› Imperium ™ Products
"*Power to Command*"

High Voltage / High Current Connector Systems

molex®
one company › a world of innovation

Imperium Connector Overview

- **Target Amperage Rating**
  - 230A to 400A “continuous” at 70 C
  - Actual ratings influenced by application and duty cycle
    - 8mm pin size, 1/0 wire
    - 11mm pin size, 3/0 wire
- **Sealed and Shielded**
  - IP6K9K Mated
- **Voltage rating**
  - 1000 VDC

SERIES:

171466-1* Cable Harness (Single Ended)**
171466-2* Cable Harness (Double Ended)**
171467-** Bulkhead Mount Header Assembly**
171466-9* Cable Harness Component Kit**

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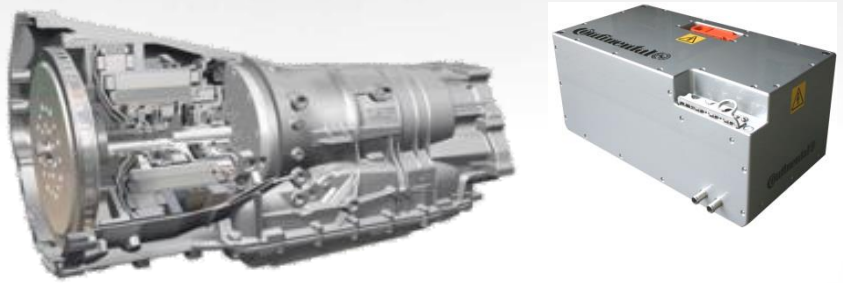
Imperium Connector Applications

- **High Voltage Battery Packs**
  - Integrated Interlock Signal
  - Double-Locking Safety Latch
  - Integrated Interlock Signal
  - 11mm pin size, 400A
  - 8mm pin size, 250A
- **High-Power Inverters**
  - High Voltage 2-terminal Input Current
  - Motor Phase Current (3-terminal version)
- **DC-DC Converters**
  - 2-terminal input current
  - MAXLOC single-terminal output
- **Motor Phase Lead Connections**
- **Harness Assemblies**
  - Molex supplies flexible & shielded interconnecting harnesses with Imperium or MAXLOC connectors

Li-Ion Battery Packs



Hybrid Transmissions

Power Electronics

EV Motors/Drives

EV Harnesses

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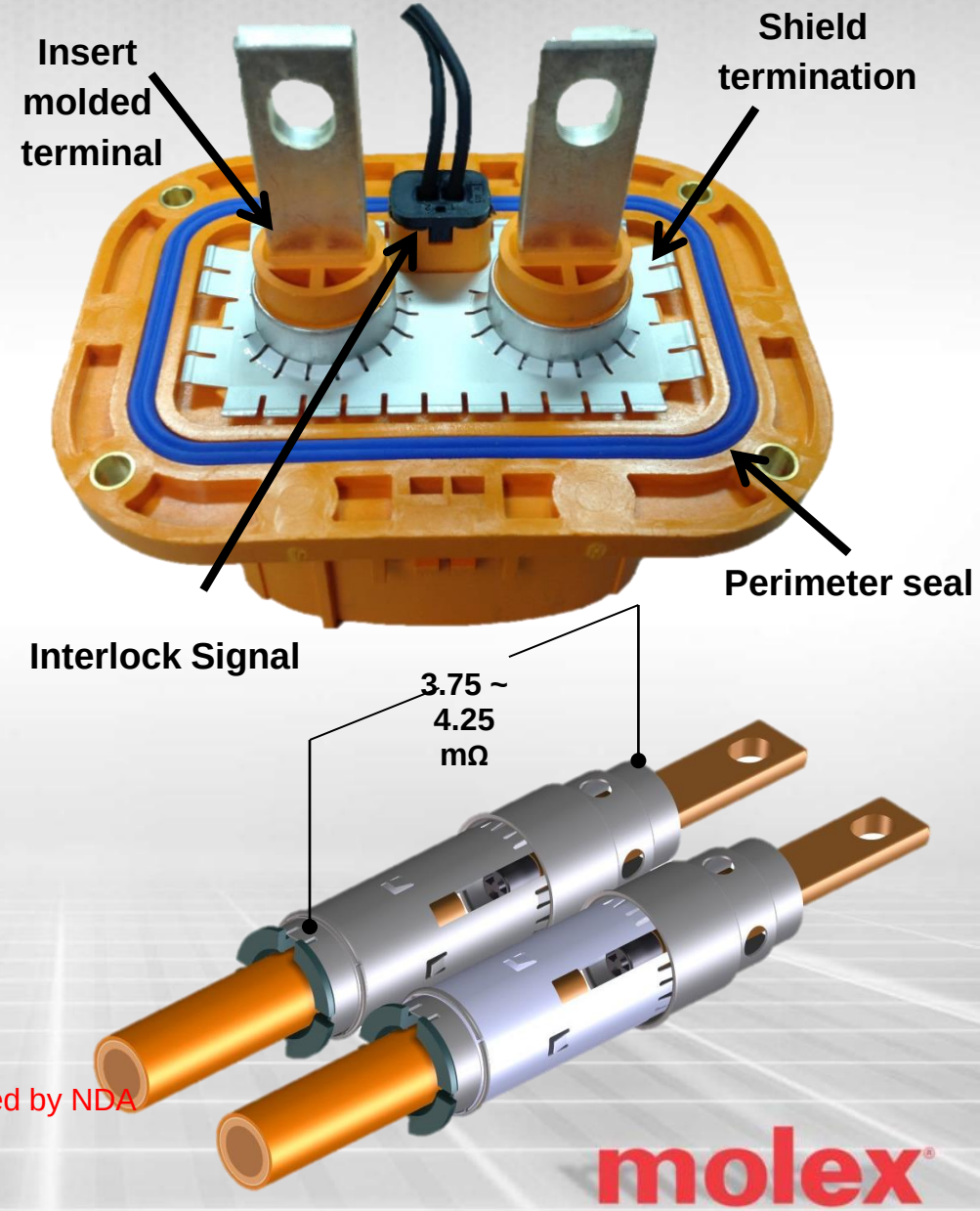
Imperium™ EMI Header design

- **Innovative bulkhead header shield termination for lowest possible shield impedance.**
- **Fully shielded power contacts from cable to bulkhead.**
- **Insert molded header for robust contact retention and sealing.**
- **Bus bar mount from back of header.**
- **Perimeter seal mounts directly to bulkhead reducing potential for tearing.**



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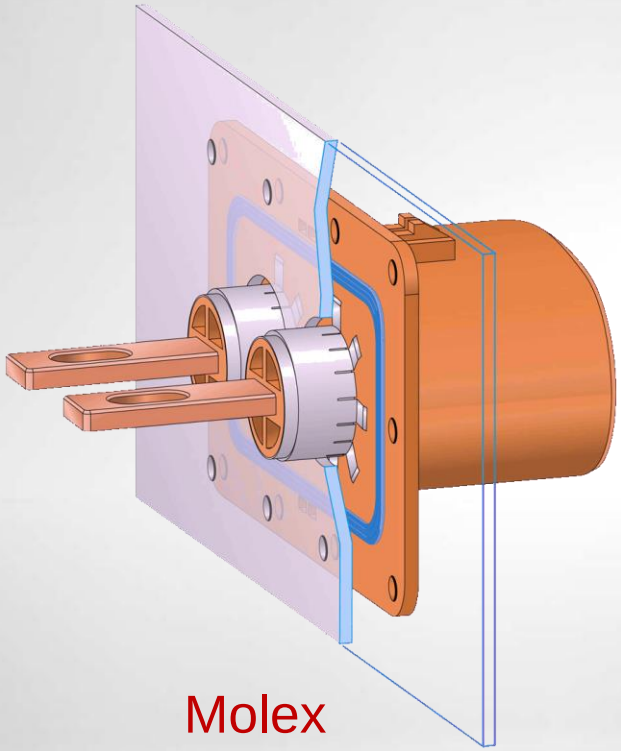
Molex Advantages - Header Seal Design



