FOR ENERGY EFFICIENT INNOVATIONS

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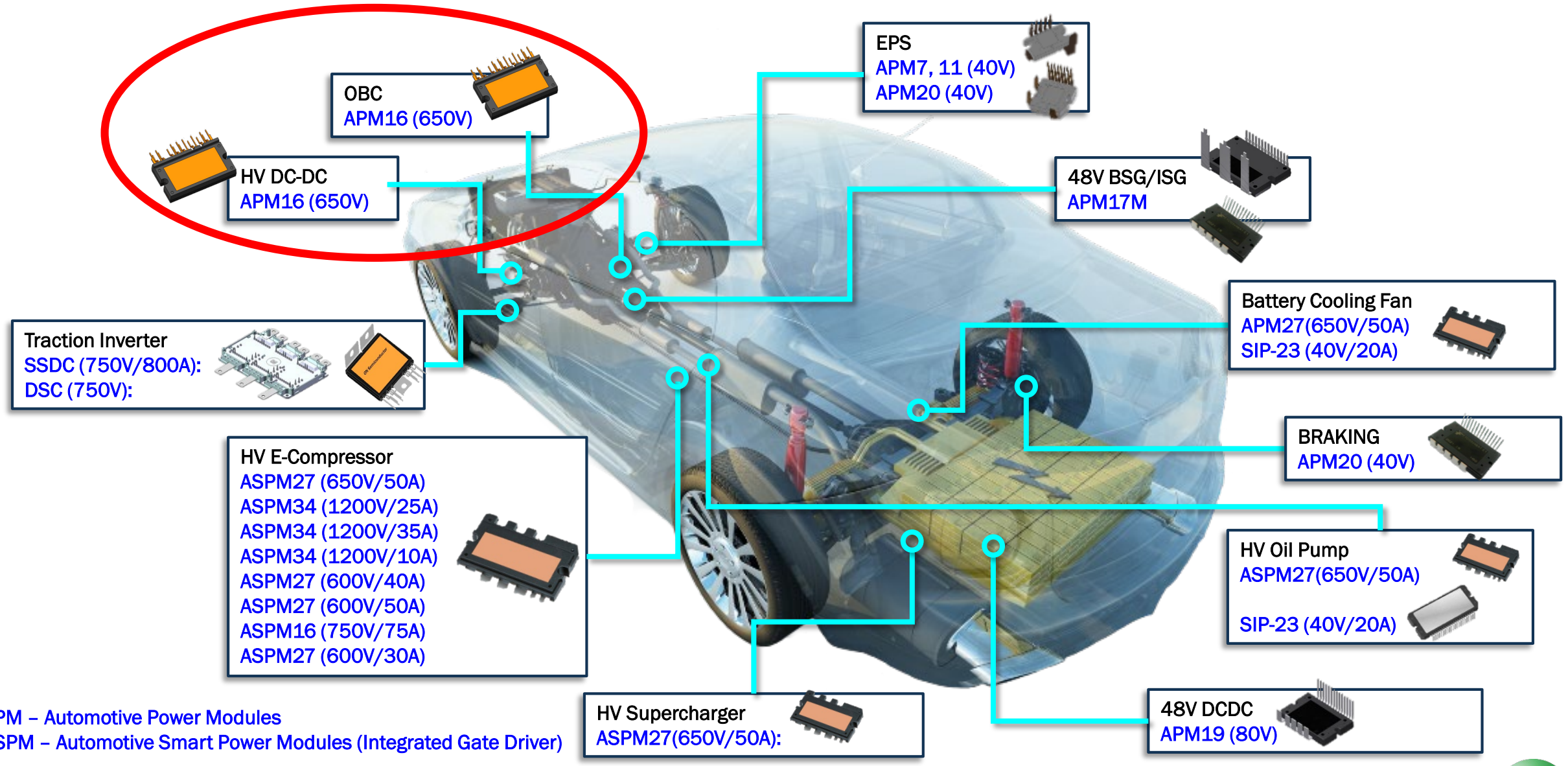
On-Board Charger (OBC) APM16

