


Eaton's Power Electronics Portfolio



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Get to know our business.

Electrical Sector

2016 Sales \$12.6 B

- Electrical Products
- Electrical Systems & Solutions

Industrial Sector

2016 Sales \$7.1 B

- Aerospace
- Hydraulics
 - Filtration
- Vehicle

Sales \$19.7 Billion USD

Net income \$1.9 Billion USD

Operating Earnings \$4.22
per share

- **Chairman & CEO – Craig Arnold**
- **Key locations in Cleveland, United States; Shanghai, China; Morges, Switzerland; São Paulo, Brazil**
- **Regional engineering teams to support products and custom solutions**
- **Customers in more than 175 countries**
- **Approximately 95,000 employees**



Powering Business Worldwide

Solving industry's toughest power management challenges around the world.



Aerospace



Buildings



Data centers



Food and beverage



Government



Healthcare



Machine building



Marine



Mining, metals and minerals



Mobile machinery and equipment



Oil and gas



Pharmaceuticals



Rail



Renewables



Residential



Utilities



Vehicles



Water/wastewater



Powering Business Worldwide

A portfolio designed to meet your power management needs.

ELECTRICAL



Power distribution and circuit protection

Backup power protection



Lighting and security

Control and automation

Structural solutions and wiring devices

Solutions for harsh and hazardous environments

Engineering services

INDUSTRIAL



Aerospace – Hydraulic and fuel systems

Automotive – Engine air mgmt., traction control and fluid products

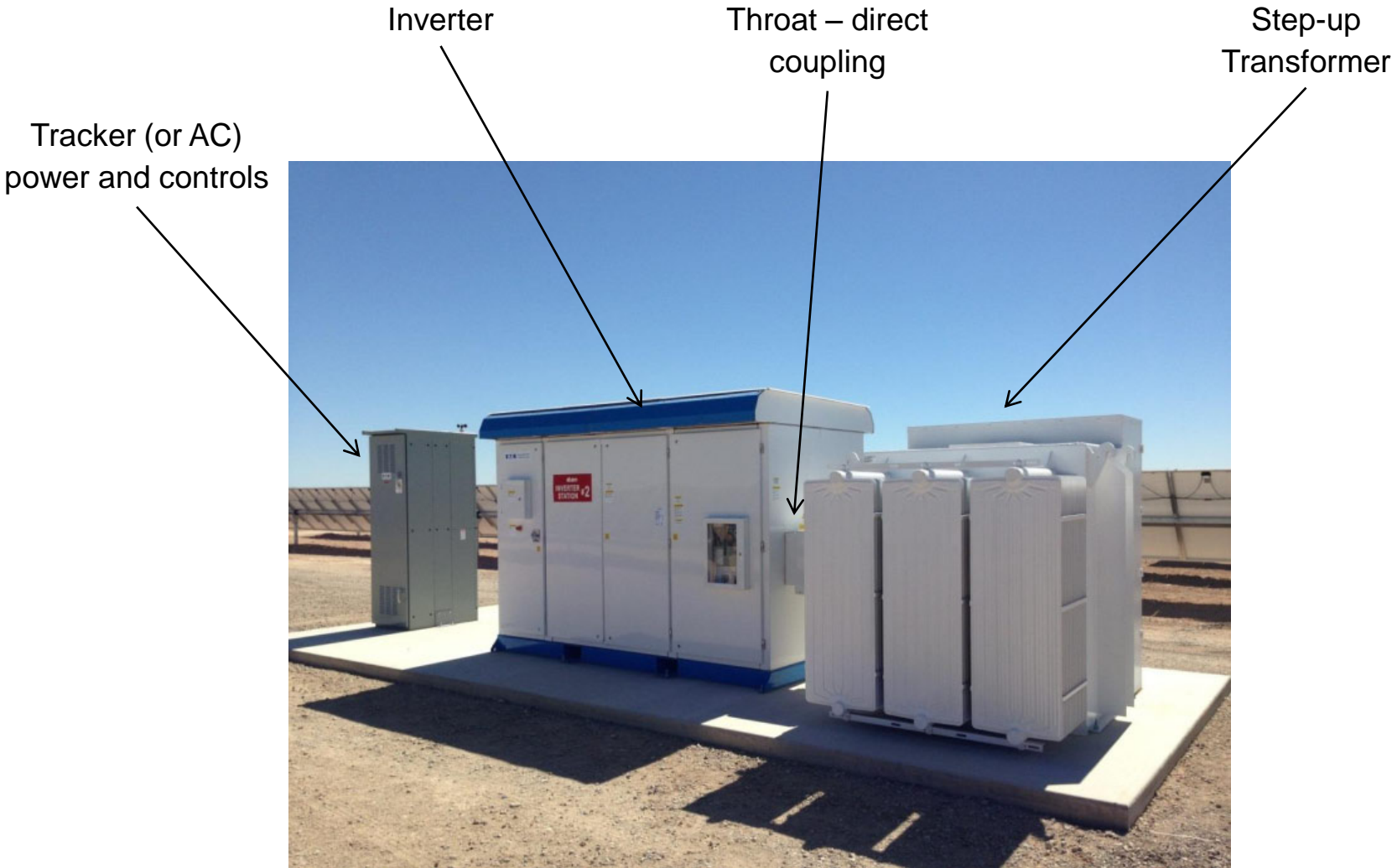
Truck – Commercial vehicle clutches and transmissions

