

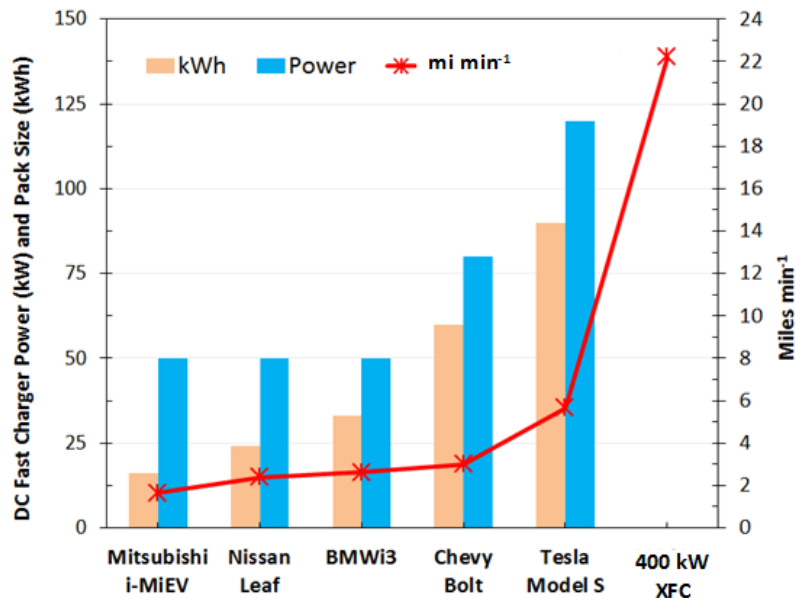
Use of 3300 V SiC MOSFETs and 1700 V SiC diodes in modern applications

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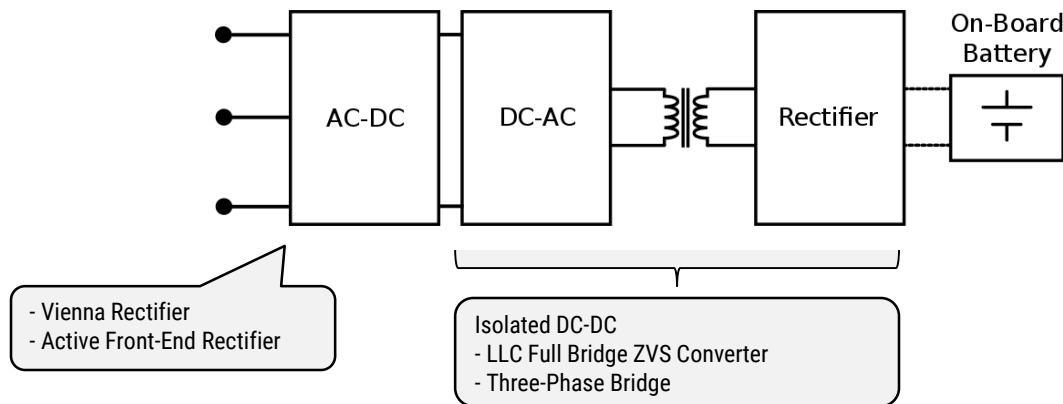
Fast Chargers for EV demand smaller size



