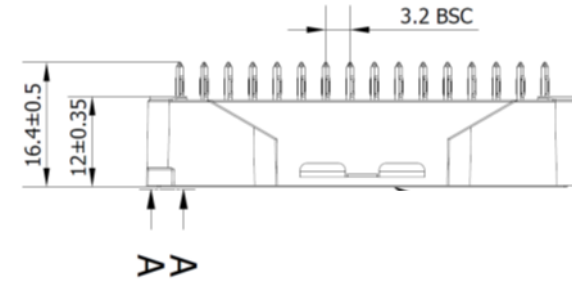
Section B-B



Detail A

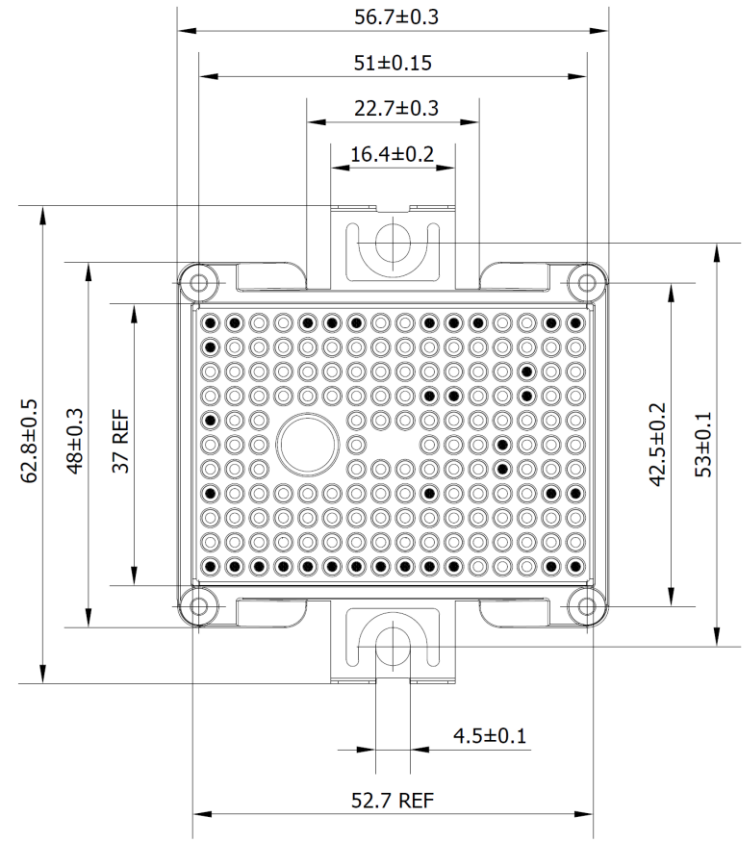
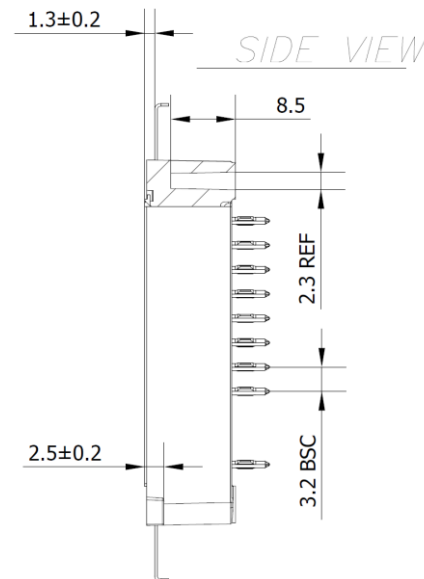
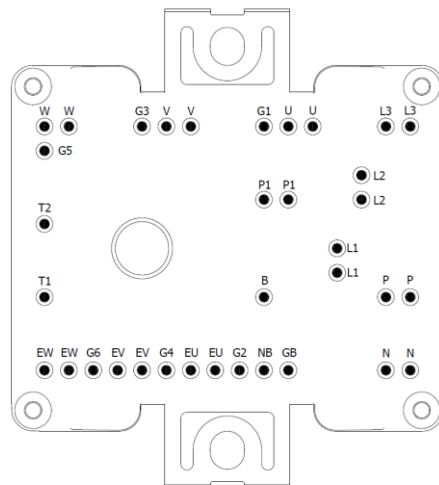
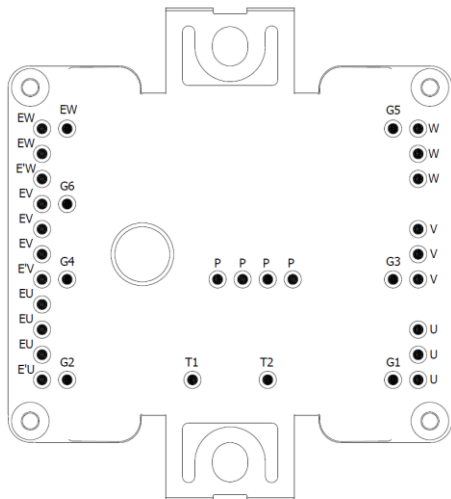


