ST Offer for Power Modules

Brief Overview

March 21, 2018

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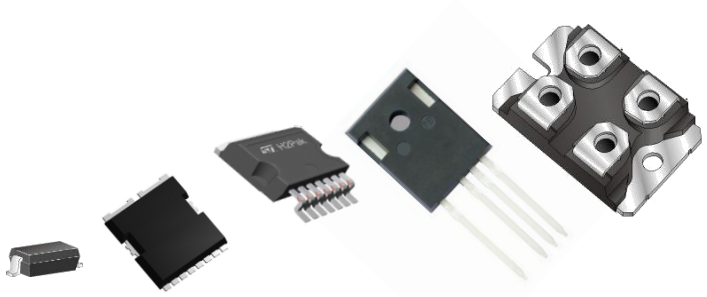
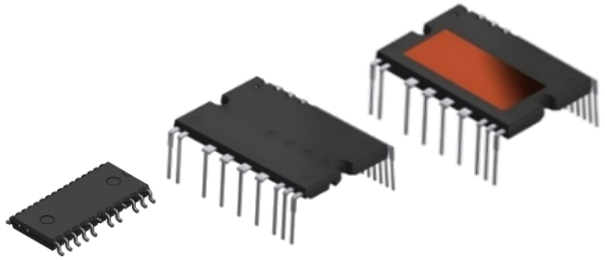
Power Transistor Division

Power Product Portfolio

From Discrete to Power Modules, ST leads the innovation





Discrete & Drivers & SIP	SLLIMM™ IPM	ACEPACK™ Power Modules
Typical Power: 10 W ÷ 5 kW	Typical Power: 20 W ÷ 3 kW	Typical Power: 3 kW ÷ 30 kW

Ideal solutions for Industrial & Robotic Drives, Home Appliances, Welding, Pumps, Fans & Blowers, Air Conditioning

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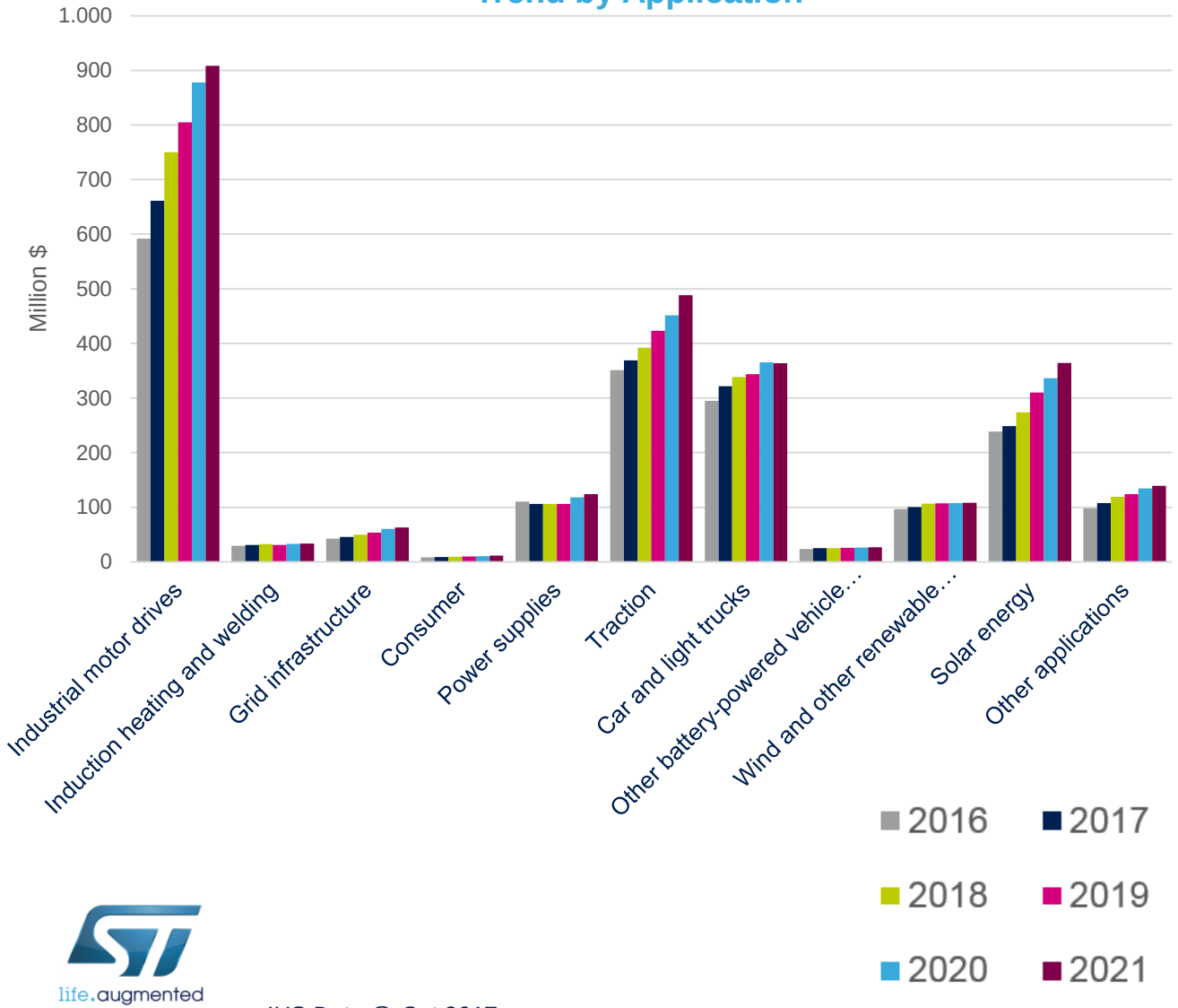
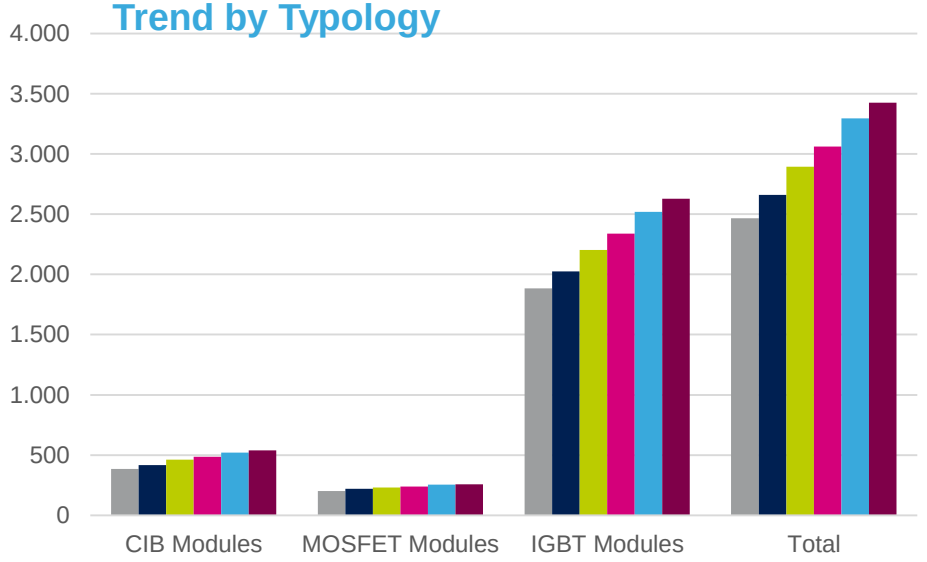
Module Market Trends 2016-2021

