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High efficiency 3-phase PFC with SiC devices & digital control

STMicroelectronics

High efficiency 3-phase PFC with SiC devices & digital control

3-Phase PFC Design Boards

Silicon Carbide Devices

STGAP2 Isolated Gate Driver ICs

STNRG388A PFC Controller

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High efficiency 3-phase PFC with SiC devices & digital control

3-phase PFC Design Boards

Reduce your time to market

Full design: Hardware And Firmware

Reference design for your own 3-Phase PFC

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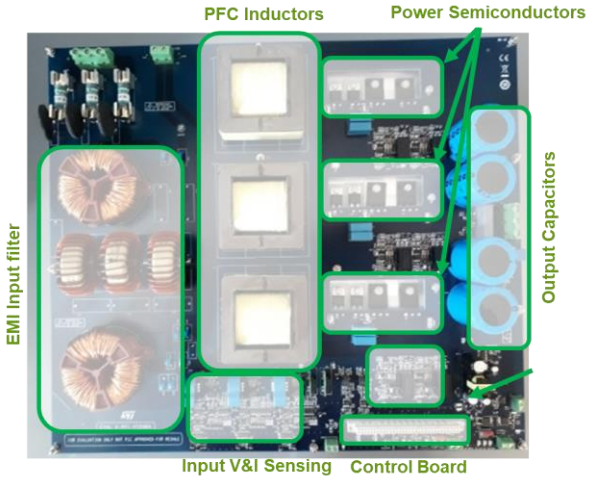
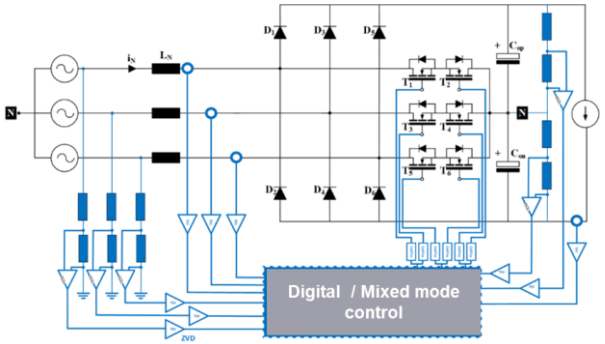
15kW 3-phase AFE reference boards

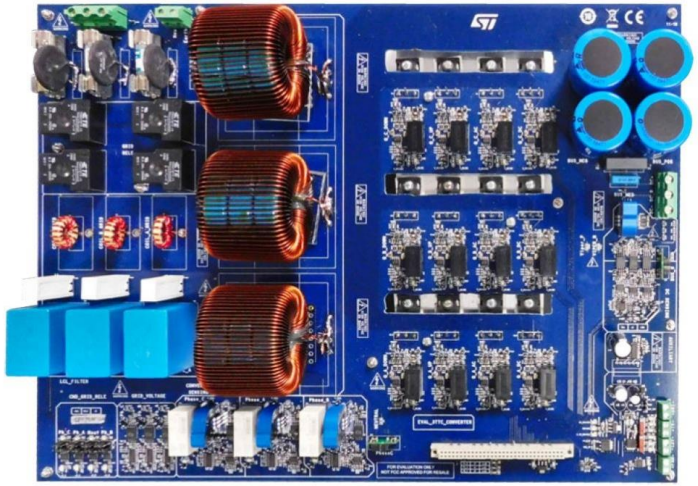
STDES-VIENNARECT - T-Type Vienna Rectifier