Filtration – Liquid filtration solutions

Hydraulics – Fluid conveyance and power and motion control products

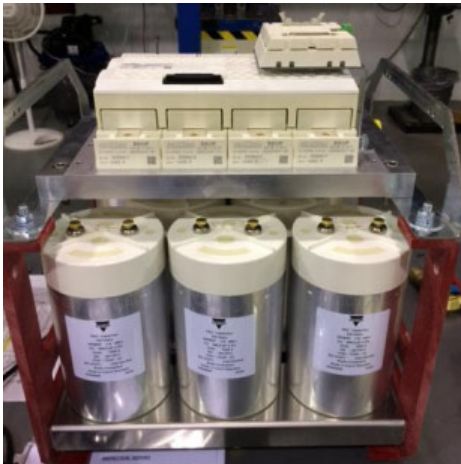


Power Xpert Inverter – 1.0 – 2.5 MW



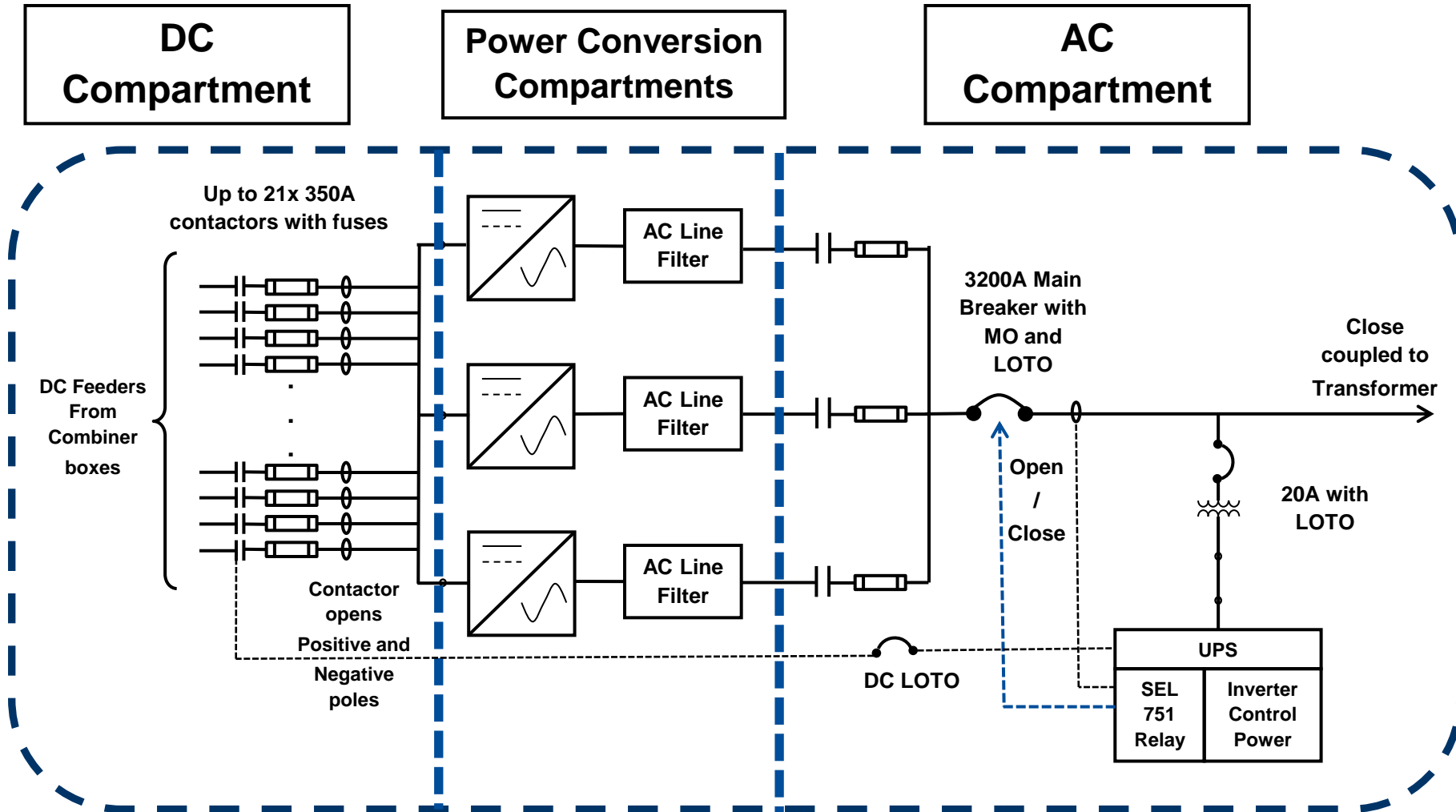
Power module design

- Latest generation of Semikron SkiiP 4 IGBT – integrated driver & heat sink
- Rated for 175°C and high cyclic duty applications
- Vishay film capacitors
- User replaceable modules



Power Xpert Utility-Scale Solar Inverter

1500Vdc – 98.5% efficiency



Power Xpert™ Energy Storage Inverter

1250 V max

- Battery Types

- LG Chem (LMO)
- Kokam (LTO)
- Enerdel (LTO)
- Altair Nano (LTO)
- ZBB (flow)
- Xtreme (ALA)
- Mitsubishi (LMO)
- JCI (NCA)
- Samsung (LMO)
- SPS/Lischen
- Powin
- Primus