300-400 kW Extra Fast Chargers are becoming ubiquitous

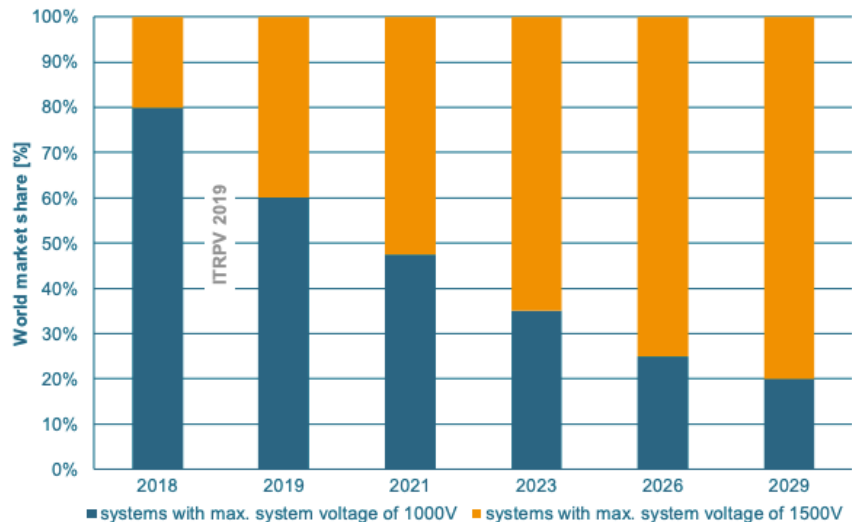
Fast Charging (DC) of Electric Vehicles

- Extreme Fast Charging (XFC) standards have been defined for charging levels above 350 kW and output voltages up to 1000 V DC
 - CHAdeMO Power Class 2.0 – **400 kW**, **1000 V DC** (Up to 400 A)
 - CCS HPC350 – **350 kW**, **920 V DC** (Up to 380 A)
- While majority of standardization process for XFC networks is aimed for heavy duty vehicles like electric trucks and buses, commercial battery electric vehicles (BEV) like Porsche Taycan (800 V on-board battery) are also capable of 350 kW fast charging



Utility Scale Solar String Inverters up to 1500V

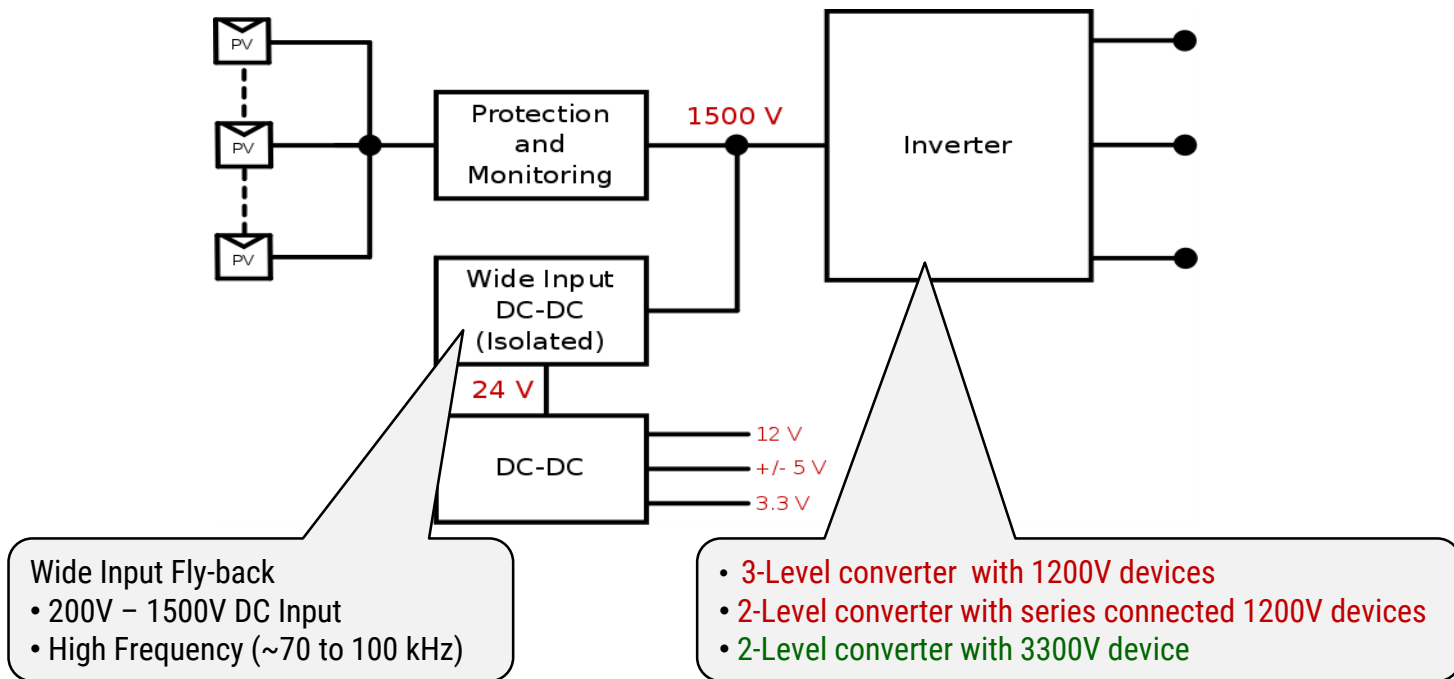
Maximum system voltage of new PV systems



Utility scale solar offers the best CapEx and OpEx rationale; and higher efficiencies

1500 V DC Bus Systems

- PV inverters and motor traction systems are now settling on 1500 V DC bus.
- Such applications demand wide input voltage range (from 200 V DC to 1500 V DC) auxiliary switched-mode power supplies based on Fly-back topology



