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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



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

3-phase PFC Design Boards



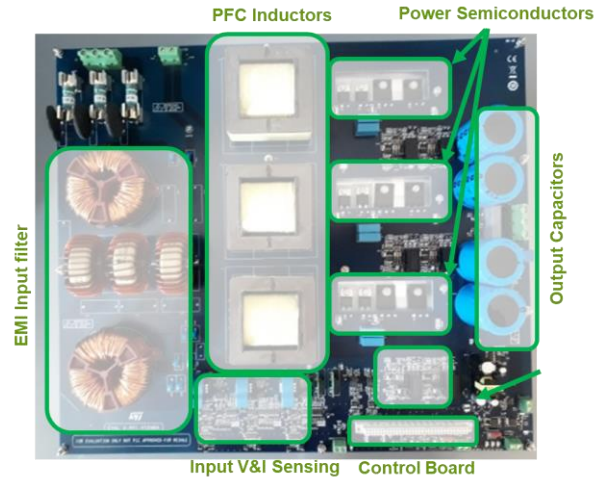
Reduce your time to market

Full design: Hardware And Firmware

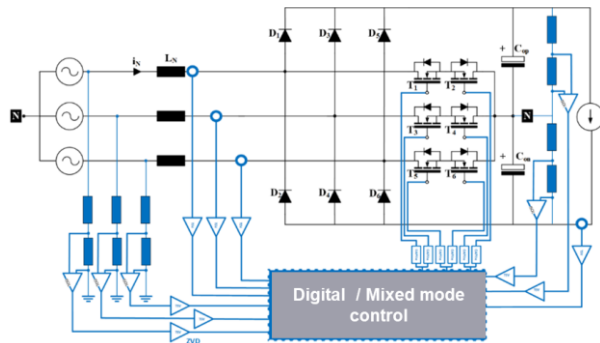
Reference design for your own 3-Phase PFC

15kW 3-phase AFE reference boards

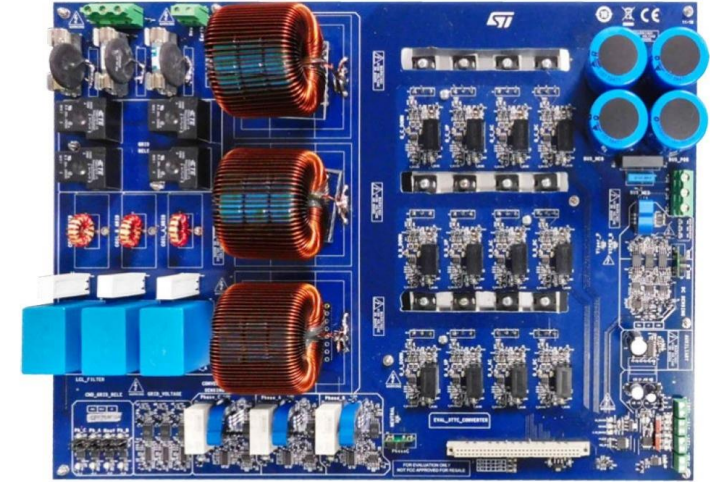
STDES-VIENNARECT - T-Type Vienna Rectifier



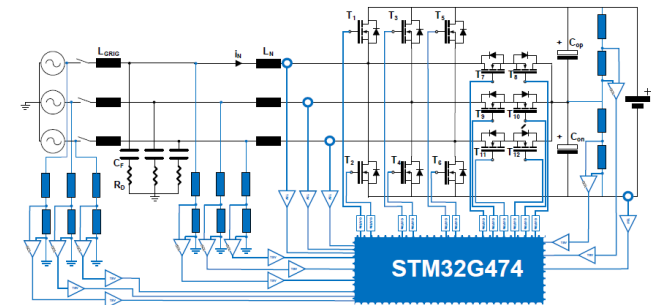
Full documentation available [here](#)