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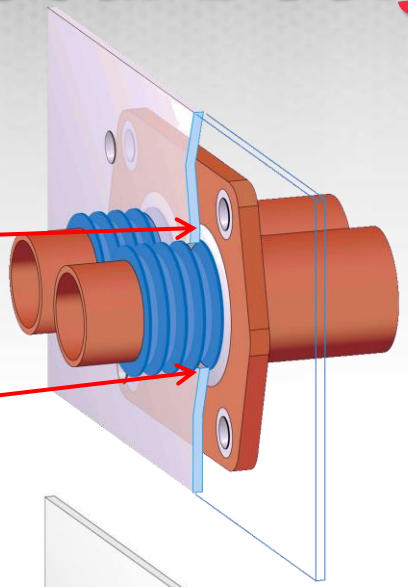
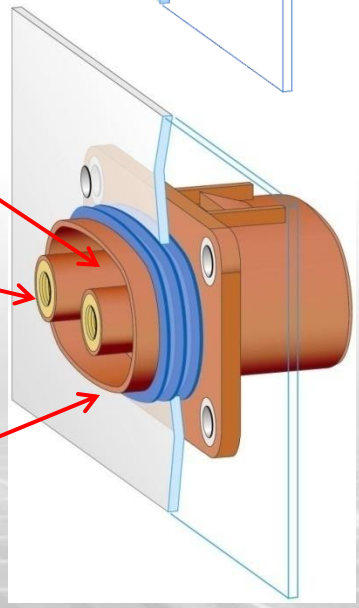
Competitor



Exposed shield – potential for corrosion

Potential water penetration when using sheet metal



Additional shield assy required during mfg

Must attach bus bar horizontally

Tight machine tolerances – difficult to manufacture

Potential for seal rolling/pinching during insertion

Imperium™ Terminals

- **Unique single piece contact design**
  - No moving parts
  - High long term reliability
- **Large cross section**
- **Pure copper for high conductivity**
- **Contact resistance in the 50 micro Ω range**
- **Robust hex crimped or vibration welded to wire**
- **Silver plated and lubed**
- **Anti overstress spring to maintain normal force**
- **Low cost since not machined**
- **Busbar attachable**

Female Crimp

Male Header Pin

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Imperium™ Terminals

- Flexible terminal geometry
- Can be integrated into a variety of housing styles and applications.
- Pluggable gland design with our MAXLOC product.
- Molex can modify geometry to match application.
- Terminals available in 8mm and 11mm pin diameter today but scalable to other sizes as well.
- Also developing a high cycle hyperboloid version for 3K to 5K insertion cycles.

Female cable bolt-on

Female bolt-down to busbar

Male Crimp

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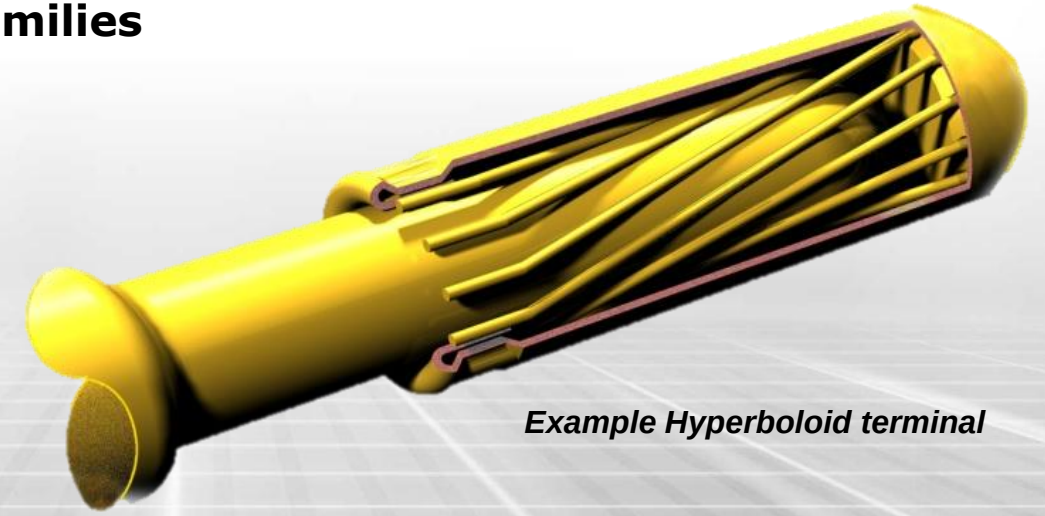
Imperium™ Terminals

- High Cycle/Low mating force version in development
- Mating cycles in the thousands
- Designed to mate with Imperium male
- 32 wire contact hyperboloid contact
- 8mm diameter up to 230A at 70C
- Excellent for High Shock/Vibe
- 11 Newton mating force per contact
- Planned terminal diameter families
  - 4-5 mm 80-100A
  - 6 mm 150A
  - 8.0 mm 200-250A
  - 11.0 mm 400A
  - Up to 14 mm 500A

Female High-Cycle Low-Insertion-Force



Example Hyperboloid terminal

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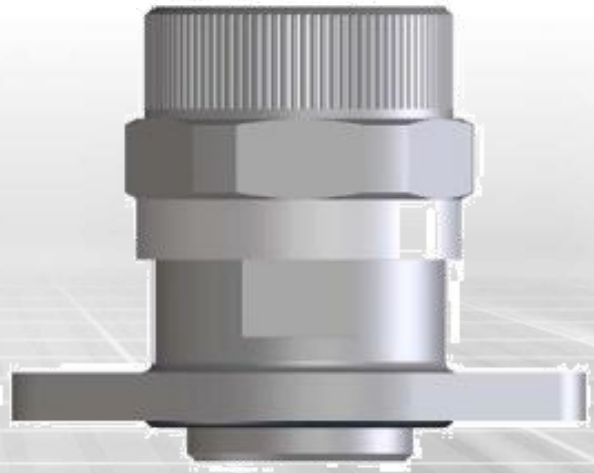
Imperium MAXLOC® Connector

Features

- Connects cable shield to enclosure
- Mounts from outside of enclosure
- Shield Ring held tight by grommet
- Sealed IP67 & IP69K & IP68
- Strain relief
- 1 AWG, 1/0 to 4/0 cable
- Die cast construction
- Cost effective
- Nickel plated to address galling
- Positive stop for compression nut
- Center and offset lug pull thru
- Multi-hole grommets can be used for multi-conductor cable for smaller wire sizes.
- 2 grommet material choices.

Benefits

- Shields EMI/RFI
- Easy to assemble onto cable
- Fast installation on the assy. line
- Sealing allows use in wide variety of applications.
- Single foot print for multiple cables.
- Low cost - high performance
- Anti back-off of compression nut.
- Allows lugs to be pulled through body



MAXLOC® Plus

Nickel Plated Aluminum Construction

STOP RING

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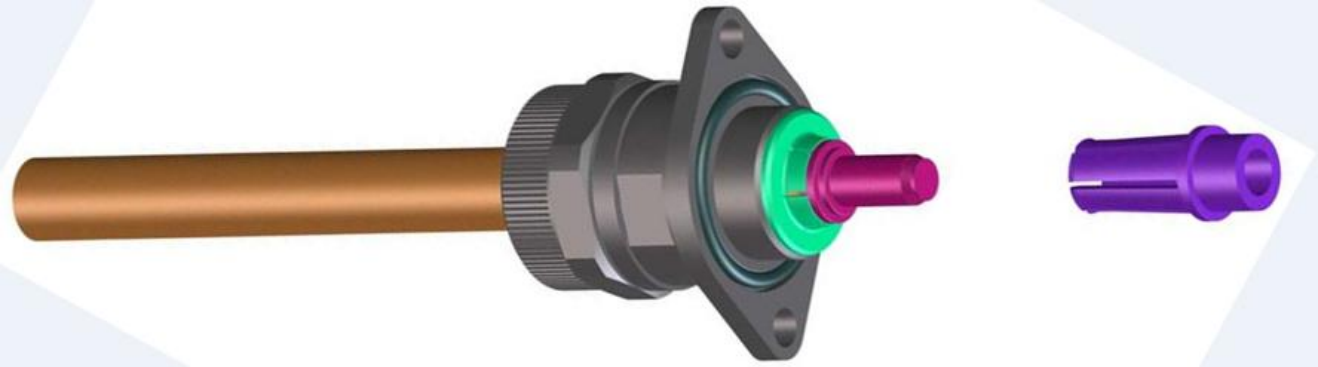
Imperium Pluggable MAXLOC

- **Fully sealed and shielded pass through, just like MAXLOC Plus, except it's a connector!**
- **New type of pluggable connector**
  - Uses Imperium pin and socket
    - Replaces battery lug
    - Available with Hyperboloid H-C/L-I-F terminal
- **Supports 1 AWG - 3/0 shielded wire**



