



The DNA of tech.™

Future Mobility

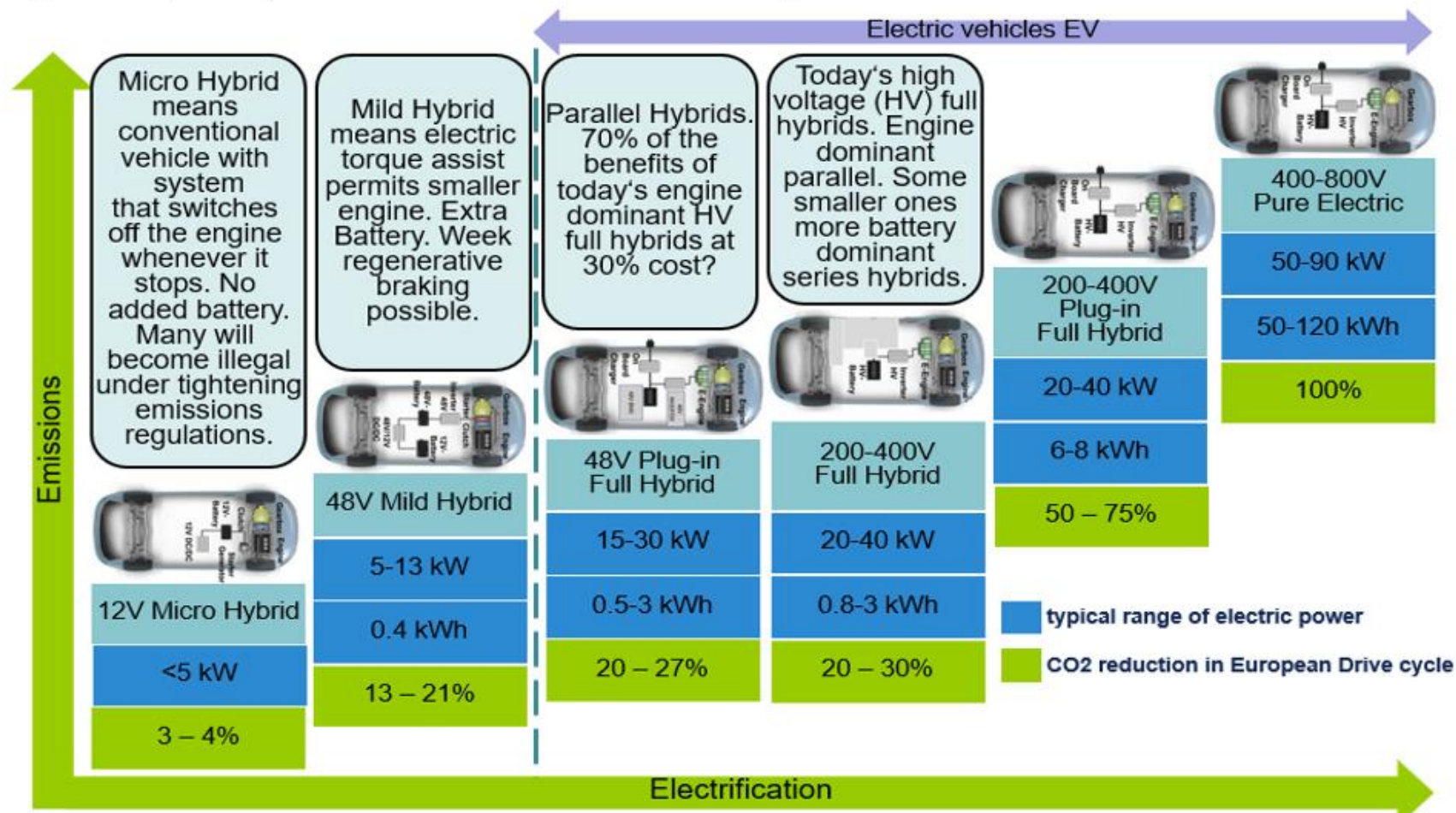
48V Power Net

Stefan Volkmann
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48V Power Net

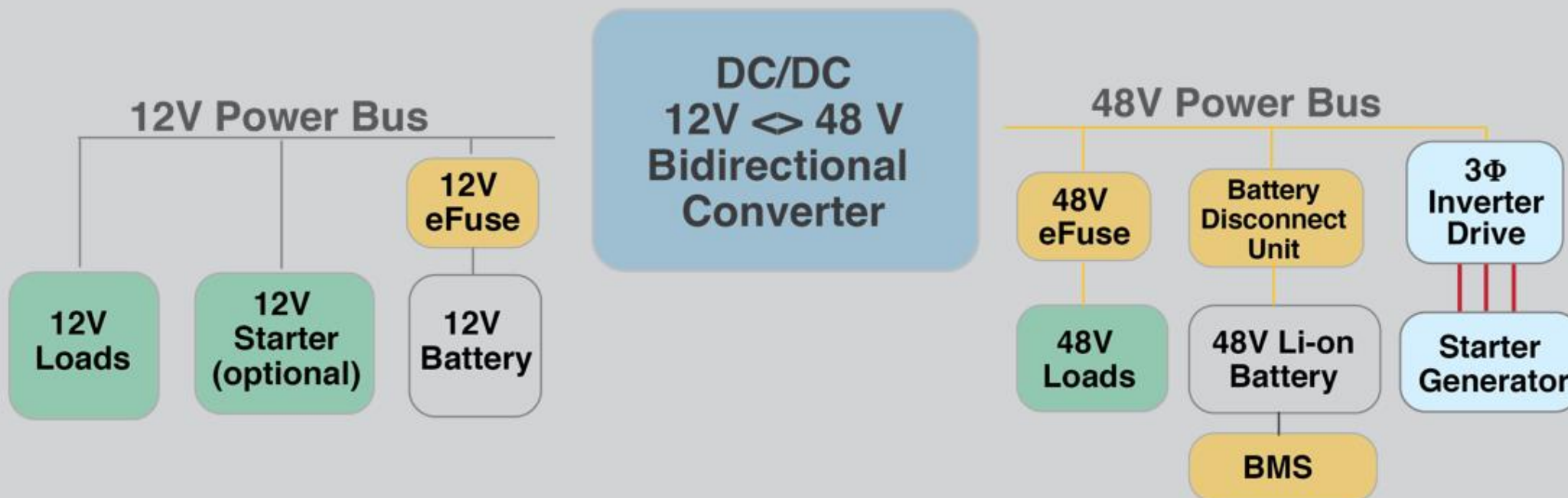
Powertrain Solutions Electrification Levels

48V MHEV (and 48V HEV) will dominate the market for the next years due to less safety regulation (< 60V). Moderate additional costs for large benefit!

