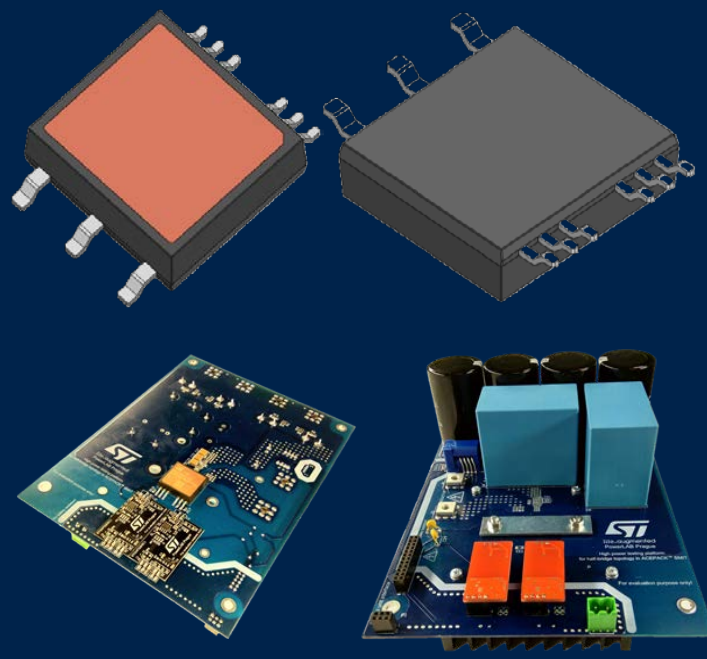
ACEPACK™ SMIT



New Molded Module for Industrial Power Applications

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Jan SVETLIK – Application Engineer EMEA, Czech

v. 1.0 – March 2021

Agenda

ACEPACK™ SMIT: Moulded Module for Power Applications:

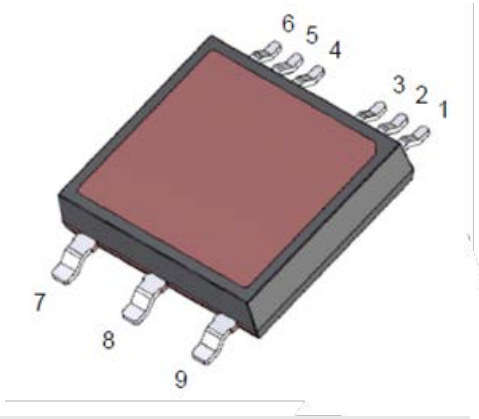
- **Technical Marketing**
  - Introduction
  - Motivation & Product Positioning
  - Planned portfolio & Application Examples
  - Promotion Material
- **Application Engineering**
  - Test Board dedicated to SMIT

Introduction

ACEPACK™ SMIT: Introduction and Main Characteristics

Why SMIT? → Surface Mounted Isolated Top-Side Cooled Package

It looks like a discrete…. But it is a module!



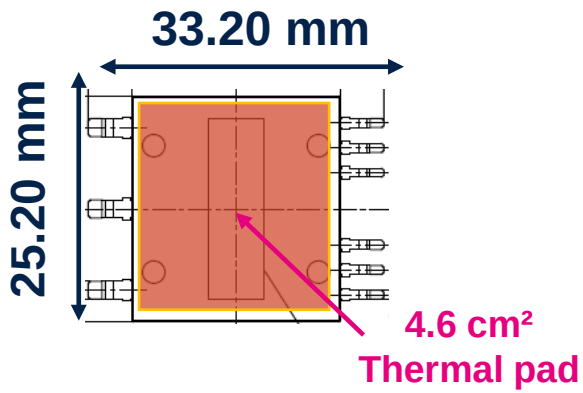
- It is molded
- It has a leadframe
- It is an SMD
- It is available in T&R*

* Tape and reel

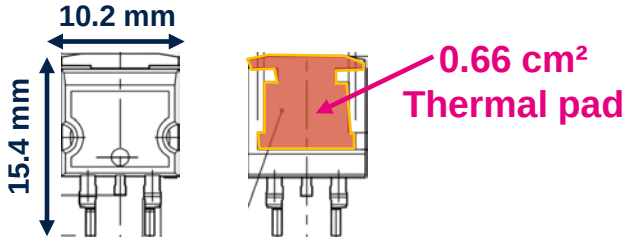
- It contains a DBC**
- It has integrated dies forming simple topologies
- It has an isolated thermal pad

** Direct Bond Copper

Dimensions



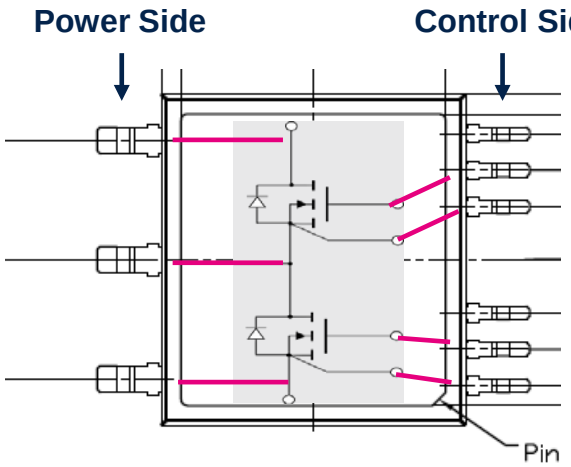
For comparison: D2PAK



~5x smaller

~7x smaller

Pin-out



- This assembly is merely illustrative. Pin connections in real products may differ.
- In rectifiers the control pins might also be used for power.

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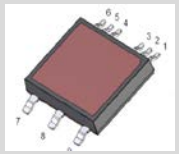
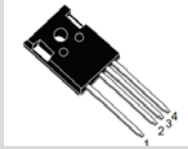
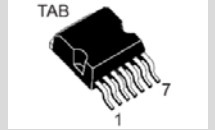
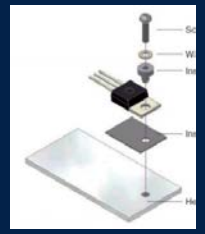
Motivation & Positioning

Motivation: Why SMIT?

	ACEPACK™ SMIT 	TO-247 (4pin) 	H2PAK (7pin) 
Isolation			
Creepage pin-to-pin	7 mm ✓✓	2.4 mm ✗	5.9 mm ✓
Isolated thermal pad	YES [1] ✓	NO ✗	NO ✗
Thermal Design			
Isolation foil to heat-sink	Application dependent —	Required ✗	Required [2] ✗
Dissipation capability (forced air)	60 to 100 W ✓✓✓	30 to 50 W ✓✓	5 to 10 W [3] ✓
Assembly			
Automatized assembly	YES ✓	Every single device requires: ✗  Screw, Washer, Thermal foil, Alignment to heat-sink, Isolation test	YES ✓
Production capability	>50 systems/day[4] ✓	<10 systems/day[4] ✗	N.A. —

[1] UL 2.5 kVrms granted
4kVrms applied

[4] Based on customer feedback for OBC systems

[2] can be avoided by Insulated metal substrate (IMS) board
[3] can be extended to 15W with IMS.

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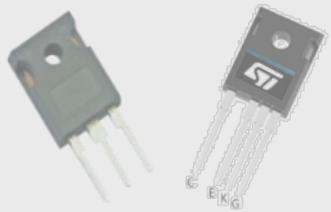
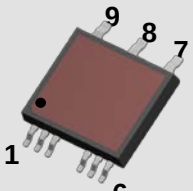
Power Classes

Discretes



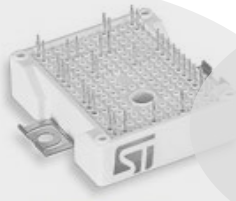
SMIT



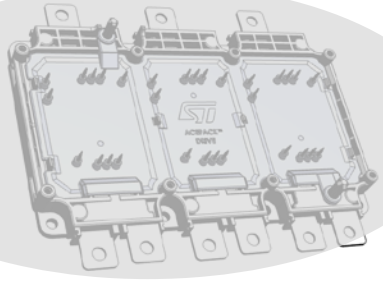
Top view

Baseplate-less Modules


ACEPACK™ 1

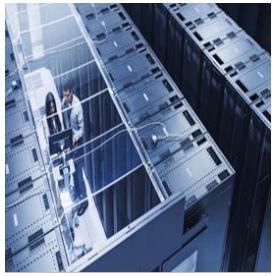

ACEPACK™ 2

Baseplate Modules



1kW | **10kW** | **50kW** | **100kW** | **300kW**

Focus Applications


SMPS


On Board Charger
(Automotive or Industrial)


EV Charger
(Bi-directional)


Storage Systems


Solar

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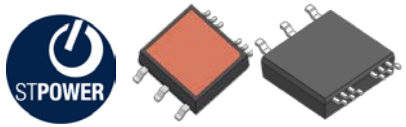
Power range is indicative, and might be extended through paralleling of devices and modular approach.

Product Portfolio

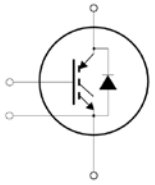


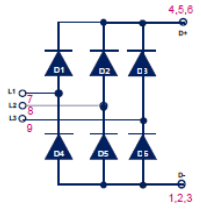
Planned Product Portfolio

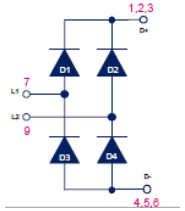
Automotive Grade

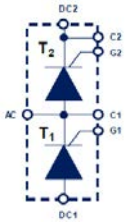
Topology	Part number	$R_{ds,on}$ / rated A* per chip	Semiconductor Technology	Samples	Planned SOP
Single Switch	STGSB200M65DF2AG	200A	650V IGBT	Available	In Production
3-ph Bridge	STPSC60H12-M3Y	60 A	1200V SiC Diodes	Available	Q2/21
Full-Bridge	STPSC40H12-M2Y	40 A	1200V SiC Diodes	Available	Q2/21
Full-Bridge	STTH120RQ06-M2Y	120 A	600V Fast recovery diodes	Available	Q3/21
Full-Bridge	STTH60RQ06-M2Y	60 A	600V Fast recovery diodes	Available	In production
SCR Half-Bridge	STTN6050H-12M1Y	60 A	1200V Thyristors	Available**	Q2/21
Mixed Bridge	STTD6050H-12M2Y	60 A	1200V Thyristors & Rectifiers	Available**	Q2/21
Half-Bridge	SH25M12W2	25 mΩ	1200V SiC MOSFETs	Available**	Q3/21
Half-Bridge	SH30M12W2AG	30 mΩ	1200V SiC MOSFETs	Available**	tbd
DuoPack	SD30M12WAG	30 mΩ	1200V SiC MOSFETs	Q1/21**	Tbd
DuoPack	SD42N60DM6AG	42 mΩ	600V MDmesh DM6 SJ MOSFET	Q2/21	Q4/21
Half-Bridge	SH32N65DM6AG	32 mΩ	650V MDmesh DM6 SJ MOSFET	Q2/21	Q4/21
Half-Bridge	SH63N65DM6AG	46 mΩ	650V MDmesh DM6 SJ MOSFET	Q2/21	Q4/21
Half-Bridge	SH68N65DM6AG	71 mΩ	650V MDmesh DM6 SJ MOSFET	Q2/21	Q4/21
Boost	SB49W65M5AG	49 mΩ + 20A Diode	650V MDmesh M5 SJ MOSFET + SIC Diode	Q3/21	Q1/22