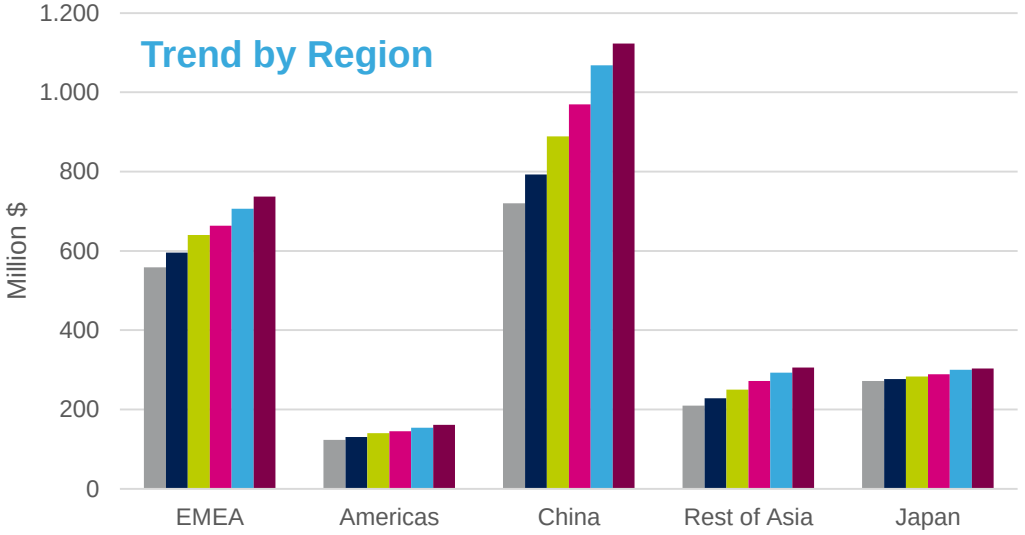
Trend by Application



Trend by Typology



Trend by Region



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IHS Data @ Oct 2017

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

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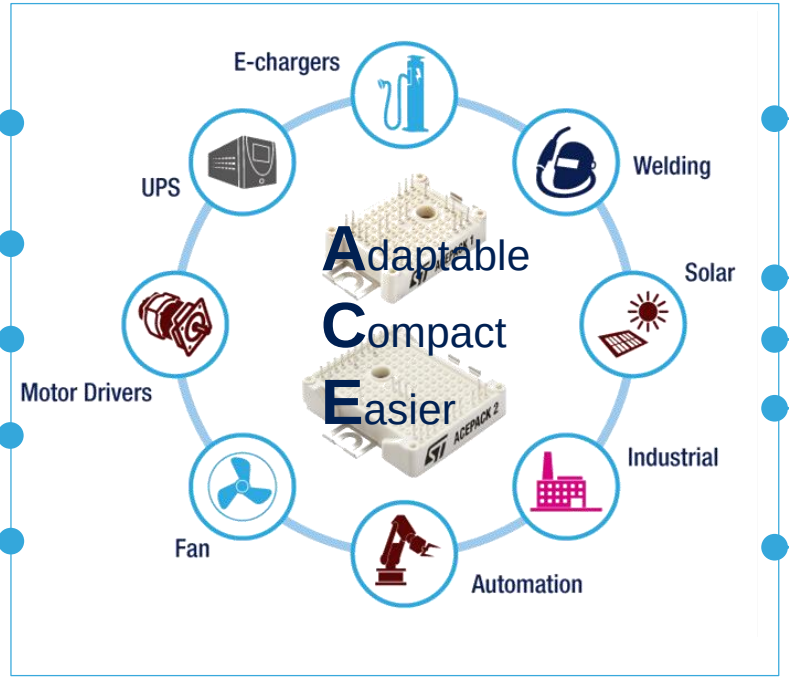
Features and Benefits

- 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

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Technology & Flexibility to Address Market Needs

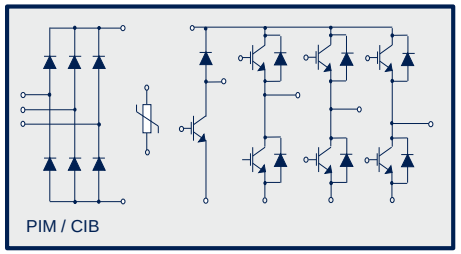
Main Features

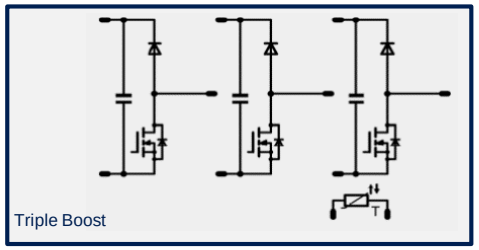
- Compact module concept
- Configuration flexibility
- Press FIT and solder pins options
- High power density
- Reliable and easy mounting system
- Integrated temperature sensor available
- Low stray inductance module design
- PCB layout design
- High reliability and quality
- RoHS-compliant modules

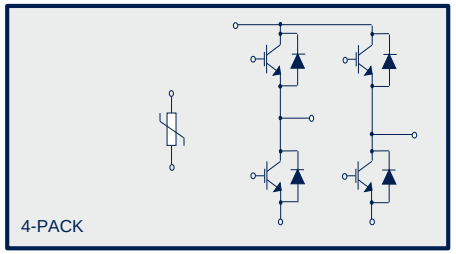
ST Power Switch capability

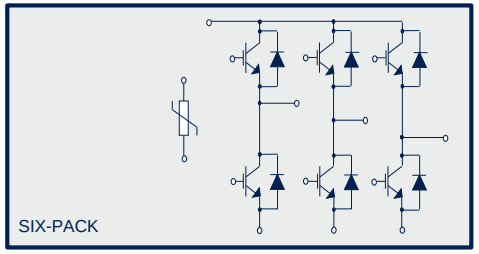
- IGBTs
- HV MOSFETs
- Diodes
- Bridge Rectifier Diodes
- Silicon Carbide MOSFETs
- Silicon Carbide Diodes
- SCR….etc.

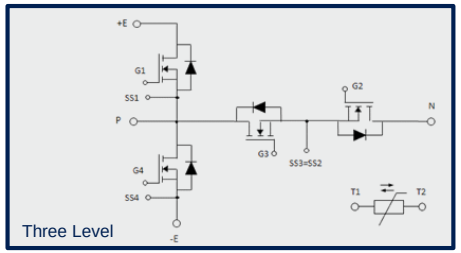
Main Topologies can be addressed in ACEPACK


PIM / CIB

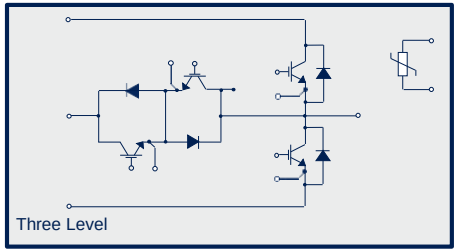

Triple Boost

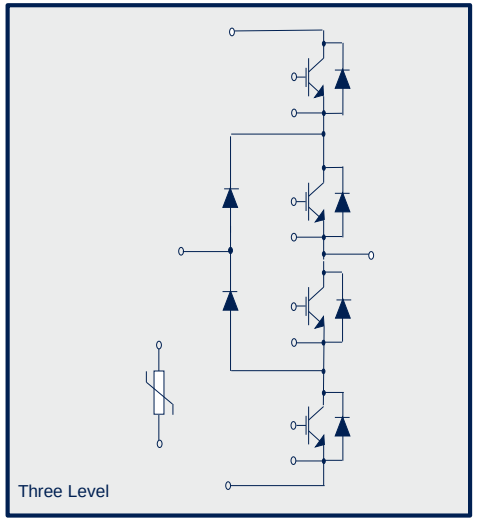

4-PACK


SIX-PACK



Three Level


Three Level


Three Level

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

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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.

