

# SCR Solid-State Relay and Bridge In-Rush Current Limiter

**800 V 150°C Thyristor SCR**



**SCR - Topology, Performance & Benefits**



**60 A AC Switch with Top Side Cooling**



**ACEPACK SMIT**





# 800V high temperature SCR Thyristor

Controlling inrush power at start-up with reliable solution



16A-50A range in SMD and Thru-Hole Packages

Replace Electro-mechanical relays with SCR



High noise immunity up to 6kV in application

Full rating: 800V and 150°C reliable operation







# Why 800 V 150 °C SCR ?

## Controlling inrush power at start-up with reliable solution

The high temperature SCR drive bigger power in AC/DC portion thanks to its 800 V rated now at 150°C junction operations

- No more Electro-mechanical parts
- Meet IEC61000-4-x for Inrush limitation
- Converter efficiency improvement
- Low Stand by losses
- Easier-to-design drive circuit
- Strong immunity to external disturbances





# Where to use 800 V 150 °C SCR ?

## Consumer



- TV SMPS
- Vacuum Cleaner
- Personal device charger
- E-bike chargers
- LED Light dimmer
- Smartplug

## Smart Appliances



- Air Conditioning
- Induction heating
- Washing Machine
- Fridge
- Dish Washer

## Industrial



- Server PS unit
- 5G repeater
- LED lighting
- AC Motor control
- Voltage regulator

## Renewable energy



- Solar inverter
- UPS
- EV chargers

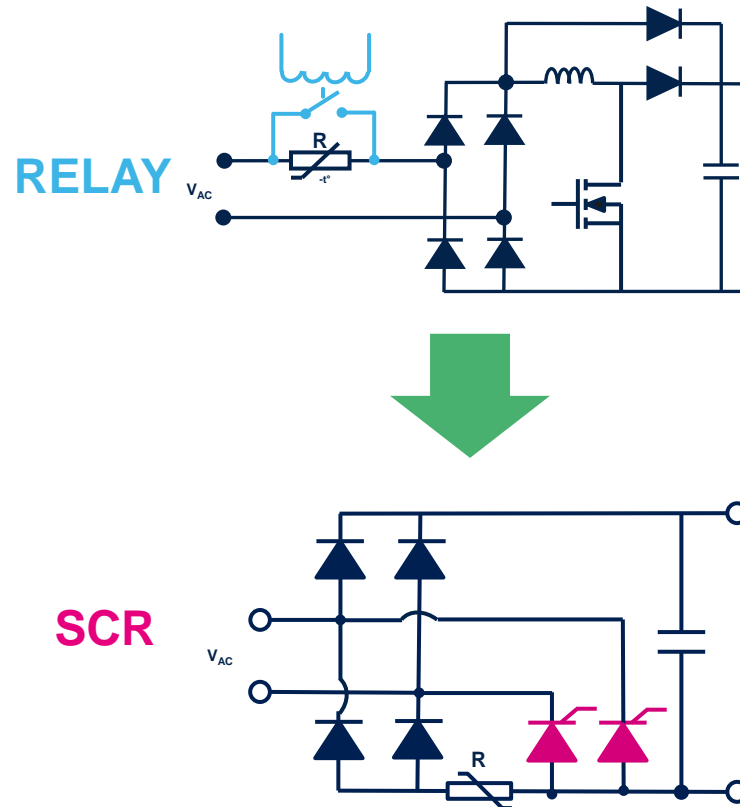






# Topology Trend for ICL in AC/DC Converter

Electromechanical relay OUT → ST SCR IN



## Application Benefits

- Power efficiency
- Power density
- Lifetime
- Acoustic noise
- Robustness to EMI