Public Information

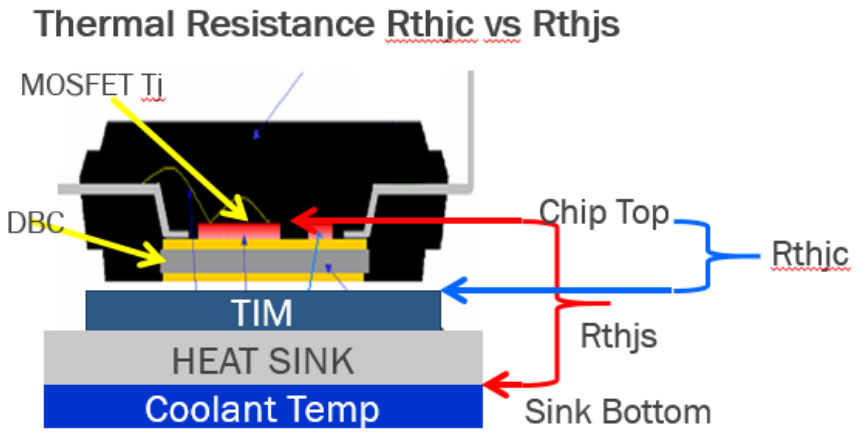
APM Solutions for Automotive xEV



APM – Automotive Power Modules
ASPM – Automotive Smart Power Modules (Integrated Gate Driver)

APM Performance benefits

[Thermal Performance]



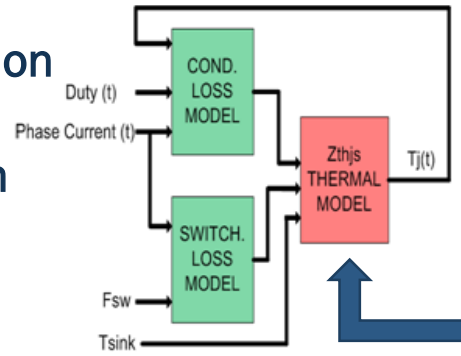
	APM	Discrete
Rthjc	>	
Rthjs	<	

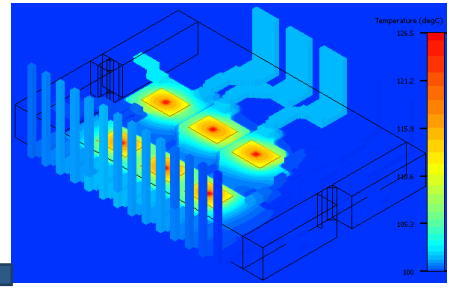
Lower Rthjs of APM => Lower Tj => Lower Rdson => Higher Power Density => Compact Size

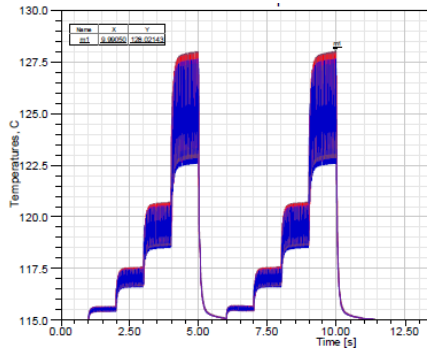
[Electrical Performance]

- Lower circuit resistance (i.e., double the number of wire bonds comparing with standard discrete package) allows customer to provide higher torque output
- Reduced stray inductances as a result of physical proximity of the devices
- Better dynamic and EMI performance
- High Isolation Voltage saving additional insulation layer