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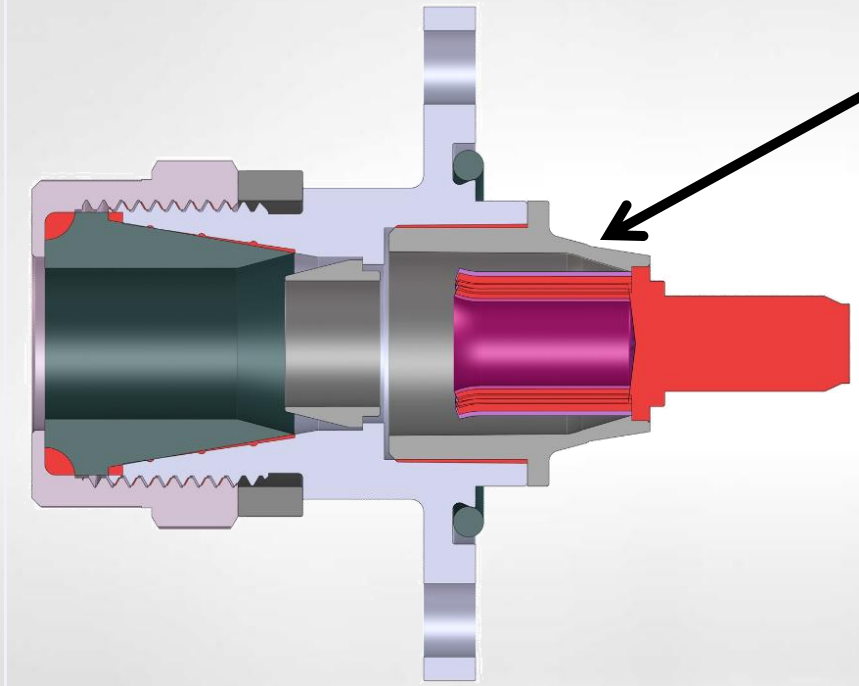
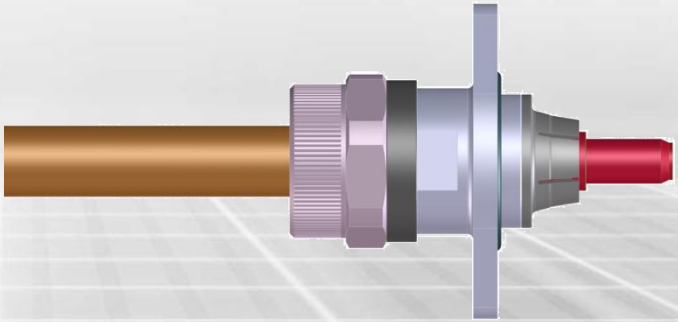
Imperium Pluggable MAXLOC

Crimped Barrel or Ultra-Sonic Welding for Plug to Cable



Cross Section



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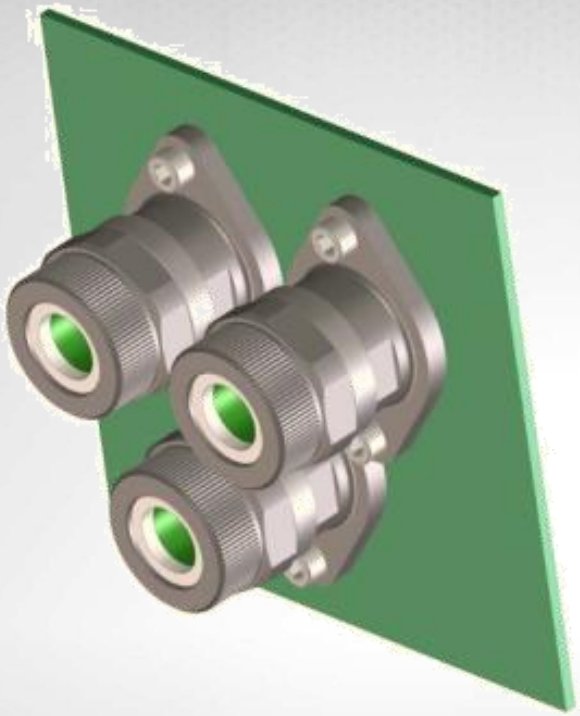
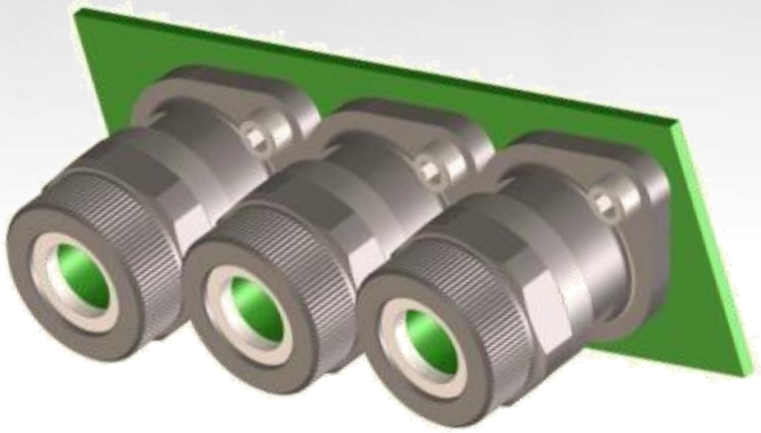
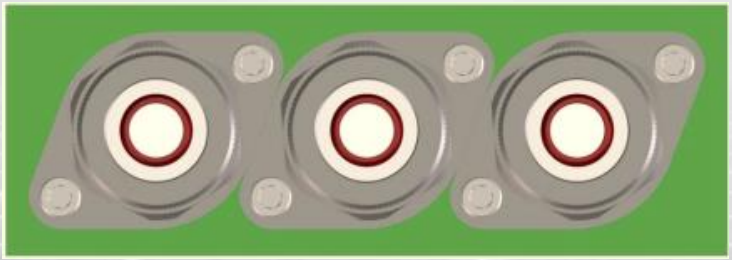
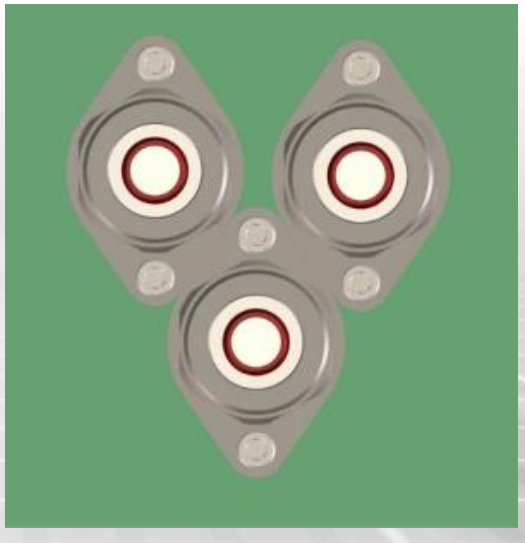
Multi-MAXLOC Mounting Options









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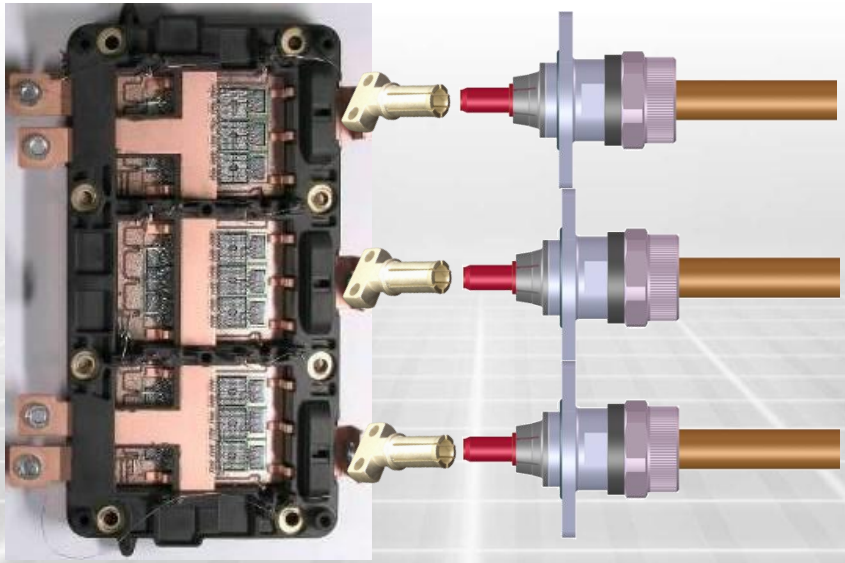
Imperium MAXLOC

Power-Module Application

- Imperium Receptacle:
  - Attach female contact to bus bar or IGBT module
  - Mates using either Imperium Connector or MAXLOC design
- Mating Harness:
  - Pluggable MAXLOC or Imperium connector attached to cable.