# Performance comparison vs electromechanical relay

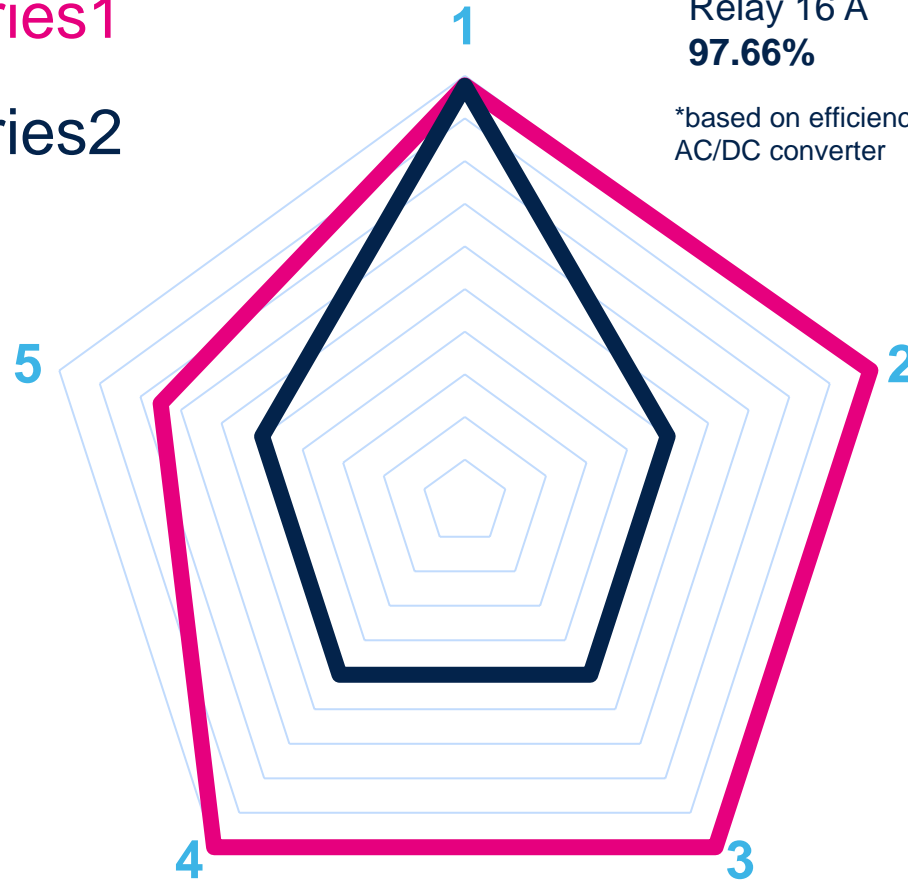
Series1

Series2

Relay 16 A  
97.66%

SCR  
97.75%

\*based on efficiency measurement on a 1 kW AC/DC converter

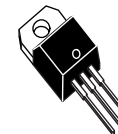


Relay 16 A  
Slow turn-on  
with bounces

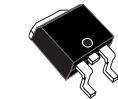
SCR  
Fast turn-on



Relay 16 A  
29 x 12.4 x 32.8 mm<sup>3</sup>



TO-220AB (I)  
10 x 15.2 x 4.4 mm<sup>3</sup>



D<sup>2</sup>PAK  
4.3 x 10 x 8.95 mm<sup>3</sup>

Relay 16 A  
20-40 dB

SCR  
0 dB

Relay 16 A  
50 k cycles  
Contact ageing

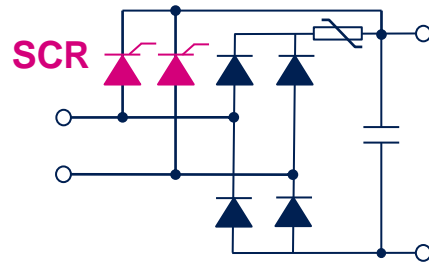
SCR  
Billions of cycles



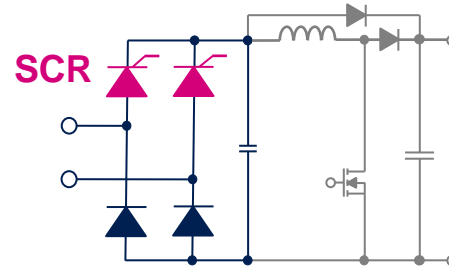


# High Temp. SCR in Digital Inrush Current Limiters

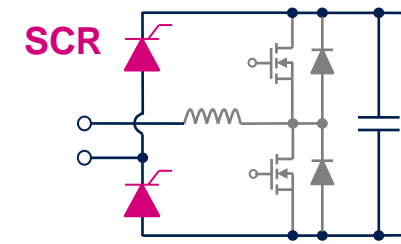
A reliable proposal to build any AC DC rectifier bridge



