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ST Silicon Carbide Products and Industrial Application Guide

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Agenda

1 About SiC material

2 ST SiC market overview

3 ST SiC diodes and feature

4 ST SiC MOSFETs

5 SiC MOSFET – switching and driving

6 New SiC related evalboards

7 ST support tools

About SiC material

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About SiC material

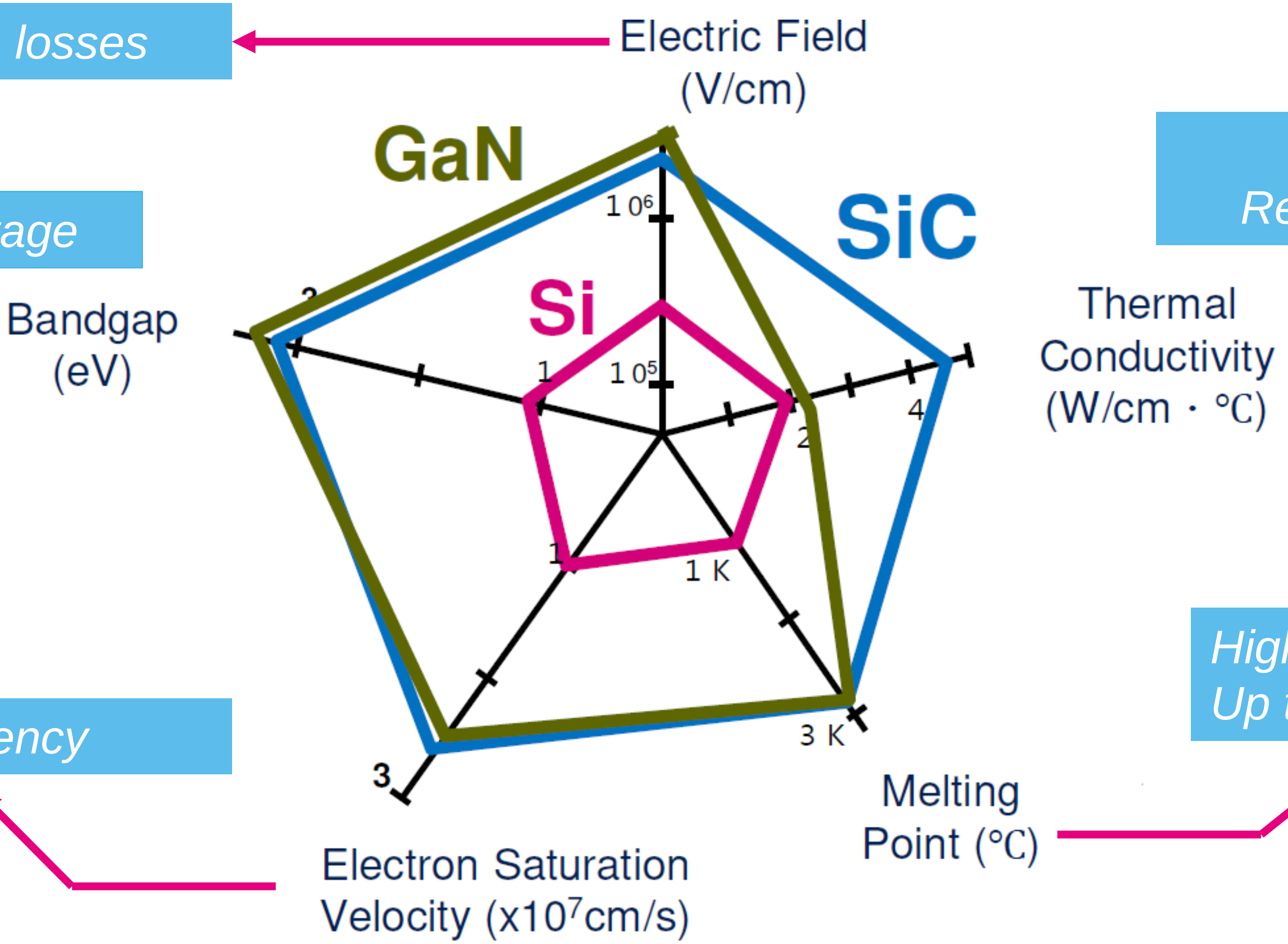
Lower ON Resistance & losses

Higher Break Down Voltage

Higher Switching Frequency

Better Thermal performance
Reduced Cooling requirements

Higher Junction Temperature
Up to 200℃



Key figures for SiC vs. Silicon

SiC Vs. Silicon Material Properties

1/300

Sic Vs. Si Resistivity

(At same applied Voltage)

x3 Thermal Conductivity

Higher Thermal Insensivity

SiC Vs. IGBT Performance

-80%

Switching Losses

mainly due to lower Resistance

vs.

SiC Module

-80%

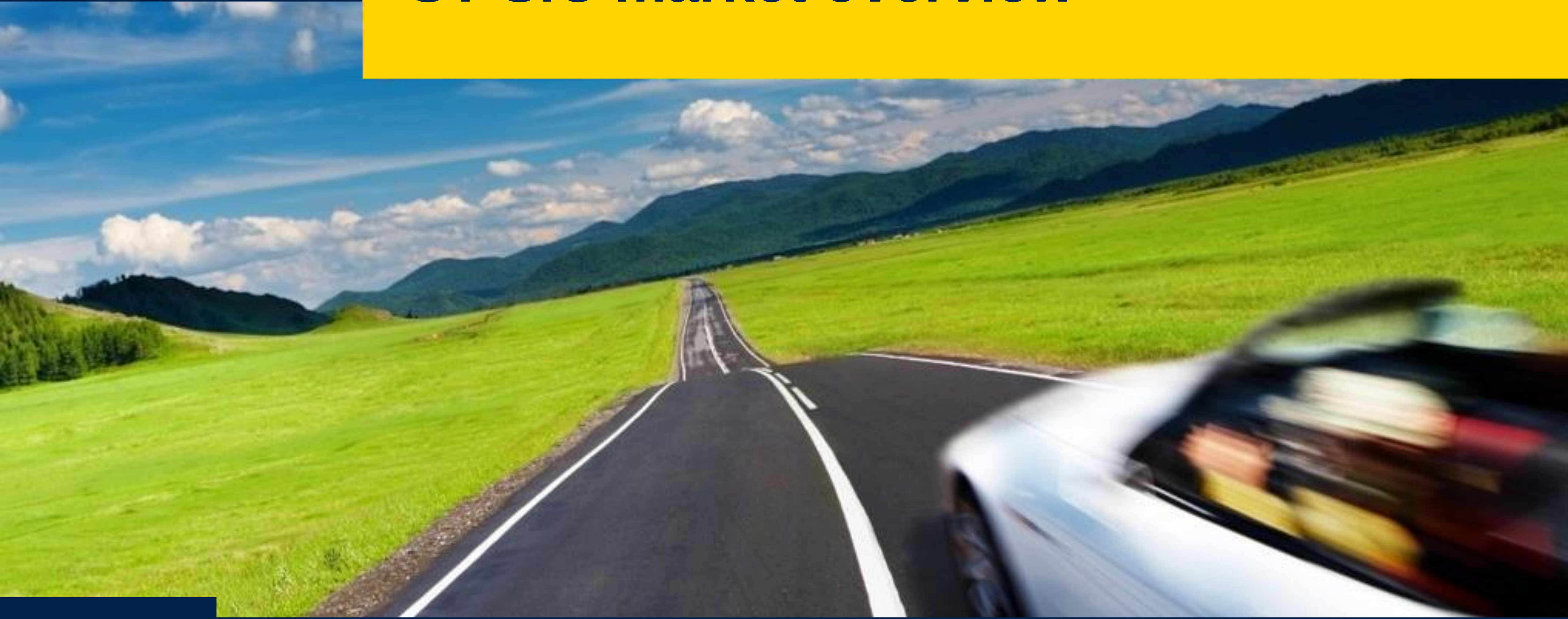
Component Weight

-85%

Component Volume Dimension

Source: Goldman Sachs

ST SiC market overview



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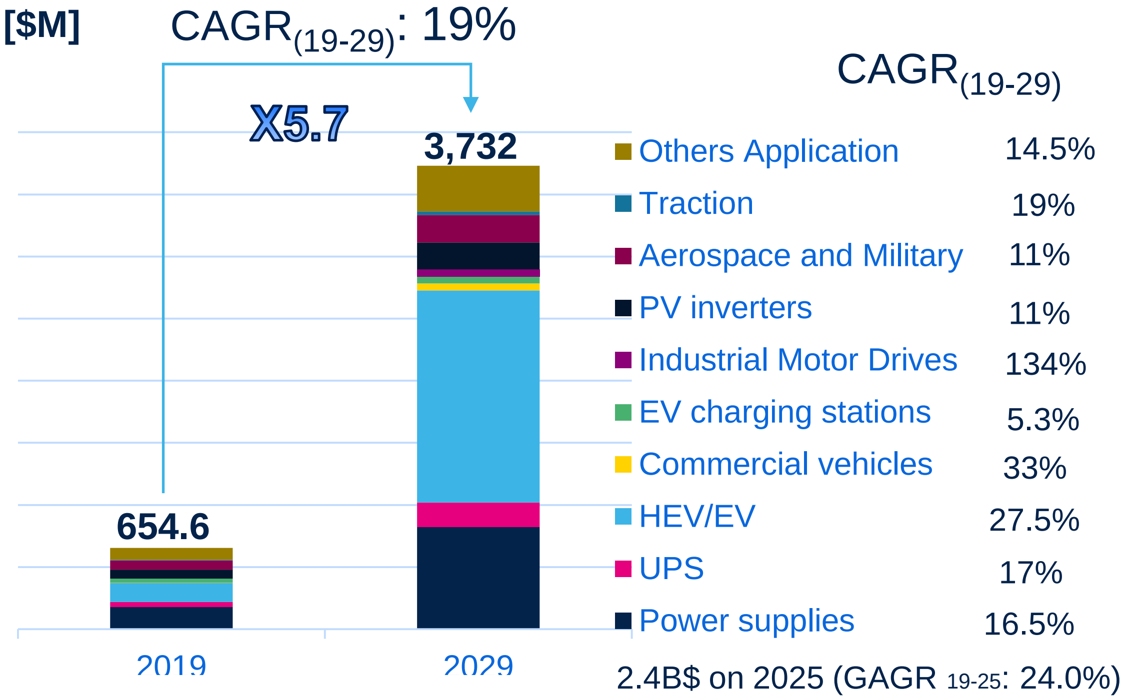
Silicon Carbide market outlook

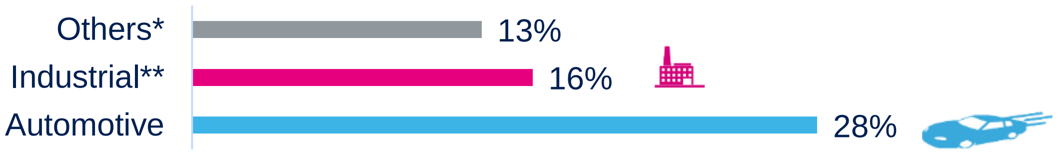
SiC power semiconductors by application



	CAGR$_{(19-29)}$
Others Application	14.5%
Traction	19%
Aerospace and Military	11%
PV inverters	11%
Industrial Motor Drives	134%
EV charging stations	5.3%
Commercial vehicles	33%
HEV/EV	27.5%
UPS	17%
Power supplies	16.5%

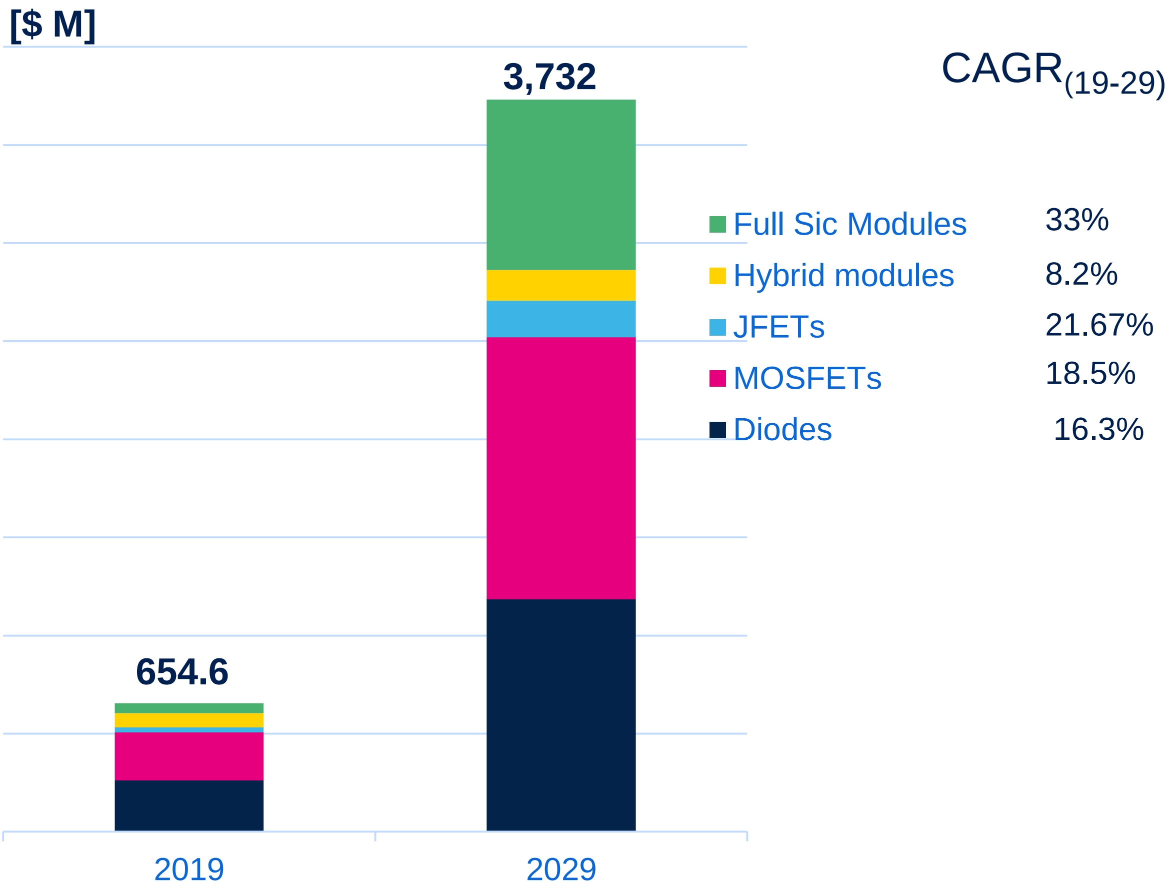
2.4B$ on 2025 (GAGR $_{19-25}$: 24.0%)

CAGR Y’19-’29



Others*	13%
Industrial**	16%
Automotive	28%

SiC power semiconductors by macro product family



	CAGR$_{(19-29)}$
Full Sic Modules	33%
Hybrid modules	8.2%
JFETs	21.67%
MOSFETs	18.5%
Diodes	16.3%

**Military and aerospace, traction, Other applications*
***renewable energies applications included*

Source: Omdia/IHS – SiC & GaN World 2020 Forecast & output Tables – mid case (June 2020)

ST mastering all Silicon Carbide manufacturing steps

Pioneering WBG materials, with longer than 20 years commitment in R&D

Catania: Power Electronics Competence Center

Ecosystem made of Academic **Research Centers** and ST as a semiconductor leader, created a true “incubator”

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Consiglio Nazionale Ricerche

Everything started from **1” wafer**

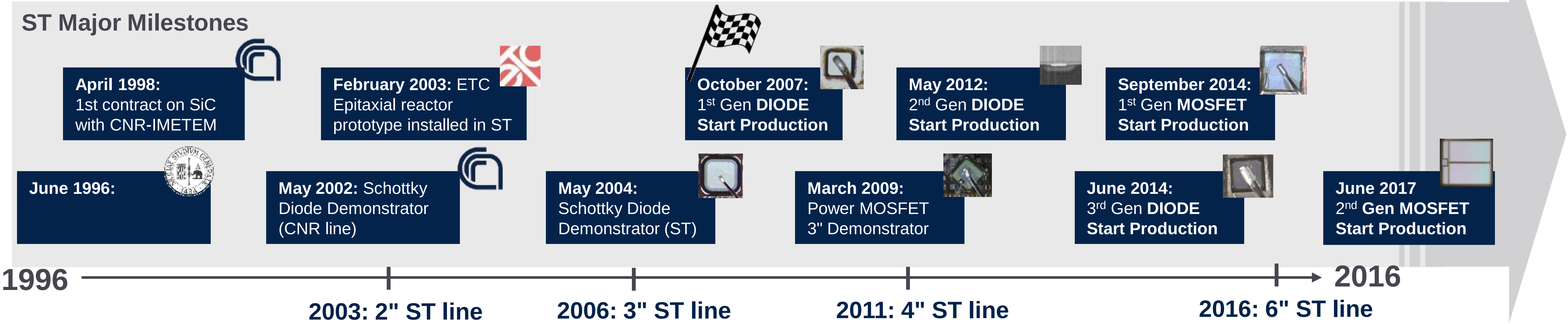
More Than 70 Patents on SiC

ST Commitment on SiC

Leveraging on CNR Facilities at early stage

> 30 Years Experience in Power Semiconductor

ST Major Milestones



June 1996:

April 1998: 1st contract on SiC with CNR-IMETEM

May 2002: Schottky Diode Demonstrator (CNR line)

February 2003: ETC Epitaxial reactor prototype installed in ST

May 2004: Schottky Diode Demonstrator (ST)

October 2007: 1st Gen **DIODE Start Production**

March 2009: Power MOSFET 3" Demonstrator

May 2012: 2nd Gen **DIODE Start Production**

June 2014: 3rd Gen **DIODE Start Production**

September 2014: 1st Gen **MOSFET Start Production**

June 2017 2nd **Gen MOSFET Start Production**

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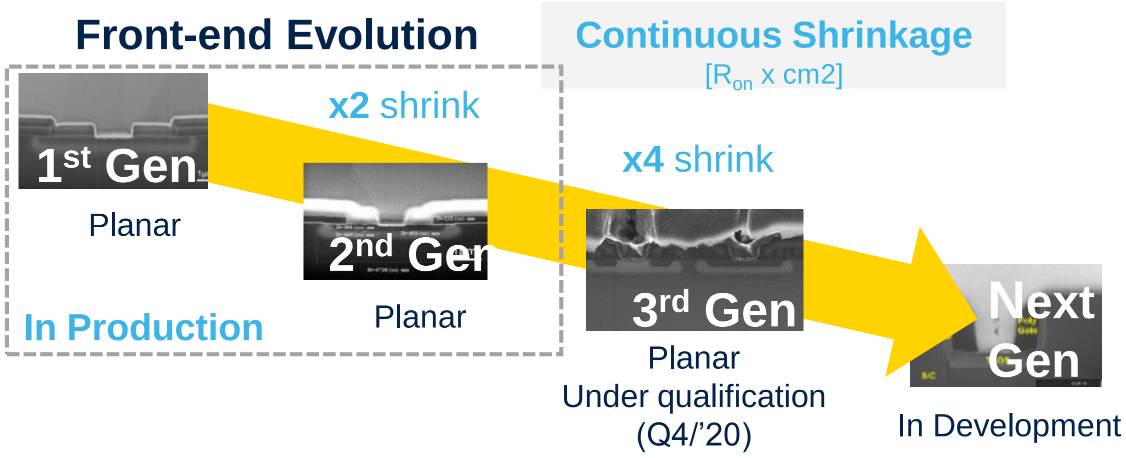
STPOWER Silicon Carbide MOSFETs

Best-in-class SiC Technology

- **ST broad range of SiC solutions:** Discrete, Bare Dice, Module
- **ST** proven very **high reliability**
- **ST continue capacity expansion** to support market acceleration
- **ST invests on advanced package** technologies



Front-end Evolution

Continuous Shrinkage
[R_{on} x cm2]

x2 shrink

x4 shrink

1st Gen
Planar

2nd Gen
Planar

In Production

3rd Gen
Planar
Under qualification
(Q4/'20)

Next Gen
In Development

ST committed to develop its SiC Supply Chain

- **Vertical integration** through **Norstel AB** acquisition
- **Extended** supply chain capability through multi-year supply agreement
- Continue **to invest** to expand **ST capacity**

STPOWER SiC MOSFET focused market

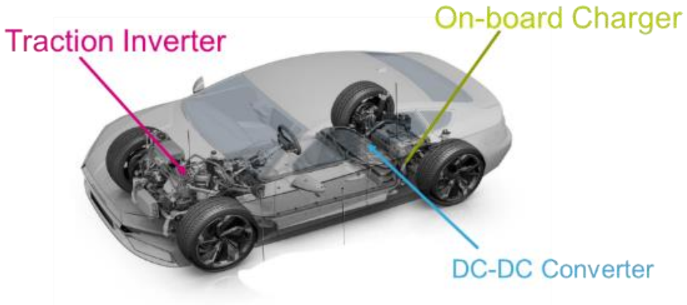
Car Electrification

GROWTH DRIVERS

- Environment: WW CO_2 emission reduction program
- Car electrification huge growth trend
- Smaller and lighter power unit form factor
- Better Inverter efficiency SiC MOSFET vs. IGBT (extra mileage / lower battery cost)

KEY APPLICATIONS

- **Traction Inverter**
- **OBC**
- **DC/DC Converter**



High End Industrial

GROWTH DRIVERS

- Better efficiency
- Smaller form factor
- Lower TCO vs. silicon technologies

KEY APPLICATIONS

- **Solar Inverter**
- **Energy Storage**
- **Power Supply**
- **Charging Station**
- **Welding**
- **Drives**

ST SiC diodes and feature

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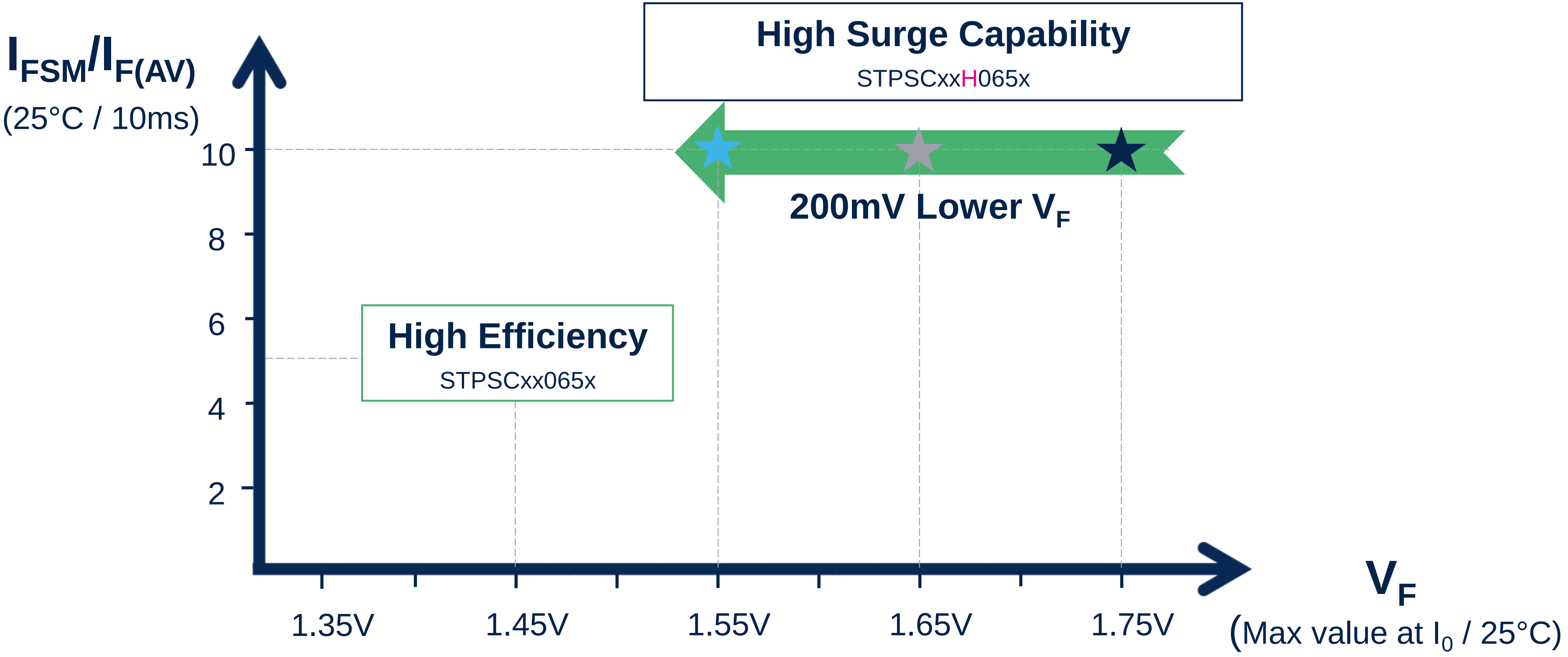
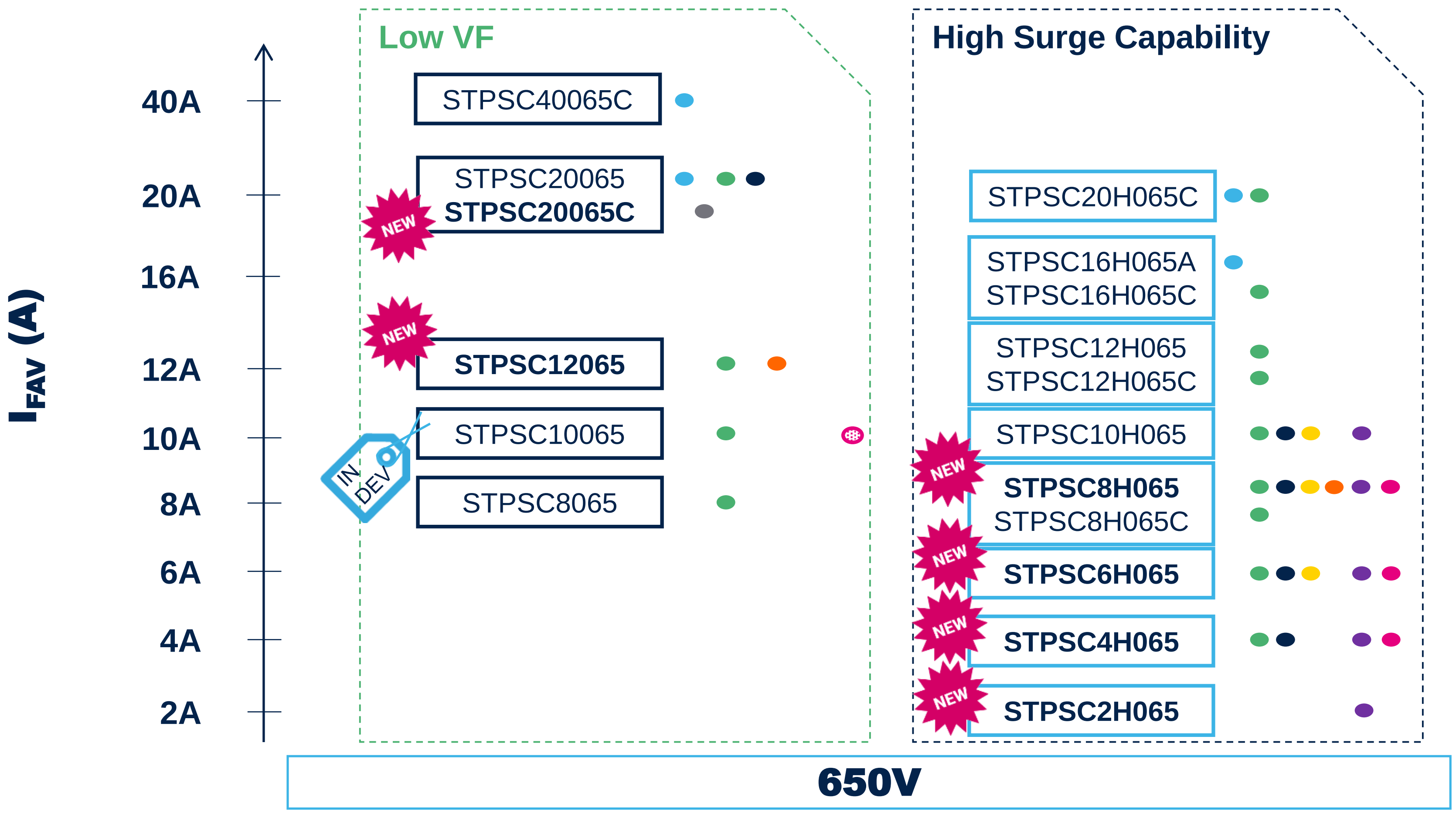
650V SiC Diodes product portfolio