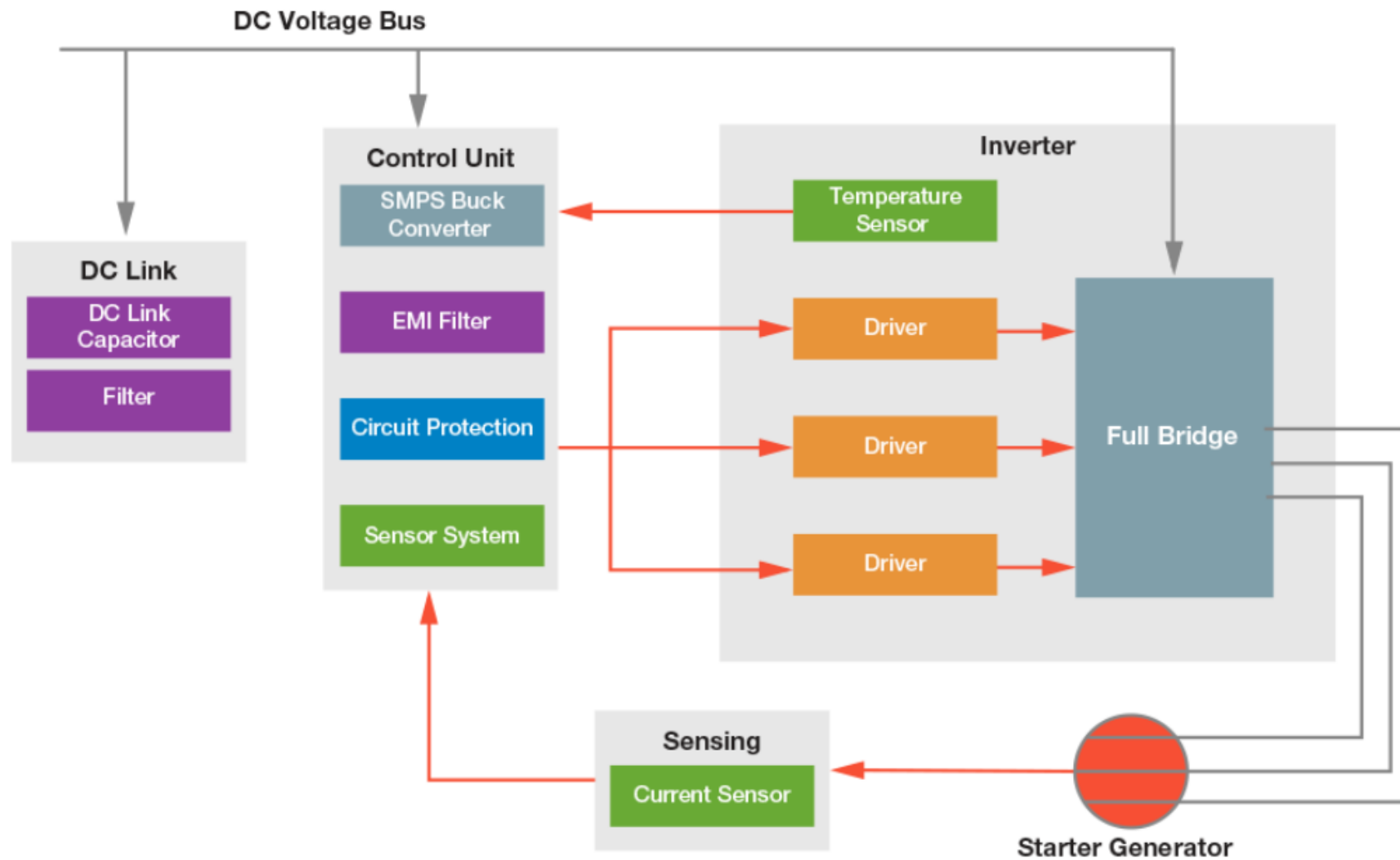


48V Applications

48 V Dual Board Net



Focus Application – 48V Powertrain Inverter

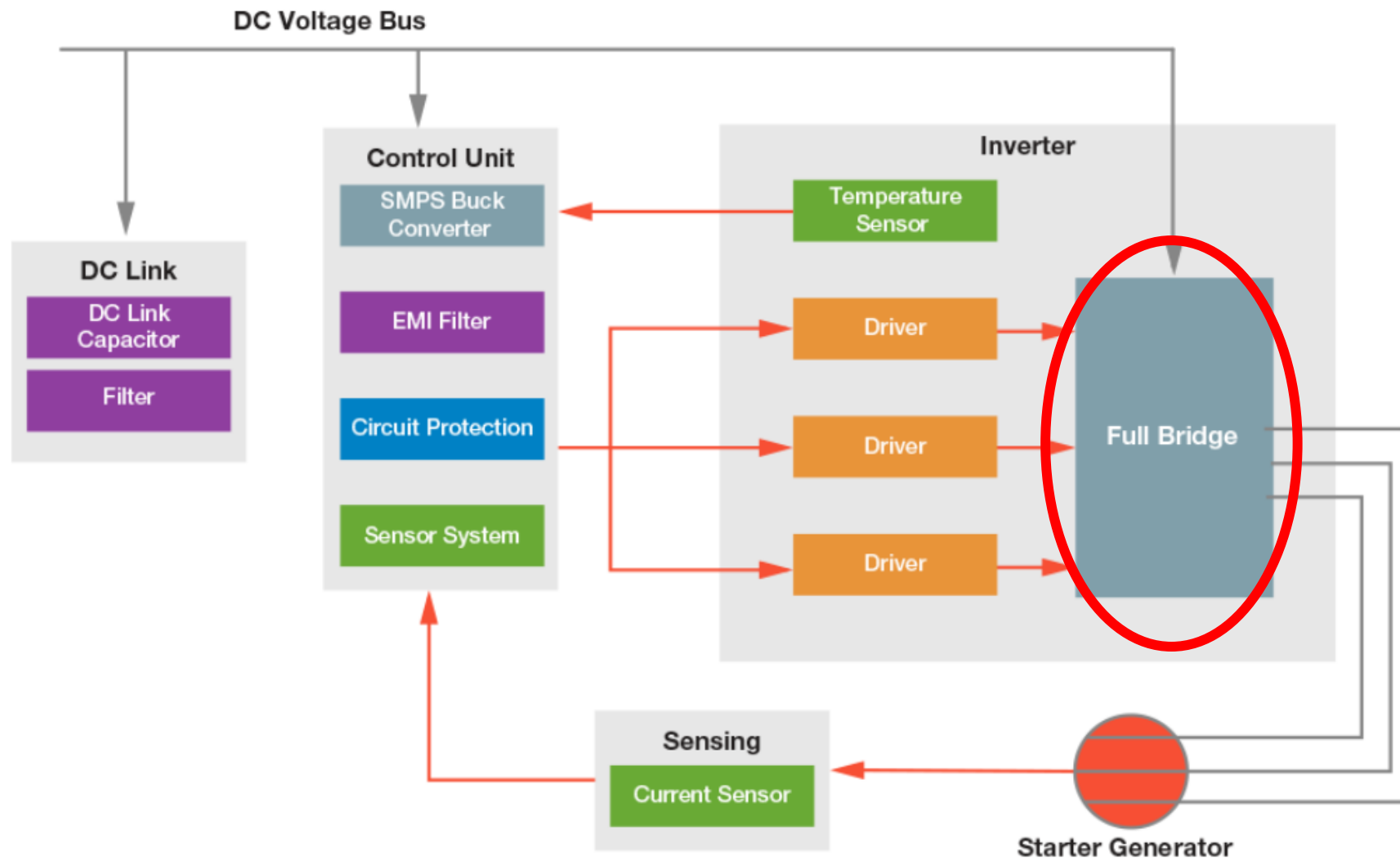




Full Bridge MOSFETs

48V Powertrain Inverter

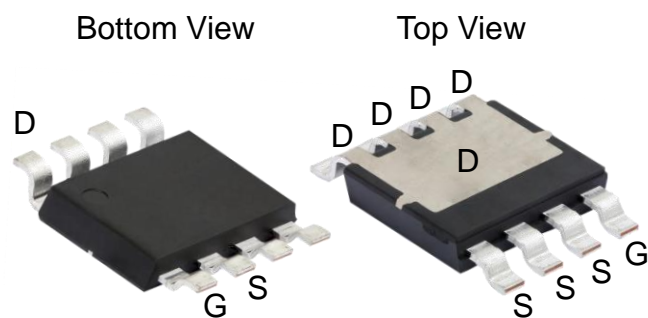
Focus Application – 48V Powertrain Inverter



PowerPAK® 8 X 8LR Package

Drain Pad on the Top Side

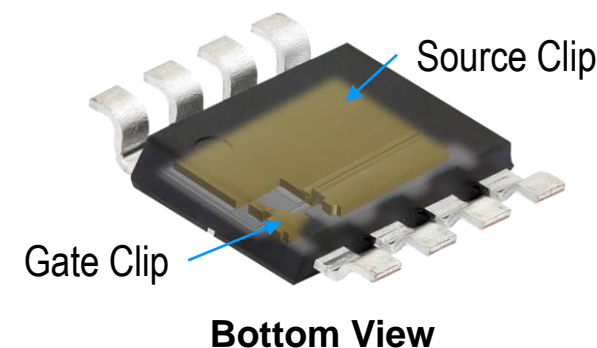
- Package footprint is 7.9 mm x 10.2 mm (Typical)
- The drain side are in the form of “reverse” gull-wing leads
- Ni plated top surface & Matt Sn plated leads
- Reversely formed source and gate leads match the orientation of drain pins



Increase Power Density
Optimized for top side Cooling
High Performance

Wire-Free Construction

- Interconnection for gate and source are clips
 - Very low electrical resistivity and parasitic inductance
- Same silicon die and electrical specification as their standard counterparts



Optimized for Heatsinking

- Gullwing leads designed for maximum mechanical stress relief
- Heat is dissipated straight to heatsink and directed away from PCB
- Relieve the heat transfer from PCB to housing or heatsink
- As PCB handles significantly less thermal transfer, the design utilizes smaller components or delivers higher output

Increase Power Density

- Removes vias needed on PCB area of the MOSFET
 - Reduces complexity and cost of PCB design
- 49% space reduction from TO-Leadless packages