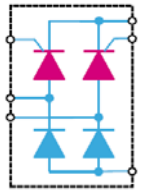
** Engineering samples

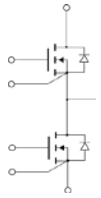

Single switch

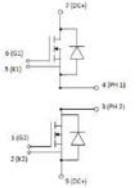

3-ph Bridge

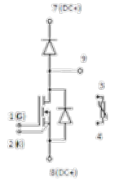

Full-Bridge


SCR Half-Bridge


Mixed Bridge


Half-Bridge


DuoPack


PFC

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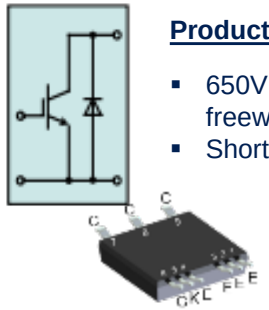
Application Examples

Application Examples (1/3)
Power Train

STGSB200M65DF2AG

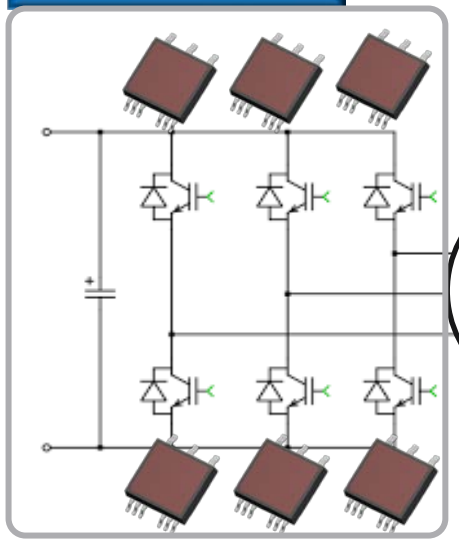
First SMIT in production



Product Features:

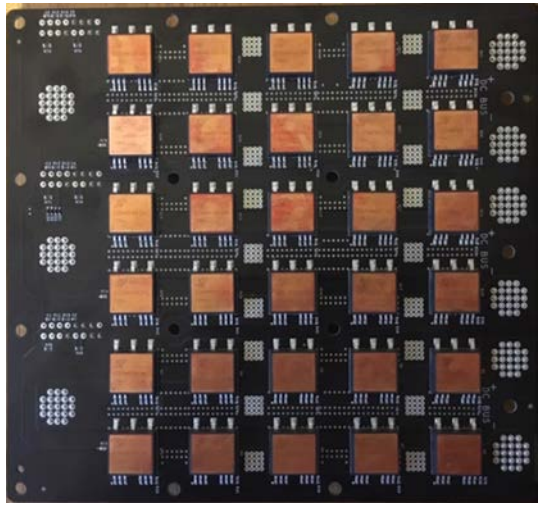
- 650V, 200A IGBT and freewheeling Diode
- Short circuit rated

B6 Inverter



Motor

105 kW Drive

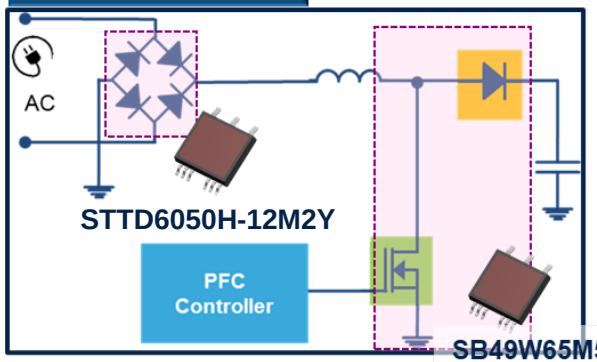


Power Train

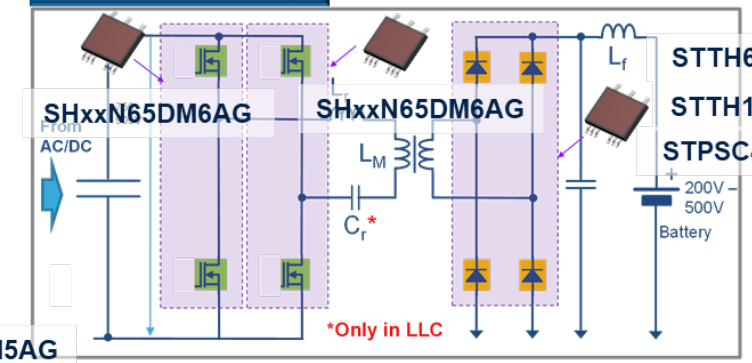
Application Examples (2/3)
Battery Chargers

1-phase

Boost PFC



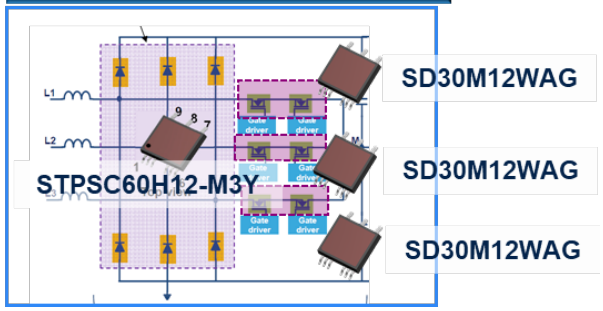
LLC / ZVS



STTH60RQ06-M2Y
STTH120RQ06-M2Y
STPSC40H12-M2Y

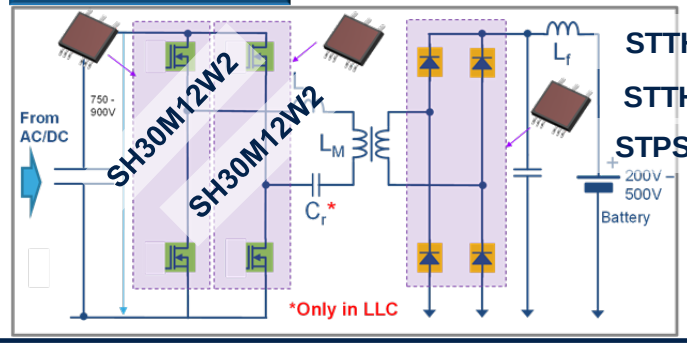
3-phase

Mod. Vienna Rectier



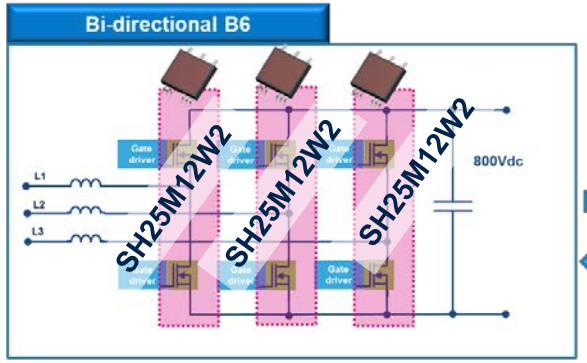
SD30M12WAG
SD30M12WAG
SD30M12WAG

LLC / ZVS

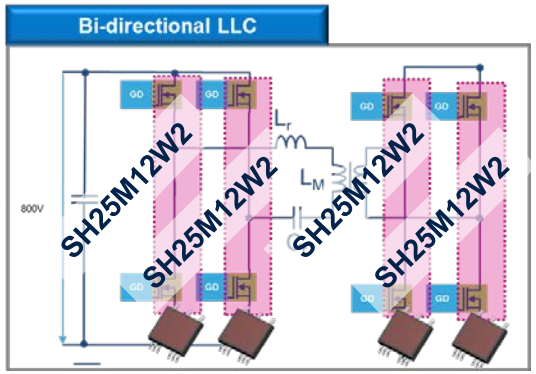


STTH60RQ06-M2Y
STTH120RQ06-M2Y
STPSC40H12-M2Y

Bi-directional B6



Bi-directional LLC



On Board Charger
(Automotive or Industrial)

EV Charger
(Bi-directional)

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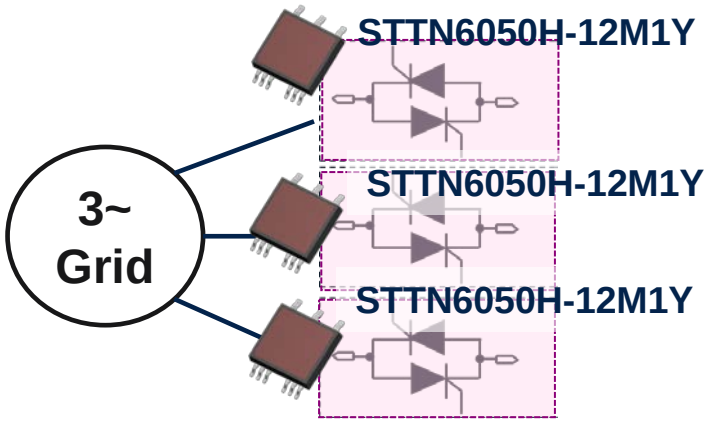
Applications & Topologies (3/3)
Solid State Relay

When compared to mechanical relay, power semiconductors are faster, more robust against mecahnical stress, and suffer less degradation over time.

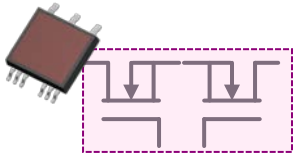
SCRs



Industrial Drive

MOSFETs

Back-to-back configuration, made out of DuoPack devices:



SD42N60DM6AG* → for 400V Batteries

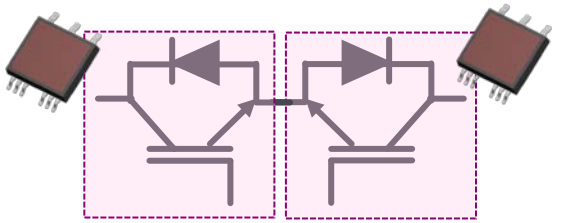
SD30M12WAG → for 800V Batteries

EV Charger

Electric Vehicle

IGBTs

Back-to-back configuration, made with single switch devices:



STGSB200M65DF2AG

Transformer protection

* Dedicated product in development

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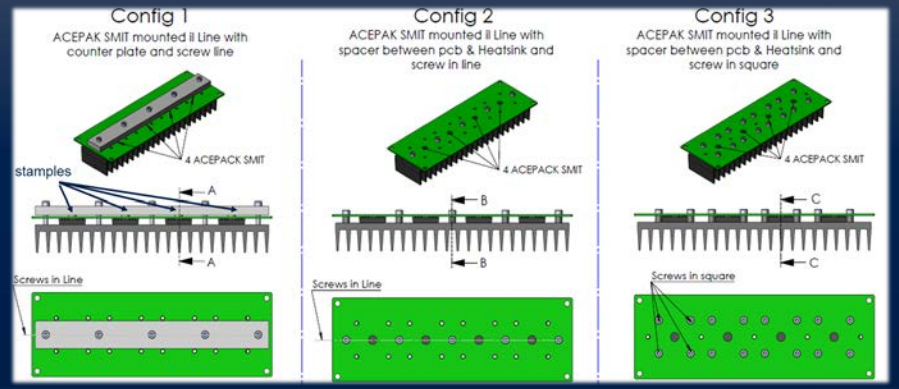
Assembly of ACEPACK™ SMIT