STDES-BIDIR - Bi-directional Active Front-End

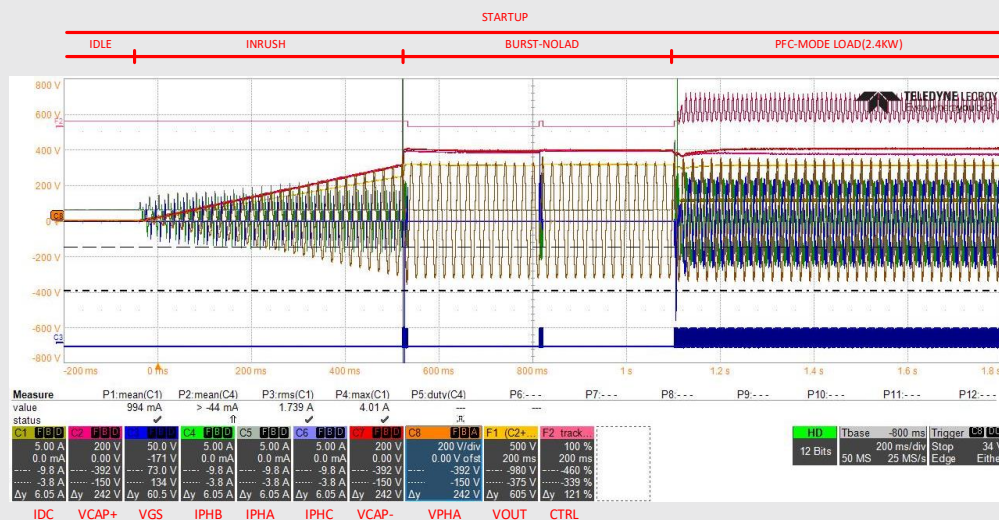


Full documentation available [here](#)