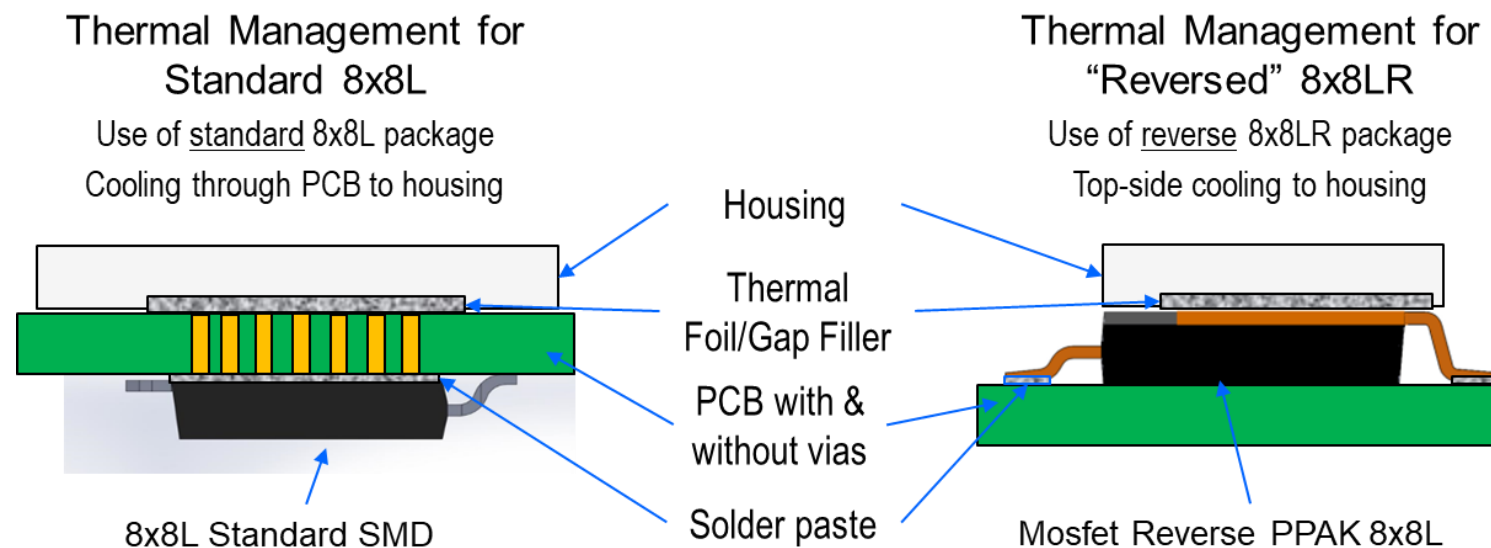


Thermal Transfer Path Comparison

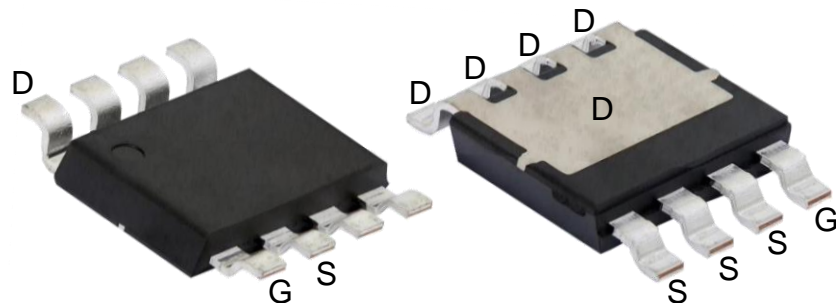
PowerPAK® 8x8L vs. PowerPAK® 8x8LR

Top side cooling of the MOSFET

- Heat is directly dissipated to heatsink, no vias needed in the PCB area of the MOSFETs
- Relieve the heat transfer from PCB to Housing → Helps to lower PCB Cost and simplify assembly
- Increased power dissipation is possible due to reduction of thermal resistance
- PCB is no longer the dominant thermal path, and the remaining components can be rescaled down
- The improved ΔT allows higher power out and power density



PowerPAK® 8x8LR – Top Side Cooled Products



Product Highlights:

- 40V 0.54 mΩ SQJQ140ER
- 100V 2.53 mΩ SQJQ112ER

Target Applications:

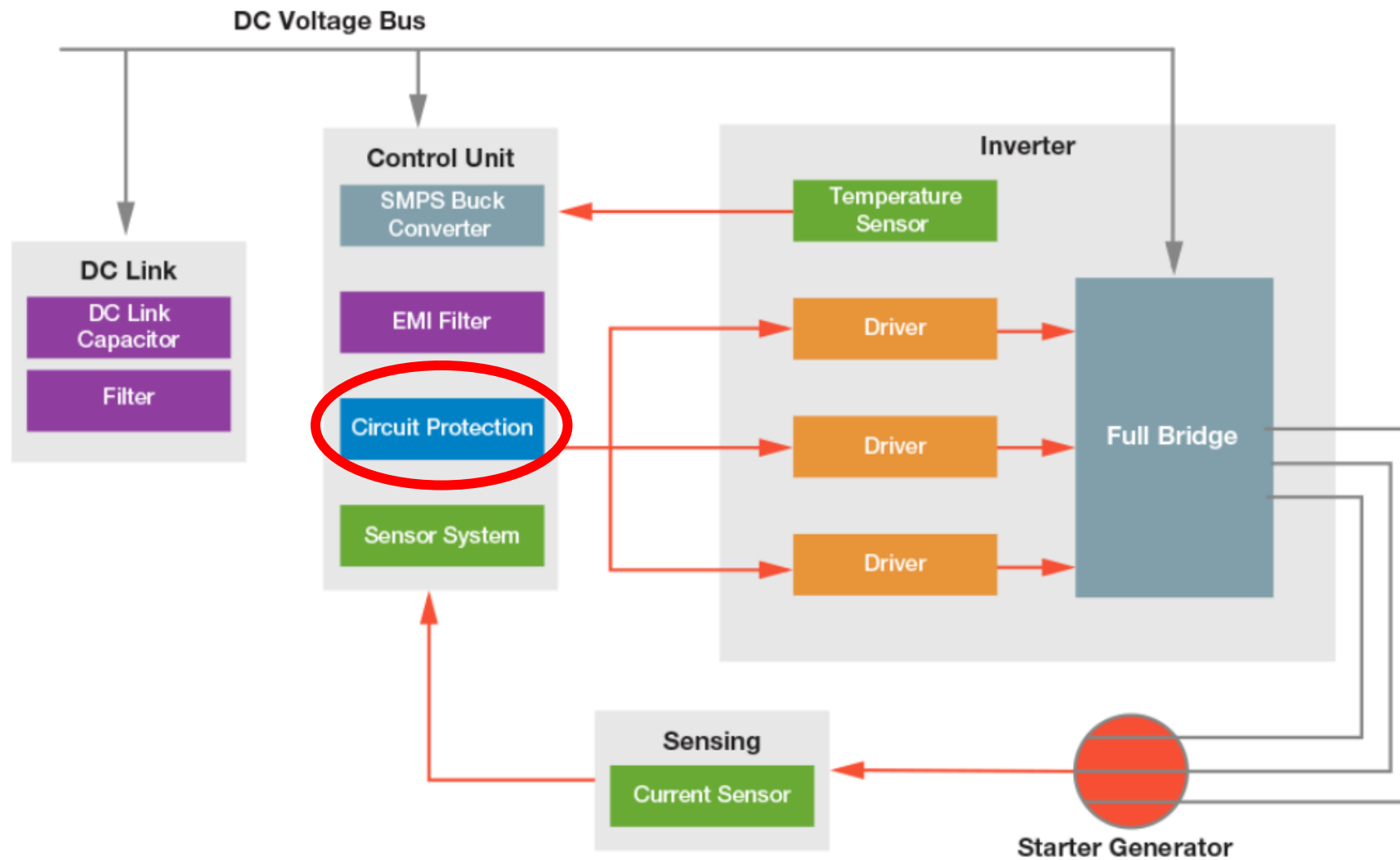
- Motor drive control
- Reverse polarity protection
- Battery management and load switching
- DC/DC converters

Datasheet PN	Polarity	V _{DS} (V)	V _{GS} (V)	R _{DS(ON)} (mΩ) Max @ V _{GS} =		V _{GS(th)} (V) Typ.
				10V	4.5V	
SQJQ140ER	N	40	±20	0.54	NA	2.8
SQJQ144AER	N	40	±20	0.9	NA	2.8
SQJQ142ER	N	40	±20	1.24	NA	2.8
SQJQ148ER	N	40	±20	1.5	NA	2.8
SQJQ184ER	N	80	±20	1.51	NA	2.8
SQJQ186ER	N	80	±20	2.3	NA	3.0
SQJQ112ER	N	100	±20	2.53	NA	2.6

Soft Clamping TVS Diodes

48V Powertrain Inverter

Focus Application – 48V Powertrain Inverter

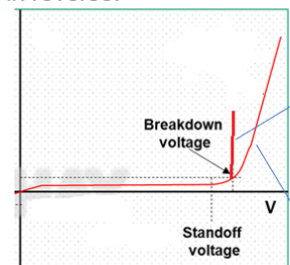


XClampR™ Transient Voltage Suppressor

- increasing requirements for protection diodes
- Based on the high power density also the protection circuitry needs to be adjusted
- XClampR™ offers low clamping voltages and high temperature stability
- equivalent to conventional 7kW TVS
- small SMC package

TVS characteristic in one quadrant (bidirectional device are symmetrical)

- TVS is a special Zener diode that could work in avalanche with very high instantaneous power, and it is designed to carry very high current in reverse.