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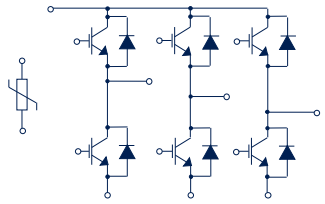
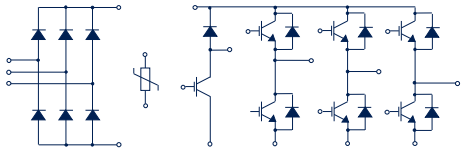
ACEPACK Module for Motor Control

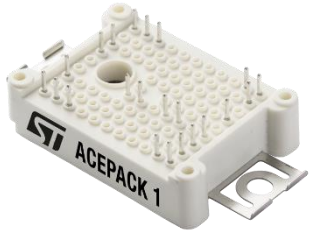
Standard products in MP (solder and press fit pins)



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

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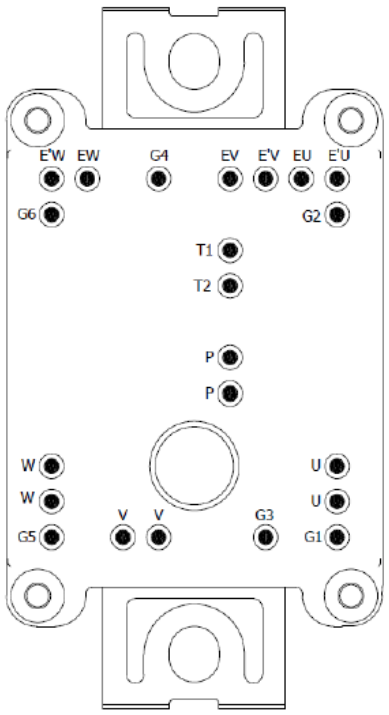
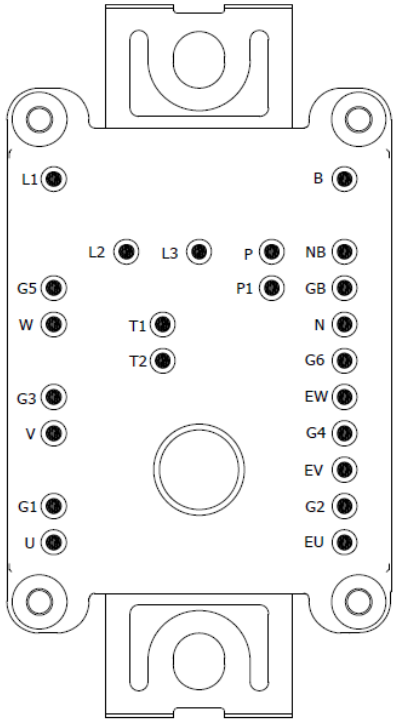
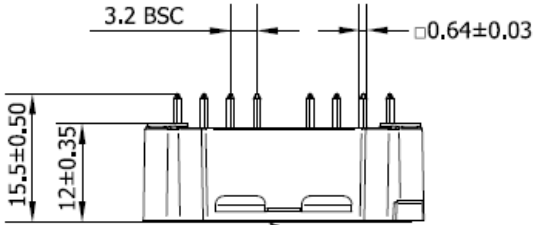
ACEPACK 1 Package

SIXPACK

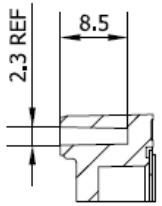


CIB

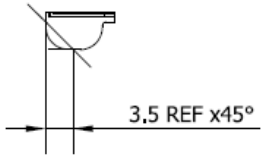


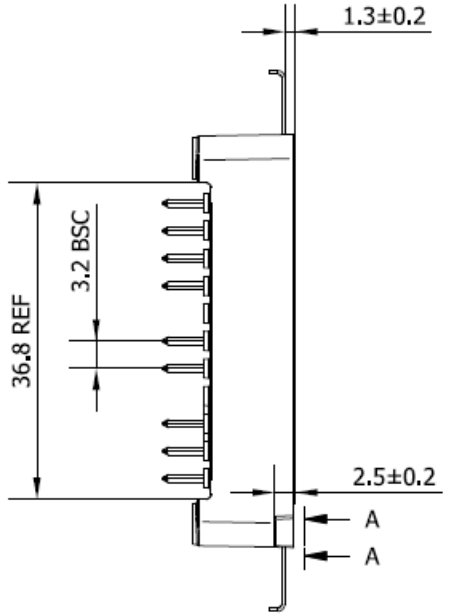


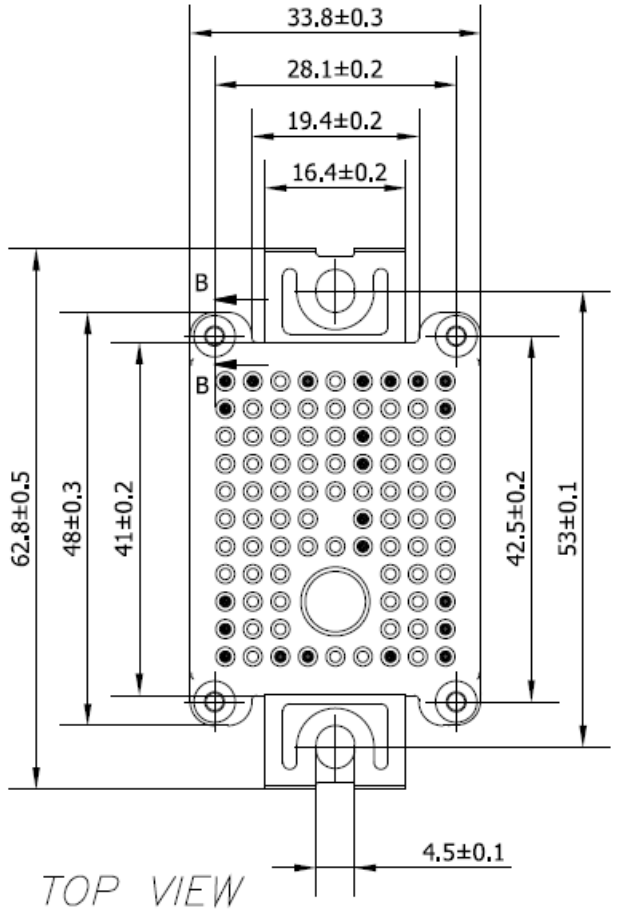
Section B-B



Detail A







TOP VIEW

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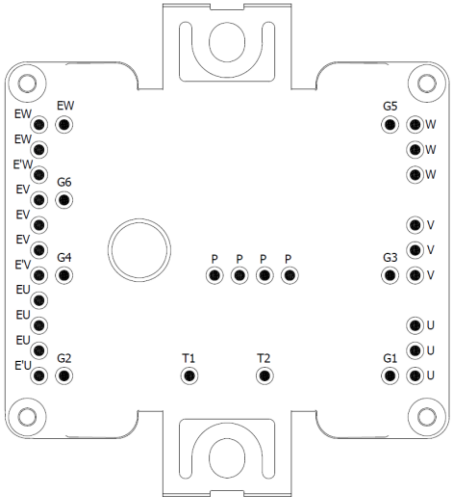
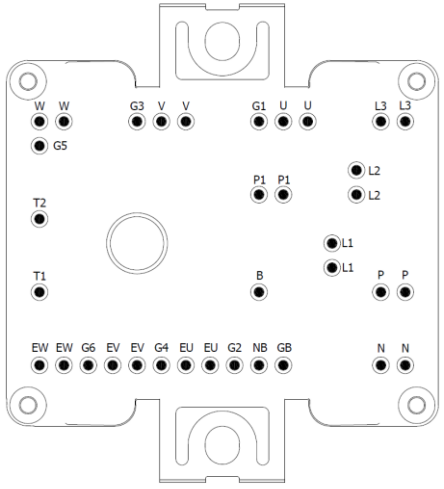
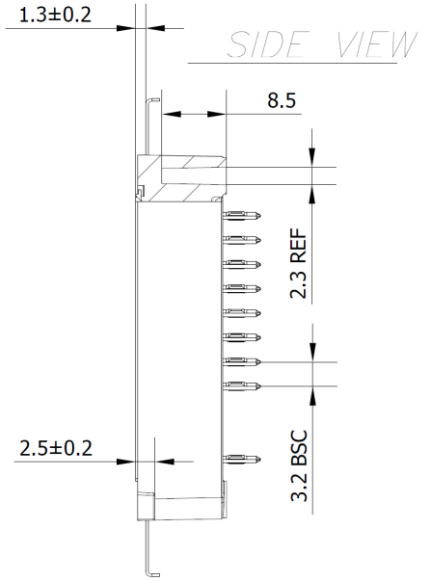
ACEPACK 2 Package