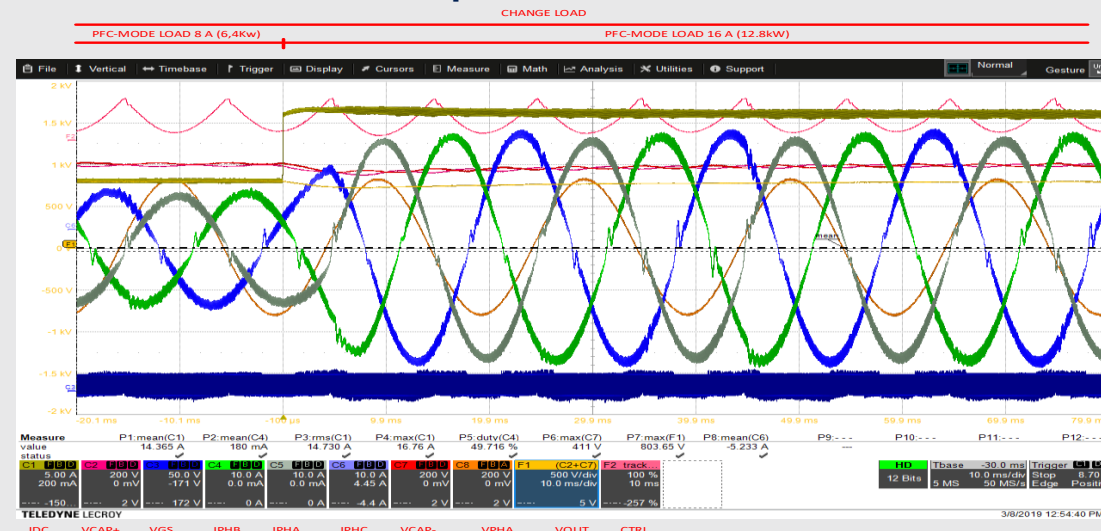


STDES-VIENNARECT - experimental results

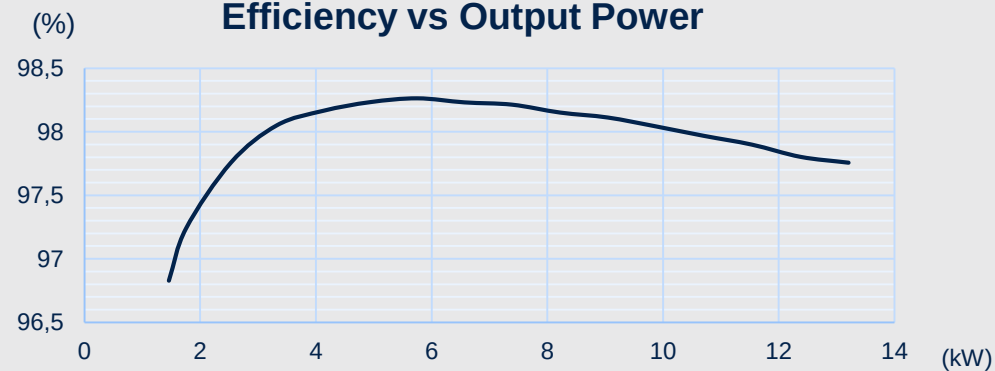
System Start-up



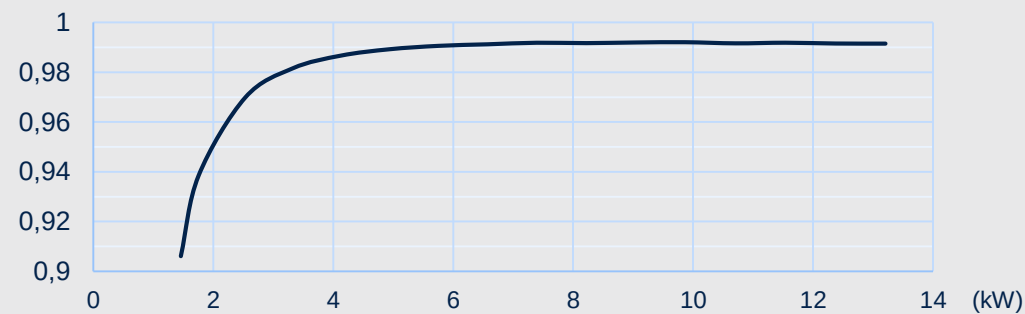
Step Load variation