ACEPACK 2 Package



SIXPACK

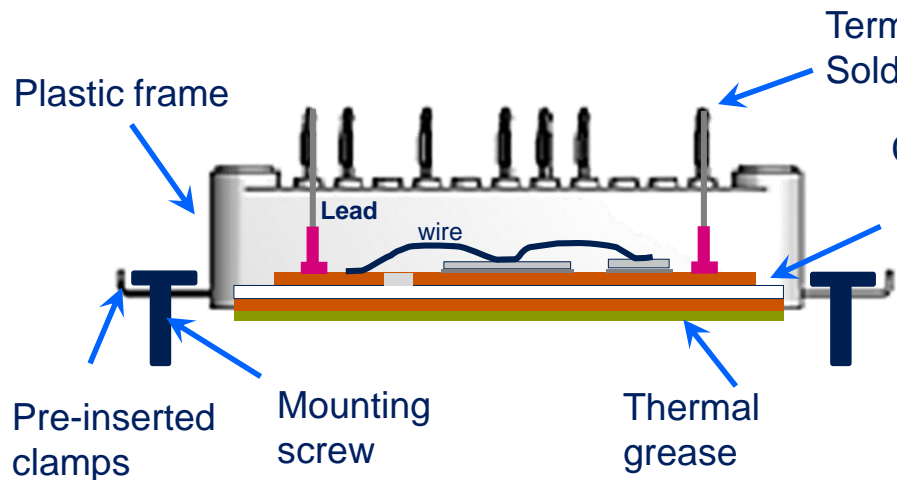
CIB



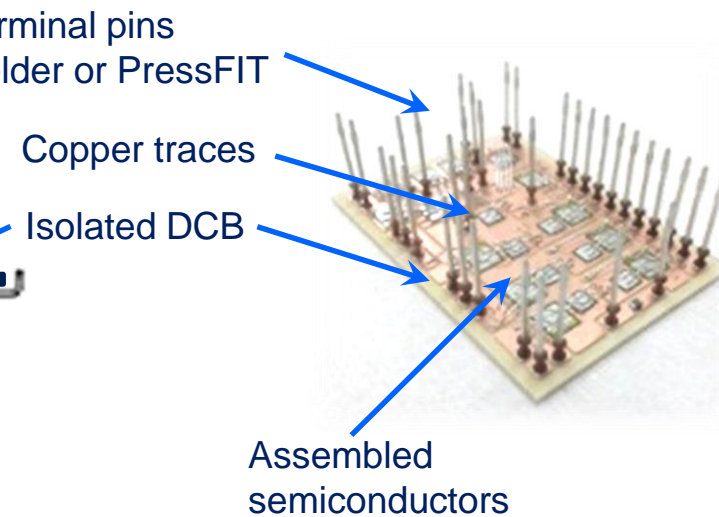
ACEPACK - Package Technology

Build from: DCB / high current pin / plastic housing

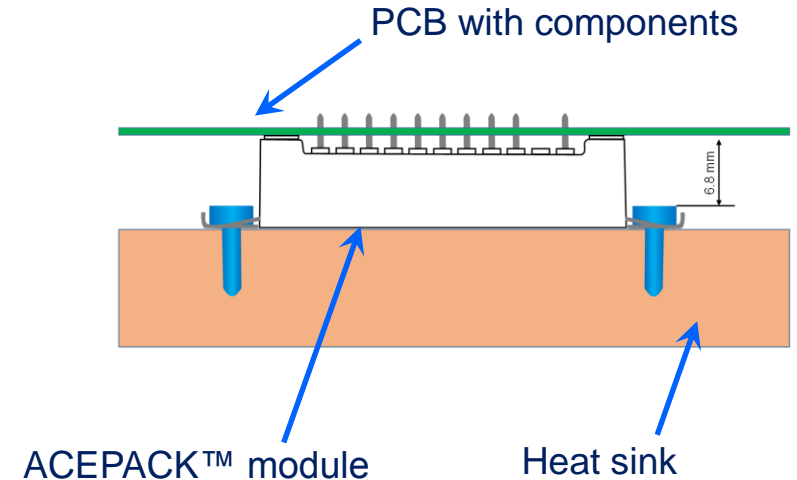
ACEPACK assembly structure



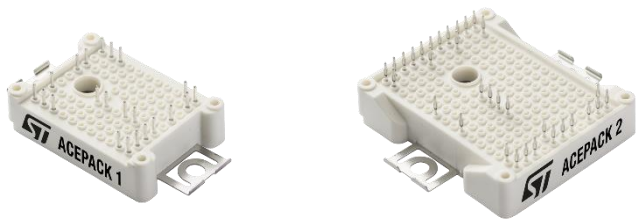
DBC 'inside' view



Assembled module



Housing provides best-in-class technology standards



ACEPACK Test in ST Lab

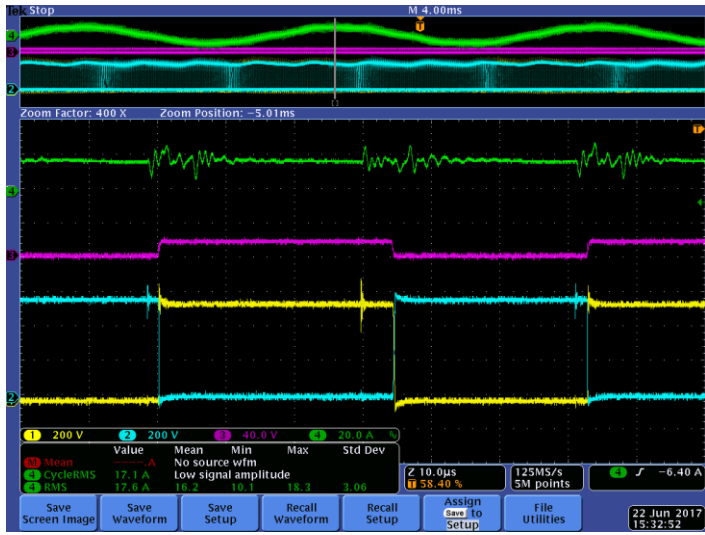
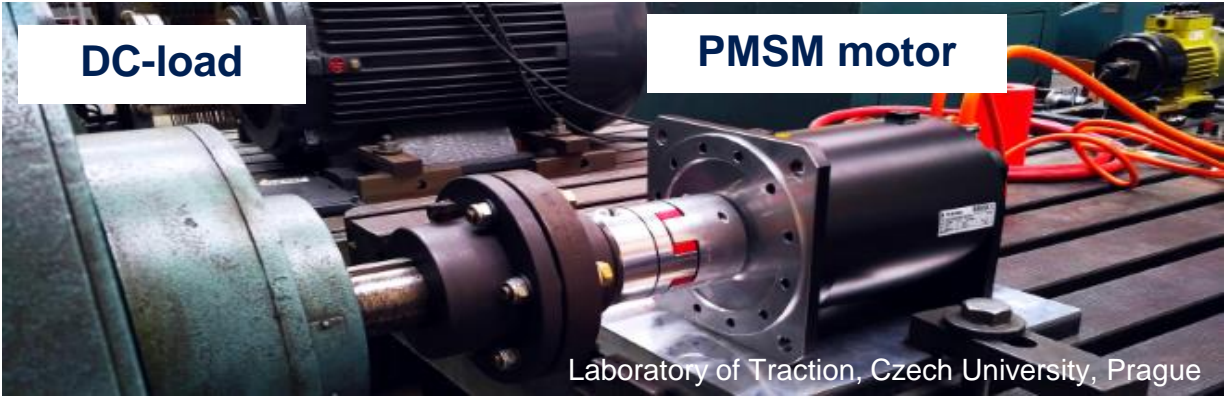
AE Lab as a key enabler of performance benchmarks