Technical Support Material

Assembly Possibilities



Application Note + Presentation


AN5384

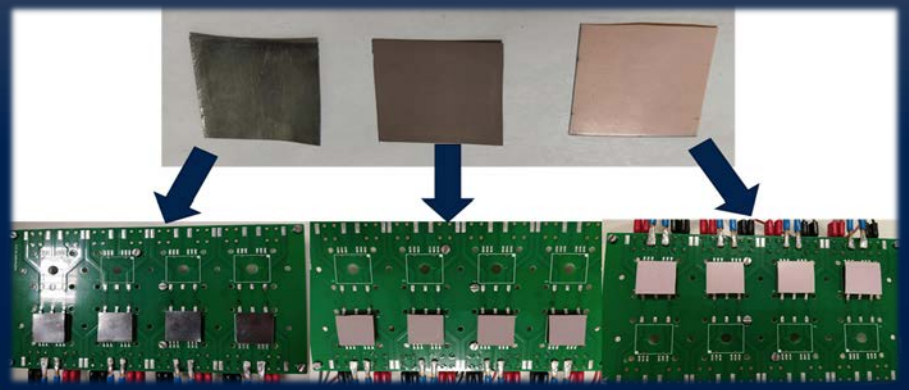
Application note

ACEPACK SMIT module package guidelines for mounting and thermal management

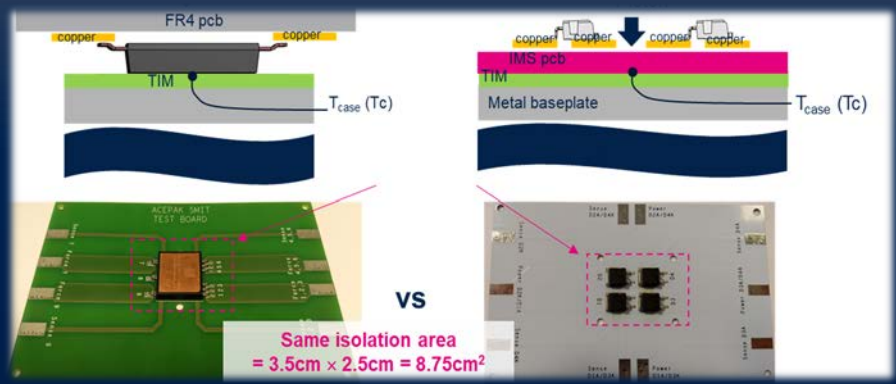
Introduction

Heat-sink Attachment

Suggested TIM*



Comparison with D2PAK



*Thermal Interface Material

ACEPACK™ SMIT Application Board

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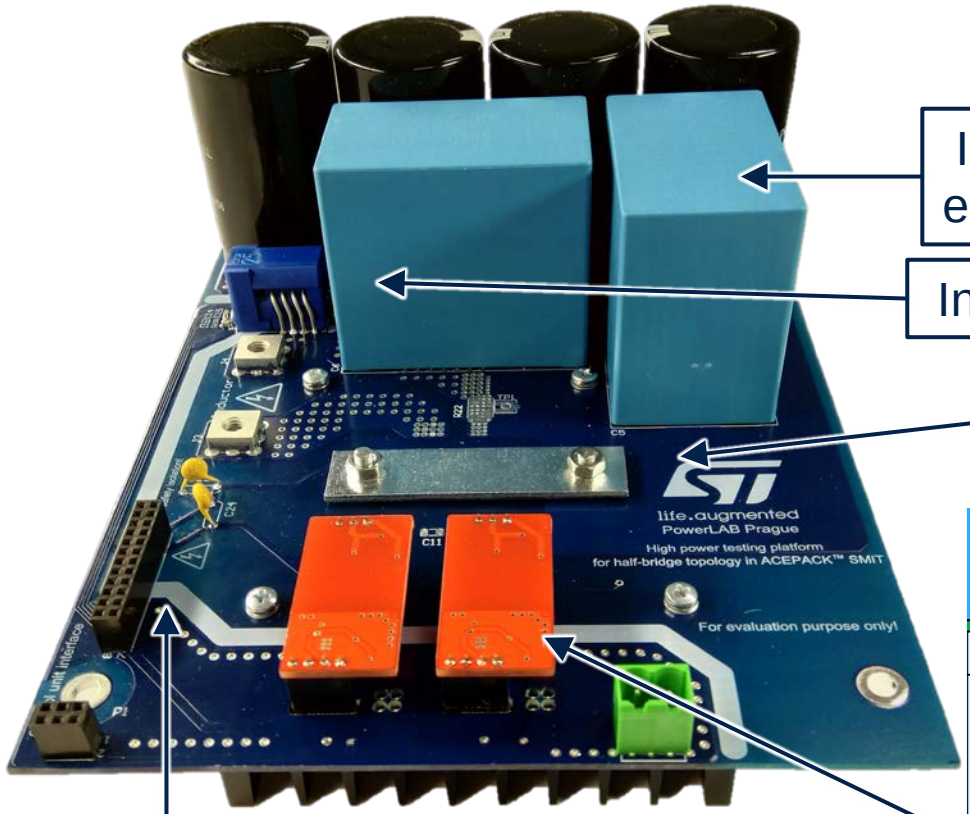
ACEPACK™ SMIT testing platform (1/2)

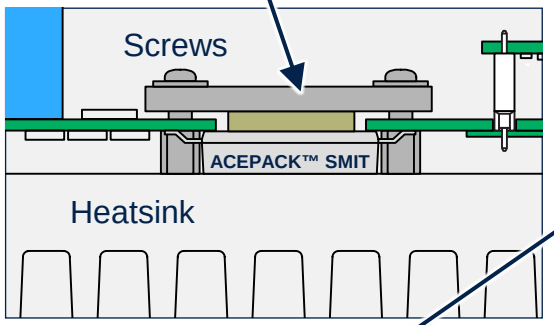
Multipurpose test setup for HB configuration



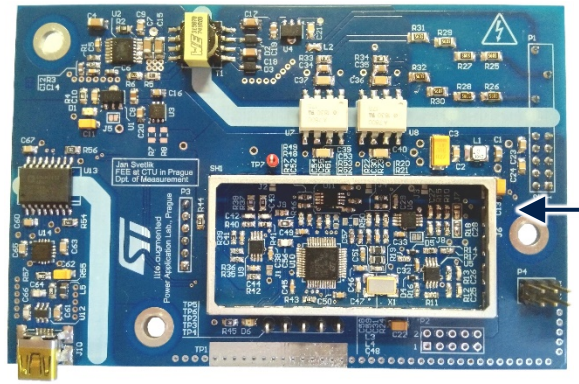
Input/Output foil and electrolytic capacitors

Inductor current sensing

Tightening fixture of ACEPACK™ SMIT

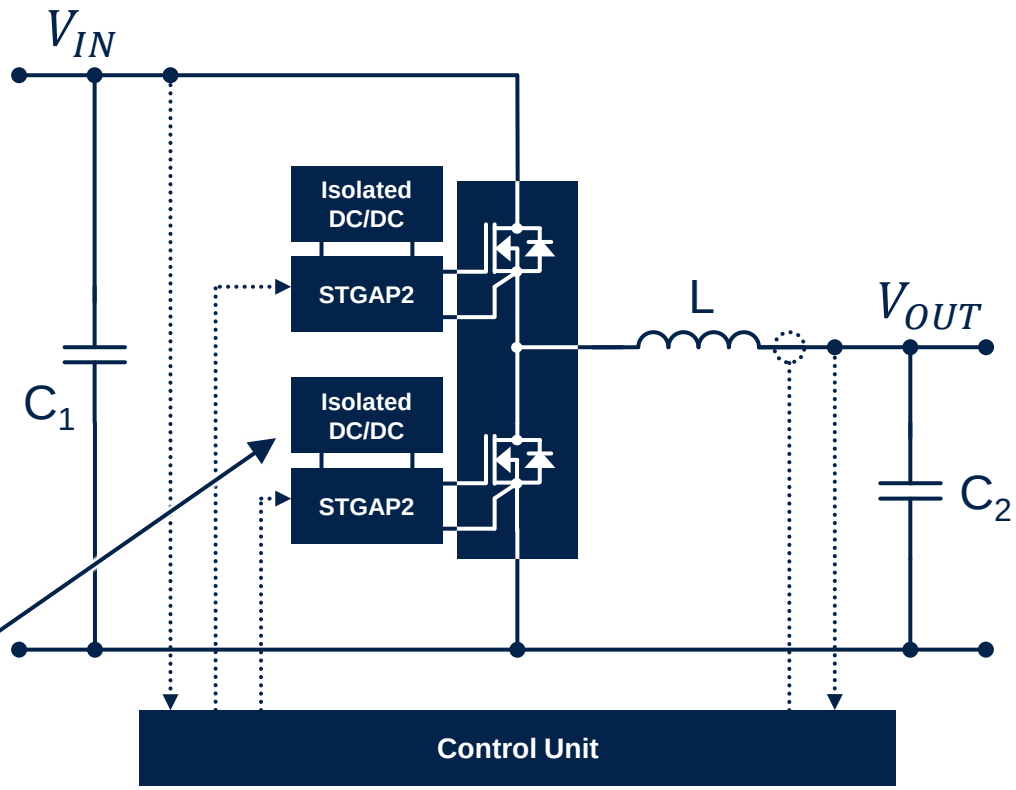


Control unit connector



Isolated DC/DC modules with **L6986I**

STM32 based control unit



Deliverables

- Testing of SiC Half-bridge in ACEPACK™ SMIT module
- Evaluation of switching behavior at different configurations
- Comparison with discrete
- Ready for continuous operation either in buck or boost mode

