CONTENTS

IMPORTANT SAFETY INFORMATION

SAVE THESE INSTRUCTIONS

THIS MANUAL CONTAINS IMPORTANT INFORMATION THAT MUST BE READ, UNDERSTOOD, AND FOLLOWED DURING DESIGN AND INSTALLATION OF THE MEGAPACK SYSTEM.

SYMBOLS

This manual uses the following symbols to highlight important information:

DANGER: Indicates a hazardous situation which, if not avoided, could result in severe injury or death.

WARNING: Indicates a hazardous situation which, if not avoided, could result in injury.

CAUTION: Indicates a hazardous situation which, if not avoided, could result in minor injury or damage to the equipment.

NOTE: Indicates an important step or tip that leads to best results but is not safety- or damage-related.

PRODUCT WARNINGS

DANGER: Risk of electrical shock. Multiple energy sources terminate inside this equipment. Always check with a properly rated voltmeter that there is no voltage on the bus before working.

DANGER: Control all forms of hazardous energy at the source before servicing Megapack or removing the Megapack AC circuit breaker or bus bar access panels in the Customer Interface Bay.

DANGER: Controlling hazardous energy by isolating Megapack from other sources does not de-energize the battery, and thus a shock hazard may still be present.

DANGER: During installation, all equipment must be de-energized.

DANGER: Hazardous voltage can cause severe injury or death.

DANGER: Electric shock could occur when touching live components.

DANGER: Megapack, even in a normally discharged condition, is likely to contain substantial electrical charge and can cause injury or death if mishandled.

DANGER: The battery used in this device may present a risk of fire or chemical burn if mistreated. Do not disassemble, operate above 50°C (122°F), or incinerate.

WARNING: To reduce the risk of injury, read all instructions.

WARNING: In order to operate, Megapack requires a solidly grounded circuit such that the line-to-ground nominal voltage does not exceed 300 V.

WARNING: All installations must conform to the laws, regulations, codes, and standards applicable in the jurisdiction of installation, such as National Electric Code (NEC) ANSI/NFPA 70 or the Canadian Electrical Code CSA C22.1.

WARNING: Do not install adjacent to or expose to any external heat source.

WARNING: Personal Protective Equipment (PPE) is required when working inside the Megapack enclosures. Service personnel must wear safety glasses and gloves with a minimum voltage rating of 1500 V DC, Class 0 per ASTM D120 and IEC EN60903 standards.

WARNING: Megapack has no user-serviceable parts. All service must be performed by Tesla-approved service personnel.

WARNING: The installation instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are qualified to do so.

WARNING: Only use this equipment as specified by Tesla. If the equipment is used in a manner that is not specified by Tesla, the protection provided by the equipment might be impaired.

WARNING: For continued protection against risk of fire, use only replacement fuses of the same type and rating as the original fuse. Fuses must only be replaced by trained personnel.

CAUTION: Megapack input and output circuits are isolated from the enclosure. System grounding, when required by the National Electric Code, ANSI/NFPA 70, or other relevant standard, is the responsibility of the installer.

CAUTION: Do not paint any part of Megapack other than external white metal surfaces, using only Tesla-provided touch-up paint. Internal or external components such as exterior cabinets or grilles should not be painted.

CAUTION: Do not use cleaning solvents to clean Megapack or expose the system to flammable or harsh chemicals or vapors.

CAUTION: Do not use fluids, parts, or accessories other than those specified in Tesla manuals, including use of non-genuine Tesla parts or accessories, or parts or accessories not purchased directly from Tesla or a Tesla-approved party.

CAUTION: Hearing damage could occur if not wearing hearing protection while Megapack is in operation.

Refer to the *Industrial Lithium-Ion Battery Emergency Response Guide* for detailed hazard information specific to the lithium-ion battery. The guide also provides hazard information for a single Tesla Megapack unit.

Voltage Classification

This section defines voltage classification as used in this document.

The table below represents Tesla's standard voltage ranges. The defined ranges, comparable to global codes and standards, help categorize potential electrical hazards where applicable.

NOTE: Any voltage referred to in this document is low voltage unless otherwise specified.

CAUTION: In general, voltages above 49 V are potentially hazardous. What is considered hazardous depends on many factors including your local codes and regulations.

Table 1. Voltage Classifications

Classification	Short Form	Alternating Current (AC) Range	Direct Current (DC) Range
Ultra-low voltage	ULV	0–49 V	0–49 V
Low voltage	LV	50–1,000 V	50–2,000 V
Medium voltage	MV	1,001–35,000 V (1 kV–35 kV)	2,001–35,000 V (2 kV–35 kV)
Sub-transmission medium voltage	STMV	35,001–69,000 V (35 kV–69 kV)	35,001–69,000 V (35 kV–69 kV)
High voltage	HV	Above 69,000 V (>69 kV)	Above 69,000 V (>69 kV)

Shutting Down in an Emergency

DANGER: If smoke or fire is visible, do not approach the Megapack and do not open any of its doors.

DANGER: Refer to the *Industrial Lithium-Ion Battery Emergency Response Guide* for details on response to a hazardous event (*Emergency Response Guide on page 25*).

CAUTION: External safety features such as E-Stops and upstream breakers differ by region and design. Always be aware of your site's safety design and external safety features.

To shut down the system in an emergency or for unknown behavior:

1. If an external E-Stop button or remote shutdown contact to Megapack is present, engage it.
2. If Megapack is serviced upstream by an external AC circuit breaker or disconnect, open the breaker or disconnect.
3. Only if safe to do so and if needed, proceed with de-energizing the Megapack (*Performing Lockout/Tagout on page 118*).
4. Contact Tesla (*Contact Information on page 27*) to advise that the system has been shut down.

Reference Documents

Visit the Tesla Partner Portal at *https://partners.tesla.com/* to find reference material referred to within this guide:

- Megapack 2 XL System Specification – *https://partners.tesla.com/home/en-us/content/download/megapack_2_xl_system_specification.pdf*
- Megapack 2 XL Installation Guide (abridged, mobile-friendly installation instructions) – *https://partners.tesla.com/home/en-us/content/view/megapack-2-xl-installation/*
- Megapack 2 XL Drawings – *https://partners.tesla.com/home/en-us/content/download/megapack_2_xl_drawings.zip*
- Megapack 2 XL Transportation and Storage Guidelines – *https://partners.tesla.com/home/en-us/content/download/megapack_2_xl_transportation_and_storage_guidelines.pdf*
- Megapack 2 XL Operation and Maintenance Manual – *https://partners.tesla.com/home/en-us/content/download/megapack_2_xl_operation_and_maintenance_manual.pdf*
- Megapack 2 XL Compliance Packet – *https://partners.tesla.com/home/en-US/content/download/Megapack_2_XL_Compliance_Packet.zip*
- Megapack 2 XL Compliance Summary – *https://partners.tesla.com/home/en-US/content/download/Megapack_2_XL_Compliance_Summary.pdf*
- Megapack 2 XL Option Codes Quick Reference Guide – *https://partners.tesla.com/home/en-us/content/download/megapack_2_xl_option_codes_quick_reference_guide.pdf*
- Megapack 2 XL Interconnection Data – *https://partners.tesla.com/home/en-US/content/download/Megapack_2_XL_Interconnection_Data.pdf*
- Controls and Communications Manual – v2 Platform – Utility-Scale Projects – *https://partners.tesla.com/home/en-US/content/download/Controls_and_Communications_Manual.pdf*
- Controls and Communications Manual – v2 Platform – C&I Projects – *https://partners.tesla.com/home/en-US/content/download/Controls_and_Communications_Manual_CI.pdf*
- Emergency Response Site Information Form *https://partners.tesla.com/home/en-US/content/download/Emergency_Response_Site_Information_Form.docx*
- Application Note: Considerations for Hazardous Materials Business Plans (HMBP) – *https://partners.tesla.com/home/en-us/content/download/considerations_for_hazardous_materials_business_plans_appnote.pdf*
- Megapack Deployment Overview – *https://partners.tesla.com/home/en-us/content/download/megapack_deployment_overview.pdf*
- Megapack Deployment Checklists – *https://partners.tesla.com/home/en-us/content/download/megapack_deployment_checklists.zip*
- Megapack Design Review Checklist – *https://partners.tesla.com/home/en-US/content/download/Megapack_Design_Review_Checklist.pdf*
- Tesla Energy Operations Contact List and Response Times – *https://partners.tesla.com/home/en-US/content/download/Tesla_Energy_Operations_Contact_List_and_Response_Times.pdf*
- SCADA Design Manual – *https://partners.tesla.com/home/en-US/content/download/SCADA_Design_Manual.pdf*
- Microgrid Controller Owner's Manual – *https://partners.tesla.com/home/en-us/content/download/microgridcontroller_manual_owners.pdf*
- Standard Tesla System Controller Enclosure Installation Manual – *https://partners.tesla.com/home/en-us/content/download/standard_tesla_system_controller_enclosure_installation_manual.pdf*
- Industrial Lithium-Ion Battery Emergency Response Guide – *https://www.tesla.com/firstresponders*

- Tesla Industrial Energy Approved Vendor List – *https://partners.tesla.com/home/en-us/content/download/tesla_industrialenergy_approved_vendor_list.pdf*
- Application Note: Using SEL-735 Meters with Tesla Products – *https://partners.tesla.com/home/en-US/content/download/Using_SEL-735_Meters_With_Tesla_Products_Appnote.pdf*
- Application Note: Megapack Integrated Wireway – *https://partners.tesla.com/home/en-us/content/download/megapack_integrated_wireway_appnote.pdf*
- Application Note: Grounding Conductor Recommendations for Megapack Applications – *https://partners.tesla.com/home/en-us/content/download/megapack_grounding_conductor_recommendations_appnote.pdf*
- Application Note: Electrical Protection Architecture – *https://partners.tesla.com/home/en-us/content/download/electrical_protection_architecture_application_note.pdf*
- Application Note: On-Site Water Supply Sizing For Exposure Protection – *https://partners.tesla.com/home/en-US/content/download/Onsite_Water_Supply_Sizing_For_Exposure_Protection_Application_Note.pdf*
- Application Note: On-Site Maintenance Infrastructure Requirements – *https://partners.tesla.com/home/en-us/content/download/on-site_maintenance_infrastructure_requirements_appnote.pdf*
- Application Note: NERC CIP Low Impact Facility Cybersecurity Compliance – *https://partners.tesla.com/home/en-US/content/download/NERC_CIP_Low_Impact_Facility_Cybersecurity_Compliance_Appnote.pdf*
- Megapack 2 XL Sample Engineered Template – *https://partners.tesla.com/home/en-US/content/download/Megapack_2_XL_Sample_Engineered_Template.zip*
- VIDEO: Megapack 2 XL – Installing Customer Connections – *https://partners.tesla.com/home/content/video/4724*

1 Megapack System Overview

1.1 Introduction

Tesla Megapack 2 XL (Megapack) is a modular, fully integrated, AC-coupled industrial battery energy storage system (BESS). This document provides the site designer the relevant information during the pre-construction phase and also provides the installation contractor the necessary details to install Megapack.

CAUTION: Any deviation from what is specified in this manual must be submitted to Tesla in writing in advance for review.

1.2 Roles and Responsibilities

NOTE: Responsibilities listed are the minimum required by Tesla. Additional responsibilities may be required.

1.2.1 Site Designer

The site designer ("designer") is responsible for all technical decisions for the project. This includes performing tasks such as:

- Civil, mechanical, and electrical design, including:
  - Consulting site geotechnical report for the geotechnical design requirements
  - Engineering all site features according to requirements in *Routes and Zones on page 72*
  - Documenting the preliminary *Electrical Control Plan on page 103*
- Coordinating controls and operation modes as required, including:
  - Consulting with the SCADA engineer
  - Refer to the *SCADA Design Manual* for details
- Analyzing local grid code requirements to inform the development of site operational settings
- Creating project-specific documentation and drawings as required (such as site layout, single-line, and network architecture)
- Coordinating and obtaining permits as required
- Creating site movement and crane delivery plan

1.2.2 Installation Contractor

The installation contractor ("installer") is responsible for completing the mechanical and electrical installation of Megapack according to appropriate local fire, electrical, and building code requirements, in addition to meeting all criteria provided in the *Megapack Deployment Checklists*.