Main Applications:

- Robotic & Industrial Drives



ACEPACK Module
650V / 1200V IGBT, 6-Pack or CIB Topology

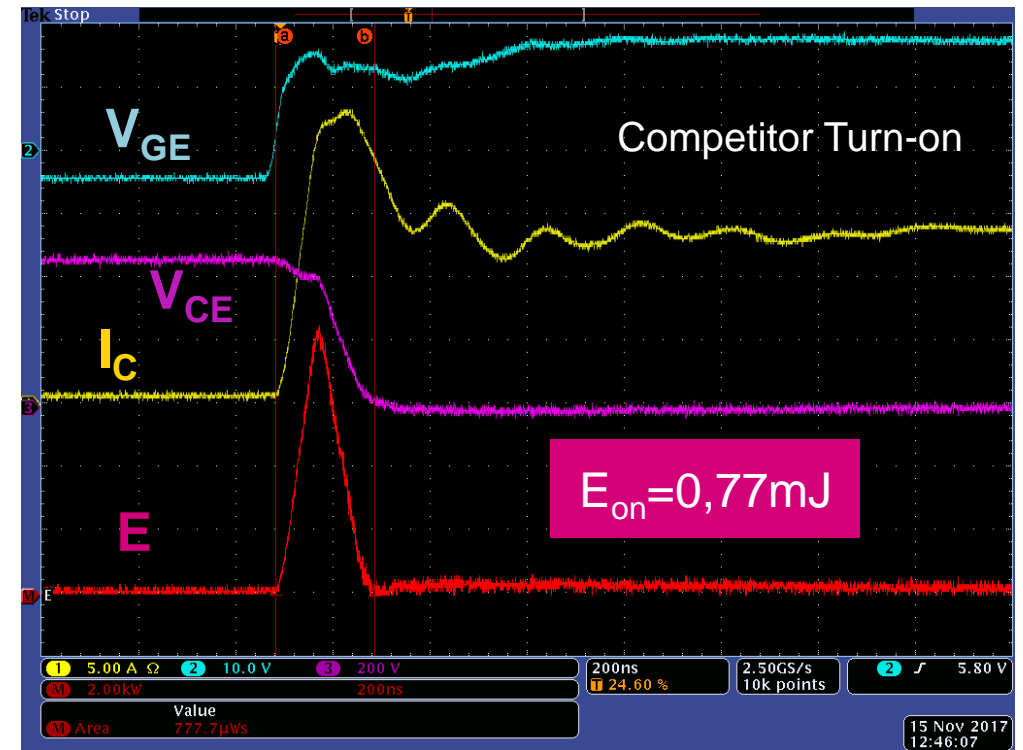
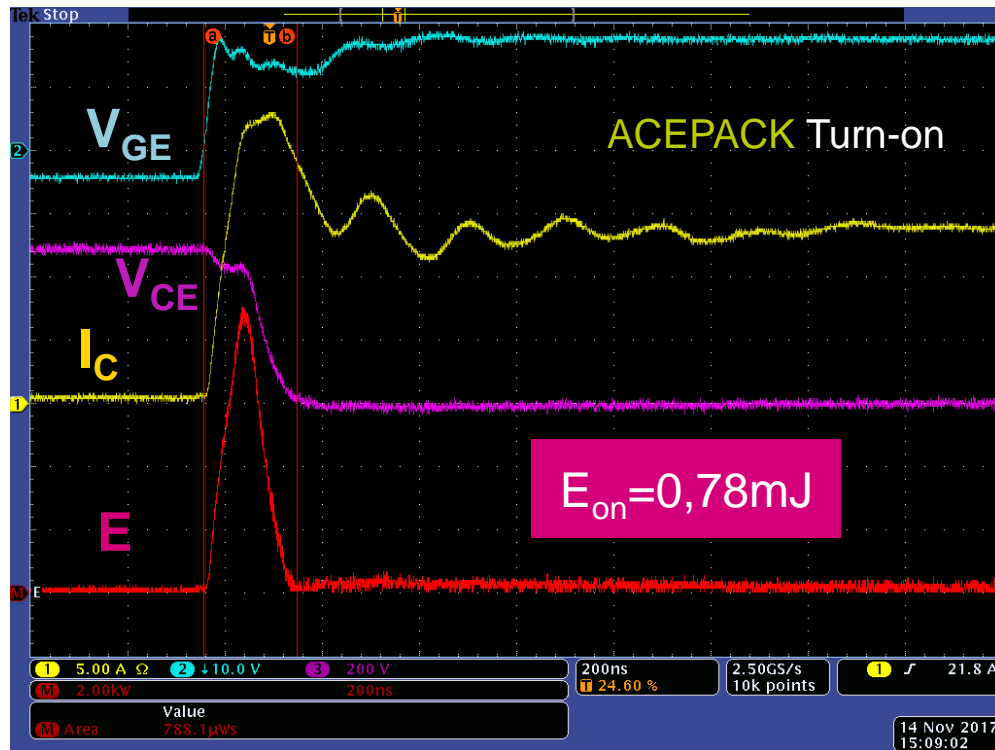