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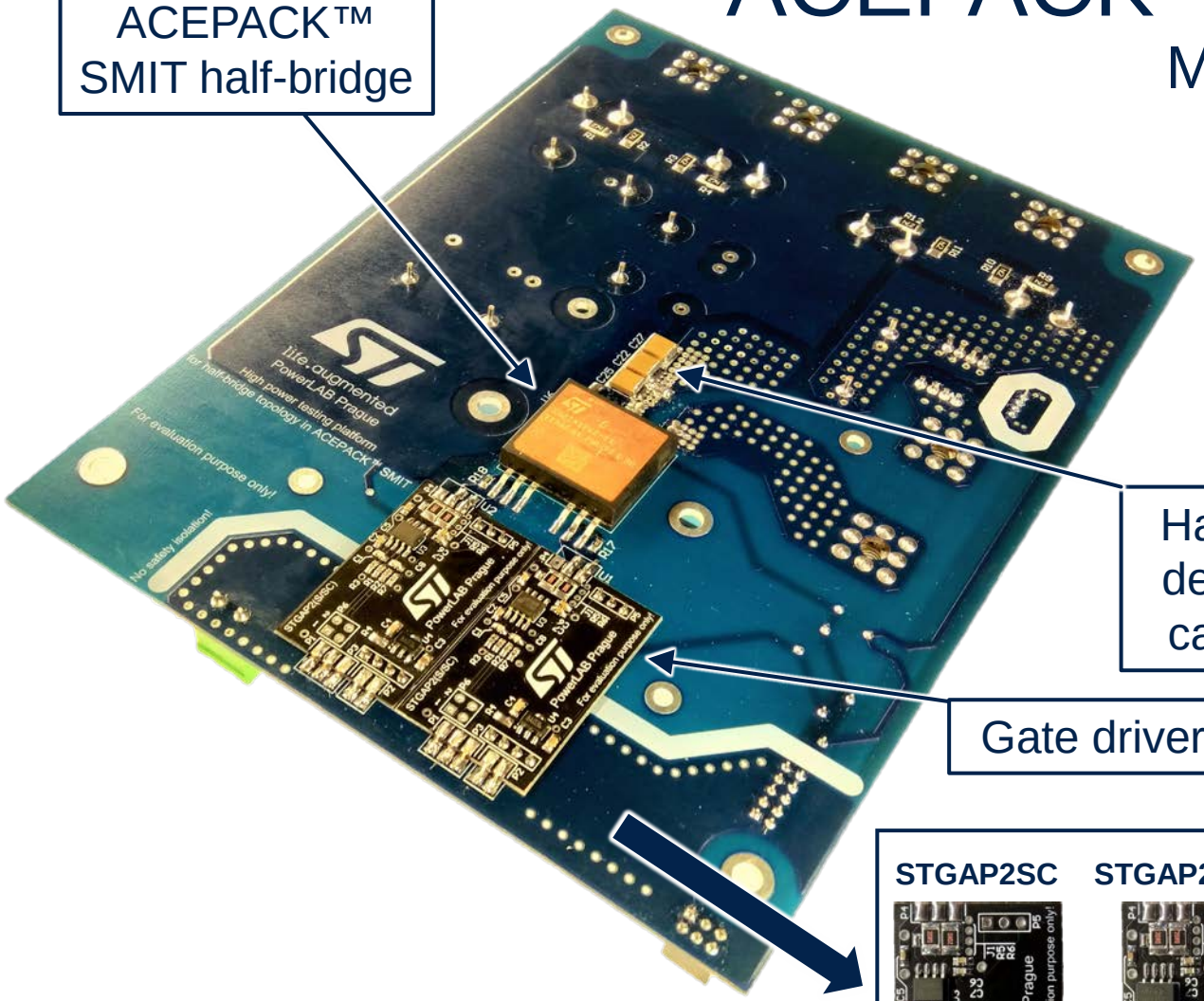
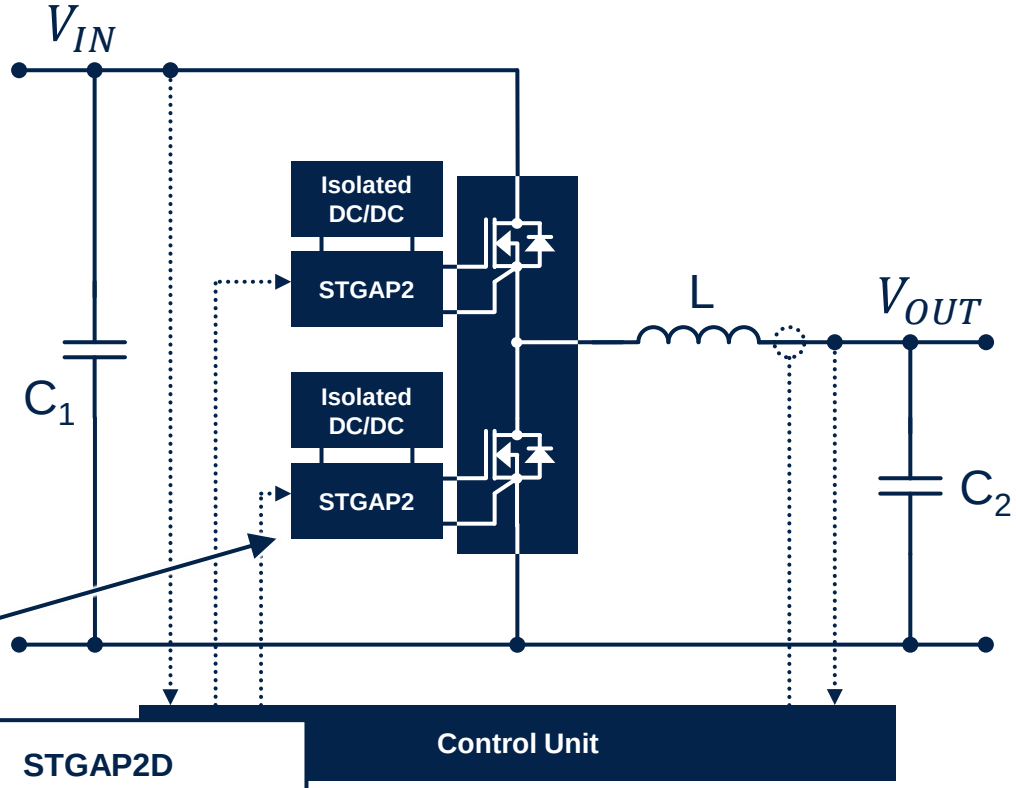
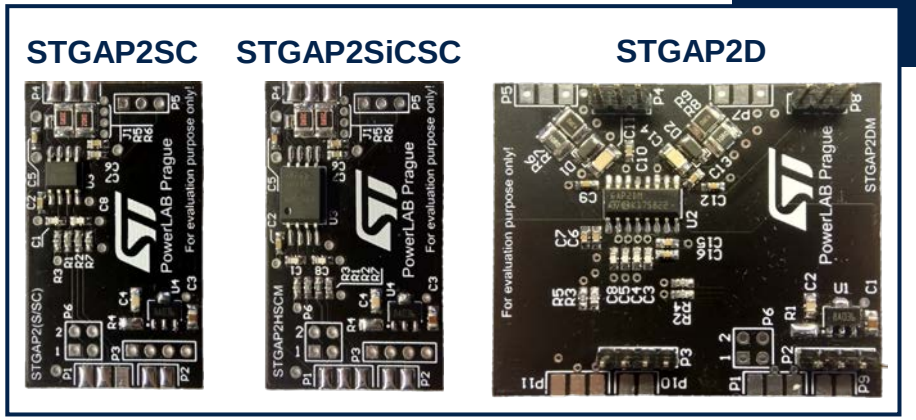
ACEPACK™ SMIT testing platform (2/2)

Multipurpose test setup for HB configuration

Bottom side view



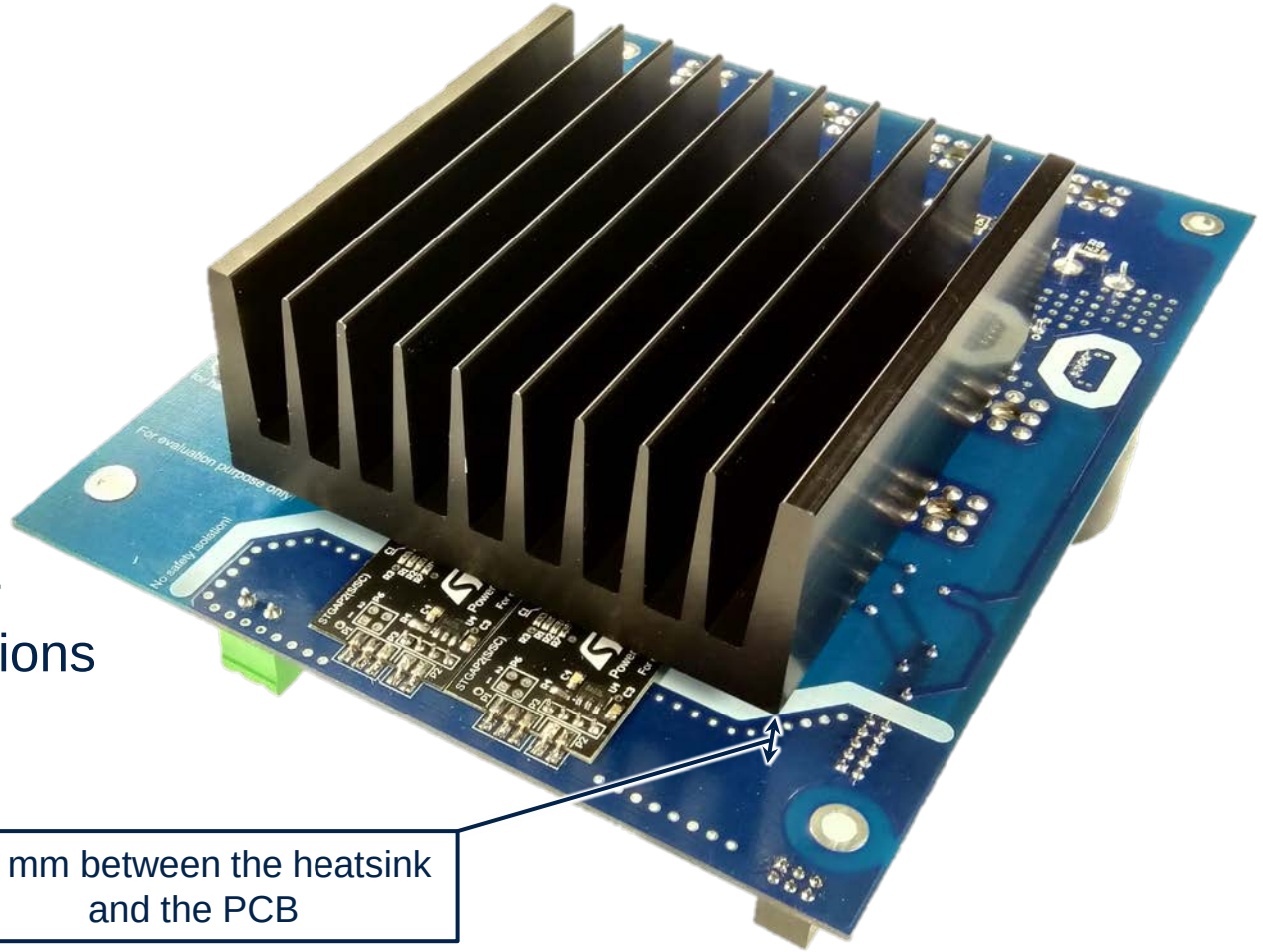




- Different driver modules with different gate drivers can be used

Summary of the key points about ACEPACK™ SMIT

- Benefits of driving via Kelvin source
  - ⇨ Optimal driving
  - ⇨ Better switching performance
- SMD package with cooling pad on top
- Improved thermal performance
- Convenient pinout for easier PCB layout
  - Not a common property over all modular solutions
- Smaller commutation loop
  - ⇨ Faster switching