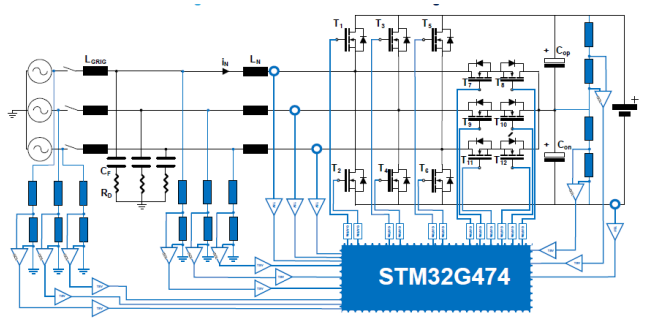
Full documentation available here



STDES-BIDIR - Bi-directional Active Front-End

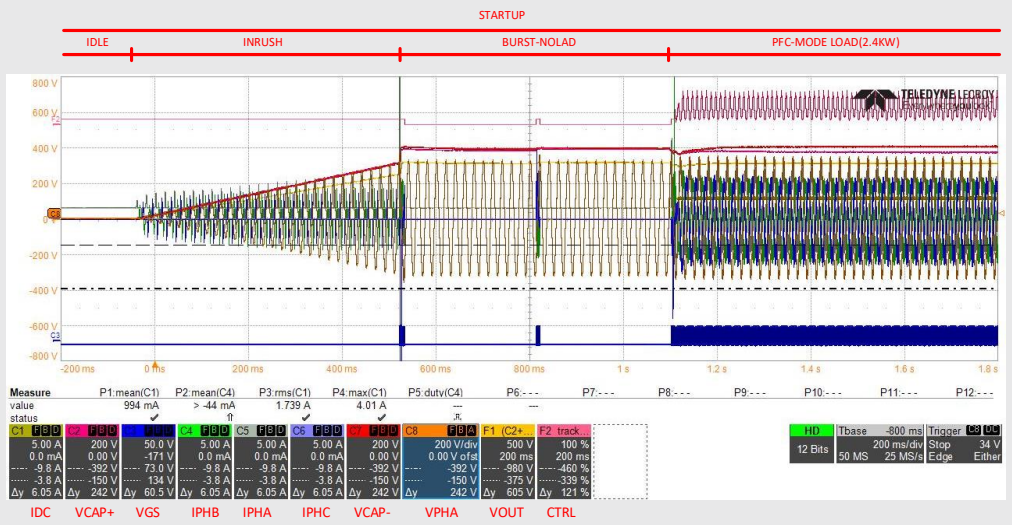


Full documentation available here

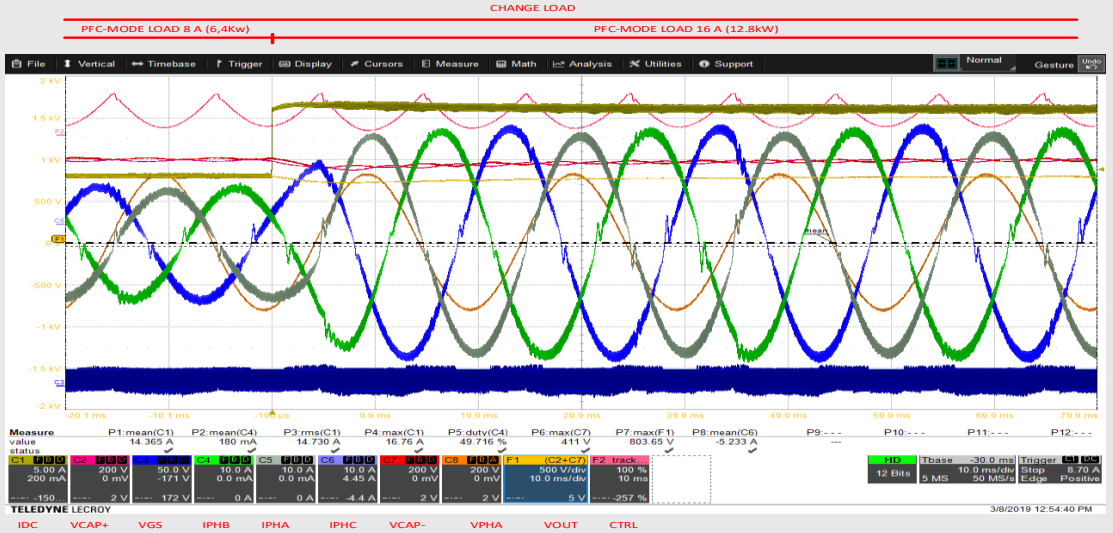


STDES-VIENNARECT - experimental results

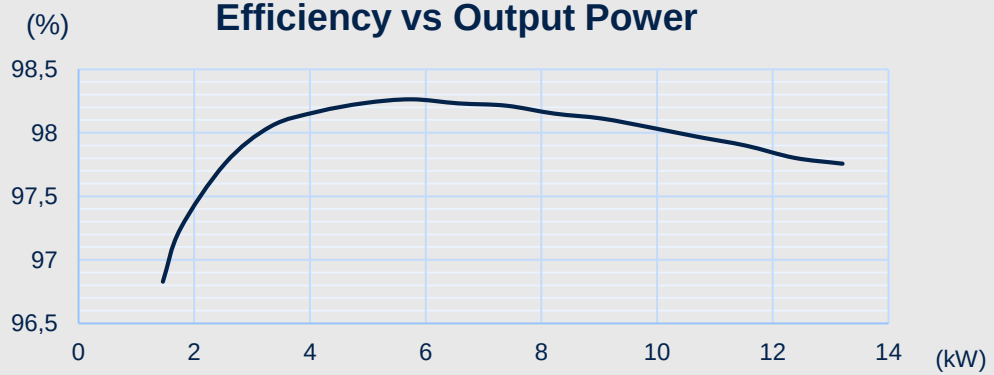
System Start-up



