



Electrifying a Sustainable Future

Reefer Outlet Assemblies And Design Considerations

Introductions

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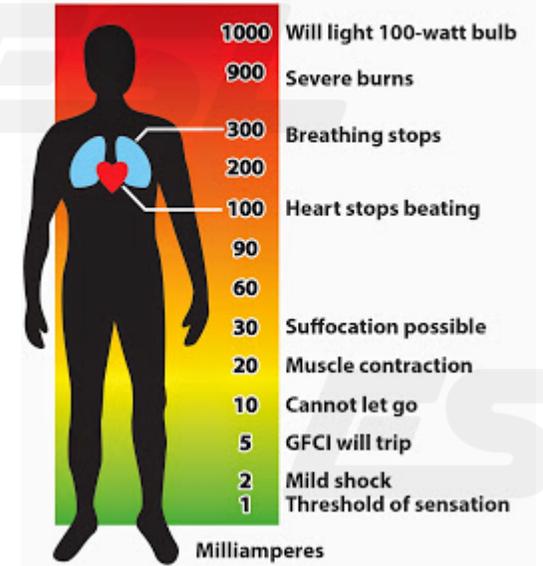
Electrical Engineer with Electrical Safety background

Resides north of Houston, Texas

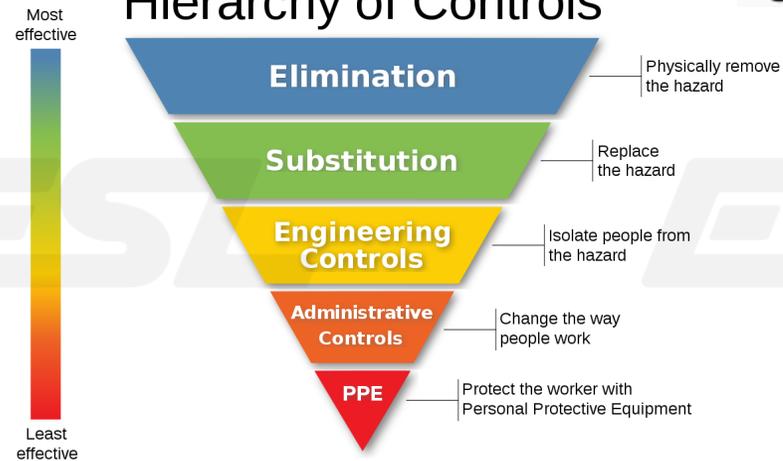
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Electricity's Effects



Hierarchy of Controls



Agenda:

Introduction to Intermodal Electrical Connections - Reefer Outlet Assemblies (ROAs)



Applications – Where ROAs are used and Why the different types of assemblies



Design Considerations



Related components and parts



Agenda update:

Introduction to Intermodal Electrical Connections - Reefer Outlet Assemblies (ROAs)

What is a “Reefer”?

What is a Safety Interlock Power Module?

Refrigerated Container Market

Overview of the product line



Applications – Where ROAs are used and Why the different types of assemblies

Design Considerations

Power Feeds - Daisy-Chain vs. Home Runs

Enclosure Materials

Short Circuit Ratings

Status Indicators

Enclosure Penetrations

Power Requirements

Related components and parts

Plugs & Replacement parts

Converter cords, Splitters

Introduction: What is a “Reefer”

“Reefer” is short for refrigerated container or refrigerated trailer. These special containers and trucks are used to transport temperature-sensitive, perishable cargo.

Refrigeration unit

Pigtail – Electrical connector with cable



Introduction: What is a “Reefer”

Container Vessel with Refrigerated Containers (white ones)



Introduction: What is a “Reefer”

Reefer Rack
at Georgia Port Authority



Introduction: Wide Range of Reefer Outlet Assemblies (ROA's) Designed Specifically for Port and Terminal Applications.

It is worth noting that most assemblies are custom.
ESL rarely sells off-the-shelf standard configurations.



Introduction: ESL's Reefer Outlet Assemblies

ESL ROA's are fabricated using **304 stainless** steel and powder coated to withstand harsh marine environments while providing operator safety and equipment protection.

ESL's ROA's are factory wired complete with ESL's **safety interlock modules** for easy installation.