As part of mechanical completion, the installer is responsible for coordinating the logistics with Tesla from the factory to the site, and directly responsible for moving Megapack between the truck trailer and final foundation location. Logistics-specific items may include:

- Site-specific movement plan
- Arranging for craning, including providing a site-specific crane lifting plan
- Coordination with responsible third party transporters such as truck drivers

- Providing all required documentation to responsible parties
- Confirming the existing *Electrical Control Plan on page 103* and updating as needed according to actual site conditions

The installer must provide the following for Tesla review prior to completing the *Megapack Deployment Checklists*:

- Arc flash calculations showing the available energy at the Megapack AC bus
- Isolating methods plan or switching scheme identifying the order of opening and who is responsible for each step

The *Megapack Deployment Checklists* list the criteria that must be inspected and completed on-site for Tesla to consider the site completed and ready for commissioning. This includes items such as:

- Physical installation such as proper anchoring, door swing, access, etc. of all equipment
- Site and foundation grading, drainage, and access
- Electrical termination checks for polarity and torque for all equipment
- Harness termination checks
- Ethernet cable checks
- Insulation resistance testing for all wires
- Meter wiring and CT polarity check
- Recording site information (serial numbers, unit and meter locations, inspection date, etc.) and emailing a scanned copy to Tesla
- Megapack and Tesla System Controller start-up

DANGER: While performing Megapack installation, always follow all *IMPORTANT SAFETY INFORMATION on page 3* and ensure personal safety at all times per local and national regulations. The installer is responsible for providing required personal protective equipment (PPE), including such items as safety glasses, hard hats, appropriate boots, and appropriate gloves (cut and electrical).

1.2.3 Site Owner

The site owner or operator is the entity who will be maintaining the site for the life of the system. This includes such responsibilities as:

- Ensuring adequate outreach with local first responders, including:
  - Completing the *Emergency Response Site Information Form*
  - Hosting a site walk with the local fire department
- Where required by local jurisdictions, prepare a Hazardous Materials Business Plan (refer to the *Application Note: Considerations for Hazardous Materials Business Plans*)
- Consulting the latest revisions of relevant information on the Tesla Partner Portal
- Providing the completed *Electrical Control Plan on page 103* to Tesla
- Maintaining *Routes and Zones on page 72* as required
- Other duties as described in the *Megapack 2 XL Operation and Maintenance Manual*

1.3 Tesla System Components

A Tesla System consists of the following components:

- One or more Megapacks – part number 1848844-XX-Y[1] (*Megapack on page 10*)
- Tesla System Controller: Standard Tesla System Controller – part number 1471208-XX-Y[1], or Large Tesla System Controller – part number 1700130-XX-Y[1] or 1459155-XX-Y[1] (*Tesla System Controller on page 17*)

[1]*Where X is a number between 0 and 9, and Y is a letter.*

A Megapack site may additionally consist of other equipment including what is outlined in *Site Architecture on page 28*.

Figure 1. Example Megapack Site

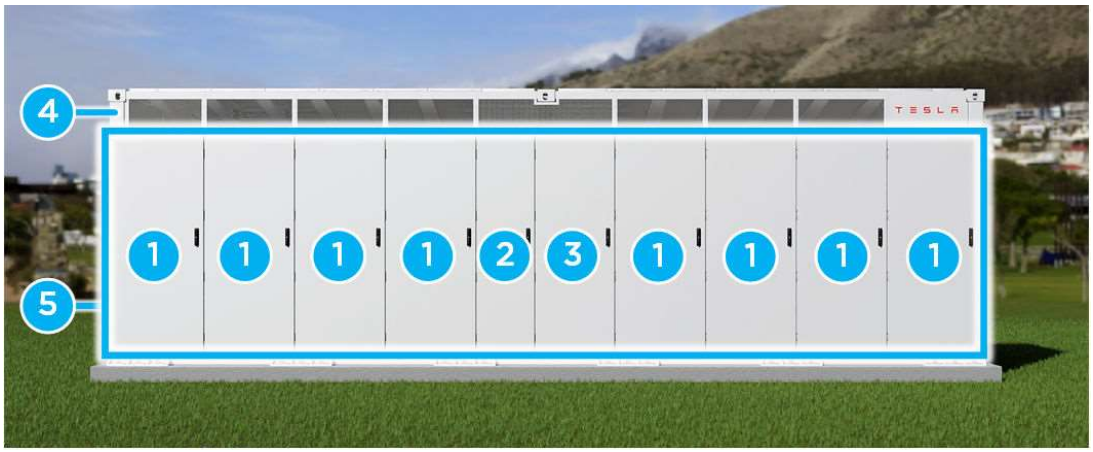
1.4 Megapack

Megapack is a fully integrated battery energy storage unit capable of charging and discharging real power and injecting and absorbing reactive power. Megapack converts power for storage in rechargeable lithium-ion battery modules and is designed to support a range of AC power and energy.

NOTE: Individual Megapack specifications are detailed on the product label (see *Megapack Labels on page 21*).

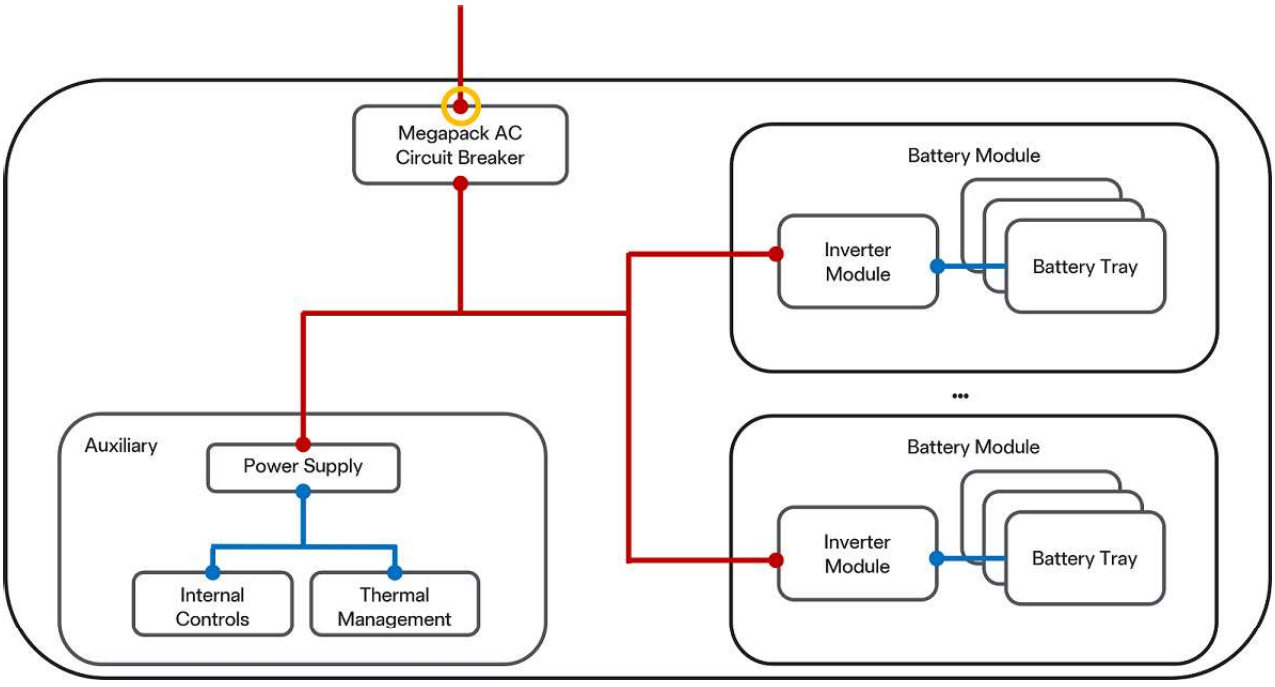
A Megapack unit consists of the following components:

Figure 2. Megapack Overview



1. Battery module bays (*Battery Modules on page 14*)
2. Thermal cabinet (*Thermal System on page 15*)
3. Customer Interface Bay (*Customer Interface Bay on page 16*)
4. Thermal roof (*Thermal System on page 15*)
5. IP66 enclosure (*Enclosure on page 16*)

Figure 3. Megapack Internal Architecture



AC
AC Output Terminals
Internal DC

The AC output terminals are the point on the AC bus bars (*AC Bus Bar Area on page 112*) at which the external AC connections to the Megapack are terminated.

1.4.1 Product Configurations

A Megapack unit is configurable and may vary based on **options** or **variants**. The product (Megapack unit) as built or later reconfigured, complete with its customizations including variants and options, is known as a **configuration**.

1.4.1.1 Megapack Options

An **option** is a product difference that the customer or sales team can select to configure the Megapack unit in a certain way to meet customer or project needs, such as number of battery modules or cell type (*Battery Modules on page 14*). Product options are defined using **option codes**. Not all combinations of option codes are possible, as some option codes are pre-defined by other option codes.

Option codes appear in a list of alphanumerical digits separate from the part number, determined at the time of product configuration during the sales process, and referenced throughout the order-to-delivery process. Finally, they are printed on the Megapack unit's labels (*Megapack Labels on page 21*) for reference throughout the Megapack's operational lifetime.

Although Megapack arrives at the site already configured, use its option codes to determine information required during design and installation.

Option codes are described at a high level below. Refer to the *Megapack 2 XL Option Codes Quick Reference Guide* for detailed calculation and ratings information.

Table 2. Product Options

Option	Option Code	Description
Cell	C###	Cell options can denote different cell characteristics such as specifications or manufacturing location. The following cell options are available: • C010 • C011 • C012
Fan Type	FN##	Fan type options affect the maximum audible noise specification (*Noise Specification and Guidance on page 67*). The following fan type options are available: • FN01 • FN02 • FN03
Number of Battery Modules	EC##	Where ## is a number between 08 and 24, which indicates the number of battery modules. Combine with GT## to derive the Megapack unit's energy capacity (kWh). Combine with GT## and P### to derive the Megapack unit's real power capability (kW).
Inverter Module Configuration	GT##	GT01: 4-Hour inverter module configuration GT02: 2-Hour inverter module configuration Combine with EC## to derive the Megapack unit's energy capacity (kWh).

Option	Option Code	Description
Apparent Power Configuration	P###	Where ### is a number between 040 - 240, which indicates the Megapack unit's apparent power capability. Additionally allows for calculation of maximum continuous charge/discharge current (A).
Low-Voltage Augmentation Configuration	CMA#	CMA0: The hardware configuration does not support future low-voltage battery augmentation CMA1: The hardware configuration supports future low-voltage battery augmentation
Grid-Forming Firmware Configuration	VF##	VF00: The configuration does not support grid-forming VF01: The configuration supports grid-forming

Tesla may also configure options (**manufacturing options**) that become part of the product's option codes, such as circuit breaker manufacturing options (*Megapack AC Circuit Breaker on page 106*). Manufacturing options are not customer-configurable.

Table 3. Manufacturing Options

Option	Option Code	Description
Thermal Configuration	TC#H	TC2H: 2-Hour thermal configuration TC4H: 4-Hour thermal configuration Preconfigured based on heat rejection requirements of the power electronics and battery module count.
Internal Bussing Configuration	QB##	QB01: 1600 A QB02: 3000 A Preconfigured based on the inverter module and apparent power configurations.
Megapack AC Circuit Breaker	BB##	BB01: 1600 A BB02: 3000 A Preconfigured based on the inverter module and apparent power configuration.
Shipping Firmware Configuration	SE##	SE00: Configuration supports transportation over water SE01: Configuration supports transportation over land only Preconfigured based on delivery location of the Megapack.
Cellular Configuration	CR##	CRNA: North America

Option	Option Code	Description
		CRCN: China CRRW: Rest of world Preconfigured based on delivery location of the Megapack.

1.4.1.2 Product Variants

A **variant** is a part or product difference that is not optionally configured but is, for example, an incremental product improvement, such as an enclosure variant (*Enclosure on page 16*).