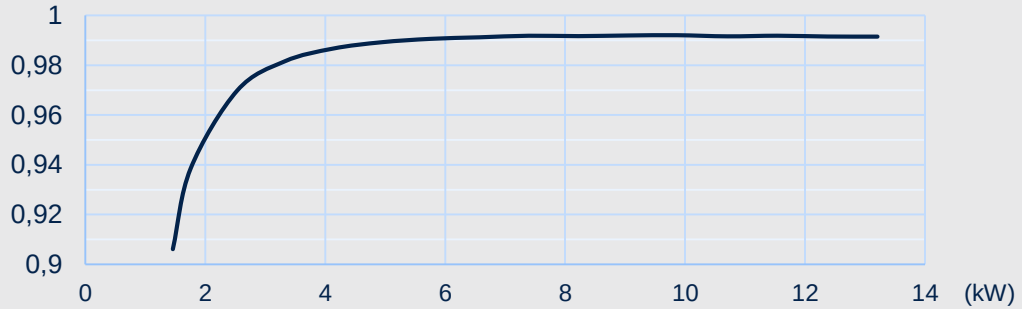
Step Load variation



Efficiency vs Output Power

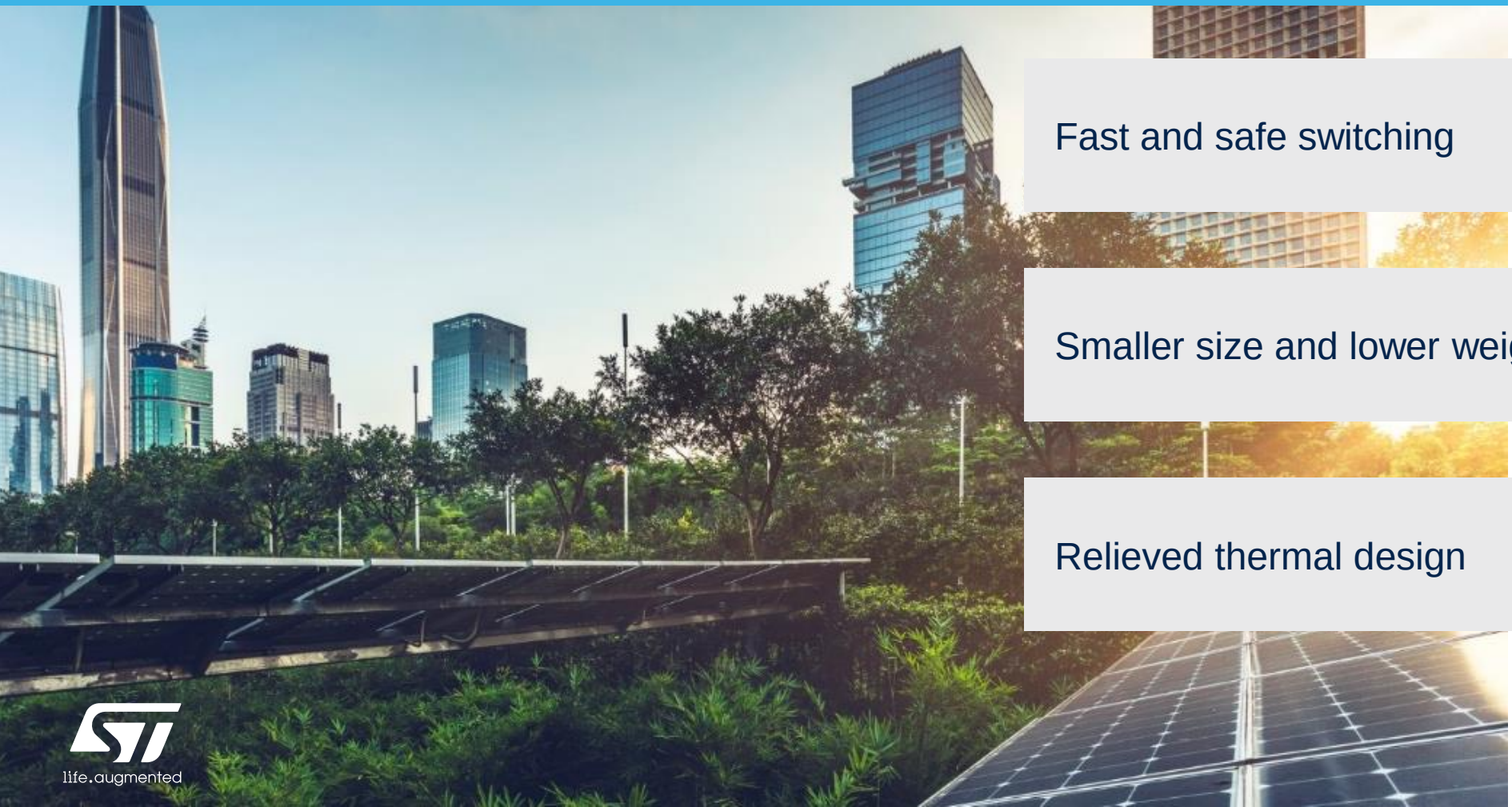


PF vs Output Power



High efficiency 3-phase PFC with SiC devices & digital control

Silicon Carbide Devices



- Fast and safe switching
- Smaller size and lower weight
- Relieved thermal design