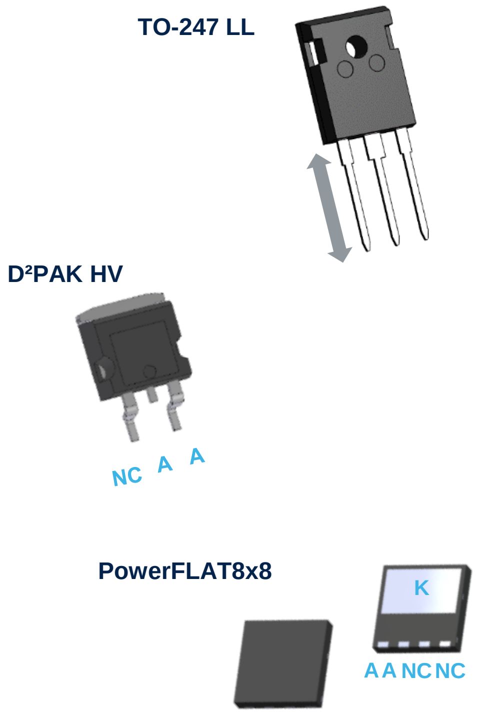


650V SiC Diodes product portfolio latest releases

SiC Diodes in new packages



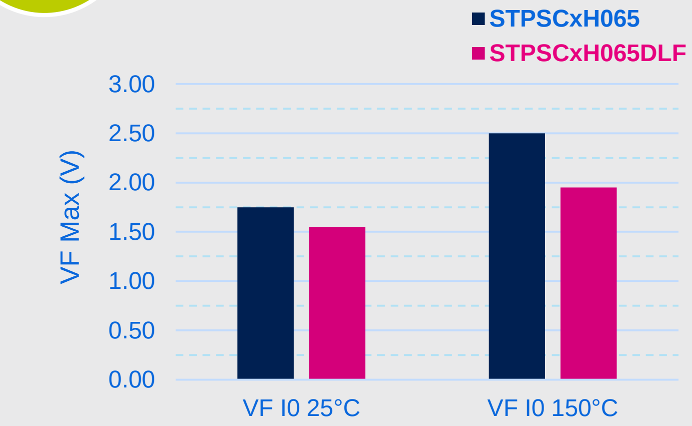
	TO247	TO-247 LL	TO-220	TO-220I	D²PAK	D²PAK HV	DPAK	PowerFLAT 8x8 HV
STPSC40065C	●							
STPSC20065	●		●	●				
STPSC20065C		●						
STPSC12065			●			●		
STPSC10065			●					●
STPSC8065			●					
STPSC20H065C	●		●					
STPSC16H065A	●							
STPSC16H065C			●					
STPSC12H065			●					
STPSC12H065C			●					
STPSC10H065			●	●	●		●	
STPSC8H065			●	●	●	●	●	●
STPSC8H065C			●					
STPSC6H065			●	●	●		●	●
STPSC4H065			●	●			●	●
STPSC2H065							●	



New PowerFLAT 8x8 package

… inside a less-than-1-mm thick package

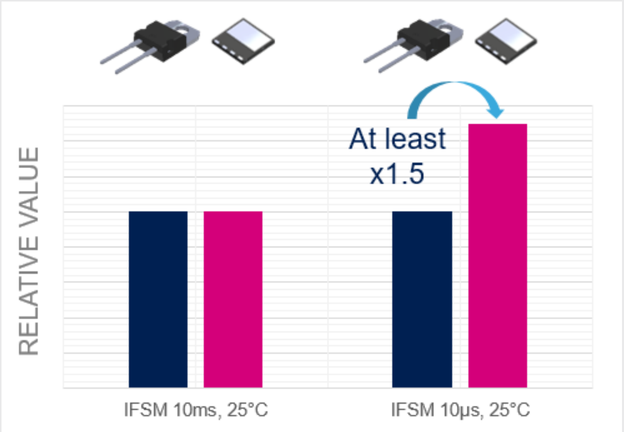
The ultimate Watts improvement



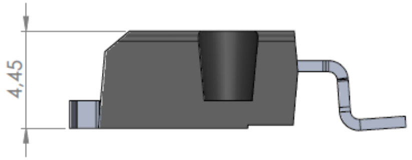
Every mV grants efficiency toward 97%, 98%, 99%

&

More Guard Band to grid disturbances

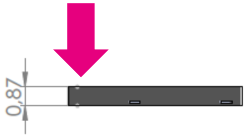


D2PAK



DPAK

PowerFLAT 8x8

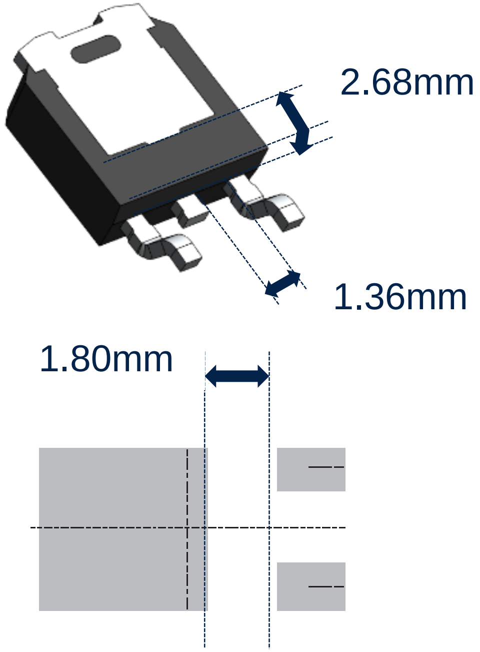


New PowerFLAT 8x8 package

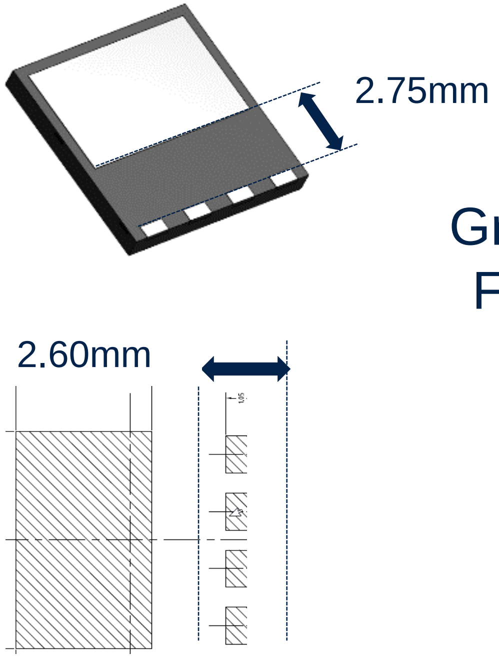
An improved Creepage Design

HIGH CREEPAGE

DPAK



PowerFLAT™ 8x8 HV



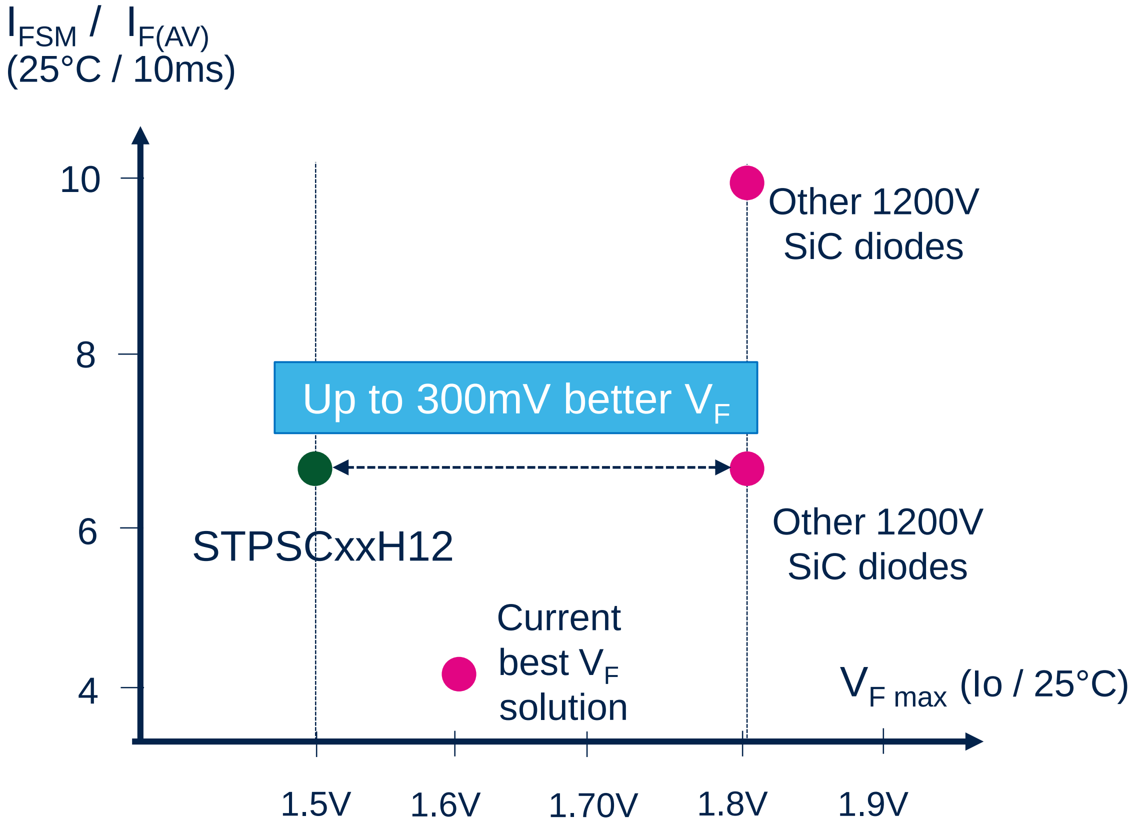
Greater Package and Footprint Creepage than DPAK

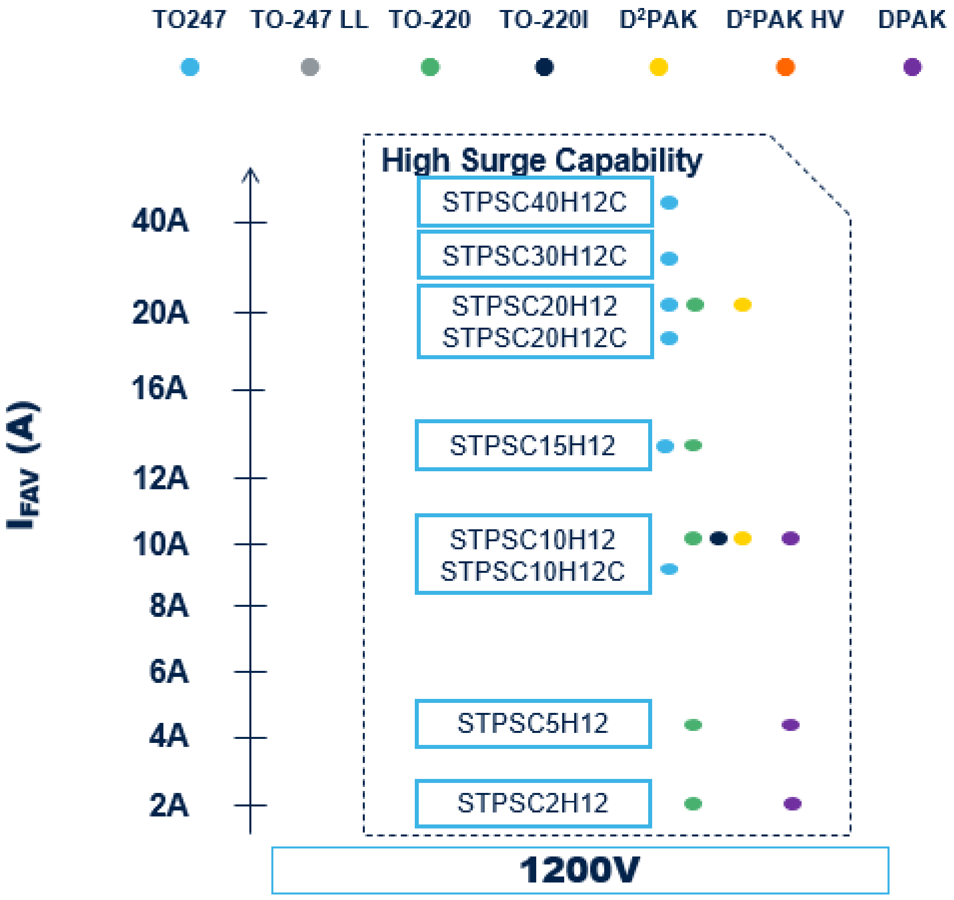
EASY COMPLIANCE TO IEC-60664-1*

*Basic Safety Standard Insulation

STPOWER SiC 1200V Diode

- Benchmark on VF





ST new SiC 1200V diode: the market reference on V_F

Reverse recovery - What is the practical difference? Let’s look at an example…

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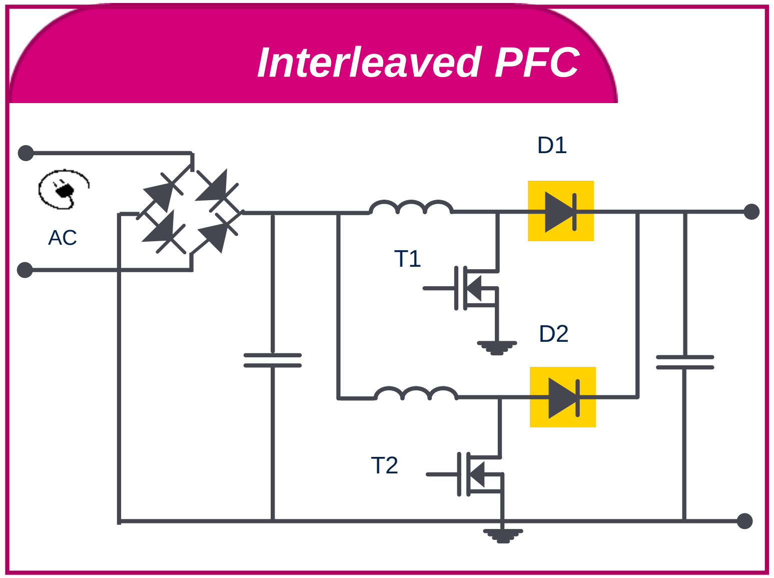
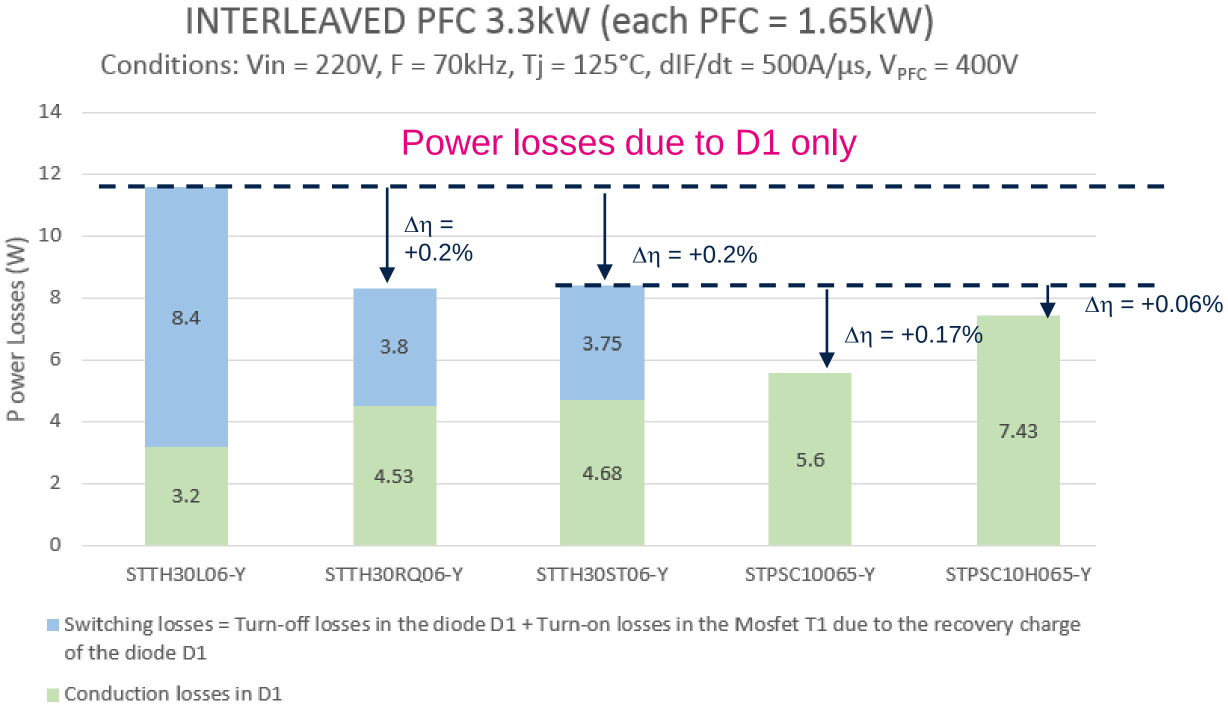
650V SiC Diode performances vs. Si Diode technology



Interleaved PFC 3.3kW: Power losses sharing



With SiC, we get :

- Best switching performance (fast and soft)
- Best efficiency in hard-switching applications thanks to best turn-off performance

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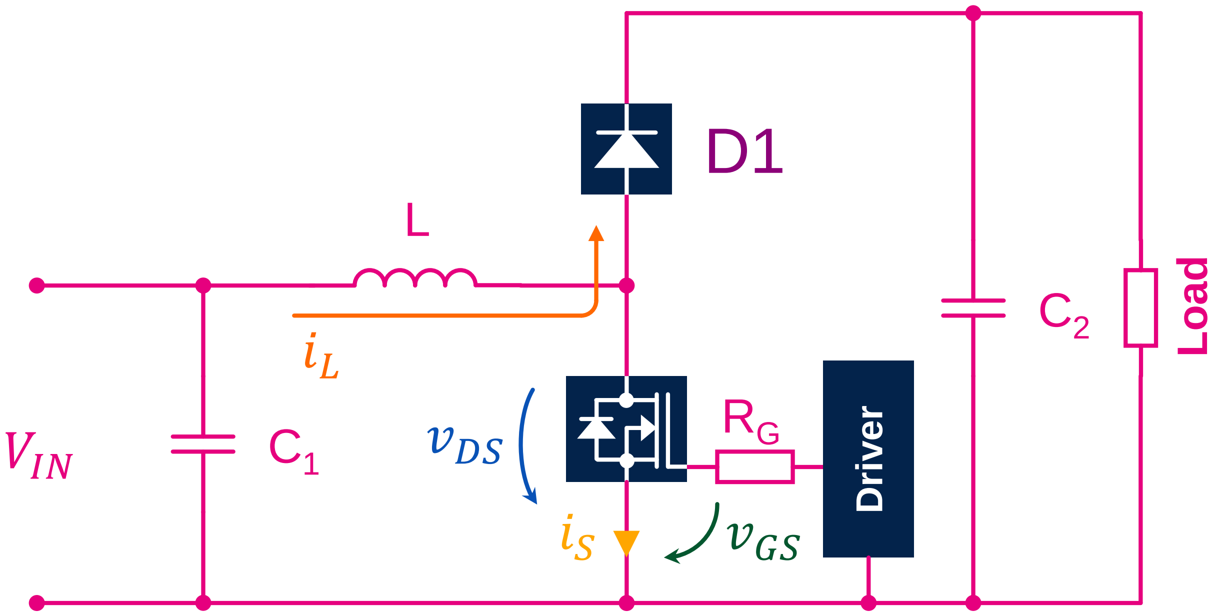
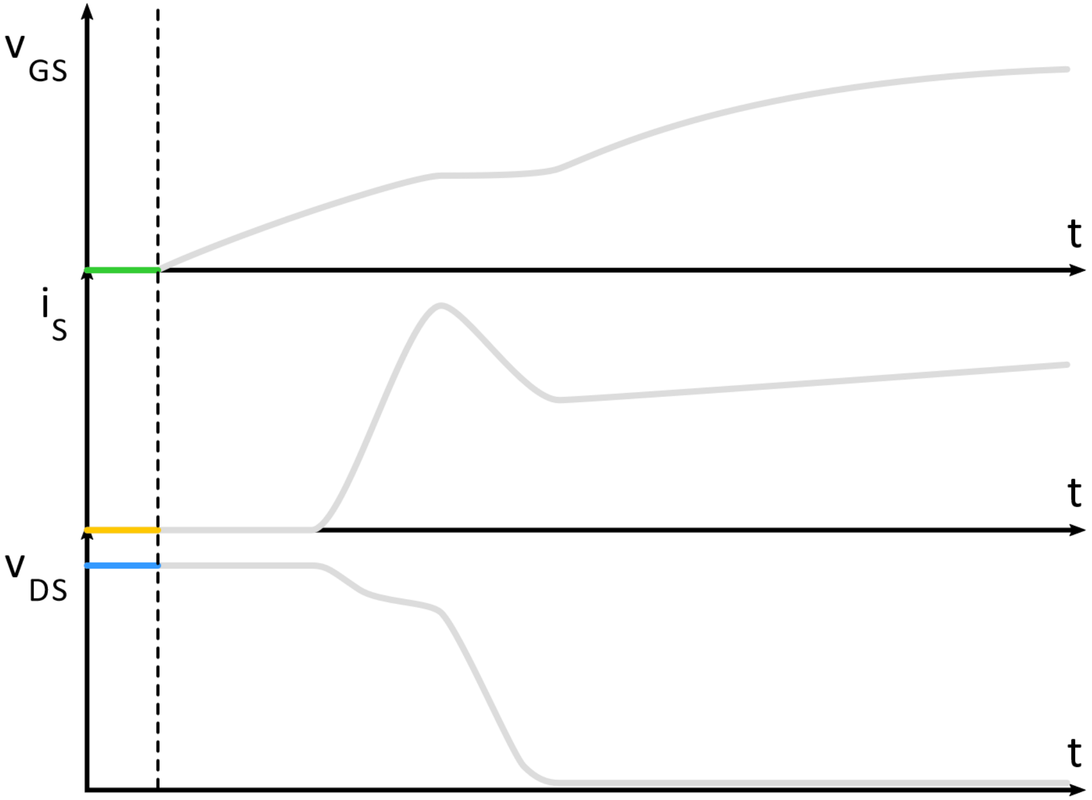
Hard switching
Example: Boost in CCM, #1

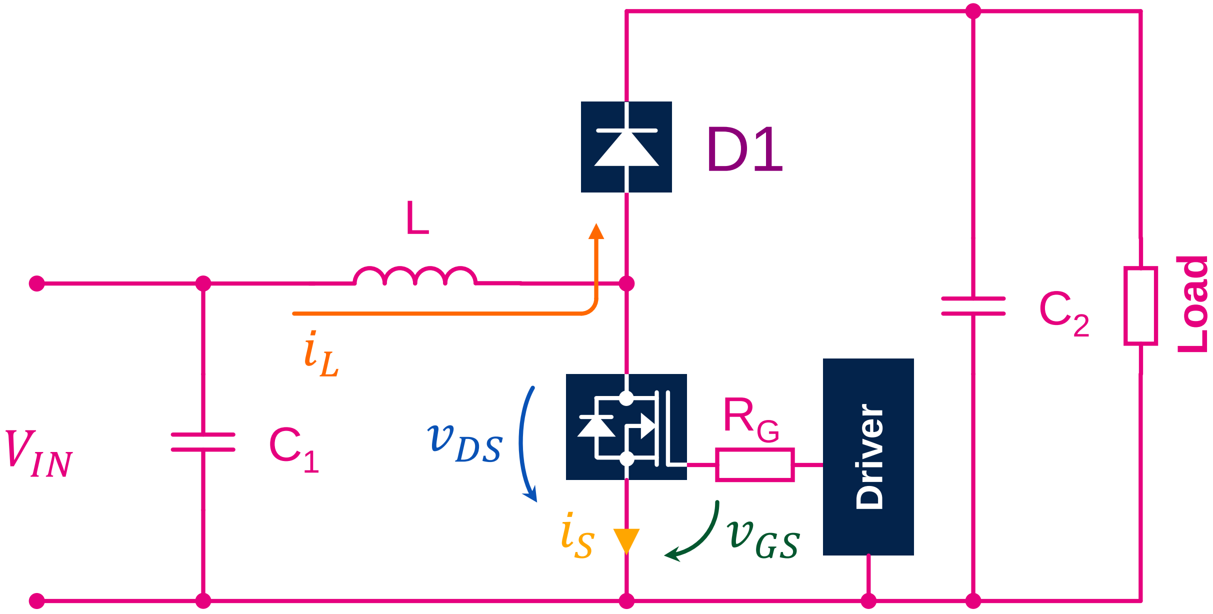
- Drain current driven by V_{GS}
- MOSFET channel starts conducting at full V_{DS} voltage