GeneSiC's SiC MOSFET and Schottky Rectifiers Performance

SiC MOSFETs

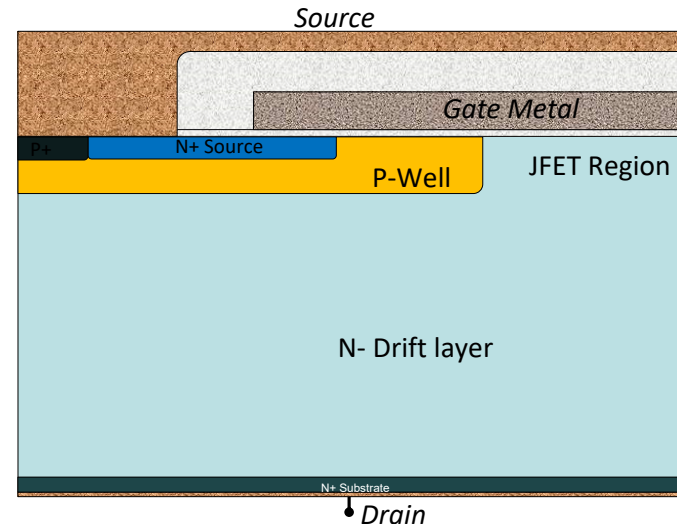
- Lowest $R_{ds(on)}$
- Fast, temperature independent switching
- High Avalanche ruggedness
- High Reliability
- Good Short Circuit Capability
- Low Costs at high volumes

SiC Schottky Rectifiers

- Low On-state drop
- Zero Reverse Recovery
- Low Leakage Currents
- High Surge Current capability
- High Avalanche rating
- Good high temperature capability
- Smallest packaged device footprints
- Low Costs at high volumes

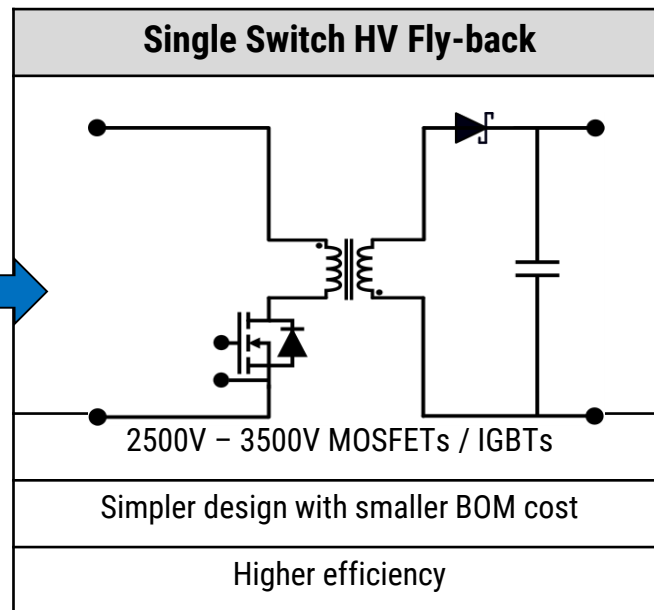
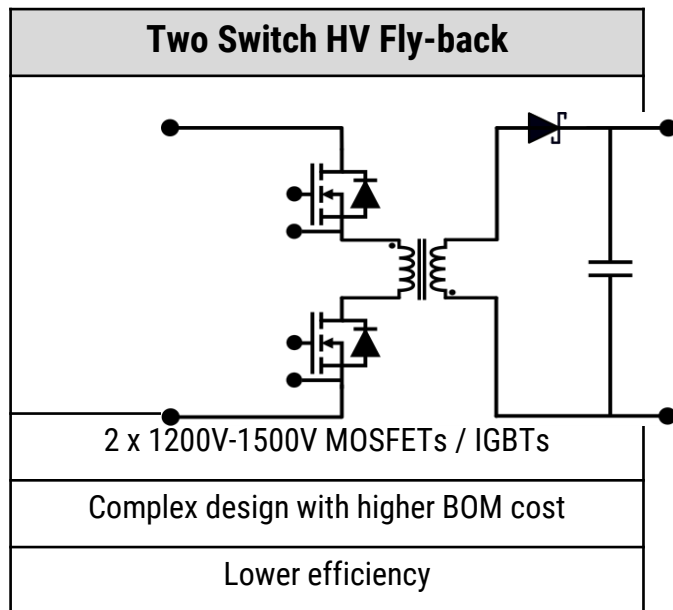
SiC MOSFET Design Considerations

- Low Drain-Source Resistance, $R_{DS,on}$
- Low Gate Charge, Input and Output Capacitances
- Robust Design for High Avalanche Ruggedness
- Low conduction loss at high temperatures
- Intrinsic diode with low reverse recovery charge
- Low Costs at high volumes

