

SiC Engagement Plan



A Leading Provider of Smart, Connected and Secure Embedded Solutions



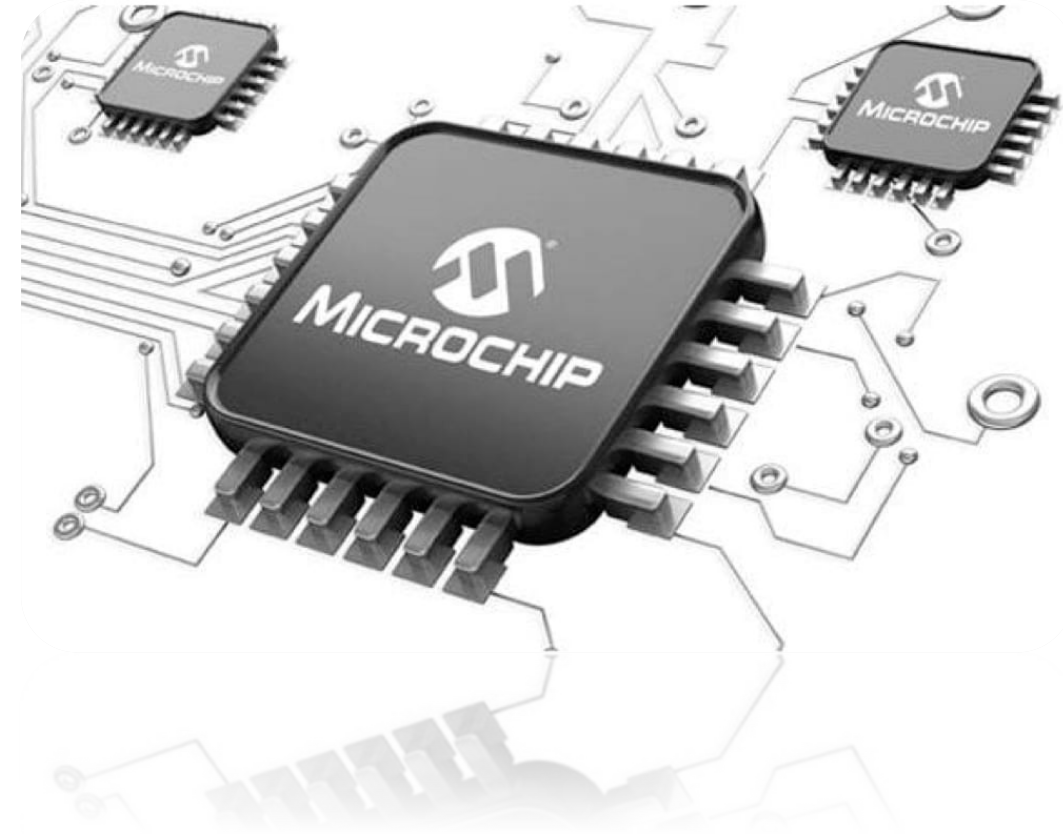
SMART | CONNECTED | SECURE

Calvin, Jacky, Power ESEs

June 15th, 2022

Agenda

- **Recap: GC Disty Training About SiC**
- **SiC Call-to-action:**
 - Hight Voltage Aux Power Supply with SiC
 - Replace Relay By eFuse with SiC
 - High Voltage / High Power Applications



GC Disty Training About SiC



A Leading Provider of Smart, Connected and Secure Embedded Solutions



SMART | CONNECTED | SECURE

Edward Lee
May 19th, 2022

Insight Update

DPM/SiC

[SiC Lead Time Support Package - Microchip - June 2021 - v3.0.pdf](#)

- **Facing SiC Supply Challenges? Client Outreach**

- Many SiC users report lead times for SiC power devices over 52 weeks, but not if they are using Microchip SiC.
- Our SiC devices offer unrivaled ruggedness and performance, and our delivery times are short – ensuring our clients maintain development schedules and successfully support existing programs.

SiC Device Cross Reference Guide







Insight Update

DPM/SiC

- **3.3 kV SiC Devices To Be Announced at APEC on March 21st**
 - These 3.3 kV MOSFETs and SBDs further expand our comprehensive portfolio of SiC solutions that include 700V, 1200V and 1700V die, discretes, modules and digital gate drivers.

SiC Portfolio: 700V – 3.3 kV Devices

Product Family	Packaging	Key Differentiation
Die		Unrivalled Ruggedness and Performance
Discretes		Widest Breadth
Modules		Lowest Inductance Standard and Custom Tailored
Gate Drivers		Fastest to Market Highest Efficiency

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3.3 kV SiC MOSFETs and Diodes Package and Die Options

Device Type	Part Number	Voltage (V)	R _{DS(on)} (mOhm)	Current (A)	Package
SiC MOSFET	MSC025SMA330D/S	3300	25	104	Die
SiC MOSFET	MSC025SMA330B4	3300	25	104	TO-247-4L
SiC MOSFET	MSC027SMA330D/S	3300	27	104	Die
SiC MOSFET	MSC080SMA330D/S	3300	80	43	Die
SiC MOSFET	MSC080SMA330B4	3300	80	43	TO-247-4L
SiC MOSFET	MSC400SMA330D/S	3300	400	8	Die
SiC MOSFET	MSC400SMA330B4	3300	400	8	TO-247-4L
SiC SBD	MSC030SDA330D/S	3300	-	30	Die
SiC SBD	MSC030SDA330B	3300	-	30	TO-247-2L
SiC SBD	MSC090SDA330D/S	3300	-	90	Die
SiC SBD	MSC090SDA330B2	3300	-	90	T-MAX (-2L)



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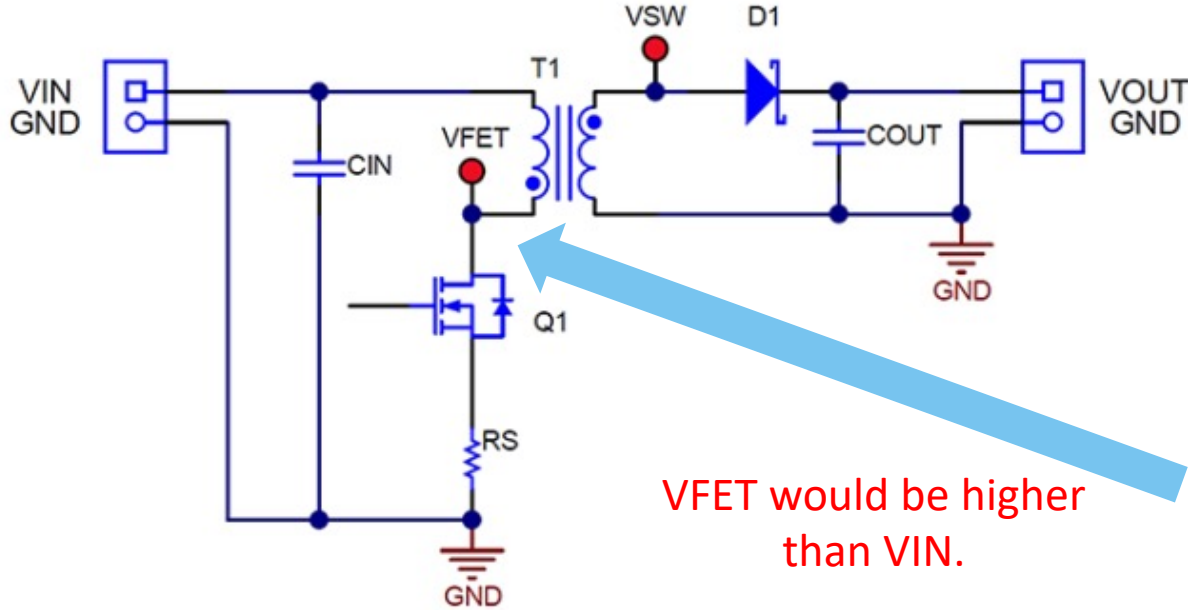
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High Voltage Aux Power Supply with SiC