1.4.1.3 Standard Configurations

Megapack's power and energy may be configured to meet specific site and project requirements. A fully populated Megapack has the following nominal ratings at 480 V AC:

Table 4. Megapack Standard Configuration Ratings

Configuration	Apparent Power Capability (kVA)	Real Power Capability (kW)	Energy Capacity (kWh)	Associated Option Codes
2-Hour C010 / C011	2400.0	1927.2	3854.4	C010 or C011, EC24, GT02, P240
4-Hour C010 / C011	1320.0	979.2	3916.8	C010 or C011, EC24, GT01, P132
4-Hour C012	1320.0	1042.5	4170.0	C012, EC24, GT01, P132

The apparent power capability (kVA) of a fully populated Megapack may be factory-configured to a lower value than the above.

1.4.2 Battery Modules

Battery modules are factory-installed into Megapack battery module bays and contain prismatic lithium-ion battery cells, the smallest non-divisible energy storage components of the Megapack. A battery module in turn is the smallest field-replaceable battery unit. Each Megapack contains up to 24 battery modules.

Battery modules may consist of C010, C011, or C012 cell options.

Battery modules may consist of C010 or C011 cell options.

Figure 4. Battery Module - C010 or C011 Cell Option

Figure 5. Battery Module - C012 Cell Option

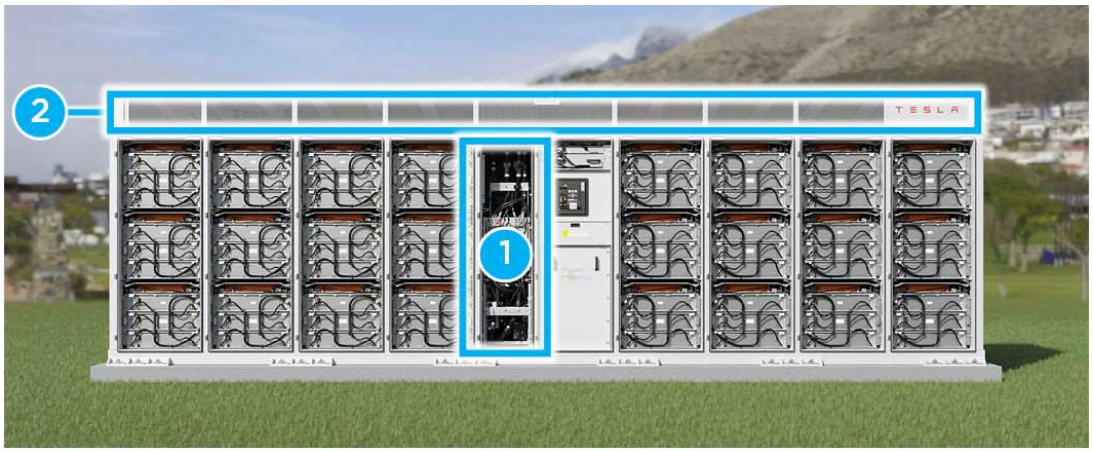
Each battery module includes an integrated inverter module for power conversion. Battery modules are connected in parallel to Megapack's internal AC bus, each with an AC power and communications output connection. The modules do not require any field assembly or adjustments and may only be replaced by Service Providers.

1.4.3 Thermal System

The thermal system provides active cooling and heating to the internal Megapack components. An external HVAC or thermal system is therefore not required for Megapack to operate.

The thermal system is comprised of the thermal cabinet and the thermal roof.

Figure 6. Thermal System



1. Thermal cabinet
2. Thermal roof

The thermal cabinet includes pumps that circulate coolant through the Megapack and a compressor that maintains thermal control, in addition to an in-line heater that can warm the coolant. The thermal cabinet also contains a power conversion system for drawing power from Megapack's internal AC bus. The thermal cabinet is accessible for servicing from ground level.

The thermal roof, or top cabinet of the enclosure, provides ventilation airspace and contains fans and radiators that cool the ethylene glycol-water coolant solution. The thermal roof is accessible for servicing with the help of a ladder or mechanical lift.

See *Thermal Specifications on page 69* for more information.

WARNING: See *Unloading on page 114* for important precautions about working on the roof.

WARNING: The thermal management section is locked during operation. Do not open this cabinet while fans are in use, to avoid hazard from moving parts.

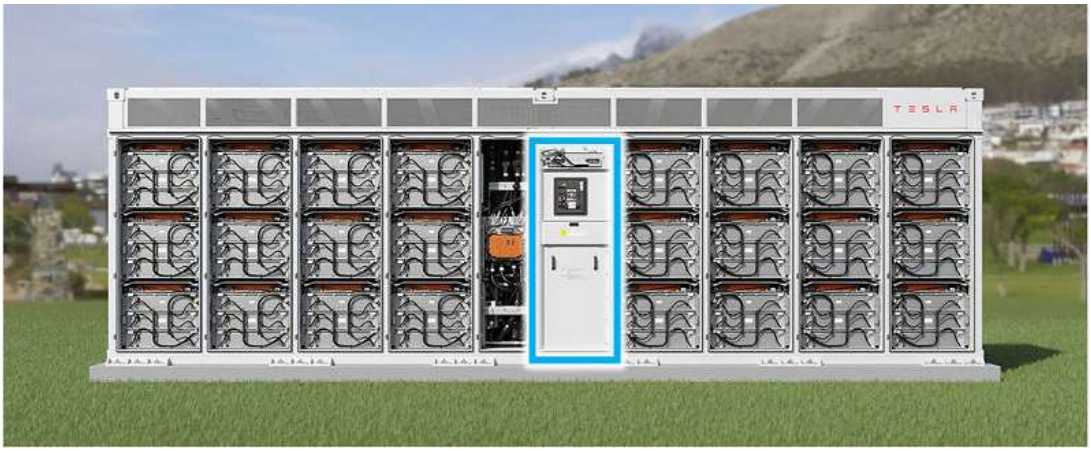
NOTE: Megapack includes an enable circuit as a safety feature. Opening the door to the thermal bay shuts down the Megapack. The thermal components located on the roof should not be serviced during operation.

WARNING: The thermal management sections are locked during operation. The thermal bay and thermal roof are only serviceable when the system is not operating. Do not open the thermal enclosures while the unit is operational to avoid hazard from moving parts.

1.4.4 Customer Interface Bay

The Customer Interface Bay is a single bay that includes all the external connections needed for initial installation (the customer I/O area and the AC bus bar area) and the Megapack AC circuit breaker.

Figure 7. Customer Interface Bay



For design information, see *Customer Interface on page 105*. For installation tasks, see *Installing Customer Connections on page 134*.

1.4.5 Enclosure

Megapack's enclosure is rated according to IP (ingress protection) code IP66. This means it provides a high level of protection against particle and water ingress for components internal to the enclosure.

This high protection rating must be maintained at all times. In particular, special precautions must be observed while installing or servicing Megapack to prevent particles, water, or debris from entering the enclosure. Refer to *Sealing the Wireway Openings on page 140* for more information.

There are two enclosure variants:

Table 5. Megapack Enclosure Variants

Variant	Number of Anchor Brackets	Wireway Configuration
-C enclosure	12	Two single-channel trays
-D enclosure	10	Two four-channel trays

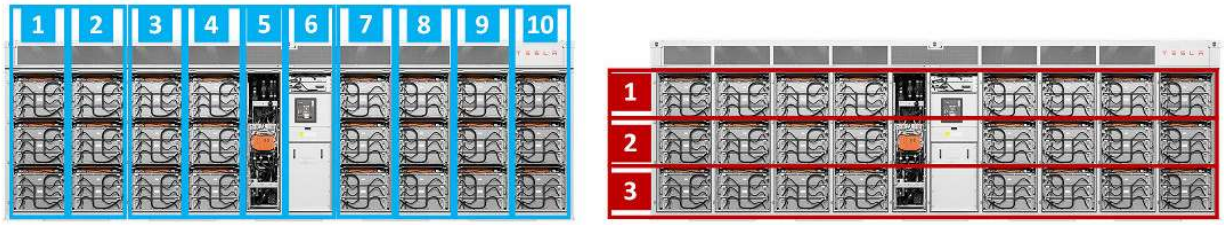
Graphics in this publication reflect the -C enclosure variant unless otherwise specified.

Refer to the *Megapack 2 XL Layout* drawings in the *Megapack 2 XL Drawings* package for detailed information.

1.4.6 Megapack Numbering Key

A numbering key can help identify locations of Megapack enclosure components to assist you when referring to them during installation or service. Below are the numbering keys for **bay** (vertical tower) and **shelf** (horizontal row) locations:

Figure 8. Megapack Bay Numbering (Left) and Shelf Numbering (Right)



For example, as depicted in *Megapack Overview on page 11*:

- The thermal bay is in bay 5
- The Customer Interface Bay is bay 6
- Battery modules are located on shelves 1–3 in bays 1–4 and 7–10.

1.5 Tesla System Controller

The Tesla System Controller is the single point of interface with which to monitor and control the entire Megapack System and approved third-party generation sources as specified in the *Tesla Industrial Energy Approved Vendor List*. It hosts the Tesla Controls Suite, which manages control functions of the Megapack System and approved third-party generation sources, aggregating real-time information and using it to optimize commands. The Tesla System Controller communicates over a private TCP network.

By default, Tesla provides two Tesla System Controllers (with the same part number). Refer to the *SCADA Design Manual* for additional details on alternative configurations. Tesla does not include additional networking equipment that may be required for the system to operate.

The Tesla System Controller has three network interfaces:

- LAN 1 RJ45/Ethernet port, which connects to the Customer Network and can be configured for WAN access
- LAN 2 RJ45/Ethernet port, which connects to the Tesla Network
- Integrated cellular modem, which by default provides cellular access for Tesla's remote connection (part numbers 1471208 and 1700130)

Refer to the relevant *Controls and Communications Manual* for complete instructions on how to interface with the Tesla System Controller.

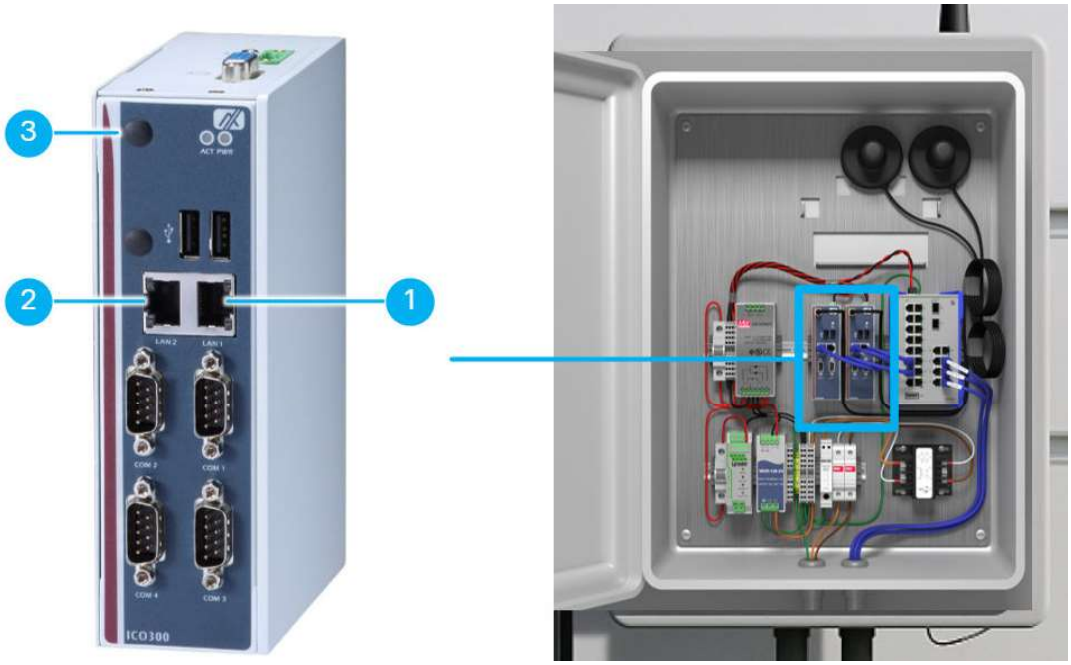
Tesla requires network separation between the Tesla Network and the Customer Network. The Tesla Network shall only contain devices that are critical for Megapack System operation. System operators can interface with the Tesla System Controller over the Customer Network.