ACEPACK Module is performing in line with the best competition

AC current and IGBT voltages

Application Benchmarks – Motor Control

A1C15S12M3-F vs. 15A/1200V competition device, $I_{peak}=14A$, $V_{DC}=500V$, $L_S=30nH$



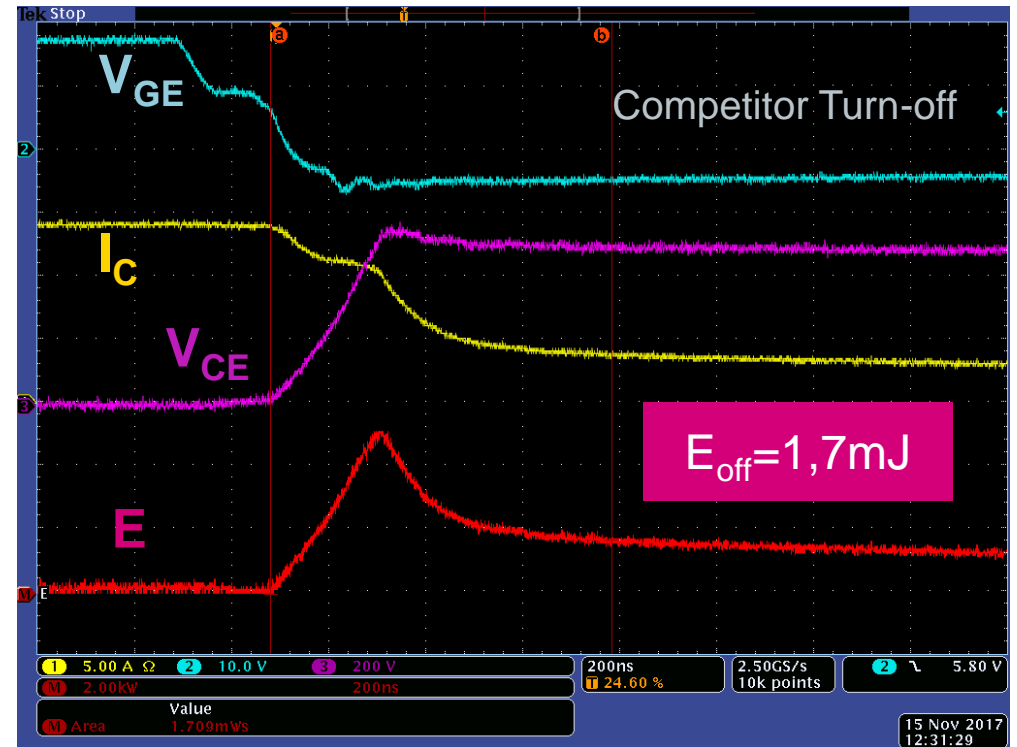
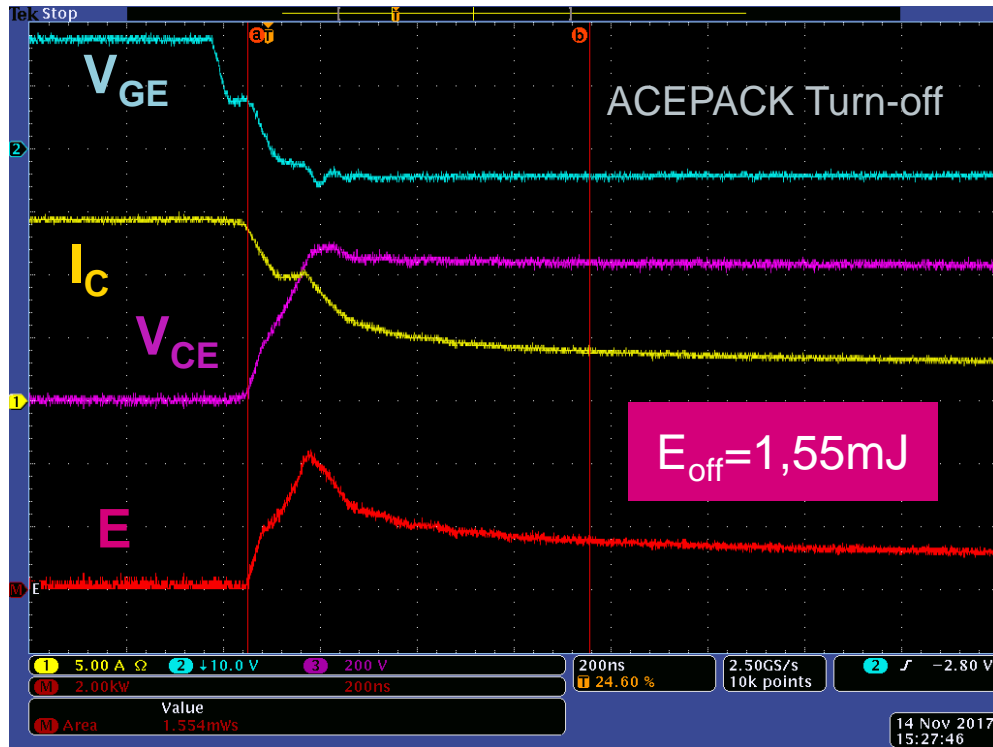
$R_{Gon}=22W$
 $V_{GE} \rightarrow -5V/+15V$