Efficiency vs Output Power

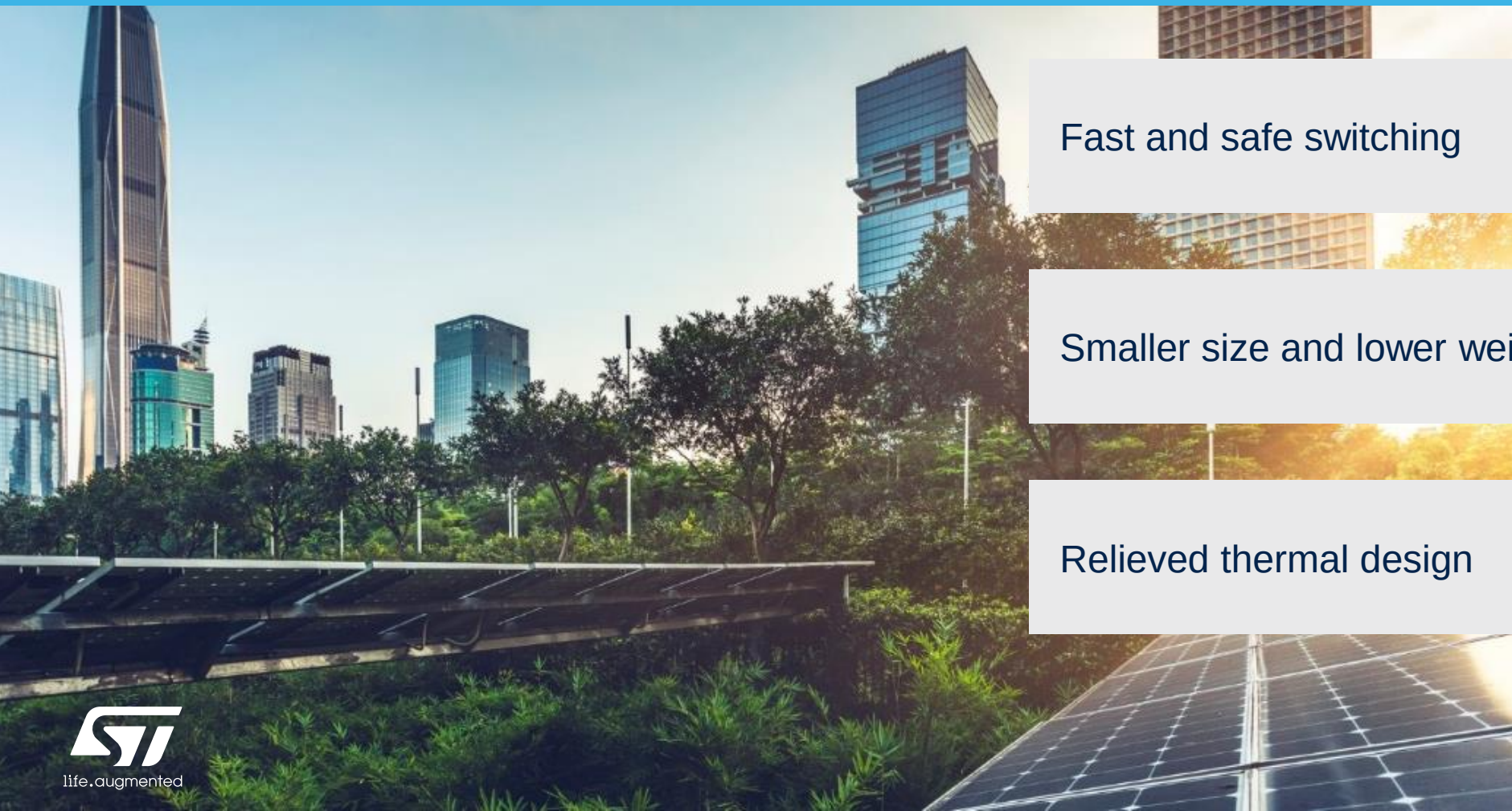


PF vs Output Power



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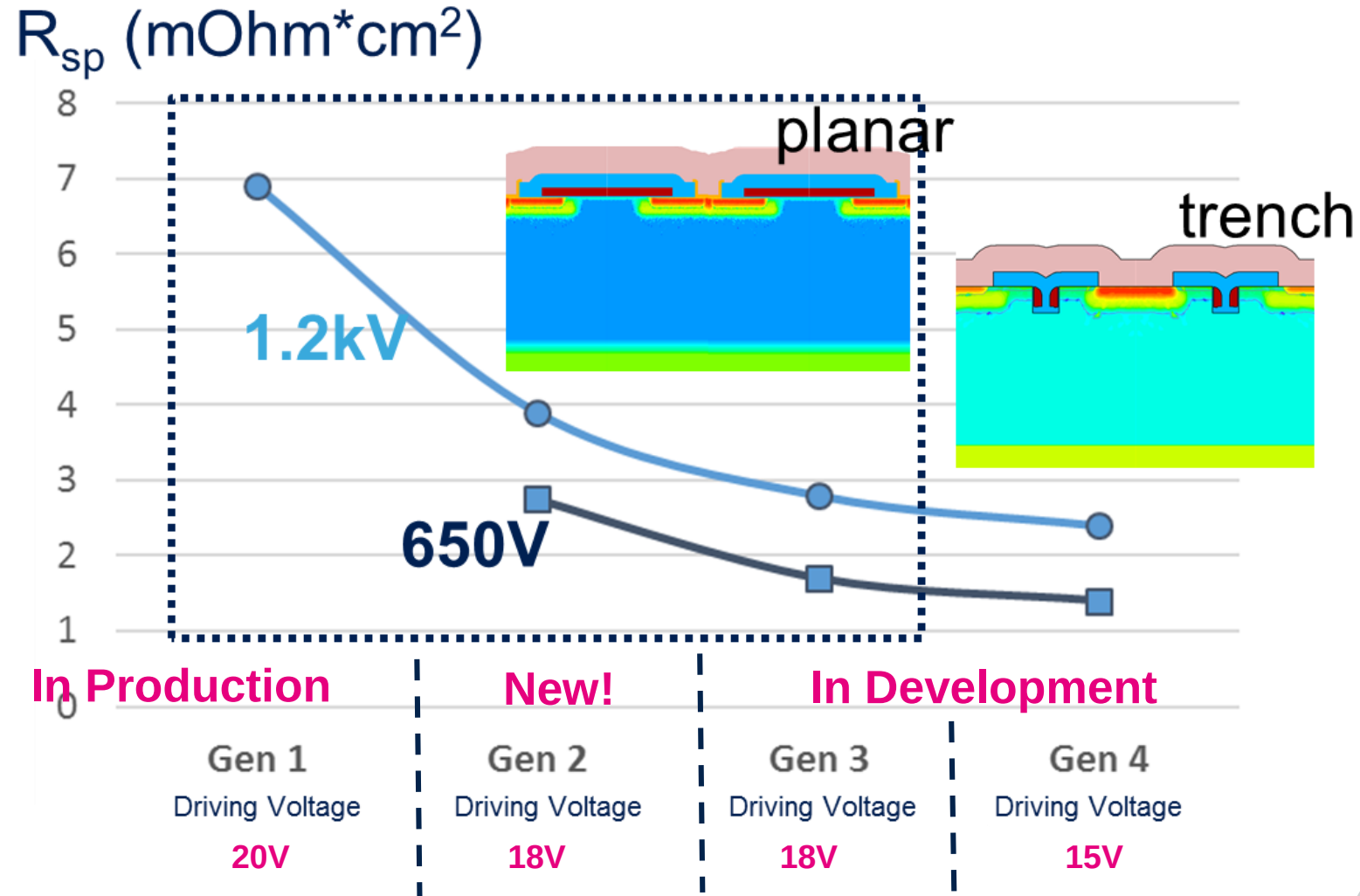
Fast and safe switching

