Solid State Power Control in Smart Power Management & Distribution

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Introduction of SSPC on Military Vehicles

- Challenge: Reliability Impact of Thermal Mechanical Breakers and Relays
  - Wear-out Mechanism
  - Fused or Oxidized Contacts
  - Uncontrolled Turn-on and Turn-off Impacting the Load
- Solution: Solid-State Power Controllers
SSPC Basic Functionality

- Provides the Same Protection of Harnesses and Loads as Thermal Breakers, but with a Solid-State Circuit
- Control Turn-On to Drive Large Capacitive Loads
- Control Turn-Off to Prevent Spikes on Inductive Loads
- Minimize EMI

I²T Curve

Controlled Gate

Gate Control

28 VDC in

28 VDC out
Ground Vehicle History

- **M1A2 Abrams Tank**
  - SSPC Inserted in 1988
  - >200K Nodes Installed
- **M2A3 Bradley Fighting Vehicle**
  - SSPC Inserted in 2004
  - >200K Nodes Installed
- **SSPC Planned for...**
  - M88A2 Hercules Tank Recovery Vehicle
  - Paladin/FAASV M109 Self-Propelled Canon
  - MULE
  - JLTV
  - M-ATV
Power Distribution Challenges

New Challenges:

- Military Vehicles Require More Power, but have Limited Generation and Storage Capability Due to Weight and Size Constraints
- Power Systems are Inflexible, Making it Difficult to Configure Vehicles for Varying Missions

Solution: Smart Solid State Power Controllers

- Network Control
- Autonomous Monitoring
- Programmability
Power Control Architectures

- High Density Load Centers
  - One or More Power Distribution Units Handling Multiple Vehicle Loads
  - Implemented Using Multi-Channel SSPC

- Point of Load
  - SSPC Modules Located Near Loads

- Design Considerations
  - Cost
  - Space
  - Load Mix
  - Flexibility
Power Distribution Example

- Loads
- Operator's Control Panel
- Point-of-Load RPC
- Control Bus (e.g. CANbus)
- Alternator and Battery
- Multi-Channel RPC
- Light
- FLIR
- VHF Radio
- Gyrocam
- CROWS
- Satcom
Smart SSPC Capabilities

- Network Control (i.e., CAN SAE J1939, Ethernet)
  - State: On/Off
  - Status: Enabled/Tripped
  - Set Current Rating
  - Battle Override
- Enables...
  - Crew Offloading, Operating Mode Selection
Smart SSPC Capabilities (Cont.)

- Network Monitoring of Load Health/Status
  - Get Output Channel Voltage and Current
  - Get SSPC Board or Load Temperature
  - Voltage, Current and Temperature Alarms

- Enables...
  - Real-Time Power Management
    - E.g., Load Shedding
    - Situational Load Profiles
  - Diagnostics
  - Prognostics
Smart SSPC Capabilities (Cont.)

- Adaptability Features
  - Wide Channel Trip Programming Range
  - Channel Paralleling
  - TARDEC Power Management API
- Enables...
  - Reduced Development Time and Cost
  - Reduced Part Number Count (i.e., Common Modules)
SSPC Design Challenges

- EMI
- Thermal Management and Dissipation
- Ruggedization and Reliability
- Robustness
  - In-rush Current
  - Transient Suppression
  - Connectors
  - Immune to Sympathetic Tripping
Technology Trends

- Diagnostics/Condition-Based Maintenance
  - Arc Fault Detection
  - Fault Location
  - Data Logging
- Increased Power Densities
  - Higher Current Density SSPC's
  - Move to 610Vdc Primary Power Distribution
- Silicon Carbide FETs
Questions