Similar switching speed for datasheet resistors values @ application commutation inductance

$R_{Gon}=39W$
 $V_{GE} \rightarrow -5V/+15V$

Application Benchmarks – Motor Control

A1C15S12M3-F vs 15A/1200V competition device, $I_{peak}=14A$, $V_{DC}=500V$, $L_S=30nH$



$R_{Goff}=22W$
 $V_{GE} \rightarrow -5V/+15V$

ST module shows higher switching speed with datasheet resistors values @ application commutation inductance

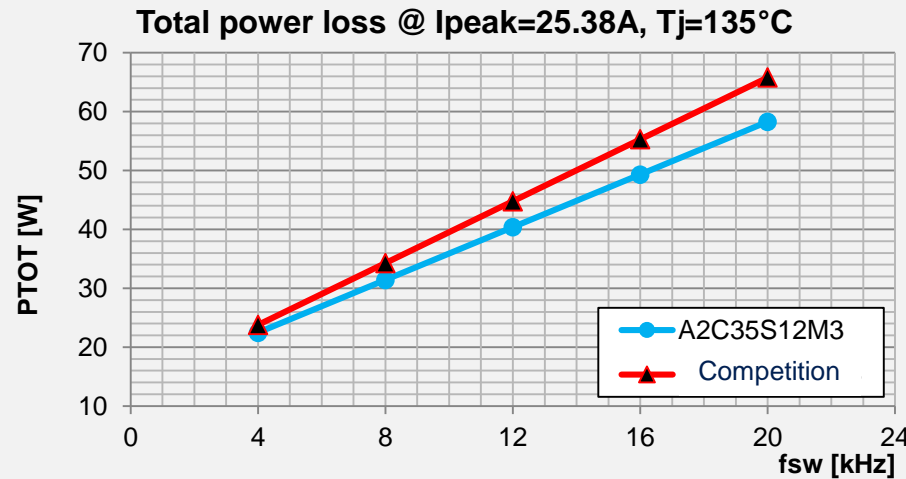
$R_{Goff}=39W$
 $V_{GE} \rightarrow -5V/+15V$

Application Benchmarks – Simulations

A2C35S12M3-F vs. 35A/1200V competition device, Pout=12.5kW

Simulation Conditions

- $V_{DC}=700V$
- $I_{RMS}=18A$
- $R_{Gon}=R_{Goff}=15W$
(different di/dt)
- $\cos\phi=0,93$
- $m=1$
- $T_j=135^\circ C$
- $L_s=100nH$



Simulation Outcome

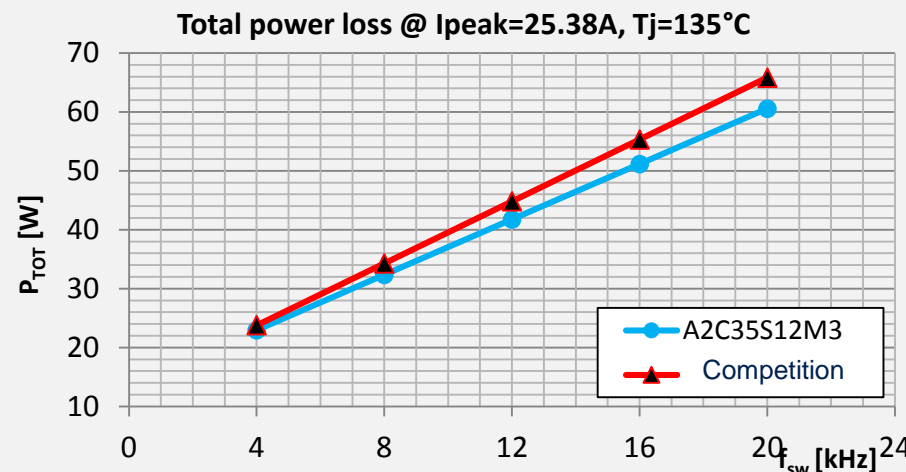
For same gate resistor R_g the ST module has **~ 7,5W less** losses per switch. In total ST modules **saves 45W** of losses per module.

Competition losses are 395W.
ST saves ~ 11% of losses.

More power or better efficiency or lower T_j (4,5°C) with ST module is possible

Simulation Conditions

- $V_{DC}=700V$
- $I_{RMS}=18A$
- $R_{Gon}=R_{Goff}=15W, ST=20W$
(same $di/dt \rightarrow 1750A/\mu s @ 35A$)
- $\cos\phi=0,93$
- $m=1$
- $T_j=135^\circ C$
- $L_s=100nH$