500kW outdoor Inverter

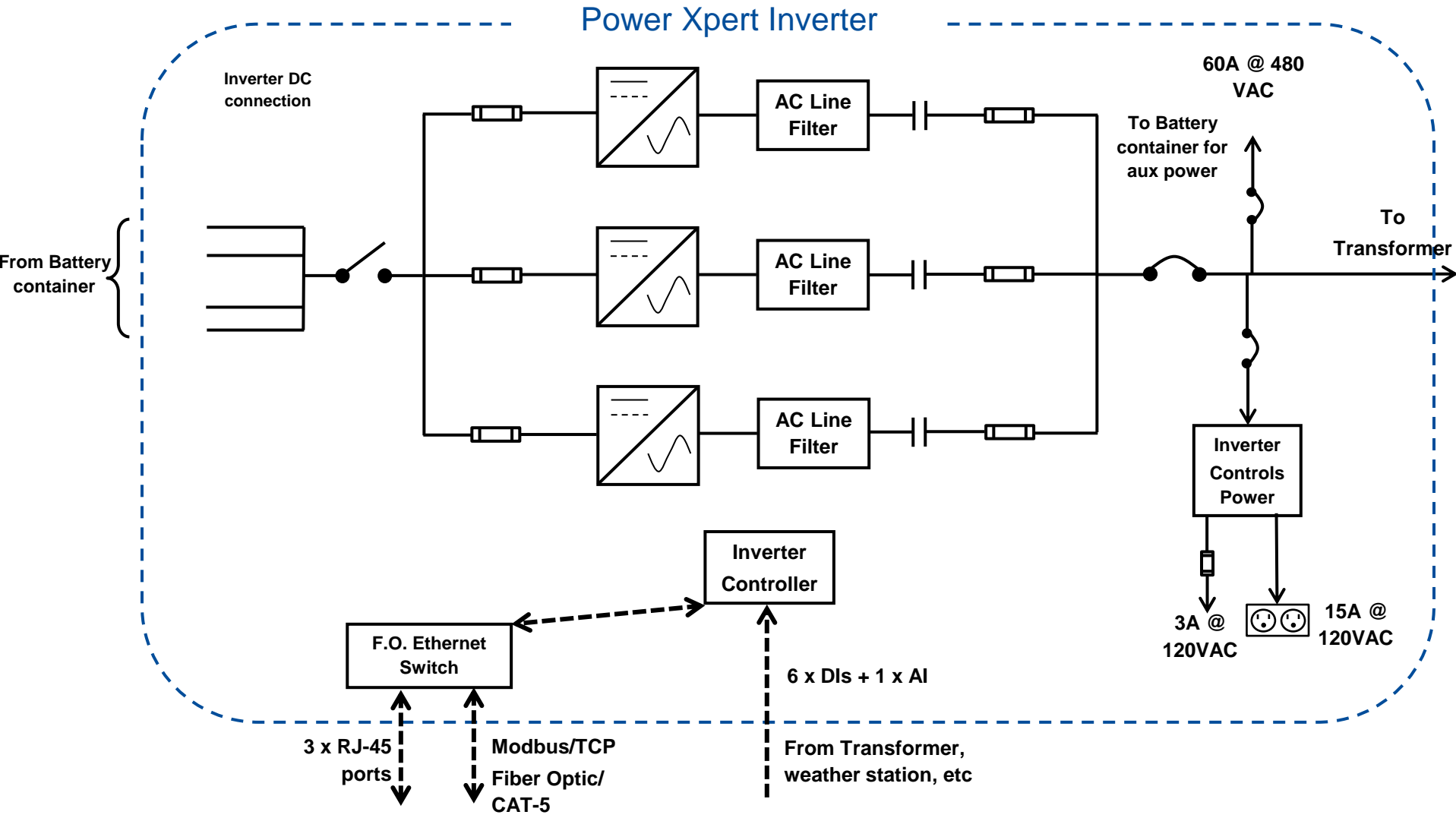


3MW site (indoor Inverters)



500kW Compact Pad Mount

Power Xpert[®] Energy Storage Inverter



Hybrid-solid state dc contactor

- 1000 Vdc
- 300 & 600 A
- Hybrid design for low loss and arc-less interruption
- Internal isolation contact
- 150,000 electrical operations
- 1,000,000 mechanical operations



S611

Soft Starter

Technical Specifications:

- 200-600 V 3-phase Rated
- 52 A to 414 A Rated
- -20°C to 50°C Rated
- 120 Vac Control Voltage
- 6 Frame Sizes
- 3-phase controller
- Globally Approvals



Product Features:

- Advanced overload protection through Eaton's C441 overload
 - Provides unique protections – Stall/Jam, Phase loss, low voltage, high voltage
- Advanced monitoring solutions
- Fault History stores last 30 faults
- Door mountable Display
- Fully field serviceable
- Extensive communication module options



- Best in class motor protection and monitoring to extend motor life
- Spare parts available to make the product field serviceable to provide customers with additional value
- Uses the same communication modules as the S811+ product offering

S811+

Soft Starter

Technical Specifications:

- 200-690 V 3-phase Rated
- 37 A to 1000 A Rated
- -30°C to 40°C Rated
- 24 Vdc Control Voltage
- 5 Frame Sizes
- 3-phase controller
- Globally Approvals



Product Features:

- Digital Interface Module (DIM)
 - Copy/Paste functionality
 - Advanced Monitoring
 - Door Mounting Kit available
- Modbus RTU standard
 - Extensive communication module options
- Specialized Pump Algorithms
- Internal Bypass Contactor
- Electronic Overload Protection



- Industry's smallest footprint reducing space needs up to 475% over current offering
- Extended Communication accessories which will allow for improved IoT compatibility
- Offered as both Open product to OEMs and enclosed though Eaton's MCC and Enclosed Control groups

Product overview

Adjustable frequency drives

Technical Specifications:

- 230-600 V/3-ph
- 0.25-800 hp
- 2.2 A to 310 A at 480 V
- 150% overload for 1 minute
- Temperature rating -30°C to 50°C (60°C with de-rating)
- Real-time clock
- Active Energy Control for energy savings up to 10% beyond competitors' VFDs

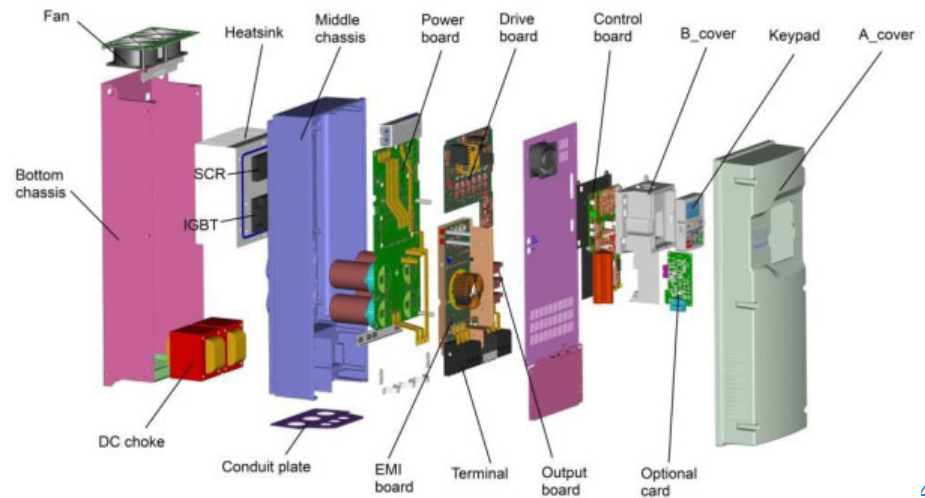


- Next generation PowerXL platform extremely price and feature competitive
- Over 9 million combinations of enclosed standard product

Power XL DG1

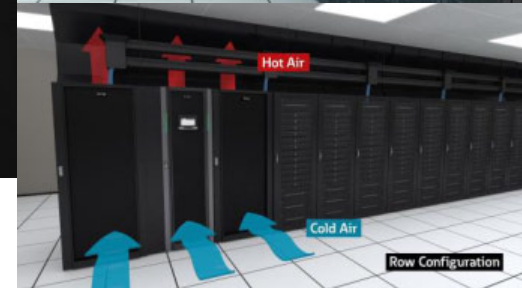
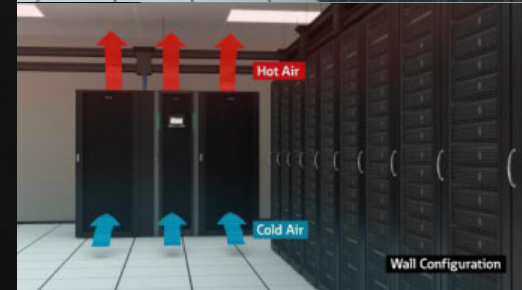
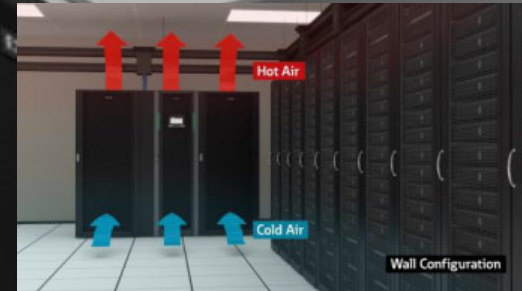
Power Section Features