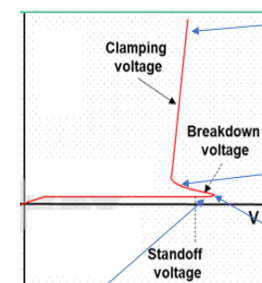


- Zener diode characteristic has voltage in avalanche region more “precise” (stable with temperature and current) but is not allowed large current real Zener diode can works only with small current (in general less than 1A).

- TVS has voltage characteristic less precise that conventional Zener diode because the structure is optimized to dissipate a large amount of energy and TVS can works in avalanche region with current very high (peak pulse current can be more that 1000A the limit is thermal! not structure).

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XClampR® characteristic (bidirectional device are symmetrical)

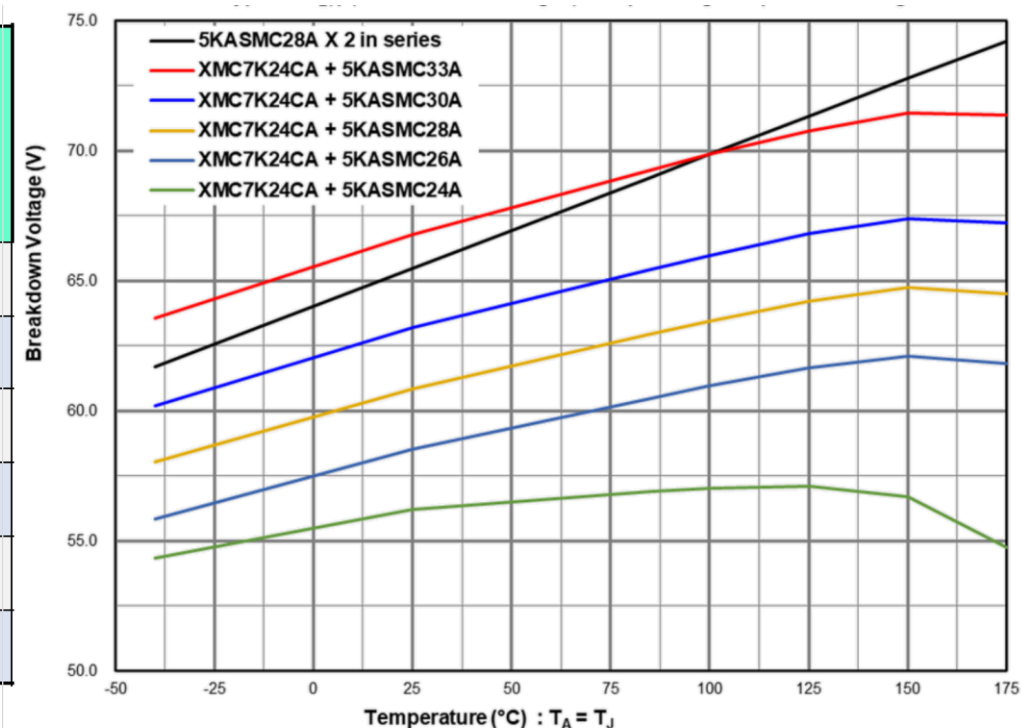


- XClampR® show clamping voltage lower than Breakdown voltage. Conventional TVS has clamping voltage always higher than Breakdown voltage.
- After turn on there is region with negative resistance that guarantee the maximum protection of circuit.
- The breakdown voltage is not the voltage where test current reach 1mA but where start the negative resistance zone
- At stand off voltage leakage is low and stable with temperature.

XClampR™ Transient Voltage Suppressor

P/N	Stand-off voltage (V)	Clamping voltage (V) at 30 A, 25 °C T _A t _d = 10 ms I _{PP} /2
5KASMC28A X 2 in series	56	83.0
XMC7K24CA + 5KASMC33A	57	72.0
XMC7K24CA + 5KASMC30A	54	68.0
XMC7K24CA + 5KASMC28A	52	65.0
XMC7K24CA + 5KASMC26A	50	62.0
XMC7K24CA + 5KASMC24A	48	60.0

- XMC7K24CA with 5KASMC series.
- Stable breakdown V_{BR} over a wide temperature range.
- Stable clamping voltage V_C .
- Low clamping voltage ratio.