**By-pass parallel  
High-side SCRs**  
< 3.6 kW



**Mixed Bridge**  
< 15 kW



**Totem Pole Boost**  
< 8 kW

Standard input full bridge rectifier

Bridgeless - Totem pole PFC

Inrush current resistor used

Voltage control

No need of MCU

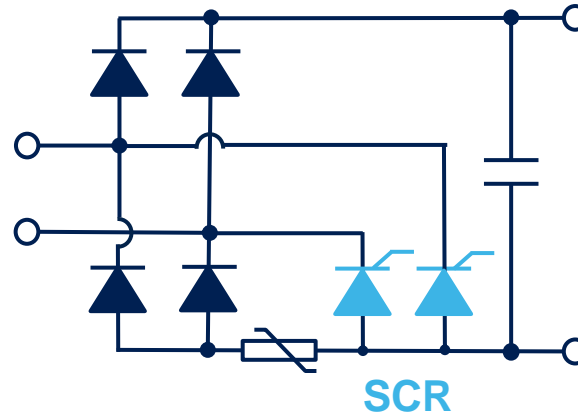
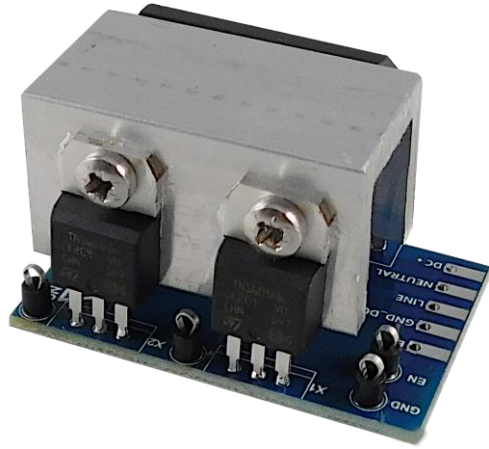
MCU driving





# STEVAL Low Side Inrush Current

## STEVAL-SCR002V1



### KEY FEATURES

- **Low side BYPASS or SMART Inrush Control**
- Input AC voltage: 90-265 VAC, 50/60 Hz
- Power range : from 50 W up to 1000 W
- Robust and Immune: IEC 61000-4-5 surge: **2 kV**  
IEC 61000-4-4 EFT burst : 4 kV min  
Low EMI Noise (EN 55014)

### KEY PRODUCTS

- **TN1605H-8T** → High TJ SCR in TO-220
- **Z0110MN** → 1 A SMD TRIAC
- **STTH110A** → 1 A Ultrafast Diode





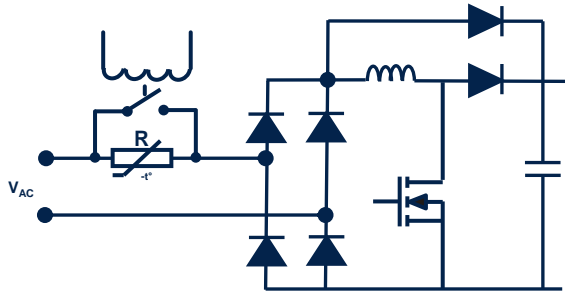
# NTC bypass with High Temperature SCR

## Example for a 1 kW / 230 V SMPS

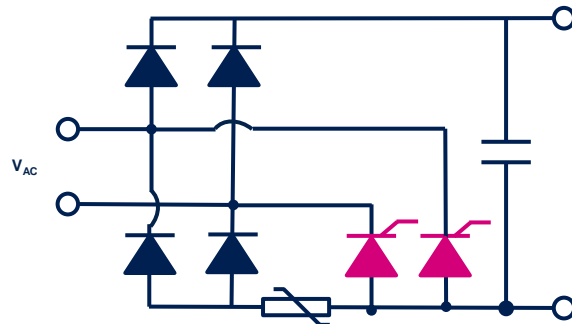
Improve your system overall efficiency by 0.4 to 0.6 %

- ✓ No acoustic noise
- and still ✓ High reliability
- ✓ No switch aging

RELAY



SCR



Efficiency of 1 kW PFC vs. output power load





# TN1605H-8 High Temperature SCR Features

800 V High Temperature SCR for robust and immune converters



## Rated for AC/DC converters

- 800 V Repetitive off-state voltage for large range of application
- 150 °C fully rated for thermal vs compactness optimized designs
- 16 A rated controlled rectifier for up to 1 kW SMPS

## Optimized switching features

- Tight triggering gate current 2 – 8 mA for accurate and easy control circuit
- 100 A/us turn-on  $di/dt$  to manage high inrush current

## Immune to EMI disturbances

- Extra 900 V on 10 ms off-state voltage for overvoltage surge management
- High  $dV/dt$  immunity up to 500 V/ $\mu$ s