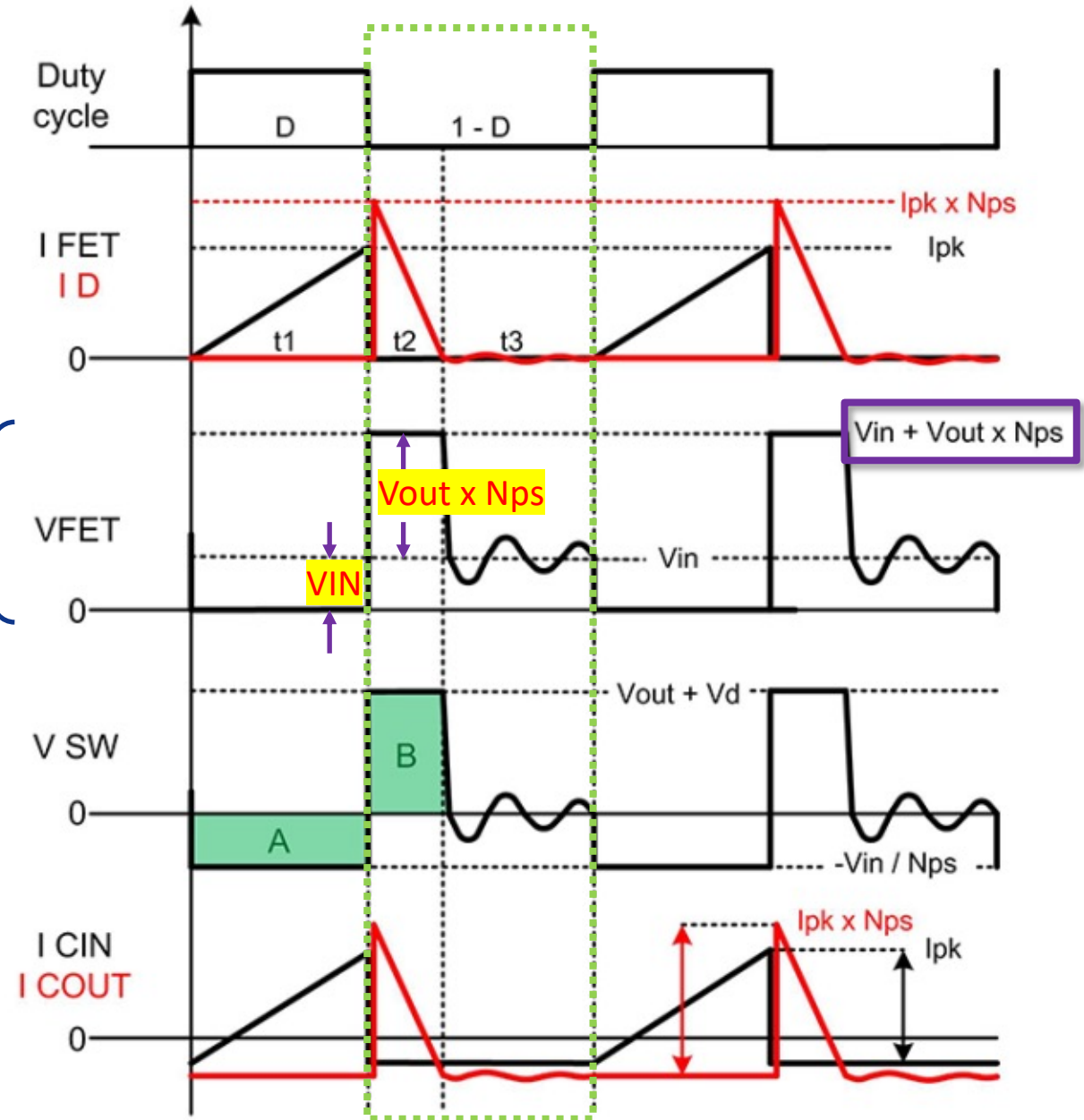
Focusing With Power KGI

Flyback Aux PS



You might have few questions:

- Why focuses Aux PS?
- Why needs high voltage MOSFET?
- Why Microchip SiC MOSFET?
- What target applications?

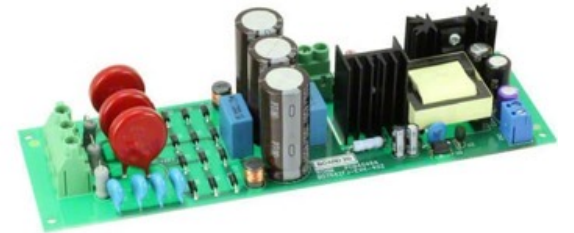
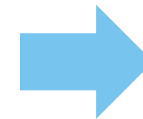
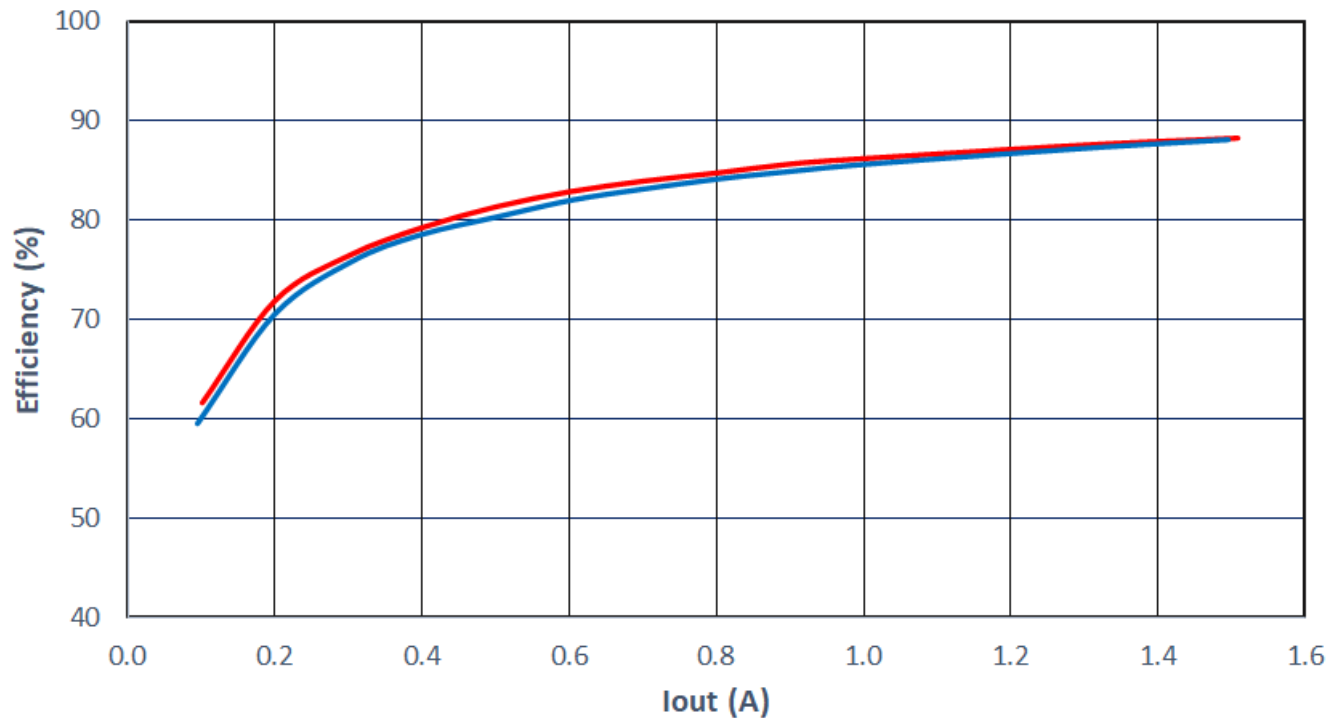


Competing Products for AuxPS (Replacing Si By SiC device)