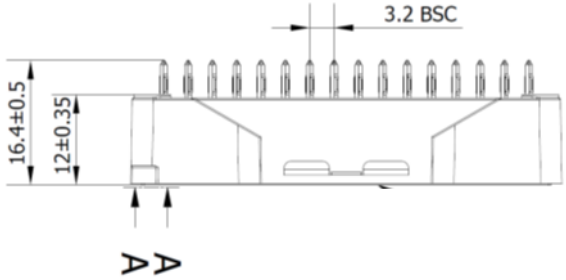
SIXPACK

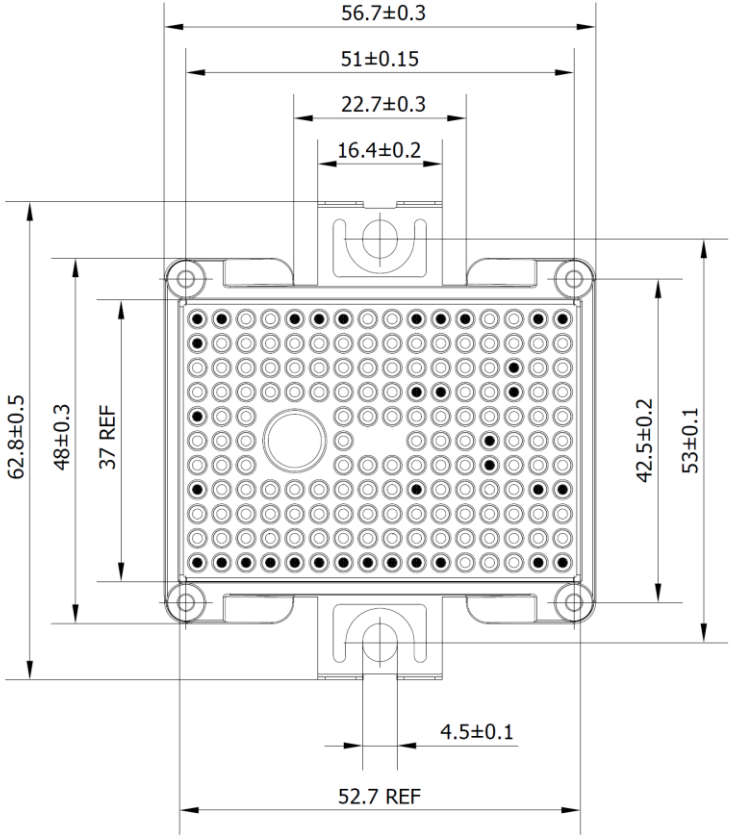


CIB









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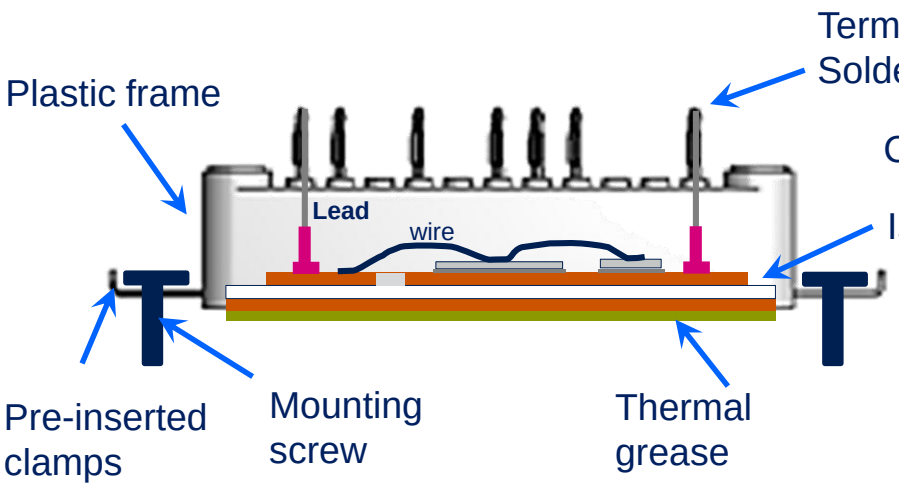
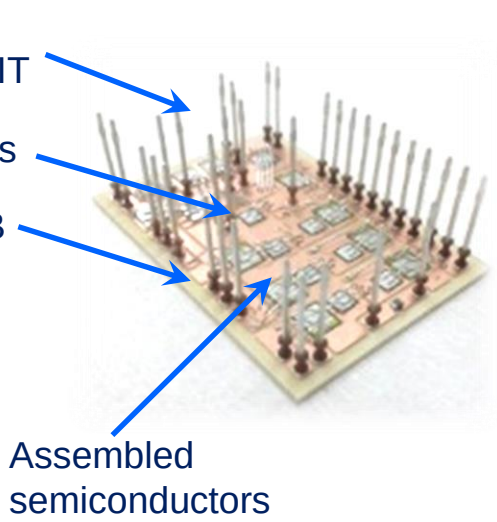
ACEPACK - Package Technology

