Solid State Power Control in Smart Power Management & Distribution

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Introduction of SSPC on Military Vehicles

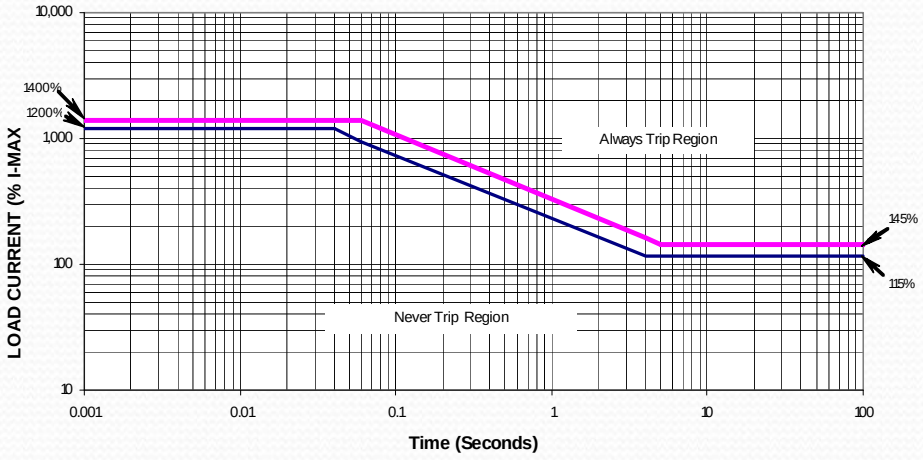
- Challenge: Reliability Impact of Thermal Mechanical Breakers and Relays
  - Wear-out Mechanism
  - Fused or Oxidized Contacts
  - Uncontrolled Turn-on and Turn-off Impacting the Load
- Solution: Solid-State Power Controllers

SSPC Basic Functionality

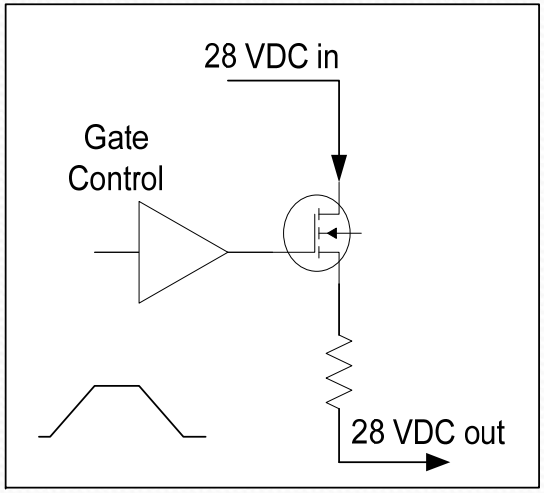
- Provides the Same Protection of Harnesses and Loads as Thermal Breakers, but with a Solid-State Circuit

- Control Turn-On to Drive Large Capacitive Loads
- Control Turn-Off to Prevent Spikes on Inductive Loads
- Minimize EMI

I^2T Curve



Controlled Gate



Ground Vehicle History

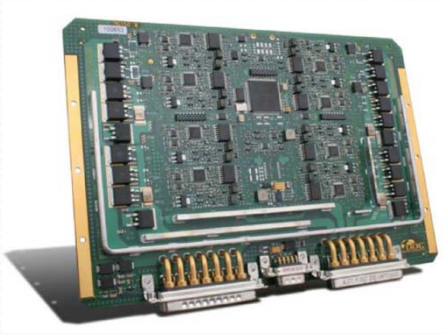
- M1A2 Abrams Tank
  - SSPC Inserted in 1988
  - >200K Nodes Installed
- M2A3 Bradley Fighting Vehicle
  - SSPC Inserted in 2004
  - >200K Nodes Installed
- SSPC Planned for…
  - M88A2 Hercules Tank Recovery Vehicle
  - Paladin/FAASV M109 Self-Propelled Canon
  - MULE
  - JLTV
  - M-ATV