## Package flexibility

- Through-hole TO-220AB & TO-220AB-I for heatsink mounting
- SMD options with low thermal resistance DPAK & D2PAK
- Insulated TO-220AB is insulated package rated at RMS 2.5 kV UL1557



# The TN1605H-8x challenge in 1 kW conversion

## ENGINEERING CHALLENGE

## THYRISTOR SOLUTION

## SYSTEM BENEFITS

Improve Immunity & Robustness

$V_{DSM} = 900 \text{ V}$  ;  $dV/dt = 500 \text{ V}/\mu\text{s}$

Ease IEC 61000-4-x EMI std compliance

Provide reliability

800 V 150°C reliable Thyristor  
With strong ITSM

Application inrush current  
management

Remove mechanical switch

AC/DC rectification with SCR

Compliance with RoHS

no EMI noise generation

No contact bouncing of a  
mechanical switch

Fit sensitive industrial electronics

No switch aging

Solid-State silicon switch

Lifetime savings



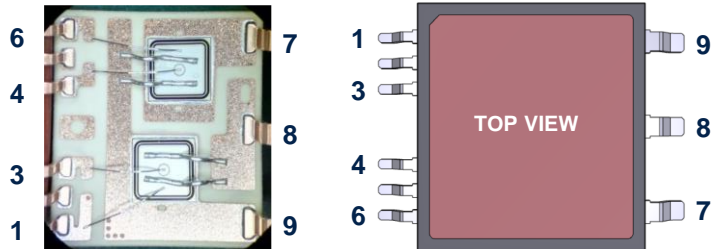
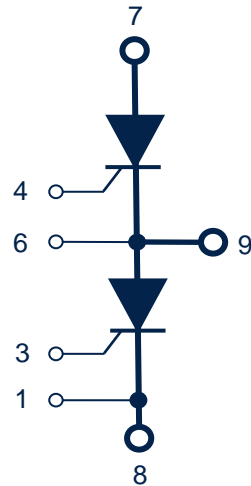




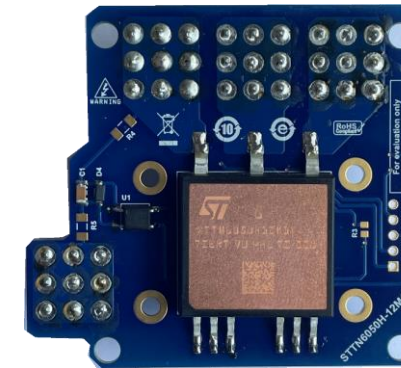
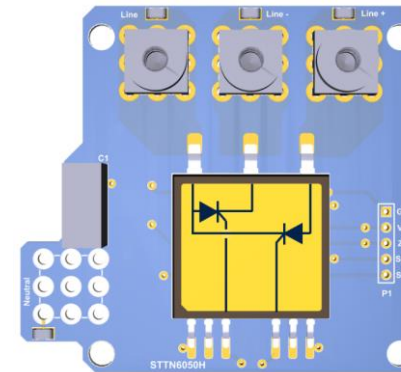
# STTN6050H-12M1Y in ACEPACK SMIT

## PRODUCT FEATURES

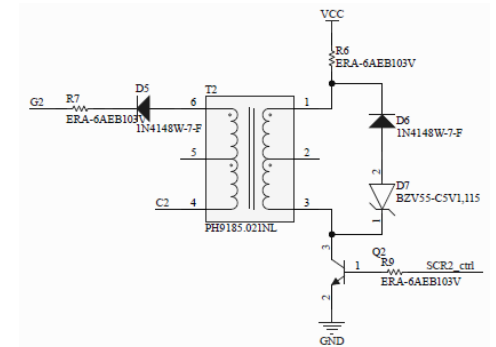
- ❖ Voltage Rating **1200 V**
- ❖ Peak Voltage (10ms) **1400 V**
- ❖ Current rating (rms) **60 A**
- ❖ Peak Current (10ms) **600 A**
- ❖ Junction Temperature **150 °C**
- ❖ Gate current **50 mA**
- ❖ Noise Immunity **1000 V/μs**
- ❖ Thermal resistance **0.75 °C/W**
- ❖ Creepage 7mm **1000 V**