Smaller size and lower weight

Relieved thermal design

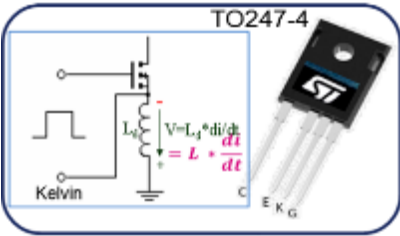
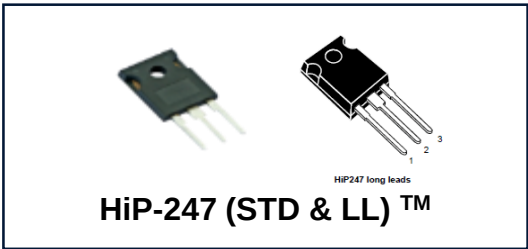


SiC MOSFET technology roadmap



V_{DS} [V]	$R_{DS(on)}$ Typ @ 25 °C [Ω]	I_d 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 & TO247-4 rated at **200°C Tj max**
- H2PAK-7 (with kelvin source) SMD option (175°C Tj max)

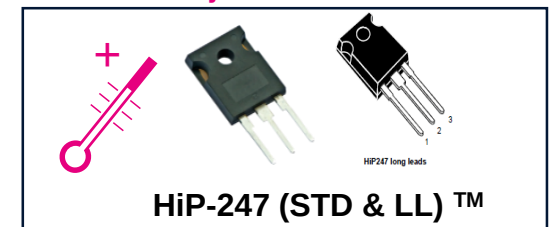


SiC MOSFET Gen 2 – planned portfolio

V _{DS} [V]	R _{DS(on)} typ @ 18V, 25°C [mΩ]	I _d	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