There are two physical variations of the Tesla System Controller:

- **Standard Tesla System Controller**: Used in Megapack Systems with up to 16 battery units (not including augmentation units). Delivered in the Standard Tesla System Controller Enclosure, which includes two Standard Tesla System Controllers. Refer to the *Standard Tesla System Controller Enclosure Installation Manual* for installation details.
- **Large Tesla System Controller**: Used in Megapack Systems with greater than 16 and up to 1,000 battery units (not including augmentation units). A single Large Tesla System Controller (or pair of controllers acting in automatic failover) supports up to 1,000 Megapacks. For projects with more than 1,000 Megapacks, additional Large Tesla System Controller(s) may be required. Refer to the *SCADA Design Manual* for additional information about requirements for designing an energy storage site larger than 18 MW. Contact your Tesla representative for more information on controller architectures for larger system sizes.

NOTE: If you have contracted a Certified Service Provider to operate and maintain your Tesla System, contact your Tesla representative for requirements.

Figure 9. Two Standard Tesla System Controllers in the Standard Tesla System Controller Enclosure (Part Number 1471208)

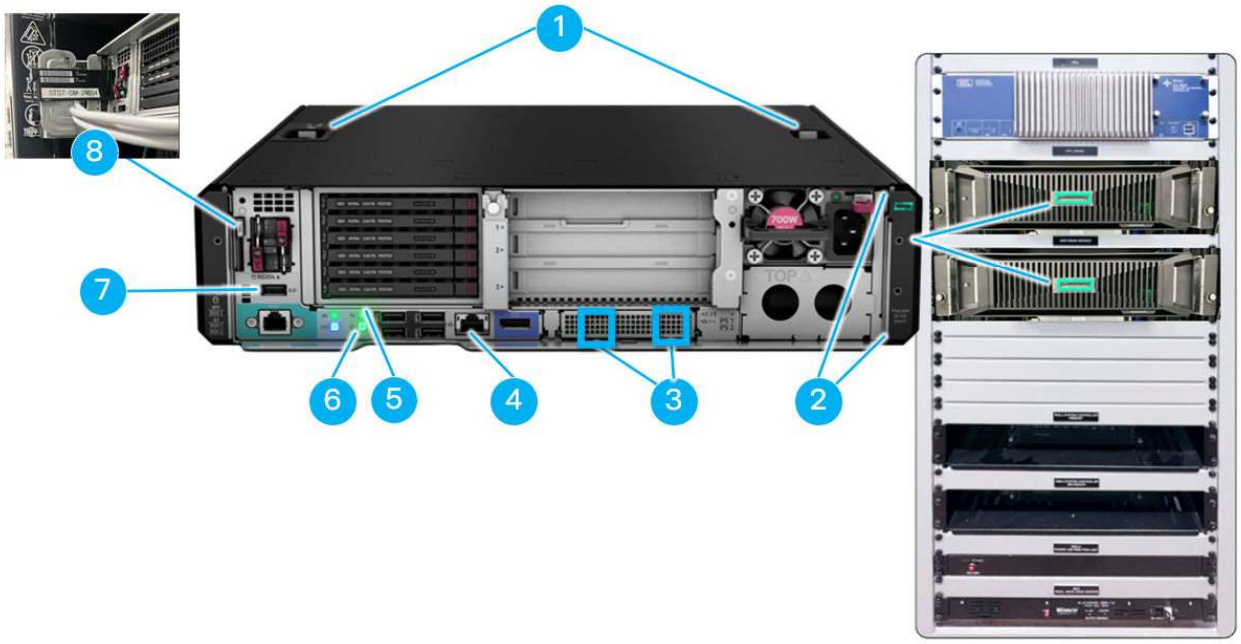


1. LAN 1 port – Customer Network
2. LAN 2 port – Tesla Network
3. Cellular WAN connection

Figure 10. Two Large Tesla System Controllers in a SCADA Network Enclosure (Part Number 1700130)

1. LAN 1 port – Customer Network
2. LAN 2 port – Tesla Network
3. Cellular WAN connection

Figure 11. Two Large Tesla System Controllers in a SCADA Network Enclosure (Part Number 1459155)



1. Quick Removal Access Panel
2. Two Power Supply Slots
3. LAN1 (left) and LAN2 (right) RJ45 ports
4. Remote Management Port
5. Health LED
6. Power On / Standby Button and System Power LED
7. Service Port
8. Information Pull Tab (Serial Number)

For more information:

- Refer to *Installing the Tesla System Controller on page 143* for installation information.
- Refer to *Standard Tesla System Controller Wiring on page 95* and *Network and Internet Considerations on page 60* for design considerations.

1.6 Hazard Mitigation Features

There are hazards inherent in any energy system. In battery energy storage systems, chemical energy in the battery cells can be transmitted as electricity or heat and gases which, when unmitigated, may result in fire.

Hazards are mitigated in multiple ways by the Tesla System, as described in this section.

1.6.1 Electrical Hazard Mitigation

Electrical hazards can include shock from unexpected voltage, heat from unanticipated escape of stored energy, and environmental hazards such as electrical storms. Megapack's electrical hazard mitigation includes:

- *System Protection Features on page 101*
- *Lightning Protection Design on page 103*

1.6.2 Explosion Hazard Mitigation

The Megapack battery enclosure has an explosion control system that mitigates the potential of the enclosure to fail in the event of a deflagration. This system includes:

- **Sparker System:** A protective feature that uses spark plugs ("Sparkers") to proactively ignite flammable discharge gases from compromised battery cells before the gases accumulate within the enclosure and could lead to an explosion hazard.
- **Overpressure vents:** Vents installed in the ceiling of the battery bay's IP66 enclosure that are designed to open during an overpressure event, such as the rapid ignition of flammable gases by a Sparker. Once opened, the overpressure vents permit gases, products of combustion, and flames to exhaust in a controlled path from the battery bay into the thermal roof. From the thermal roof, this exhaust releases out of the roof vents.

1.6.3 Fire Hazard Mitigation

If fire occurs as a result of these hazards, the battery enclosure is designed to prevent it from propagating to nearby enclosures or exposures.

1.6.4 Other Safety Features

In addition to features provided to mitigate hazards, the Tesla System provides additional features that you can use to enhance safety, including:

- *Safety Disconnect Features on page 103*
- **Battery management system:** Megapack provides firmware and software that can be used to monitor the system including battery cell temperature and fault tolerance.

1.7 Product Labels

1.7.1 Megapack Labels

Megapack labels provide the specifications and product reference for each individual Megapack unit.

NOTE: The labels pictured here are example labels. Refer to the labels on the Megapack units themselves for specific product configuration information.

The **Megapack external label** is a small metal label laser-etched onto the outside of the Customer Interface Bay door above the handle. It contains:

- Description of the product, with kWh, kW, and amp ratings
- Part number followed by option codes
- Serial number
- Date of manufacture

Figure 12. Megapack External Label - Example

1. Part number
2. Serial number
3. Option codes

The **Megapack nameplate label** is a large sticker affixed to the inside of the Customer Interface Bay door, and contains nameplate information such as:

- AC input/output specifications including relevant power and energy ratings, in kWh, kW, and amps
- Part number followed by complete list of option codes
- Serial number
- Date of manufacture
- Weight (mass)
- Other detailed product specifics and compliance marks

Figure 13. Megapack Nameplate Label - Example

1. Part number
2. Serial number
3. Option codes

1.7.2 Tesla System Controller Labels

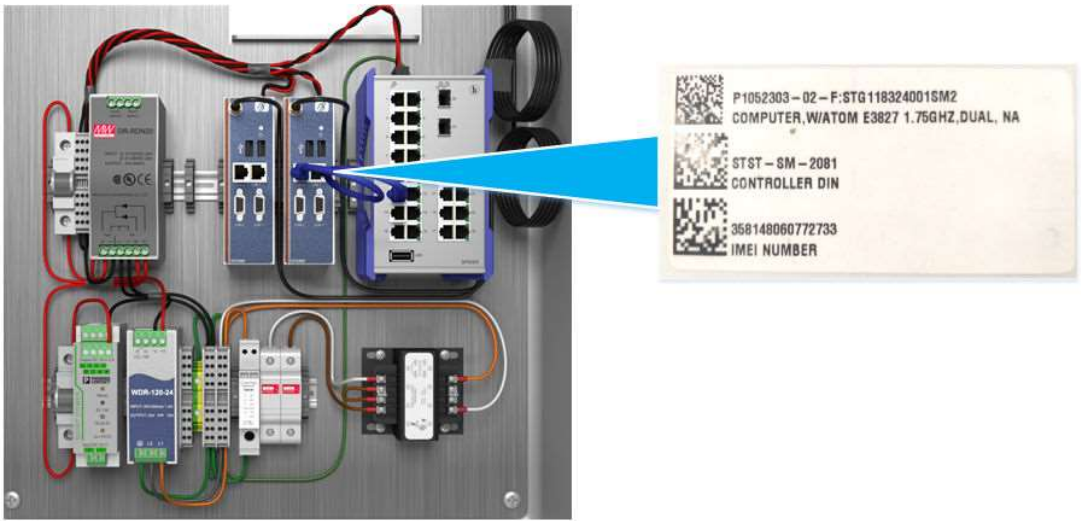
Look on the controller computer of any variant of the Tesla System Controller to locate its labels. The part number is typically identified with P or PN. The VIN is typically labeled *CONTROLLER DIN* and takes the format *STST-SM-####*.

For more information about the Tesla System Controller and its variants, refer to *Tesla System Controller on page 17*.

1.7.2.1 Standard Tesla System Controller

Standard Tesla System Controller labels are located on the side of the computers in the Standard Tesla System Controller Enclosure:

Figure 14. Standard Tesla System Controller Label (Example)



NOTE: There may be two Standard Tesla System Controllers in the Standard Tesla System Controller Enclosure. Each has its own identifiers.

1.7.2.2 Large Tesla System Controller

The labels for the Large Tesla System Controller (part number 1700130) are located on the top and side of the computer:

Figure 15. Large Tesla System Controller (1700130) Label on Top (Example)

Figure 16. Large Tesla System Controller (1700130) Label on Side (Example)

The labels for the Large Tesla System Controller (part number 1459157 or 1459158) are located on the top of the computer and on the information pull tab:

Figure 17. Large Tesla System Controller (1459155) Information Pull Tab Label (Example)

NOTE: Typically, two Large Tesla System Controllers are provided. Each has its own identifiers.

1.8 Emergency Response Guide

The *Industrial Lithium-Ion Battery Emergency Response Guide* (ERG) provides an overview of product materials, handling and use precautions, hazards, emergency response procedures, and storage and transportation instructions. Tesla recommends that a physical copy of the ERG is transported along with Megapack, and subsequently remains on site and accessible at all times for the life of the product. The ERG is periodically updated. Download the latest revision from *https://tesla.com/firstresponders*.

The ERG may be used in place of traditional Safety Data Sheets (SDS) commonly associated with the health and safety of a chemical product, however Safety Data Sheets are available for materials in Tesla Energy products. Refer to the Tesla Partner Portal or contact Tesla for more information.

NOTE: Tesla BESS coolant is not a regulated substance according to the United States Department of Transportation (USDOT). Tesla BESS refrigerant is a regulated substance according to the USDOT.

1.8.1 Available ERG Translations

The *Industrial Lithium-Ion Battery Emergency Response Guide* (ERG) is available in various languages as indicated below. As information in the ERG is periodically updated and translations are periodically added, always check the Tesla First Responders Information page at *https://www.tesla.com/firstresponders* for the latest revision of this guide, for ERGs for other Tesla products, and for the latest additional translated versions.

English	Deutsch	Español	Français
עִבְרִית	Italiano	日本語	한국어
Nederlands	简体中文	繁體中文	Português
Slovenščina			

1.9 Getting Support

This guide, in addition to other required and supportive documentation, is distributed via the Tesla Partner Portal at *https://partners.tesla.com/*.

NOTE: Ensure that the installation team has the most recent revisions of this document and the *Megapack Deployment Checklists* before beginning work. If you are an installation contractor and are not sure if you have the required documents, check with the site manager or Tesla support.