## BIDIRECTIONAL SWITCH APPLICATION

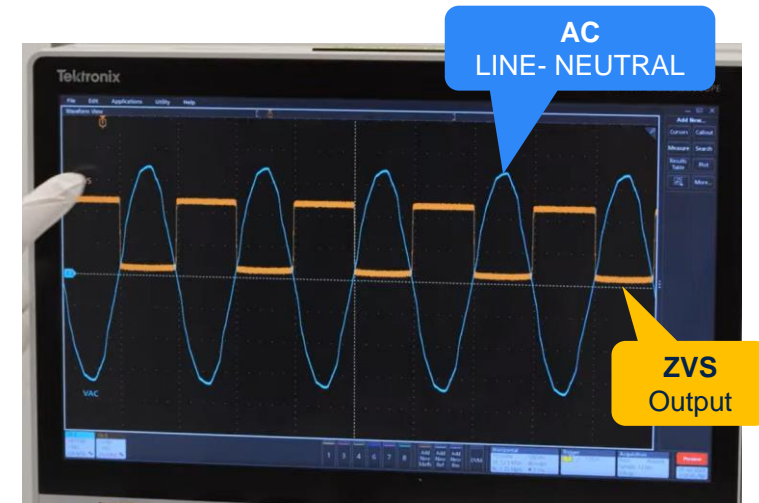
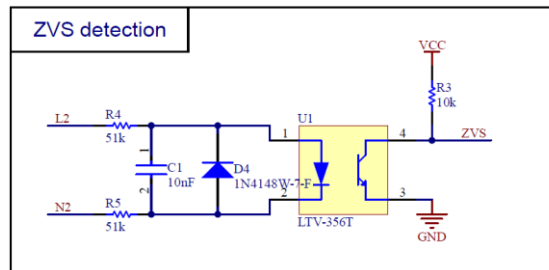
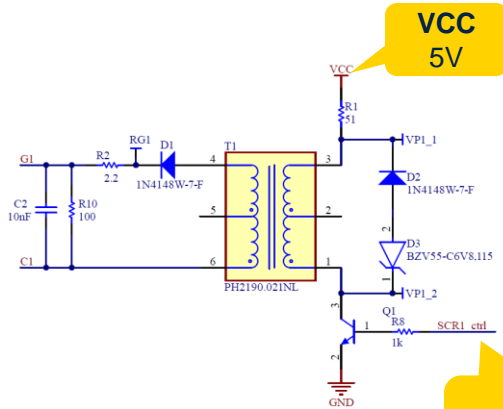
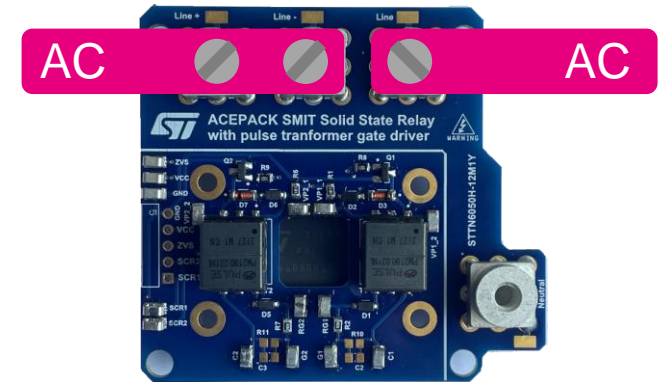
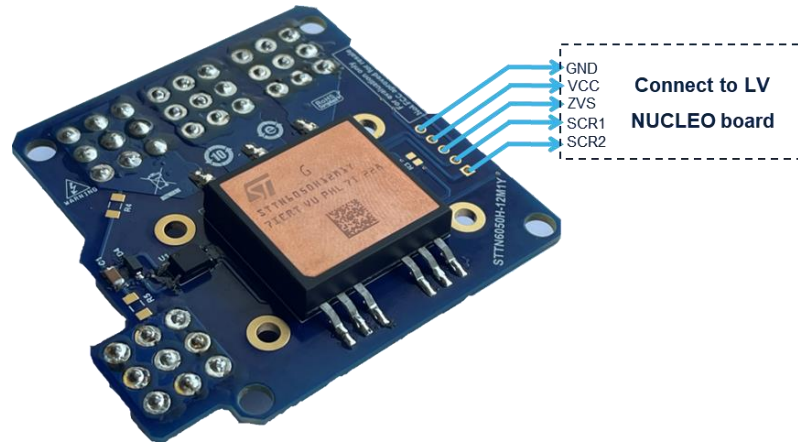
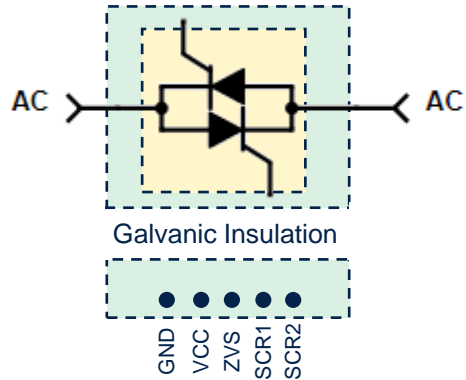