Packages

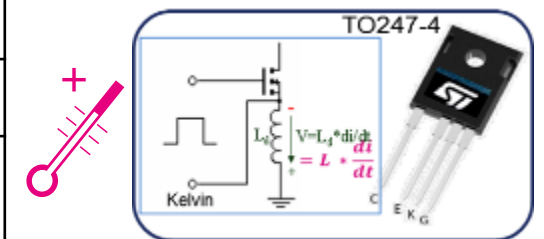
$T_{j,max}=200^{\circ}\text{C}$



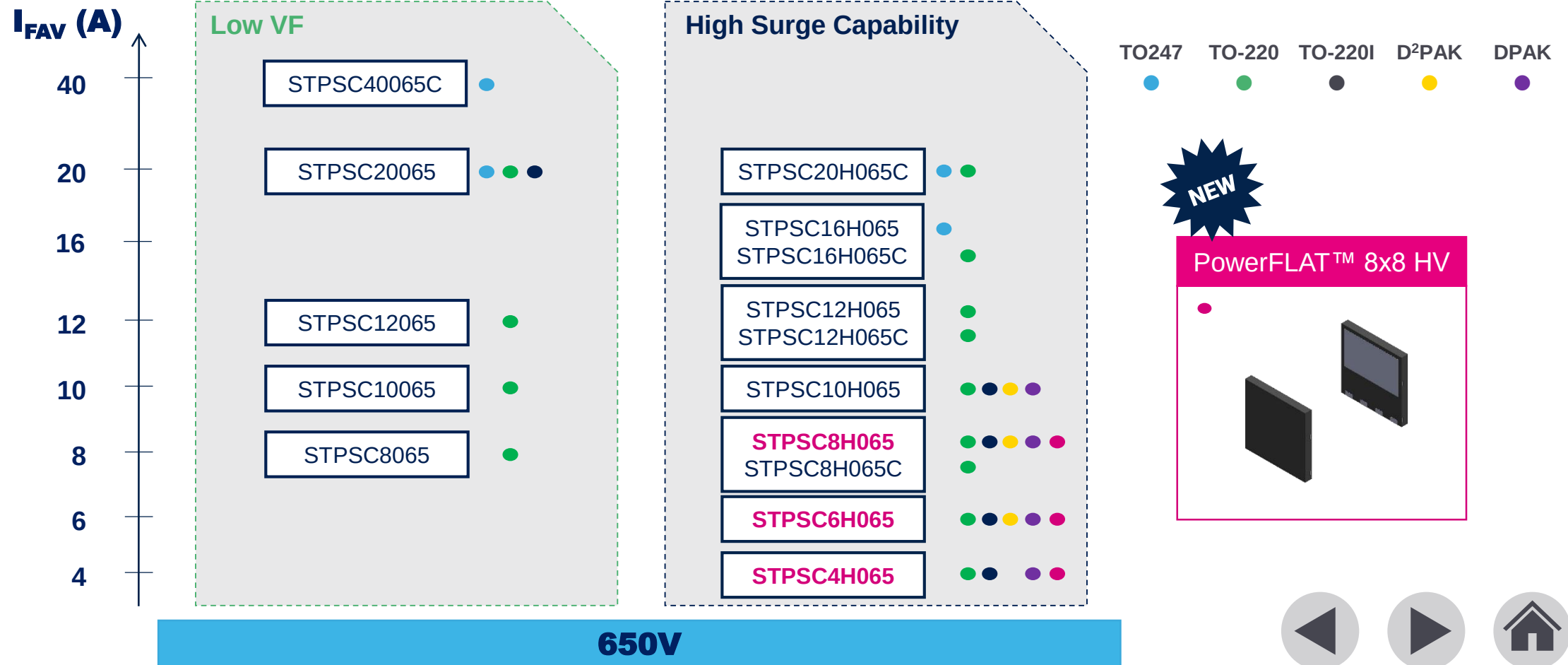
SMD



Kelvin Source + $T_{j,max}=200^{\circ}\text{C}$

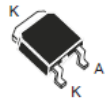


Extend package portfolio with Flat Package

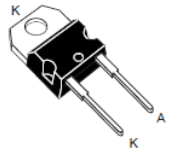




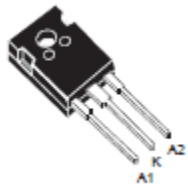
1200V SiC portfolio from 2 to 40A



DPAK HV 2L



TO-220AC



TO-247 LL



Part number	I _{F(AV)}	V _F [V] max Per diode		I _{FSM} [A]		I _R [μA] max	Q _{cj} [nC] typ	Package					Samples Available
		I _F = I ₀						DPAK HV	D2PAK	TO-220	TO-247 LL	TO-247	
		25°C	150° C	10μs 25°C	10m s 25°C	Vr=1200V 150°C	V _R =800 V						
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

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

STGAP2 Isolated Gate Driver Technology

The Perfect Partner for SiC MOSFET

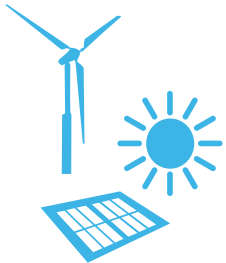
Clean and Compact Design: 8 pins 1-ch/16 pins 2-ch