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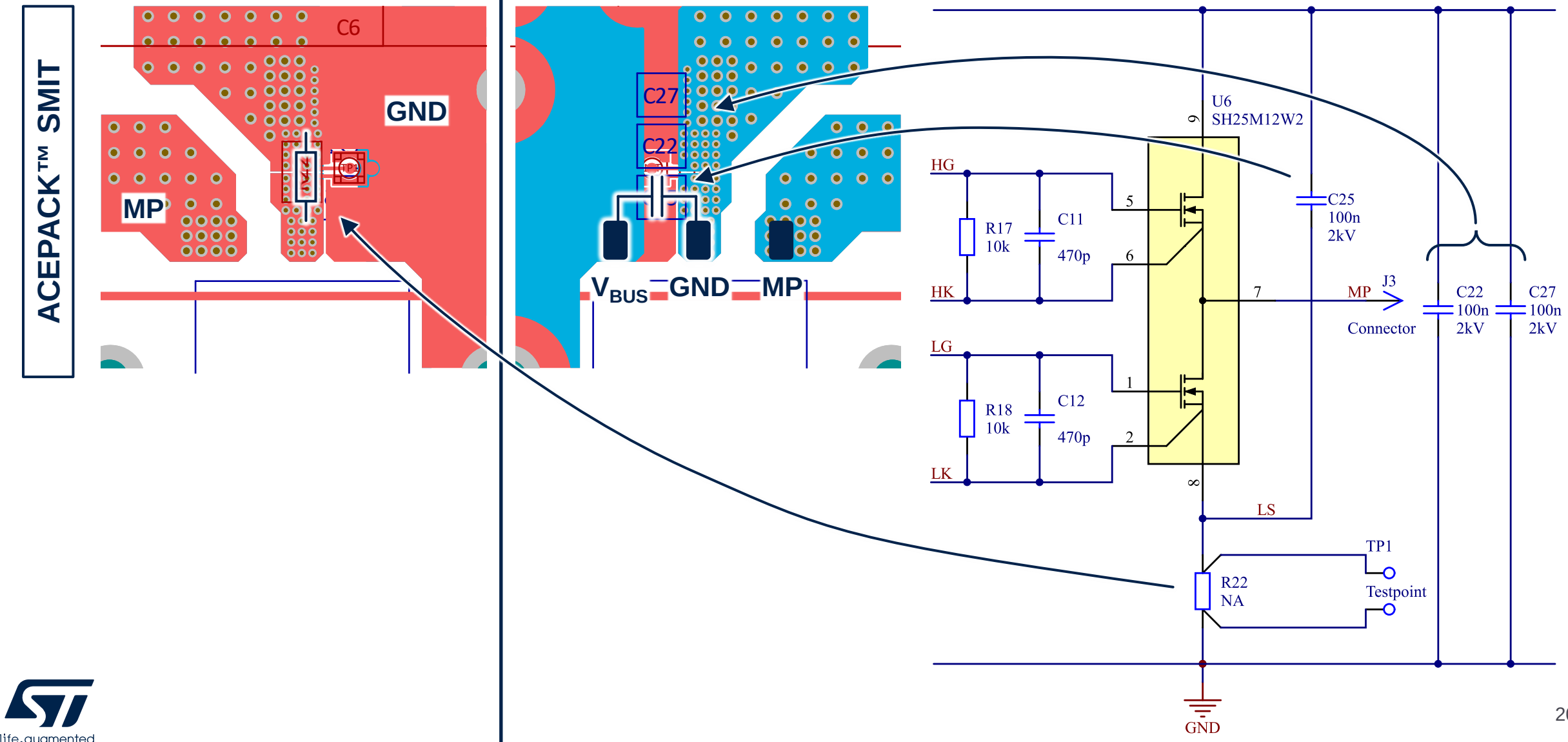
Test platform PCB layout details (1/5)

Commutation loop components

Top layer
Bottom layer
Top components
Bottom components

Top side view

Bottom side view



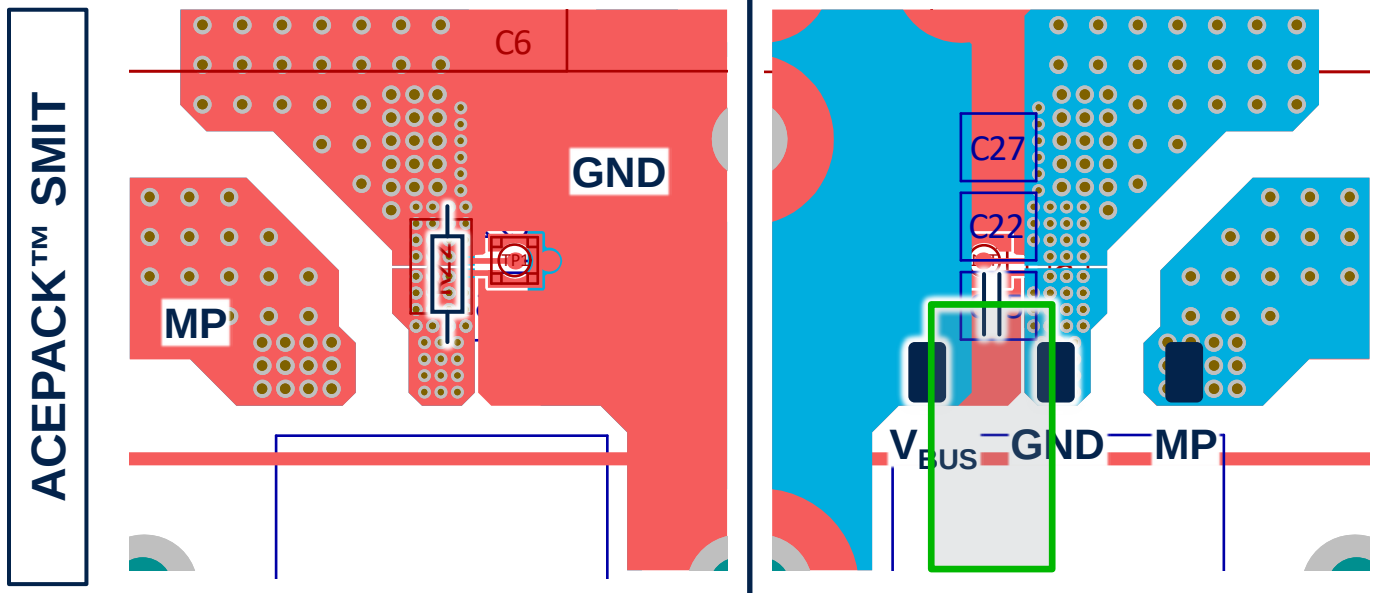
Test platform PCB layout details (2/5)

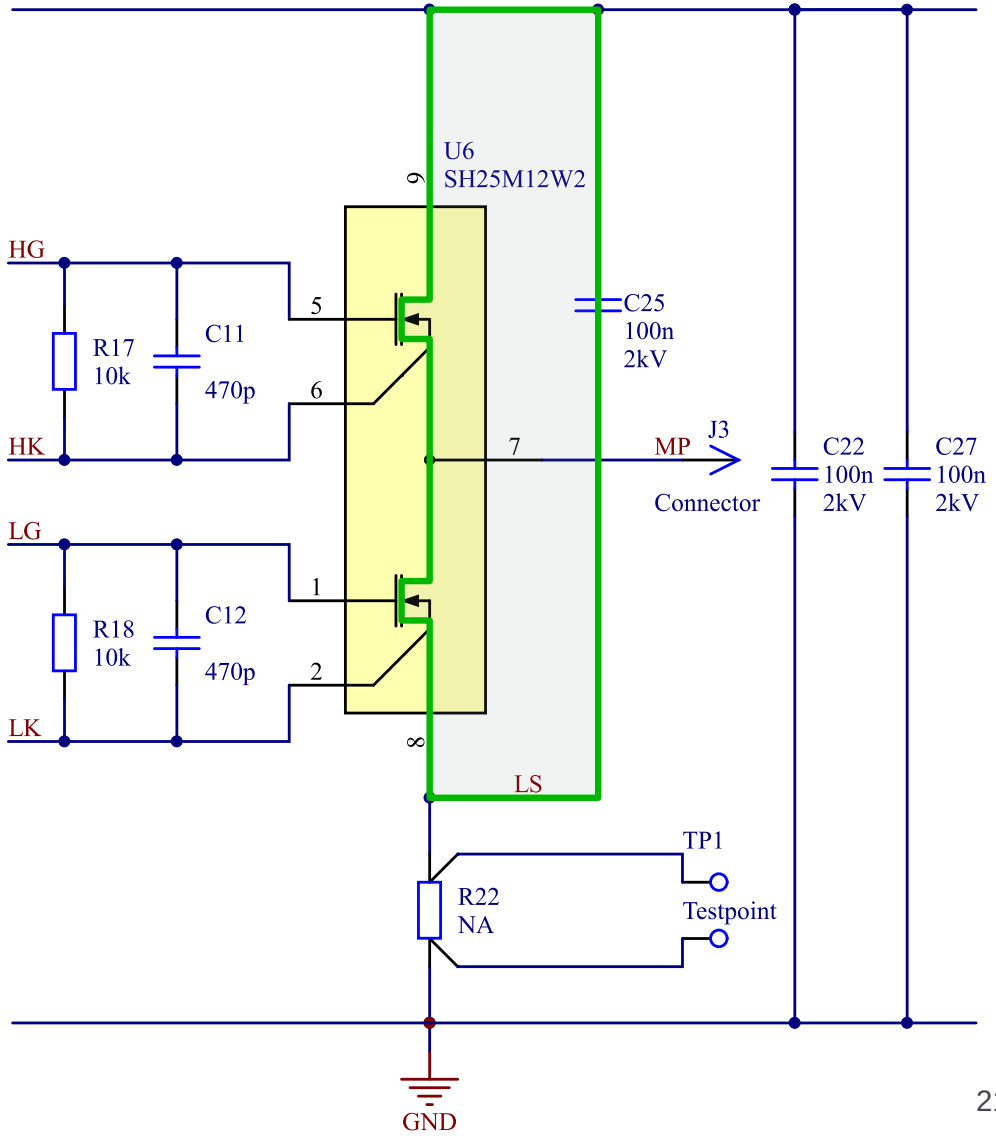
Size of the commutation loop

Top layer
Bottom layer
Top components
Bottom components

Top side view

Bottom side view





Test platform PCB layout details (3/5)