ESL can build ROA's furnished with **1 to 40 outlets with a UL listing.**

UL 231 – Power Outlets

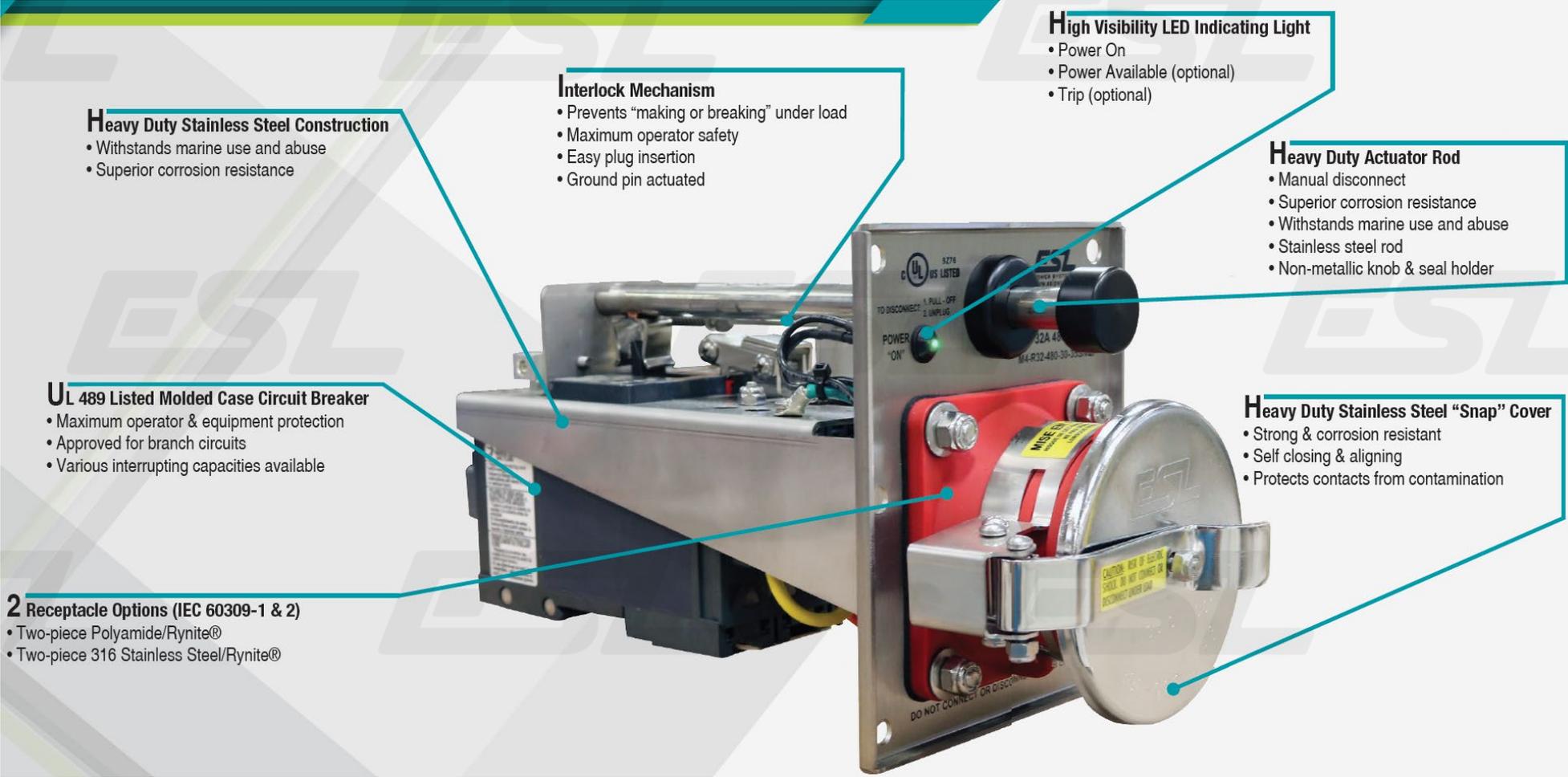
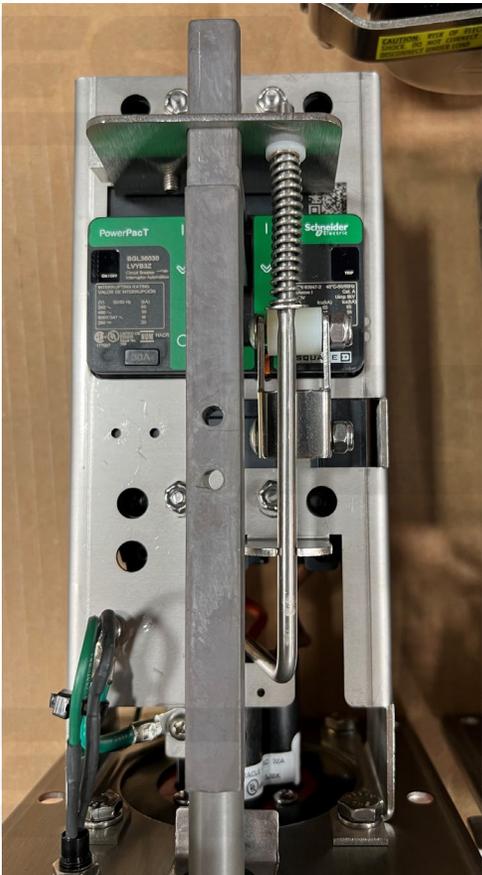
UL 589 – Molded Case Breakers