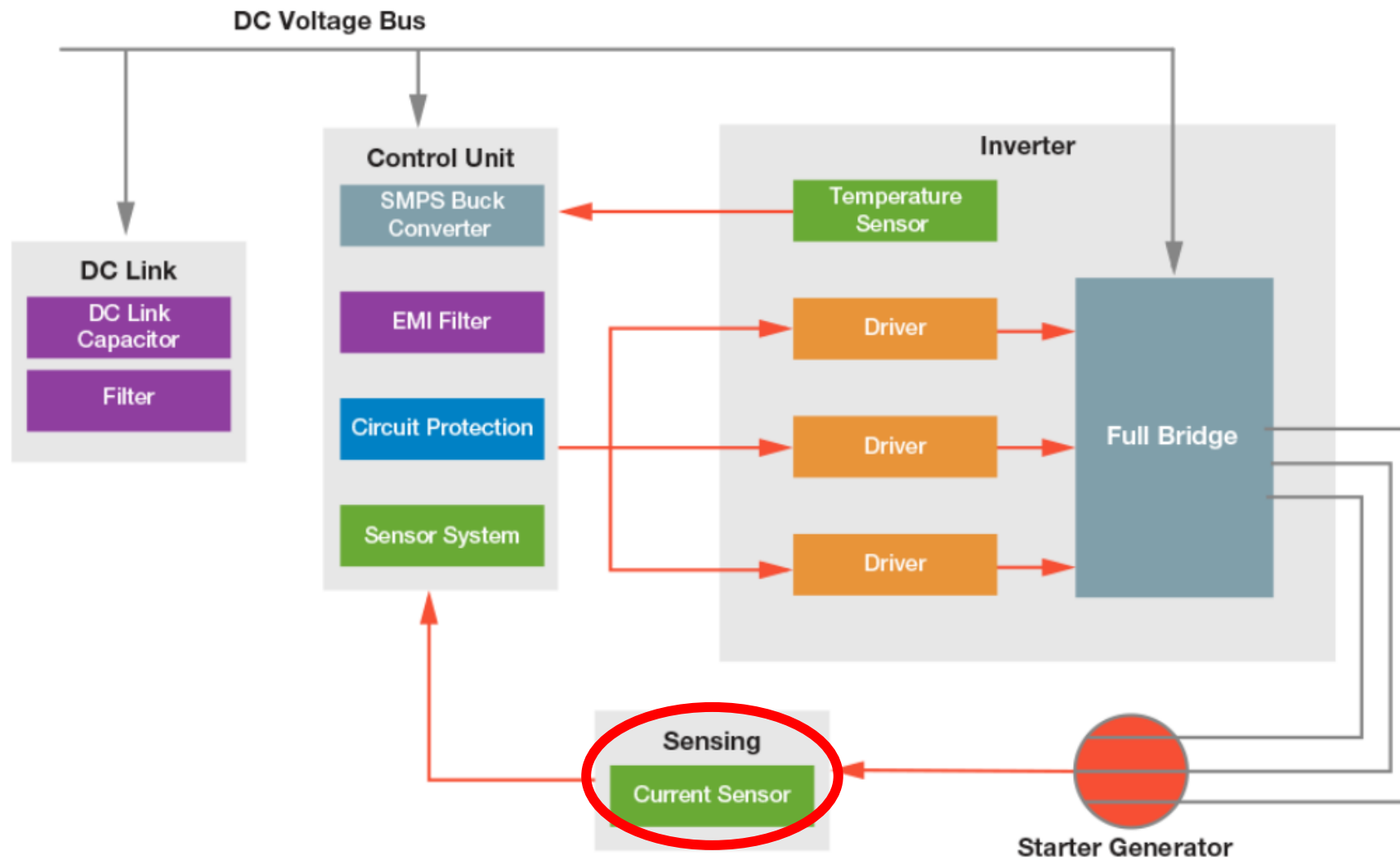


XMC7K24CA & 5KASMC series combination
Typical breakdown voltage in function of temperature.

Current Sensing Shunt Resistors

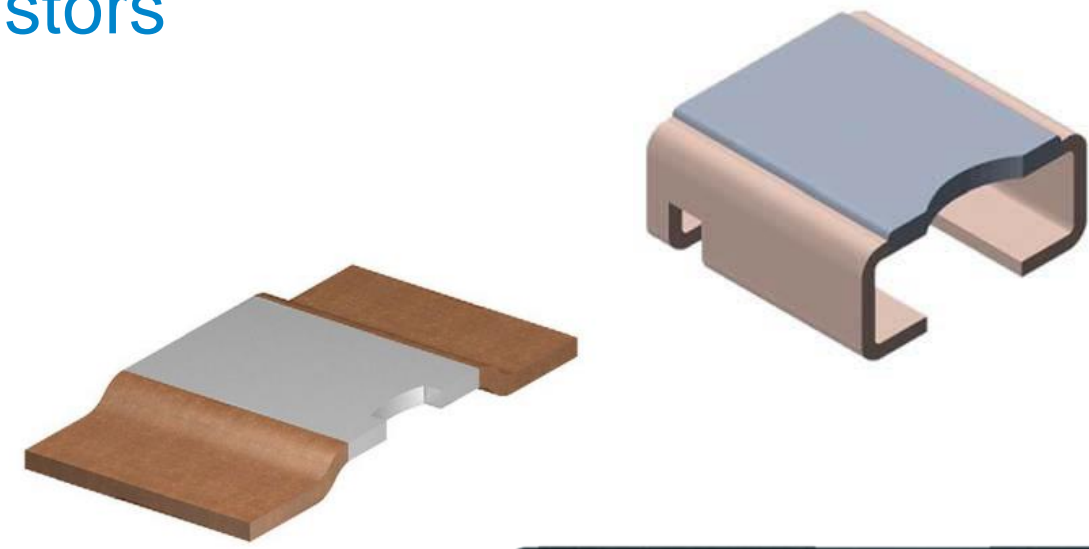
48V Powertrain Inverter

Focus Application – 48V Powertrain Inverter



Low ohmic current sense resistors

- WSLP2726 rated 2W to 12W
 - very low resistance down to 0.2mΩ
- WSLP5931 rated 5W
 - very low resistance down to 0.2mΩ



Advantages	Benefits
High power density	Power density > 200 W/in ² enables compact high power designs
Low resistance values	Low power dissipation, improved power efficiency
Low TCR	Better stability with temperature / applied power
Pulse Capability	Robust, fault-tolerant designs