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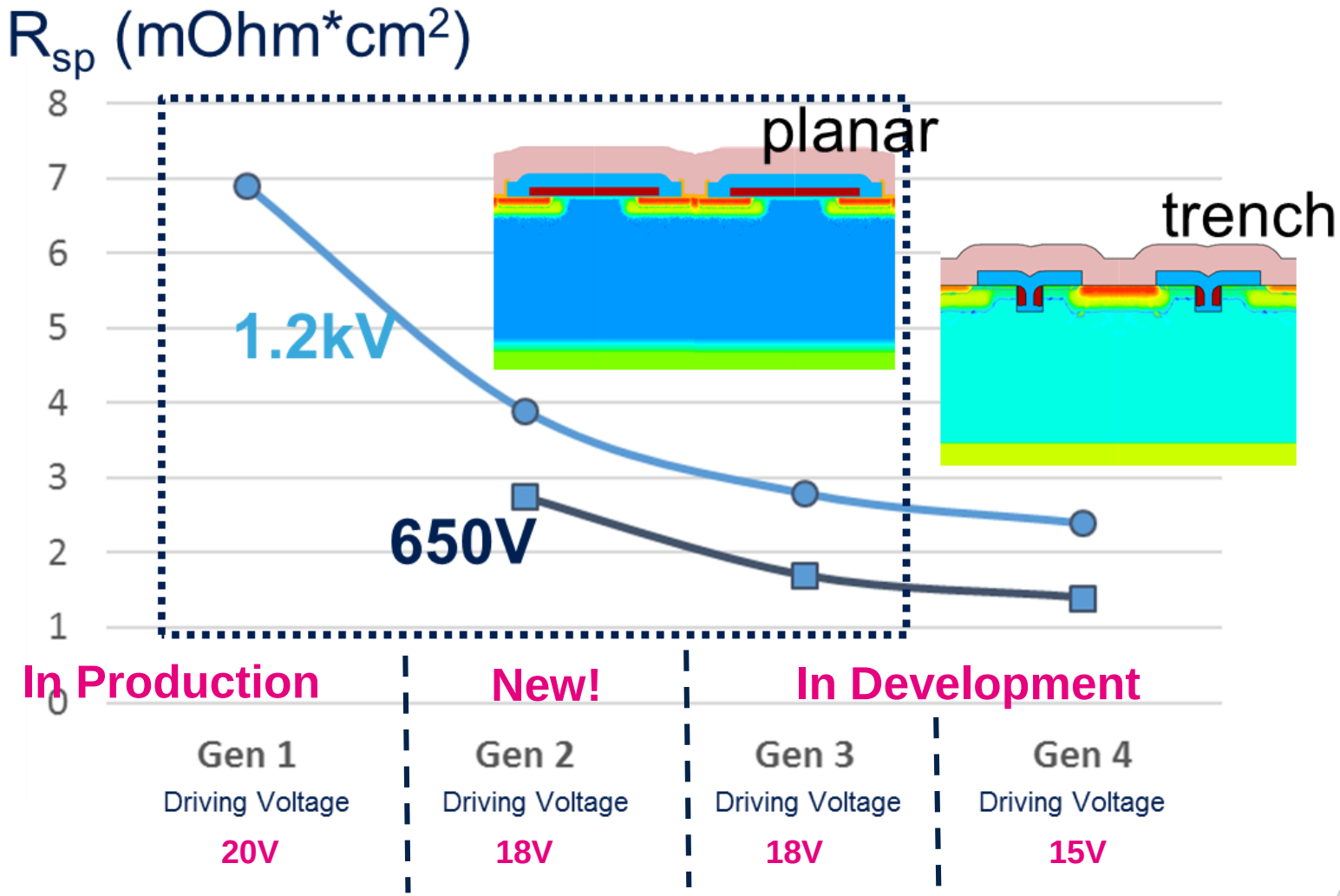
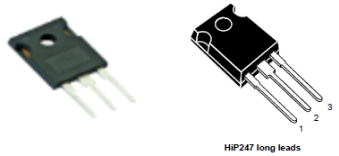
SiC MOSFET technology roadmap



SiC MOSFETs Gen 1

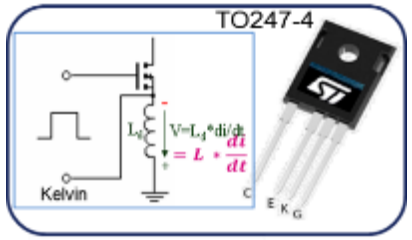
V_{DS} [V]	$R_{DS(on)}$ Typ @ 25 °C [Ω]	Id A	Package	P/N
1200 Gen1 V_{gs}=20V	0.052	65	HiP247 HiP247/LL H2PAK-7 HiP247-4	SCT50N120 SCTWA50N120 SCTH50N120-7 **SCTWA50N120-4** (Q2´20)
	0.08	40	HiP247 HiP247/LL H2PAK–2	SCT30N120 SCTWA30N120 SCT30N120H
	0.169	20	HiP247LL HiP247 H2PAK–2	SCT20N120, SCT20N120AG SCTWA20N120, SCT20N120H
	0.52	12	HiP247 HiP247LL H2PAK–2	SCT10N120 SCTWA10N120 SCT10N120H

Flattest $R_{DS(on)}$ curve over temperature up to 200°C in HiP-247 package



HiP-247 (STD & LL) ™

H2PAK
2 and 7 leads



- HiP-247 & TO247-4 rated at 200°C Tj max
- H2PAK-7 (with kelvin source) SMD option (175°C Tj max)

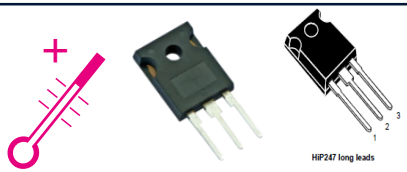
SiC MOSFET Gen 2 – planned portfolio

V_{DS} [V]	R_{DS}(on) typ @ 18V, 25°C [mΩ]	Id	Package	P/N
650	18	90	HiP247 H2PAK-7 HiP247-4L	SCTW90N65G2V SCTH90N65G2V-7 SCTWA90N65G2V-4
	23	100	H2PAK-7 HiP247 Bare die	SCTH100N65G2-7AG SCTW100N65G2AG SCT100N65G2D2AG
	55	45	H2PAK-7	SCTH35N65G2V-7AG
	55	45	HiP247 H2PAK-7 HiP247-4	SCTW35N65G2V SCTH35N65G2V-7 SCTW35N65G2V-4
1200	22	80	HiP247 HiP247-4 H2PAK-7	SCTW70N120G2V SCTWA70N120G2V-4 SCTH70N120G2V-7
	30	80	H2PAK-7 HiP247 dice	SCTH100N120G2-AG SCTW100N120G2AG SCT100N120G2D2AG
	40	60	H2PAK-7 HiP247-4 HiP247	SCTH60N120G2-7 SCTWA60N120G2V-4 SCTW60N120G2V
	45	60	H2PAK-7 HiP247	SCTH60N120G2-AG SCTW60N120G2AG
	70	45	HiP247 H2PAK-7	SCTH40N120G2V SCTWA40N120G2V-4 SCTW40N120G2V-7
	75	40	H2PAK-7 HiP247	SCTH40N120G2V7AG SCTW40N120G2VAG