Introduction: Safety Interlock Power Modules are the Heart of all Reefer Outlet Assemblies (ROA's).



Introduction: Anatomy of ESL's Safety Interlock Power Module



Introduction: Benefits and Features

ESL's enclosures can be **custom designed** to meet customer specific requirements.

Achieve a desired look by choosing from several RAL **colors** for the powder coat finish.

Have a peace of mind knowing that ESL's **304 stainless assemblies** are durable and will continue looking good for decades.

Extraordinary **ingress protection** is achieved by fabricating enclosures to **NEMA 4X standards**.

The ROA enclosures always have continuous seam welds.

Contractors will find ESL's assemblies easy to install and terminate because we include appropriately sized **power distribution blocks**. Can accept copper or aluminum conductors.

Designers have the option of **daisy chaining** assemblies.

ESL's **safety-interlock design** makes connecting and disconnecting safer for port and terminal operators.

Safety-Interlock Modules prevent "Making" or "Breaking" under load.



Introduction: Benefits and Features (continued)

Because the modules include integrated breakers, they inherently provide **branch circuit protection**.

Maintenance downtime is reduced due to ESL's modular design.

The **modular design** makes it easy to remove and install modules.

ESL offers a **factory rebuild program**.



ESL's **commitment to safety and quality** is further demonstrated by our adherence to **compliance**.

Assemblies and individual modules are UL and cUL listed.

All multi-gang assemblies are furnished with the required amount of **power distribution blocks** to **maintain the UL listing**.



Introduction: Refrigerated Container Market

ESL has built **95%** or more of the reefer outlets currently used in the United States.

An estimated 300,000+ ESL outlet assemblies installed throughout the world.

Demand for Climate Controlled Freight continues to increase.

Much of what we consume is transported in refrigerated containers and trucks.

Odds are these containers and trucks were connected to an ESL outlet along the way.



Introduction: Refrigerated Container Market



Did you know that we export about \$500 million of chicken feet to China each year?



Introduction: Refrigerated Container Market



Introduction: Refrigerated Container Market



Introduction: Refrigerated Container Market Underslung and Clip-on Generators

“Underslung generators” are often attached to the rolling chassis.

Generators can also be “clipped-on” to the reefer container.

ESL does not build generators. Photos included for information only.

However, ESL does build the plugs.



Overview of Product Line & Various Applications

Pedestal / Pad Mount Assemblies

Bunker Mount Assemblies

Rack / Wall-Mount Assemblies

Single-Gang Modules

Rear Actuated Assemblies

Inserts for Power Pack Assemblies

Portable Distribution Trees

Reefer Sharing Units RSU's



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Applications: Pedestal / Pad Mount Assemblies

Pedestal assemblies typically include 2-8 outlet modules.

However, designs can include more than 8 outlet modules.

Typically specified for “**grounded applications.**”

Designers should consider how the reefer container pigtails will be routed.



Applications: Bunker Mount Assemblies

Bunker mount assemblies typically include 2 or 4 outlet modules.