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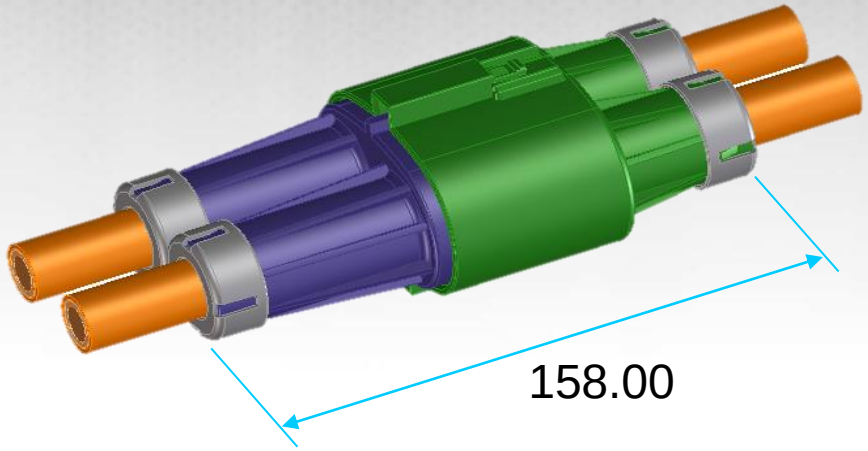
Imperium MAXLOC

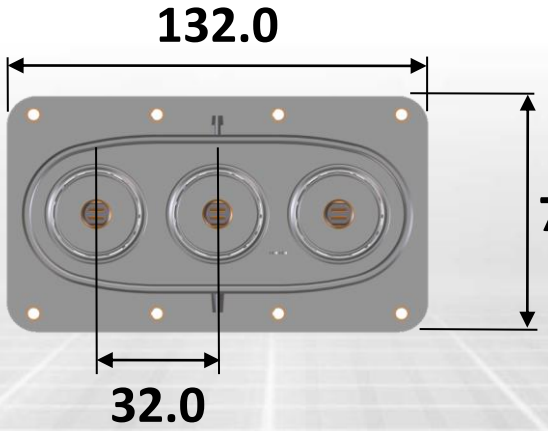
Features:

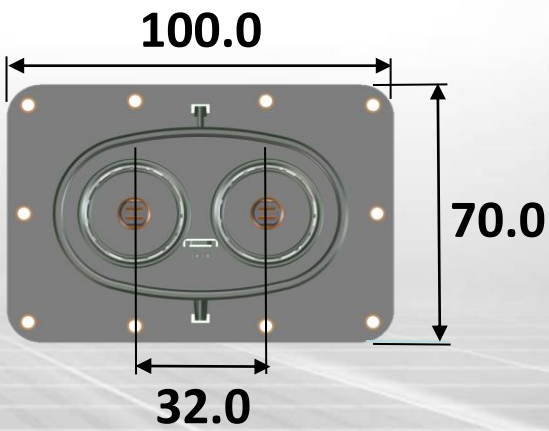
- Uses a cost affective pass-through for large wire applications, 1awg-4/0
- Amp rating up to 400 amp continuous, 500 amp intermittent.
- Ease of manufacturing
  - "Permanent" pluggable solution
  - Assembly does not require second access door to connect power contact
  - Does not require HVIL on connector due to bolted design
    - HVIL could be integrated into device, via secondary access panel
    - Similar solution as most electric motors

Imperium™ Product Options

- **3 circuit Wire to Bulkhead**
- **2 and 3 circuit Wire to Wire**
- **Right angle wire exit**
  - With mate assist
- **1 AWG wire version**
- **100 to 200 amps**
  - 4AWG to OAWG
- **300 to 400 amps**
  - 2/0 to 4/0
- **Versions without shielding, sealing**

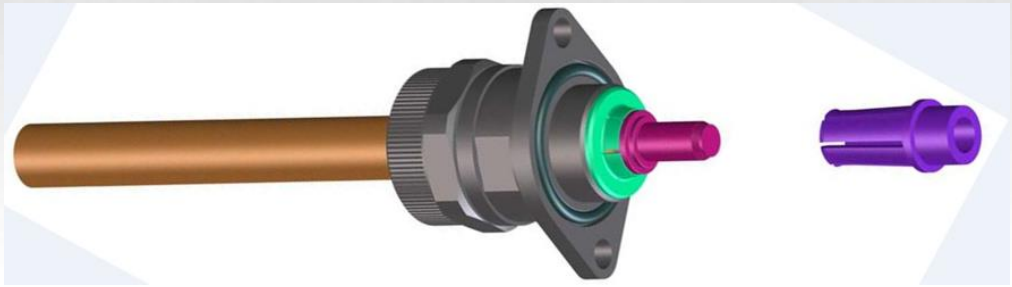






Custom Applications - Sensors

- MAXLOC pluggable
- 11mm diameter Imperium™ male
- Bolt down female terminal
- Custom housing with integrated current sensor
- Mounts onto IGBT bus bar
- Multiple terminal designs possible
- Uses MAXLOC cable gland



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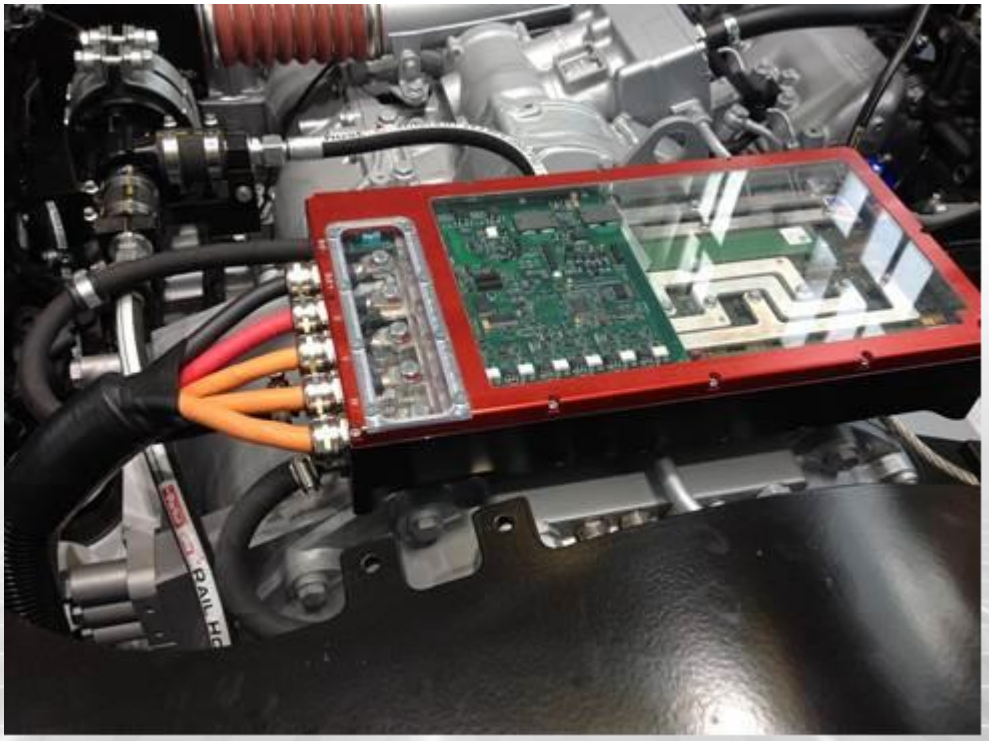
Target Markets & Applications

- **Electric Vehicle (EV)/Hybrid Vehicle(HV)/Plug in hybrid (PHEV)**
  - Toyota Prius, Nissan Leaf, Tesla, Fisker, Siemens, Renault, Bosch
- **Agriculture and Construction Equipment**
  - John Deere, CAT, Case New Holland, AGCO, Fendt, Parker Hannifin
  - Custom Imperium solutions targeted in this space due to inverter size
- **Medium Duty and Heavy Duty Commercial Vehicles**
  - Smith Electric, SEVCON, Navistar, Allison Transmission, ZF Hybrid Transmission, BAE, JCI, Eaton, Cummins, Paccar (Peterbuilt), etc.
- **Hybrid Bus Applications**
  - New Flyer, Novabus (Volvo), Gilig, Allison Transmission, BAE
- **Military Applications**
  - Oshkosh, Raytheon, Saft, BAE
- **Recreational Vehicles**
  - Polaris, Seadoo (BRP)

Next Gen Inverter Applications



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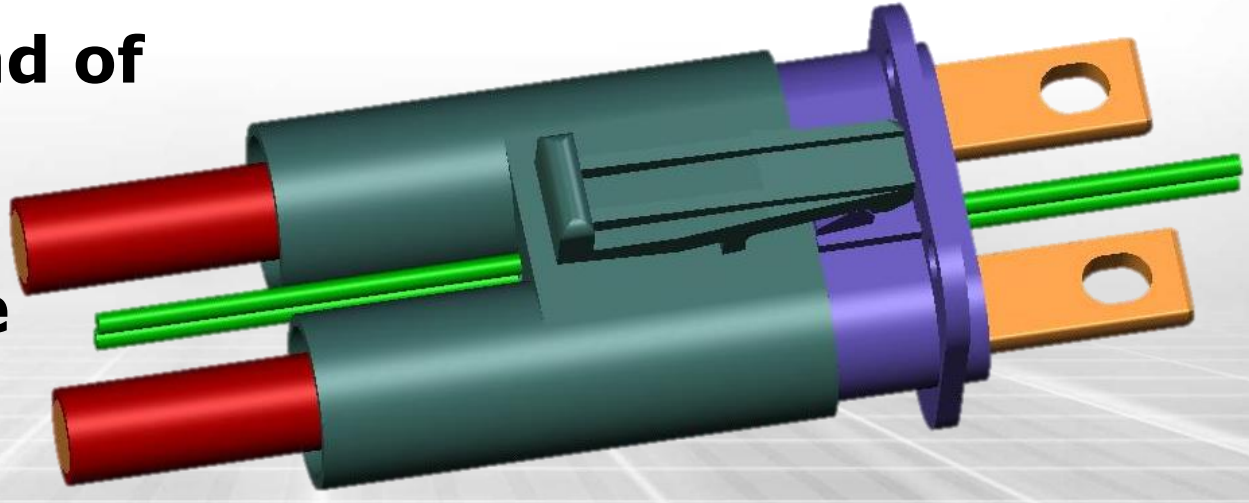
Tractor-to-Implement Applications

- High Current
- Low Voltage (56V)
- 150A and 300A versions
- Makes use of e-Power instead of hydraulics
- Can utilize Imperium base contact set.