Simulation Block Diagram





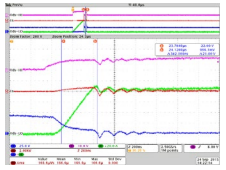


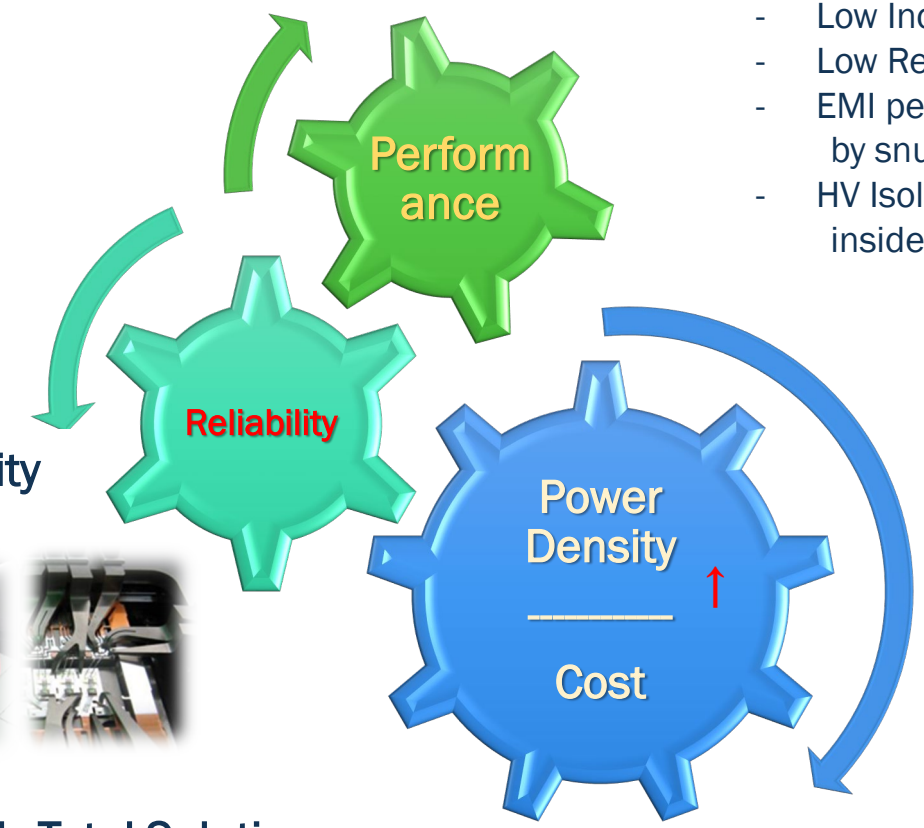
Highly optimized thermal performance → APM can reach Rthjs << 1 K/W

Benefits of ON Semiconductor Power Modules (APM)

Electrical Performance

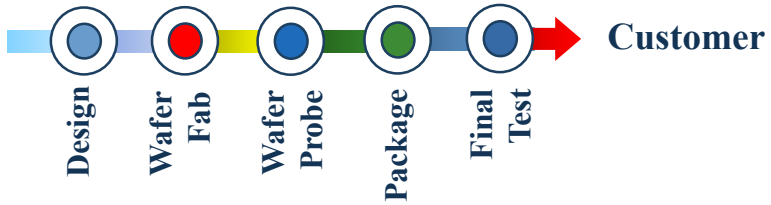
- High Current Capability
- Low Inductance
- Low Resistance
- EMI performance by snubber
- HV Isolation inside