Power Distribution Challenges

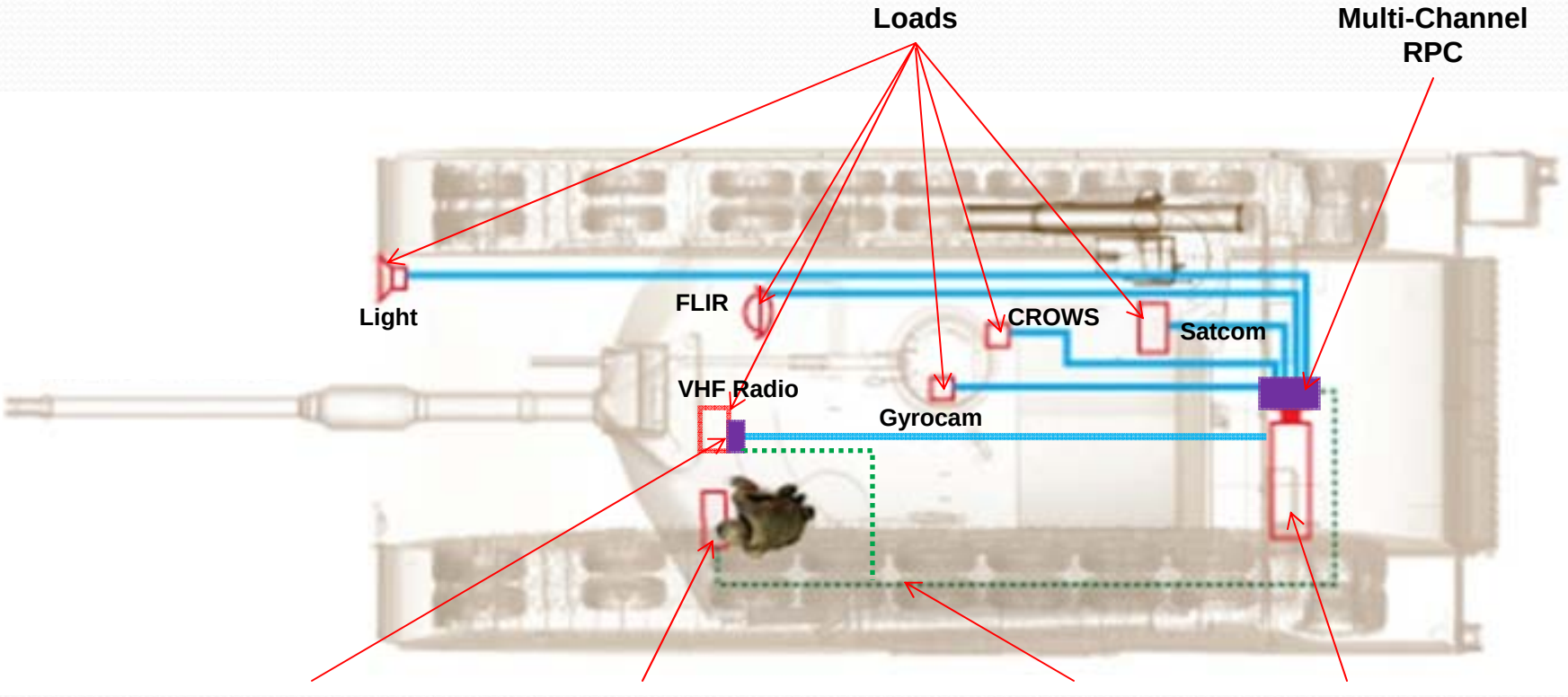
- New Challenges:
  - Military Vehicles Require More Power, but have Limited Generation and Storage Capability Due to Weight and Size Constraints
  - Power Systems are Inflexible, Making it Difficult to Configure Vehicles for Varying Missions
- Solution: Smart Solid State Power Controllers
  - Network 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



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