To get support or to provide product feedback, refer to *Contact Information on page 27*.

1.9.1 Contact Information

In case of critical performance issues (for example, if the Tesla site is 100% non-operational), call the appropriate Tesla telephone number listed below and select **Urgent** for 24/7 support.

For other inquiries, visit the **Online Support and Ticketing Portal** or telephone the support contacts provided below.

Online Support and Ticketing Portal
https://ion.tesla.com/ For information about using the Energy Service Portal, refer to the *Energy Service Portal User Guide*: *https://partners.tesla.com/home/en-us/content/download/tesla_ion_user_guide_en-na.pdf*

Urgent Support via Telephone (24x7)
Asia: +1 571 573 9163 Australia/New Zealand: +61 2 432 802 81 Europe/Middle East/Africa: +31 2 08 88 53 32 Japan: +1 571 573 9163 North America: +1 650-681-6060

Technical Support via Telephone		
North America: +1 650-681-6060	Asia/Pacific: +61 2 432 802 81	France: +33 173218702
Japan: +0120 312-441	The Netherlands: +31 208885332	Slovenia: +38 617778699
South Africa: +27 213004878	Switzerland: +41 445155607	United Kingdom: +44 1628450645

2 Site Architecture

In addition to *Tesla System Components on page 9*, a Megapack site may require other equipment and design considerations as noted in this section.

2.1 Archetypes

Standard control Archetypes represent a type of project built with a Tesla battery system and specify metering installation requirements, pre-defined control functions (site- and inverter-level), and system behavior under special conditions based on the project's electrical topology.

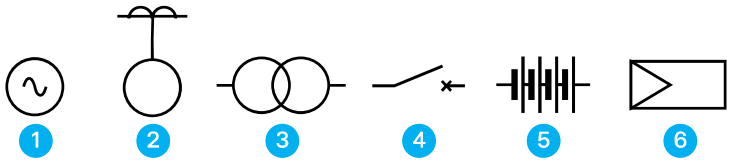
The following Archetypes are available for Tesla projects:

- Utility Battery Only – The Utility Battery Only Archetype is designed for front-of-the-meter, utility-scale storage projects.
- Utility Co-Located Plant (Battery Only) – The Utility Co-Located Plant (Battery Only) Archetype is designed for projects consisting of both batteries and solar generation assets in which only battery control is within Tesla's scope, or for projects with multiple battery meters instead of a single battery meter at the point of interconnection.
- Utility Hybrid – The Utility Hybrid Archetype is designed for projects consisting of both batteries and solar, where the system is being controlled as a single combined resource (referred to as a hybrid resource) and both solar and battery control is within Tesla's scope.
- Battery Dispatch Only – The Battery Dispatch Only Archetype is used in projects where Tesla provides control capabilities at the battery-level. Site-level control capabilities are outside of Tesla's scope and must be managed by a third-party controller.
- Grid-Connected Only – The Grid-Connected Only Archetype is used in projects where the system is grid-connected and Tesla provides both battery-level and site-level control capabilities. These projects consist of a net load meter, Tesla battery, and optional solar generation assets connected to the grid.
- Backup – The Backup Archetype is used in projects where the system is normally grid-connected and provides load backup in the event of abnormal grid conditions. Tesla provides battery-level, site-level, and islanding control capabilities. These projects consist of a Tesla battery and an Islanding Controller.
- Off-Grid Microgrid – The Off-Grid Microgrid Archetype is used in projects where the system is an isolated grid capable of supporting loads and managing battery operation in coordination with other generation assets. These projects consist of a Tesla battery and approved solar, generator, and/or wind assets while operating off-grid.
- Grid-Connected Microgrid – The Grid-Connected Microgrid Archetype is used in projects in which the system is connected to the grid and is also capable of islanding, and charging or discharging in coordination with generation assets in order to support loads. These projects consist of a Tesla battery and approved solar, generator, or wind assets while operating on-grid and off-grid.

Electrical topology and associated design guidance varies per Archetype. Guidance where unique for each Archetype is provided throughout this section.

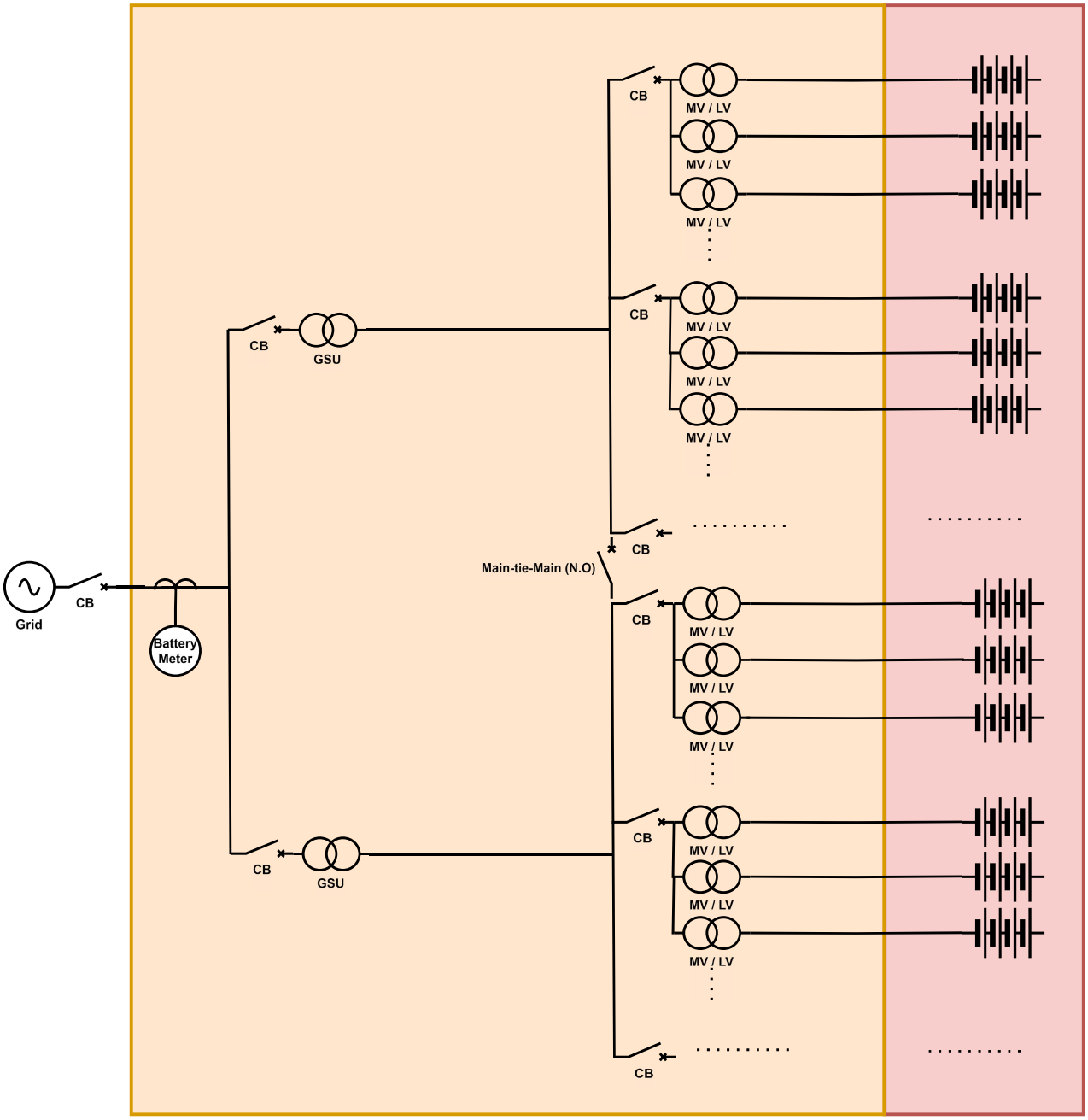
A diagram of the electrical topology for each Archetype is provided below. In the diagrams, shaded areas represent different control sections as indicated in each diagram's legend. Icons in the diagrams generally indicate the following components:

Figure 18. Icon Key



1. Grid
2. Meter: At various locations, as indicated in diagrams
3. Transformer: With types indicated, including generator step-up (GSU), medium voltage (MV), low-voltage (LV)
4. Circuit breaker: Also abbreviated CB
5. Battery assets: Megapack units
6. Solar assets: Also abbreviated PV for photovoltaics

Figure 19. Utility Battery Only Archetype – Electrical Topology & Control Sections



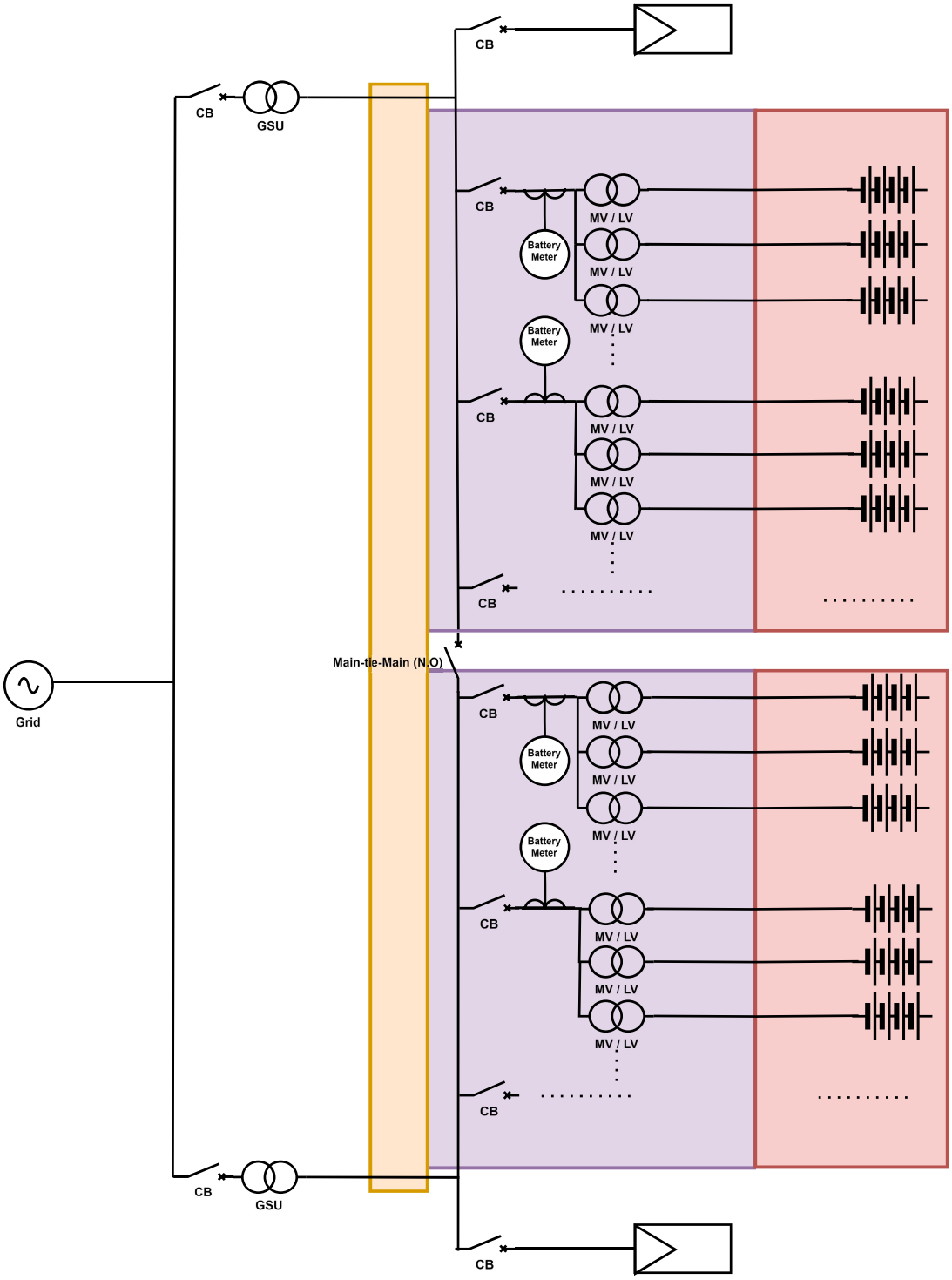
Control Sections

On-Grid

Battery Assets

NOTE: In projects using the Utility Battery Only or Utility Hybrid Archetypes, in order to black start a facility, the meter and main circuit breaker shall be arranged as shown in the diagram. The main circuit breaker must be on the utility- or line-side of the battery meter for black start to function.