Comparison with TO247-4 solution

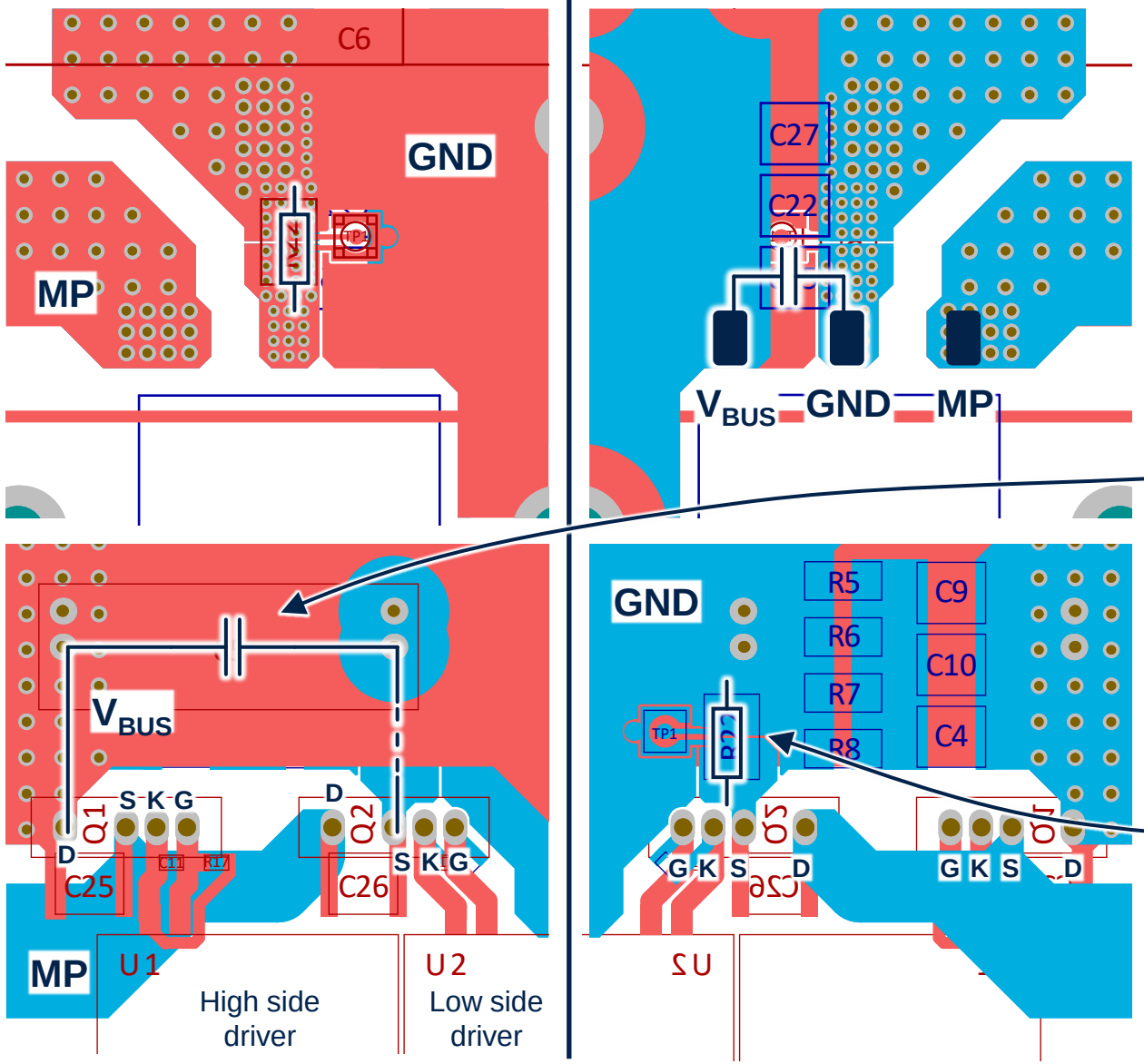
Top layer
Bottom layer
Top components
Bottom components

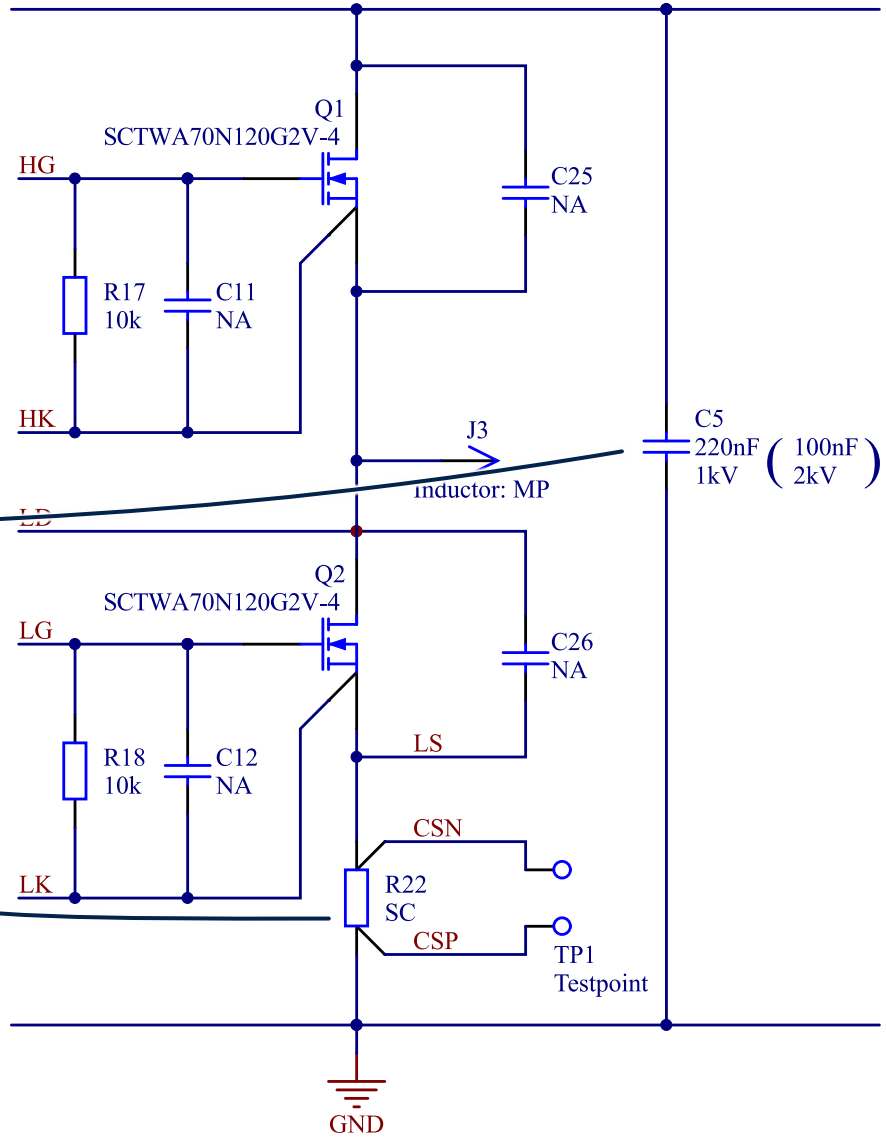
Top side view

Bottom side view

ACEPACK™ SMIT

TO247-4





Test platform PCB layout details (4/5)

Size of the CL at TO247-4 platform

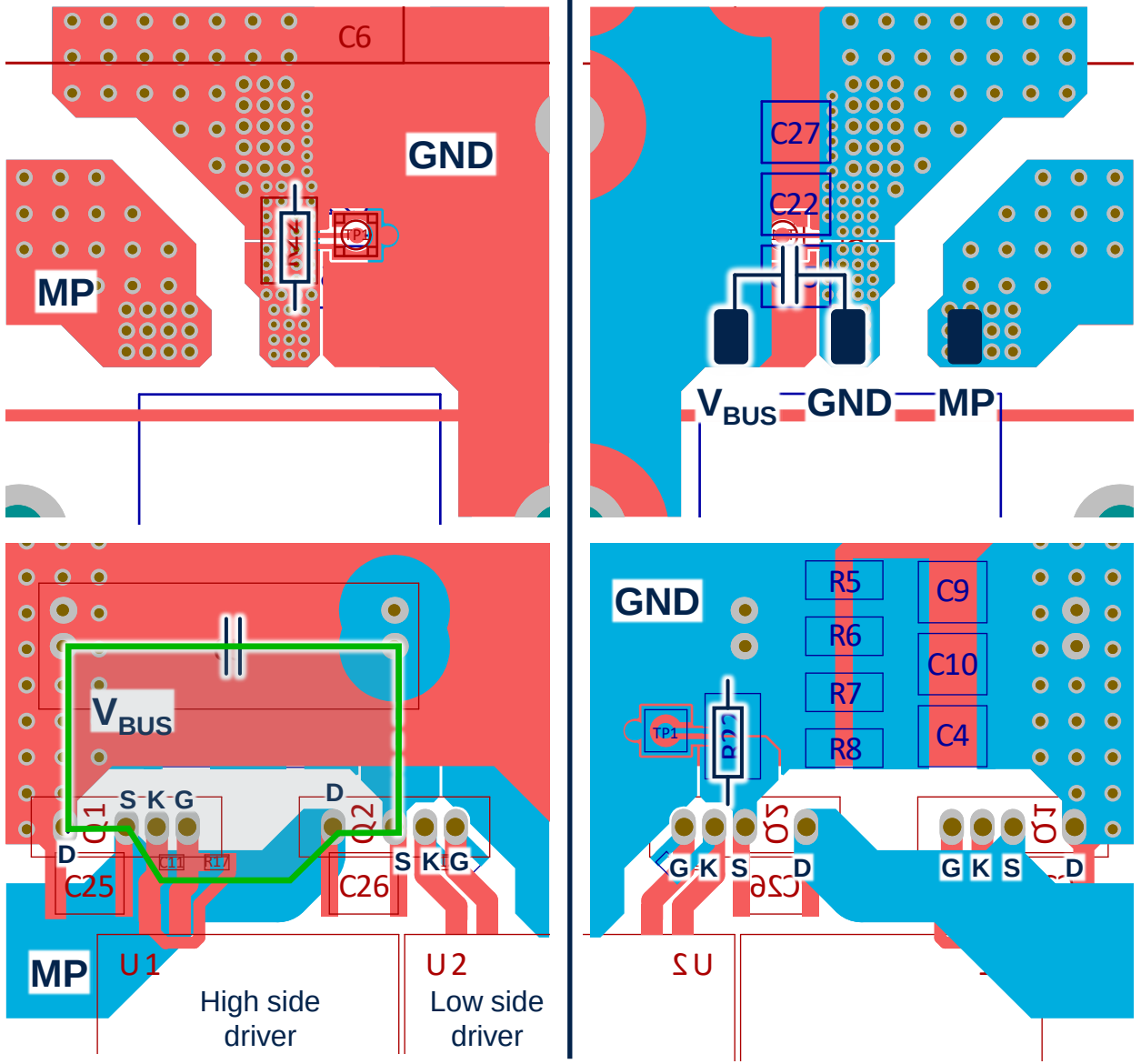
Top layer
Bottom layer
Top components
Bottom components