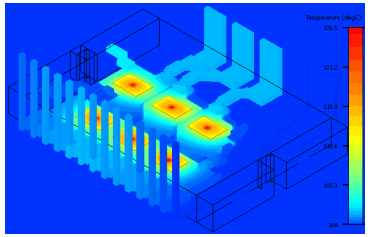


Proven Reliability

Fab + Assembly Total Solution

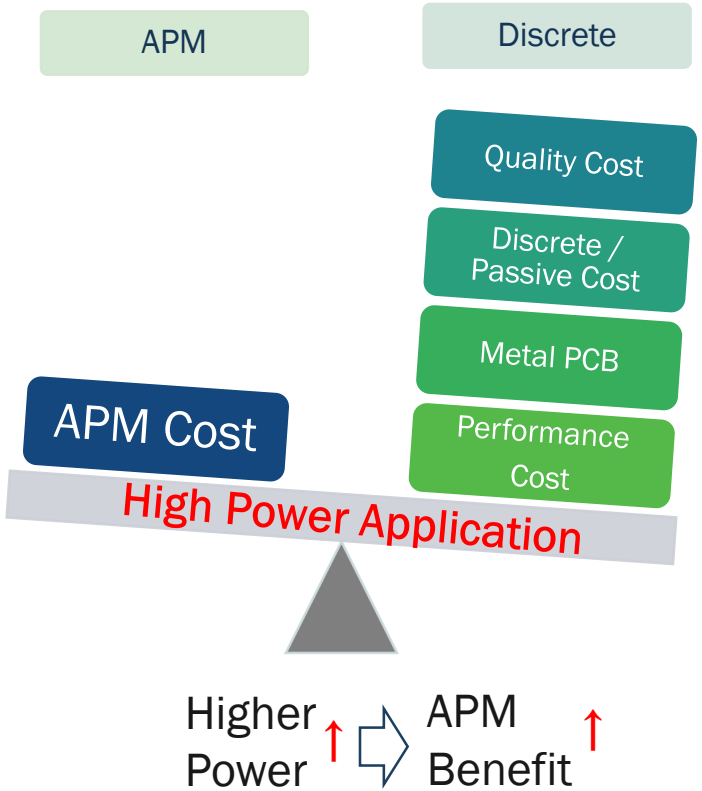


Low Thermal Resistance Junction to Heat sink



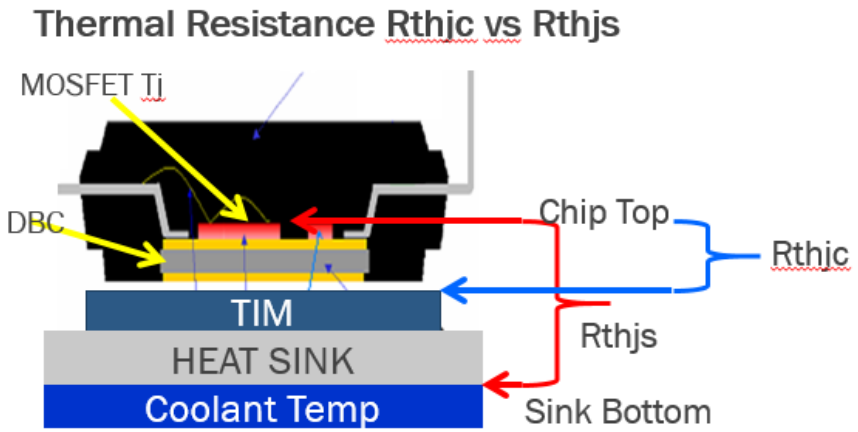
Smaller foot print

System Cost



APM Performance benefits

[Thermal Performance]



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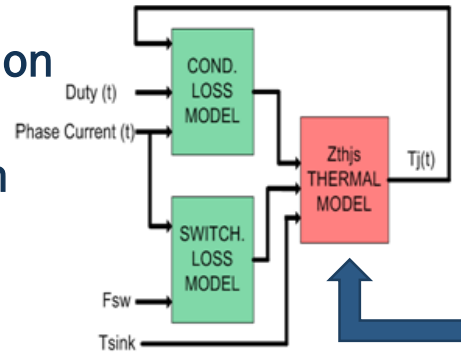
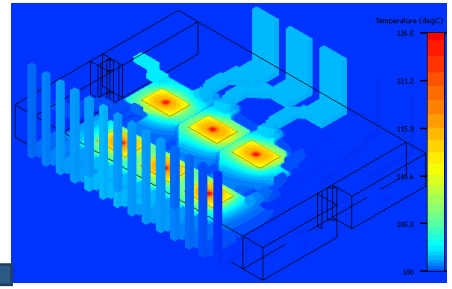
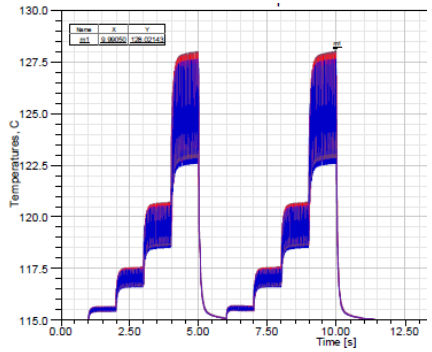