Figure 20. Utility Co-Located Archetype – Electrical Topology & Control Sections



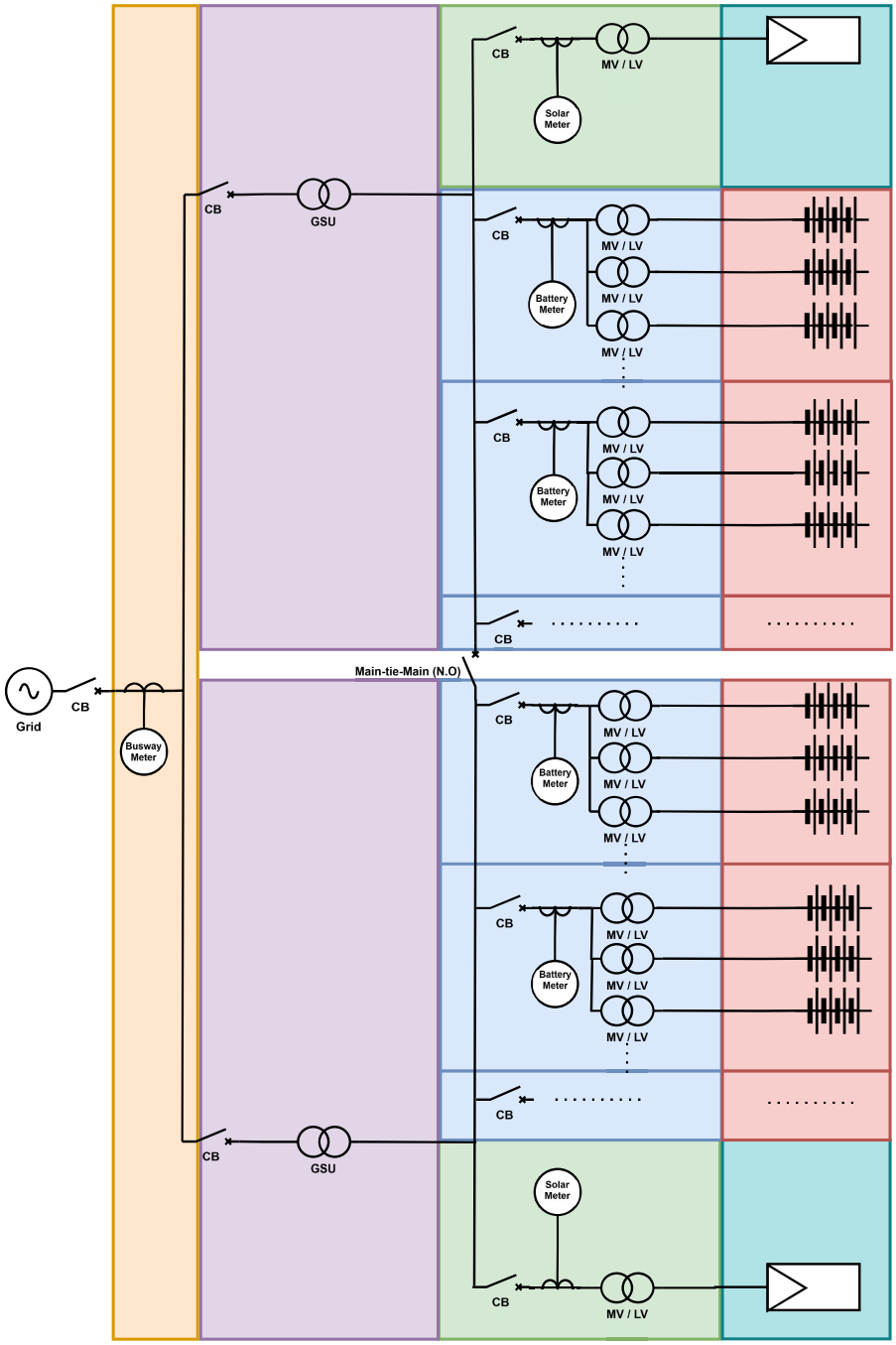
Control Sections

On-Grid

Metered Battery Sub-Site

Battery Assets

Figure 21. Utility Hybrid Archetype – Electrical Topology & Control Sections

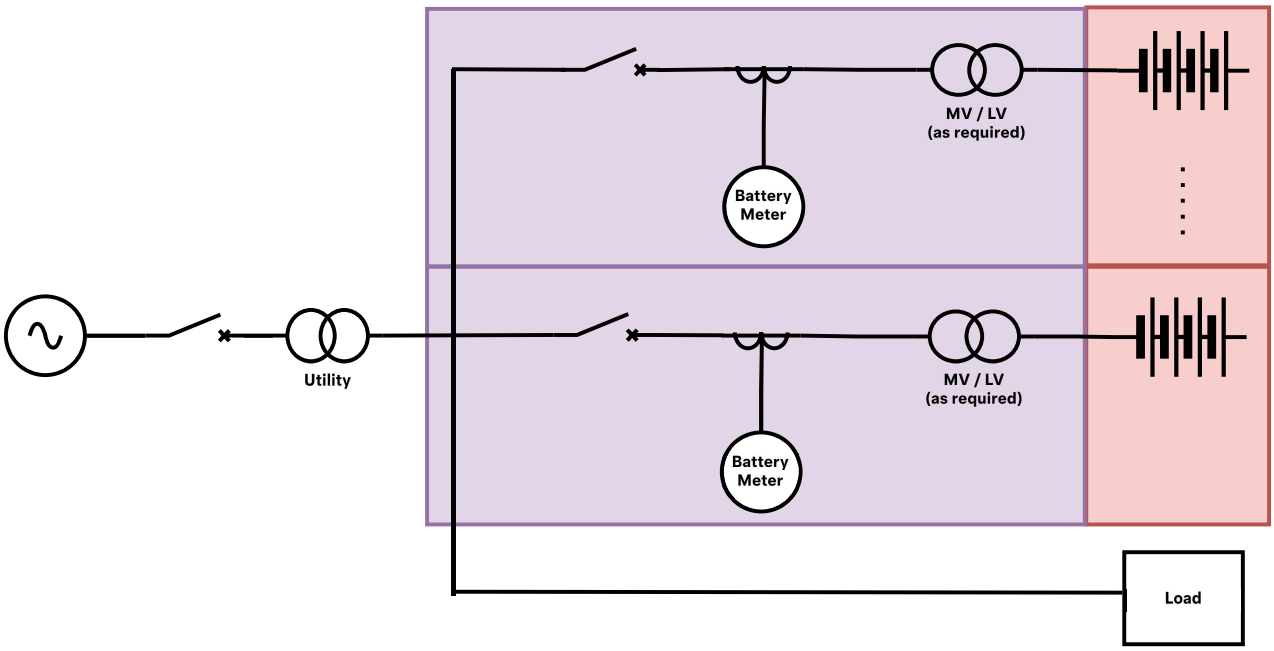


Control Sections

- On-Grid
- Hybrid Sub-Site
- Metered Solar Sub-Site
- Metered Battery Sub-Site
- Solar Assets
- Battery Assets

NOTE: In projects using the Utility Battery Only or Utility Hybrid Archetypes, in order to black start a facility, the meter and main circuit breaker shall be arranged as shown in the diagram. The main circuit breaker must be on the utility- or line-side of the battery meter for black start to function.

Figure 22. Battery Dispatch Only Archetype – Electrical Topology & Control Sections

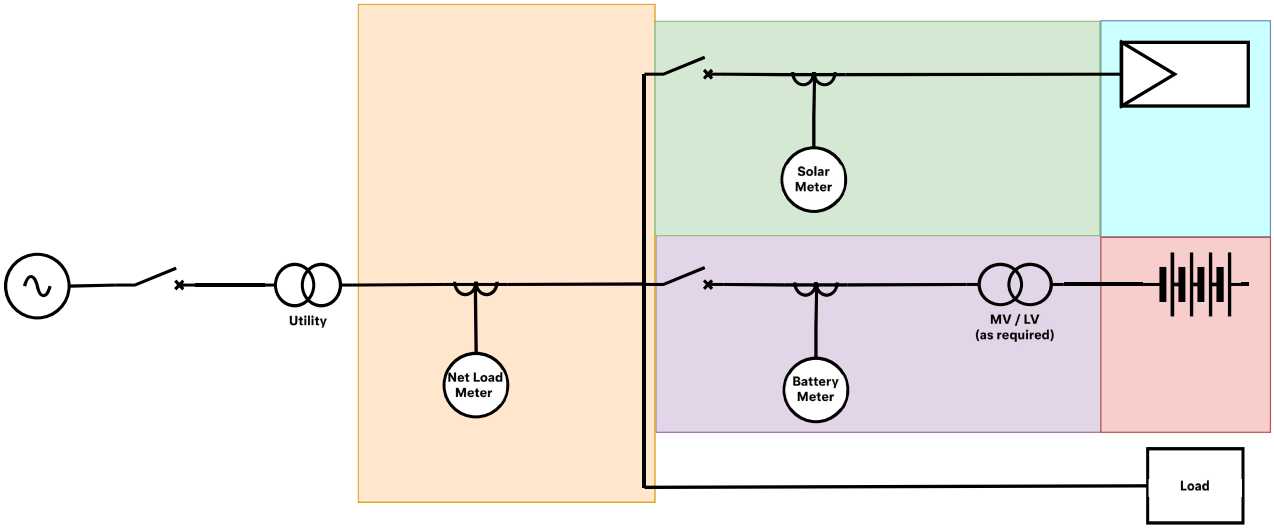


Control Sections

Metered Battery Sub-Site

Battery Assets

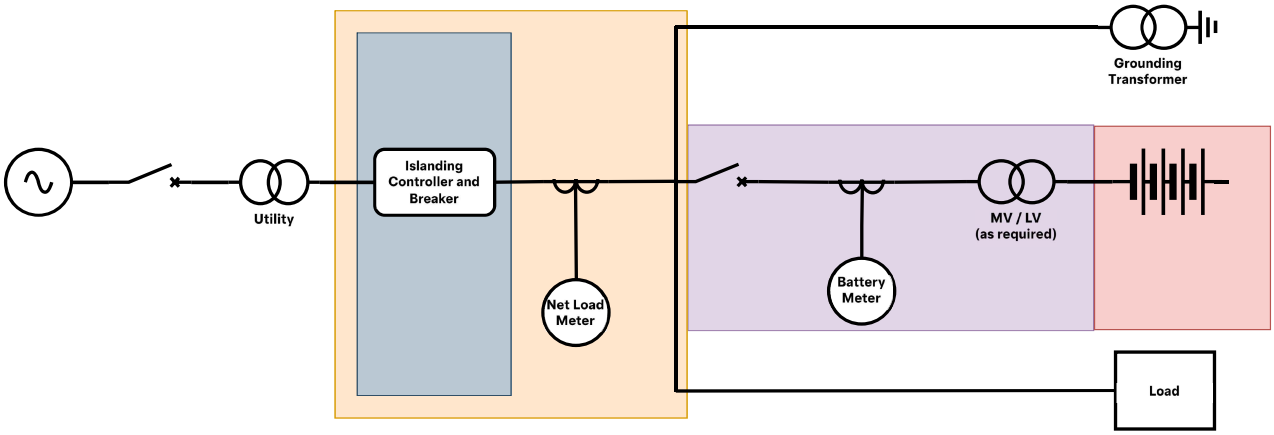
Figure 23. Grid-Connected Only Archetype – Electrical Topology & Control Sections



Control Sections

- On-Grid
- Metered Solar Sub-Site
- Metered Battery Sub-Site
- Solar Assets
- Battery Assets