Build from: DCB / high current pin / plastic housing

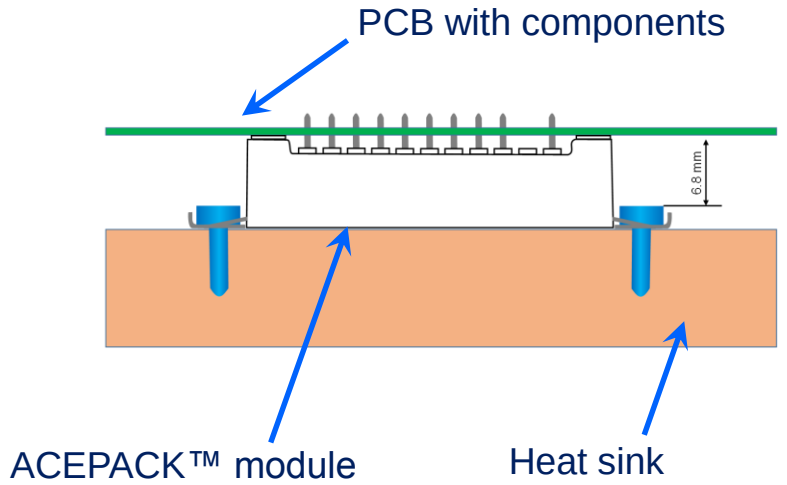
ACEPACK assembly structure



DBC 'inside' view



Assembled module



Housing provides best-in-class technology standards

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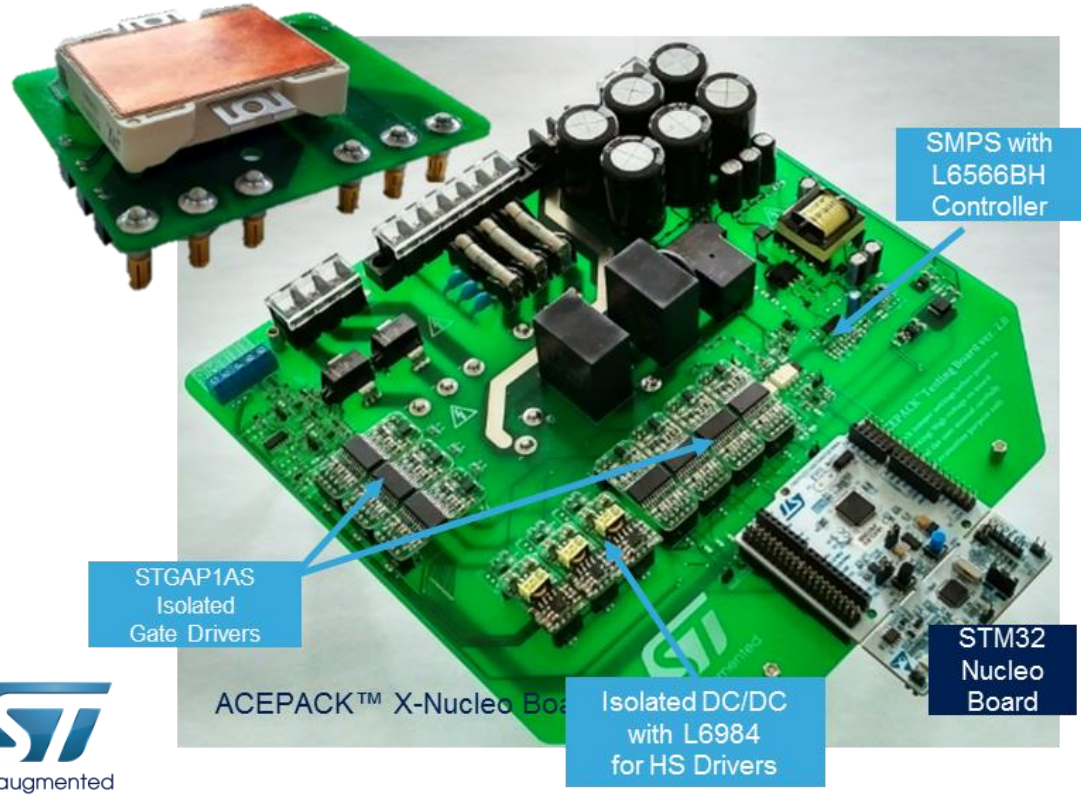
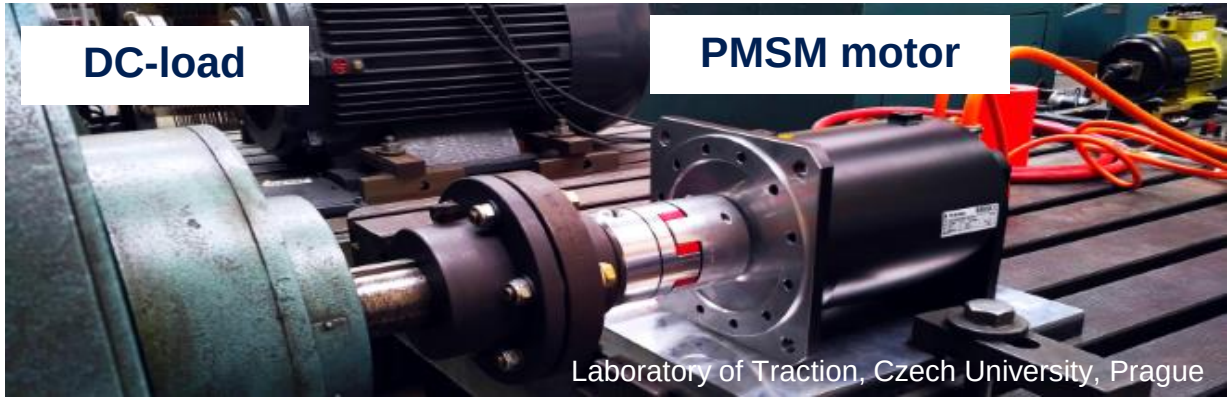
ACEPACK Test in ST Lab

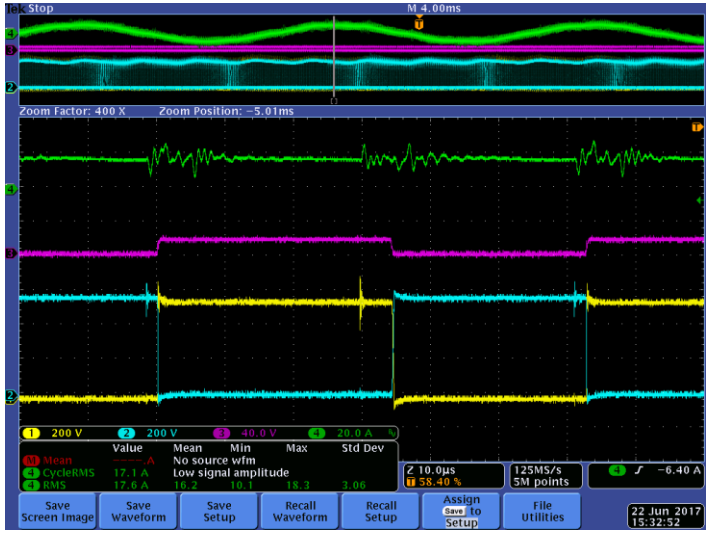
AE Lab as a key enabler of performance benchmarks

Main Applications:
- Robotic & Industrial Drives

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







AC current and IGBT voltages

ACEPACK Module is performing in line with the best competition

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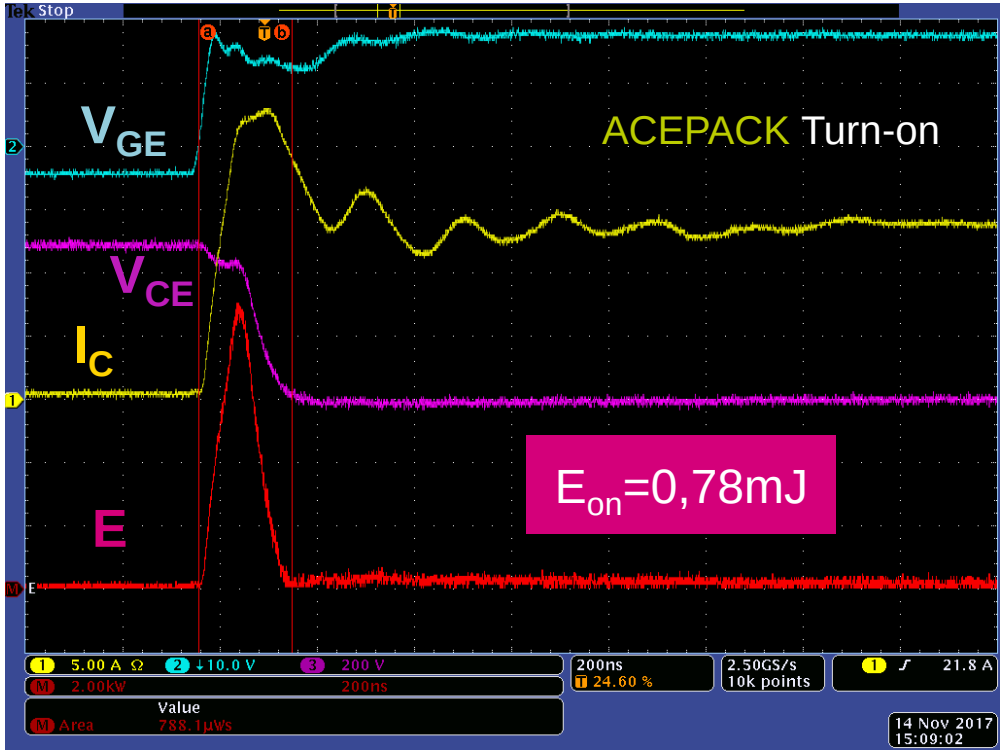
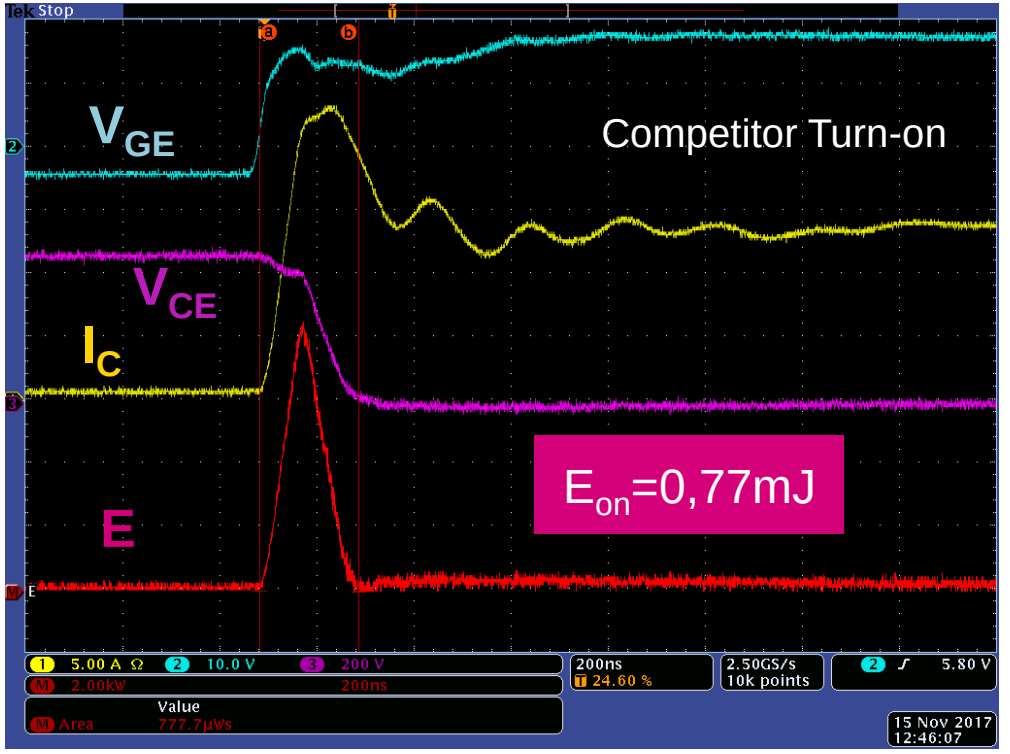
Application Benchmarks – Motor Control