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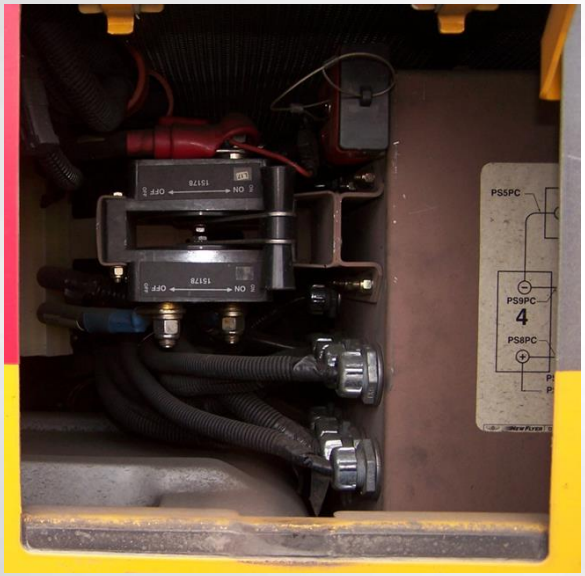
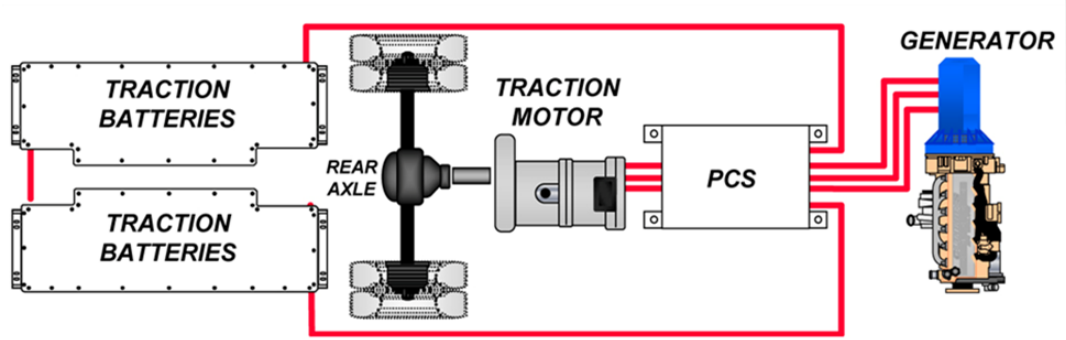
Hybrid Bus Applications

- New Flyer, Novabus and BAE Systems build hybrid buses
- Allison transmission & ZF build hybrid drivetrains





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CV Hybrid Utility Applications

Odyne/JCI builds hybrid utility vehicles

Odyne Systems of Waukesha awarded plug-in hybrid system contract

Courtesy of Odyne Systems of Waukesha

A ComEd digger derrick truck is shown plugged into an Odyne Systems hybrid power system.

By *Thomas Content* of the Journal Sentinel June 6, 2013

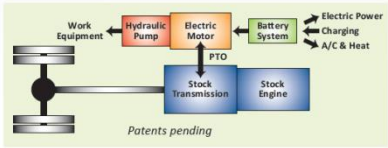
Odyne Systems of Waukesha has received a contract to supply its plug-in hybrid system technology to about 120 large plug-in hybrid trucks to utilities under a $45 million contract with the research arm of the utility industry.

The Electric Power Research Institute in Palo Alto, Calif., awarded the funding to Odyne as part of a federal Department of Energy initiative supporting electric vehicle commercialization. The South Coast Air Quality Management District in southern California is also a partner in the project.

Johnson Controls' power solutions business, based in Glendale, said it will supply advanced lithium-ion batteries for the Odyne system.

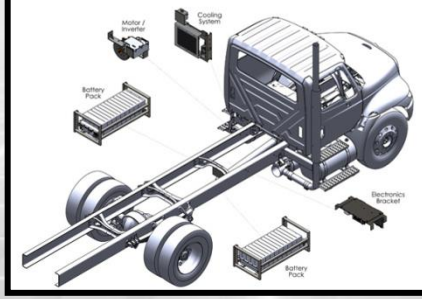
The contract marks a "significant" step toward high-volume production of hybrid systems that are built onto the chassis of a diesel utility truck, said Joe Dalum, president of Odyne.

Odyne Parallel Hybrid System Diagram



Odyne Parallel Hybrid System Truck View

Mechanical back-up.



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MOLEX CABLE ASSEMBLIES

- **Molex can build and assemble complete harness/connector systems in a variety of styles.**
- **Crimp Tooling for Lugs & Terminals is in our Juarez plant now.**
- **Ultra-Sonic welding**
  - Working on new terminal now with multiple vendors.
  - Most reliable connection available.
  - Low cost.
  - Molex will offer this option.

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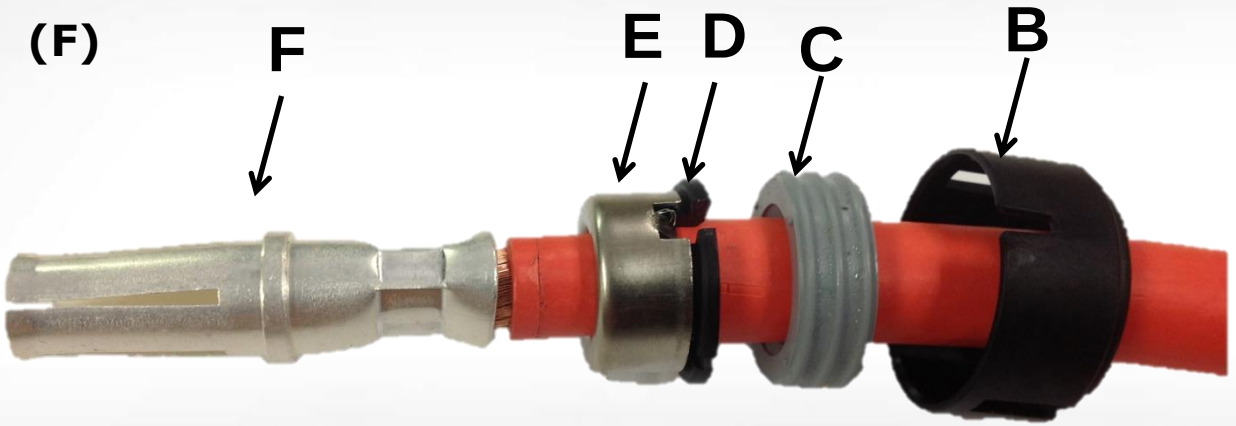
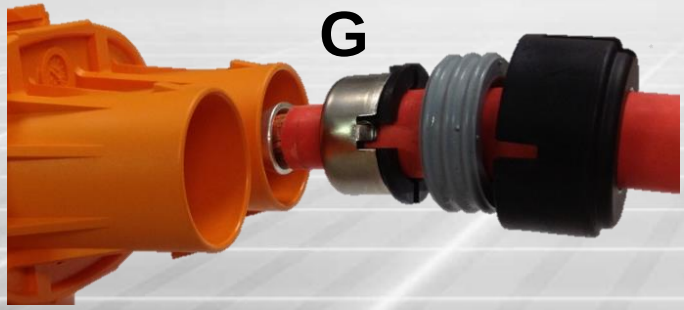
Imperium™ Cable Assembly Steps

- Prepare cable- Strip/Retain and cut (A)
- Insert Top Cover onto cable (B)
- Insert Cable seal onto cable (C)
- Insert Shield inner and outer ferrule onto cable and seat them with shield ferrule terminator tool. (D and E)
- Crimp Terminal (F)