Simulation Outcome

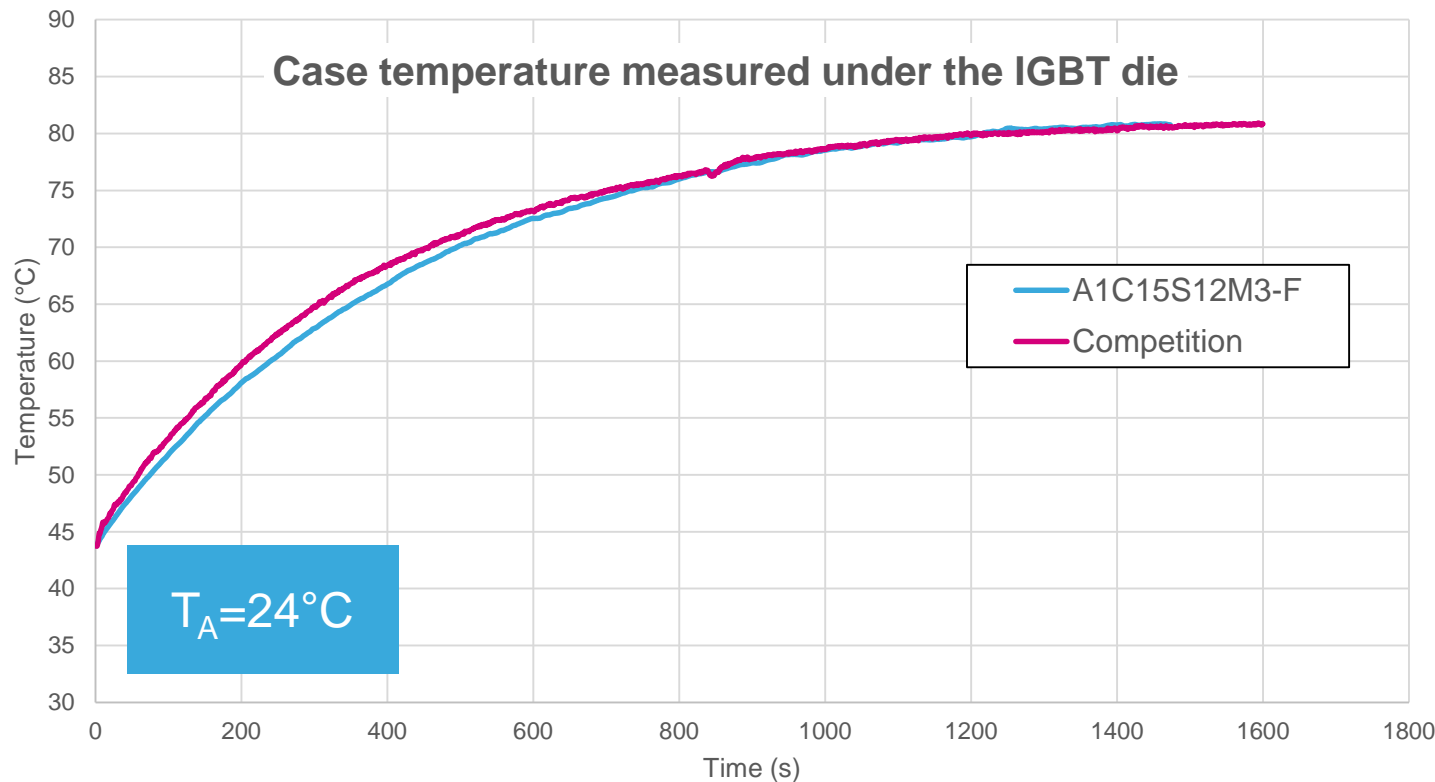
For same $di/dt = 1750A/\mu s$ (@35A, $T_j=150^\circ C$) ST module have **~ 5,3W less** losses per switch. In total ST modules **saves 31W** of losses per module.

Competition losses are 395W.
ST saves ~ 8% of losses.

More power or better efficiency or lower T_j (3,2°C) with ST module is possible

Applications Benchmark – Motor Control

A1C15S12M3-F vs. 15A/1200V competition device, $I_{peak}=14A$, $V_{DC}=500V$, $L_S=30nH$



Inverter conditions

- $V_{DC}=500V$
- $I_{RMS}=10,6A$
- $R_{Gon}=R_{Goff}=22W$ (ST)
- $R_{Gon}=R_{Goff}=39W$ (Competition)
- $\cos\phi=0,93$
- $P_{out-mechanic}=1170W$



In application conditions, the module case temperature remains similar for ST and the competition product. Here relatively low mechanical power was measured

ACEPACK™ & Design-in Tools

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STVAL-CTM002V1 board enables quick ACEPACK™ evaluation



Complete board ready to test with AC motor

3-phase input and output

Overvoltage and Overload protection

Full compatibility with MC STM32 ecosystem

RS232 and CAN connection

Board includes: A2C35S12M3-F, STGAP1S, STM32F303, DC/DC module...

The dynamic electro-thermal simulation software dedicated to ST power devices

ST PowerStudio



ST PowerStudio

Developed for

- SLLIMM, ACEPACK, Discrete*
- Several Applications
- Windows, MAC OS X*, Android* and iOS*

Powerful and flexible

- Dynamic load sim. (up to 10 steps)
- Long mission profile duration of hours
- Several thermal setup

Connectivity

- Multilanguage (English, Chinese*, Japan*, ...)
- Quick link with st.com documents
- PDF Output Report

Product Selection

Application: DC-AC [Reset]

Topology (mandatory field): 3-phase 2-level

Topology Design: [Circuit Diagram]

Product Information:

- Configuration: IGBT Converter Inverter Brake
- Package: ACEPACK 1
- Package size: 33.8 mm x 48 mm
- Package technology: Plastic case with DBC
- Pin option: Solder pins
- Voltage (V): 1200
- Current (A) @Tc=100°C: 15
- Temperature monitoring: Integrated NTC

Package: [Image of ACEPACK 1 package]

Family: ACEPACK

Device (16) (mandatory field): A1C15S12M3 [Web Page]

Mission Profile: Static Load Dynamic Load

Thermal Set-up: Fixed T Heatsink Without Heatsink Fixed Heatsink Rth (°C/W) 2

Heatsink Zth Parameters:

	(Ω)	(s)
R1	2	τ1 100
R2	0	τ2 0
R3	0	τ3 0
R4	0	τ4 0

Input Data:

	Limits	
t_sim: Simulation time (s)	0.001 ÷ 15	1.0
Iph: RMS Phase Current (A)	0.01 ÷ 15	1.00
Pout: Output Power (W)	0.1 ÷ 20000	216.37
Vdc: DC Link Voltage (V)	20 ÷ 960	300.00
fsw: Switching Frequency (kHz)	1 ÷ 40	10
fsine: Output Frequency (Hz)	0.1 ÷ 500	50
PF: Power Factor	0.1 ÷ 1	0.8
MI: Modulation Index	0.01 ÷ 1	0.85
Tamb: Ambient Temperature (°C)	25 ÷ 100	50
Ths: Heatsink Temperature (°C)	25 ÷ 150	90.0

Steady State: No

Output Data

	T1	D1
Conduction Loss (avg) (W)	0.32	0.10
Switching Loss (avg) (W)	0.46	0.49
Total Loss (avg) (W)	0.78	0.60
Junction Temp. (Max) (°C)	91.98	92.46
Junction Temp. (avg) (°C)	91.36	91.54
T1+D1 Total Loss (avg) (W)	1.38	
System Total Loss (avg) (W)	8.28	
Heatsink Temperature (Max)	90.00	
Heatsink Rth (°C/W)	4.83	

Charts

Graph 1: Junction Temperature vs. time

Graph 2: T1-D1 Power Loss vs. time

Close Start Stop Report About Manual Forum



* Available in the next releases

Qualified accordingly to industrial standards

Test	PC	Std ref.	Conditions	SS	Steps
Die Oriented Tests					
TEST		User specification	All qualification parts tested per the requirements of the appropriate device specification.		
External visual		JESD22 B-101	All devices submitted for testing		
HTRB	N	JESD22 A-108	Tj = 125°C, BIAS = 960V Tj = 125°C, BIAS = 520V	25	1000 h
HTGB	N	JESD22 A-108	Tj = 125°C, BIAS = 30V	25	1000 h
HTSL	N	JESD22 A-102	TA = 125°C	25	1000 h

Test	PC	Std ref.	Conditions	SS	Steps
Package oriented test					
H3TRB	N	JESD22 A-101	TA=85°C ; RH=85% BIAS = 100V	35	1000 h
AC	N	JESD22 A-102	Pa=2Atm / Ta=121°C	35	96 h
TC	N	JESD22 A-104	Ta = -40°C to 125°C	50	500 cy
PwCy	N	Mil-Std 750D Method 1037	ΔTj≥100°C , Imax=75A (A2P75S12) Imax=35A (A1P35S12) Imax=15A (A1C15S12)	15	200Kcy
IOL	N		ΔTc=60°C (ΔTj≥100°C) , Imax=75A , Ton=1sec / toff=39sec	15	10Kcy
ESD		ESDA-JEDEC JES-001 ANSI-ESD S5.3.1	HBM	9	
Vibration Test		JESD22 B-103	VIBRATION: a=3g; f=5/500Hz; 4' x 3 orientat. x 4cycles		



Future Semiconductors and Topologies

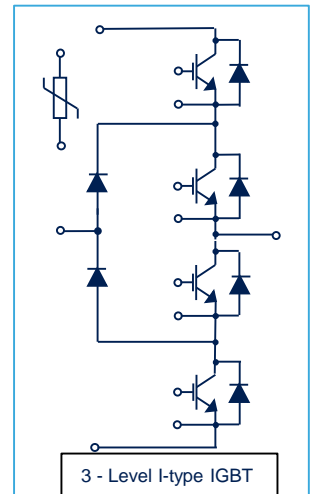
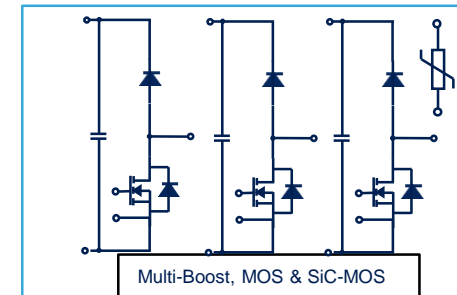
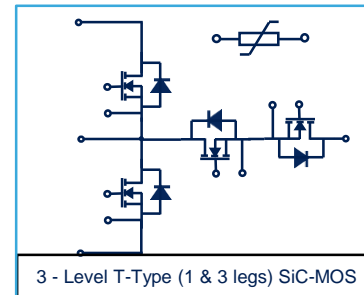
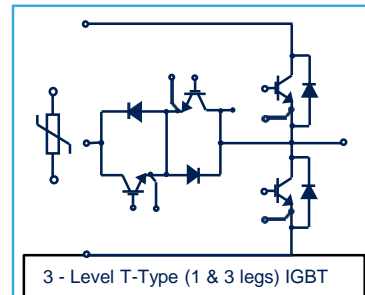
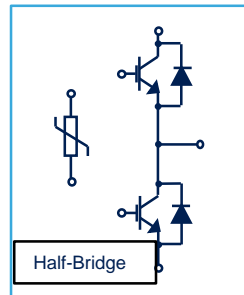
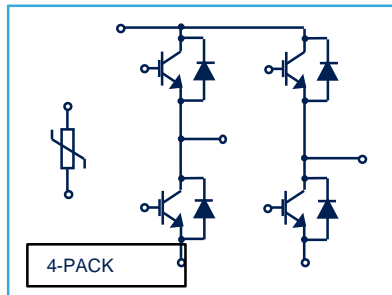
Selected topologies and ST semiconductors

Variety of possible topologies

- 3-phase bridges with rectifiers (CIB)
- 3-phase bridges (PACK)
- Half-Bridge
- 3-level T and I types
- booster multi-phase
- ...

Variety of semiconductors

- IGBT, 650V, 1200V (variety of types)
- Si diodes, 650V, 1200V (variety of types)
- Silicon Carbide MOSFETs
- Silicon Carbide Diodes
- HV MOSFETS
- SCR and rectifier diodes
- ...