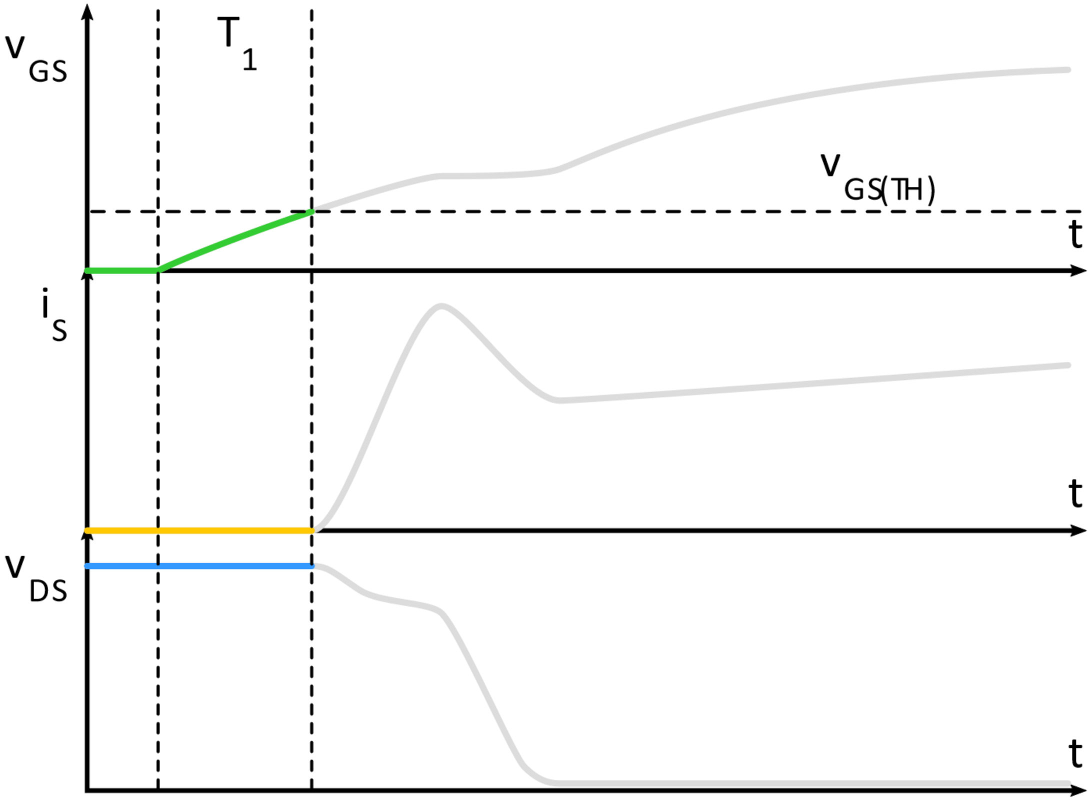




Hard switching
Example: Boost in CCM, #2

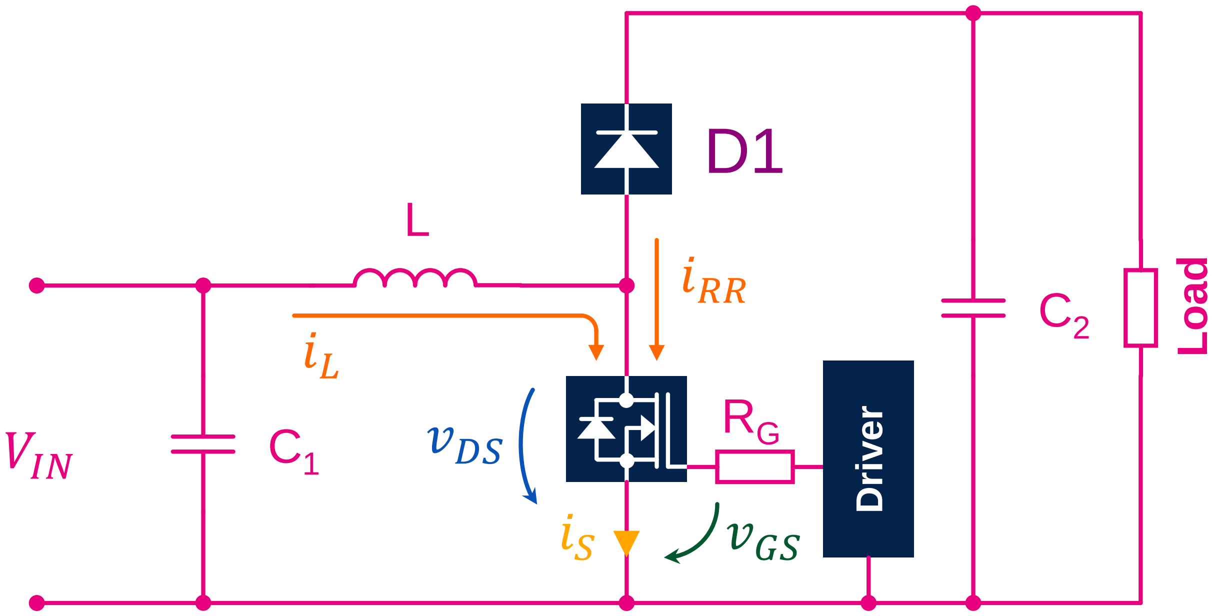
- Drain current driven by V_{GS}
- MOSFET channel starts conducting at full V_{DS} voltage

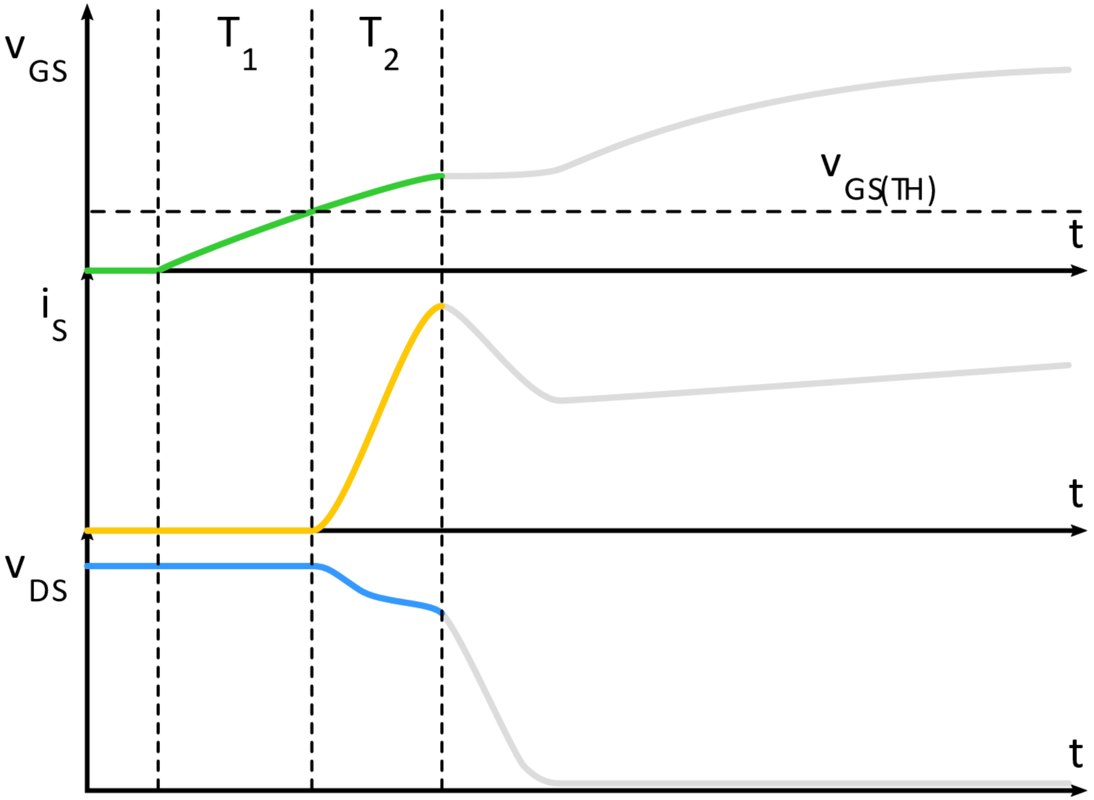




Hard switching
Example: Boost in CCM, #3

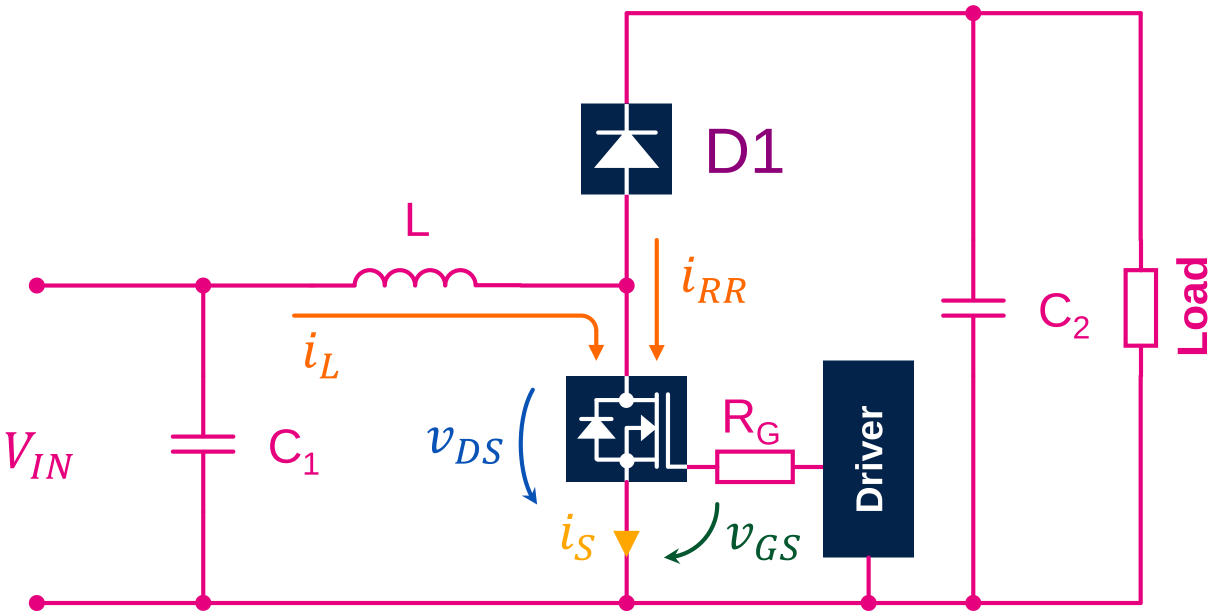
- Drain current driven by V_{GS}
- MOSFET channel starts conducting at full V_{DS} voltage

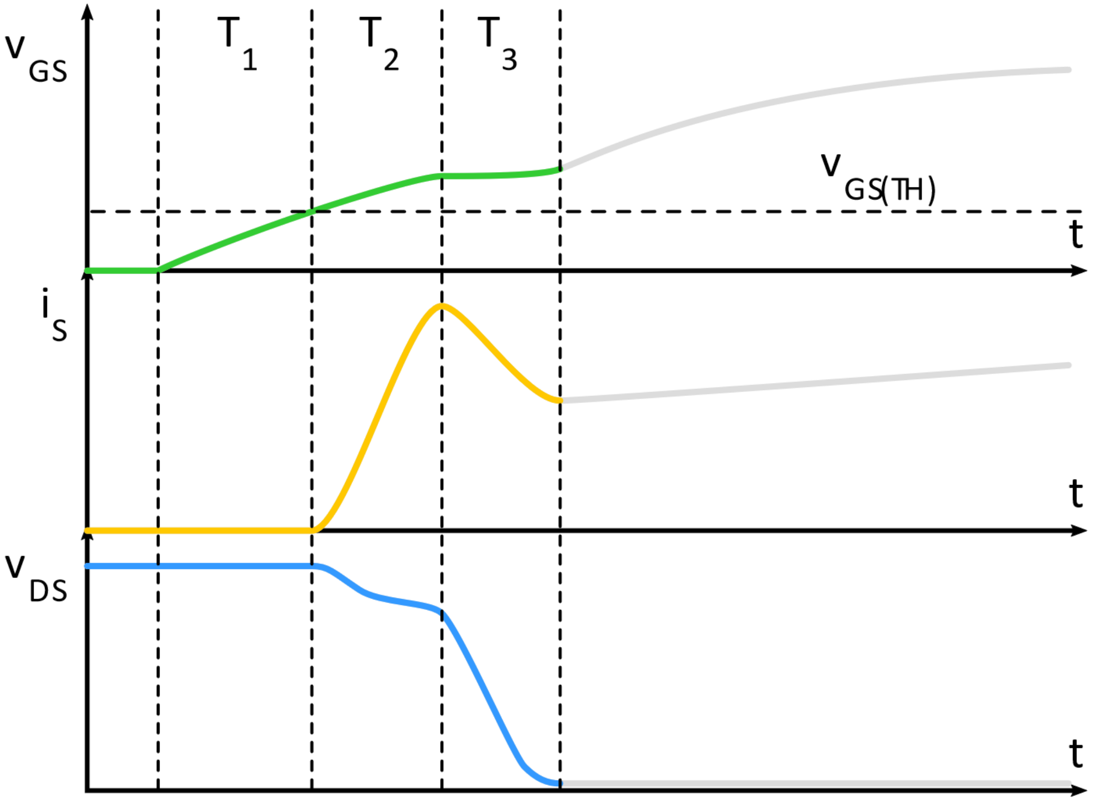




Hard switching
Example: Boost in CCM, #4

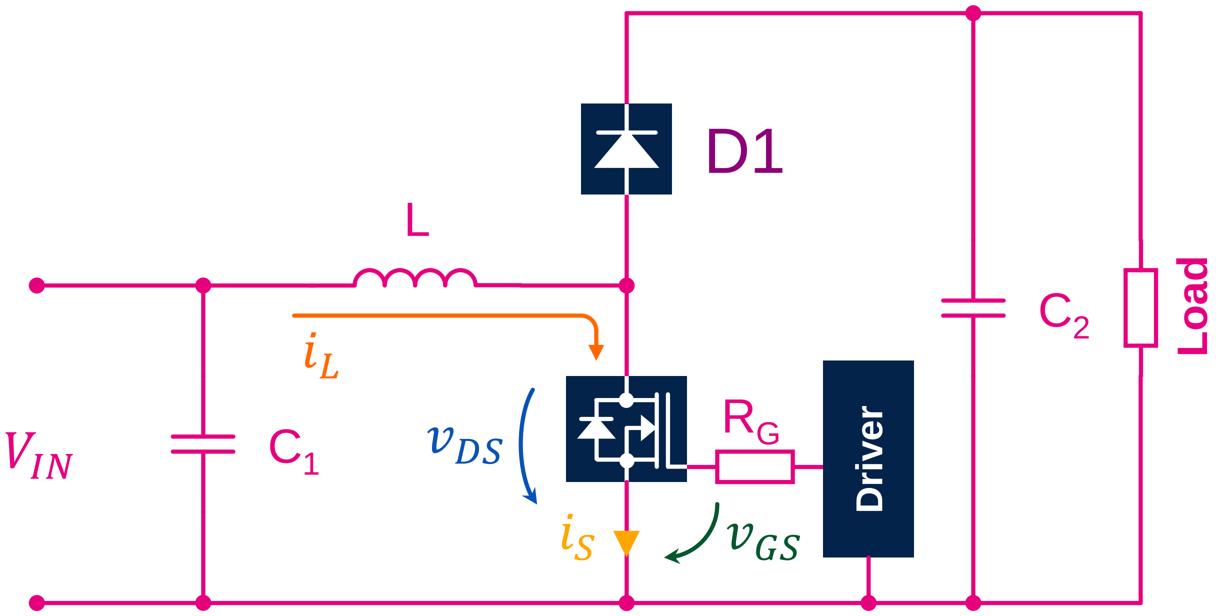
- Drain current driven by V_{GS}
- MOSFET channel starts conducting at full V_{DS} voltage

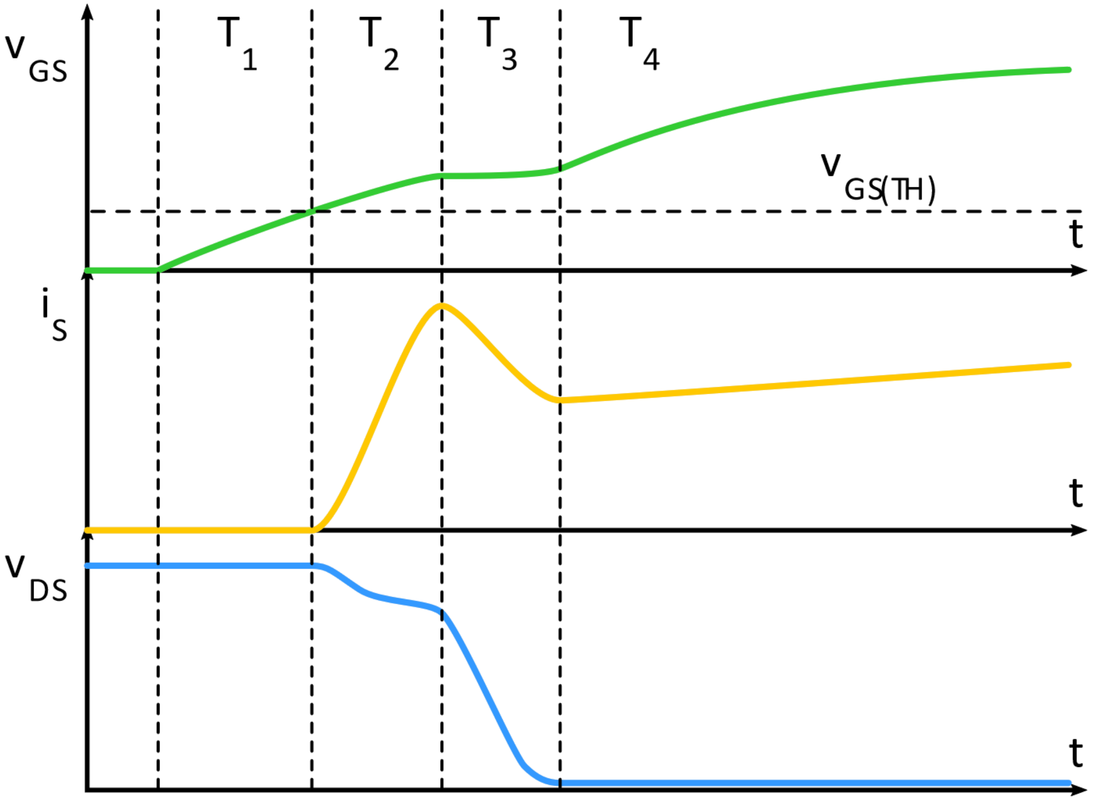




Hard switching
Example: Boost in CCM, #5

- Drain current driven by V_{GS}
- MOSFET channel starts conducting at full V_{DS} voltage



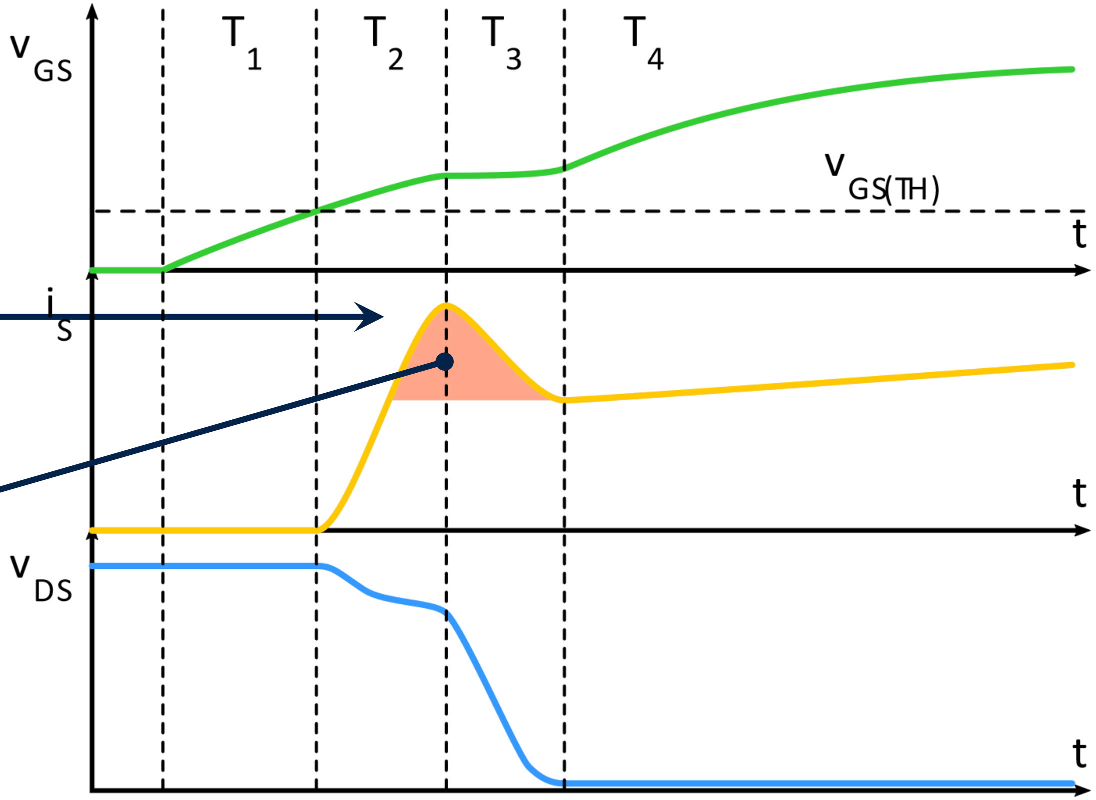


Hard switching
Example: Boost in CCM, #6

- Drain current driven by V_{GS}
- MOSFET channel starts conducting at full V_{DS} voltage

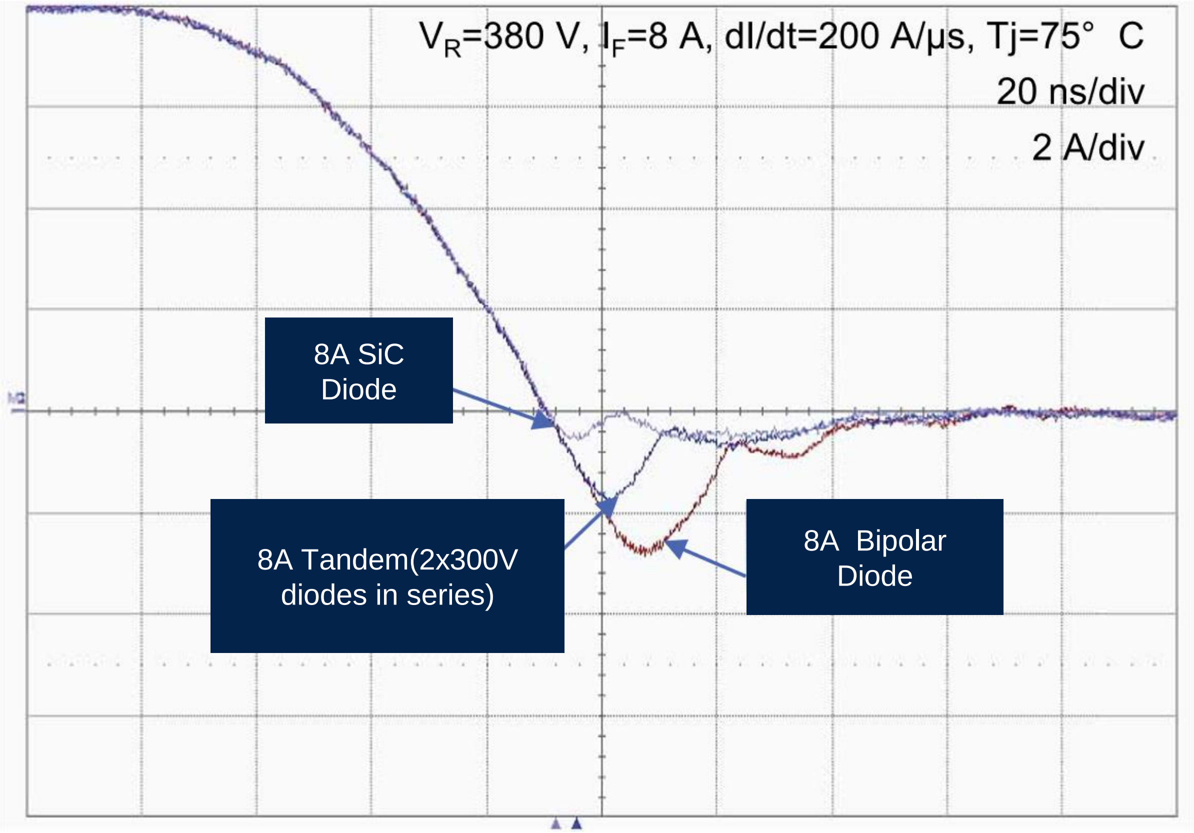
Reverse recovery of the boost diode D1

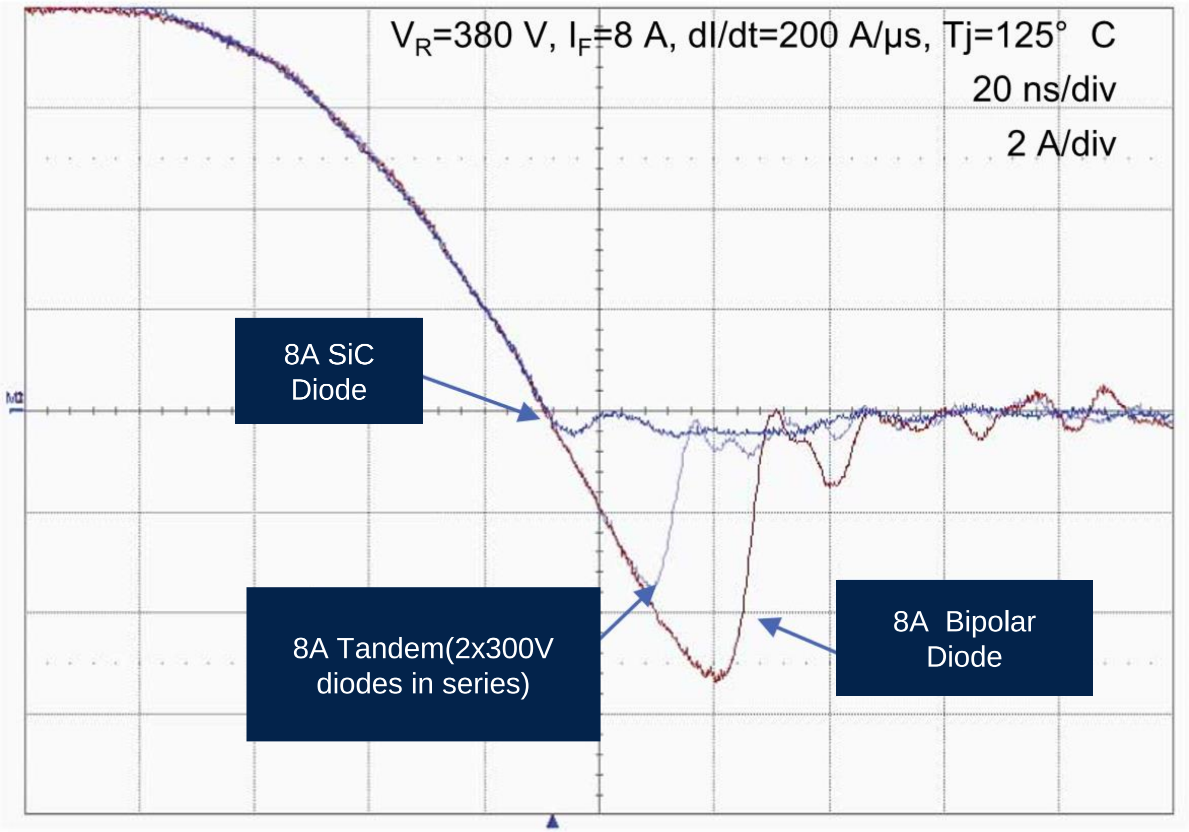
Area ~ Q_{RR}



- Q_{RR} dissipated in the MOSFET

SiC diodes
Reverse recovery





- SiC boost diode D1 ⇨ no minority carrier recombination ⇨ no recovery
- Ideal for hard switching topologies