- Integrated 5% dc link choke & input surge protection
- EMC filters standard on all drives
- Temperature controlled fan & cold weather feature
- Brake chopper standard on Frames 1-3
- Compact foot-print and conformal coated boards



State-of-the-art double-conversion UPS

- Transformer-less topologies with double conversion efficiencies reaching 97% with use of three-level converters and advanced digital signal processing
- High-frequency power conversion continues to increase power density
- Modular designs, allowing for N+1 redundant operation and scalable designs
- Flexible thermal management becoming increasingly more important



Comprehensive 3-phase BladeUPS offering to 60 kW

- Simplifies installation and service with true plug-and-power connections and hot-swappable batteries and electronics modules
- BladeUPS accessories extend runtime without dedicated module racks
- Preassembled start-up services are available that include installation and start-up configuration



Product portfolio 8-400 KW



Product	9155	9355	9355	9390	93PM	93E
Power Range	8-15kVA	10-15kVA	20-30kVA	20-160kVA	20-400kW	20-60kVA
Native Voltage	208V	208V	208V	208V 480V	480V	208V 480V

Product portfolio 100-1200 KW

**Power Xpert™ 9395P high performance UPS
200-1200 kW/kVA**



93PM (400): 100-400 kW



9395/9395P: 225-1200 kVA

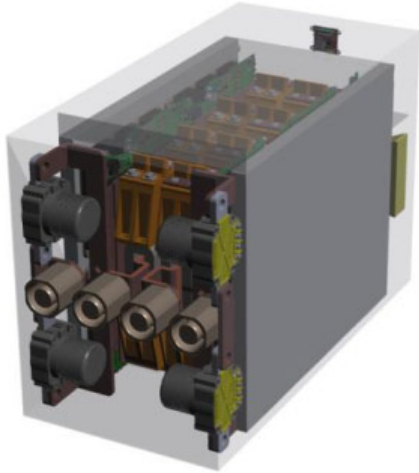


PDU/RPP

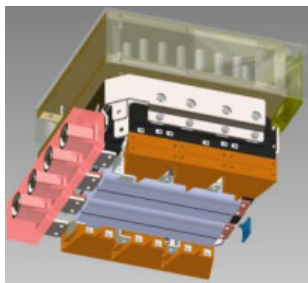


Portfolio

Solid state 1000 Vdc circuit breaker



Liquid cooled package



Air cooled package

DC Contactor



IGBTs



Inductors

Diodes



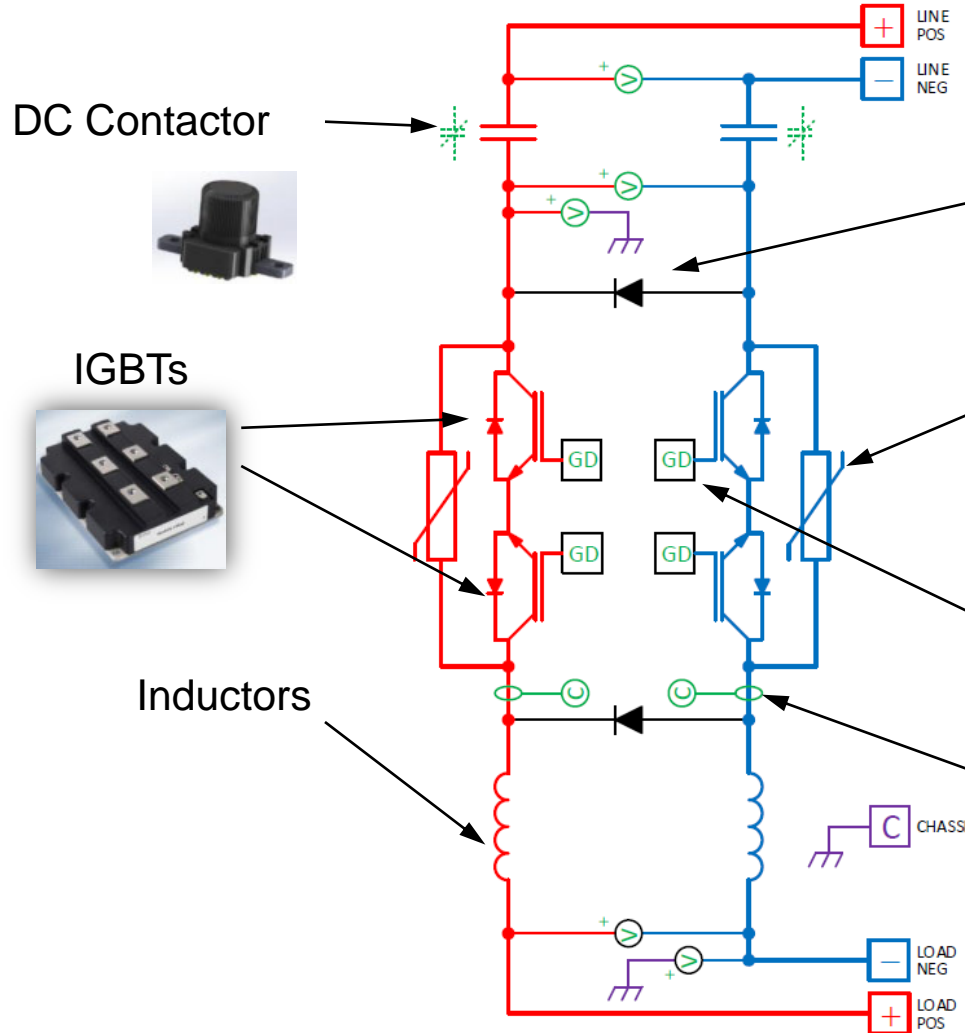
MOVs



Gate Drivers



Current Sensors



SC9000 EP Product Offering



SC9000 EP in a integrated control gear lineup

Air Cooled Single Inverter

Air Cooled Parallel Inverters

System Flexibility

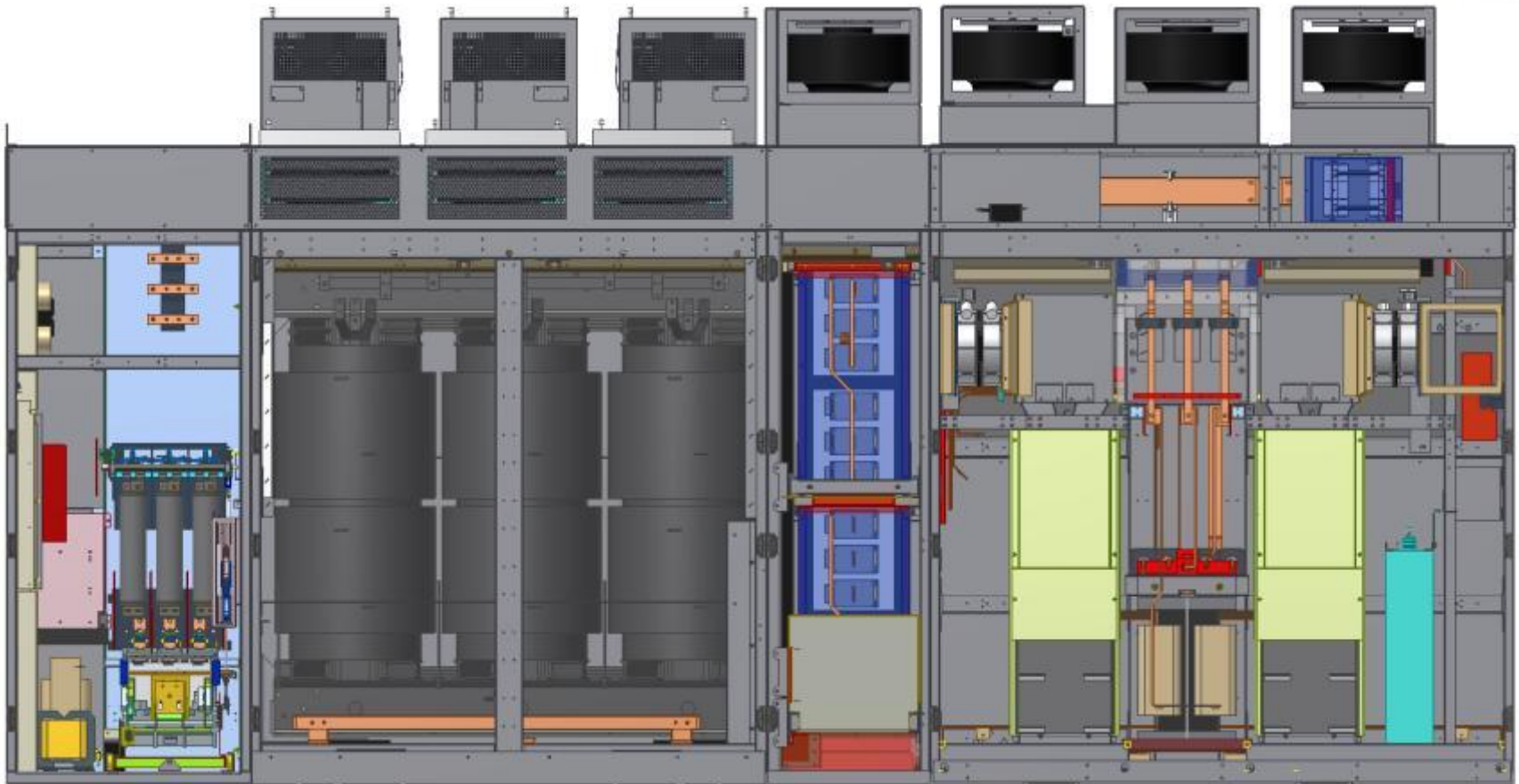
- 250 – 2500 hp @ 2400V
- 250 – 3500 hp @ 4160V
- 250 – 3000 hp @ 3300V

- 3750 –6000 hp @ 4160V
- 3250 – 5000 hp @ 3300V

- Arc Resistant!**
- Up to 13,800V input/output for pump & fan applications
- Bypass starters available
- Synchronous Motor Control

Eaton SC9000 EP Frame Size E

3250-4000 hp @ 3300V / 4750-6000 hp @ 4160V



222W x 92H x 50D

Eaton SC9000 EP Harsh Environment Duty



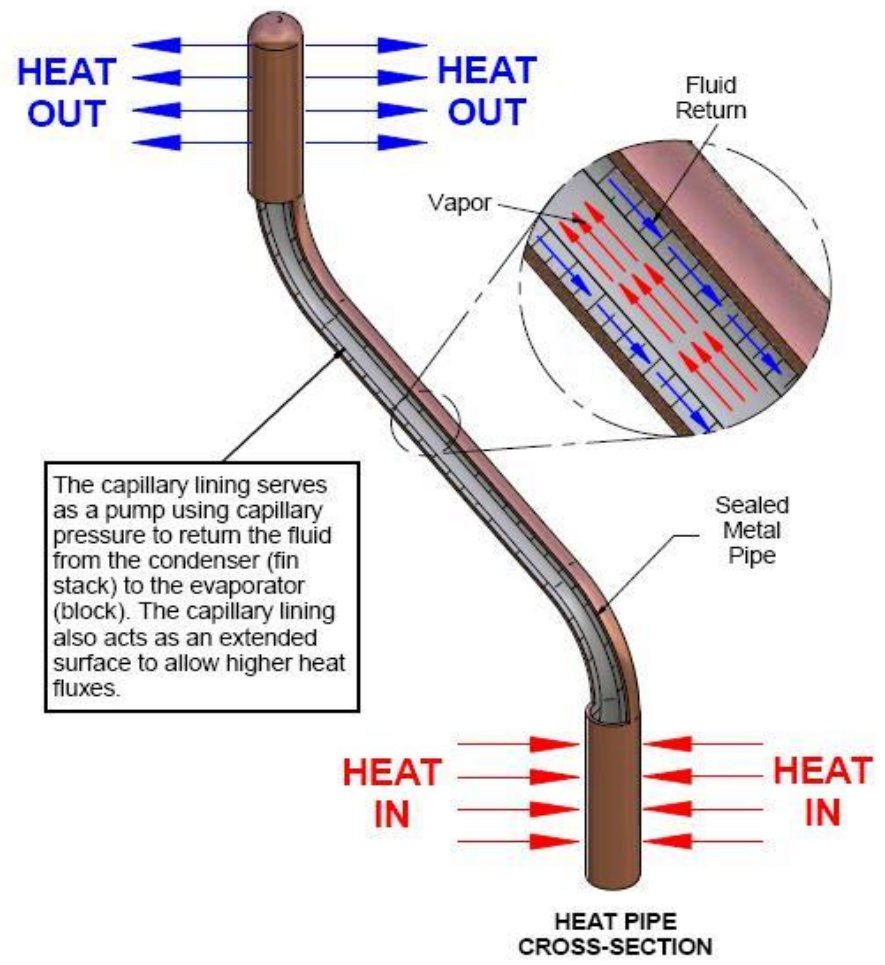
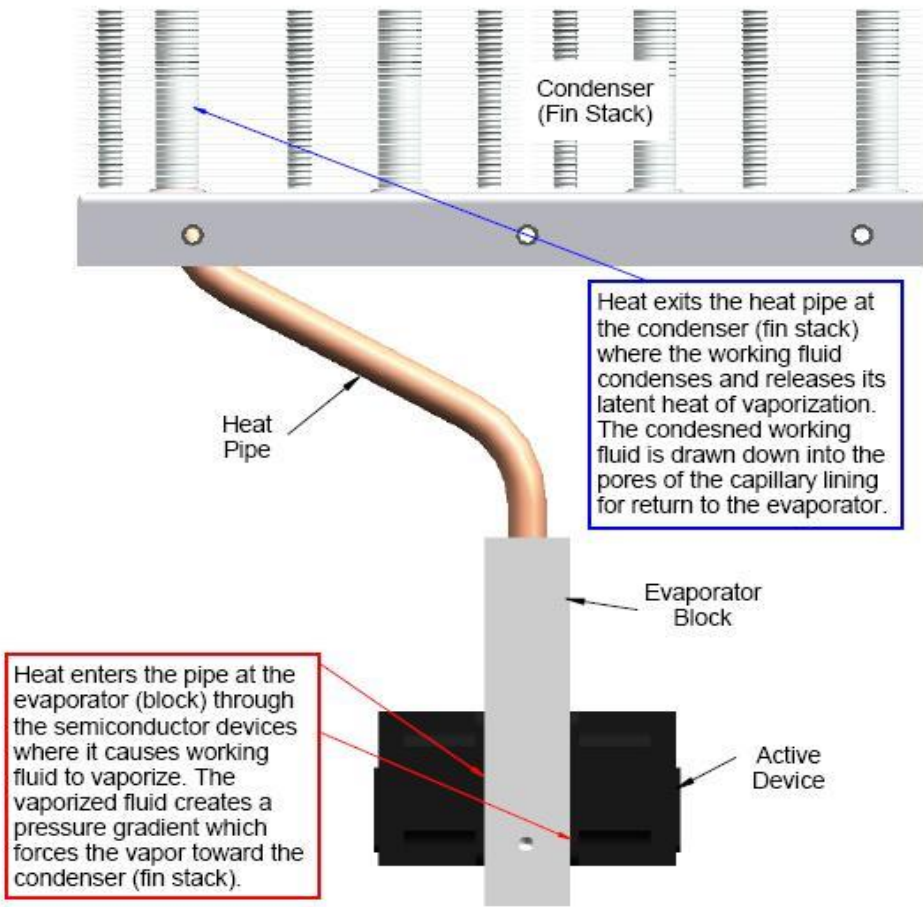
Powerpole sectionalizes the inverter into separate encapsulated phase sections versus one encapsulated Power Module