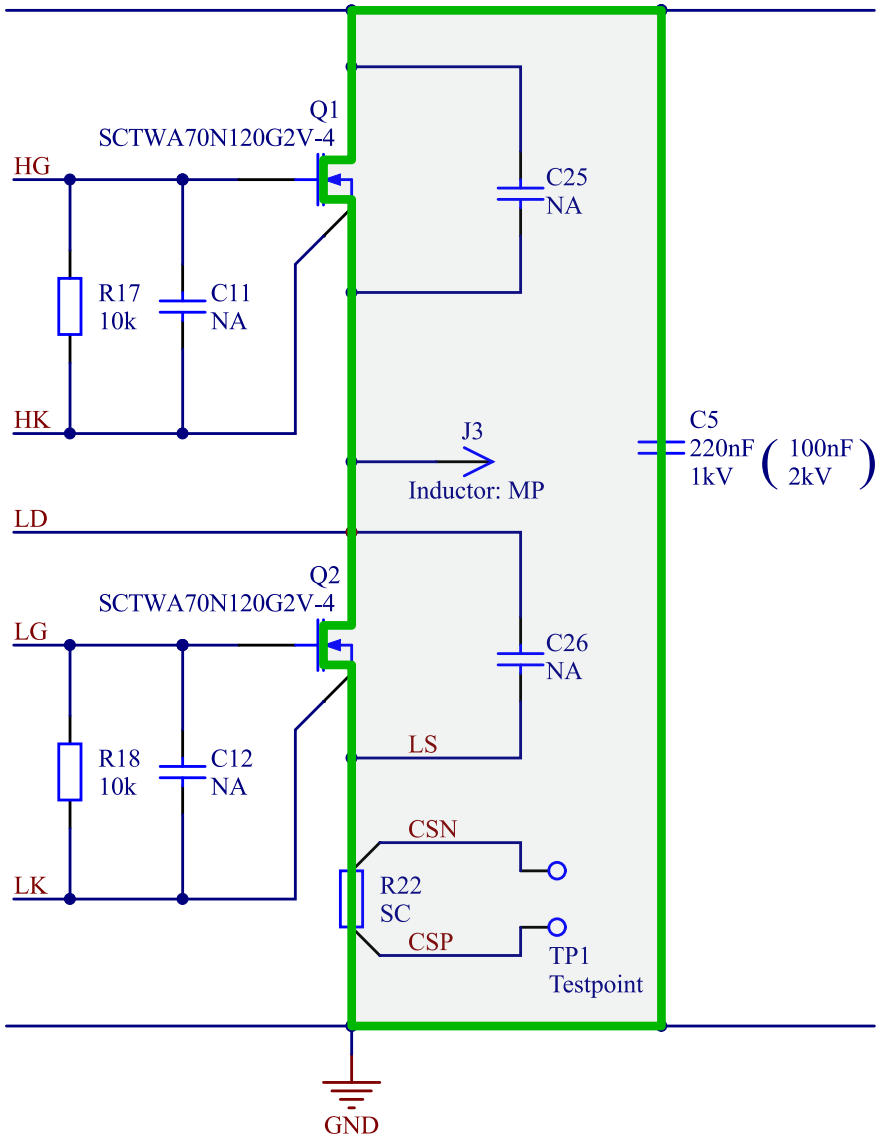
Top side view

Bottom side view

ACEPACK™ SMIT

TO247-4





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Test platform PCB layout details (5/5)

ACEPACK™ SMIT vs TO247-4

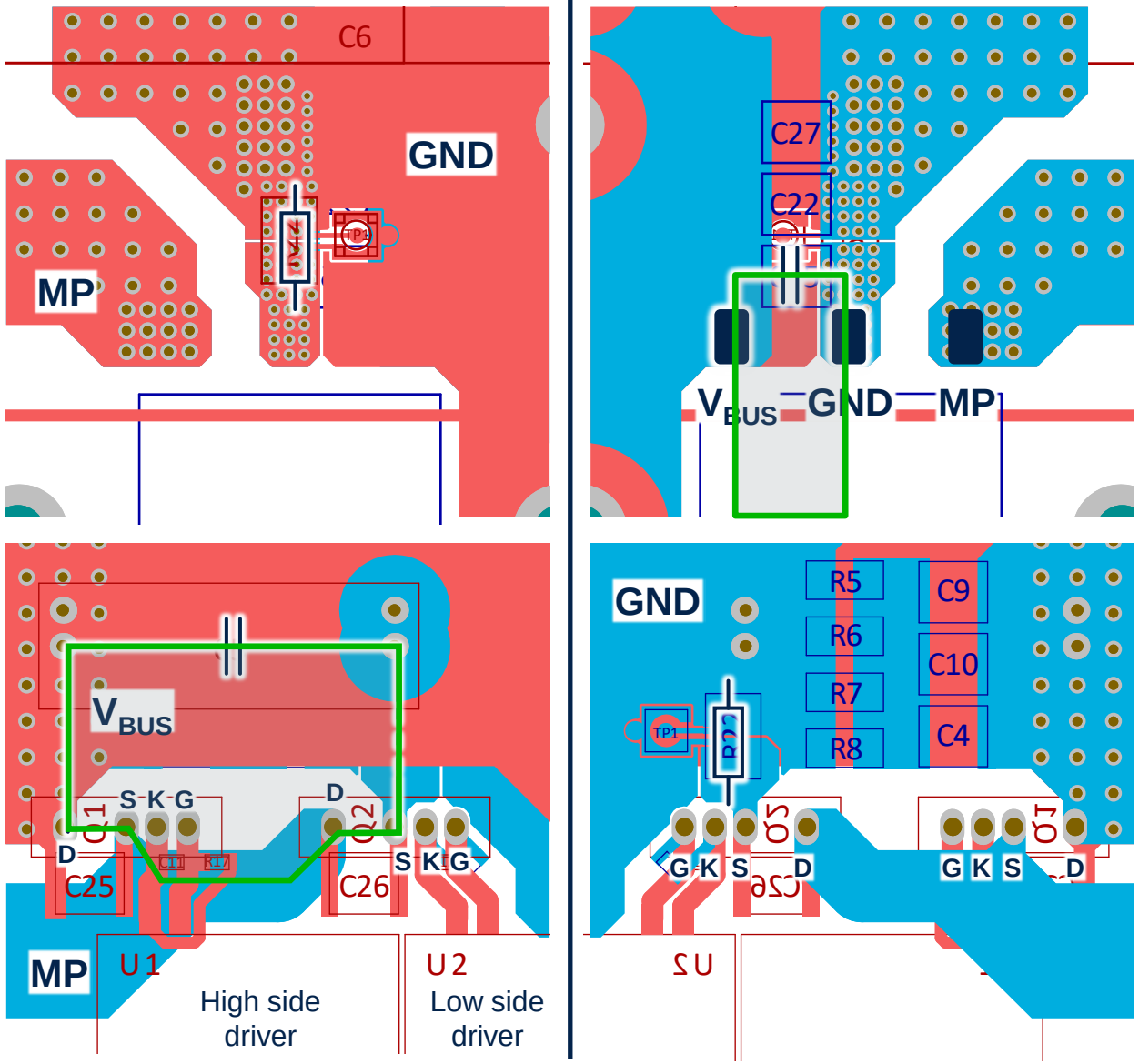
Top layer
Bottom layer
Top components
Bottom components

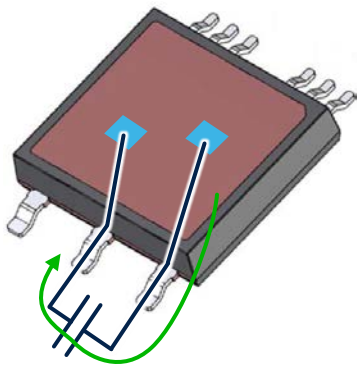
Top side view

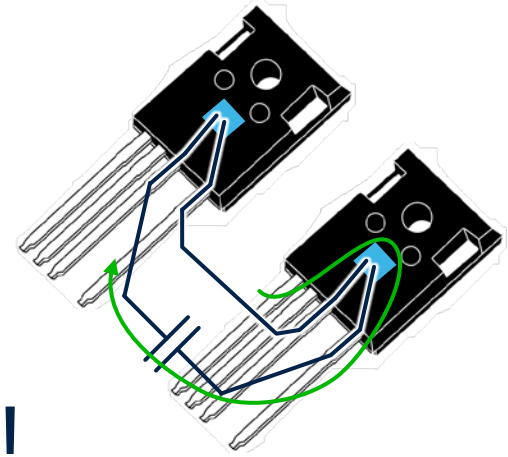
Bottom side view

ACEPACK™ SMIT

TO247-4







- **60% shorter path**
- **40% smaller area**

!

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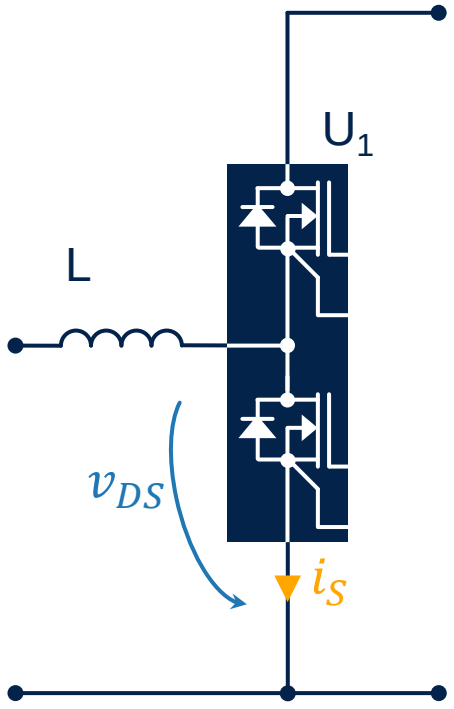
Testing of a SH25M12W2 device (1/2)

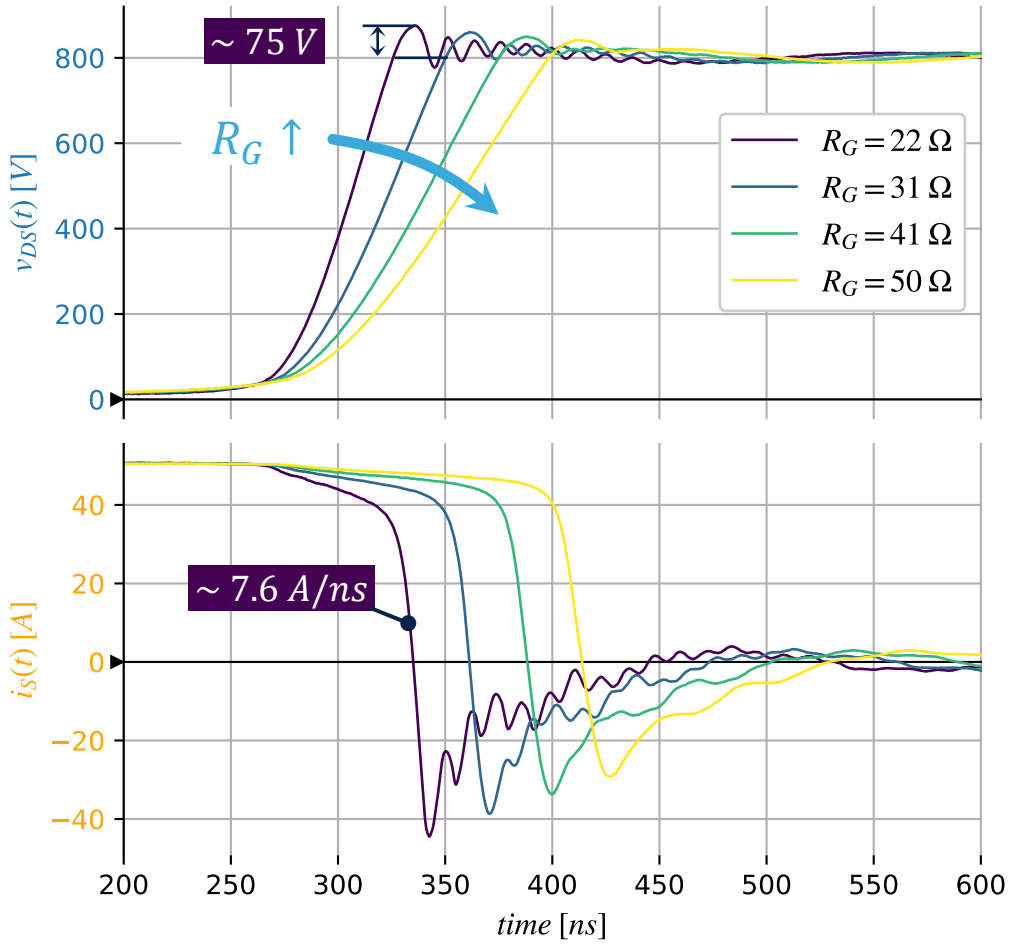
Switching waveforms at different conditions