SiC MOSFET Products

STPOWER SiC MOSFET series positioning

Breakdown Voltage	650V ★		1200V ★		1700V ★
Series	G2		G1	G2	G1
R_{DS}(on) mΩ	18-55		52-520	22-75	65-700
I_D Current	45-120A		12-65A	40-100A	6-25A
Focus Applications	Renewable energy Power Supply OBC, DC-DC	Power Conversion Industrial drives	Photovoltaic HVAC	Street Lighting Charging stations OBC, DC-DC, Traction	High Voltage Power Supply DC-DC

★ **AG Qualification available**

SiC MOSFET in Mass Production: 1200V Gen1 (1/3)

Part Number	**V_{DS} [V]**	**R_{DS}(on) Typ @ 25 ºC [Ω]**	**Id [A]**	**Package**				
				HiP247	HiP247-LL	HiP247-4LL	H2PAK-2L	H2PAK-7L
				Tj max= 200°C				
1200 Gen1 (Vgs=18V) series								
SCT50N120	1200	0.052	65	X				
SCTWA50N120					X			
SCTWA50N120-4						X		
SCTH50N120-7								X
SCT30N120		0.080	40	X				
SCTWA30N120					X			
SCT30N120H							X	
SCT20N120		0.169	20	X				
SCTWA20N120					X			
SCT20N120H							X	
🚗 SCT20N120AG				X				
SCT10N120		0.520	12	X				
SCTWA10N120					X			
SCT10N120H							X	
🚗 SCT10N120AG				X				

🚗 Automotive Grade

The Best Rdson vs. Tj behavior Option

SiC MOSFET in Mass Production: 650V Gen2 (2/3)

	Part Number	V_{DS} [V]	R_{DS}(on) Typ @ 25 ºC [Ω]	Id [A]	Package			
					HiP247	HiP247-LL	HiP247-4LL	H2PAK-7L
					Tj max= 200°C			*Tj max= 175°C*
	650 Gen2 (Vgs=18V) series							
	SCTW90N65G2V	**650**	**0.018**	**119**	X			
	SCTWA90N65G2V					X		
	SCTWA90N65G2V-4						X	
	SCTH90N65G2V-7							X
🚗	**SCTW100N65G2AG**		**0.020**	**100**	X			
	SCTWA100N65G2AG					X		
	SCTWA100N65G24AG						X	
	SCTH100N65G2-7AG							X
	SCTW35N65G2V	**650**	**0.55**	**45**	X			
	SCTWA35N65G2V					X		
	SCTWA35N65G2V-4						X	
	SCTH35N65G2V-7							X
🚗	**SCTW35N65G2VAG**				X			
	SCTWA35N65G2VAG					X		
	SCTWA35N65G2V4AG						X	
	SCTH35N65G2V-7AG							X

🚗 Automotive Grade

The best Rdson vs Qg trade-off

SiC MOSFET in Mass Production: Gen2-1200V (3/3)

Part Number	V_{DS} [V]	R_{DS}(on) Typ @ 25 ºC [Ω]	Id [A]	Package			
				HiP247	HiP247-LL	HiP247-4LL	H2PAK-7L
				Tj max= 200°C			
1200 Gen2 (Vgs=18V) series							
SCTW70N120G2V	1200	0.025	80	X			
SCTWA70N120G2V-4						X	
SCTH70N120G2V-7							X
SCTW40N120G2V		0.070	45	X			
SCTWA40N120G2					X		
SCTWA40N120G2V-4						X	
SCTH40N120G2V-7							X
🚗 **SCTW40N120G2VAG**		0.075	35	X			
SCTWA40N120G2AG					X		
SCTWA40N120G24AG						X	
SCTH40N120G2V-7AG							X

🚗 Automotive Grade

1200V Gen2 -The Best Rdson vs. Qg trade off

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SiC MOSFET Product Plan
1700V devices being introduced in mass production

Part Number	V_{DS} [V]	R_{DS}(on) Typ @ 25 ºC [Ω]	Id [A]	Package				
				HiP247	HiP247-LL	HiP247-4LL	H2PAK-2L	H2PAK-7L
				Tj max= 200°C			*Tj max= 175°C*	
1200 Gen2 (Vgs=18V) series								
SCT1000N170	**1700V**	**1**	**6**	x				
🚗 **SCT1000N170AG**				x				
SCTWA1000N170					x			
SCT20N170		**0.064**	**25**	x				
🚗 **SCT20N170AG**				x				
SCTWA20N170					x			

🚗 Automotive grade

1700V SiC MOSFET’s – The First Very High Voltage devices Automotive & Industrial Qualified

SiC MOSFET: advanced packaging technologies

Package offer - Discrete – Bare Dice – Advanced packages

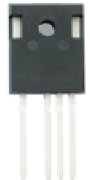
Key advantages to…

- Increase Power Density
- Reduce parasitic effects
- Target higher efficiency

Rated at

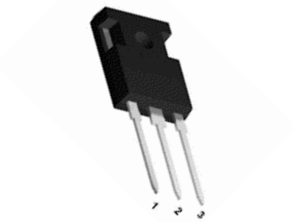
200°C!!!

Available Packages

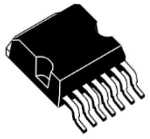


HiP247-4L

HiP247

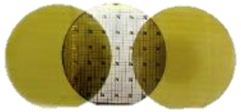


HiP247-LL



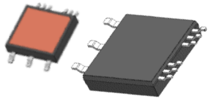
H2PAK

Bare Dice Strategic offer for Key Players



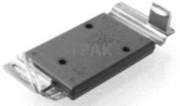
***SiC** Forthcoming Packages*

PowerFLAT



ACEPACK SMIT

ACEPACK 1 & 2



STPAK

HU3PAK

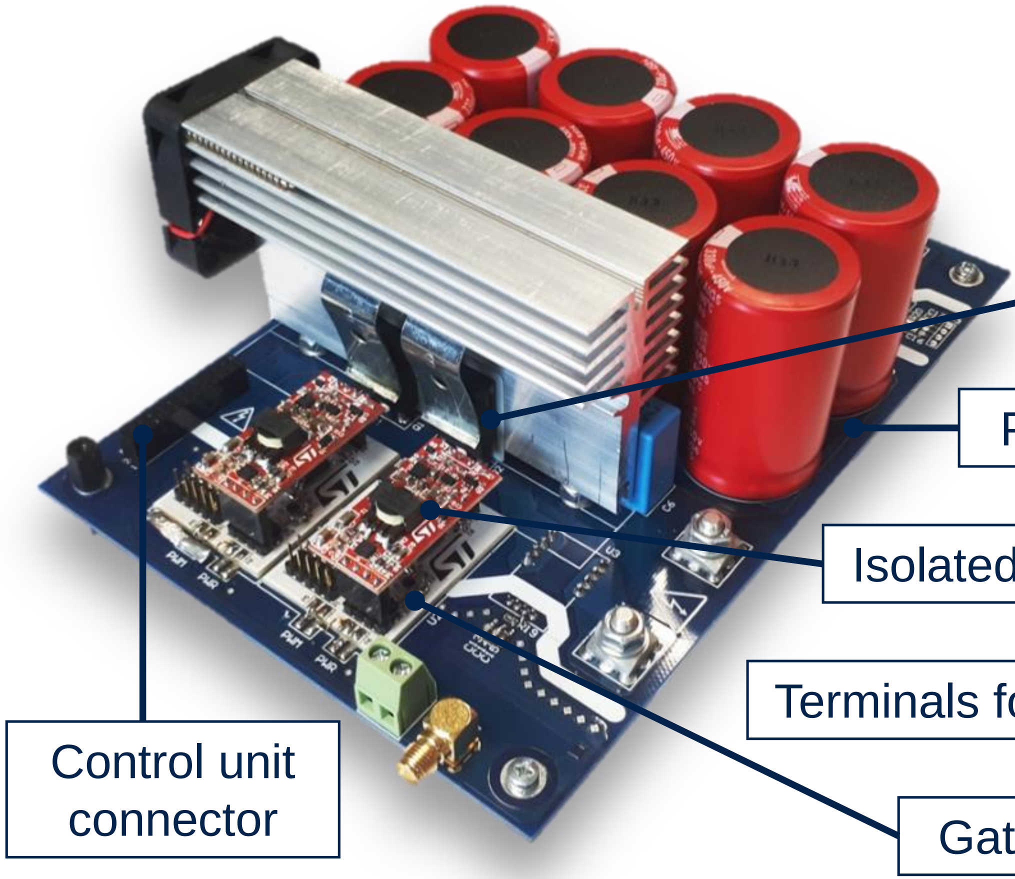
TO220FP

DPAK

ACEPACK DRIVE

Switching performance measurement

Half-Bridge testing platform
Buck / Boost



SiC Half-Bridge

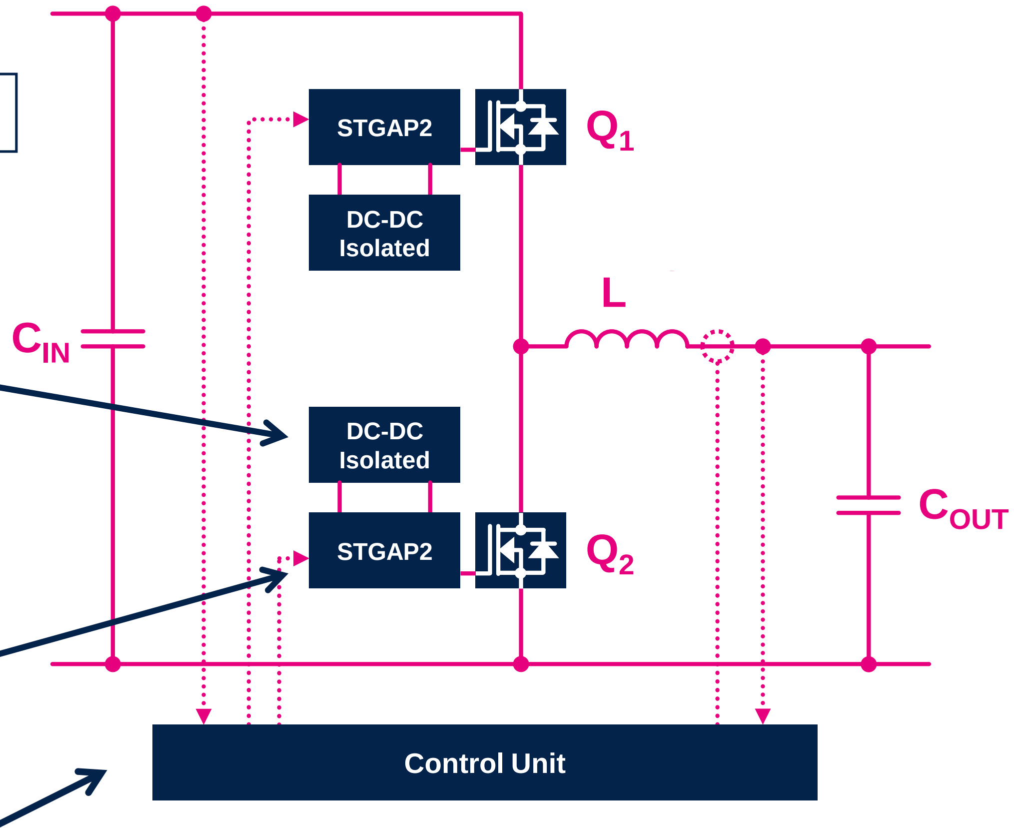
Power stage board

Isolated DC/DC sub-board

Terminals for external inductor

Gate driver sub-board

Control unit connector



Control board based on STM32 MCU

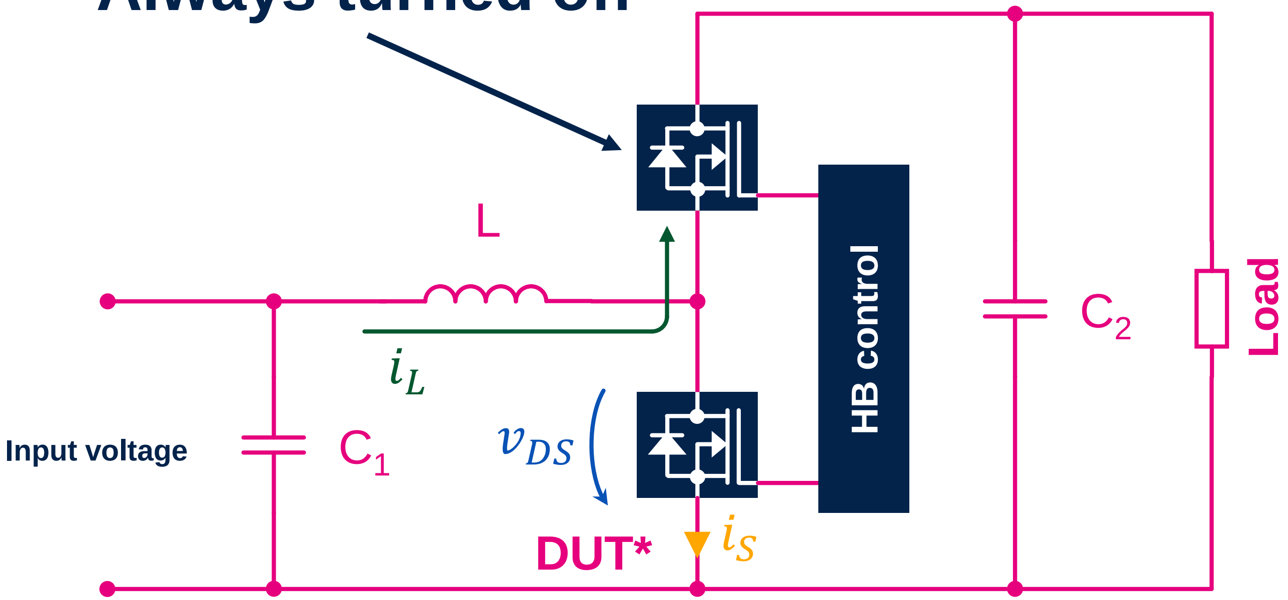
Deliverables

- **SiC MOSFET switching behavior, in combination with Switch/Diode**
- **Dynamic losses of power semiconductors**
- **Reference design for STGAP2**
- **Reference design for DC/DC converter**

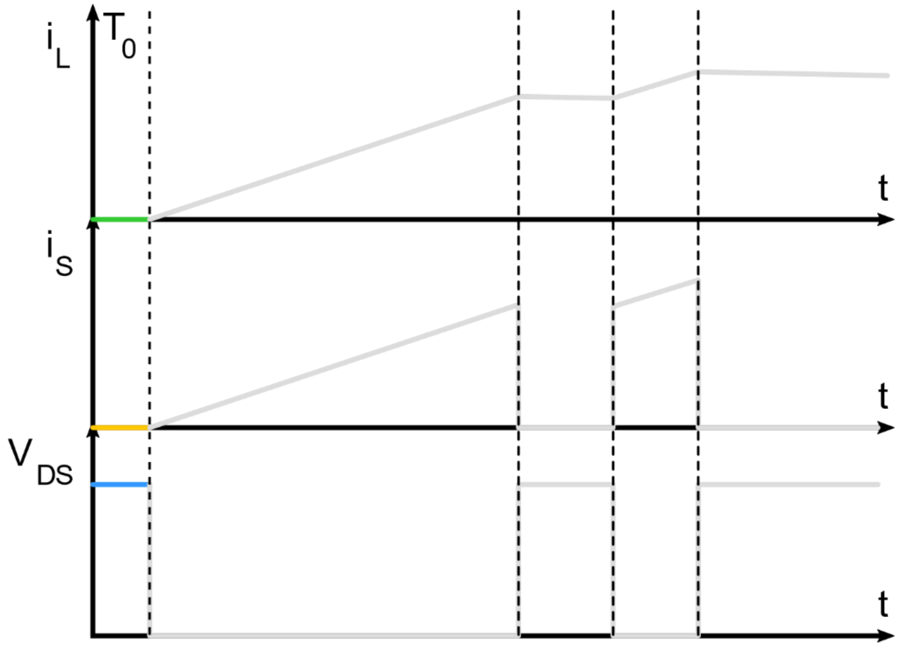
Double pulse test
Principle of operation #1

T_0: Idle Stage

Always turned off



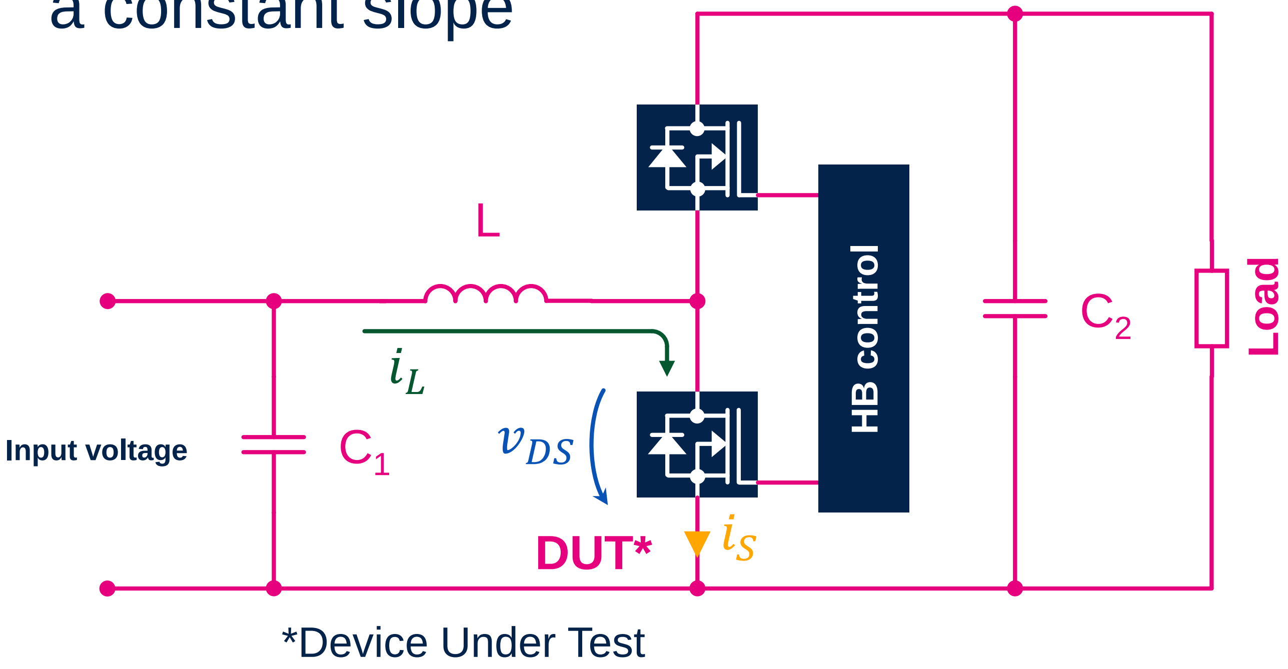
*Device Under Test



The Double-Pulse test is perfectly suited to measure the switching energy of a DUT (Device Under Test)

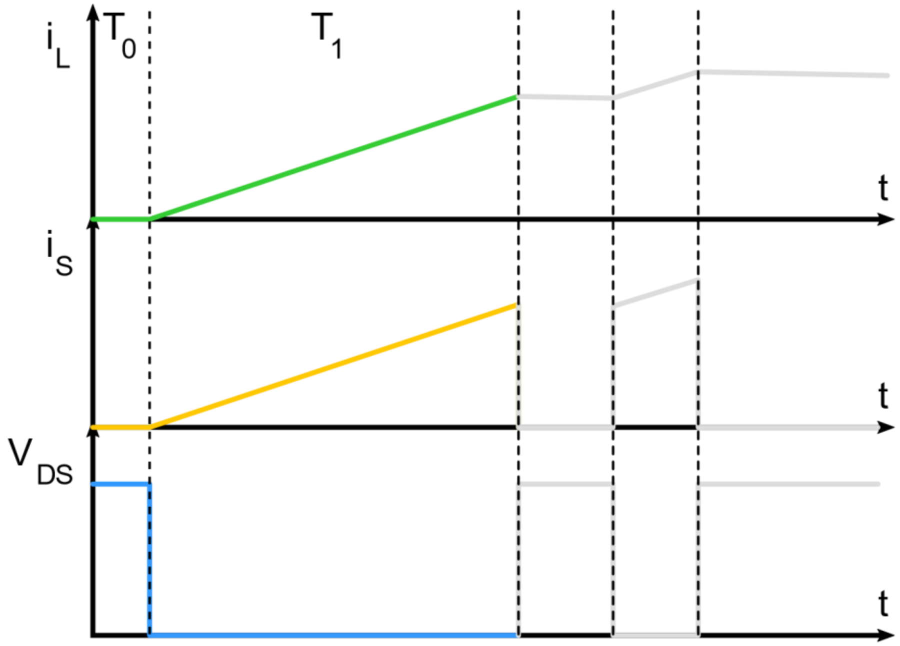
Double pulse test
Principle of operation #2

$\frac{di}{dt} = \frac{V_L}{L}$ → current increases with a constant slope



*Device Under Test

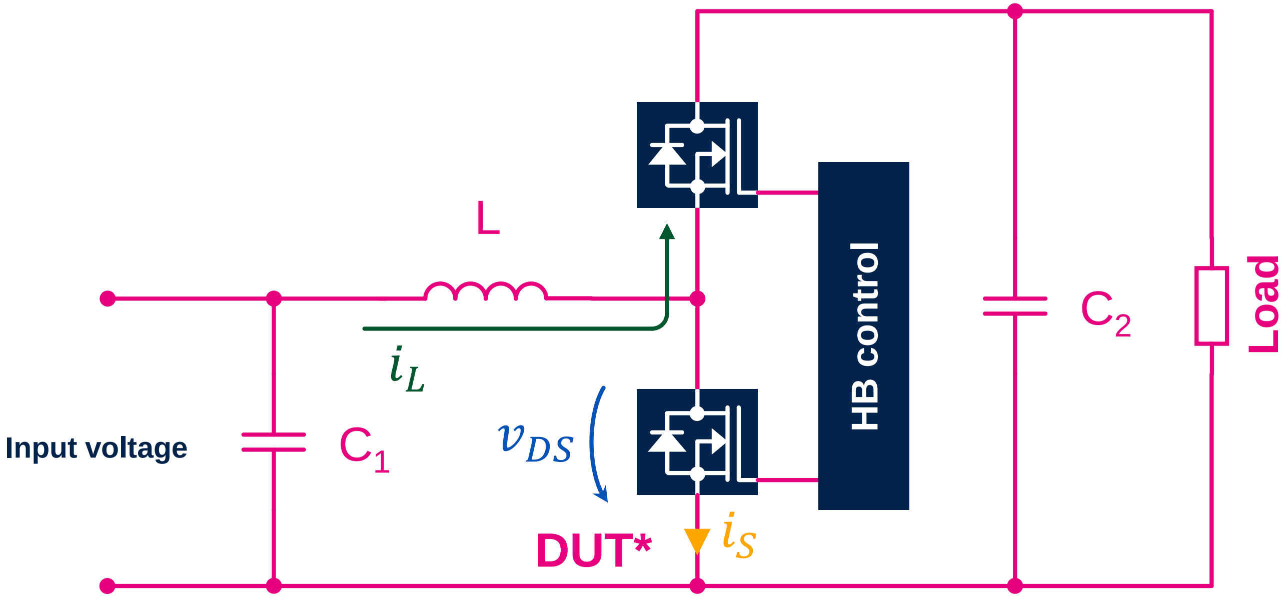
T_1: Linear current Increase



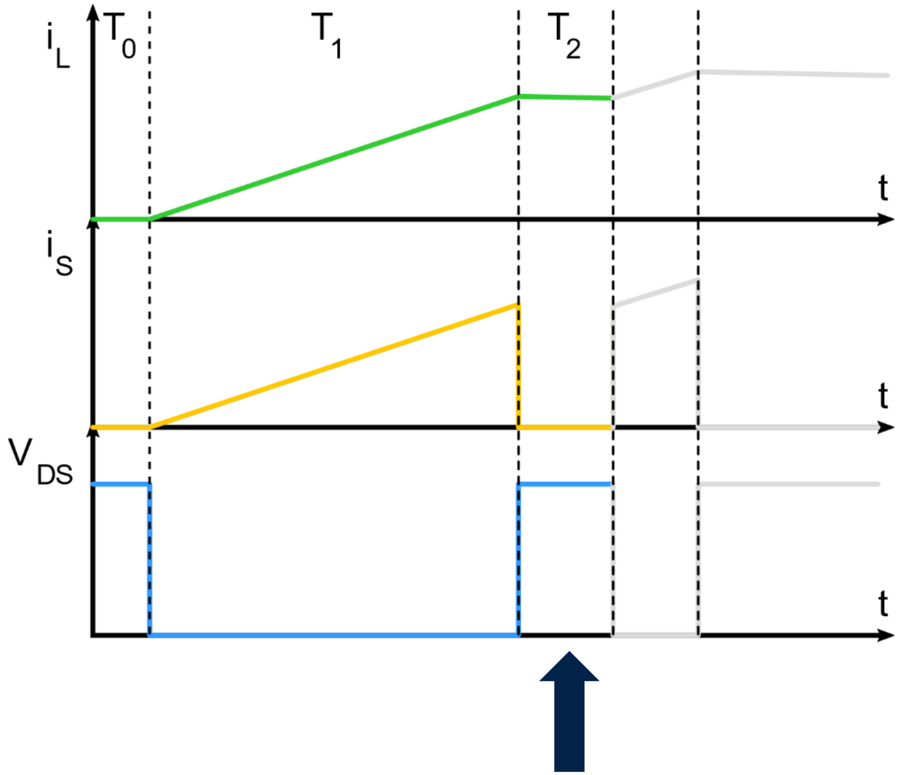
T_1 long enough to reach the wished current level.