Highly optimized thermal performance → APM can reach Rthjs << 1 K/W

APM Design benefits

Smaller Power circuit

Easier assembly

Insulated thermal interface

Reduced system costs & less mechanical complexity & higher power density

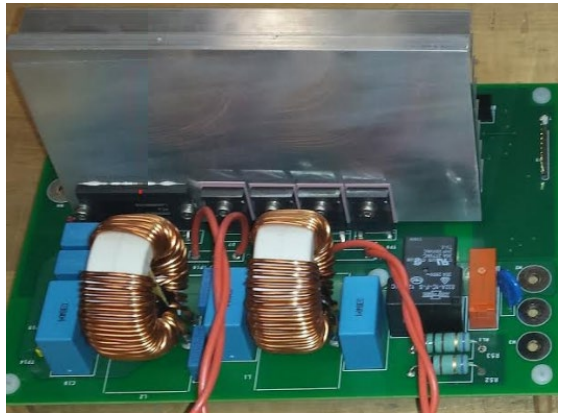
- Smaller system, smaller housing
- More compact layout
- Thermistor, shunts, passive components and power interconnections inside of the module
- Higher current density
- Better utilization of MOSFET Die due optimized thermal path (~30%)
- Smaller PCB area possible
- Lower total resistance, high efficiency

- Fully tested and optimally matched power circuit.
- Minimize assembly points and defect rate.
- Reduced system failure rate at the end customer
- Reduced number of components – Quality control cost reduction
- Simplified assembly
- Bus bar saves high current on PCB

→ **Lower SYSTEM LEVEL COST**

- PCB, housing and system volume reduction.
- No high currents on PCB
- Integrated electrical isolation
- Simplified and smaller thermal interface
- Increased Yield and Productivity

Half the size of discrete solution
APM16 vs. 4x TO247 !