	Part Number (datasheet linked)	R _{DSon} at T _j = 25 C (Typ/Max)	Package	Support materials?
ST Micro Silicon MOSFET	STW12N170K5	2.3 ohm/2.9 ohm	TO-247-3	<ul style="list-style-type: none"> App note Evaluation board
Microchip SiC MOSFET	MSC750SMA170B	750 mohm/ 940 mohm	TO-247-3	<ul style="list-style-type: none"> PLECS model
Wolfspeed SiC MOSFET	C2M1000170J	1000 mOhm / 1400 mOhm	TO-263-7	<ul style="list-style-type: none"> App note PLECS model Reference design
	C2M1000170D		TO-247-3	
Infineon SiC MOSFET	IMBF170R450M1	364 mOhm / 390 mOhm	TO-263-7	<ul style="list-style-type: none"> App note Evaluation board
	IMBF170R650M1	526 mOhm / 580 mOhm	TO-263-7	
	IMBF170R1K0M1	809 mOhm / 880 mOhm	TO-263-7	
Rohm SiC MOSFET	SCT2750NY	750 mOhm / 975 mOhm	TO-268-2	<ul style="list-style-type: none"> App note Evaluation board
	SCT2H12NY	1150 mOhm / 1500 mOhm	TO-268-2	
	SCT2H12NZ		TO-247-3	
Littelfuse SiC MOSFET	LSIC1MO170E1000	750 mOhm / 1000 mOhm	TO-247-3	<ul style="list-style-type: none"> App note
United SiC SiC JFET	UF3C170400K3S	410 mohm	TO-247-3	<ul style="list-style-type: none"> App note Evaluation board

Better Performance With Lower Price

- **Verify our devices are drop-in ready in competitors' ref designs**
 - Target: Clients already in production or design-in stage with competitors, but suffering long lead time



Why Microchip in the HV AuxPS Socket?

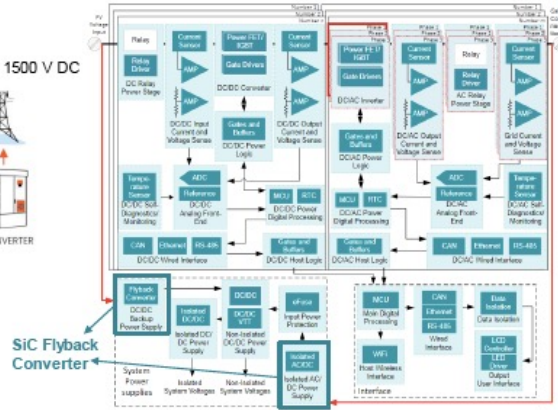
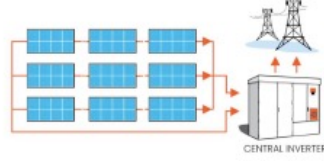
- Exciting opportunity for **near-term revenue!**
 - Microchip SiC lead times are much better than competitors quoting 40+ weeks
 - EV traction does not use 1.7 kV, so this product is even more vulnerable to lead time issues
- **High-volume socket**
 - HV flyback power supplies are ubiquitous – charging infrastructure, motor drives, central/string solar inverters, UPS and SMPS, and even automotive
 - There are dozens of customers who will EACH buy 500K pcs to 2M pcs per year
- **Better performance and lower price (!)** compared with the incumbent silicon solution
- **Few resources required** due to simple design and established solutions
- **Helps us reduce SiC prices** by driving more wafers through the fab using a small die with high yield

HV Aux PS in...

Aux power supplies in central PV inverter

Where:

- Typical power levels of 20 W to 150 W
- Operating input voltage range: 1000 V to 1500 V DC



Why SiC?

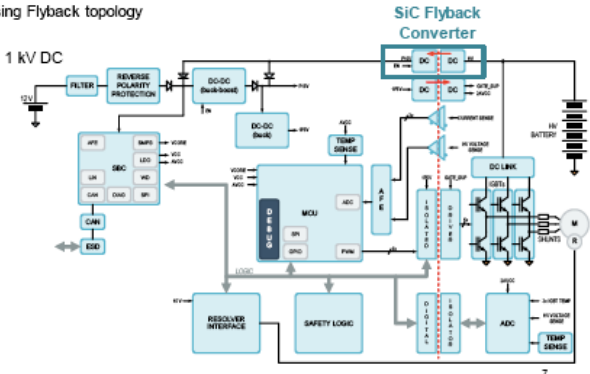
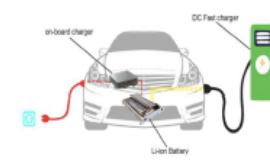
- Higher VDS rating (1700 V SiC)
- High efficiency

TEXAS INSTRUMENTS

Aux power supply in traction inverter of EV

Where:

- Redundant/back-up power supplies using Flyback topology
- Typical power levels of 10 W to 20 W
- Operating input voltage range: 50 V to 1 kV DC



Why SiC?

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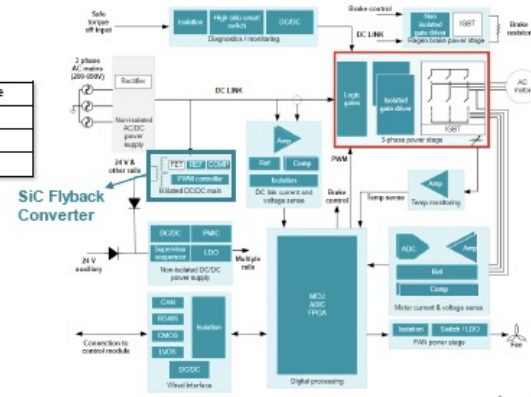
TEXAS INSTRUMENTS

Aux power supply in AC motor drive

Where:

- Typical power levels of 20 W – 60 W
- Operating input voltage range:

Grid voltage	Input voltage range
200 vac, 3phase	100 V – 400 V
380 – 480 vac, 3phase	200 V – 820 V
525-690 vac, 3phase	300 V – 1130 V



Why SiC?

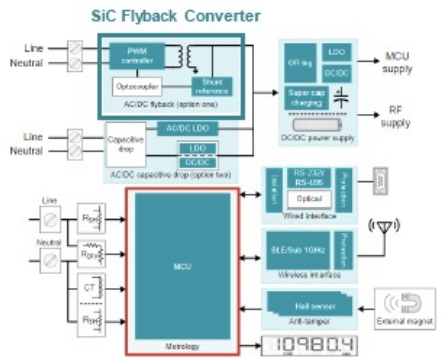
- Higher VDS rating
- Removal of heatsink

TEXAS INSTRUMENTS

Aux power supply of electricity meter

Where:

- Typical power levels of 15 W – 20 W
- Operating input voltage range: 300 V to 950 V DC



Why SiC?