Powerpole offers low overall lifecycle costs while maintaining the patented environmental protection of the SC9000 EP – encapsulation of devices, conformal coating on controls, and mechanical barriers to prevent damage to adjacent components in the event of a fault.

The reliability (FIT) of the SC9000 EP remains high with the 3-Level topology

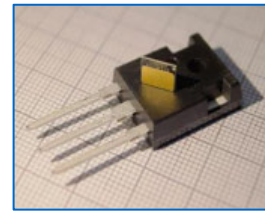
Ampgard SC 9000

Heat Pipe Thermal Management System



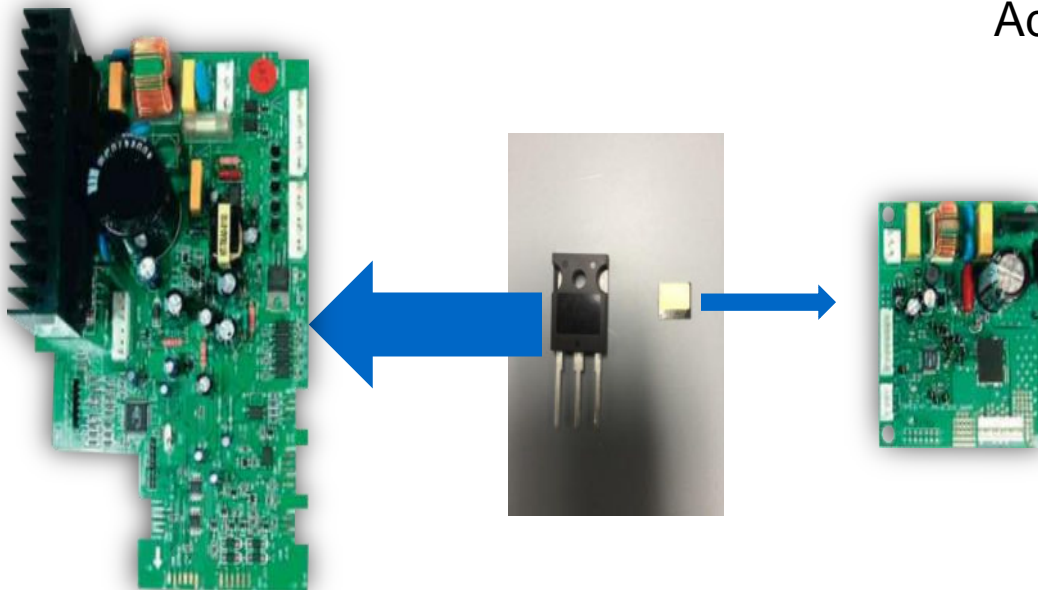
Closed and sealed system allowing for Harsh Environment applications

1-phase UPS using GaN devices



GaN for < 650V – for 1P UPS

Adapting existing UPS to GaN



SuNLaMP – Combined PV and battery grid integration using HF magnetics

Funding agency: DoE Solar Energy Program

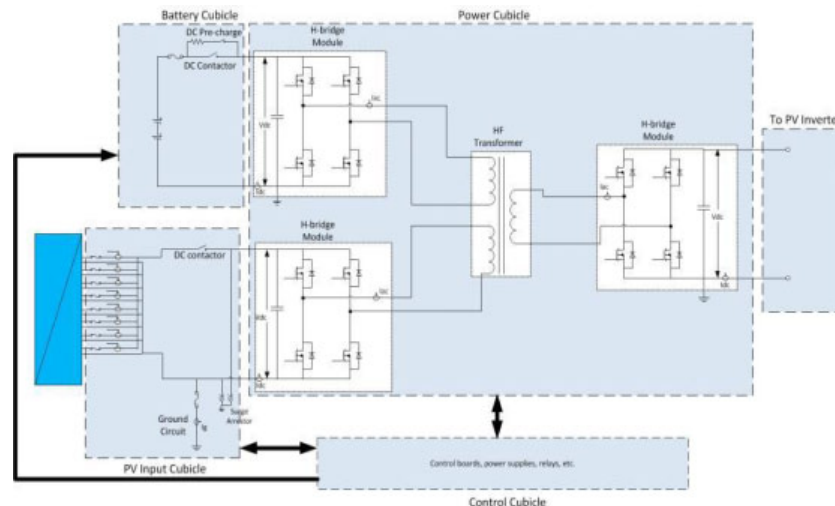
Opportunity

- WBG devices using topology that enables integrated filtering and bidirectional converter implementation to enable solid state voltage transformation, SST
- Renewables and energy storage integration in HF magnetic component at different voltages
- Investigate the potential of dc and grid integration in residential and small commercial applications