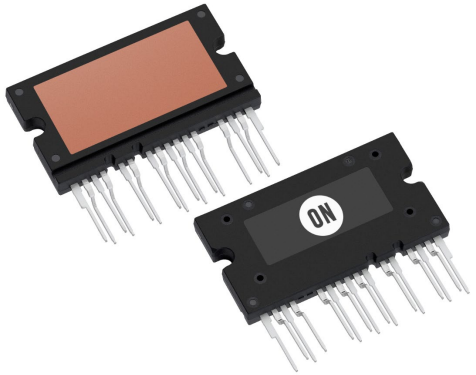


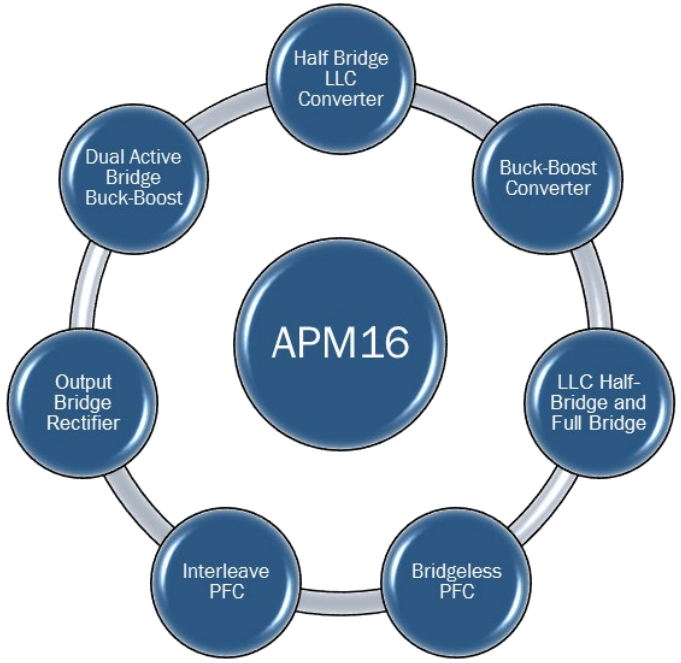
HV OBC & DC/DC Modules

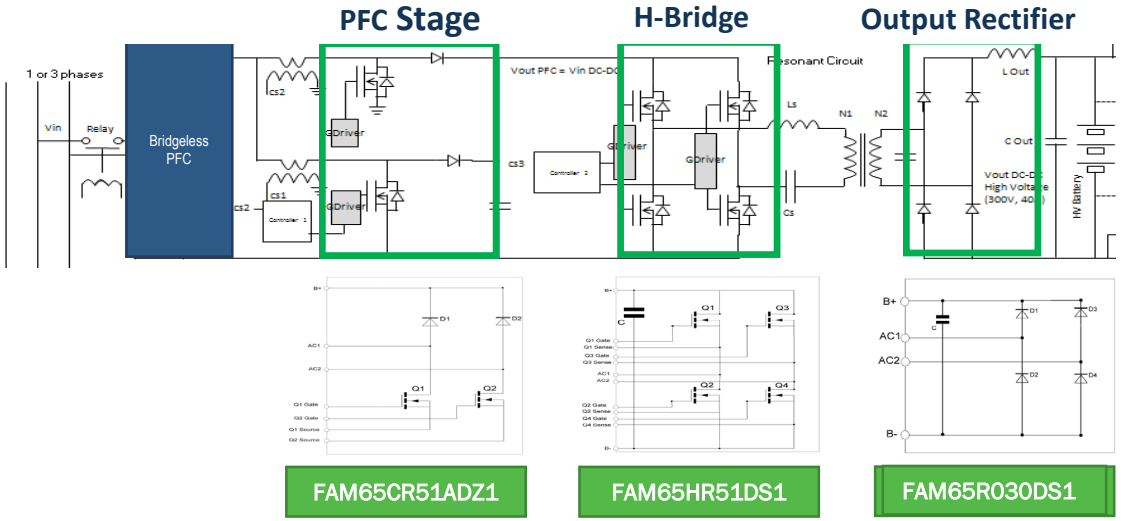
Features

- One package outline covers multiple circuit configurations
- Automotive qualified per AECQ101 and AQG324
- Ceramic substrate option - AlN or Al2O3 : Low junction-sink thermal resistance
- Pb Free

Package:
40.1 mm × 21.9 mm× 4.5 mm







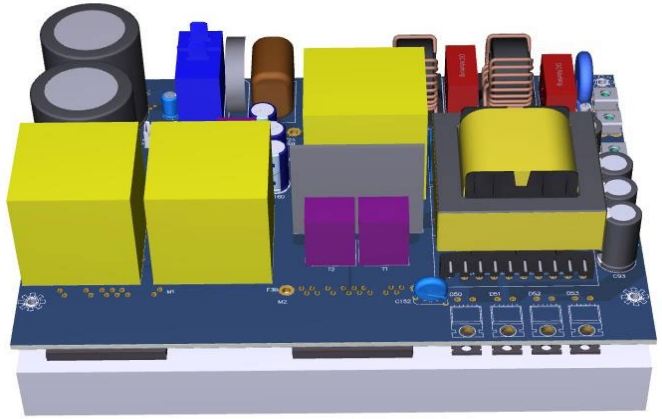
Specifications

Part number	Silicon	Voltage	Rating	Tj rating	Substrate	Config
FAM65HR51DS2	SFIII	650V	51mΩ max @25C	55C/150C	Al2O3	H-Bridge
FAM65CR51DZ2	SFIII	650V	51mΩ max, @25C	-55C/150C	Al2O3	PFC
	Stealth	600V	1.24V@15A, 27ns@Tj=175C	-55C/175C		
FAM65R030DS1/2	Si	650V	1.2V,60ns and 30A @Tj=25C	-55C/175C	Al2O3	Bridge Rect.