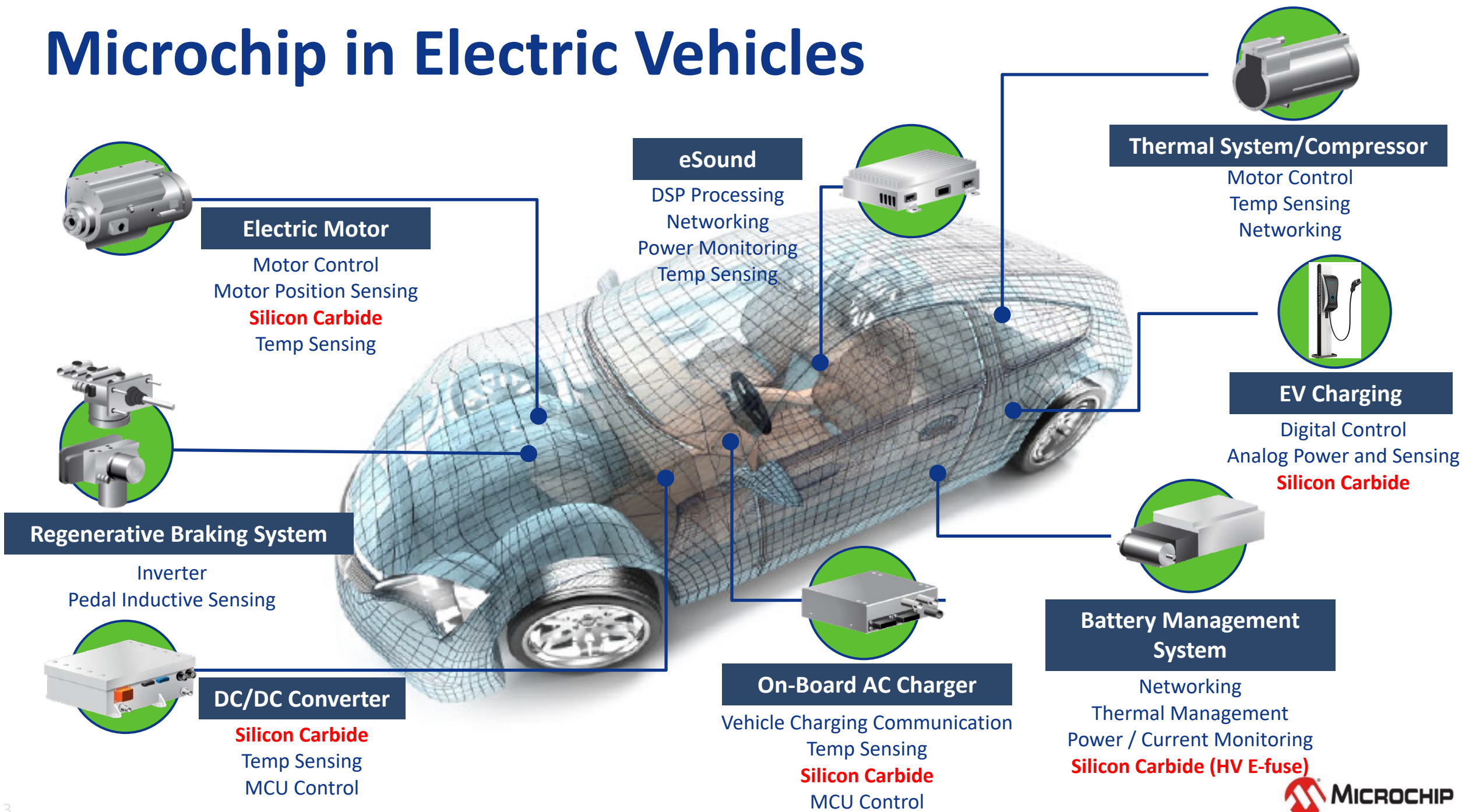
- Higher VDS rating

TEXAS INSTRUMENTS

eFuse with SiC

Focusing With Power KGI

Microchip in Electric Vehicles



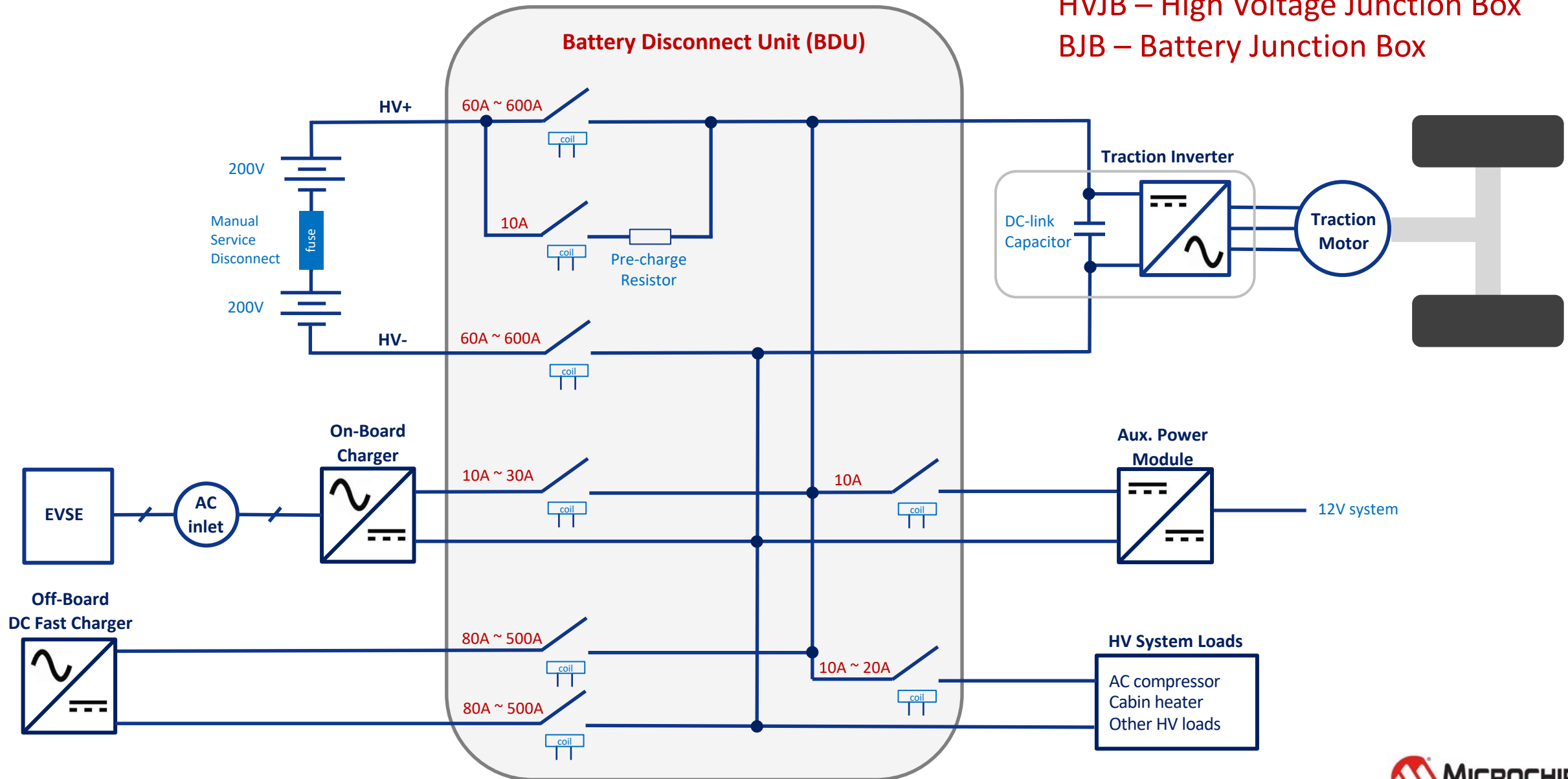
Electric Vehicle High Voltage Relays

- Relays and contactors in EV high voltage propulsion, charging and accessory systems
- Currents range from 10's to 100's of Amps, continuous and pulsed loads
- Predominantly 400 V battery systems
 - Move to 800V anticipated over next 3-5 years
- **On-board applications**
 - Main contactors
 - Pre-charge relay
 - OBC relays
 - Accessory relays
 - DC fast charger contactors
- **Off-board applications**
 - Electric vehicle supply equipment (Level 1 charging)
 - Charging stations (Levels 2 and 3 charging)



EV Battery Disconnect Unit

BDU – Battery Disconnect Unit
PDU – Power Distribution Unit
HVJB – High Voltage Junction Box
BJB – Battery Junction Box