Designers should consider how to protect the bunkers.

Typically specified to provide power to reefers on chassis.



Applications: Reefers can be Stacked

Stacked containers are often accessed using “Reefer Racks”



Applications: Rack / Wall Mount Assemblies

Rack / Wall Mount Assemblies typically include 2 to 4 outlets modules.

Reefer containers can be stacked as high as 5 to 6 containers high. Reefer racks are designed and built to provide safe and convenient access to connecting and disconnecting the electrical connectors.

Conduits typically run vertically in racks.
ESL can provide assemblies with **precut holes for conduits**.

ESL does not design and manufacture reefer racks.

ESL's sales team can provide advice for clients considering reefer rack applications.



Applications: Single-Gang Modules

Individual Outlets

Better choice for **Automated terminals**

Outlets are closer to the Reefers

No confusion as to slot location

“**Plug Sensing**“ can be implemented

The signals can be integrated into the ASC scheduler to prevent lifting an energized container

More Feeder Cables/Conduits in Reefer Rack

Less cables on walkway as compared to Multi-Gang designs



Applications: Rear Actuated Assemblies

Rear Actuated Assemblies offer a **higher level of safety**.

For these assemblies, the ON/OFF actuator rods are located on the side opposite the receptacles.

This ensures that the operator is away from the plug and receptacle connection when the unit is energized.



Applications: Inserts for Power Pack Assemblies

Inserts are typically **integrated with generators** in a containerized portable “Power Pack.”

The outlets are factory wired to a power distribution block.

The inserts include gasketed bolt-on access cover(s) for access from inside the Power Packs.



Applications: Portable Distribution Trees

Portable units are furnished in 10-Gang, 20-Gang, and 30-Gang designs.

Furnished with and without **single pole cams** for temporary or permanent installations.

Enclosures are furnished with **forklift pockets** for easy mobility.

Mounting holes in the pockets are provided for permanent installations.

All access covers are equipped with a gasket to maintain the NEMA 4X rating.



Applications: Portable Distribution Trees

It is not uncommon to see these “Portable Distribution Trees” used in permanent “Grounded” application.

Note the protective cage around the ROA.



Applications: Reefer Sharing Units RSU's

The typical **RSU** configuration involves using a **timer to alternate power** between two reefer containers.

The most common configuration alternates power every 4 hours.



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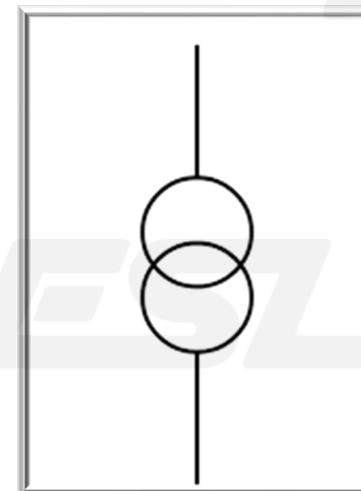
Enclosure Penetrations

Power Requirements

Related components and parts

Plugs & Replacement parts

Converter cords, Splitters



Design Considerations: ESL Safety Interlock Power Modules

The breakers can be supplied with various trip ratings to allow for different overload and short-circuit protection.

There are several voltage and amperage options for the modules:

30A @ 240V

50A @ 240V

60A @ 240V

30A @ 480V ← Most common

60A @ 480V

The breakers can be furnished with different **interrupt ratings**.

35kAIC is the standard.

Many legacy modules used breakers rated at 22kAIC.

65kAIC is an option.

The modules are fabricated with **stainless steel** components.



Design Considerations: ESL Safety Interlock Power Modules

Additional Options:

Indicators

Auxiliary Contacts

Trip Options

More detailed list of options:

Pilot Lights

Power "ON" Light

Power "Available" Light

Shunt Trip

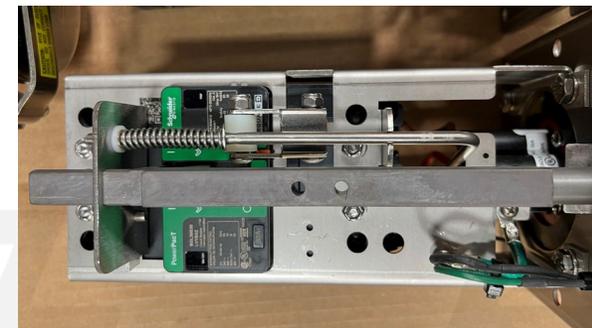
Electrically Interlocked

Auxiliary Contact

Trip Alarm Contact

Plug Sensing Contact

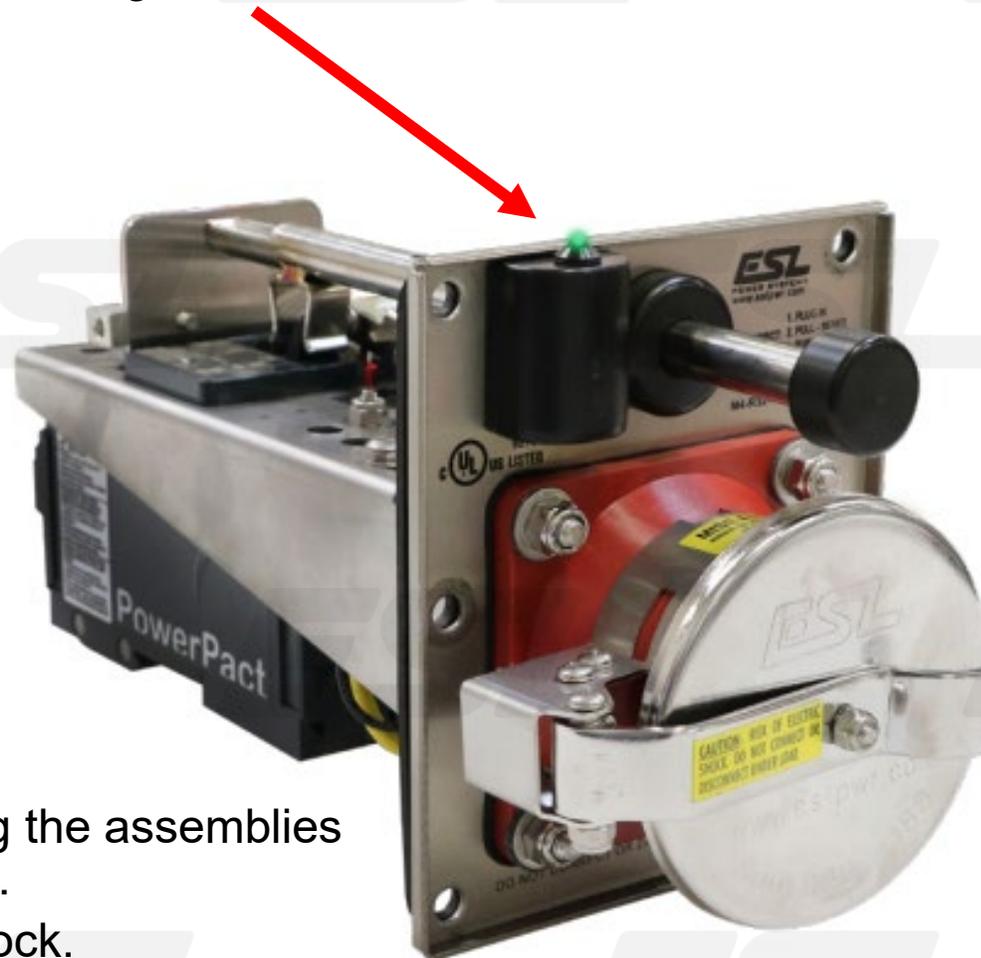
Nylon Screw Cover



Design Considerations: ESL Safety Interlock Power Modules

Modules can be provided with 90-degree LEDs

Item No: 1706-56ANP9

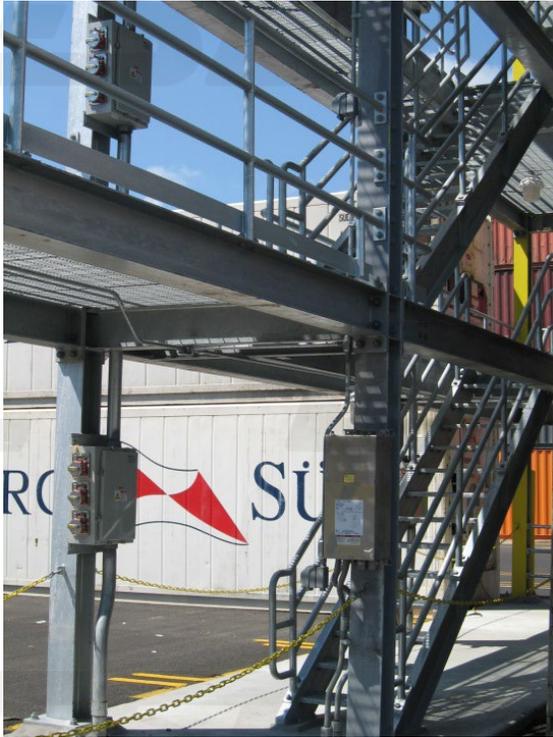


Some applications require mounting the assemblies where the modules face the ground.

Example: Single-Gang ROA on a dock.