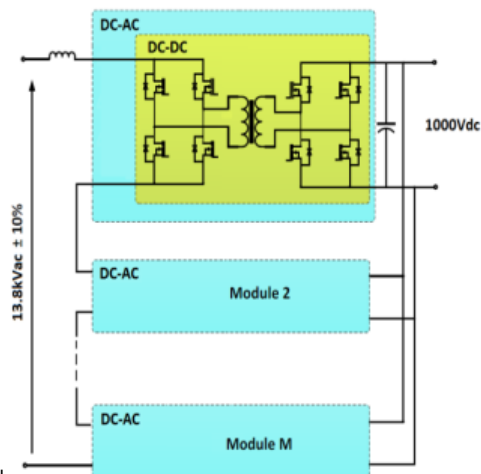
Program Description

- Conversion Efficiency > 98%
- Service Life 25 yrs
- Power Density 100 W/in³
- System control, gate drivers and embedded systems simulation to allow efficient integration to MV grid
- 50 kW, 1000 V converter and HF transformer design and demonstration
- Scaled up 2 MW, 13.8 kV converter and HF transformer paper design

Proposed Topology 50 kW, 1000 Vdc



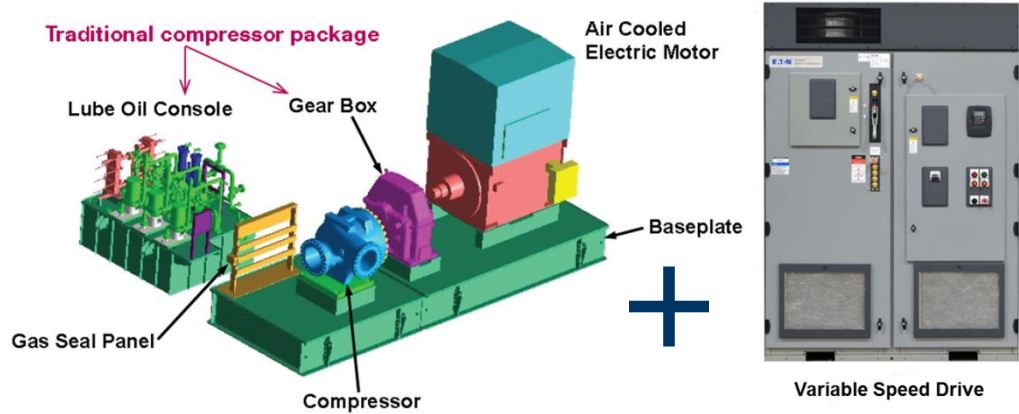
System Integration, 2 MW, 13.8 kVdc



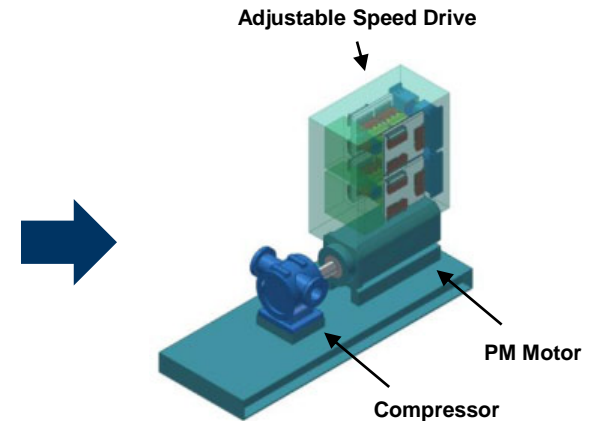
- Centralized module control
- Modules in Series/parallel for grid system integration
- OC/OV Protection
- Multi port for energy storage and PV integration

Value proposition – improve system efficiency & reliability

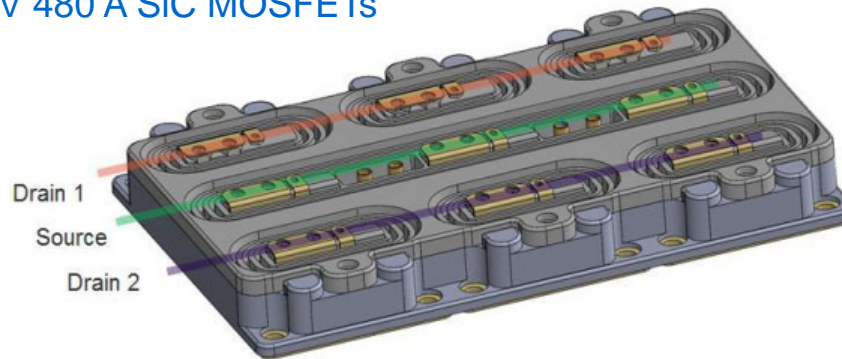
Traditional Solution



Integrated SiC ASD & Motor

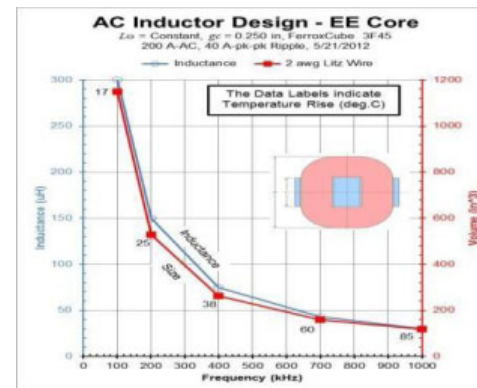
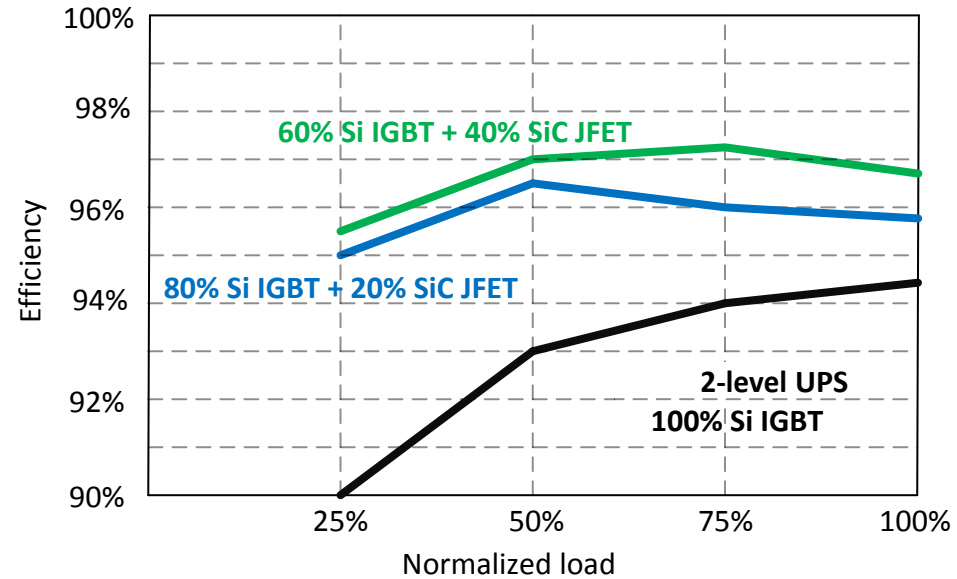