Automotive Grade

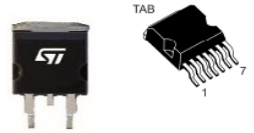
Packages

$T_{j.max}$=200°C



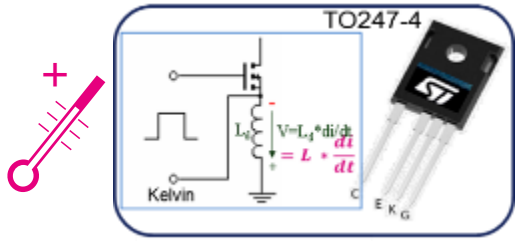
HiP-247 (STD & LL) ™

SMD



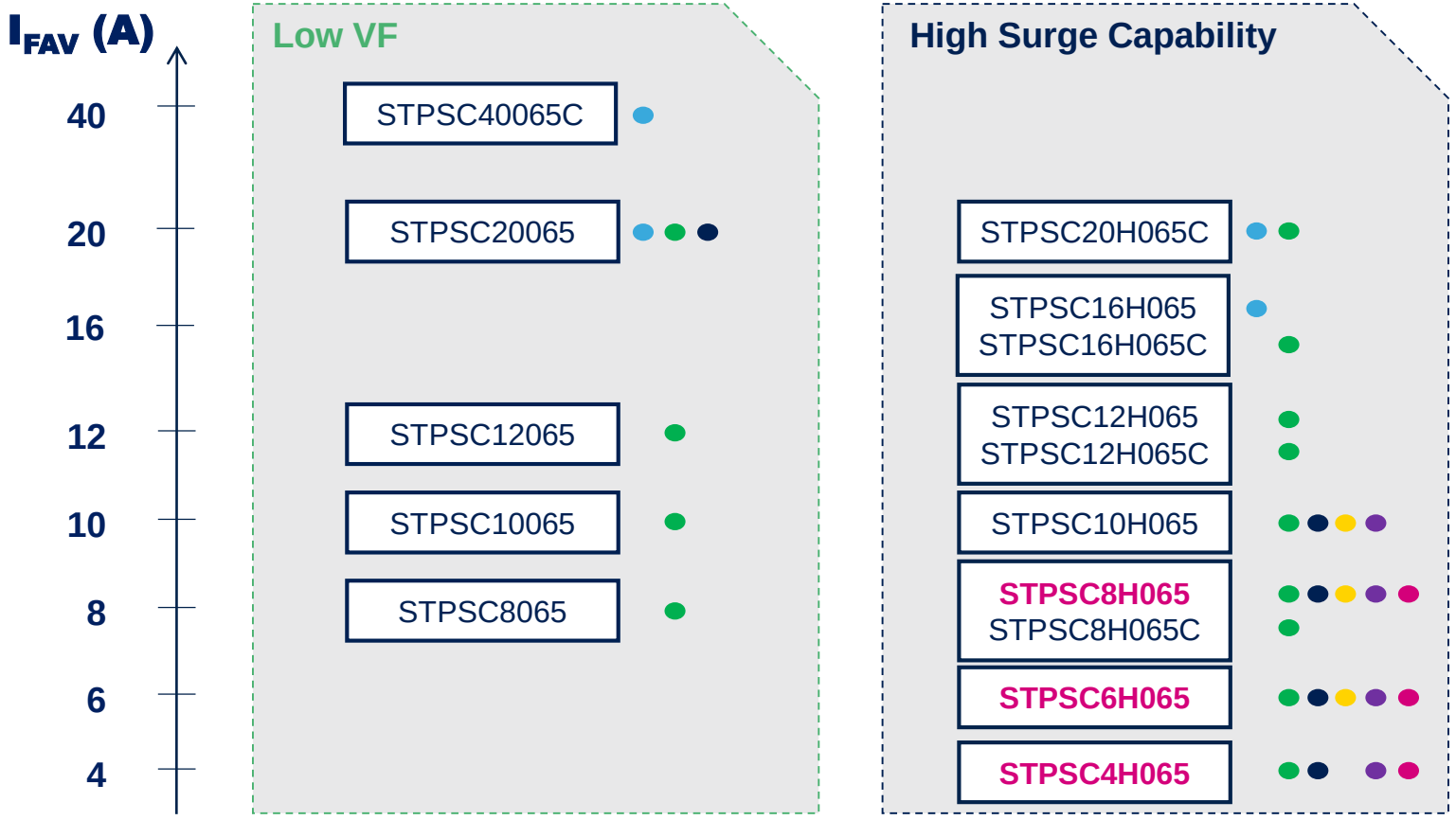
H2PAK
2 and 7 leads

Kelvin Source + $T_{j.max}$=200°C



650V SiC diode portfolio

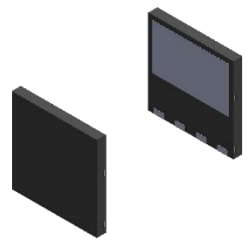
Extend package portfolio with Flat Package