### SCR insulated gate driver schematic



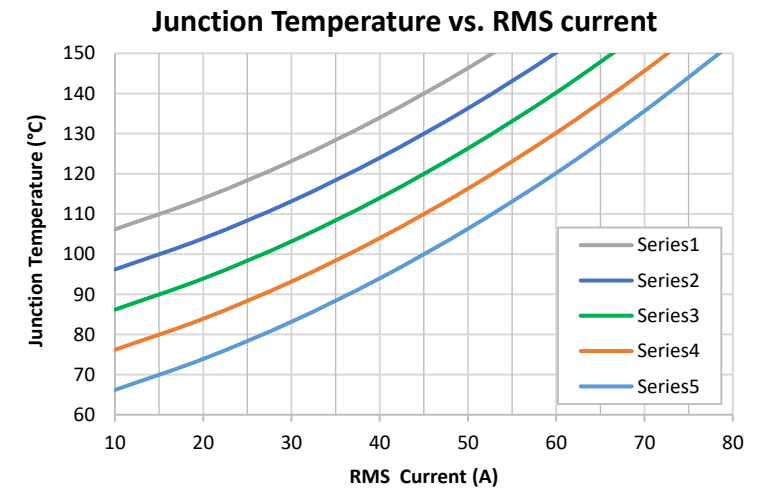
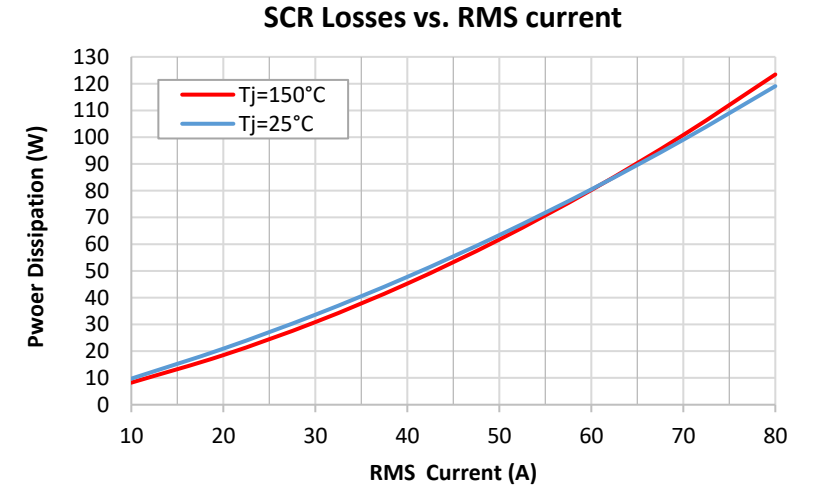
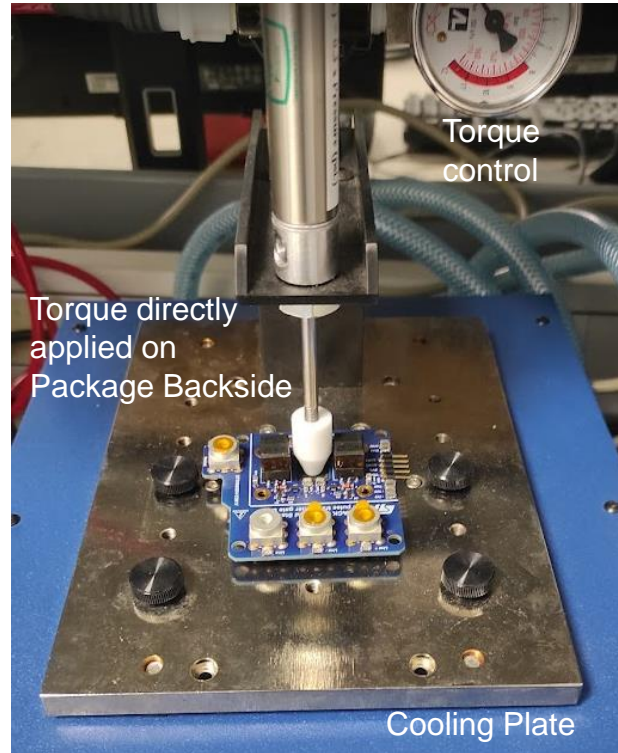
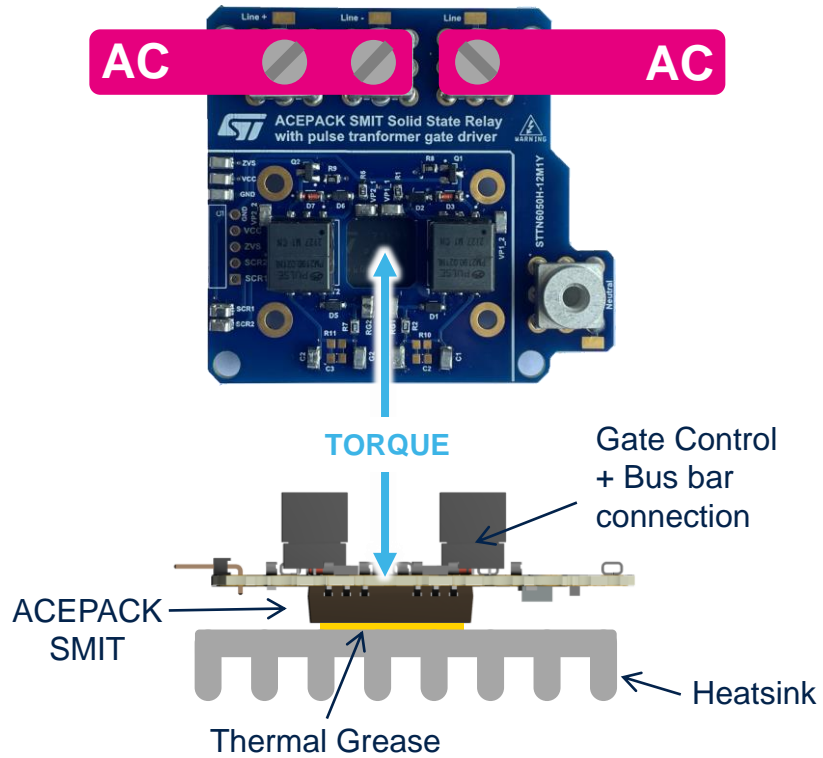