Double pulse test
Principle of operation #3

T_2: Free-Wheeling Phase



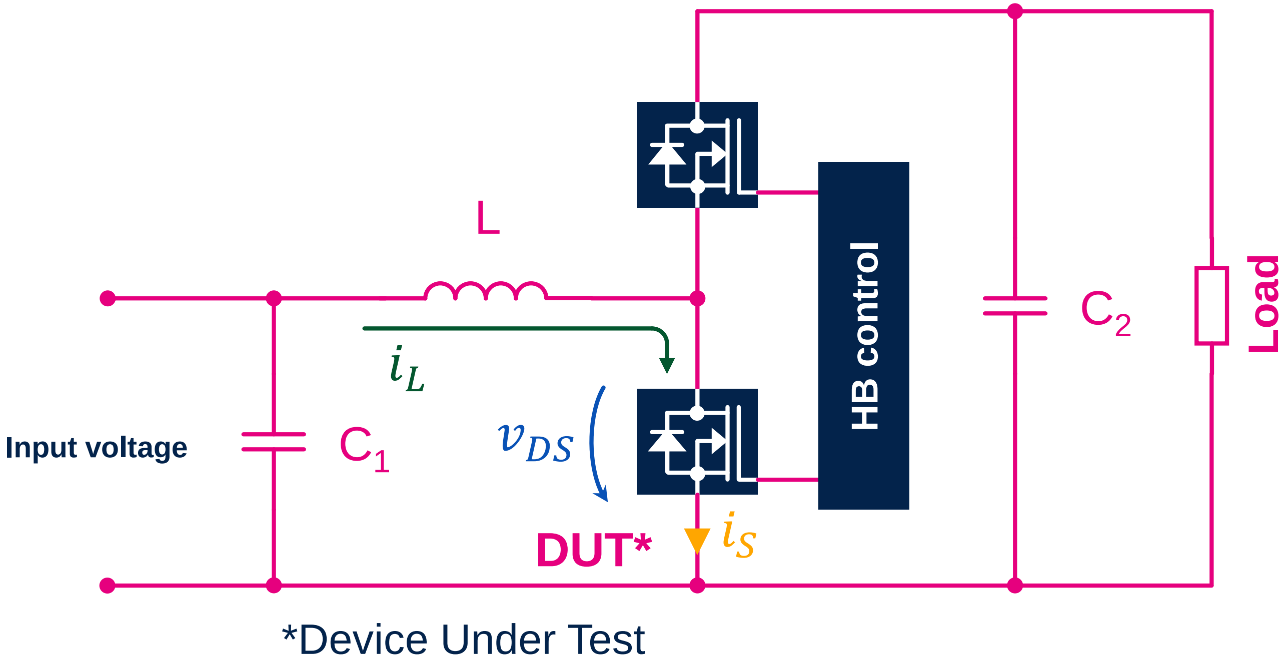
*Device Under Test



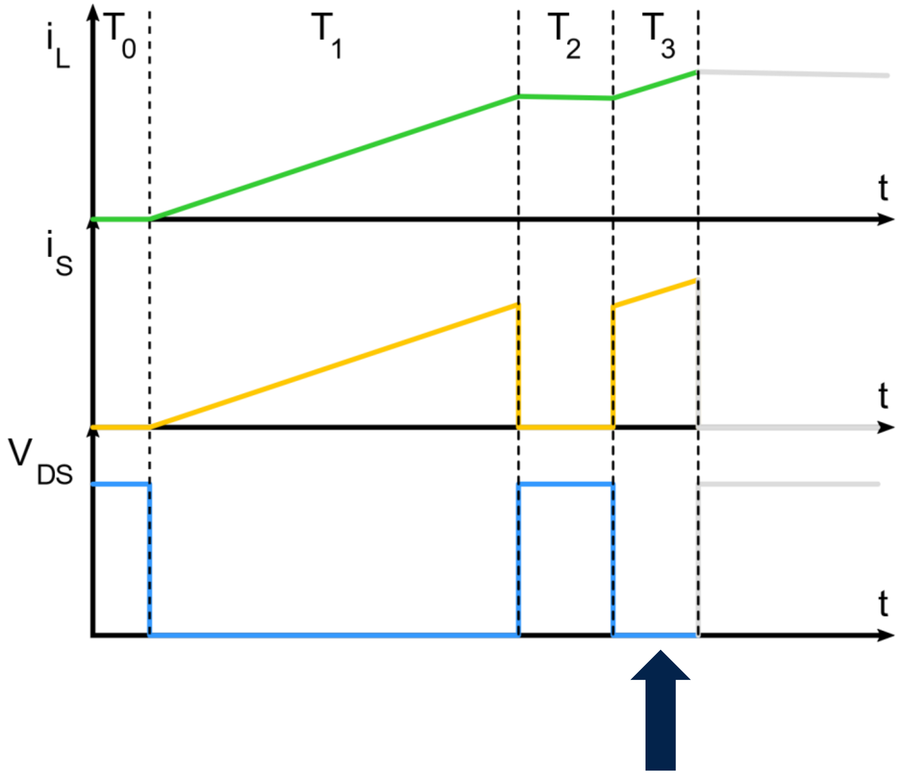
T_2 long enough to wait for switch-off transient, but not too long to decrease inductor current too much.

Double pulse test
Principle of operation #4

T_3: 2nd Linear Increase Phase



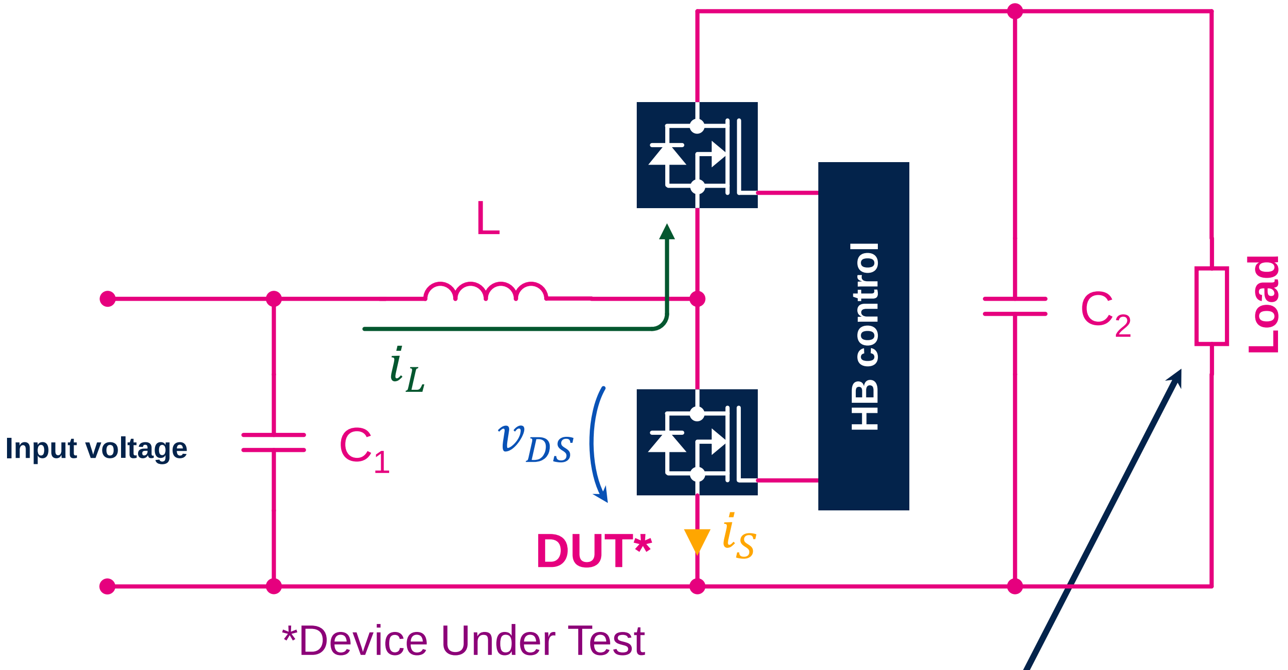
*Device Under Test



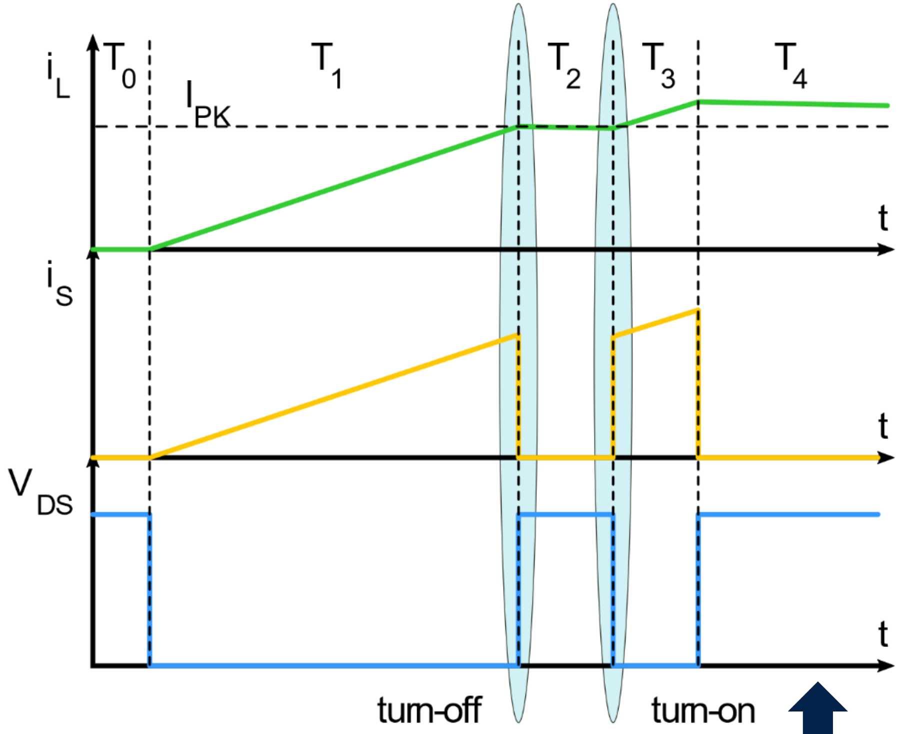
T_3 long enough to wait for switch-on transient.

Double pulse test
Principle of operation #5

T_4: Reset Phase



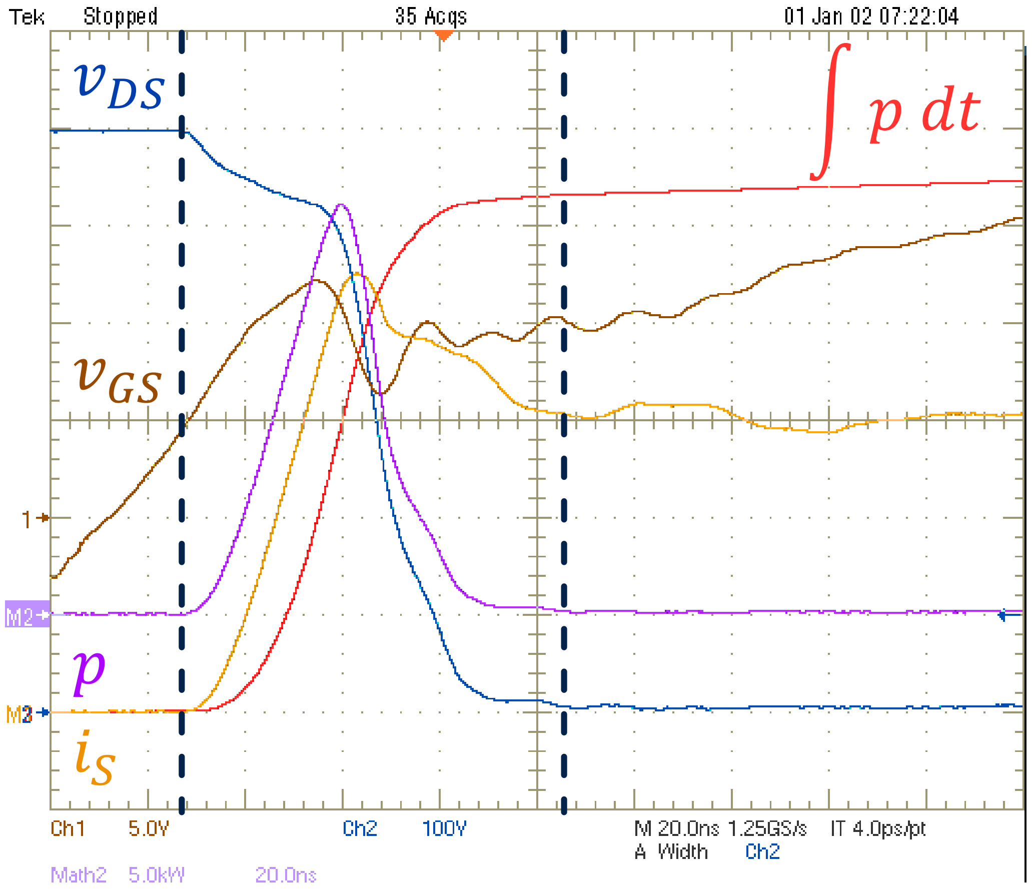
Sufficient load to dissipate energy from the inductor before the next period



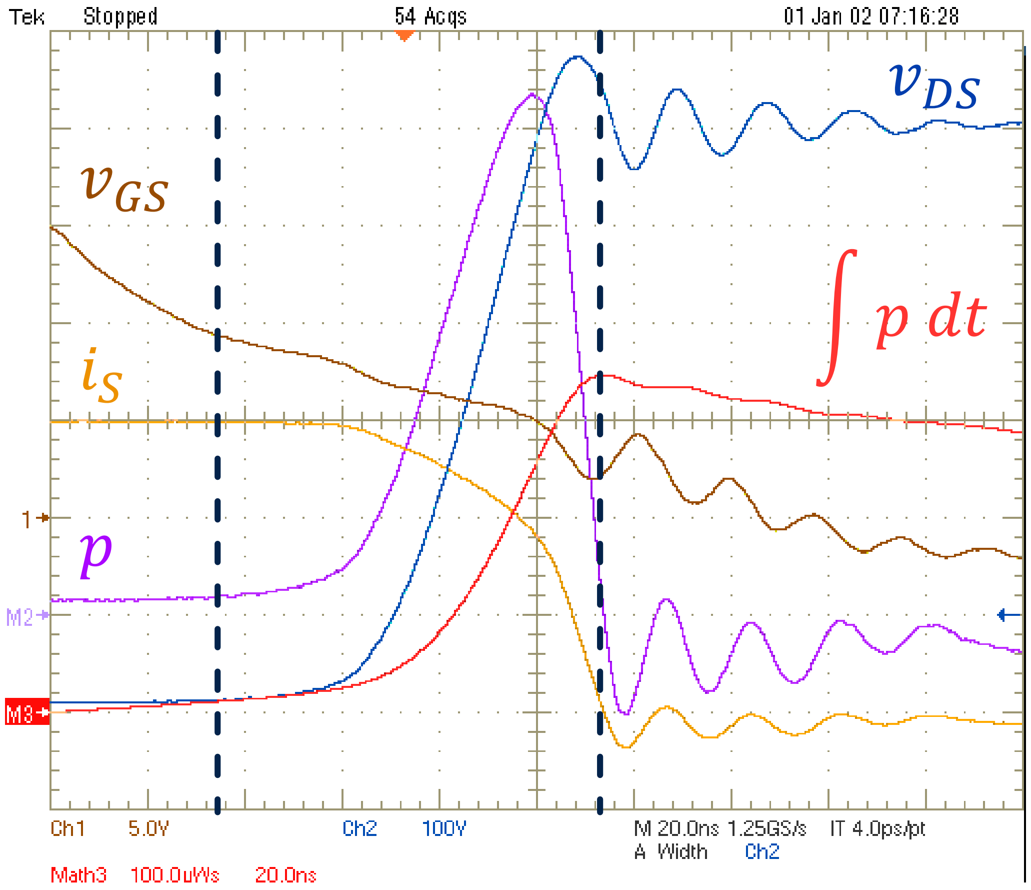
T_4 long enough to demagnetize the inductor.

Switching energy measurement
Turn-on/off transient detail

$R_G = 10\ \Omega,\ I_{PK} = 30\ A$



Turn-on transient

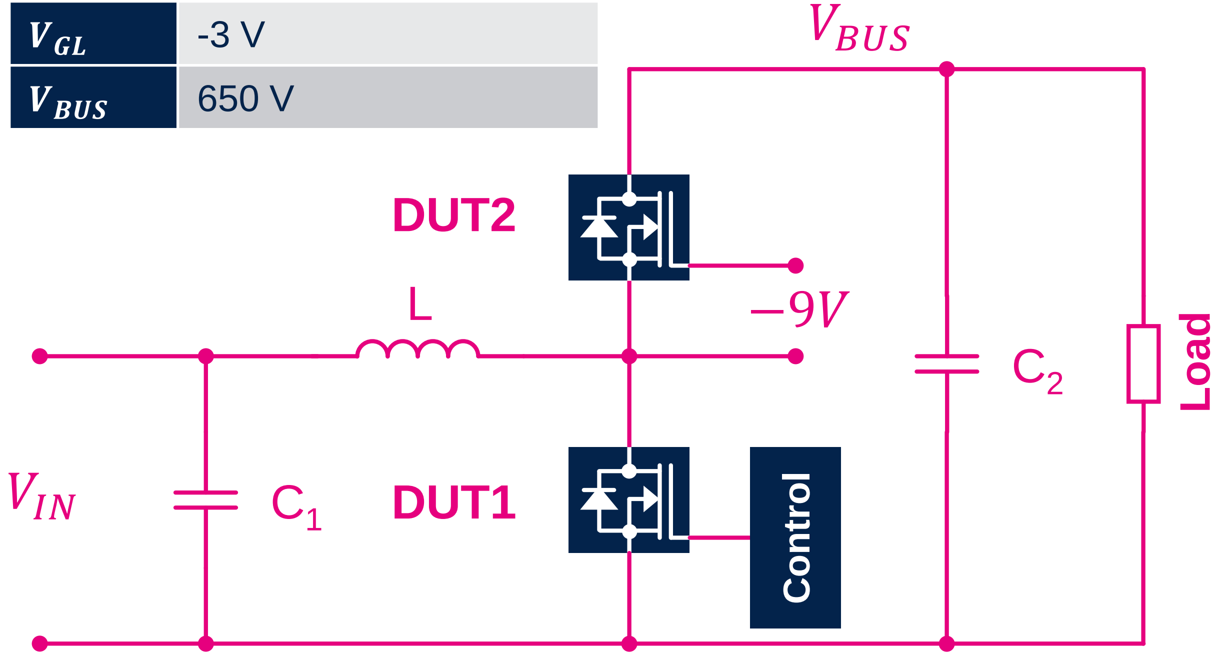


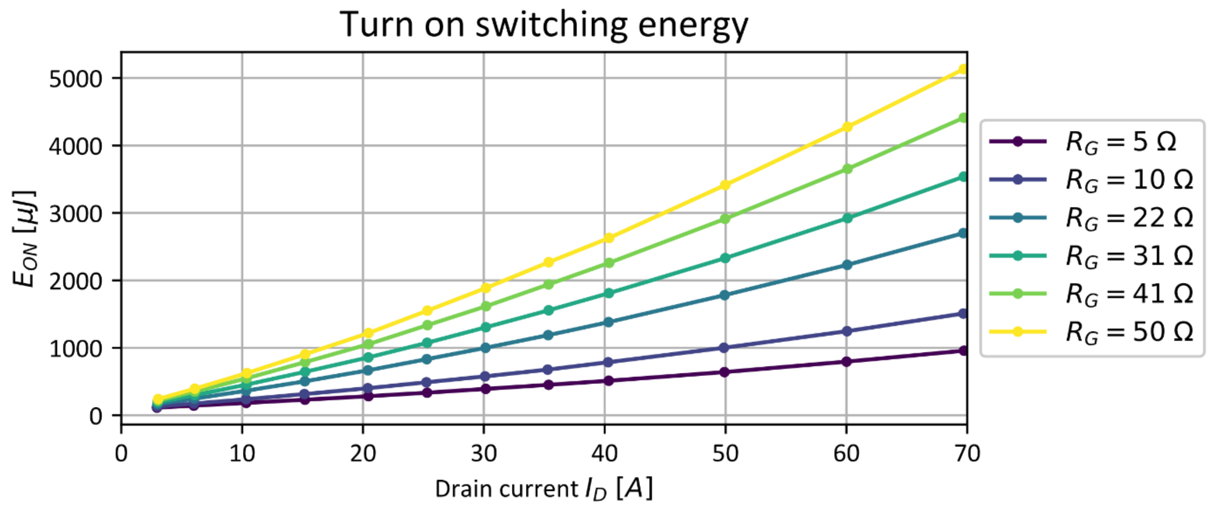
Turn-off transient

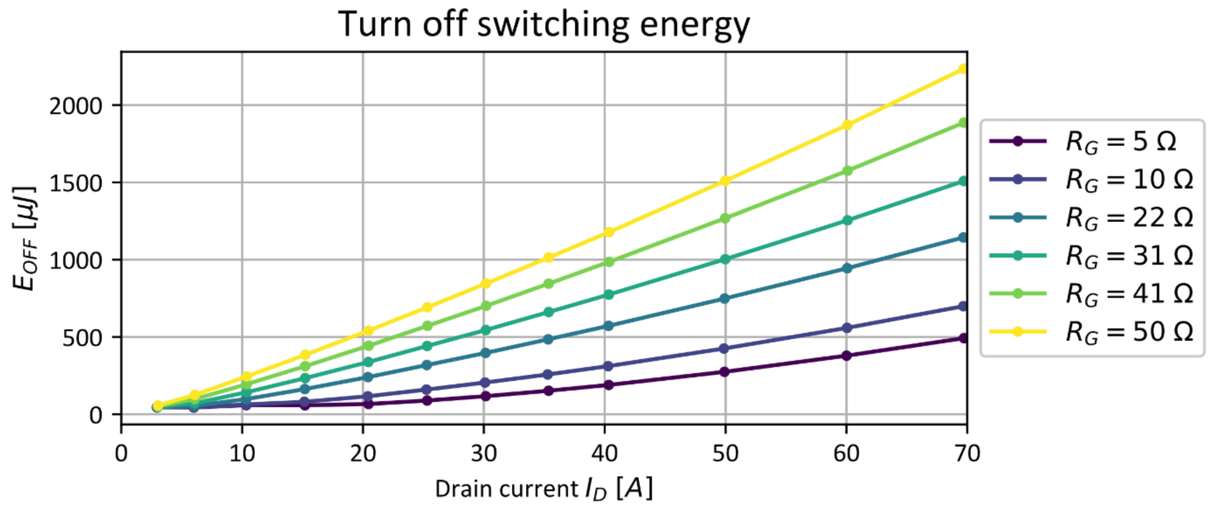
The switching energy is calculated by integrating the product of v_{DS} and i_S

Switching performance
Switching energy

DUT1	SCTW60N120G2V-4
DUT2	SCTW60N120G2V-4
V_{GH}	18 V
V_{GL}	-3 V
V_{BUS}	650 V



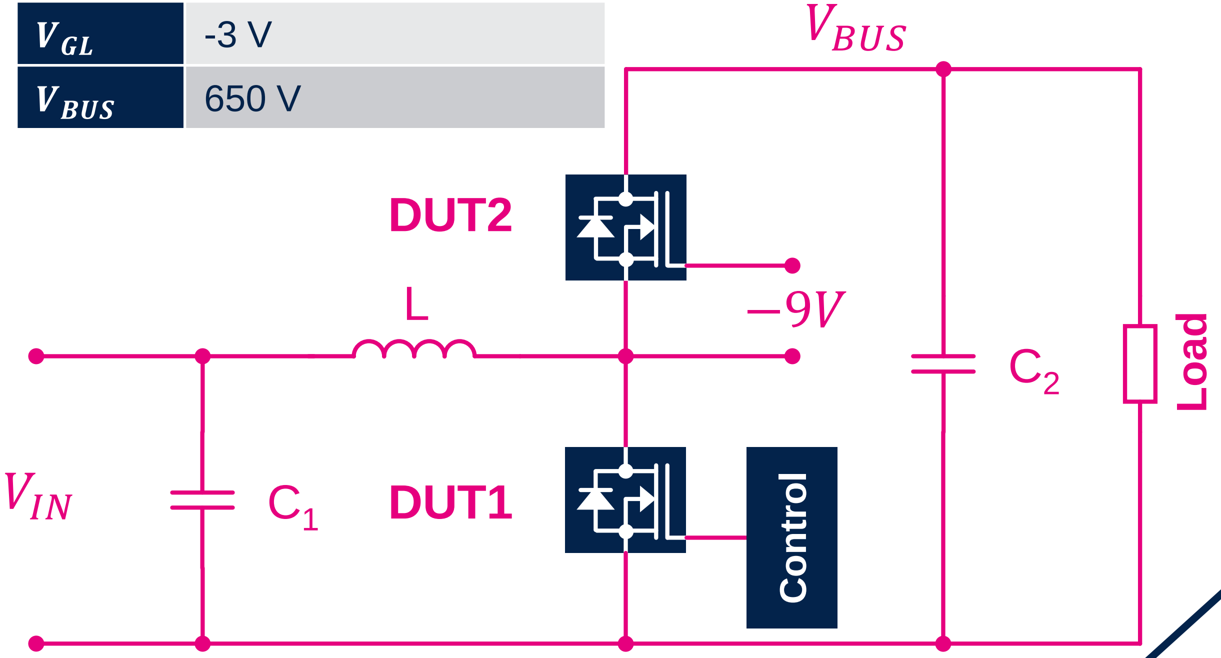


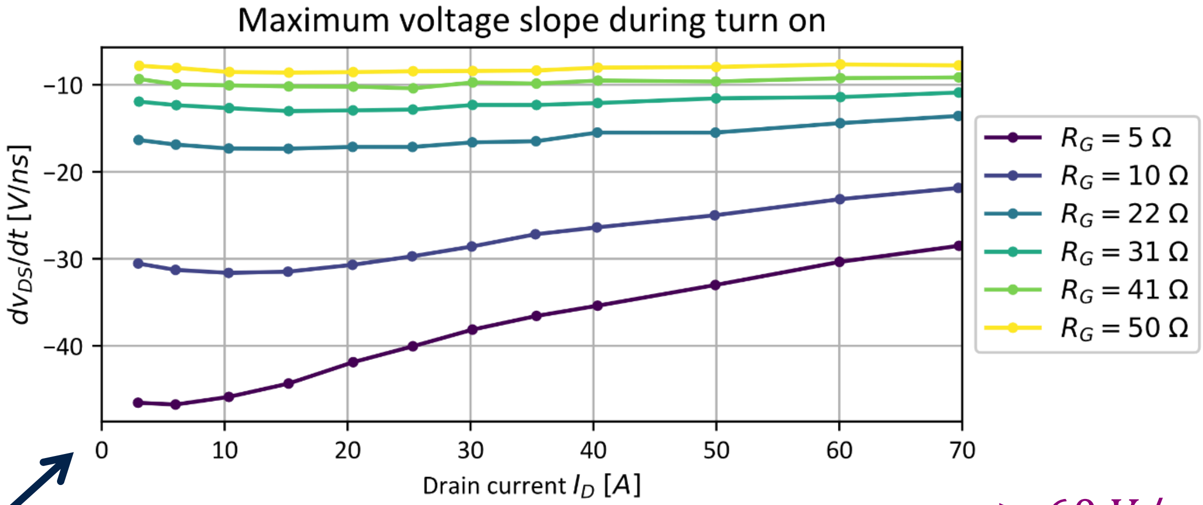


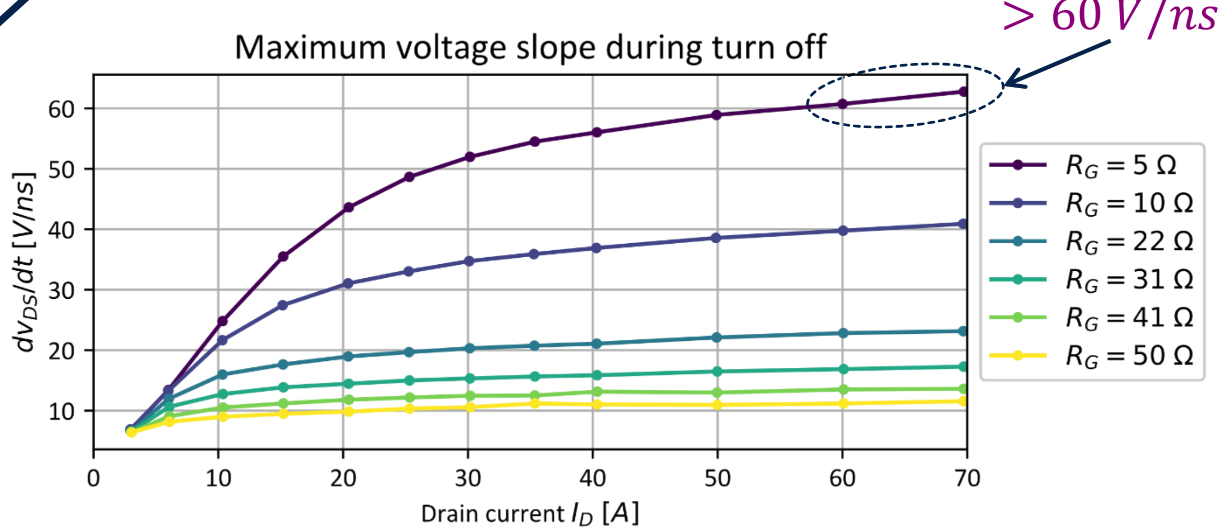
As lower Rg as higher the switching speed → higher EMI → Lower Rg results in lower switching losses