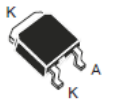
TO247 TO-220 TO-220I D^2PAK DPAK

NEW

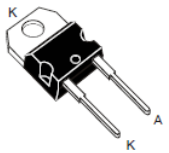
PowerFLAT™ 8x8 HV



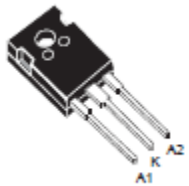
1200V SiC portfolio from 2 to 40A



DPAK HV 2L



TO-220AC



TO-247 LL

Part number	$I_{F(AV)}$	V_F [V] max Per diode $I_F = I_0$		I_{FSM} [A]		I_R [µA] max	Q_{cj} [nC] typ	Package					Samples Available
		25°C	150°C	10µs 25°C	10ms 25°C	Vr=1200V 150°C	V_R=800 V	DPAK HV	D2PAK	TO-220	TO-247 LL	TO-247	
STPSC2H12	2 A	1.5	2.25	105	15	80	15.6	■		■			√
STPSC5H12	5 A	1.5	2.25	210	35	200	36	■		■			√
STPSC6H12	6 A	1.9	2.6	100	36	1500	29	■					√
STPSC10H12	10 A	1.5	2.25	420	71	400	57	■	■	■	■		√
STPSC15H12	15 A			630	105	600	94			■	■		√
STPSC20H12	20 A			700	140	800	129		■	■	■		√
STPSC10H12C	2x5A	1.5	2.25	210	35	200	36				■		√
STPSC20H12C	2x10A			420	71	400	57				■	■	√
STPSC30H12C	2x15A			630	105	600	94				■		√
STPSC40H12C	2x20A			700	140	800	129				■		√

■ *In production*

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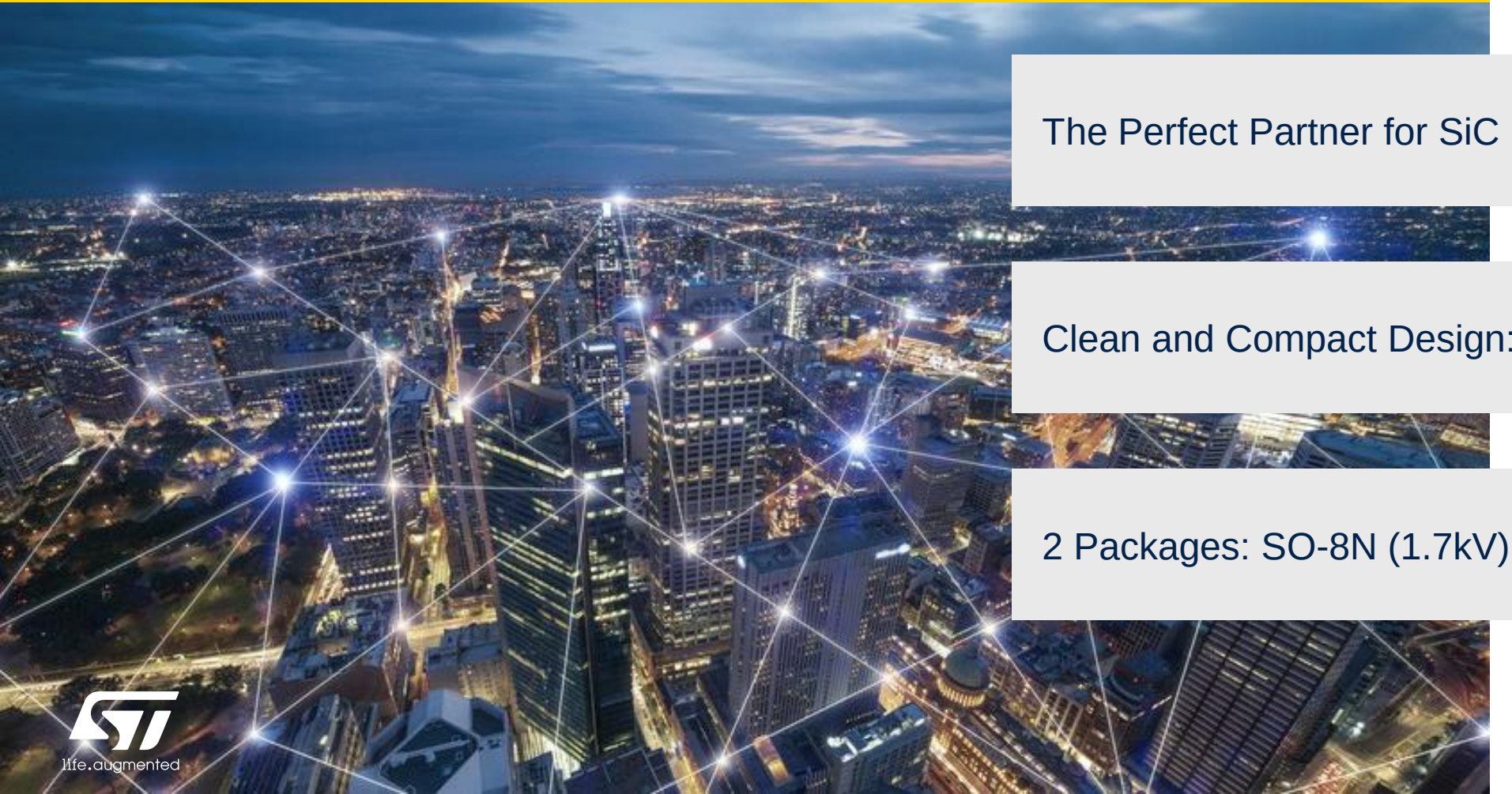
High efficiency 3-phase PFC with SiC devices & digital control