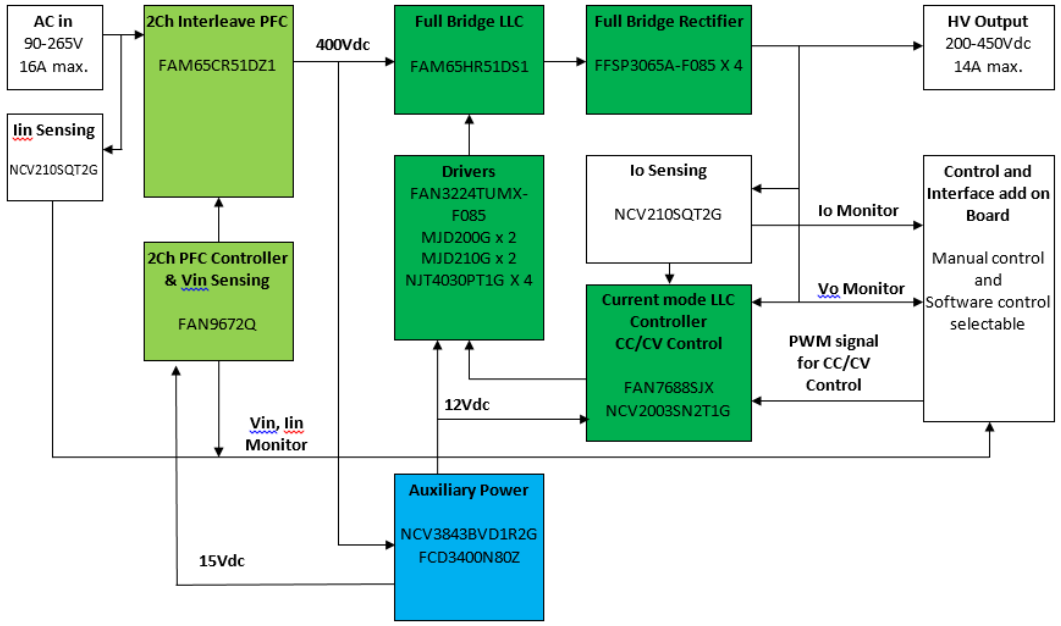
Automotive Module Based OBC Demo

Design Features

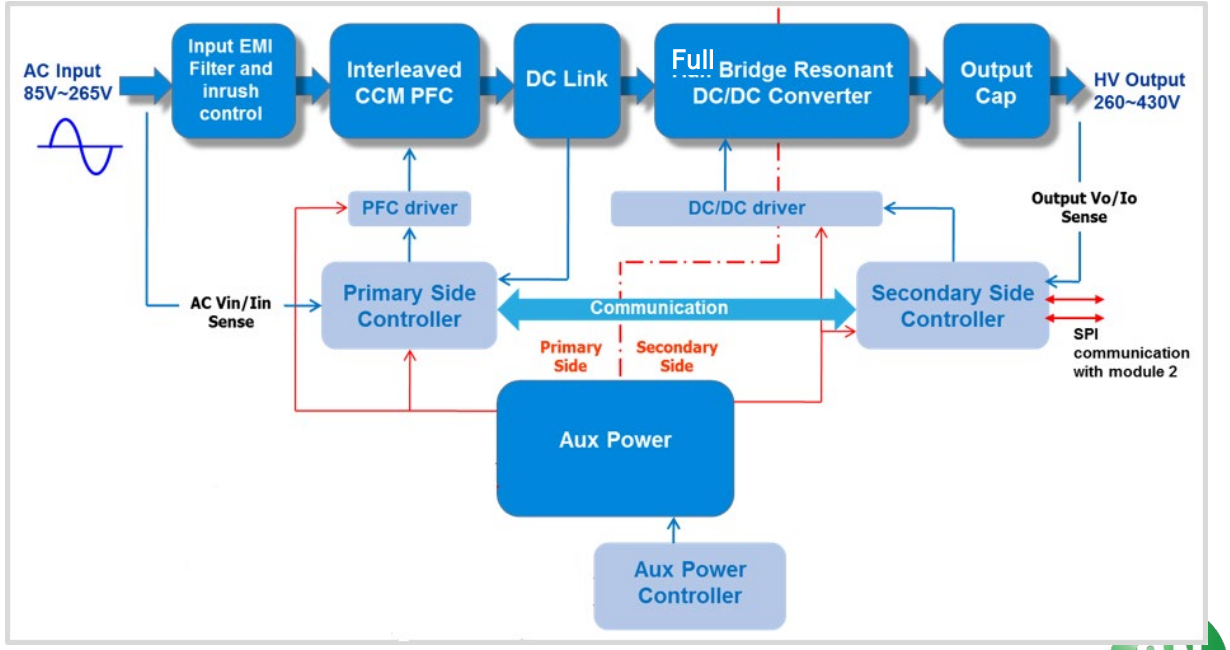
- AQG324 Qualified APM to reduce PCB space and size.
- 2CH Interleaved PFC for higher efficiency and power density.
- Full bridge LLC to boost efficiency by high bus voltage usage.
- Flyback topology to supply auxiliary power.
- Hardware PFC and LLC control for improved fault modes.
- Fully functional solution including input/output current/voltage sensing and CC/CV PWM control interface.