Design Considerations: Daisy-Chain vs. Home-Runs



Daisy-Chain:

- Minimize cable/conduit runs
- Use ROA as J-Box
- Larger enclosures to accommodate larger PDBs
- May have enough room for Power Meter and Remote Monitoring Systems

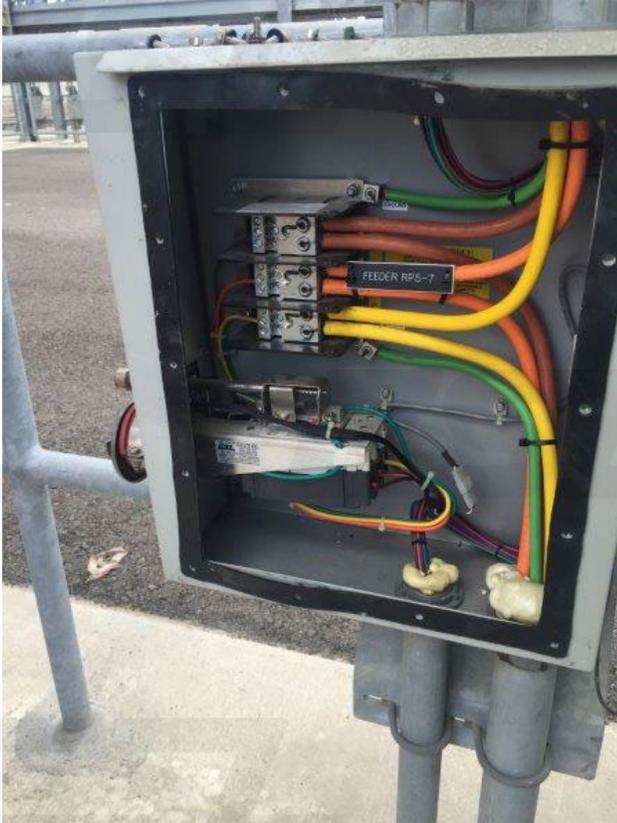


Home-Runs:

- Increased number of conduits and cables
- More breakers in panelboard; however, smaller breakers
- Smaller ROA enclosures due to smaller PDB



Design Considerations: Daisy-Chain



Daisy-Chain:

Minimize cable/conduit runs

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Design Considerations: Home-Runs