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





R_{Gon}=22W
V_{GE} → -5V/+15V

Similar switching speed for datasheet resistors values
@ application commutation inductance

R_{Gon}=39W
V_{GE} → -5V/+15V

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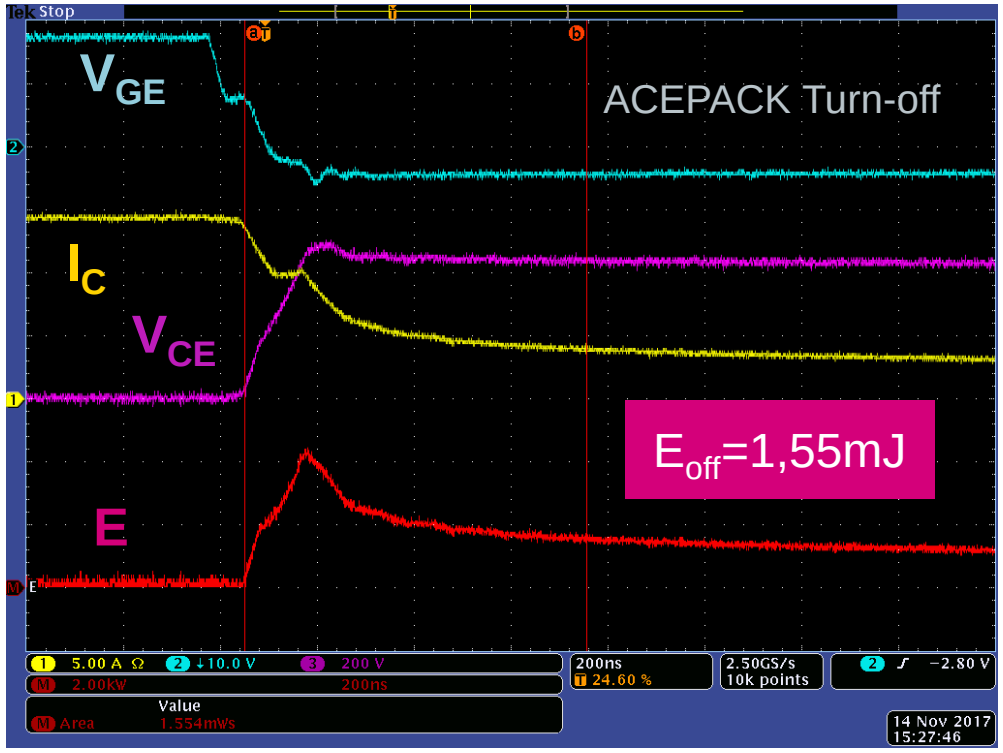
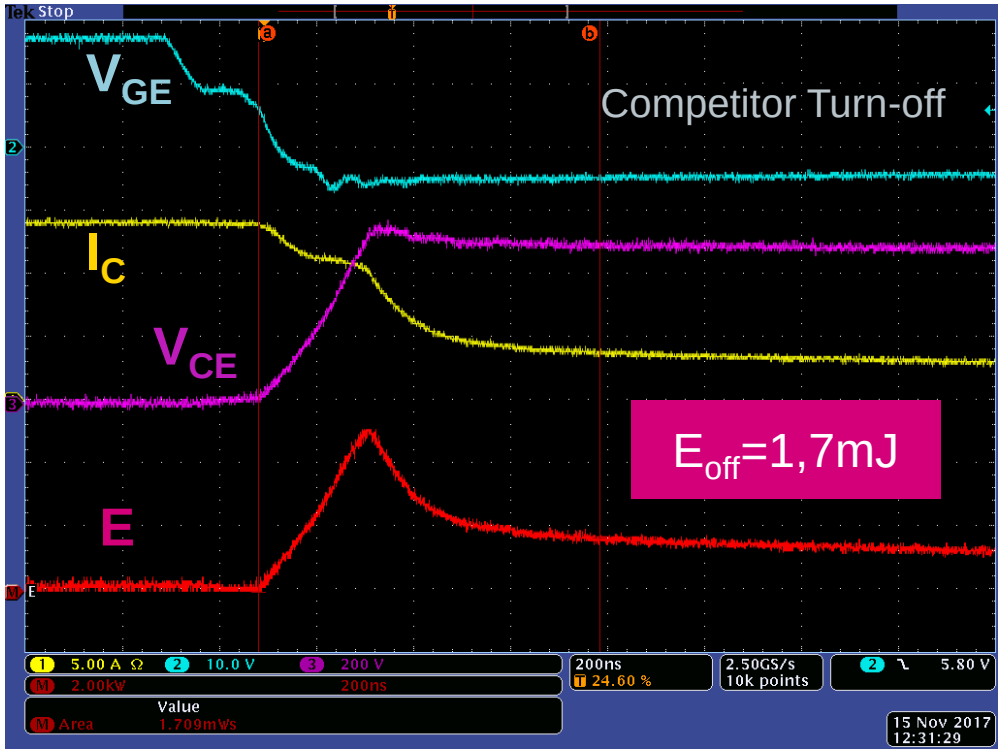
Application Benchmarks – Motor Control

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





R_{Goff}=22W
V_{GE} → -5V/+15V

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

R_{Goff}=39W
V_{GE} → -5V/+15V

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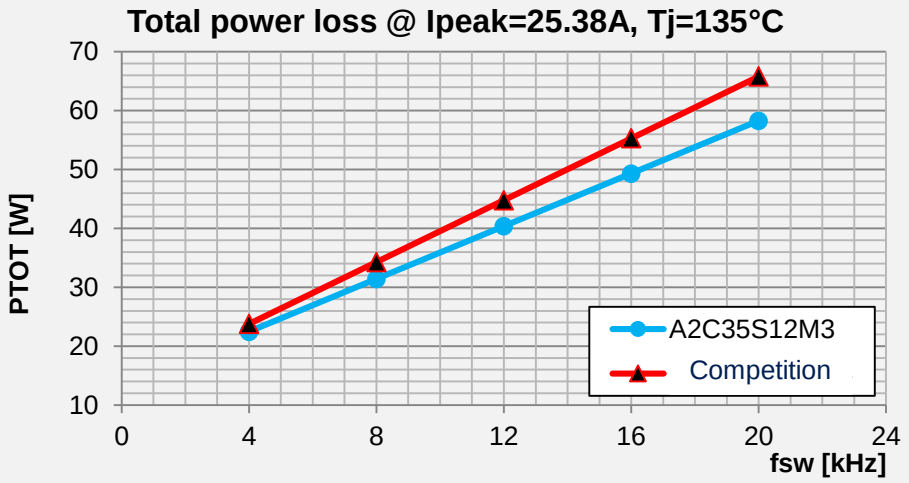
Application Benchmarks – Simulations

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)
- → CosPhi=0,93
- → m=1
- → Tj=135°C
- → L_S=100nH



Simulation Outcome

For same gate resistor Rg 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.