Switching performance
Maximum voltage slope

DUT1	SCTW60N120G2V-4
DUT2	SCTW60N120G2V-4
V_{GH}	18 V
V_{GL}	-3 V
V_{BUS}	650 V





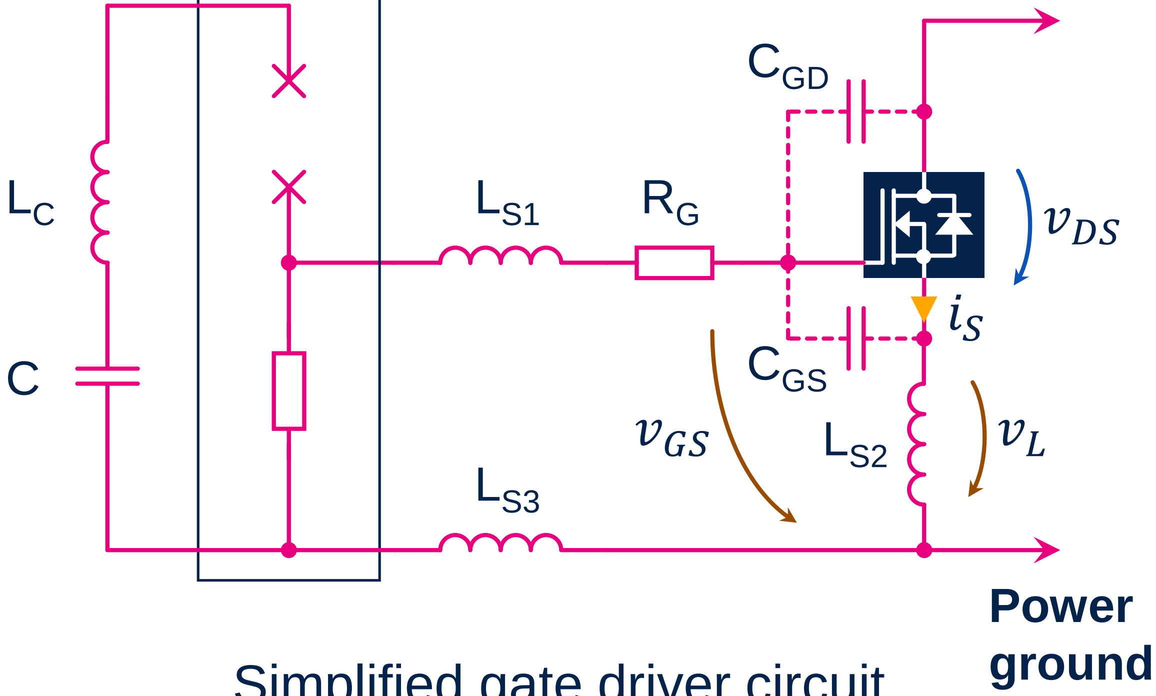


High dv/dt immunity of gate driver is required

Standard vs. Kelvin source version

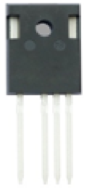
Standard vs. Kelvin source
Example: 3-pin TO-247

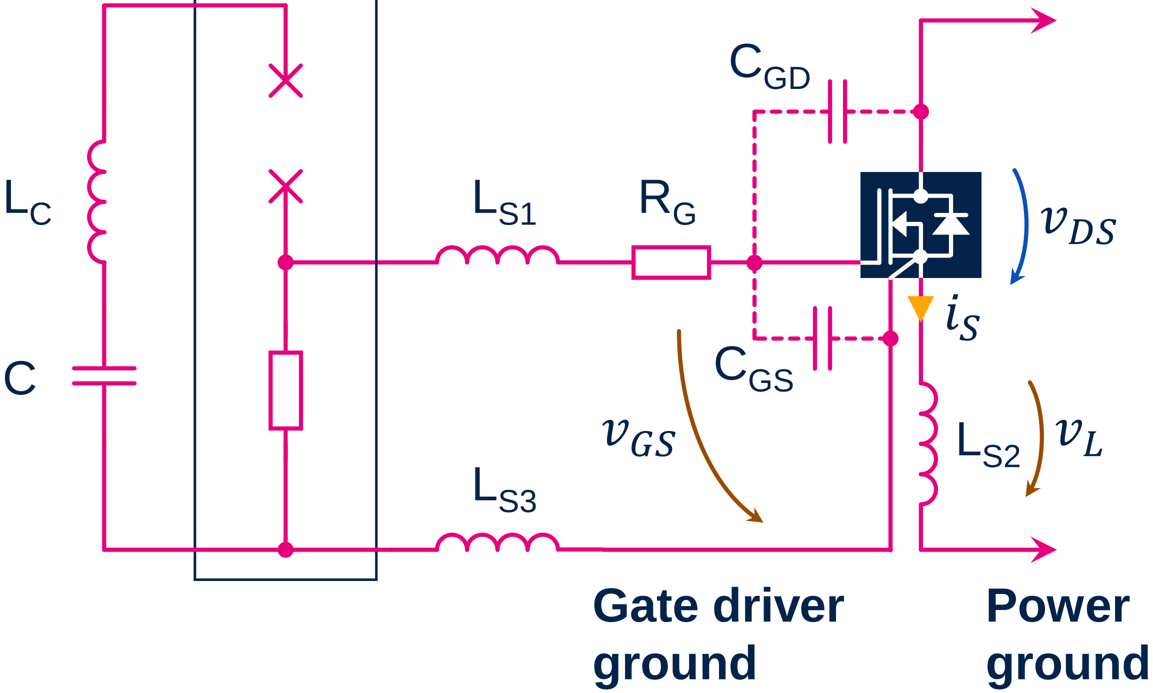
3-pin device



Simplified gate driver circuit

Kelvin source device

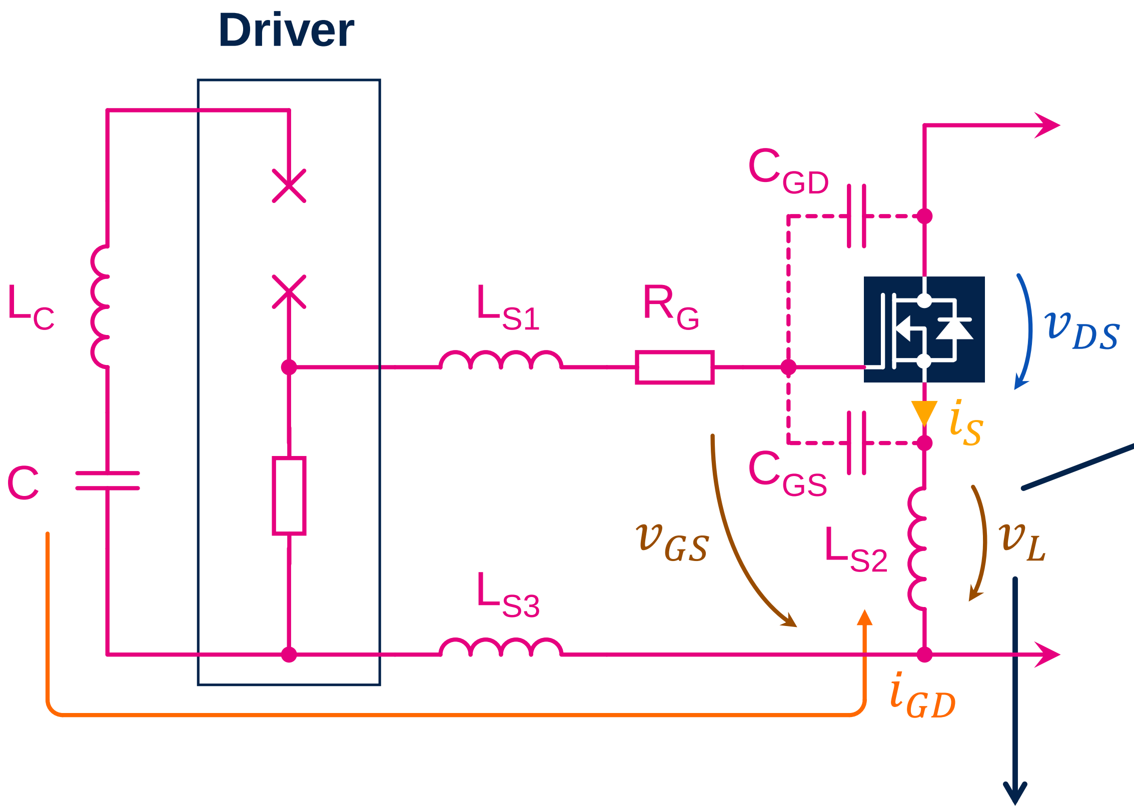


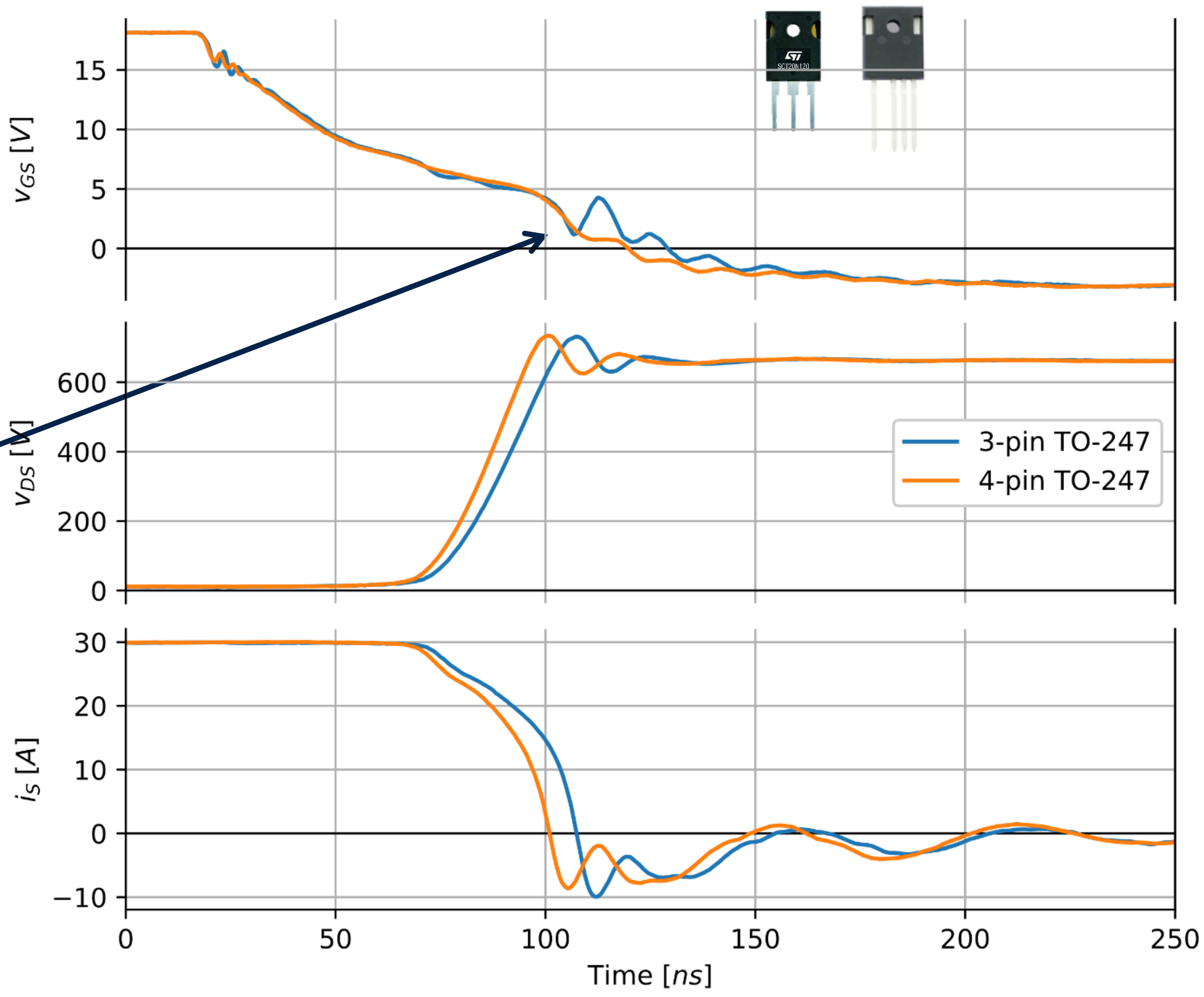


What is the difference?

Turn off 3-pin vs. 4-pin
Hard switching example

Higher turn off energy



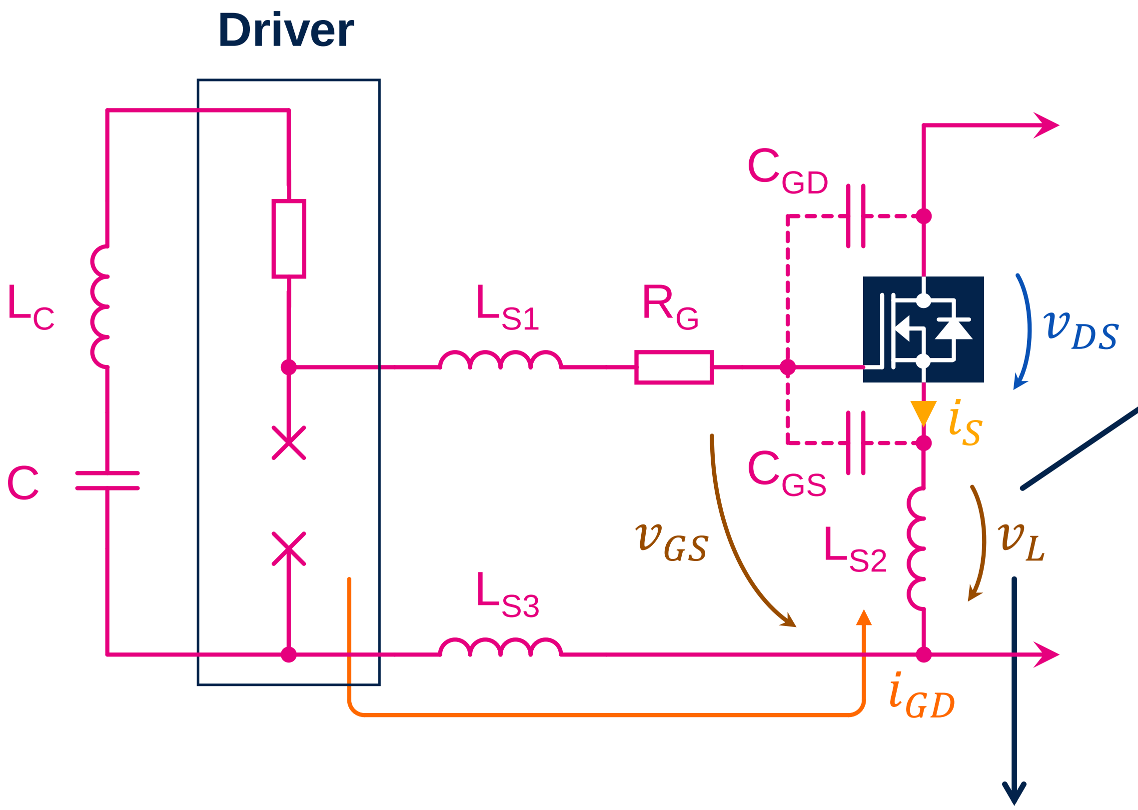

Turn off transient comparison of 3-pin and 4-pin package

$$v_L = L_{S2}\frac{di_S}{dt}$$

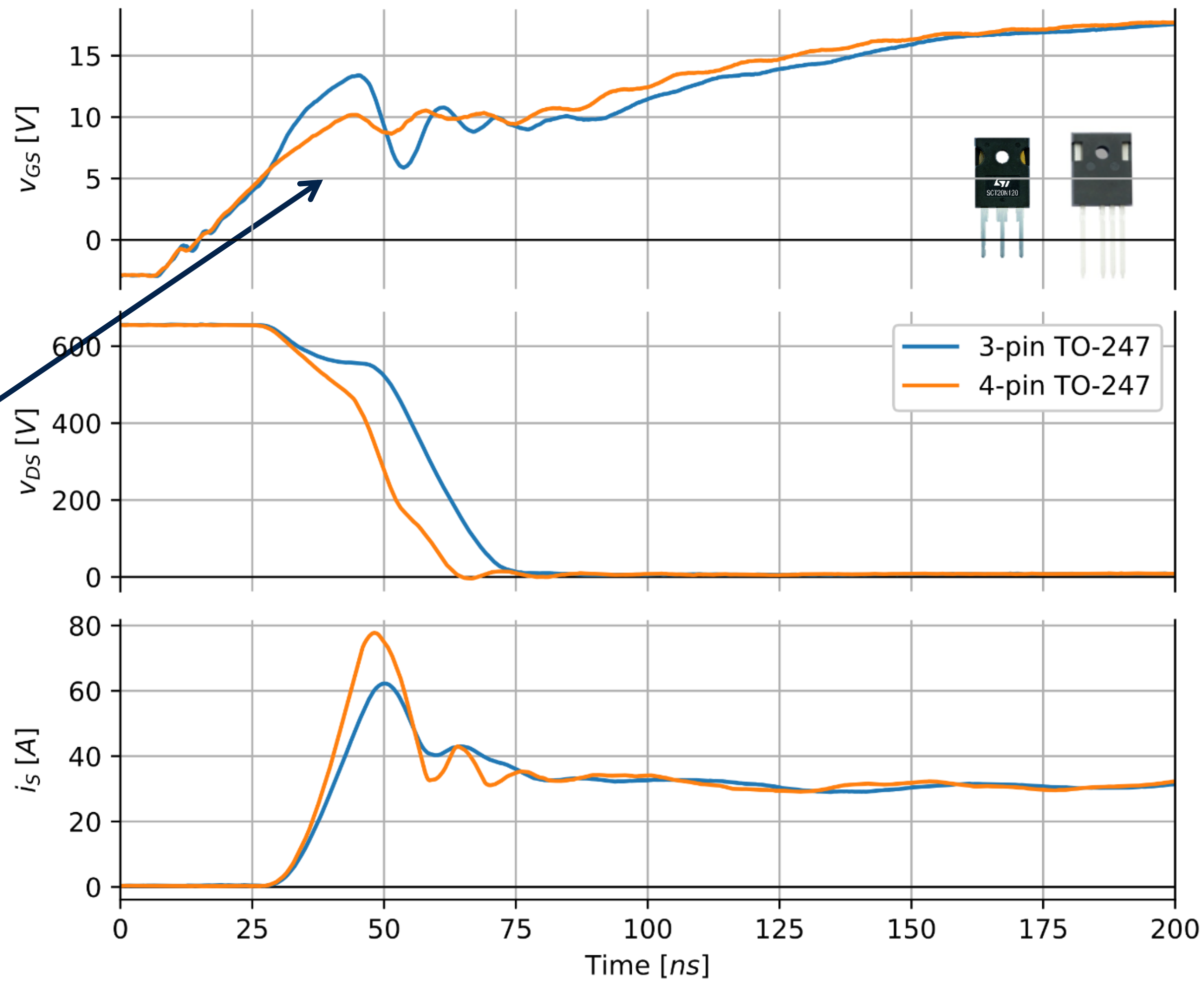
Voltage v_L slows down discharging of the C_{GS}

Turn on 3-pin vs. 4-pin
Hard switching example

Higher turn on energy



Turn on transient comparison of 3-pin and 4-pin package

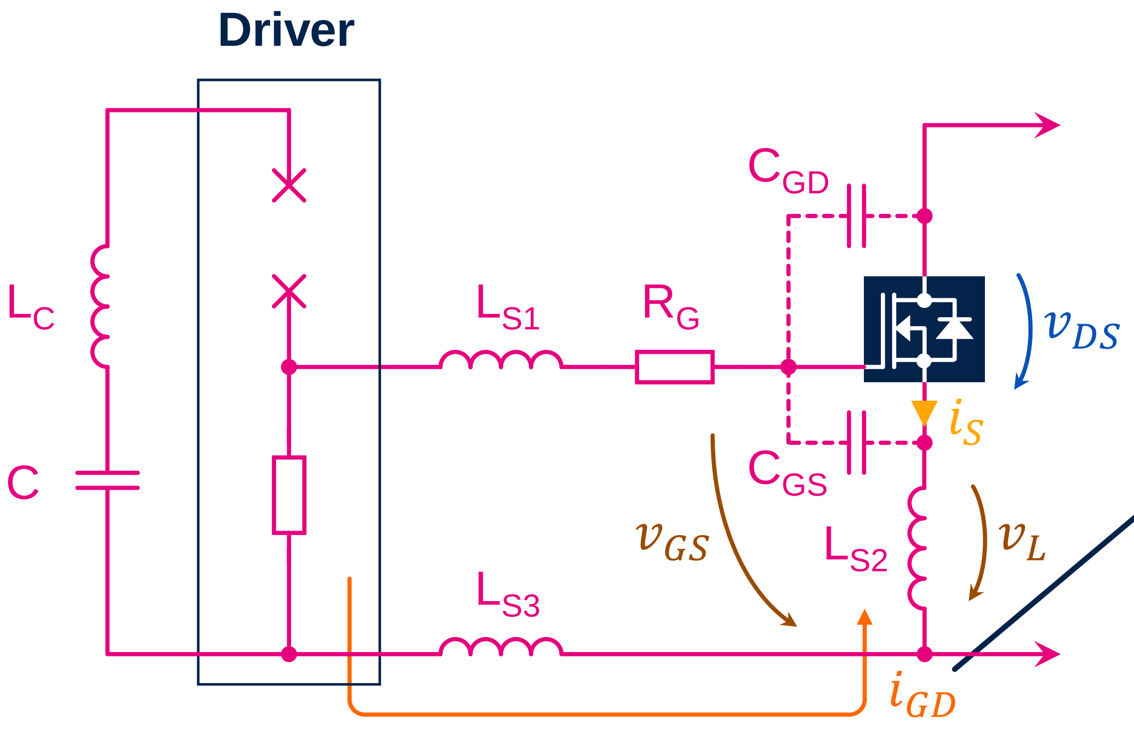


$$v_L = L_{S2}\frac{di_S}{dt}$$

Voltage v_L slows down charging of the C_{GS}

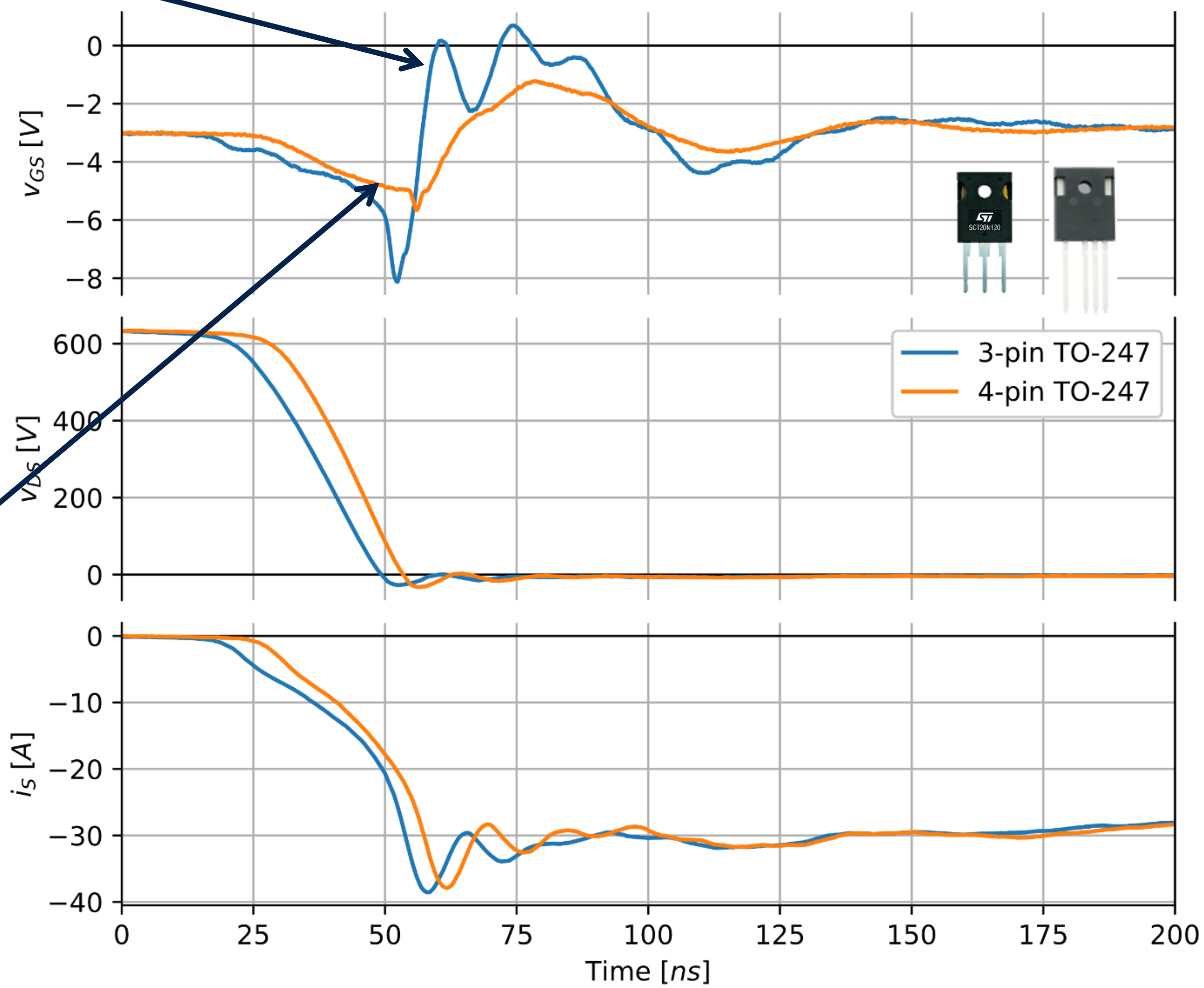
Pre turn on 3-pin vs. 4-pin
Soft switching example