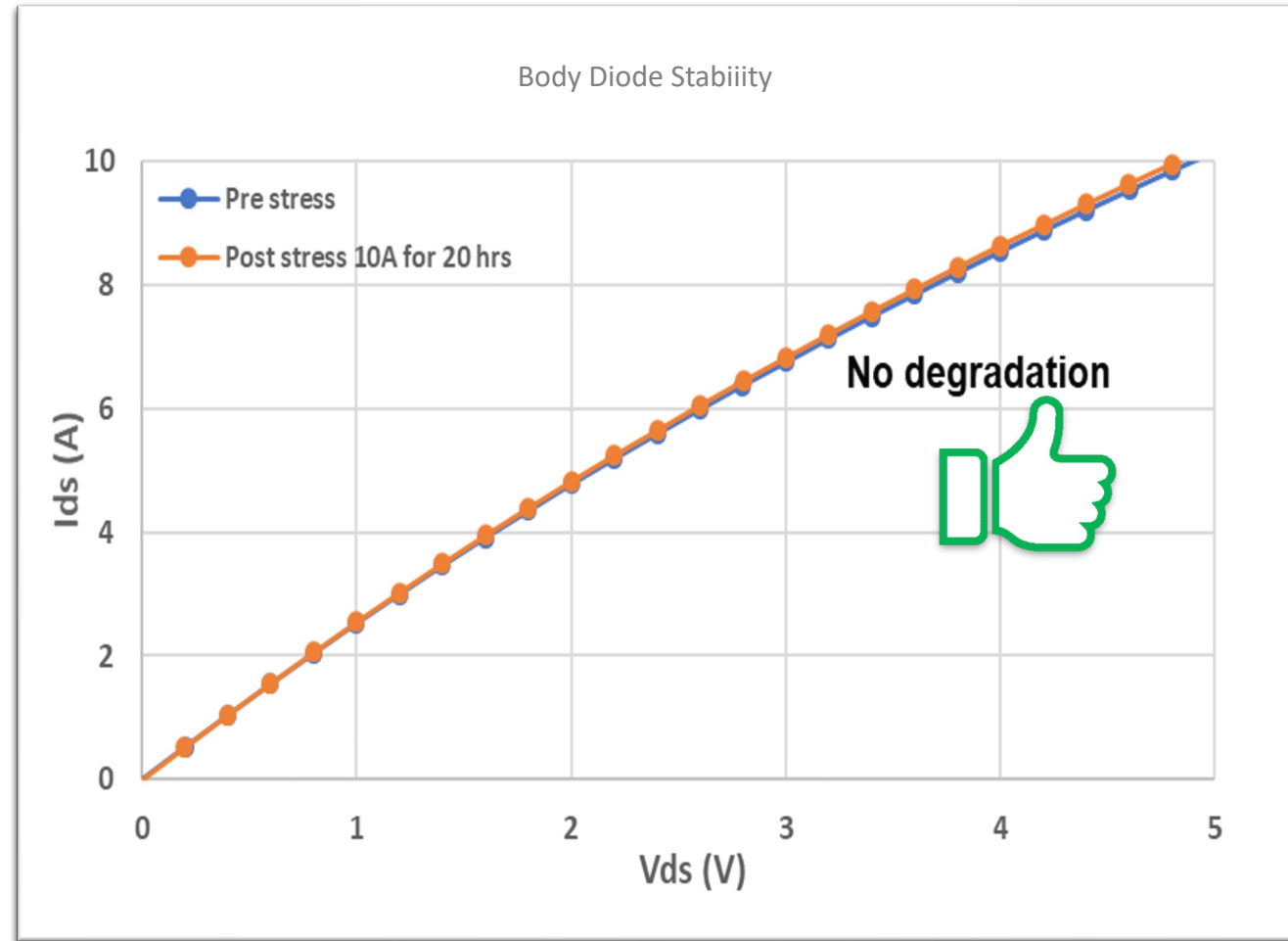


Benefits of SiC

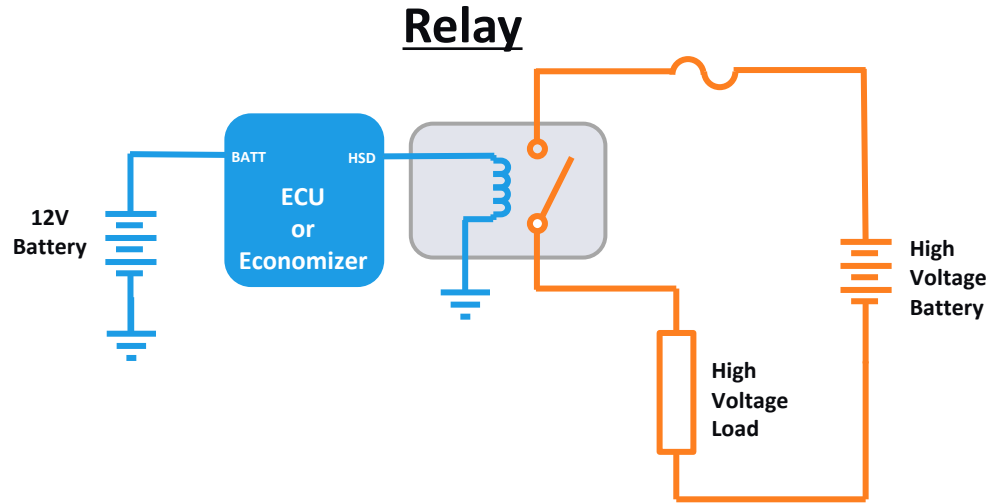
Characteristics	SiC vs. Si	Benefits
Breakdown field (MV/cm)	10x higher	Lower on-resistance
Electron saturation. velocity (cm/s)	2x higher	Faster switching
Bandgap energy (eV)	3x higher	Higher junction temperature Lower off-state leakage current
Thermal conductivity (W/m·K)	3x higher	Higher power density

Design Considerations – Microchip SiC Technology

- High single event and repetitive avalanche
- Low $R_{DS(on)}$ temperature coefficient
- High short-circuit withstand time
- Rugged body diode

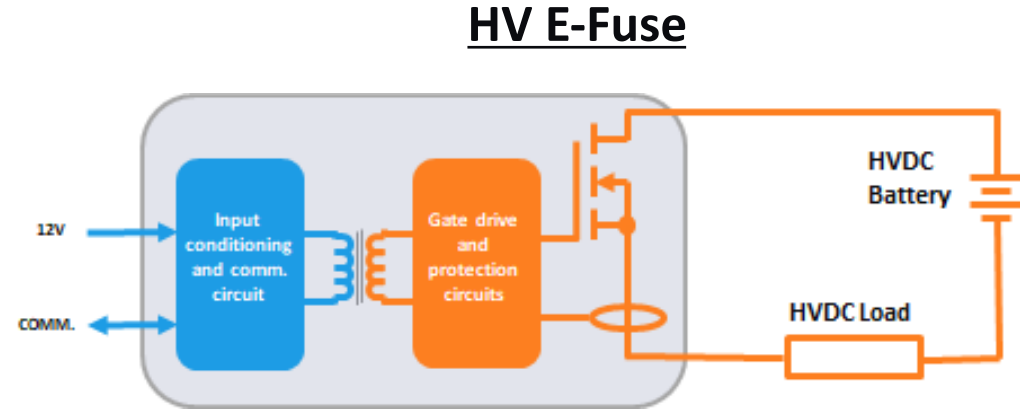


E-Fuse vs Electromechanical Relay



Pro's & Con's

- Simple, known technology
- Low contact resistance
- Galvanic isolation
- Economizer for high current relays
- Slow turn-off
- Limited life
- Arc flash



Pro's & Con's

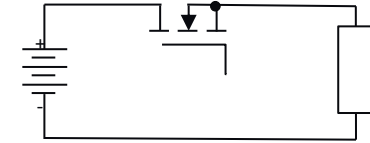
- Simplifies system design
- Fast response time
- Configurable I^2t current profile
- Protection and diagnostics
- Multiple die to achieve comparable resistance
- No galvanic isolation

Low contact resistance and high voltage capability are generally most important. Limited selection of 800V-capable automotive relays presents opportunity for E-Fuse.