VISHAY Power Metal Strip® Overview of Power & Packages

High Power Density

< 50mm² Board Space > 50mm² Board Space

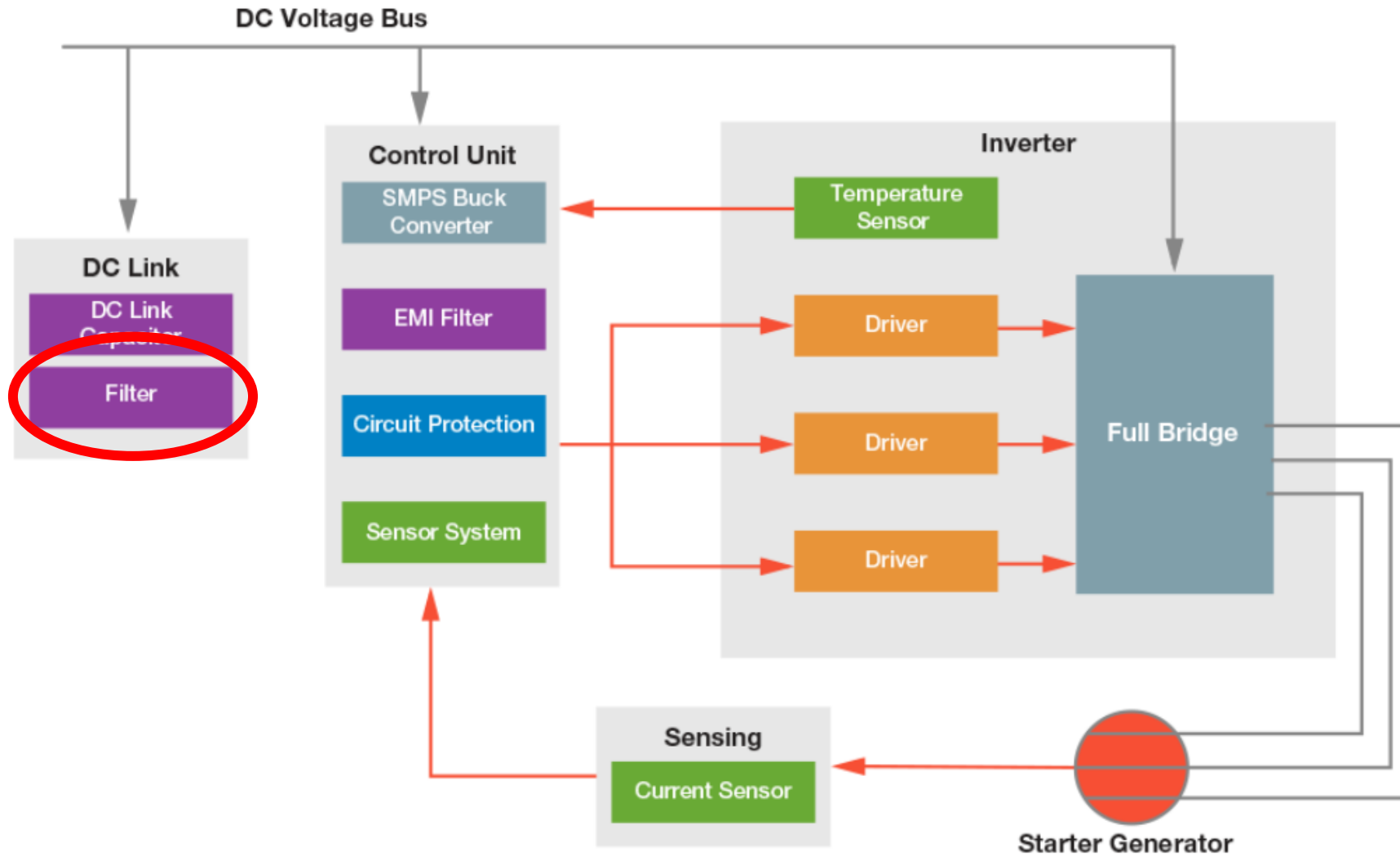
- Broad Resistance Range (0.0001Ω to 1.0 Ω)
- Many power ratings (0.4W to 15W)
- High temperature performance (up to 275°C)
- Tight tolerances (down to 0.1%)
- Low TCR (down to ±30 ppm/K)
- Excellent Overload Capability



Filter Inductors

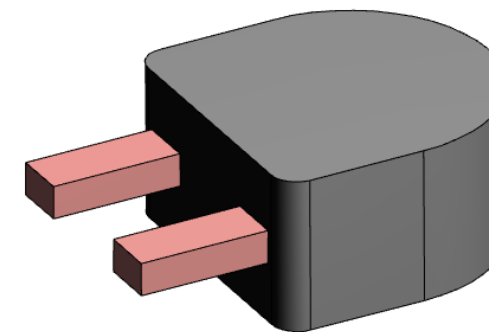
48V Powertrain Inverter

Focus Application – 48V Powertrain Inverter

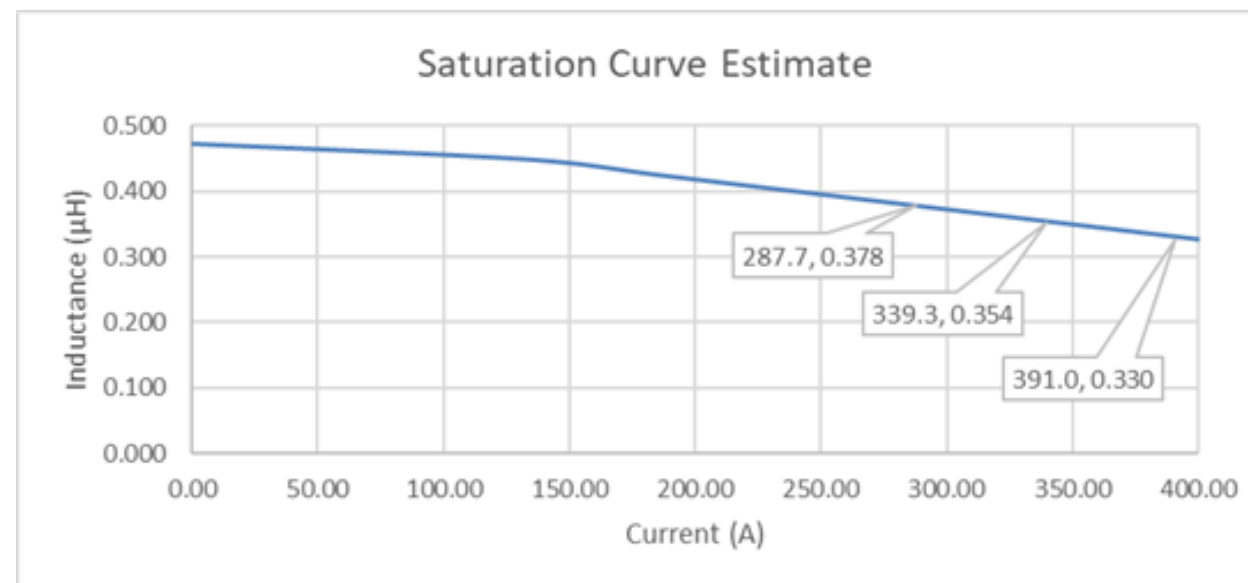


IHXL1100 High Current Inductor

- Inductance 470nH
- DCR = 0.12mΩ typ. and 0.14mΩ max.
- Heat rating current (+40°C) = 138A
- Saturation Current (-20%) = 285A
- Saturation Current (-30%) = 387A
- Very high current capability in very small form factor (approx 30mm x 30 mm x 15mm)



- Iron powder core with soft saturation:
 - stable behavior also in worst case situation
 - temperature stable



IHLP® Power Inductors

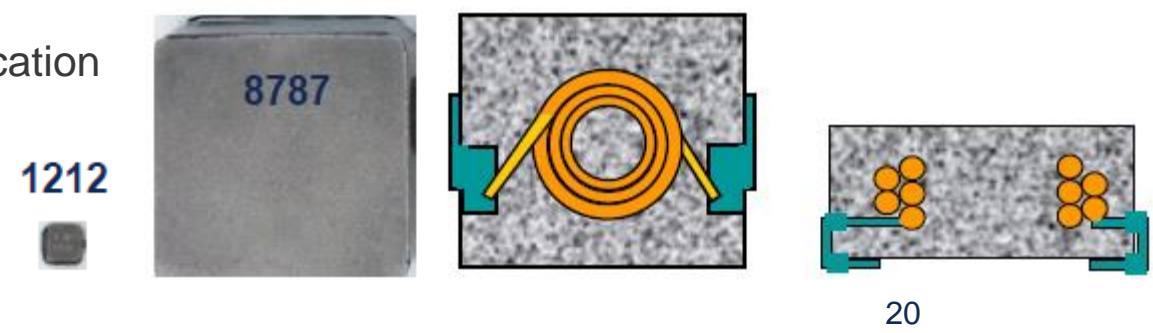
- Technology
 - Metal Composite Inductor with Lead-Frame Design