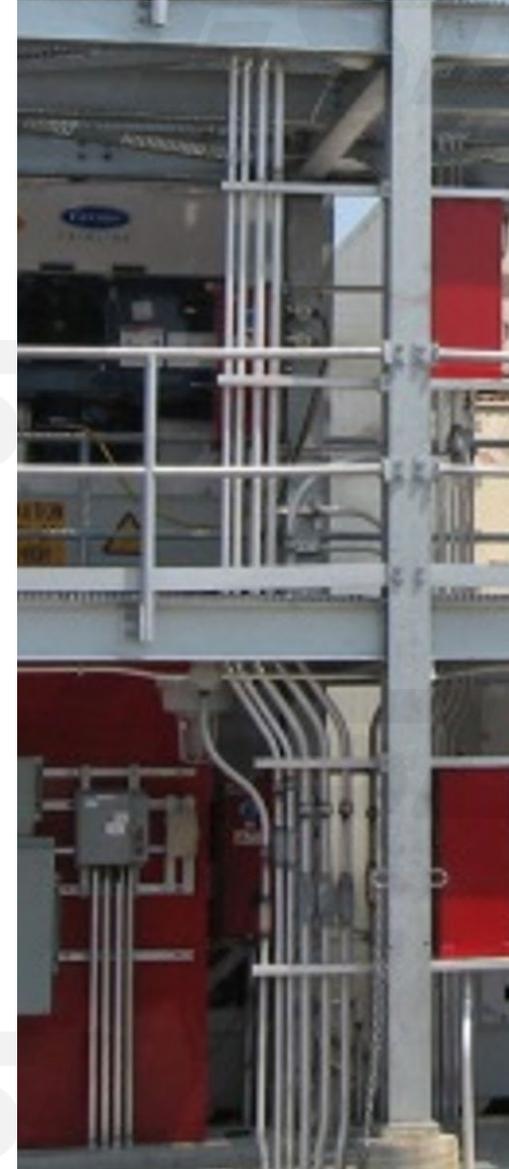


Home-Runs:

Increased number of conduits and cables

More breakers in panelboard; however, smaller breakers

Smaller ROA enclosures due to smaller PDB



Design Considerations: Other Details

ROA Enclosure Material can be **304 Stainless** or **316 Stainless**

Feeder Cables must be specified – So we can size the Power Distribution Blocks

Enclosure penetrations

Conduit Size

Location of penetrations (Top? Bottom? Side?)

Flexible Cable or Conduit

Where are the ROAs going to be installed? - **Avoid Submersion**

Power Metering ← ESL may be able to assist.

ESL does not get involved in Reefer Monitoring – Electronics. Our partner RTE does.

RTE

Disconnect breakers can be integrated.

Short Circuit Rating Must be specified

35kAIC ← Assumed - Standard

65kAIC

Plug Sensing

Aux Contacts



ESL

Design Considerations: Power Requirements

How much power is required per outlet?

Disclaimers:

We [ESL] are not power engineers.

ESL's official response is a **conservative** number of **15kVA per outlet**.

ESL recommends **consulting with a power engineer** that has experience designing reefer outlet projects.

Two data points: 150A breaker vs. 200A breaker for a 10-Gang ROA

Example 1: 150Amp breaker → Risky, lower cost, smaller feed conductors

Experience shows that a 150 Amp breaker will trip when a bad reefer is plugged in with as little as 6 other reefers already online.

I don't know the details of the coordination study.

Example 2: 200Amp breaker → Less risky, more cost, larger feed conductors

A reasonable assumption may be 13.6kVA per outlet

$13.6\text{kVA} / 480\text{V} / \text{Sqrt}(3) = 16.4\text{A}$ per outlet

$16.4\text{A} * 10 \text{ Outlets} = 164\text{A}$... Often bumped up to a breaker with a 200Amp trip setting



Design Considerations: Power Requirements

How much power is required per outlet?
Transformer sizing and diversity factor

Depends on assumptions like this:

13.6kVA per outlet

Normal loads already at or near desired conditions

Average climate ... not extreme like Texas!

How many outlets per substation? **Could be** 250 outlets per substation.

The more outlets per substation, the lower the diversity factor. Perhaps a Range of (0.8 to 0.65)

A port with over 1500 outlets might use a diversity factor as low as 0.4 when considering total kVA

ESL recommends consulting with an experienced power engineer.



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ESL Reefer Plugs & Connectors

Most Common



IEC 60309-2, UL
30A, 480V

30A, 250V



50A, 240V



30A, 240V



60A, 240V



60A, 480V



50A, 250V

60A, 480V



ESL Product Information for Plugs and Connectors

ESL's Reefer Plugs and Connectors are available in a variety of configurations used throughout the intermodal industry.