2 Packages: SO-8N (1.7kV) and SO-8W (6kV)



Isolated Gate Drivers STGAP2S & STGAP2D

Different flavors for different needs



STGAP2S

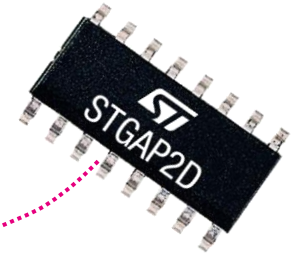
- 1.7kV Isolation
- 4A sink and source current
- Single channel
- Active Miller Clamp or G_{ON}/G_{OFF} pins

SO8N

STGAP2D

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

SO16N



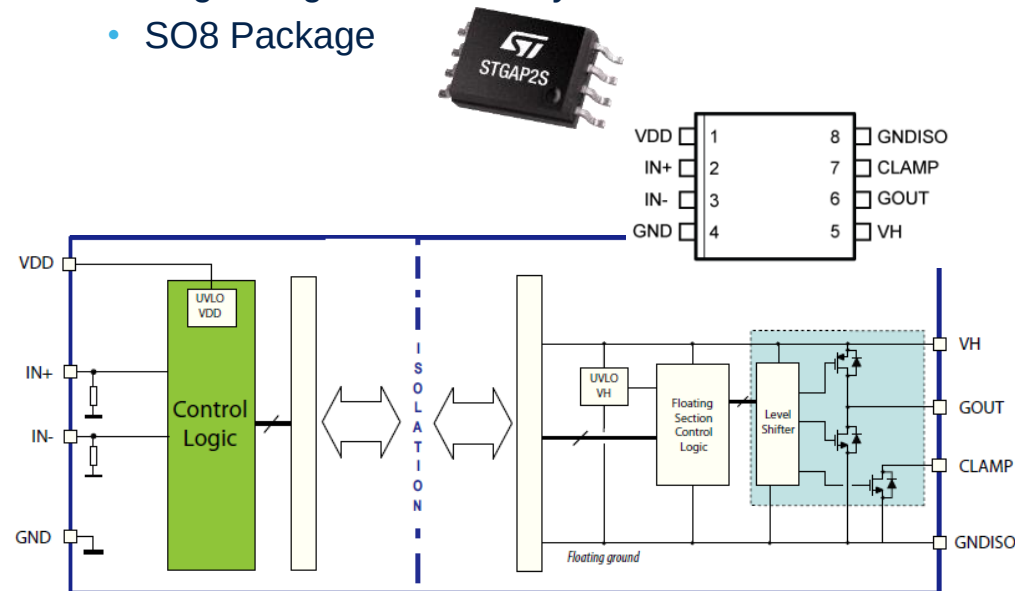
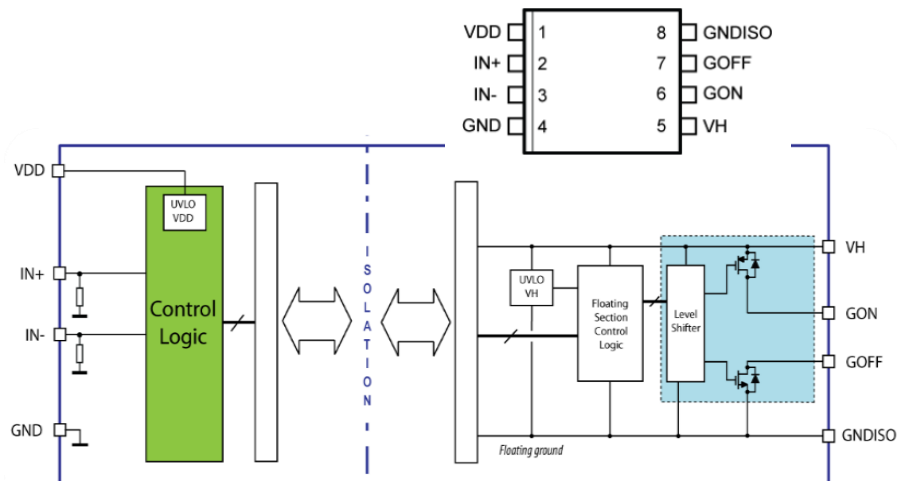
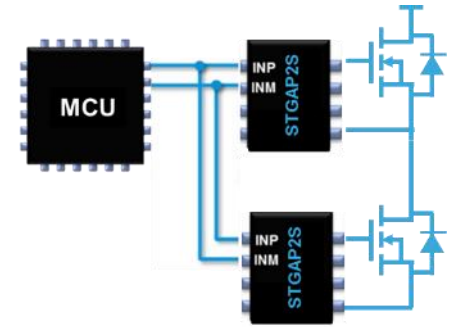