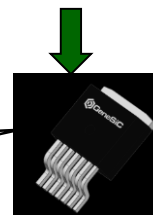


Standard DMOSFETs for highly uniform production and robust and reliable performance

Auxiliary SMPS – 1500 V DC Bus



G3R1000MT33J
3300V 1Ω SiC MOSFET
D2PAK-7L SMD (with Kelvin Source)

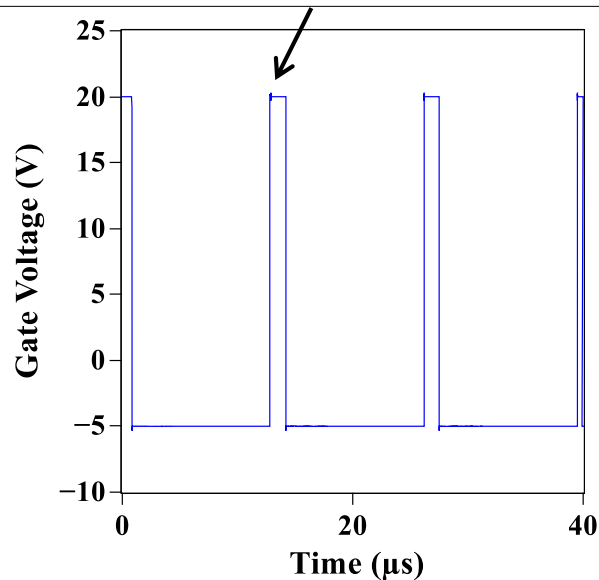
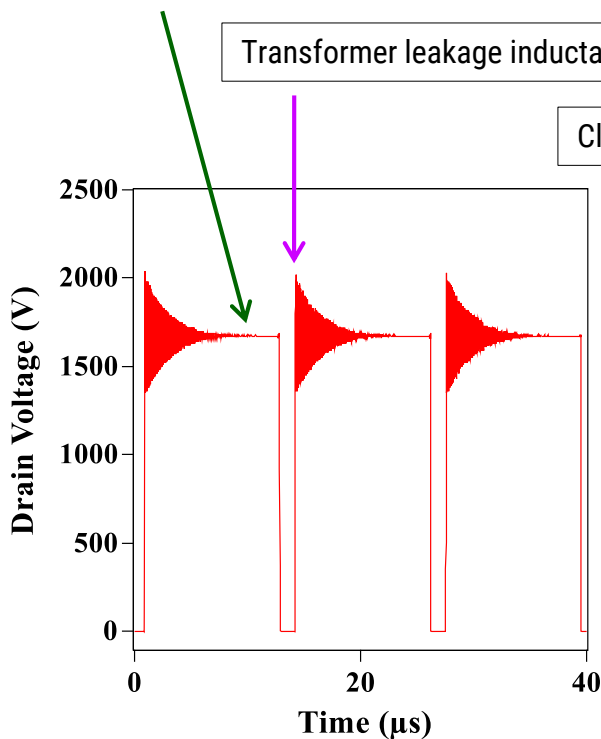


Single Switch Fly-back at 1500V DC

Voltage stress on switch (ideal) = $V_{IN,max} + N \cdot (V_{OUT} + V_{F,diode})$

Transformer leakage inductance introduces voltage overshoots of $\sim 0.3 \times V_{IN,max}$

Cleaner and faster switching by SiC MOSFET at 75 kHz



3300V 1 Ω SiC MOSFET v/s Competitors

	GeneSiC G3R1000MT33J (3300V 5A)	Competitor 1	Competitor 2	Competitor 3
Device Type	SiC MOSFET (Planar)	Si Power MOSFET	Si Power MOSFET	IGBT
V_{(BR)DSS}	3300V	3000V	2500V	2500V
Package	TO-263-7 (with Kelvin source)	TO-247-3 (HV)	TO-264-3	TO-268-2 / TO-247-3
T_j (Max)	175 °C	150 °C	150 °C	150 °C
I_D (25 °C)	5 A	4 A	5 A	5 A
R_{DS,ON} (25 °C)	1 Ω	12.5 Ω	8.8 Ω	V _{CE} > 3.5 V
R_{DS,ON} (150 °C)	2 Ω	34 Ω	23.5 Ω	V _{CE} > 4.5 V
Avalanche	≥ 3800 V	Yes	Yes	No
C_{iss}	450 pF	3680 pF	8560 pF	145 pF
C_{oss}	10 pF	177 pF	315 pF	8.7 pF
Gate Drive	+ 20 V / - 5 V	+ 10 V	+ 10 V	15 V
Distributor Price	~ \$20 / unit	~ \$51 / unit	~ \$48 / unit	~ \$17 to \$20 / unit