Circuit configuration



Control configuration



OBC Design Details Description

Component featured

Part number	Function
FAN9672Q	PFC controller
FAN7688SJX	LLC controller
NCV3843B	PWM controller
FAN3224TUMX-F085	Low-side gate driver
NCV890100PDR2G	Buck mode switching regulator
NCV51460SN33T1G	Precision voltage reference
NCV210SQT2G	Current sense amplifier
NCV2003SN2T1T	Precision operational amplifier
SC431AVSNT1G	Precision voltage reference
FODM8801C	Opto-coupler

Control features

PFC Controller FAN9672

- Continuous Conduction Mode with Average Current Mode Control
- Two-Channel Interleave Operation
- Programmable Operation Frequency Range: 18 kHz~40 kHz or 55 kHz~75 kHz
- Programmable PFC Output Voltage, UVLO, Soft-start
- Two Current-Limit Functions
- TriFault Detect™ Protects Against Feedback Loop Failure

LLC Controller FAN7688

- Secondary Side PFM Controller for LLC Resonant Converter with Synchronous Rectifier Control
- Charge Current Control for Better Transient Response and Feedback Loop Design
- Adaptive Synchronous Rectification Control with Dual Edge Tracking
- Closed Loop Soft-Start for Monotonic Rising Output
- Wide Operating Frequency (39 kHz ~ 690 kHz)
- Green Functions to Improve Light-Load Efficiency
- Protection Functions: OCP, OVP, OTP, VCC-UVLO, overload, all with Auto-Restart
- Wide Operating Temperature Range -40°C to +125°C

PWM Controller NCV3843

- Trimmed Oscillator, Frequency Guaranteed at 250 kHz
- Current Mode Operation to 500 kHz
- Automatic Feed Forward Compensation
- Latching PWM for Cycle-By-Cycle Current Limiting
- Internally Trimmed Reference with Undervoltage Lockout
- High Current Totem Pole Output
- Low-startup/operating current, UVLO with Hysteresis

Why use APM module Solution?

Vs discrete solution	APM Module	Discrete Components	Remarks
PCB Layout Design	√ Simple	Complex	By using integrated power module; - Circuit design can be more compact - Save the materials including device housing, clip heat sinks, insulation materials and interconnections wires resulting in overall cost reduction. - Based on the excellent high thermal performance junction to sink, Optimum cooling route can be designed which improve overall system efficiency than the system based on the discrete.
Manufacturing Process	√ Simple	Complex	
Converter Size / Weight	√ Smaller / Lighter	Larger / Heavier	
Noise Immunity (EMC)	√ Improved circuit pattern & Snubber	Weak (Complex PCB pattern)	
High voltage isolation	√ HV isolation inside the module	Need additional isolation layer	
Thermal Resistance – junction to case	√ Lowest	Higher	
Cooling Efficiency	√ Low	Complex cooling route design required	

Vs Other Power modules	APM Module	Case Module	Remarks
Reliability	√ Highest (Thermal stress, Mechanical & Vibration)	Lower than APM	• Transfer molded ON's APM module solution whose high reliability performance was proven in automotive field since 2008, can provide much lighter and compact solution than gel filled case module.
Converter Size / Weight	√ Smallest / Lighter	Larger and Heavier than APM	