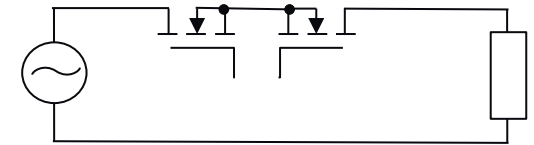
Electromechanical Relays and Solid State Comparison

Performance, Reliability, and Safety	Relays	Solid State
Resistance	Contact resistance	$R_{(DS)ON}$
Operating current	Coil, economizer	Gate drive
Response time	Milliseconds	Microseconds
Controllability	no	yes
PWM operation	no	yes
DC systems	yes	yes
Temperature	$T_{AMB} = 85^{\circ}\text{C}$	$T_{JUNC} = 175^{\circ}\text{C}$
Aging, wear-out	Contact erosion, corrosion	no
Mechanical durability	Vibration, mechanical shock, drop	n/a
Overshoot, ringing	-	Controllable
Galvanic isolation	yes	no
Electric arc	Inductive loads	no
Hazardous environments	Sealed	yes

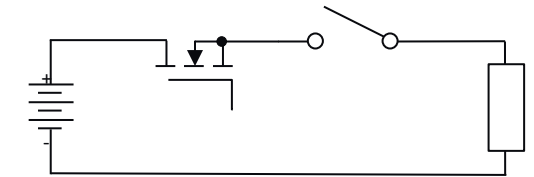
- **DC system**



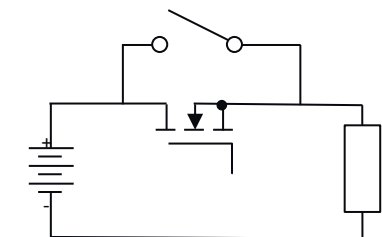
- **AC system**



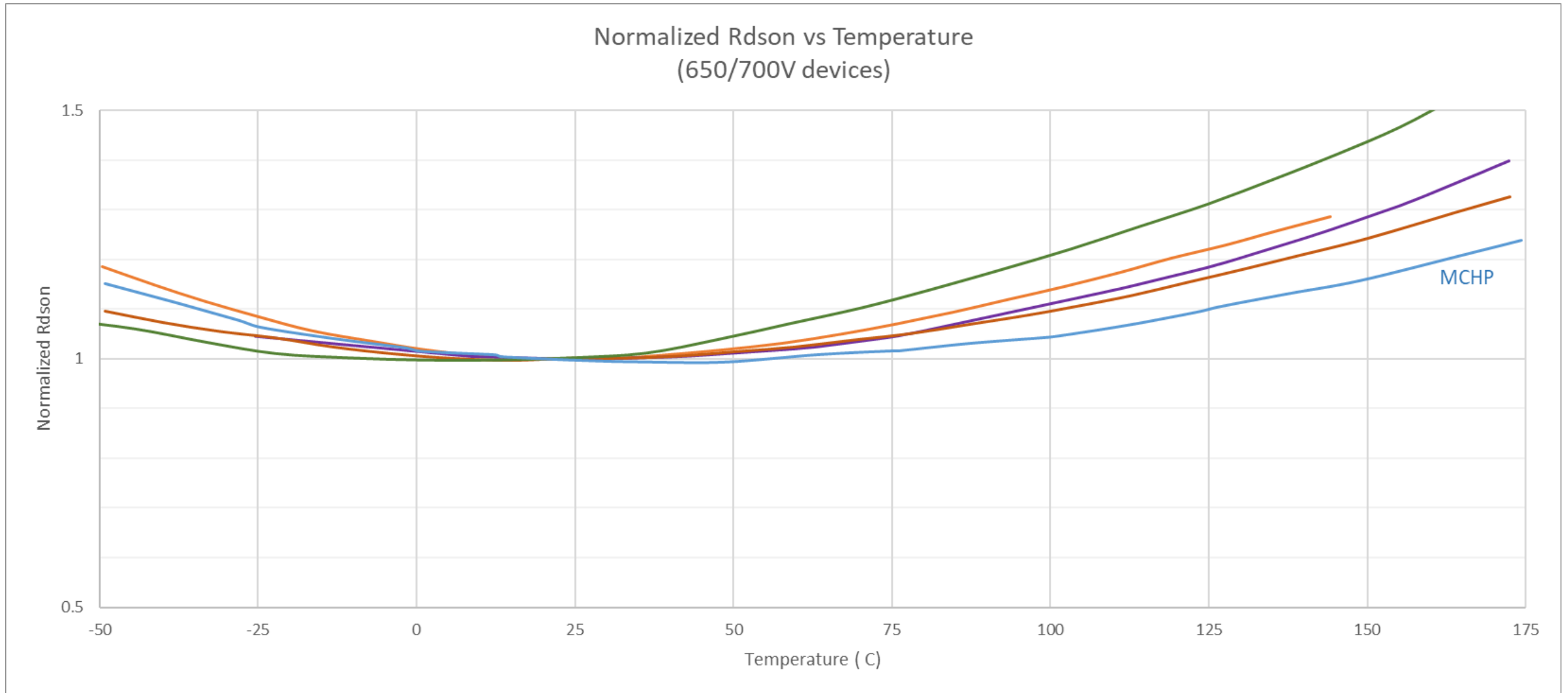
- **Hybrid - Series configuration**



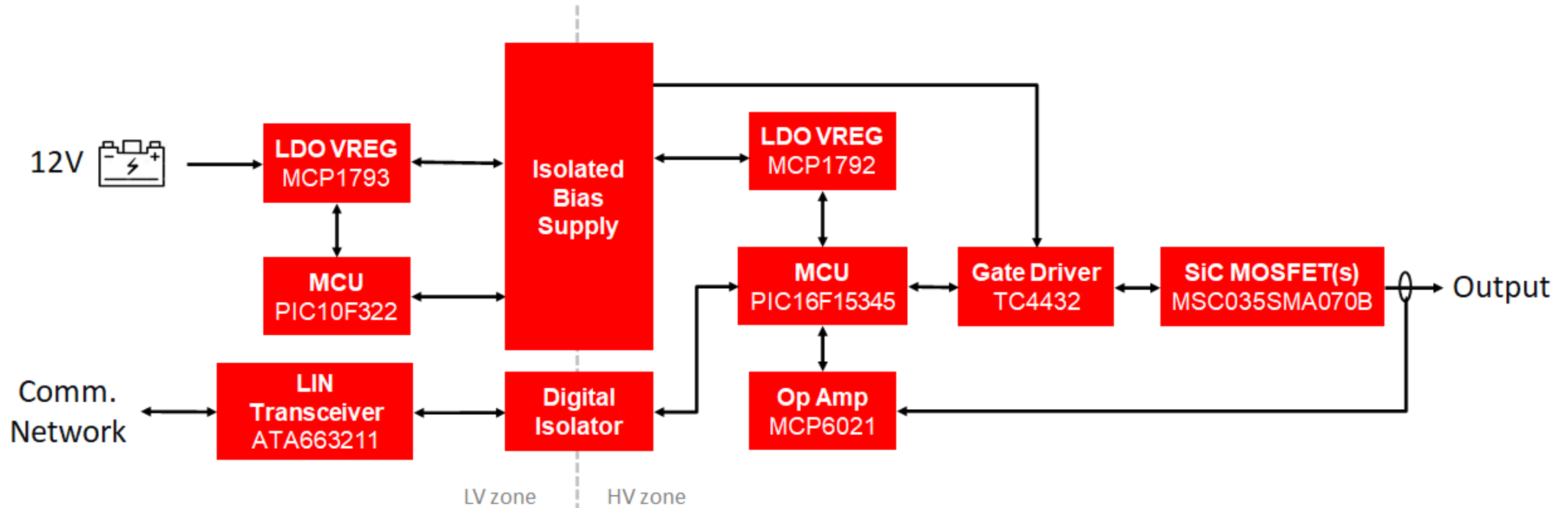
- **Hybrid - Parallel configuration**



$R_{DS(on)}$ Vs. Temperature – 700 V SiC Devices



Reference Design – Total System Solution



Target Specifications

- 400V and 800V DC battery system
- Up to 30A continuous load
- Short-circuit withstand time up to 10 μ s
- Configurable current limit profile
- Communication interface for configurability and diagnostics