Risk of unwanted turn on



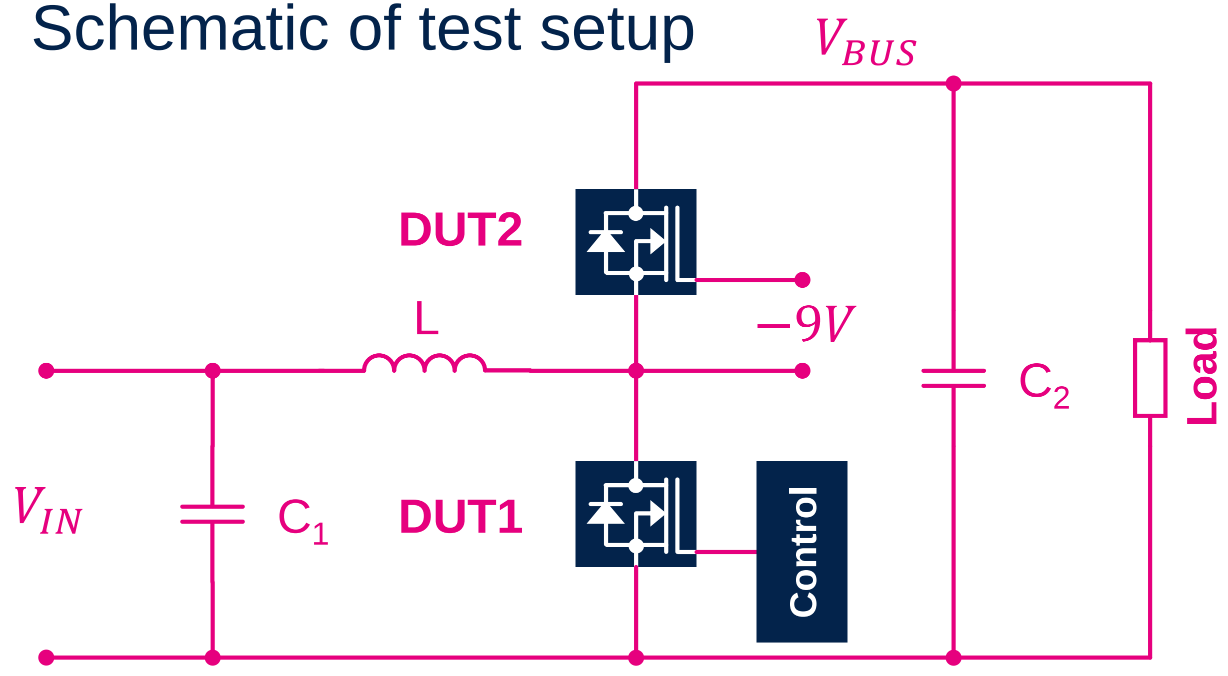
Induced oscillation inside the driving loop

Turn on transient comparison of 3-pin and 4-pin package

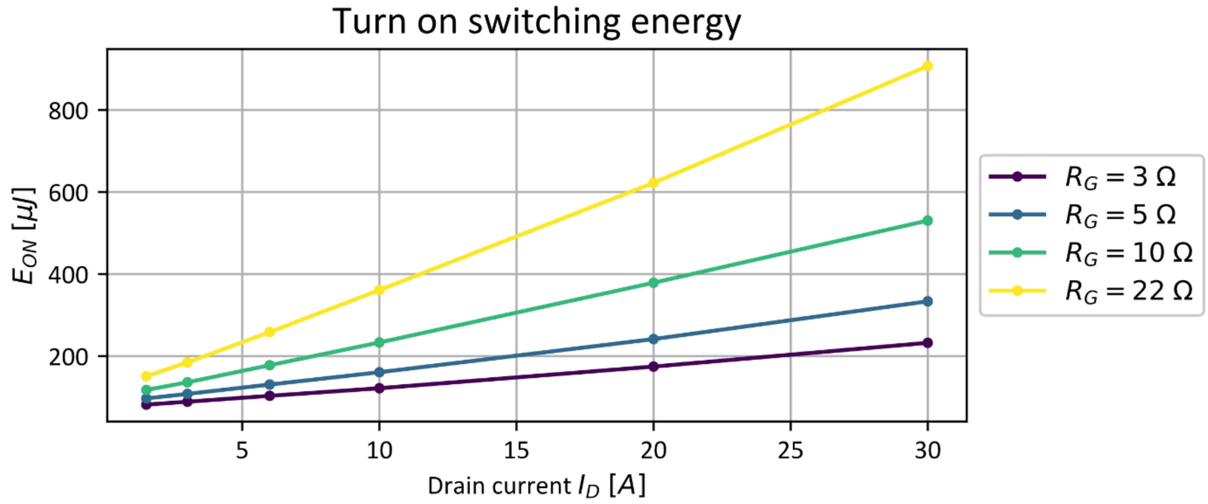


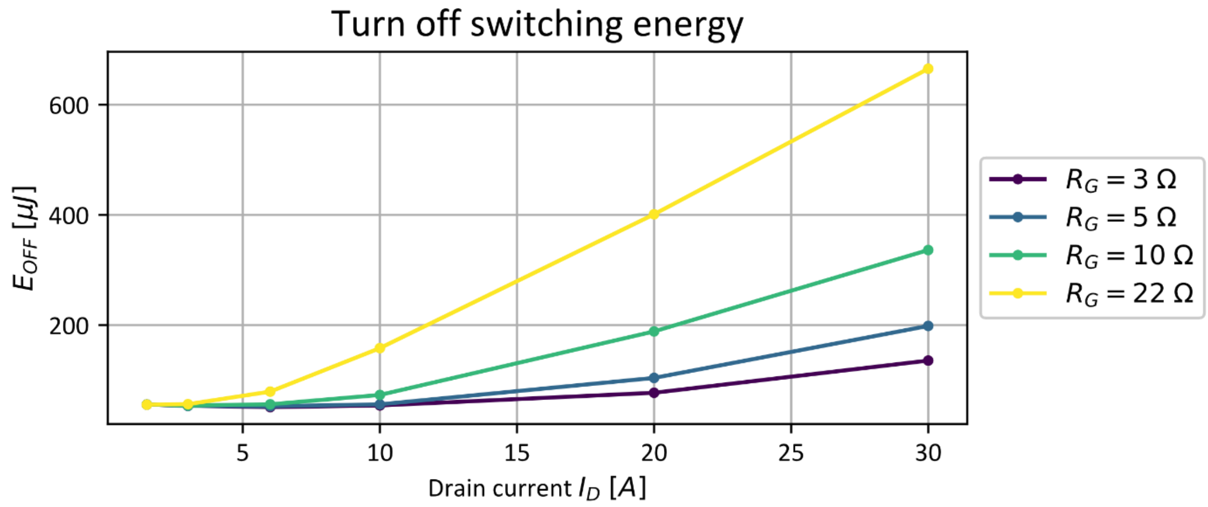
Switching energy
25 mΩ SiC MOSFET in 3-pin TO-247 package

Schematic of test setup

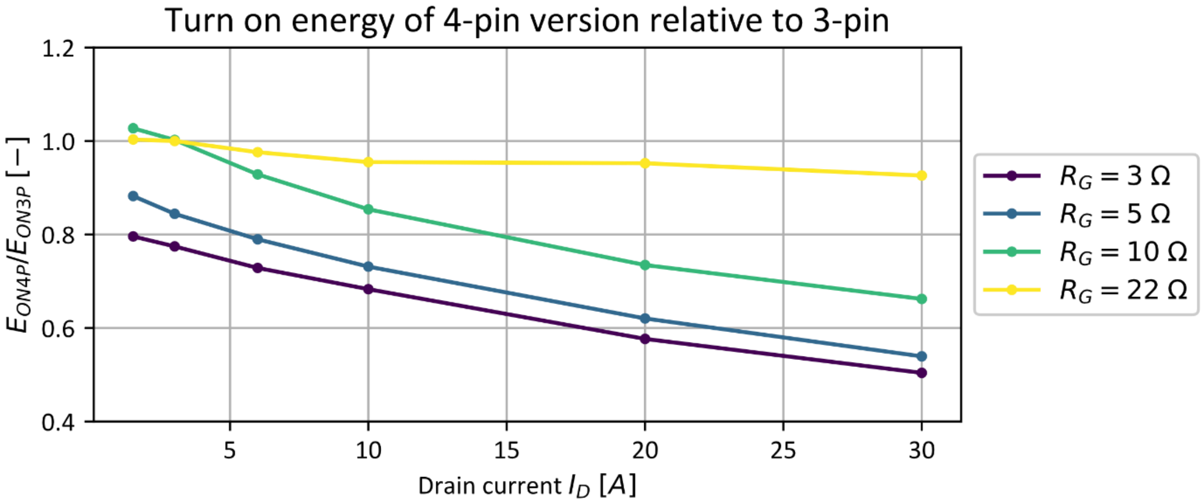


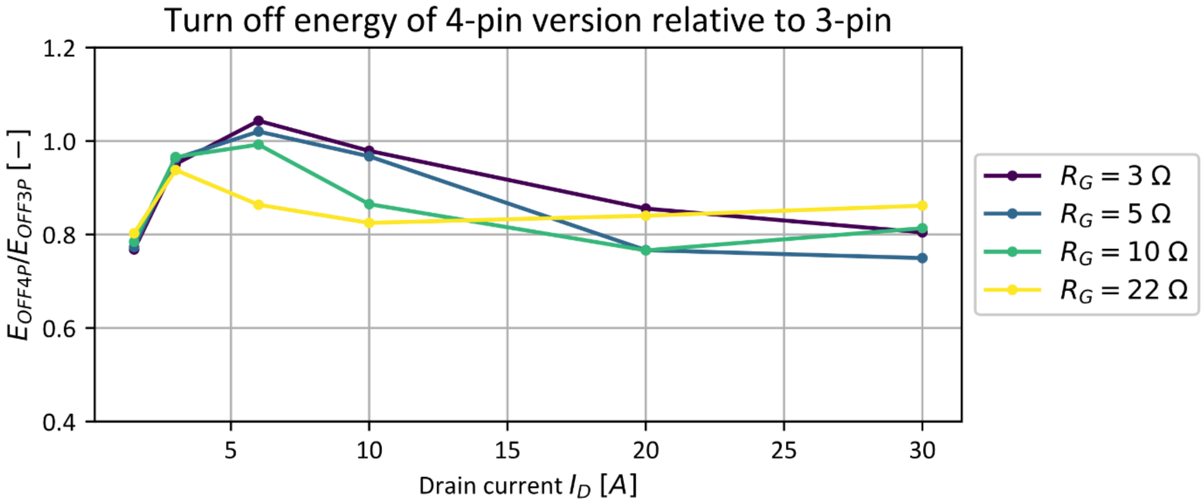
DUT1	SCTW70N120G2V
DUT2	SCTW70N120G2V
V_{GH}	18 V
V_{GL}	-3 V
V_{BUS}	600 V


Turn on switching energy


Turn off switching energy

Switching energy
Comparison of 3-pin and 4-pin package

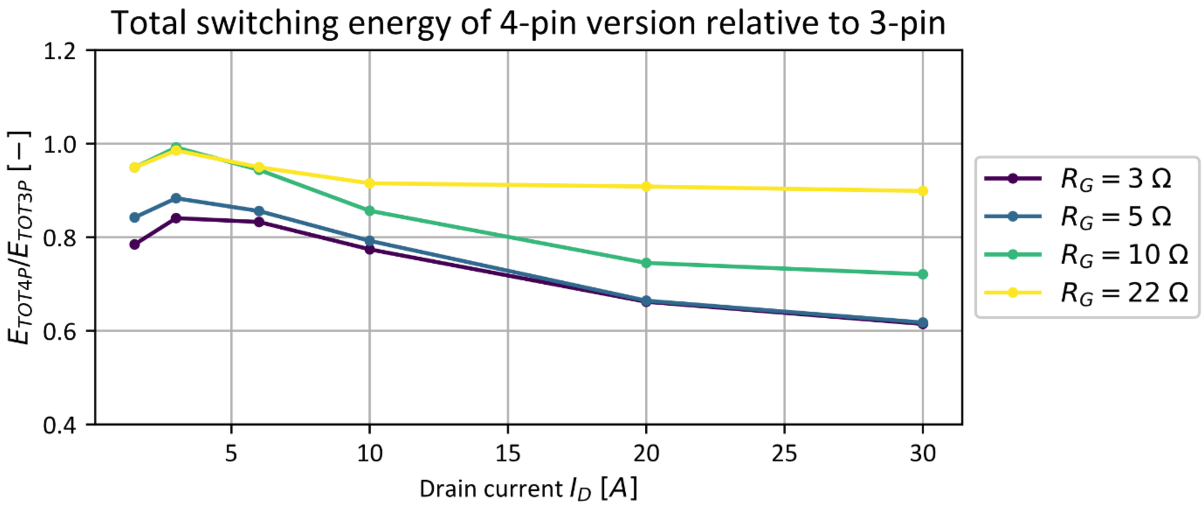

Turn on energy of 4-pin version relative to 3-pin


Turn off energy of 4-pin version relative to 3-pin

- 40% reduction of **switching** looses for lower R_G, and high I_D

	3-pin	4-pin
$E_{ON}\ [\mu J]$	531	351
$E_{OFF}\ [\mu J]$	336	274

$$I_D = 30\ A, R_G = 10\ \Omega$$


Total switching energy of 4-pin version relative to 3-pin

SiC MOSFET Driving

life.augmented

STGAP2S / STGAP2D

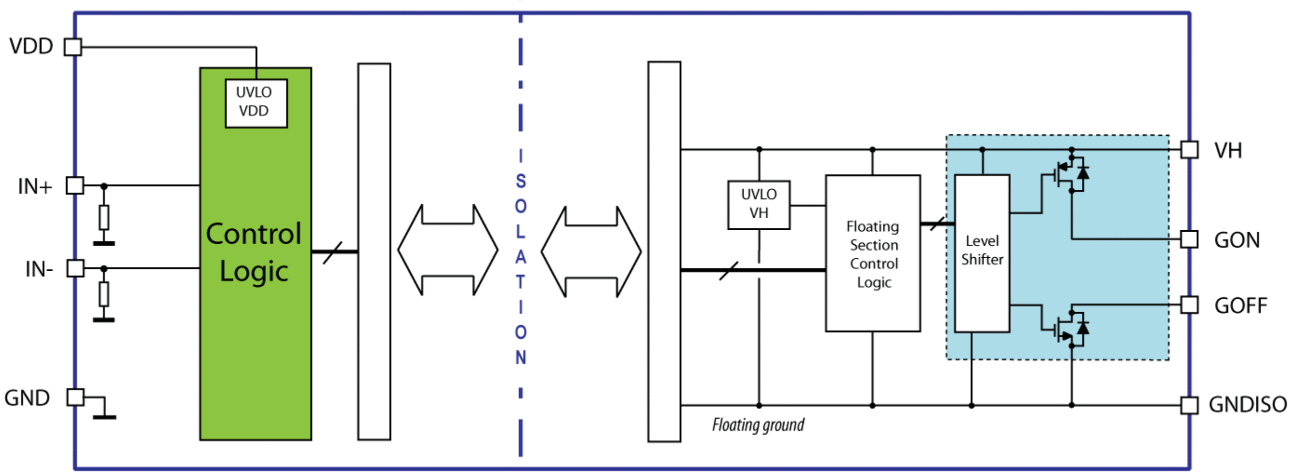
Galvanic isolated 4 A Single & Dual channel gate drivers

Born to drive Mosfet, IGBT and SiC in High Power applications

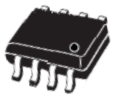
Available in following versions:

- STGAP2D - Half-bridge Dual Channel
- STGAP2SM - Single Channel gate driver
- STGAP2SCM - Single Channel with Miller CLAMP pin

- Galvanic isolation
  - **1.7 kV** in standard **SO-8** package
  - **6 kV** in wide **SO-8W** package
- Up to **26 V supply voltage**
- Best in class for **propagation delay 80 ns**
- Minimum transient immunity ±100 V/ns



SO-8N



SO-8W

In Production	2020

Main benefits

- Best in Class for **fast speed**
- **Reduced BOM** thanks to embedded Isolation and Miller Clamp feature
- **Minimum footprint** and lightweight

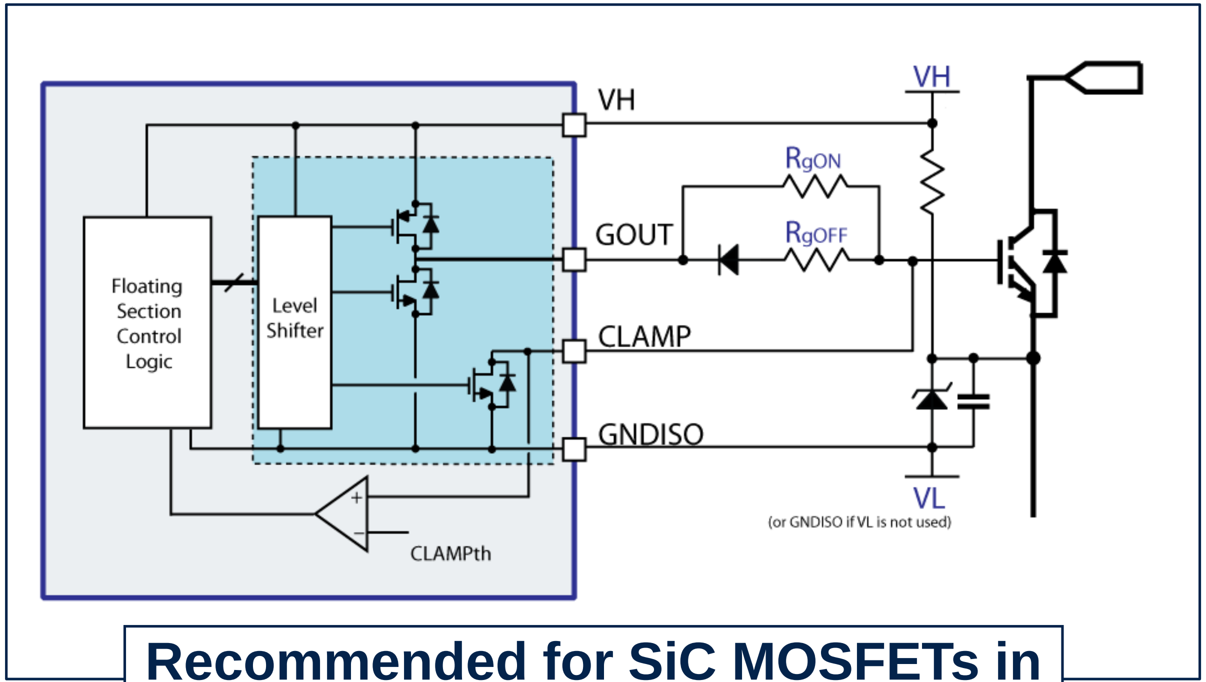
SO8 package

SO16 package

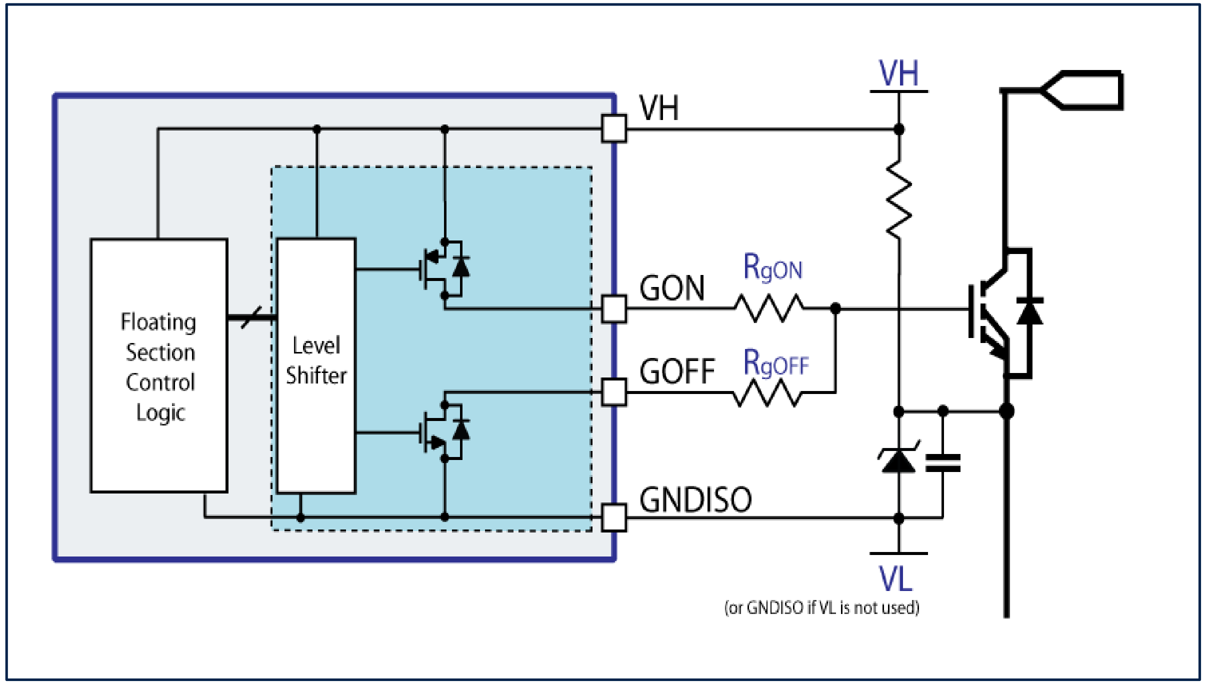
Associated Reference boards:
EVALSTGAP2DM
EVALSTGAP2SM
EVALSTGAP2SCM

SiC MOSFET
About Driving… STGAP2S

1700 V, 4A gate drivers



Recommended for SiC MOSFETs in bridge topologies



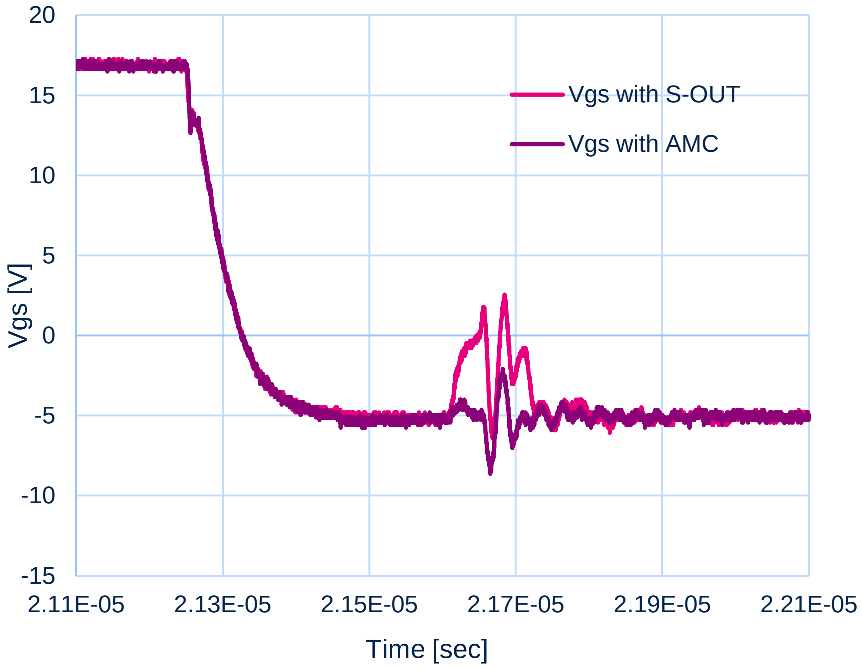
Option 1:
Single output and Miller CLAMP

Option 2:
Separated sink\source outputs (no Miller Clamp)

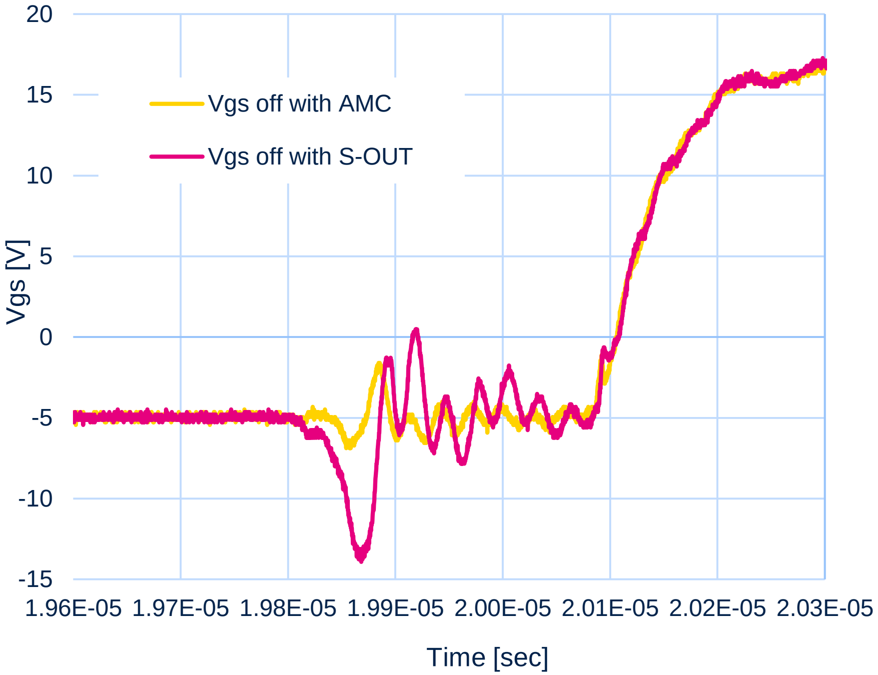
SCTW35N65G2V
55 mΩ, 650 V SiC MOSFET

SiC MOSFET
Dynamics: Advantages of Active Miller Clamp

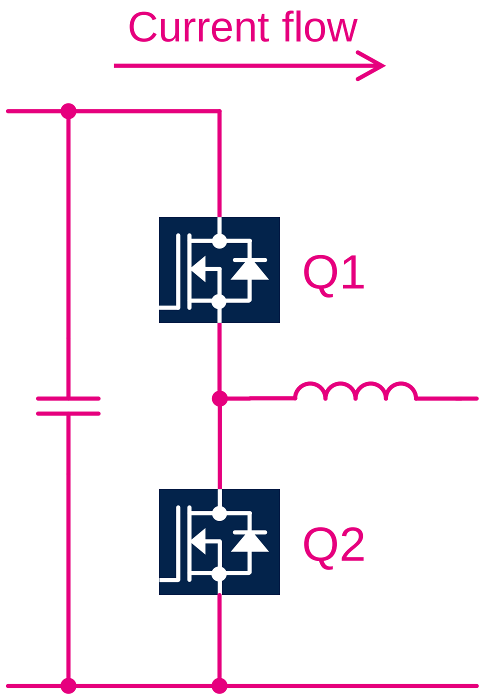
Positive Glitch



Negative Glitch



Example: Half-Bridge



driver configuration
- **S-Out:** separated output (no Miller Clamp)
- **AMC**: Active Miller Clamp