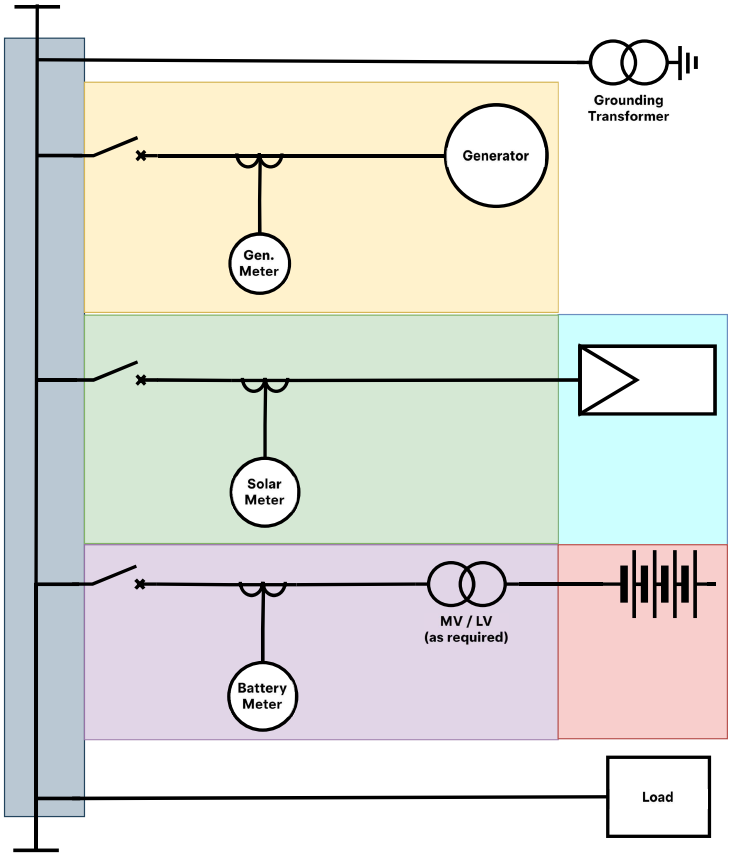
Figure 24. Backup Archetype – Electrical Topology & Control Sections



Control Sections

- On-Grid
- Islanding Control
- Metered Battery Sub-Site
- Battery Assets

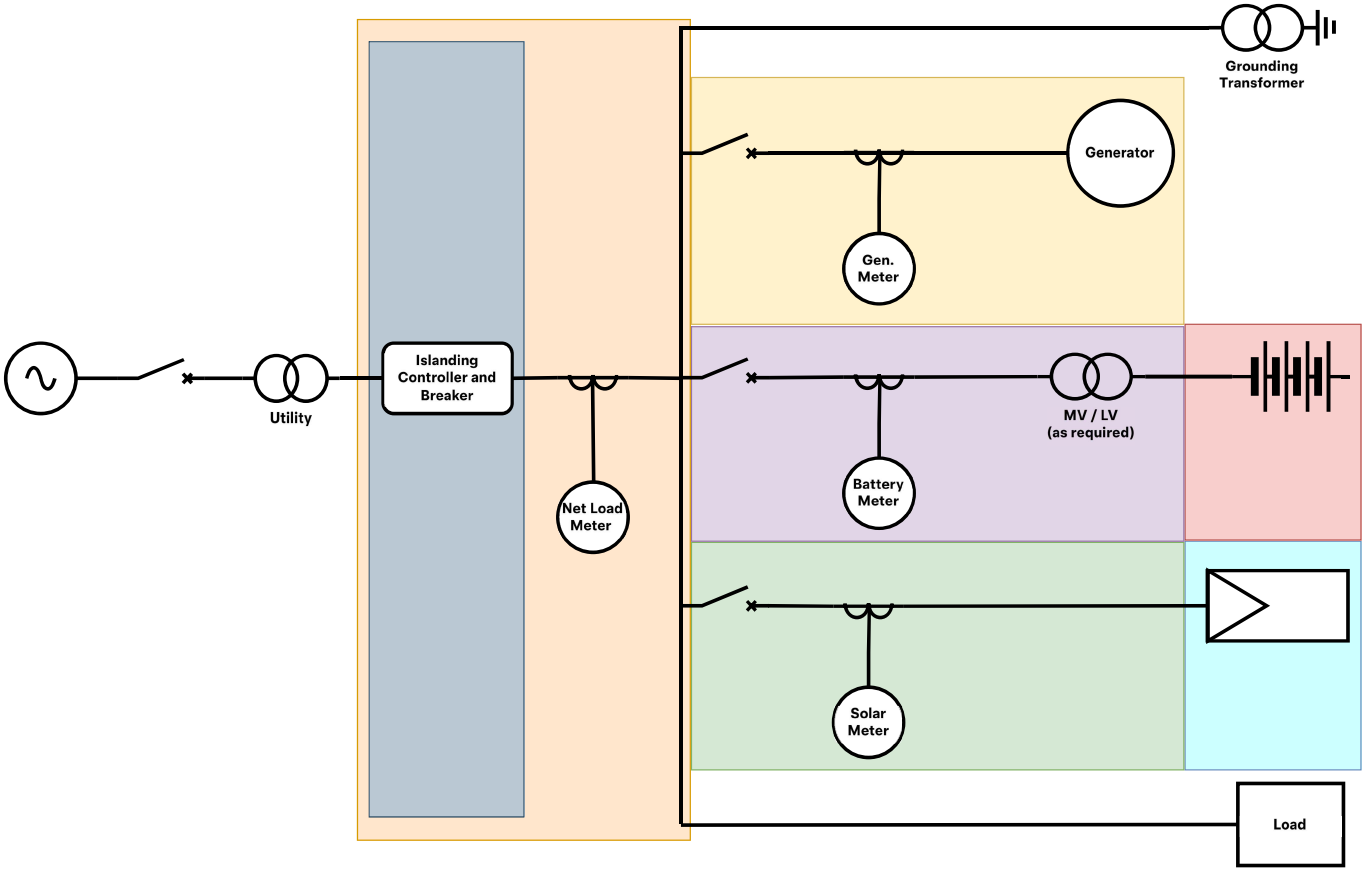
Figure 25. Off-Grid Microgrid Archetype – Electrical Topology & Control Sections



Control Sections

- Microgrid Control
- Metered Generator Sub-Site
- Metered Solar Sub-Site
- Metered Battery Sub-Site
- Solar Assets
- Battery Assets

Figure 26. Grid-Connected Microgrid Archetype – Electrical Topology & Control Sections



Control Sections

- On-Grid
- Islanding and Microgrid Control
- Metered Generator Sub-Site
- Metered Battery Sub-Site
- Metered Solar Sub-Site
- Battery Assets
- Solar Assets

2.2 Equipment per Archetype

Supported or required equipment varies per Archetype, generally according to the guidelines in this section.

Table 6. Equipment for Utility Archetypes

Equipment	Utility Battery Only	Utility Co-Located Plant (Battery Only)	Utility Hybrid
Meters			
Battery (*Battery Meter on page 42*)	Required Exactly 1	Required (1 per battery sub-site) Minimum 2, up to 10 supported	Required (1 per battery sub-site) Minimum 1, up to 10 supported
Solar (*Solar Meter on page 43*)	N/A	N/A	Required (1 per solar sub-site) Minimum 1, up to 10 supported
Busway (*Busway Meter on page 44*)	N/A	N/A	Required Exactly 1 at the point of interconnection for the hybrid plant
Other Equipment			
Ground reference (*Ground Reference Design on page 52*)	Required	Required	Required

Table 7. Equipment for C&I Archetypes

Equipment	Battery Dispatch Only	Grid-Connected Only	Backup	Off-Grid Microgrid	Grid-Connected Microgrid
Meters					
Battery (*Battery Meter on page 42*)	Required Minimum 1, up to 10 supported	Required Minimum 1, up to 10 supported	Required Minimum 1, up to 10 supported	Required Minimum 1, up to 10 supported	Required Minimum 1, up to 10 supported
Solar (*Solar Meter on page 43*) Refer to *On-Grid Solar Controls* or *Opticaster* in the *Controls and Communications Manual – v2 Platform – C&I Projects* for more information.	N/A	Required for on-grid solar controls or Opticaster, otherwise optional Up to 10 supported	Required for Opticaster, otherwise optional Up to 10 supported	Optional Up to 10 supported	Required for on-grid solar controls or Opticaster, otherwise optional Up to 10 supported

Equipment	Battery Dispatch Only	Grid-Connected Only	Backup	Off-Grid Microgrid	Grid-Connected Microgrid
Busway (*Busway Meter on page 44*) Refer to *Busway Hard Limits* in the *Controls and Communications Manual – v2 Platform – C&I Projects* for more information.	N/A	Required for busway limits, otherwise optional Up to 10 supported	Required for busway limits, otherwise optional Up to 10 supported	Required for busway limits, otherwise optional Up to 10 supported	Required for busway limits, otherwise optional Up to 10 supported
Generator (*Generator Meter on page 46*)	N/A	N/A	N/A	Optional Up to 10 supported	Optional Up to 10 supported
Wind (*Wind Meter on page 47*)	N/A	N/A	N/A	Optional Up to 10 supported	Optional Up to 10 supported
Net Load (*Net Load Meter on page 45*)	N/A	Required Exactly 1	Required Exactly 1	N/A	Required Exactly 1
Other Equipment					
Islanding controller and breaker (*Islanding Controller Design on page 55*)	N/A	N/A	Required	N/A	Required
Ground reference (*Ground Reference Design on page 52*)	Required	Required	Required	Required	Required

2.3 Energy Meter Design

The Tesla System Controller uses various energy meter inputs for different control functions. Every system requires, at a minimum, a battery meter. Additional energy metering in various capacities is supported or required as described per each Archetype (*Equipment per Archetype on page 37*).

This section describes requirements for procuring meter hardware. Refer to the *Tesla Industrial Energy Approved Vendor List* for supported meter hardware in addition to the requirements below.

NOTE: Energy meters must be provided, installed, and configured by the contractor. Tesla will confirm communication with these energy meters but is not responsible for their accuracy.

NOTE: See *Connecting Energy Meters on page 144* for instructions on connecting meters.

NOTE: The system requires Ethernet to connect meters to the Tesla System Controller. RS-485 is not supported.

NOTE: Tesla is not responsible for the accuracy of the energy meters provided, installed and configured by the customer. Consult with the energy meter manufacturer in the event of faulty communications from energy meters.

NOTE: See the *Application Note: Using SEL-735 Meters with Tesla Products* for details about configuring SEL-735 meters.

2.3.1 Meter Form

The Tesla System Controller only supports Form 9 (Wye) and Form 5 (Delta) meter forms. Other configurations are not supported. The table below shows guidance on the meter form for medium voltage (MV) and low voltage (LV) applications, as well as for the required current transformer (CT) and potential transformer (PT) values. Applications for UL 1741 power control systems (PCS) require Form 9.

Refer to *Meter Locations on page 41* for the importance of installing the correct meter polarity.

Table 8. Meter Wiring Configurations

Wiring Configuration	Required Meter Form	PTs Required	CTs Required	Applicable for UL 1741 PCS?	Notes
Three-Phase, Four-Wire	Form 9* (Four-Wire Wye)	3	3	Yes	--
Three-Phase, Three-Wire, Neutral Grounded at transformer	Form 9* (Four-Wire Wye)	3	3	Yes	Wire SEL 735 PT neutral to site ground
Three-Phase, Three-Wire, Ungrounded	Form 5 (Three-Wire Delta)	2	2	No	--

* Required for compliance with UL 1741 PCS. This certification is a requirement in many interconnection tariffs including California Rule 21 for non-export and inadvertent export applications, as well as NEM paired solar.

2.3.2 Meter Part Numbers

NOTE: Example part numbers provided in this section are for vertically mounted meter bodies, but horizontally mounted meter bodies may also be specified.

The SEL-735 is available in **Advanced, Intermediate, and Basic options.**

The Advanced meter is required:

1. When there is a project specific requirement for wider range of harmonic measurements, or
2. When there is a contractual/project requirement for response time test in performance testing.
    - **Note:** The response time test is not part of standard Tesla Performance tests and is included based on customer/contractual requirements.

For all other applications, the Basic or Intermediate SEL-735 meter can be used for metering.

NOTE: Part numbers in this section only include the features required for the SEL-735 meter to interface with the Tesla System Controller. The customer is responsible for ensuring the meter configuration fulfills all project requirements.