3300V SiC MOSFET Summary

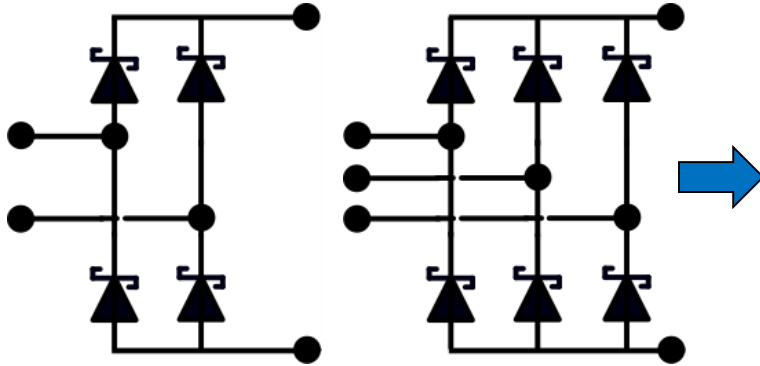
3300V 1 Ω SiC MOSFET based Fly-back converter

- High blocking voltage (≥ 3300 V) for fail-safe designs
- Higher avalanche ruggedness for simpler, rugged designs
- Low devices capacitances and faster switching times
- Low conduction and switching loss
- Higher current handling capability and cooler operation

Benefits to wide input (up to 1500 V DC) auxiliary SMPS –

- ✓ Simpler design with best-in-class reliability
- ✓ Elimination / reduced requirements of voltage clamps or snubber circuit
- ✓ Reduced the size and weight of magnetic components

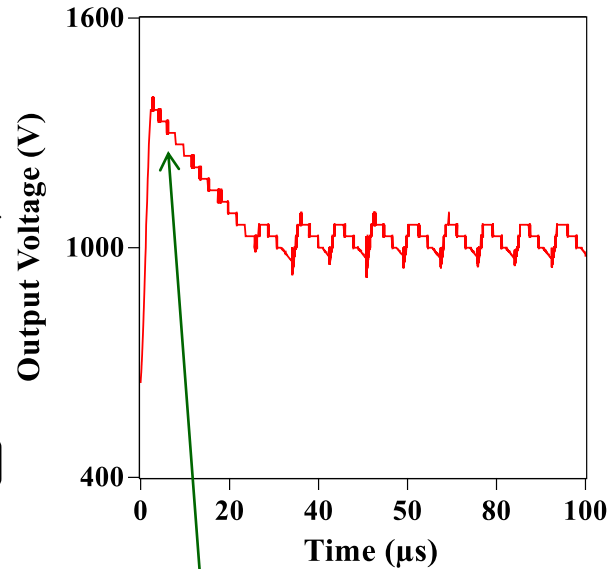
XFC Requirements



Passive rectification on the secondary side of isolated DC-DC converter

Design Requirements :

- 920V to 1000V Output Voltage (DC)
- Up to 1600V stress on rectifiers
- High avalanche capability
- High switching frequency (>40 kHz)



Voltage overshoots in some operating modes -
1400V to 1600V overshoots for 1000V
converters

Information provided by customer

1700V SiC Schottky MPS in XFCs

Features

- High blocking voltage (≥ 1700 V)
- Higher avalanche and surge ruggedness for simpler, rugged designs
- Zero reverse recovery
- Cooler operation

Benefits

- ✓ Simpler design with best-in-class reliability
- ✓ High switching frequency operation
- ✓ Reduced the size and weight of magnetic components

1700V and 3300V SiC Devices

SiC MOSFET

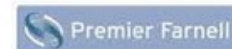
V_{DSS}	$R_{DS(on)}$	Bare Chip	T0-263-7	T0-247-3	T0-247-4
1700 V	1000 m Ω		G3R1000MT17J	G3R1000MT17D	
	45 m Ω	✓			G3R45MT17K
	20 m Ω	✓			G3R20MT17K
3300 V	1000 m Ω		G3R1000MT33J		
	350 m Ω		G3R350MT33J		
	120 m Ω	✓	G3R120MT33J		

SiC Schottky MPS

I_F	V_{RRM}	Bare Chip	T0-263-7	T0-247-2	SOT-227
5 A	1700 V		GB05MPS17-263	GB05MPS17-247	
10 A				GB10MPS17-247	
25 A		✓		GB25MPS17-247	
50 A				GB50MPS17-247	
100 A					GB2X50MPS17-227



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