V_{BUS}	800 V
I_{PK}	50 A
R_G	22, 31, 41, 50 Ω
$T_A \sim T_J$	25 °C

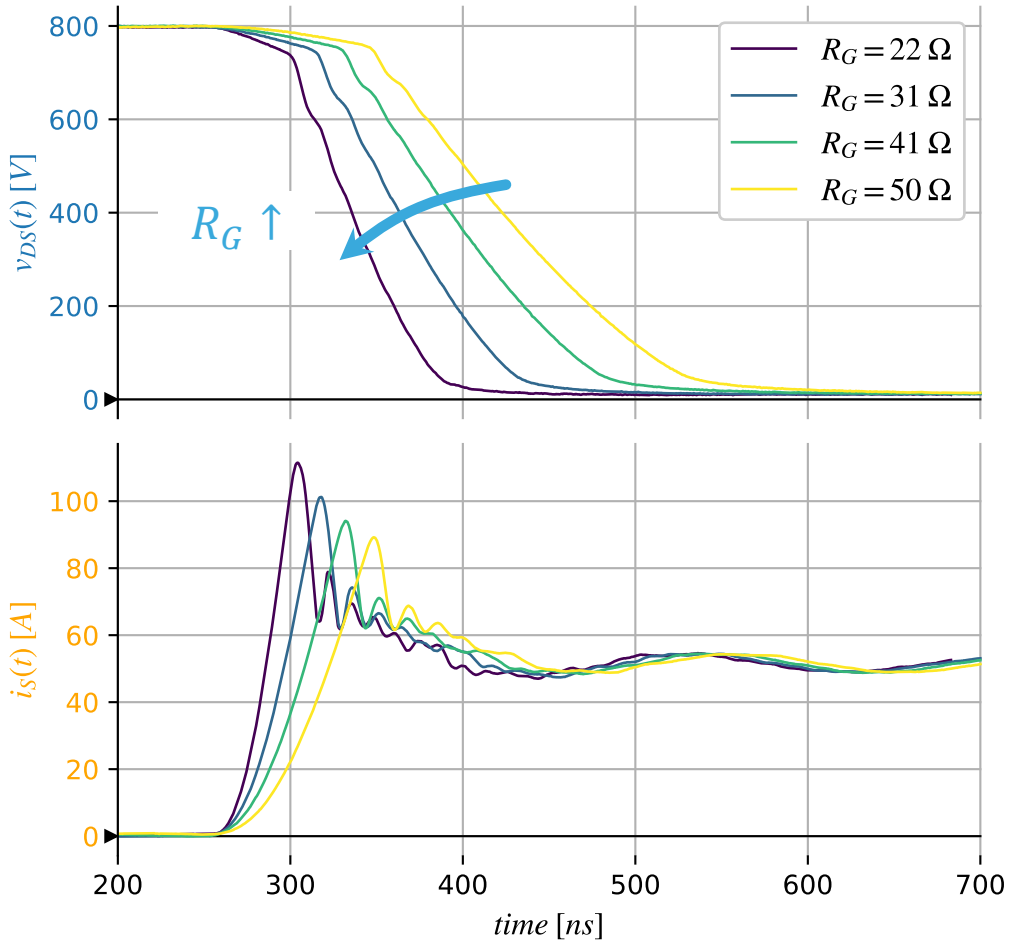
U_1: SH25M12W2



Turn off transient waveforms



Turn on transient waveforms



$L_{CL} < 10\ nH$ ⇨ more than **80% less** compared to TO247 4-pin!

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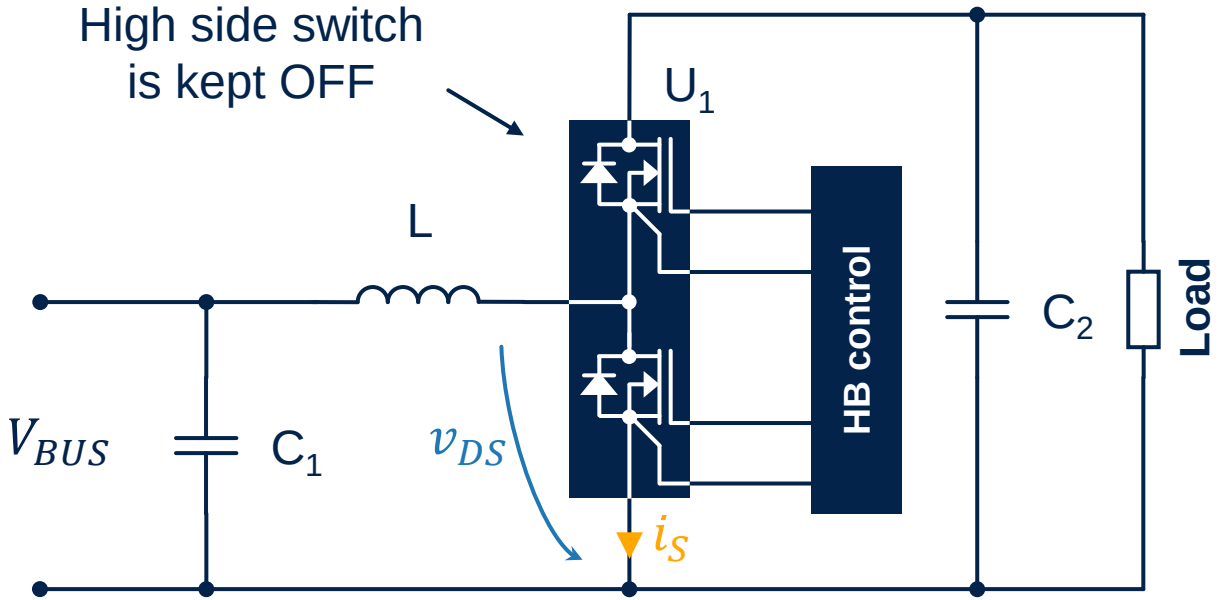
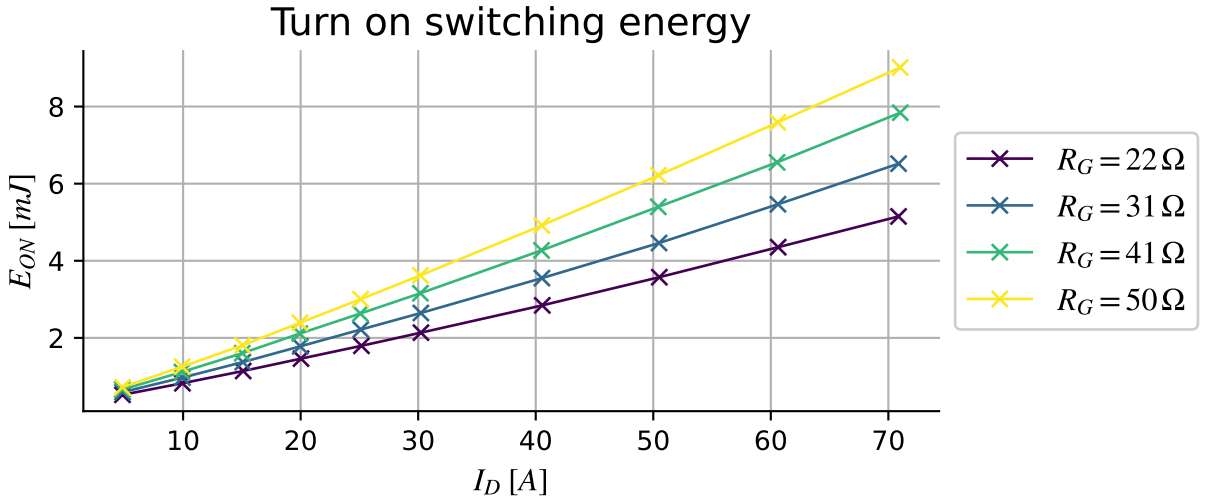
Testing of a SH25M12W2 device (2/2)

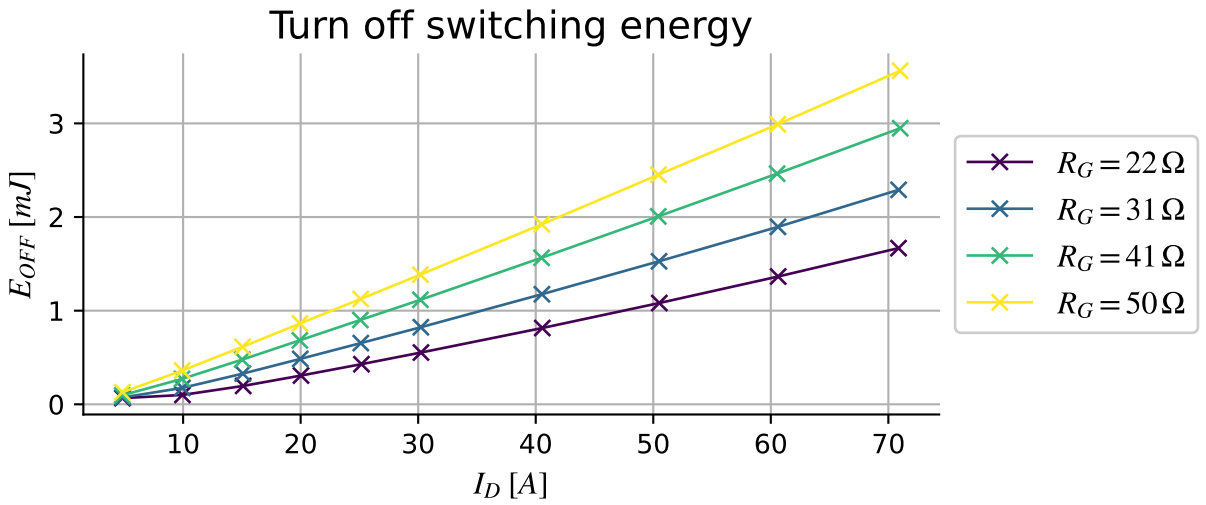
Switching energy estimation

Measurement setup details *:

DUT	SH25M12W2
V_{BUS}	800V
R_G	22, 31, 41, 50Ω
T_A ~ T_J	25°C







* The switching performance evaluated using double pulse test.

Thank you

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