Call-To-Action

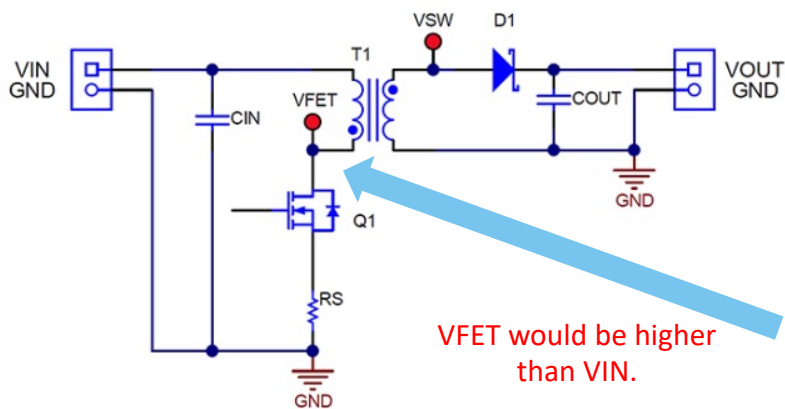
High Voltage Aux Power Supply With SiC

Taiwan KGI

High Voltage Aux Power Supply with SiC

- Power KGI Sharing: To Distributors

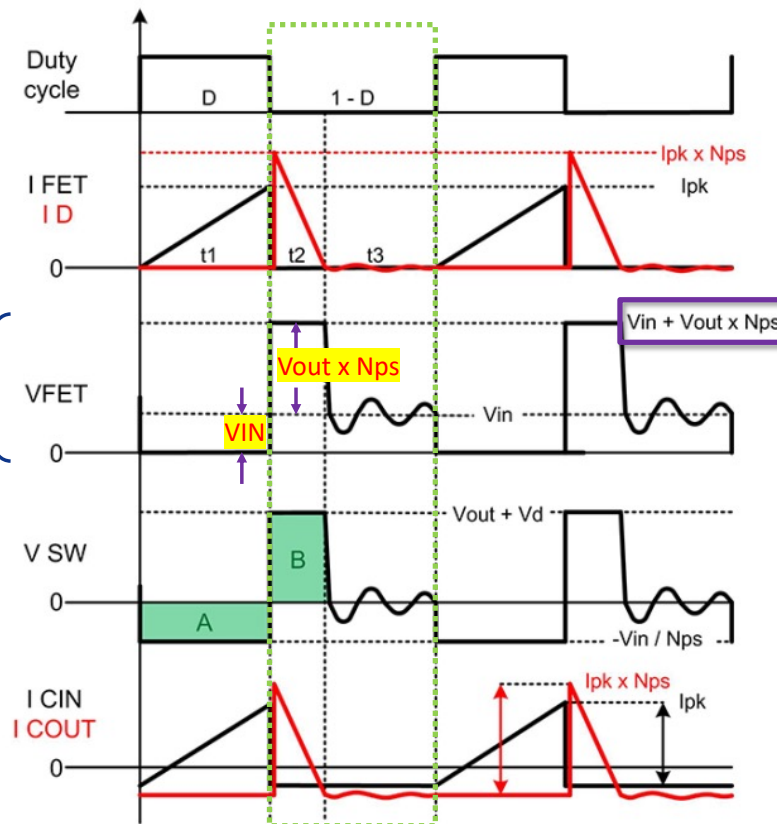
Flyback Aux PS



VFET would be higher than VIN.

You might have few questions:

- Why needs high voltage MOSFET?
- Why Microchip SiC MOSFET?
- What target applications?



Power KGI 5



SiC Power Solutions

Lead Time Support Package, v3.0

Competitor Part Matrix:

- Schottky Diode Discretes
- MOSFET Discretes
- Power Modules

MARCH 1, 2022

Microchip Technology Incorporated 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Main Office 480-792-7200

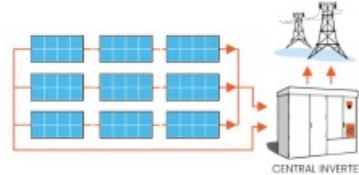


Potential Applications Requiring HV Aux Power

Aux power supplies in central PV inverter

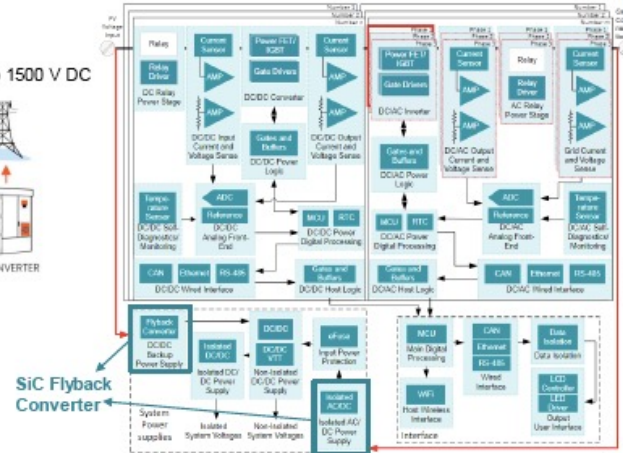
Where:

- Typical power levels of 20 W to 150 W
- Operating input voltage range: 1000 V to 1500 V DC



Why SiC?

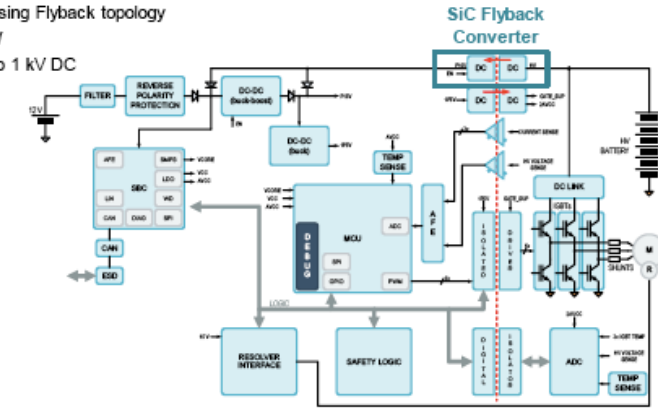
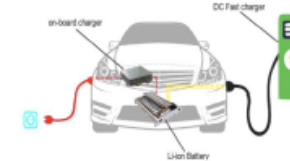
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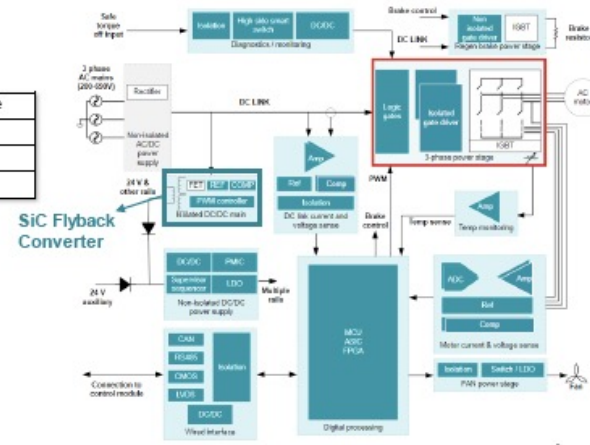
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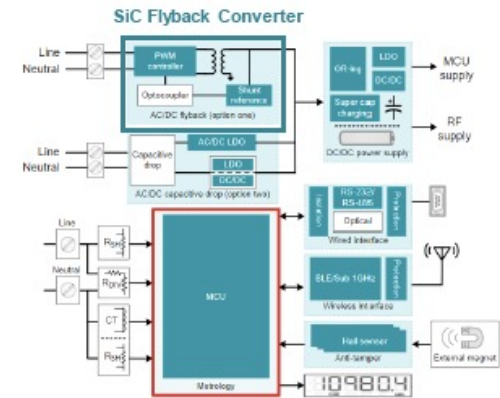
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- Removal of heatsink



Aux power supply of electricity meter

Where:

- Typical power levels of 15 W – 20 W
- Operating input voltage range: 300 V to 950 V DC



Why SiC?