Heavy-duty design for harsh marine environments

Watertight seal

Universal grommet

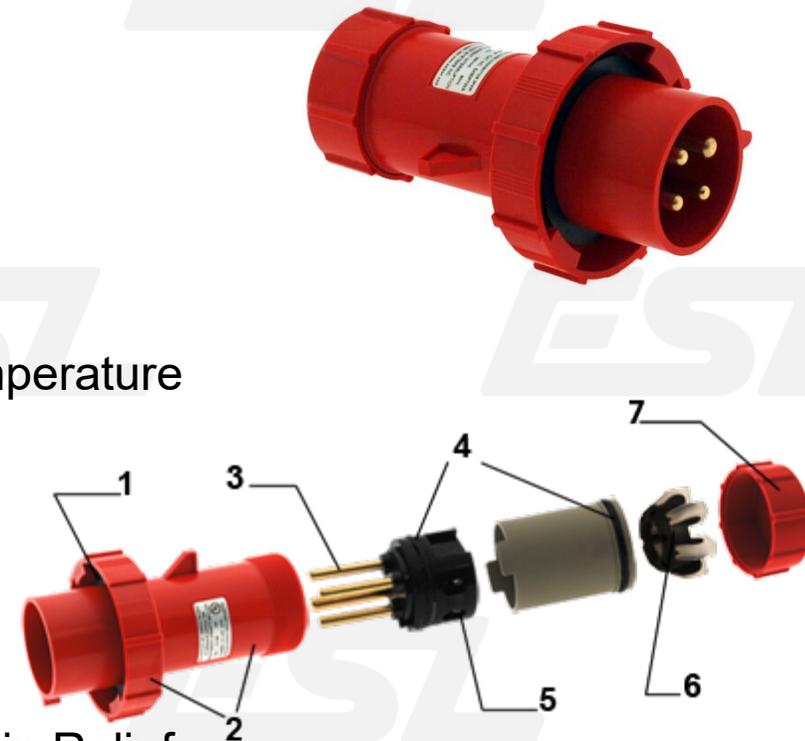
High resistance to chemicals & impact

UL & cUL Listed



Exploded View of ESL's 32A 480V Male Plug

- 1 Gasket for a Watertight Connection to the Mating Receptacle
- 2 Polyimide Housing and Locking Ring with Resilience and Strength
- 3 Brass Contacts for Superior Electrical Contact & Lower Operating Temperature
- 4 O-Rings to Protect Against Water Intrusion
- 5 High Temperature - Heavy Duty Phenolic Inserts
- 6 Self-Locking Grommet for Easy Installation and Watertight Seal & Strain Relief
- 7 Polyimide Back Cover Automatically Seals Grommet as it is Tightened



ESL Spare Parts Kits and Replacement Components

Ask ESL for **Master Distributor** contact information.

ESL Offers a wide range of **spare parts kits**.

Components and Replacement Parts are **readily available** to customers.



ESL Extension Cords, Cord Converters, Y-Splitter

Extension cords complete with 32A 480V Male Plug and Female Connector wired with SE00W 10/4 Yellow Cable

Manufactured to specified lengths as required

32A 480VAC Wired with SE00W 10/4 Yellow Cable

50A 240VAC Wired with S00W 8/4 Cable



Resources

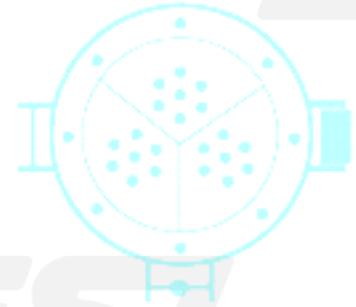
- www.eslpwr.com
- **Intermodal Brochure**
 - <https://eslpwr.com/wp-content/brochure/reefer-outlets-sockets-brochure.pdf>



ESL's Product Lines – Bonus!



Wayside Power for Connecting Locomotives



Shore Power Solutions for Vessels



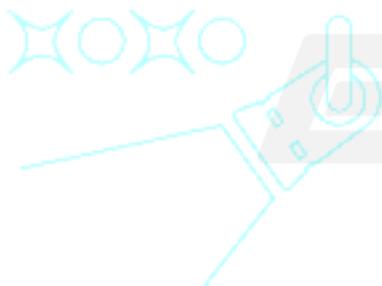
Medium Voltage Disconnect Cabinets for Electric Cranes



Reefer Outlet Assemblies for Refrigerated Containers



eTRUconnect® - Shore Power Refrigerated Truck Trailer



Show Switches Power Distribution for Theatres/Arenas



Shipyard Power Distribution Units



Emergency Power Connection Equipment for Roll up generators



Transport Refrigeration Units (TRU)



ESL Power Systems, Inc.

Your partner in providing safe, dependable and custom engineered electrical solutions.

Thank You for joining us today

➔ Questions? ➔

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