- Advantages
 - Provides smallest footprint/profile combination for inductance range of 47nH to 100µH
 - Excellent DC current saturation characteristics
 - Excellent temperature stability for Inductance, Core Loss and Saturation
 - Available in HighTemp (up to 180°C) and AEC-Q200

- Market & Applications
 - Automotive, Industrial, AMS, Telecommunication
 - DC/DC Converter
 - Signal Filtering

Quick Facts

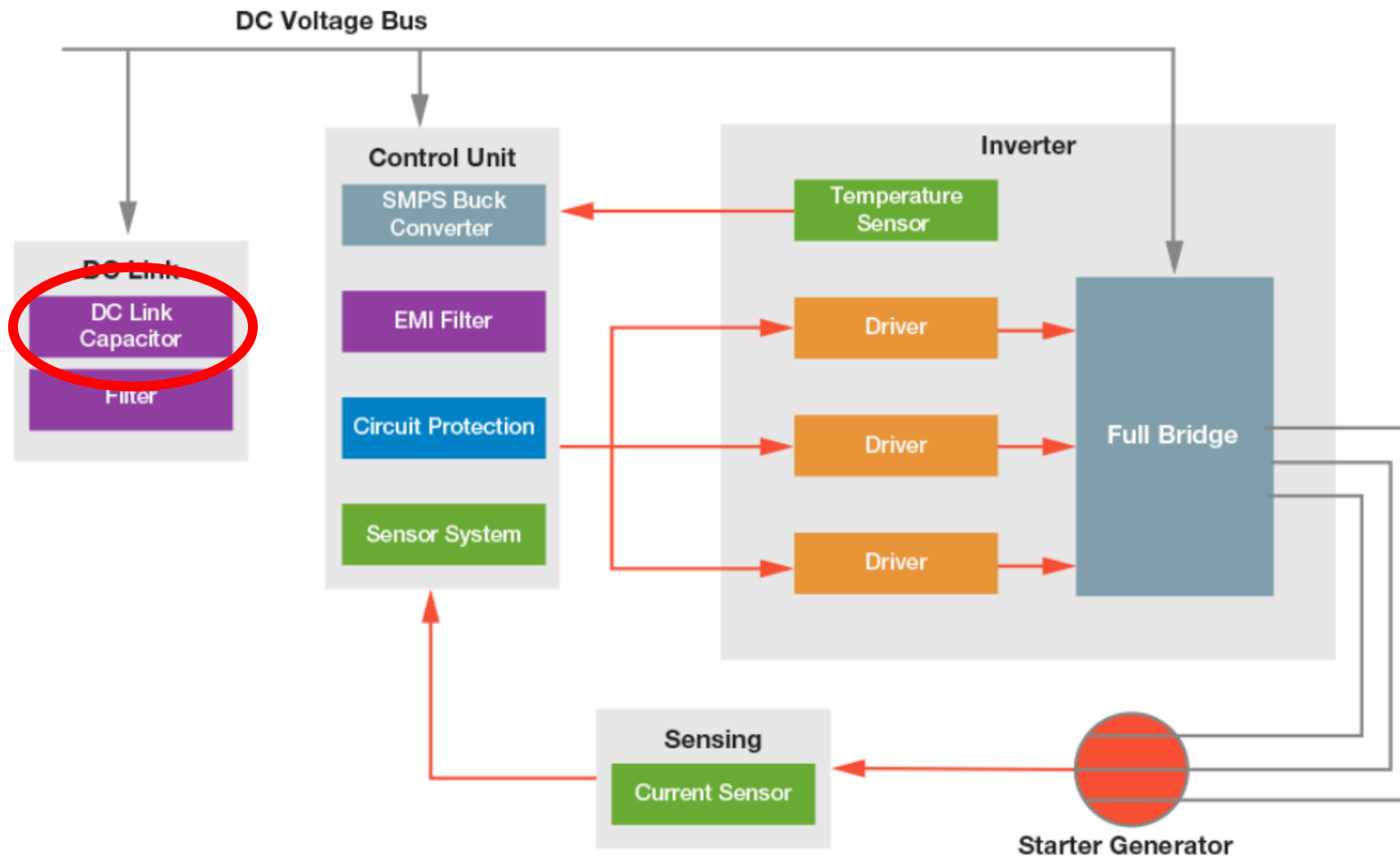
- **Case Size:**
3mm x 3mm –
12mm x 12mm
- **Profile:**
0.9mm – 13mm
- **Inductance:**
47nH – 100µH
- **Frequency:**
0.1MHz – 5MHz



DC Link Capacitors

48V Powertrain Inverter

Focus Application – 48V Powertrain Inverter



MKT1820 Polyester Film Capacitor

FEATURES

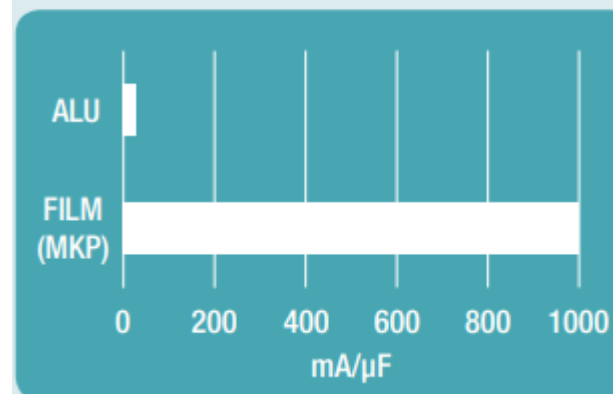
- AEC-Q200 qualified (rev. D) for PCM ≤ 27.5 mm (for larger available components on request)
- High temperature capabilities, up to 150 °C
- Capacitance up to 560 μ F
- 4-pin version available under request for pitch ≥ 37.5 mm, under request
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

- Automotive
- DC filtering
- Low voltage DC link



FILM CAPACITOR RIPPLE CURRENT CAPABILITY VS. ALUMINUM ELECTROLYTICS



QUICK REFERENCE DATA

Capacitance range	1000 pF to 560 μ F
Capacitance tolerance	± 20 %, ± 10 %, ± 5 %
Climatic testing class according to IEC 60068-1	55/125/56
Maximum application temperature	125 °C
Reference standards	IEC 60384-2
Dielectric	Polyester film
Electrodes	Metallized

Thank you for your Attention.