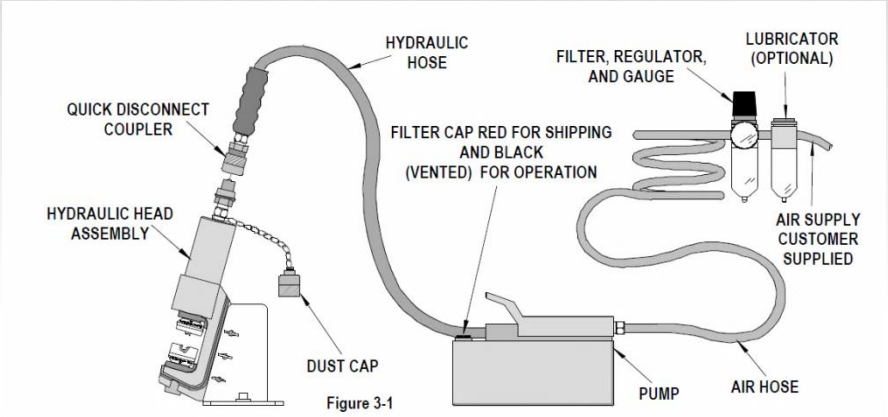


- Insert terminated cable into receptacle subassembly (X2). (G)
- Seat Top Cover onto receptacle subassembly. (X2) (H)

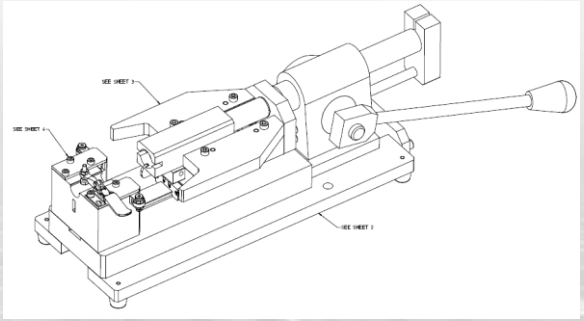


Imperium™ Application Tooling

- **Molex will offer application tooling to support assembly.**
- **PPHHLS -19286-1000**
  - $6000.00 USD per unit
  - 6 weeks leadtime
- **Bench Mount 19286-0051**
  - $1400.00 USD per unit
  - 6 weeks leadtime

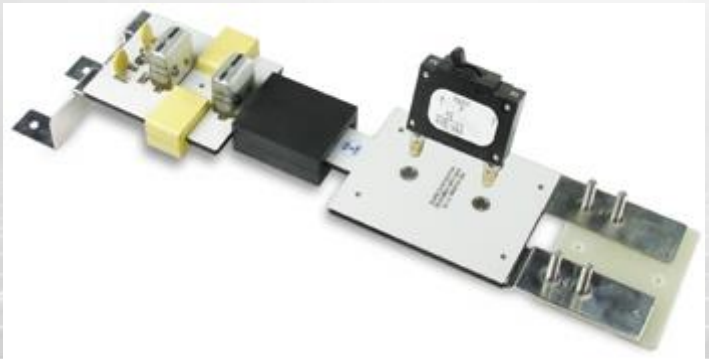


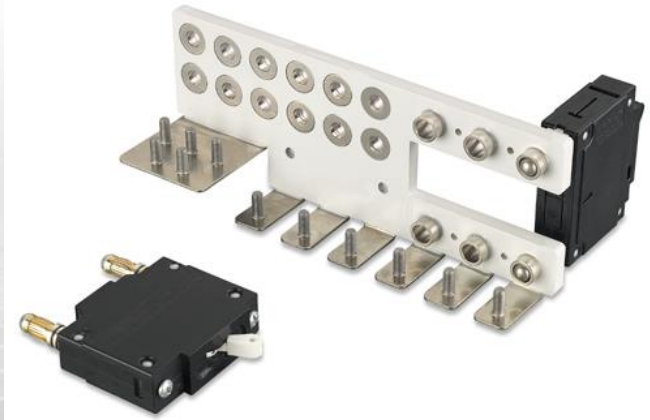
- **Crimp Dieset- 19290-0080 for 1/0 and 19290-0100 for 1 awg**
  - $700.00 USD per unit
  - 6 weeks leadtime
- **Shield Ferrule Terminator 62203-0600**
  - $6000 to $8000 estimated cost.
  - 6 to 8 week leadtime.



Potential Bus Bar Applications

- **Molex Laminated Bus Bars**
  - Reduce Weight and Space
  - Increase Reliability & Endurance
  - Form Factor (TM, Stiffening, Mount Platform)
  - Reduce Noise
  - Provide Interconnect Flexibility
  - Enhance Appearance and Environmental Compliance

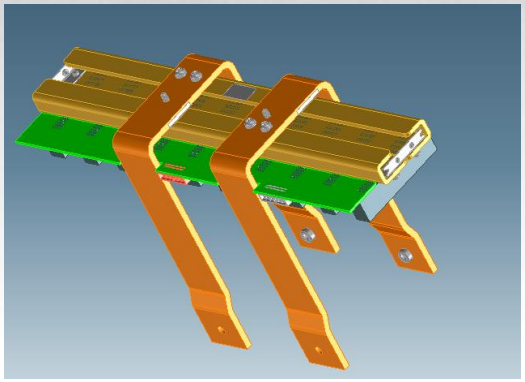


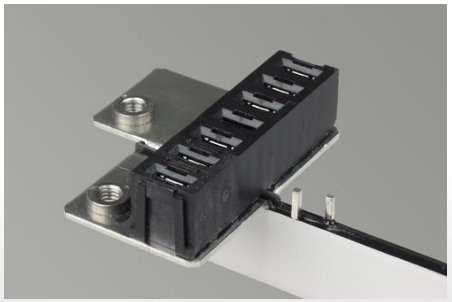


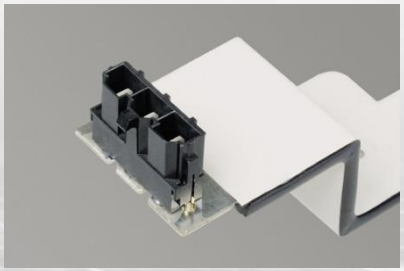
Potential Bus Bar Applications

Energy Management

- Solar Energy Systems
- Wind Generators
- Fuel Cells
- Hydro-Electric
- Turbine Generators
- AC to DC Converters
- DC to AC Inverters
- DC to DC Converters







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Thank You

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one company › a world of innovation