STGAP2S

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



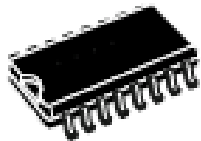


STGAP2D

Functional Isolation 1700 V, 4A isolated gate drivers

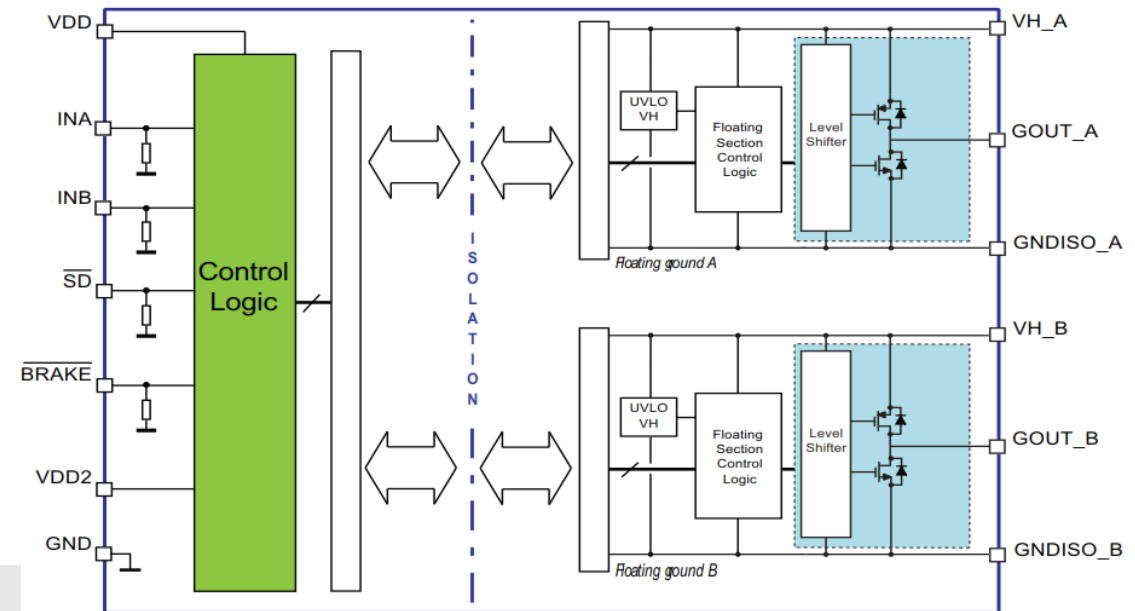
- 3V3 / 5 V logic inputs (logic thresholds 1/3, 2/3 of VDD)
- **Up to 26 V supply voltage**
- **4 A Sink/Source current capability**
- Short propagation delay: 80 ns
- UVLO Function
- Stand-by function
- 100 V/ns CMTI
- Functional Isolation up to 1700 V
- Temperature shut-down protection

- 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



VDD	1	16	GNDISO_A
INA	2	15	GOUT_A
INB	3	14	VH_A
SD	4	13	N.C.
BRAKE	5	12	N.C.
VDD2	6	11	GNDISO_B
GND	7	10	GOUT_B
N.C.	8	9	VH_B



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

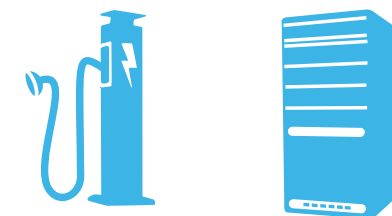


STNRG388A

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 & I²C communication interfaces

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



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



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