Flyers and Technical Notes

ACEPACK™: Adaptable, Compact, and Easier Packages Power Modules



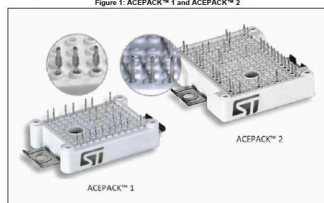
Compact, high-performance power modules for simple, efficient and rugged industrial motor designs up to 30 kW

- ST offers new ACEPACK 1 and ACEPACK 2 Power Modules with Space and Converter Inverter Brakes (CIB) topologies. With an embedded NTC thermistor, these highly reliable power modules offer the best compromise between conduction and switching loss, maintaining the efficiency of any converter system up to 20 kHz in hard-switching circuit for an application range from 3 to 30 kW. Offering PressFit and additional solder pin options for flexible and stable mounting, these robust power modules, which are part of ST's M series French Golex Field-Stop IGBTs, ensure a compact design and cost-effective system.
- KEY FEATURES**
 - 15 to 75 A current rating at 25 °C
 - 500V to 600V (breakdown voltage) IGBT topologies
 - 2.5 kV motor voltage (V_{CE} - I_{CE})
 - Integrated 5k NTC temperature sensor
 - Soft and fast recovery diode
 - PressFit and solder comb pin options
 - Robust and easy mounting system
 - Low energy inductive load design
 - KEY BENEFITS**
 - High power density
 - High reliability and quality
 - 175 °C maximum junction temperature for increased robustness
 - KEY APPLICATIONS**
 - Industrial motor drive
 - 3-phase inverter for motor drives up to 30 kW
 - Uninterruptible power supplies (UPS)
 - Hybrid and electric vehicles (HEV and EV)



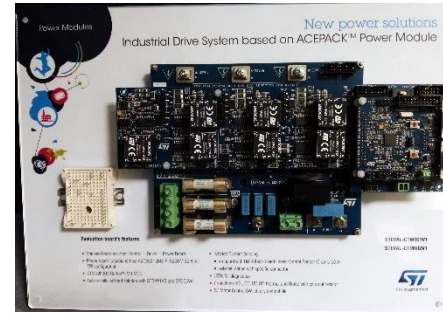
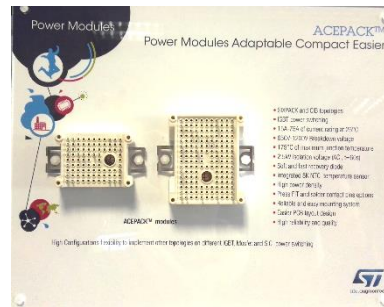
TN1250 Technical note Press-fit ACEPACK™ power modules mounting instructions

Introduction
ST introduces the ACEPACK™ Power Module family, designed for easy mounting and reliable performance in rugged applications. The available module form factors are ACEPACK™ 1 with 33.8 mm x 49 mm and ACEPACK™ 2 with 55.7 mm x 45 mm body dimensions. Various die selections in silicon and silicon carbide substrates can be housed in several configurations. These modules feature a compact, fully isolated, low profile housing able to integrate very high power density components in a low junction-to-case thermal resistance DSC. Power modules simplify the design and increase reliability, while PCB size and system costs are optimized. The following sections provide recommendations for the connection of these modules to a printed circuit board (PCB) and mounting and dismounting methods to achieve adequate connections, reliability and performance in typical applications.

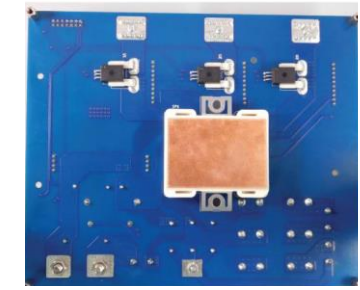
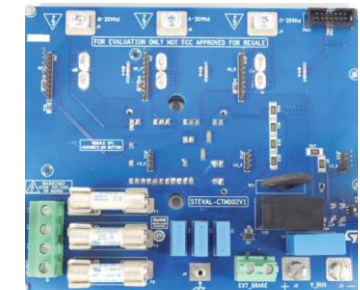


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Promotional plastic panel



Reference Designs



STEVAL-CTM002V1

STEVAL-CTM001V1

Power Modules

ST Offers for Power Modules Applications

Brief Overview

Presentations e-presentations

Evaluation Tool Software

ST PowerStudio

Product Selection

Application: DC-AC

Topology (Mandatory Field): Inverter

Topology Design: IGBT

Family: ACEPACK

Device (Mandatory Field): ACEPACK2

Package: TO-247

Input Data:

U _{in} (Simulation time (s))	0.001 - 15	1.0	No
I _g (RMS Phase Current (A))	0.001 - 15	1.00	No
P _{out} (Output Power (W))	0.1 - 20000	218.17	No
V _{dc} (DC Link Voltage (V))	20 - 960	300.00	No
f _{sw} (Switching Frequency (kHz))	1 - 40	10	No
f _{mod} (Output Frequency (Hz))	1 - 500	50	No
PF (Power Factor)	0.1 - 1	0.8	No
M ₁ (Modulation Index)	0.0 - 1	0.85	No
T _{amb} (Ambient Temperature (°C))	25 - 150	50	No
T _{case} (Case Temperature (°C))	25 - 150	50.0	No

Product Information:

Configuration: IGBT Converter Inverter Brake	
Package: TO-247	
Package size: 33.8 mm x 49 mm	
Package mounting: Press-fit with GRC	
Voltage (V _{CE})	500
Current (I _{CE})	15
Temperature (junction)	175

Charts:

- Graph 1: Junction Temperature vs. time
- Graph 2: T_J-D_T Power Loss vs. time

STSW-POWERSTUDIO



Grazie
감사합니다
謝謝

Merci
Danke
Thanks

For additional information, please visit:

http://www.st.com/content/st_com/en/products/power-modules/acepack-power-modules.html