STGAP2 Isolated Gate Driver Technology



- The Perfect Partner for SiC MOSFET
- Clean and Compact Design: 8 pins 1-ch/16 pins 2-ch
- 2 Packages: SO-8N (1.7kV) and SO-8W (6kV)

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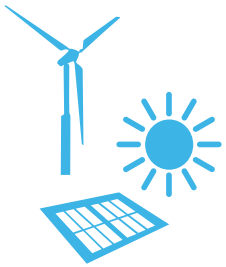
Isolated Gate Drivers
STGAP2S & STGAP2D

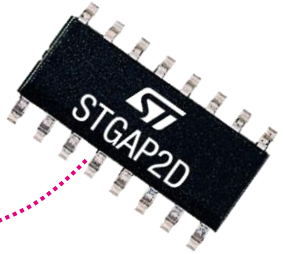
Different flavors for different needs



STGAP2S

- 1.7kV Isolation
- 4A sink and source current
- Single channel
- Active Miller Clamp or G_{ON}/G_{OFF} pins

SO8N



STGAP2D

- 1.7kV Isolation
- 4A sink and source current
- Dual channel
- Compact layout
- Industrial grade

SO16N

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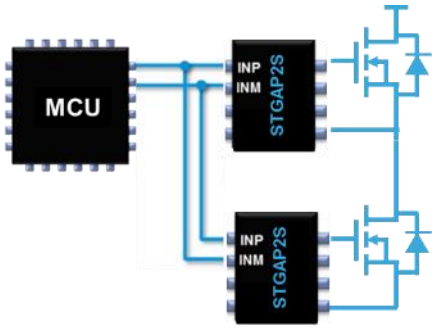
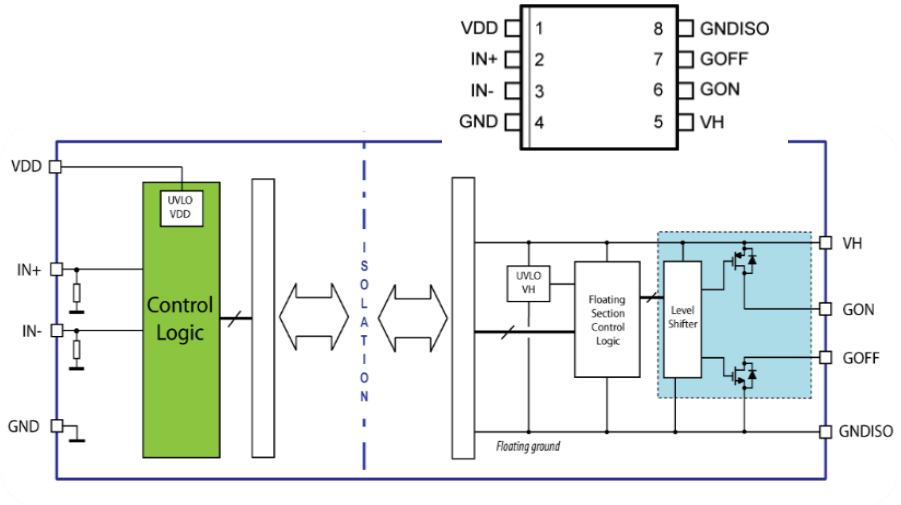
STGAP2S

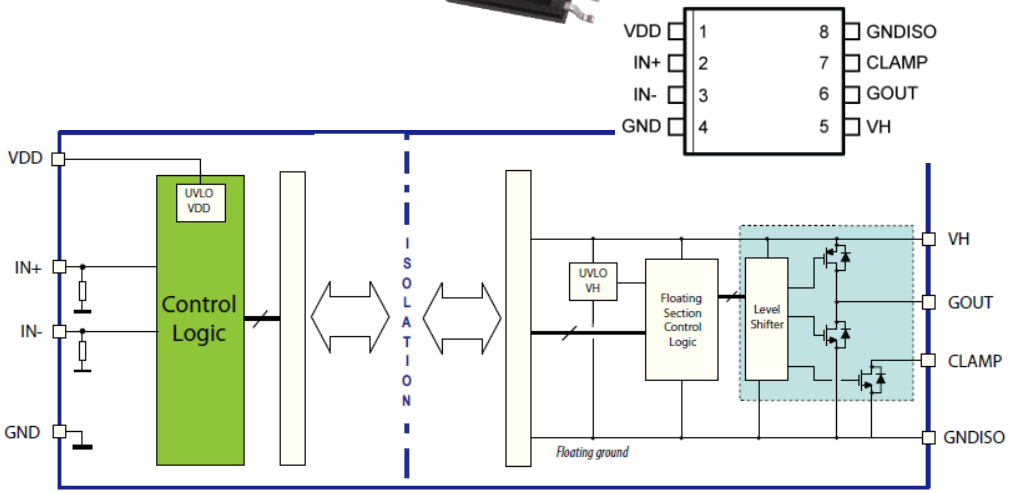
Functional Isolation 1700 V, 4A isolated gate drivers