Additional Information

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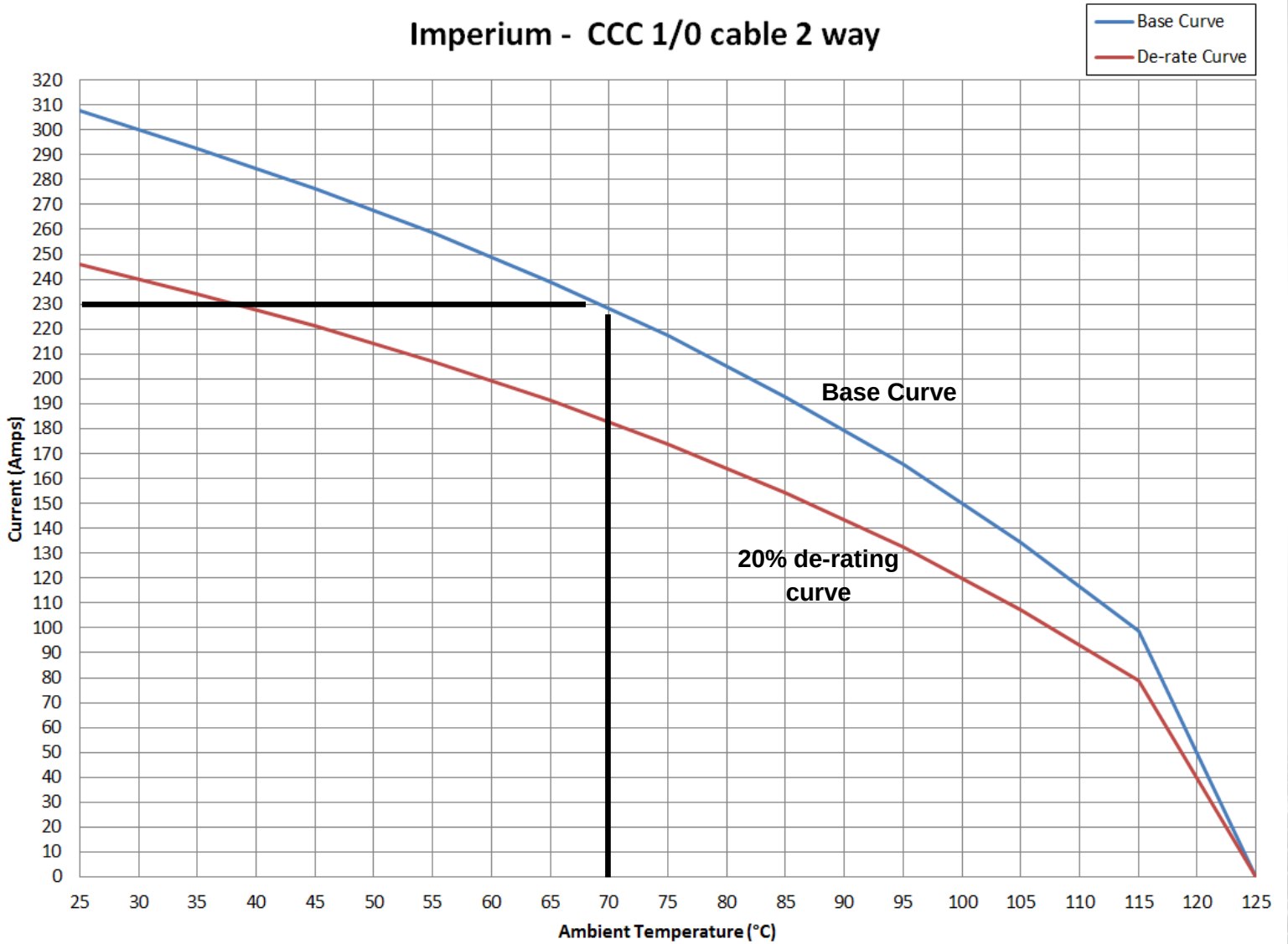
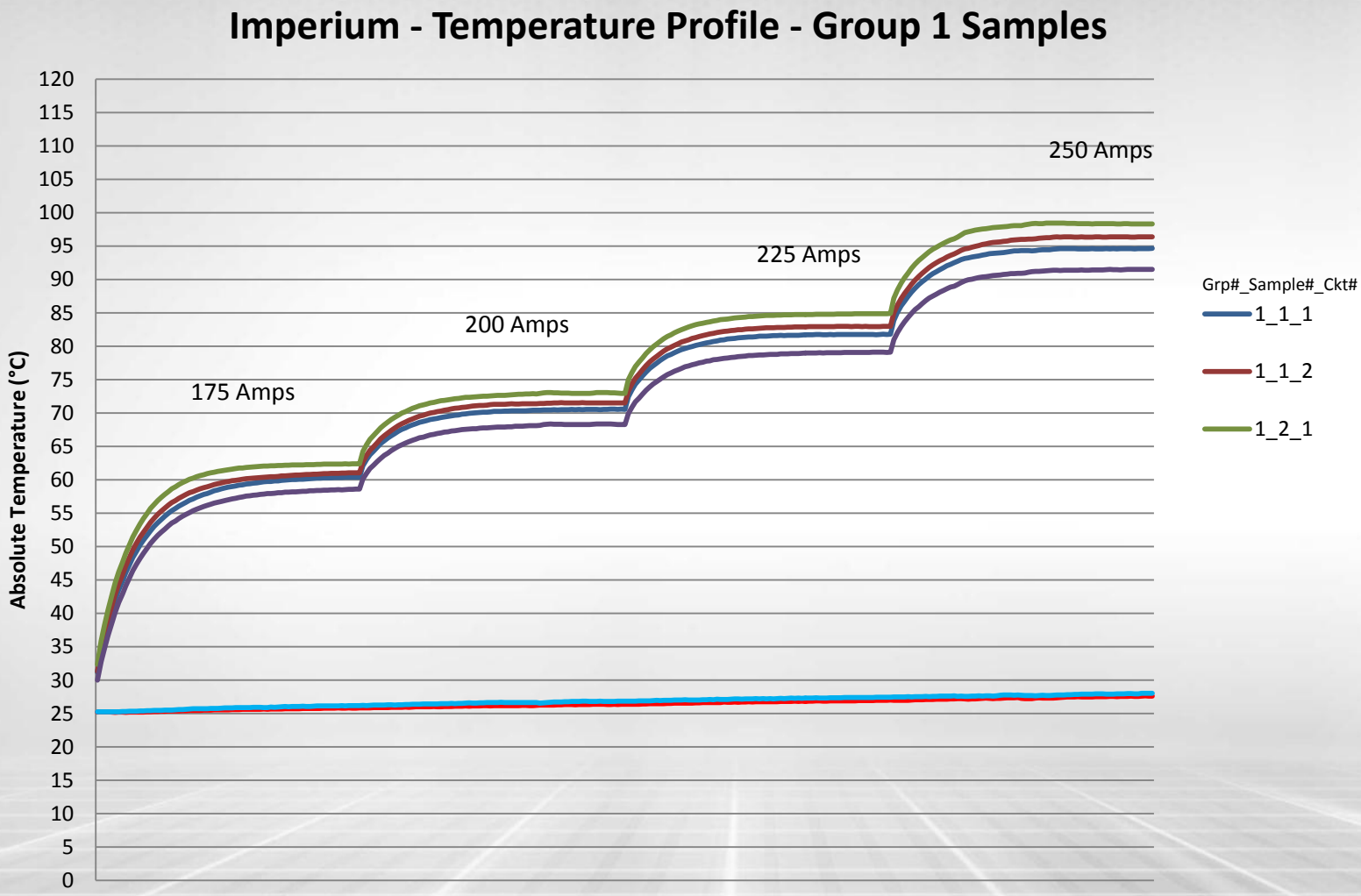
Imperium Current Rating



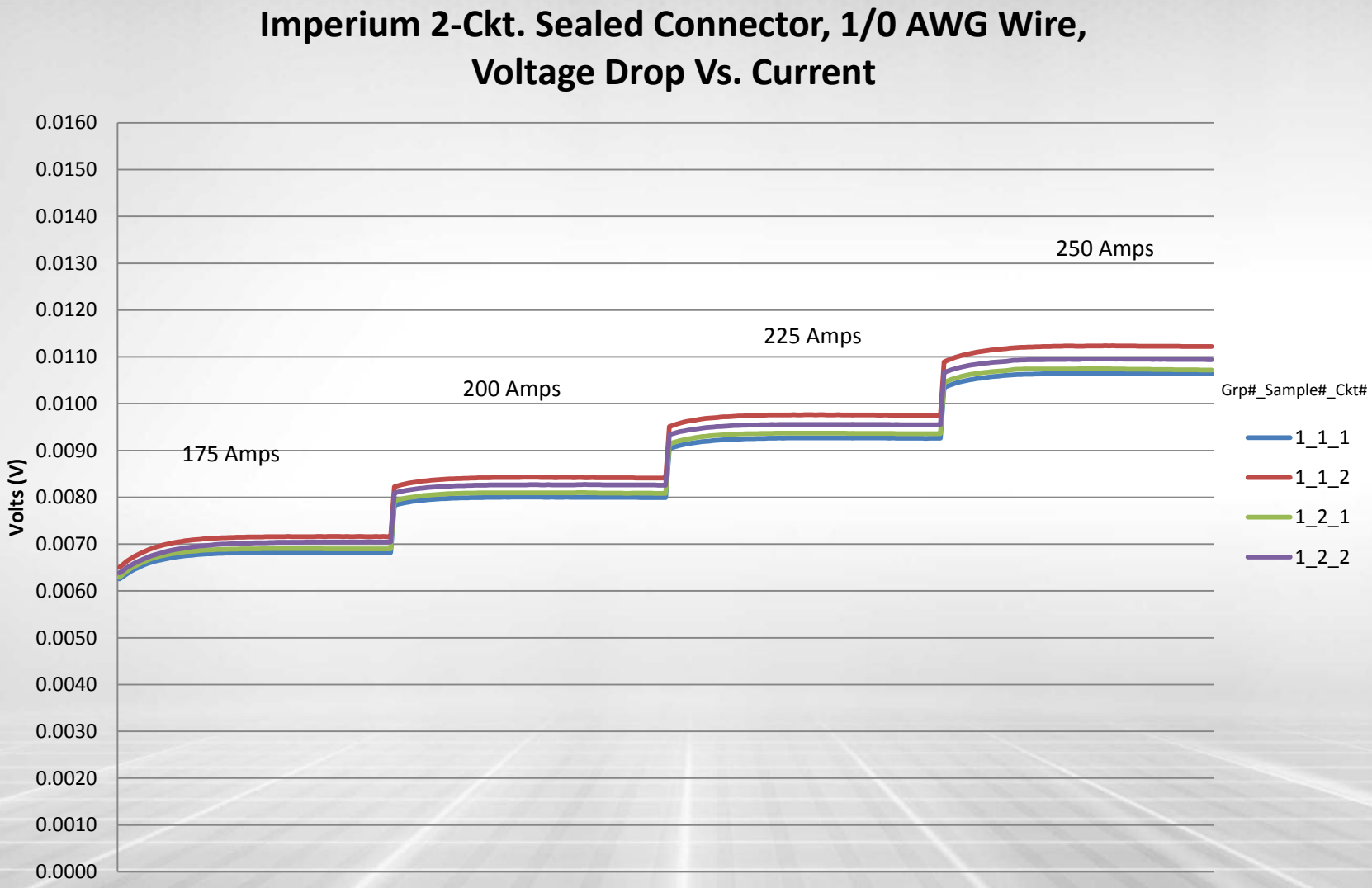
Initial testing, based on Champlain FX 1/0 cable rating based on T-rise testing