- Higher VDS rating

Potential Applications Requiring HV Aux Power

- **More high-voltage applications:**
 - 1200V SiC for DC Source 800VDC BUS (例如：捷運系統 750VDC)
 - 1700V SiC for PV inverter 1000VDC BUS

Call-to-action

自動儲存 關閉

SiC Survey

常用 插入 繪圖 頁面配置 公式 資料 校閱 檢視 操作說明搜尋

貼上 新細明體 (本文) 12 A⁺ A⁻ B I U 通用格式 條件式格式設定 插入 格式化為表格 刪除 儲存格樣式 格式 編輯 敏感度

C2 Top Gun

	A	B	C	D	E	F	G	H	I	J
1										
2		代理商:	Top Gun							
3										
4		客戶名稱	主應用End-equipment	Aux Power 電源架構	Aux Power 輸入電壓 (V)	Aux Power 功率 (W)	Aux Power 切換頻率 (Hz)	目前主控IC編號或驅動電壓 範圍, 用以判斷驅動相容性	目前主開關型號(如果已知) 用以選出替代方案	
5	Example	AAA	PV Inverter	Flyback	1000	15	65k	編號未知, 驅動電壓0~15V	待查	
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HV Aux Power eFuse with SiC +

就緒 125%

Call-To-Action

Replace Relay By eFuse with SiC

Taiwan KGI

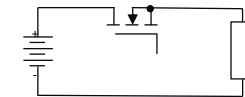
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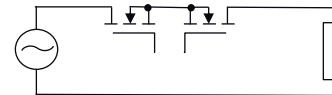
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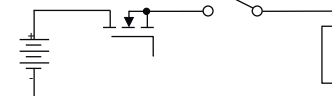
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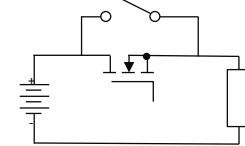
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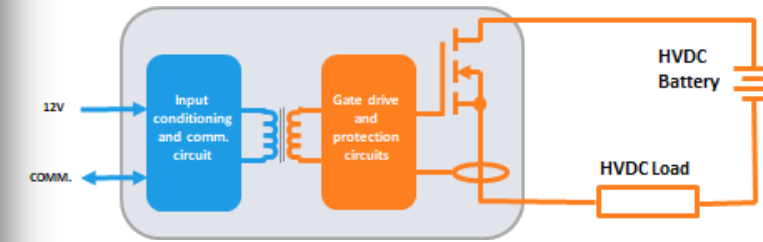
- Hybrid - Series configuration



- Hybrid - Parallel configuration



HV E-Fuse

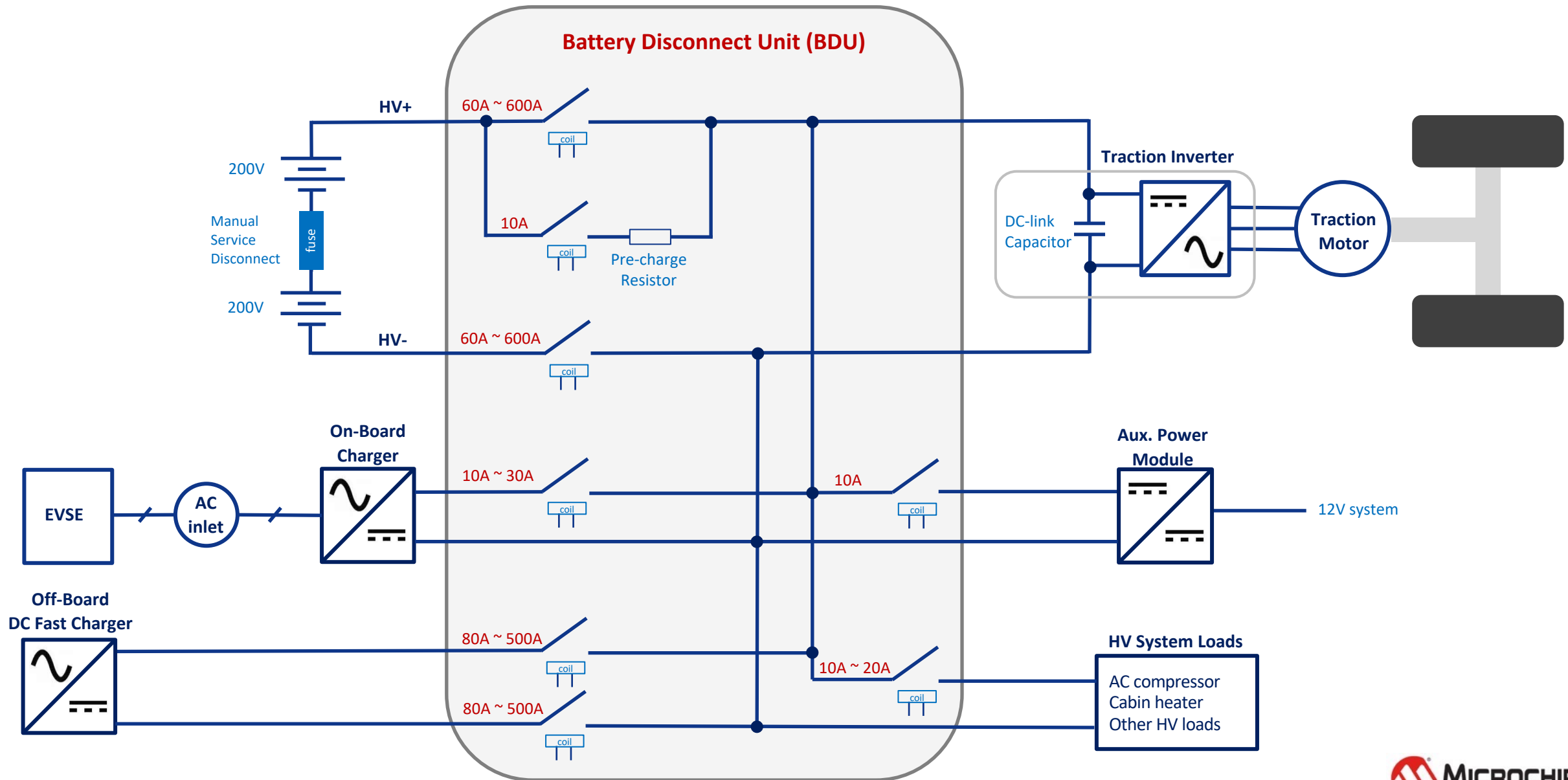


Pro's & Con's

- Simplifies system design
- Fast response time
- Configurable I^2t current profile
- Protection and diagnostics
- Multiple die to achieve comparable resistance
- No galvanic isolation



Potential Applications Requiring eFuse with SiC



Potential Applications Requiring eFuse with SiC

- 充電樁(充電站)輸出Relay
- 電動車或載車的電源轉換或負載設備
- 電源Breakout Box
- 空調系統
 - 例如捷運空調系統
- **Pre-charging circuit**
 - Inverter
 - BMS
 - 有電池或大電容的地方通常都需要預充電路，避免極大充電電流（形同短路電流）而產生故障疑慮。

Call-to-action

自動儲存 關閉

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1													
2		代理商：	Top Gun										
3													
4		客戶名稱	主應用End-equipment	Relay 電壓 (V)	Relay 電流 (A)	系統功率 (W)							
5	Example	AAA	On board charger	400V	10A	3.3K							
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HV Aux Power eFuse with SiC

就緒 125%

Call-To-Action

High Voltage / High Power Applications

Including Motor Control

Taiwan KGI

Call-to-action

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C2 fx Top Gun

	A	B	C	D	E	F	G	H	I	J	K	L	M
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2		代理商:	Top Gun										
3													
4		客戶名稱	主應用 End-equipment	主應用 電源架構	電源架構 輸入電壓 (V)	電源架構中 DC Bus電壓 (如果有)(V)	電源架構 輸出電壓 (V)	電源架構 輸出功率 (W)	電源架構 切換頻率 (Hz)	開關硬切 or 高效率柔切 技術	功率密度 要求 (如果有)	目前主控IC編號或驅動電壓 範圍, 用以判斷驅動相容性	目前主開關型號(如果已知) 用以選出替代方案
5	Example	AAA	Induction heating/welding machine	Full Bridge	220Vac	400Vdc	Variable	50kW	65k	高效率柔切 技術	無要求	編號未知, 驅動電壓 -5~18V	Wolfspeed CAS300M12BM2
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HV Aux Power eFuse with SiC HV or HP Applications +

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