- 3V3 / 5 V logic inputs (logic thresholds 1/3, 2/3 of VDD)
- **Up to 26 V supply voltage**
- **4 A Sink/Source current capability**
- Short propagation delay: 80 ns
- UVLO Function
- Stand-by function
- 100 V/ns CMTI
- Functional Isolation up to 1700 V
- Temperature shut-down protection

- Active High & Active Low input pins, for HW interlocking
- **STGAP2SM**: Separated Outputs option for easy gate driving tuning
- **STGAP2SCM**: Miller CLAMP pin option to avoid induced turn-on
- Negative gate drive ability
- SO8 Package





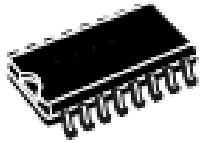


STGAP2D

Functional Isolation 1700 V, 4A isolated gate drivers

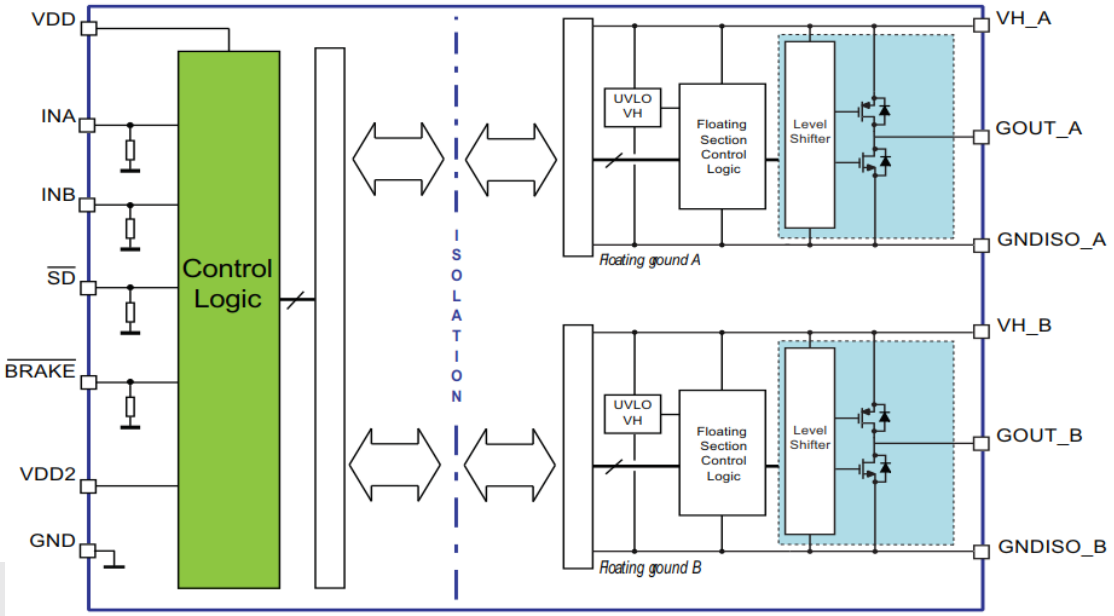
- 3V3 / 5 V logic inputs (logic thresholds 1/3, 2/3 of VDD)
- **Up to 26 V supply voltage**
- **4 A Sink/Source current capability**
- Short propagation delay: 80 ns
- UVLO Function
- Stand-by function
- 100 V/ns CMTI
- Functional Isolation up to 1700 V
- Temperature shut-down protection

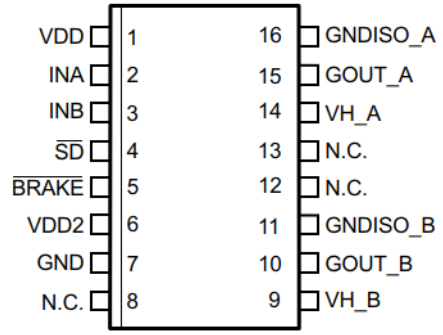
- Single input pin, in phase with output
- Shut-Down SD pin, with integrated pull-down
- BRAKE pin
- Interlocking
- Negative gate drive ability
- SO16 Package



KEY APPLICATIONS

- Motor control
- Factory automation
- Industrial drives and fans
- DC-DC converters
- Induction heating
- Welding





High efficiency 3-phase PFC with SiC devices & digital control

STNRG388A PFC Controller

- 6 PWM Outputs for all 3-phase Switches
- Simple and fast design
- Dedicated Firmware for T-Type Vienna rectifier

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STNRG388A

Digital controller for power conversion with ST SMED concept

- 6 PWM based on ST SMED (state machine event driven)
- 96MHz PLL
- Integrated 8 bit core
- ADCs up to 8 channels
- UART & I^2C communication interfaces

Resources	
PWM	6
DIGIN	6
ADCIN	8
CMP	4
CMP with ext. ref.	4
GPIO	6
Flash memory	32 KB
E^2PROM memory	1 KB
SRAM memory	6 KB
ADC gain	x1
Interfaces	I^2C, Serial (UART)
Temperature	-40 / +105 °C
Package	TSSOP38

Boards	Description
EVLSTNRG-1KW	1 kW SMPS digitally controlled multi-phase interleaved converter using STNRG388A
EVLSTNRG-170W	170W SMPS with digitally controlled PFC and resonant LLC stage using STNRG388A
STDES-VIENNARECT (not for sale)	15 kW, three-phase Vienna rectifier with low cost mixed-signal control for power factor correction
STEVAL-ISA164V1	STNRG388A evaluation board

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Thank you

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