Terminal Temperature Rise



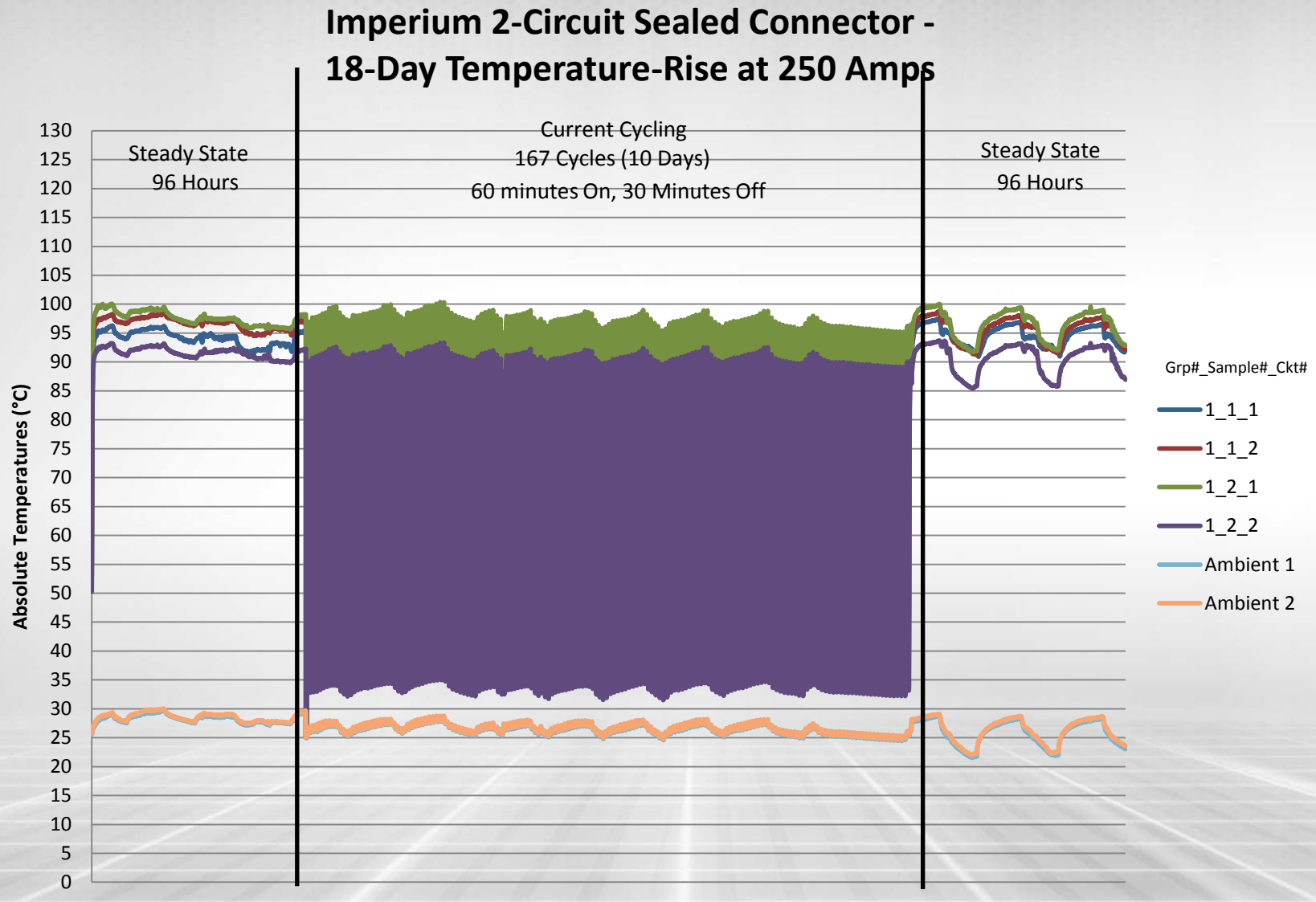
Initial Screen testing, based on Champlain FX 1/0 cable

Terminal Voltage Drop



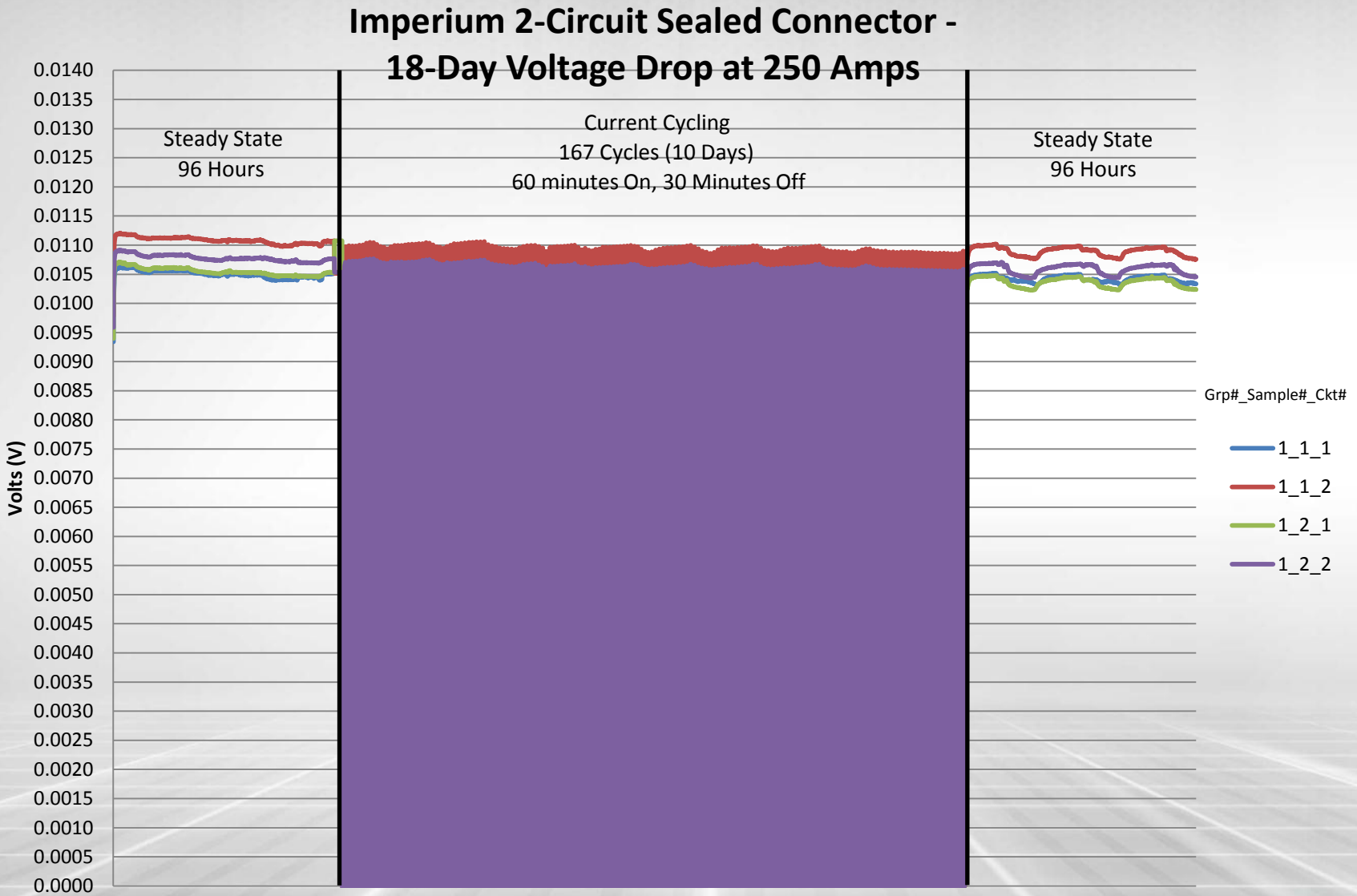
Initial Screen testing, based on Champlain FX 1/0 cable

Contact Stability Screen Test



Initial Screen testing, based on Champlain FX 1/0 cable

Contact Stability Screen Test



Initial Screen testing, based on Champlain FX 1/0 cable

molex