# 60A Solid State Relay Evaluation Board





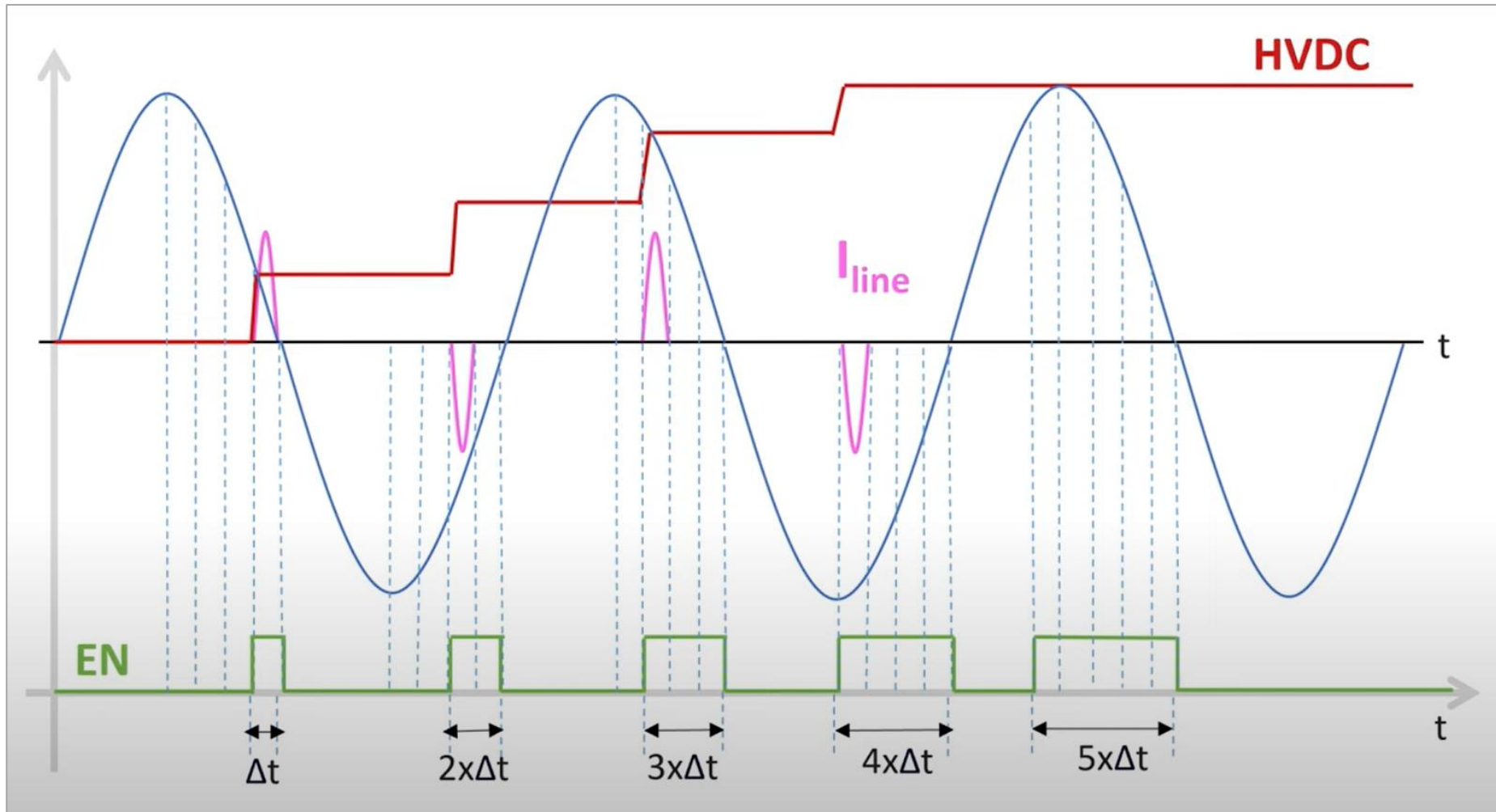
# 60A Solid State Relay Evaluation Board





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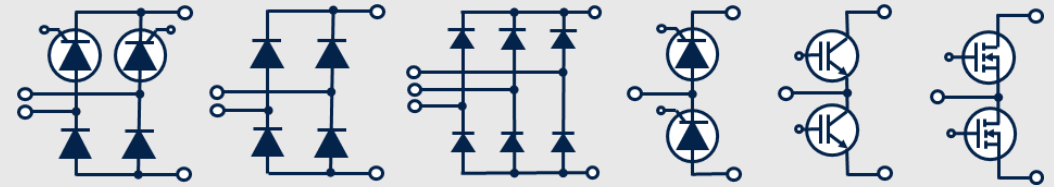
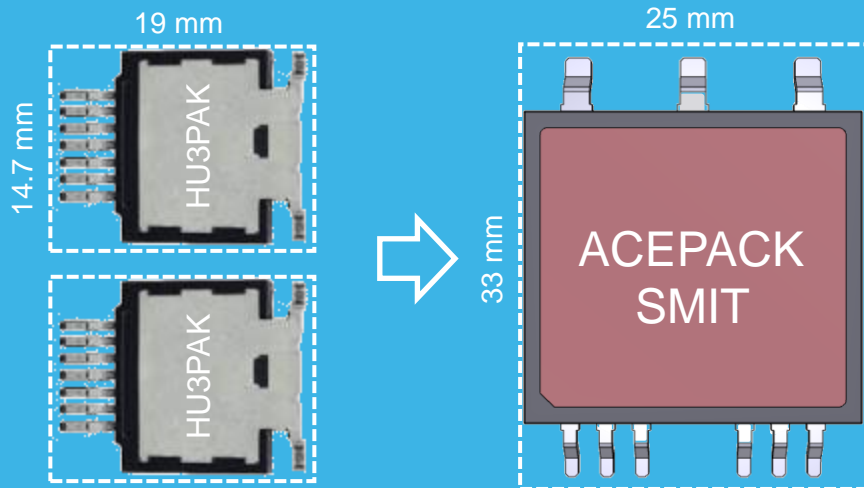
## Soft Start to limit in-rush current





# ACEPACK SMIT

## Surface Mount with **Isolated Top** cooled package



Top side cooling → thermal resistance < **0.2°C / W**

Creepage distance 7 mm **1000 V<sub>AC</sub>**

**4 kV** insulation, 4mm lead-heatsink distance