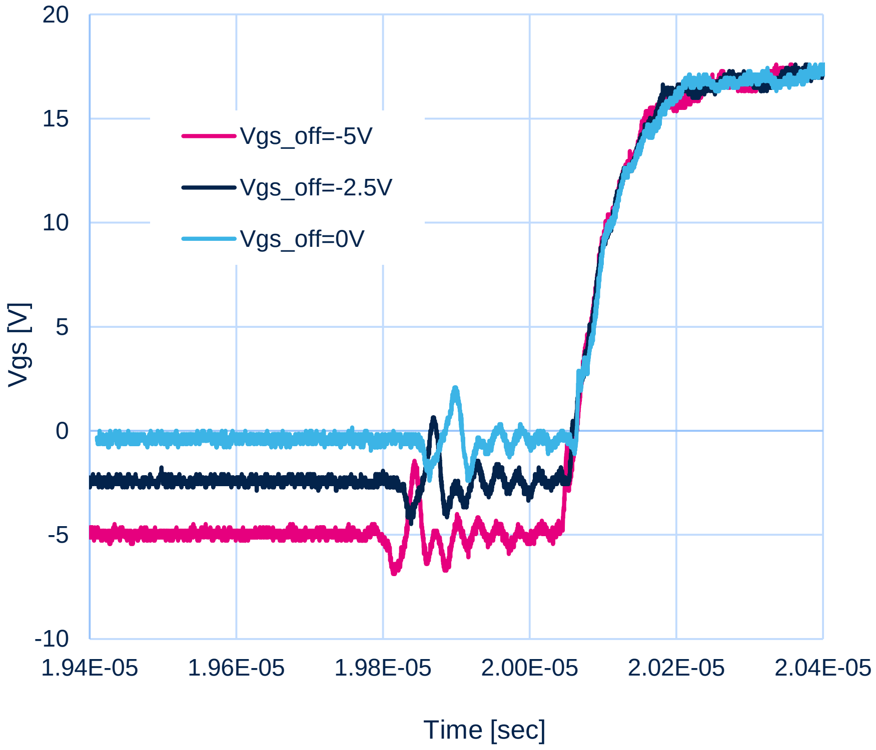
$$V_{GH} = 18\,V$$
$$V_{GL} = -5\,V$$

Active Miller Clamp is recommended for SiC MOSFETs in bridge toplogies

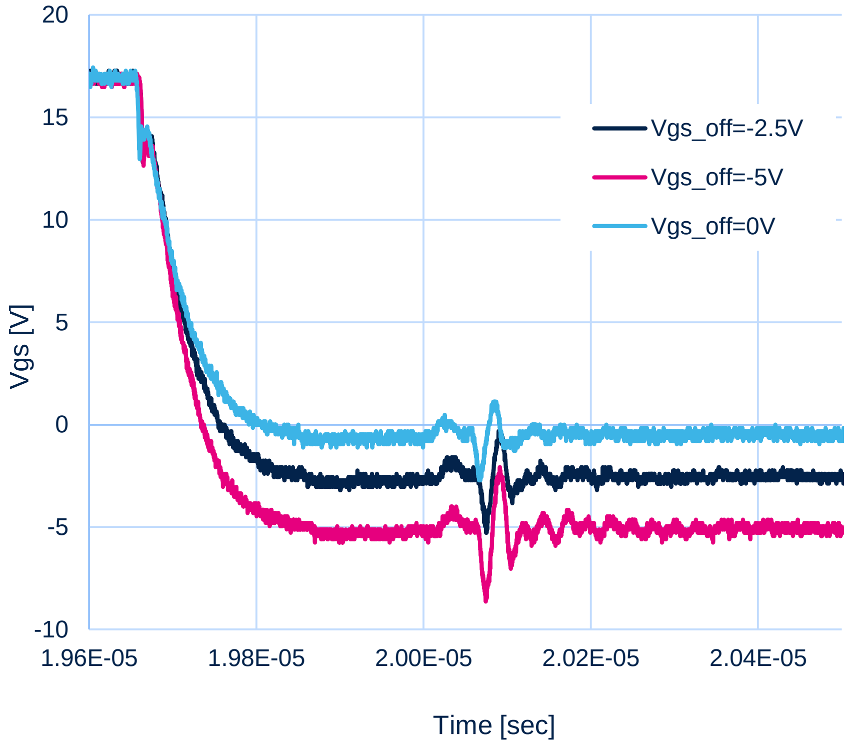
SiC MOSFET
Extended Vgs max ratings for safe switching

SCTW35N65G2V
55 mΩ, 650 V SiC MOSFET

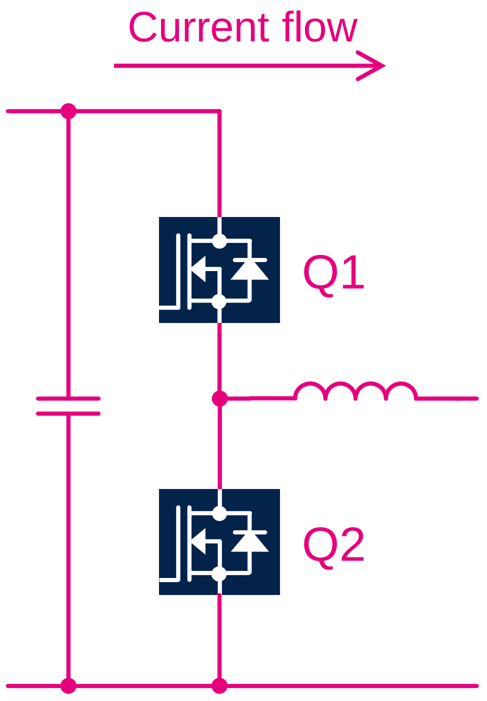
Positive Glitch



Negative Glitch



Example: Half-Bridge



ST Offers highest negative V_{GS} ⇨ high margin

A range of V_{GL} can be suggested
⇨ application dependent!

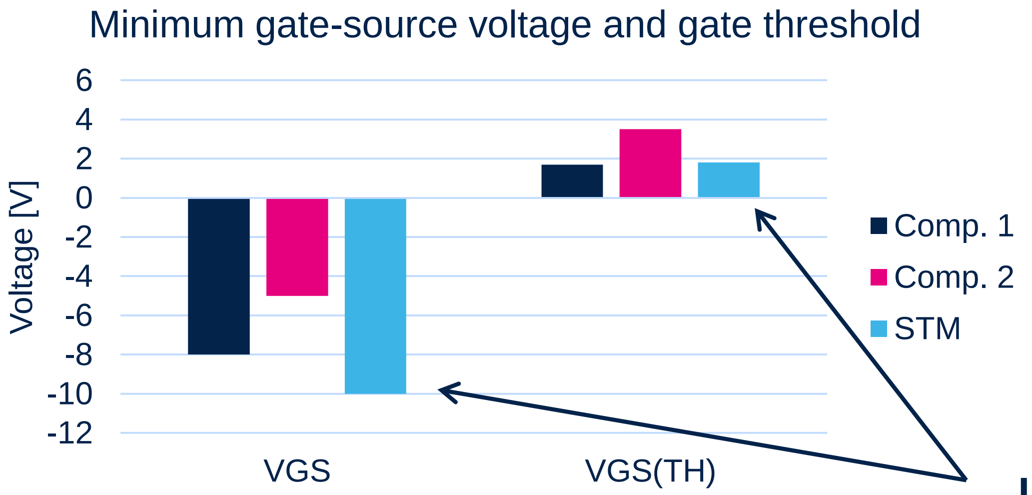
Gate driver parameters
Summary of key points

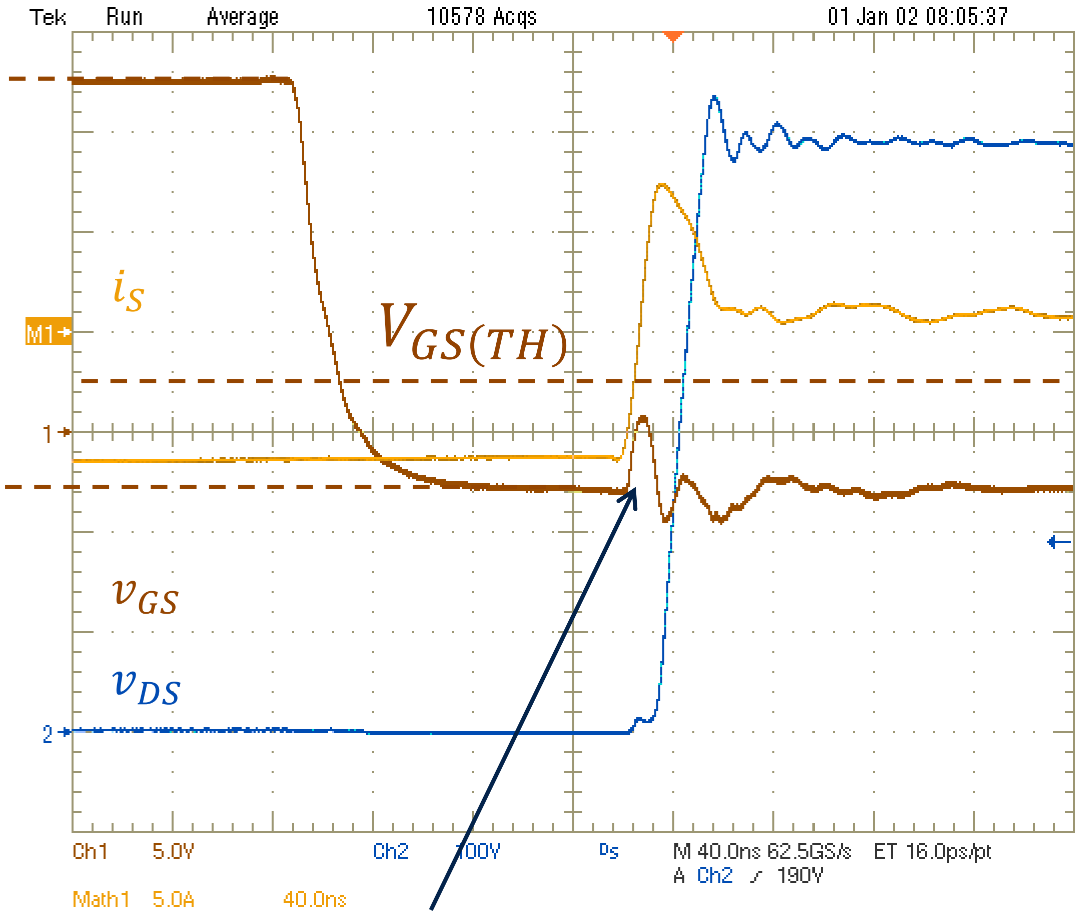
$V_{GS(on)} = 18\ to\ 20V,$

- To get the best $R_{DS(on)}$

$V_{GS(off)} = -3\ to\ -5V,$

- Greater margin to the $V_{GS(TH)}$





Spikes might cause parasitic turn-on

Higher negative voltage can be applied

Summary

- Driving a SiC MOSFET is almost easy as driving a silicon MOSFET:
  - ST suggest using recommended Vgs , like 18V to get the right $R_{DS(on)}$
  - Adequate current capability to ensure high switching speed
- Turn-off a SiC MOSFET with Negative driving voltage :
  - Negative voltage is suggested only for bridge topologies to avoid any possible undesired turn-on due to gate voltage oscillations (Miller turn-on effect).
  - The negative voltage (in the range [-6V,-2V] has an impact on the turn-off switching losses reduction. This of course will depend on the sinking current driver’s capability.
  - To turn-off with a few negative volts (-6V is the minimum recommended) in order to not exceed the max.
- The main aspects influencing switching behavior are:
  - Turn-off energy (Eoff) dependence on Rg and VGS-off (negative bias gate voltage)
  - Turn-on energy (Eon) dependence on Rg
  - Miller effect, which affects Eon and Err (reverse recovery energy)
  - Gate drive current requirements

New SiC related evalboards

15kW VIENNA Rectifier

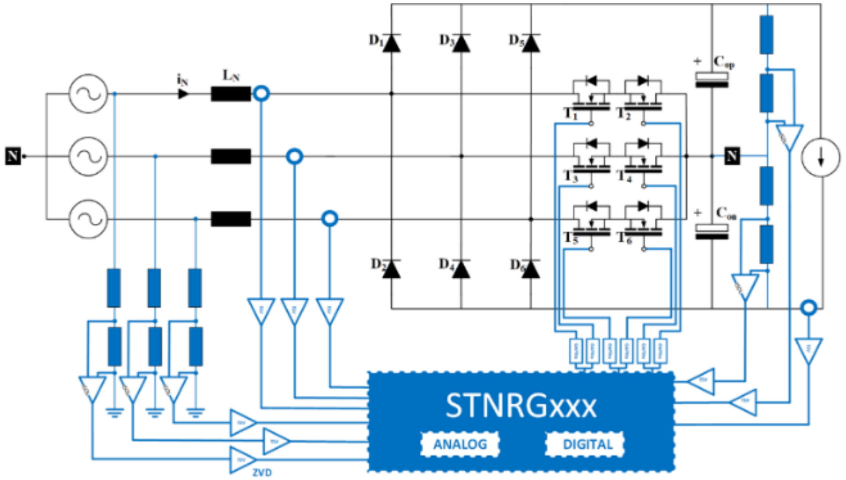
ST Demoboard: STDES-VIENNARECT

Main specs

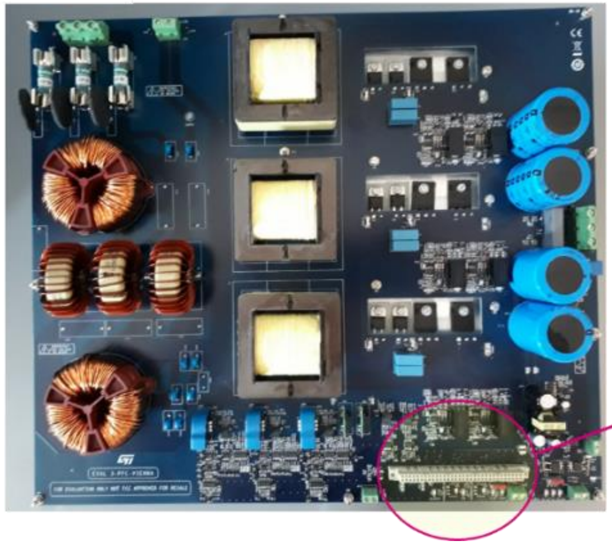
- 3-phase, 3-level AC/DC power converter
- Rated nominal output DC voltage: 800 VDC
- Rated nominal input AC voltage: 400 VAC at 50 Hz
- Nominal output power AC/DC: 15 kW
- Power factor, PF>0.99
- Inrush current control and soft start-up
- THD lower than 5% at nominal operation
- Power section based on SiC MOSFETs and diodes:
- High frequency operation (70 kHz)
- High peak efficiency greater than 98%
- Passive element weight and size reduction

Key products

- **STNRGPF03* (Digital controller for 3Ph PFC)**
- **SCTW35N65G2V (6x SiC MOSFET)**
- **STGAP2S (Galvanic Isolated Gate Driver)**
- **STPSC20H12D (SiC diodes) , STPS1L30A, STPS2H100A, STTH1L06A, STPS1150A, STPS2L60A (Schottky and Ultrafast diodes)**
- **VIPer26HD (High Voltage Converter)**



15kW Power board



Control board

4 Layer PCB (40x36 cm)

*Under Development

15kW 3L T-Type Converter PFC

ST Demoboard: STDES-PFCBIDIR

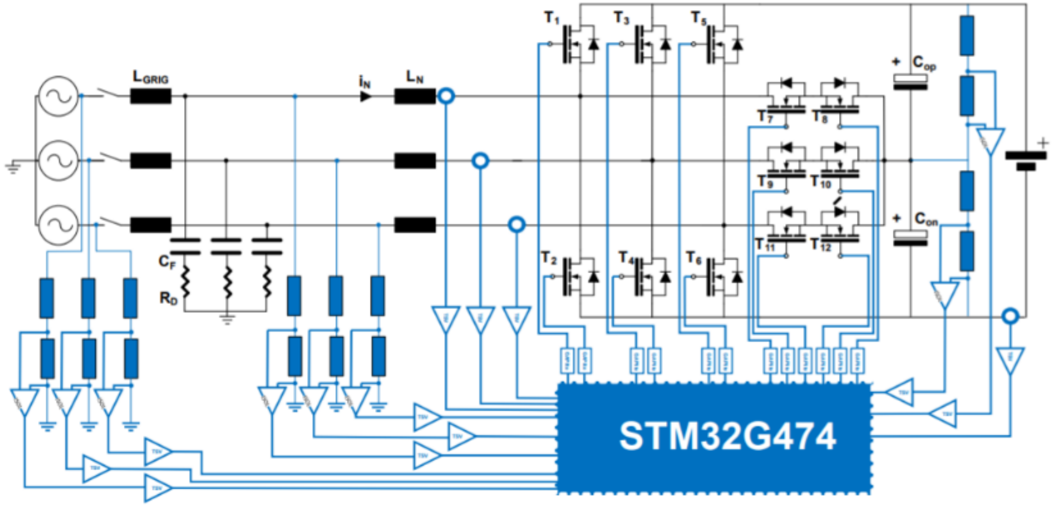
Main specs

- Pout = 15kW @ Vin = 380Vac & Vout =800V
- PF > 0.98 @ 20% load (target)
- THD < 5% @ 20% load (target)
- Ր > 99%
- CCM decoupling current control loop
- Active & Reactive power control
- Grid Connection capability
- Switching frequency = 100kHz
- I_ripple = 2.5A
- VDC_ripple = 10Vpp

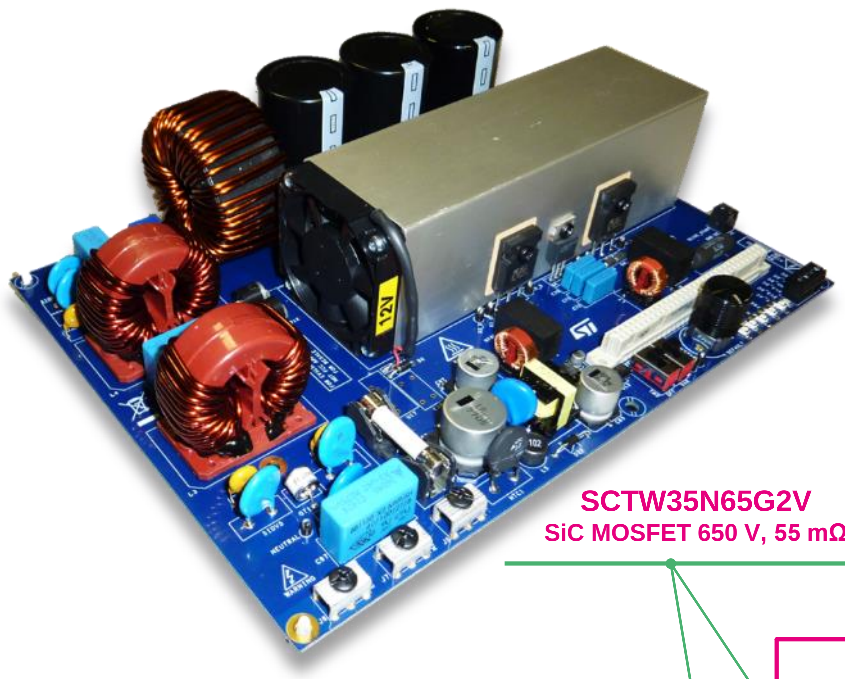
Key products

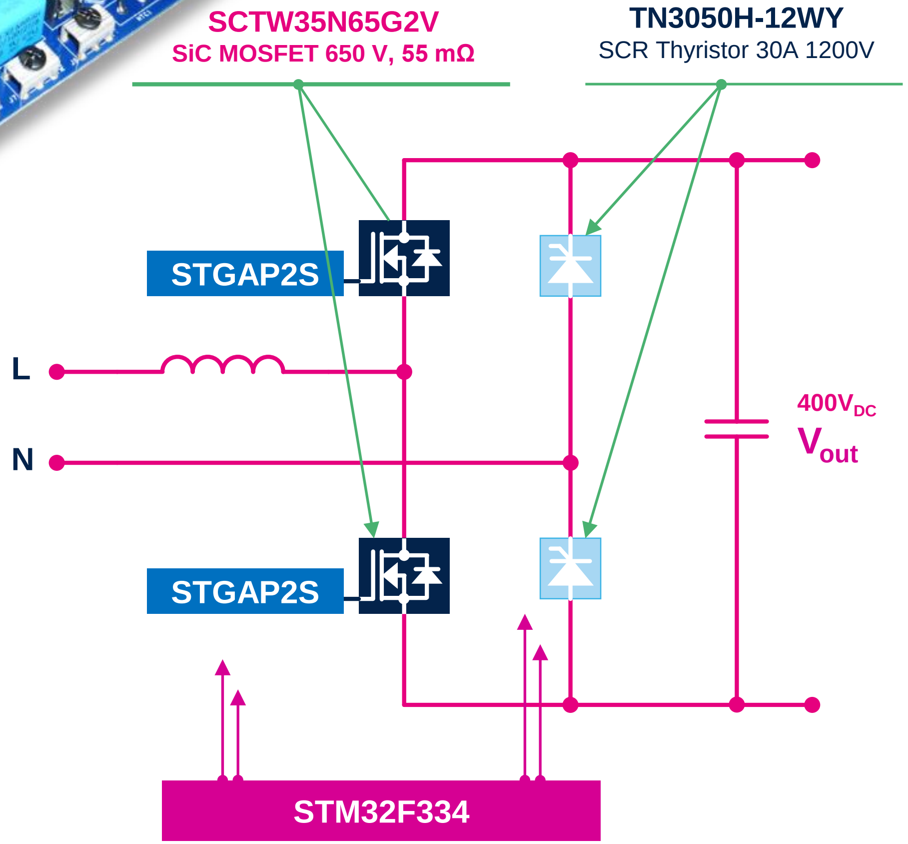
- **SCTW40N120G2V (6x 70mΩ 1200V SiC MOSFET)**
- **SCTW35N65G2V (6x 55mΩ 650V SiC MOSFET)**
- **STGAP2S (Galvanic Isolated Gate Driver)**
- STPS1L30A, STPS2H100A, STTH1L06A, STPS1150A, STPS2L60A (SiC, Schottky and Ultrafast diodes)
- STS6NF20V (N-channel 20 V, STripFET II Power MOSFET)
- TSV911IDT, TSV912IDT, TSV914IDT (wide-bandwidth rail to rail Op-Amps)
- STLM20W87F (Analog temperature sensor)
- LD29080DT50R, LD29080S33R, (LDOs)
- VIPer26K (High Voltage Converter)

Figure 1. Bidirectional converter block diagram



STEVAL-DPSTPFC1
3.6 kW 1-ph Totem-Pole PFC





- Input AC voltage: **85 V_{AC} up to 264 V_{AC}**
- Input AC frequency: 45 Hz up to 65 Hz
- DC output voltage: **400 V_{DC}**
- Maximum input current: **16 A_{RMS}**
- Ambient temperature: tested from 0 °C up to 45 °C
- Peak Efficiency: **97.7 %** with **4.7%** THD
- Compliant with:
  - EN 55015 and IEC 61000-4-11 and IEC 61000-3-3
  - IEC 61000-4-5 surge: 4 kV
  - IEC 61000-4-4 EFT burst: criteria A @ 4 kV min
- Cooling: forced air cooling with active fan
- Designed for operation with DC / DC converter
- Peak **inrush** current tuning

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ST SiC MOSFET/Diode support tools

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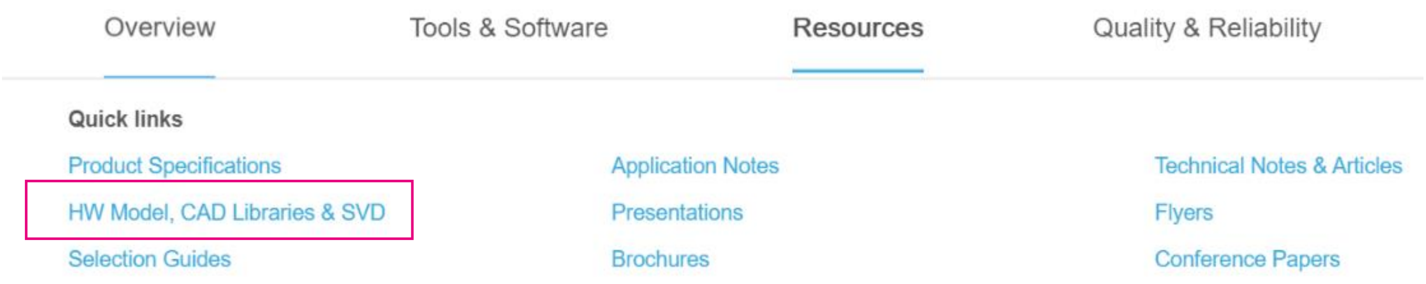
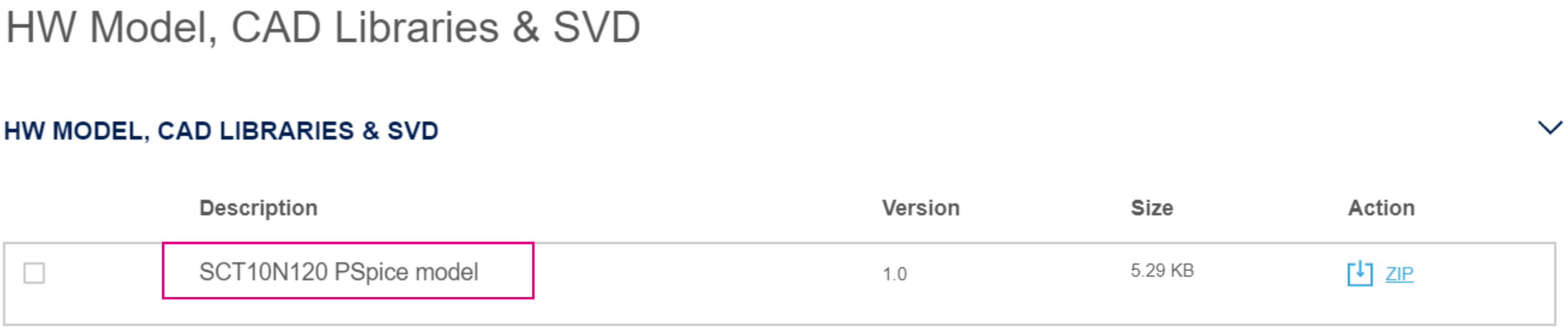
SiC Diode support tools

- Application Notes
  - AN4242 – New generation of 650 V SiC diodes
    - https://www.st.com/content/ccc/resource/technical/document/application_note/2c/90/d1/db/92/da/49/92/DM00075656.pdf/files/DM00075656.pdf/jcr:content/translations/en.DM00075656.pdf
  - AN5088 - Rectifiers thermal management, handling and mounting recommendations
    - https://www.st.com/resource/en/application_note/dm00437554.pdf
  - AN5436 - Thermal behavior and printed circuit board assembly recommendations for STMicroelectronics PowerFLAT 8x8 HV package
    - https://www.st.com/content/ccc/resource/technical/document/application_note/group1/01/52/a9/72/04/31/46/44/DM00676401/files/DM00676401.pdf/jcr:content/translations/en.DM00676401.pdf
- Simulation Models
  - Silicon-carbide (SiC) Schottky diode PSpice models (.lib & .olb)



SiC MOSFET support tools

- **Application Notes**
  - AN3152 – The right technology for solar converters
    - https://www.st.com/resource/en/application_note/cd00264004.pdf
  - AN5355 - Mitigation technique of the SiC MOSFET gate voltage glitches with Miller clamp
    - https://www.st.com/resource/en/application_note/dm00628522.pdf
  - AN4671 - How to fine tune your SiC MOSFET gate driver to minimize losses
    - https://www.st.com/resource/en/application_note/dm00170577.pdf
- **STPOWER MOSFET finder mobile App for tablets and smartphones (Apple Store, Google Play, Wandoujia)**
  - https://www.st.com/content/st_com/en/products/mobile-applications/finders-apps/st-mosfet-finder.html
- **Simulation Models**
  - SiC MOSFET PSpice models (.lib & .olb)



HW Model, CAD Libraries & SVD

HW MODEL, CAD LIBRARIES & SVD

	Description	Version	Size	Action
☐	SCT10N120 PSpice model	1.0	5.29 KB	ZIP

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