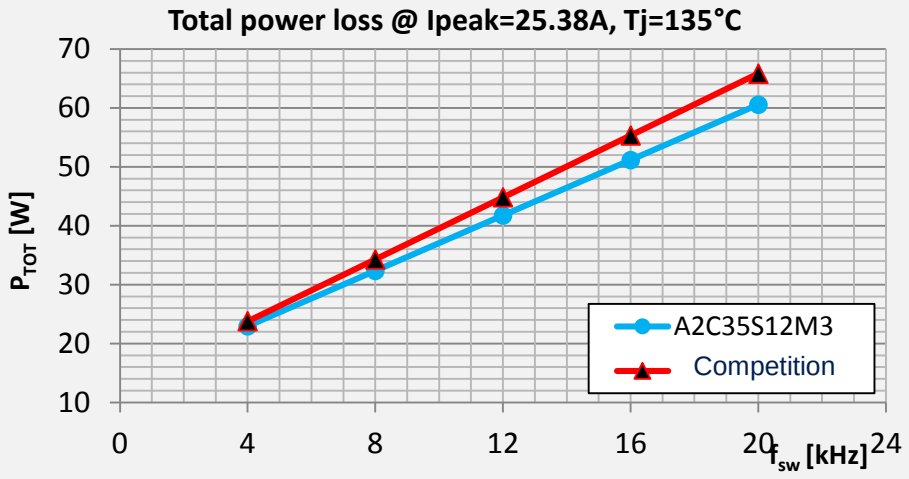
More power or better efficiency or lower Tj (4,5°C) with ST module is possible

Simulation Conditions

- → V_{DC}=700V
- → I_{RMS}=18A
- → R_{Gon}=R_{Goff}=15W, ST=20W

(same dI/dt → 1750A/µs@35A)

- → CosPhi=0,93
- → m=1
- → Tj=135°C
- → L_S=100nH



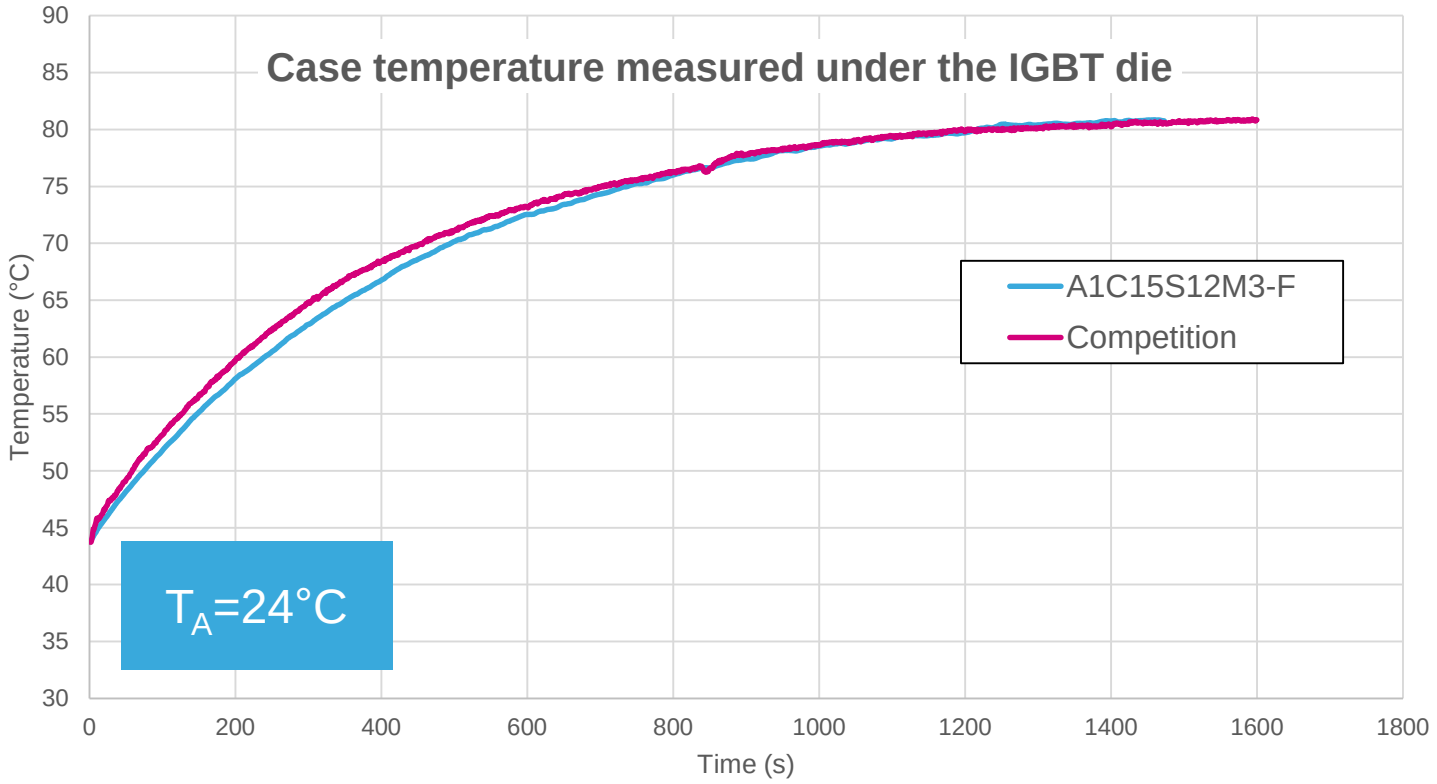
Simulation Outcome

For same dI/dt = 1750A/µs (@35A, Tj=150°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 Tj (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}=Rg_{Goff}=22W (ST)
- → R_{Gon}=R_{Goff}=39W (Competition)
- → CosPhi=0,93
- → $P_{out\text{-}mechanic}$=1170W

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

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ACEPACK™ & Design-in Tools

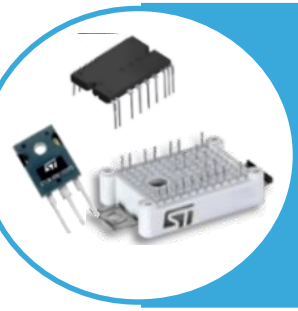
STEVAL-CTM002V1 board enables quick ACEPACK™ evaluation

- 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…

ST PowerStudio

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



Developed for

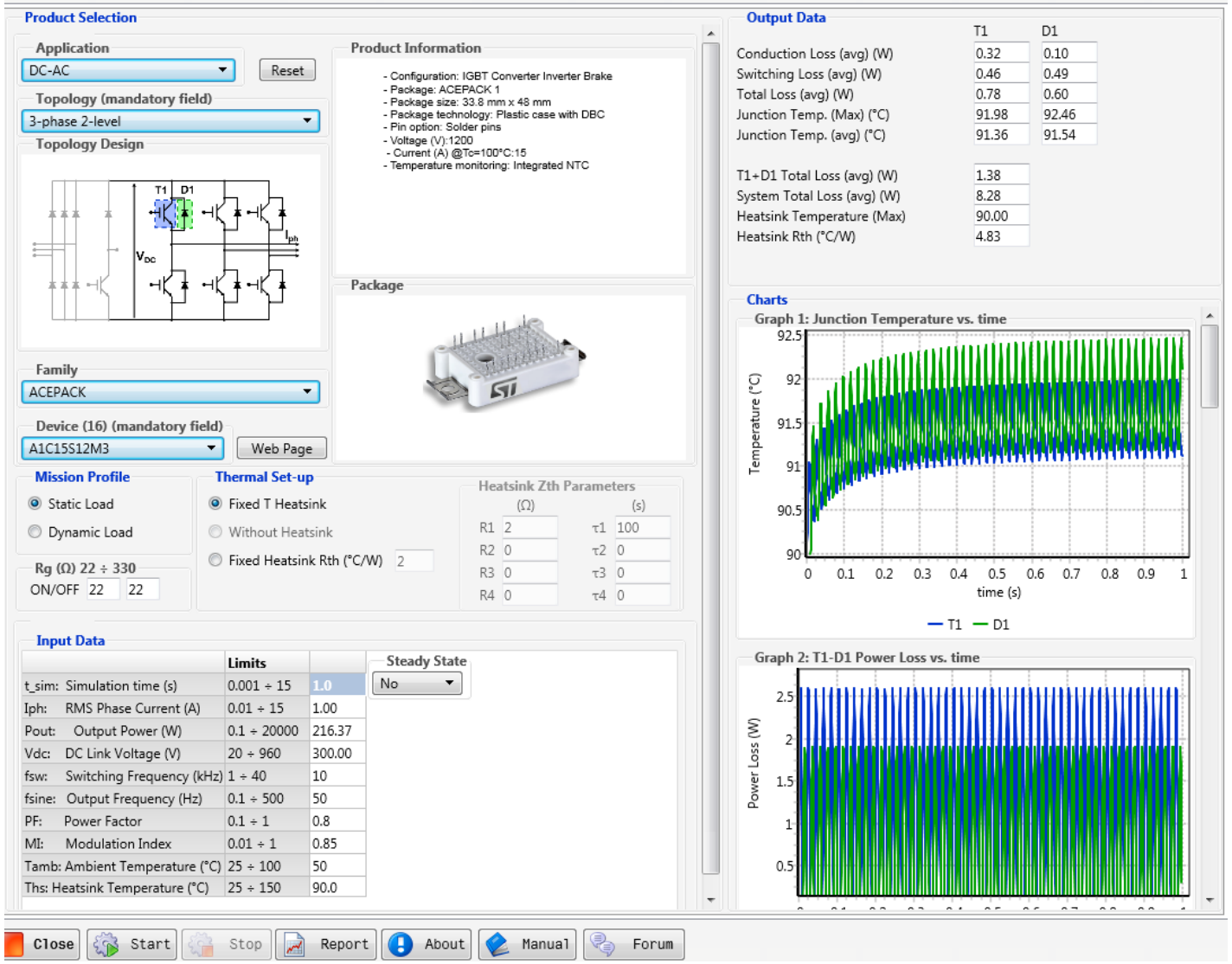
- SLLIMM, ACEPACK, Discrete*
- Several Applications
- Windows, MAC OS X*, Android* and iOS*