10 kV 480 A SiC MOSFETs



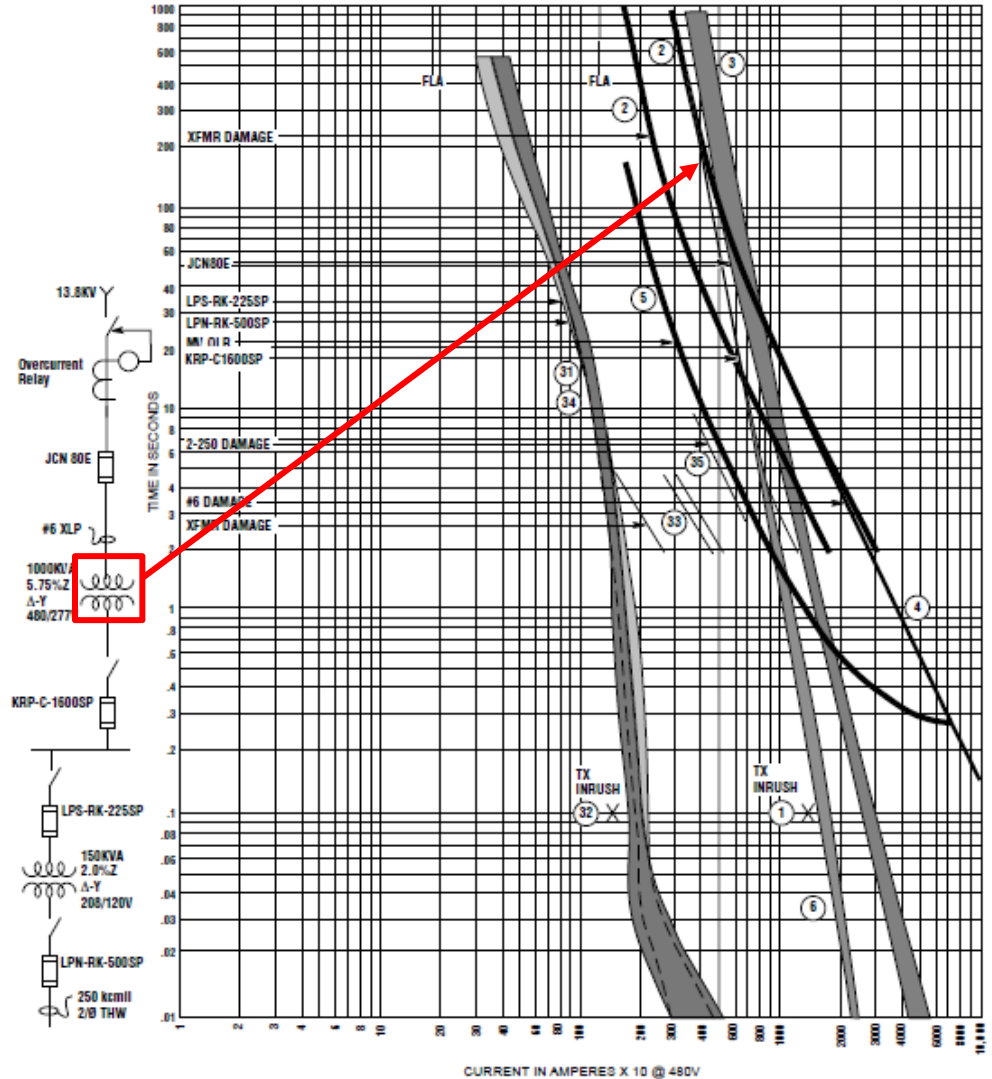
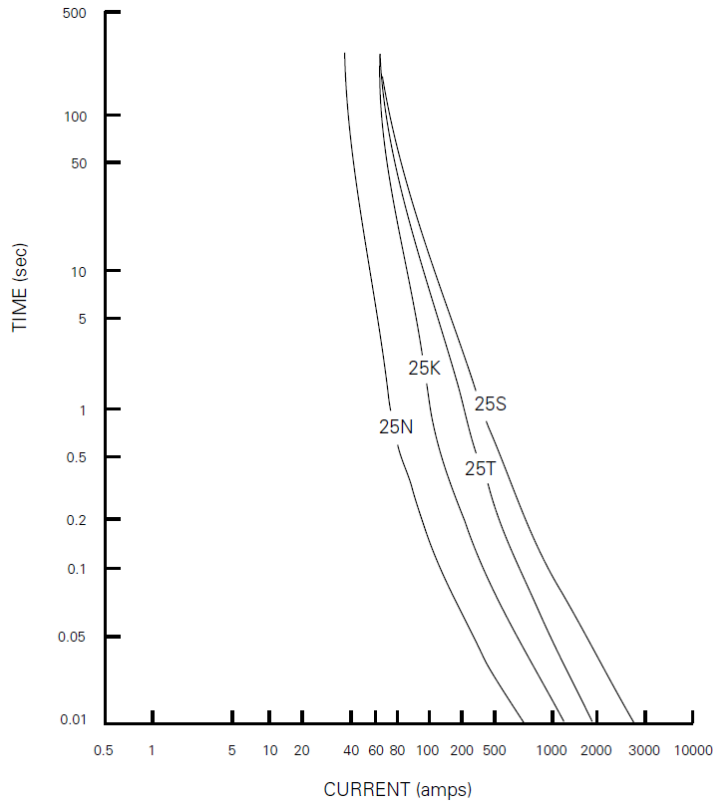
Technical advances continuing to shape the industry

- **Wide bandgap semiconductors and advanced magnetics** design resulting in higher efficiency power conversion - but high cost prevents wide commercial penetration
- **Faster DSP processors** and increased computational bandwidth further enabling advanced algorithms - "embedded software content" overcoming "hardware content"



Faster isn't always better... Selective coordination challenge

Cutout Fuse Link TCCs



EATON

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