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



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* Available in the next releases

ACEPACK Quality

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		

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Future Semiconductors and Topologies

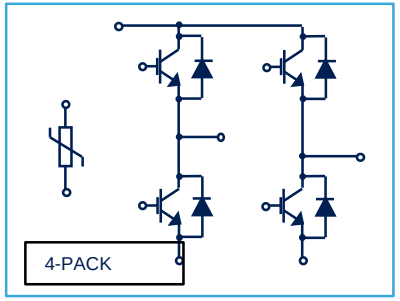
Selected topologies and ST semiconductors

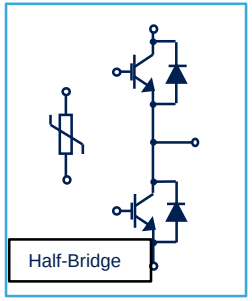
Variety of possible topologies

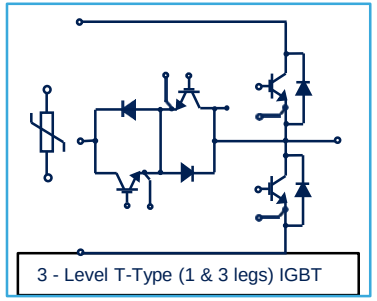
- → 3-phase bridges with rectifiers (CIB)
- → 3-phase bridges (PACK)
- → Half-Bridge
- → 3-level T and I types
- → booster multi-phase
- → …

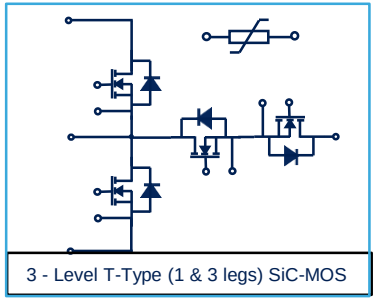
Variety of semiconductors

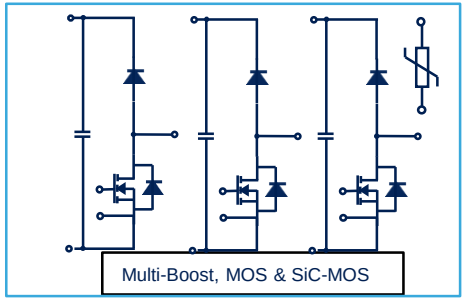
- → IGBT, 650V, 1200V (variety of types)
- → Si diodes, 650V, 1200V (variety of types)
- → Silicon Carbide MOSFETs
- → Silicon Carbide Diodes
- → HV MOSFETS
- → SCR and rectifier diodes
- → …

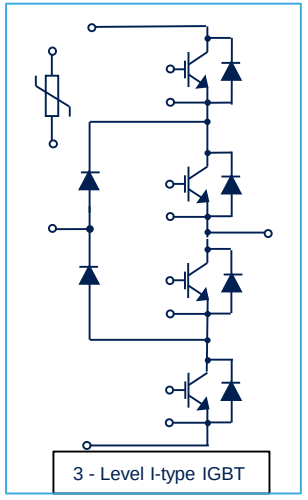












Semiconductors and package ownership makes ST offer unique

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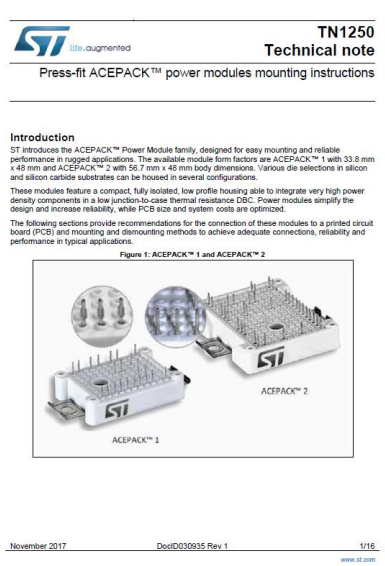
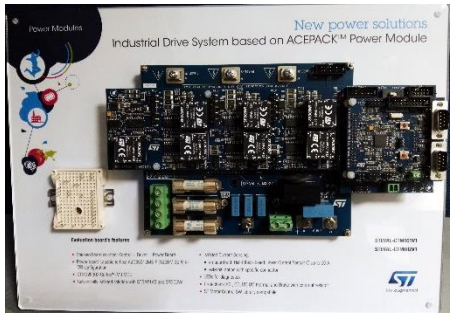
Support Material

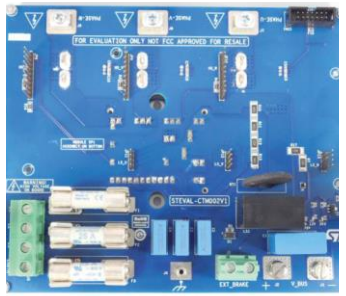
Flyers and Technical Notes

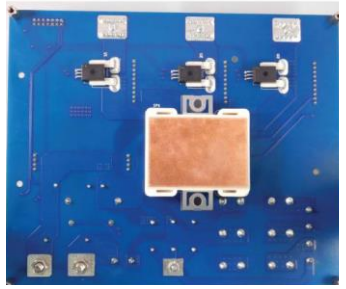


Promotional plastic panel



Reference Designs



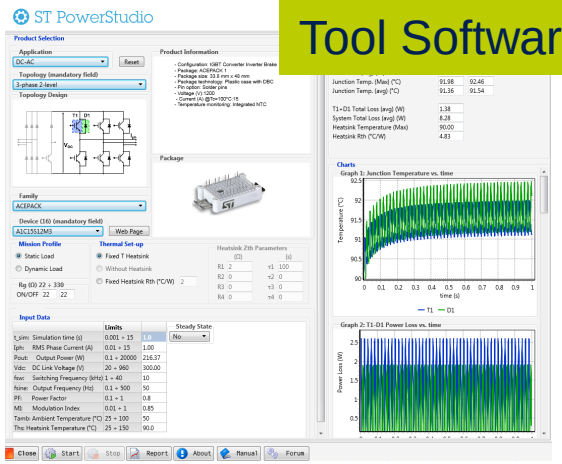


STEVAL-CTM002V1

STEVAL-CTM001V1

Presentations e-presentations

Evaluation Tool Software



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Grazie
감사합니다
謝謝

Merci
Danke
Thanks

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