Table 9. Advanced Option Part Numbers

Frequency	Power Supply	Advanced Form 5 (Three-Wire Delta)	Advanced Form 9 (Four-Wire Wye)
60Hz	110-240 V AC and 110-250 V DC	Popular model code: 735#0301	Popular model code: 735#0302
60Hz	24-48 V DC	0735BX20524EXXXXXX16101XX	0735BX20924EXXXXXX16101XX
60Hz	12-24 V DC	0735BX20514EXXXXXX16101XX	0735BX20914EXXXXXX16101XX
50Hz	110-240 V AC and 110-250 V DC	0735BX20544EXXXXXX15101XX	0735BX20944EXXXXXX15101XX
50Hz	24-48 V DC	0735BX20524EXXXXXX15101XX	0735BX20924EXXXXXX15101XX
50Hz	12-24 V DC	0735BX20514EXXXXXX15101XX	0735BX20914EXXXXXX15101XX

Table 10. Intermediate Option Part Numbers

Frequency	Power Supply	Intermediate Form 5 (Three-Wire Delta)	Intermediate Form 9 (Four-Wire Wye)
60Hz	110-240 V AC and 110-250 V DC	Popular model code: 735#03VX	Popular model code: 735#H99M
60Hz	24-48 V DC	0735BX10524EXXXXXX16101XX	0735BX10924EXXXXXX16101XX
60Hz	12-24 V DC	0735BX10514EXXXXXX16101XX	0735BX10914EXXXXXX16101XX
50Hz	110-240 V AC and 110-250 V DC	0735BX10544EXXXXXX15101XX	0735BX10944EXXXXXX15101XX
50Hz	24-48 V DC	0735BX10524EXXXXXX15101XX	0735BX10924EXXXXXX15101XX
50Hz	12-24 V DC	0735BX10514EXXXXXX15101XX	0735BX10914EXXXXXX15101XX

Table 11. Basic Option Part Numbers

Frequency	Power Supply	Basic Form 5 (Three-Wire Delta)	Basic Form 9 (Four-Wire Wye)
60Hz	110-240 V AC and 110-250 V DC	Popular model code: 735#0101	Popular model code: 735#0102
60Hz	24-48 V DC	0735BX00524EXXXXXX16101XX	0735BX00924EXXXXXX16101XX
60Hz	12-24 V DC	0735BX00514EXXXXXX16101XX	0735BX00914EXXXXXX16101XX
50Hz	110-240 V AC and 110-250 V DC	0735BX00544EXXXXXX15101XX	0735BX00944EXXXXXX15101XX
50Hz	24-48 V DC	0735BX00524EXXXXXX15101XX	0735BX00924EXXXXXX15101XX
50Hz	12-24 V DC	0735BX00514EXXXXXX15101XX	0735BX00914EXXXXXX15101XX

2.3.3 Current and Potential Transformer Requirements

Energy meters must abide by the minimum accuracy requirements for current transformers (CTs) and potential transformers (PTs) as listed in the table below per region as appropriate. Equipment with greater accuracy may be installed if needed.

Table 12. Minimum Accuracy Requirements

Equipment	United States	Non-United States
Current Transformer (CT)	Class 1.2% Per ANSI/IEEE C57.13	Class 0.5S Per IEC 61869-2
Potential Transformer (PT) also known as Voltage Transformer (VT)	Class 1.0% Per ANSI/IEEE C57.13	Class 1.0 Per IEC 61869-3

2.3.4 Meter Locations

The Tesla System Controller supports a set of meter locations, corresponding to different monitored energy sources. This section details the different meter locations, their use cases, and sign conventions to guide wiring. Refer to *Equipment per Archetype on page 37* to determine meter requirements per Archetype, and *Wiring Current Transformer Inputs on page 145* for wiring installation steps.

2.3.4.1 Battery Meter

A battery meter monitors the output of the battery system only, which consists of Tesla battery units and transformers/conductors up to the point of metering. No additional load or generation is included through a battery meter. A battery meter is required on every Tesla battery system and is used to monitor the system's energy throughput and power output.

The meter sign convention is as follows:

- Real power discharged from the batteries is positive
- Reactive power injected by the batteries (overexcited) is positive
- Energy Exported increases with positive/discharge power

Figure 27. Battery Meter Wiring Convention

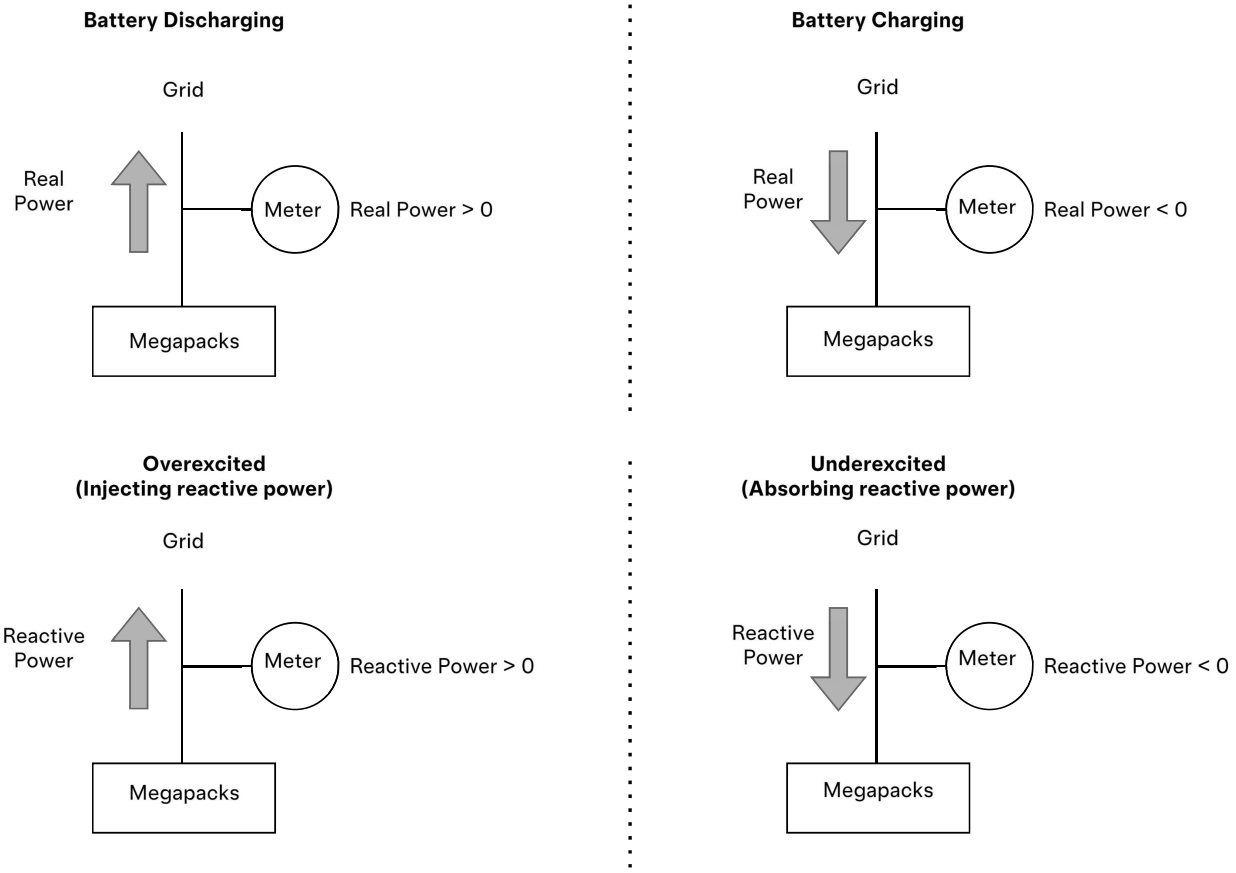


Table 13. Battery Meter Information

Metered Energy Source	Tesla batteries only.
Metering Convention	A discharge from the batteries leads to positive power at the meter.
Number of Meters Supported	Archetype-dependent, up to 10 maximum.

2.3.4.2 Solar Meter

A solar meter monitors solar assets and is used on systems in which the Tesla System Controller monitors and leverages solar data. Generation from solar assets leads to positive power at the meter.

Figure 28. Solar Meter Wiring Convention

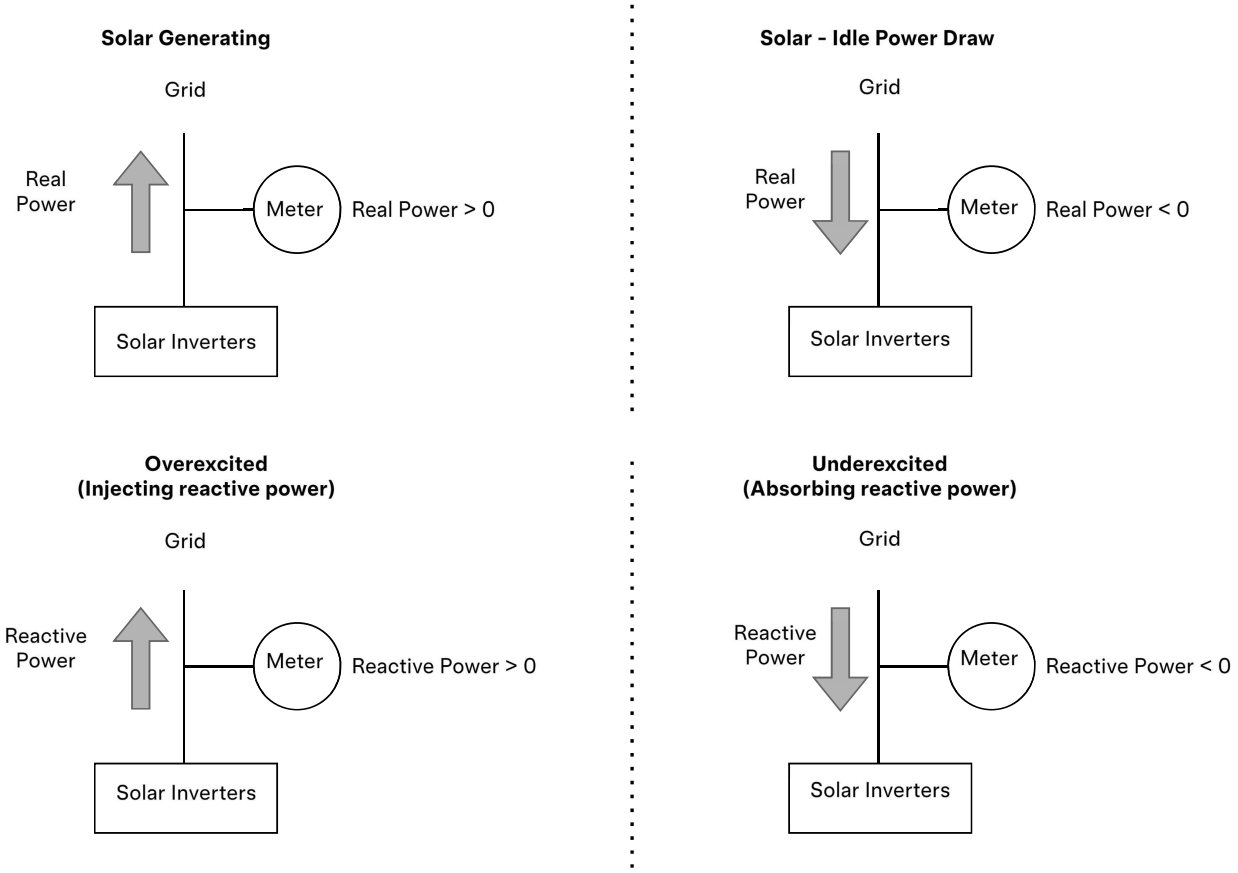


Table 14. Solar Meter Information

Metered Energy Source	Solar assets only.
Metering Convention	Solar generation leads to positive power at the meter.
Number of Meters Supported	Archetype-dependent, up to 10 maximum.

2.3.4.3 Busway Meter

A busway meter monitors more than one generation asset or load and can be installed at any location consisting of more than one generation or load type.

Figure 29. Busway Meter Wiring Convention

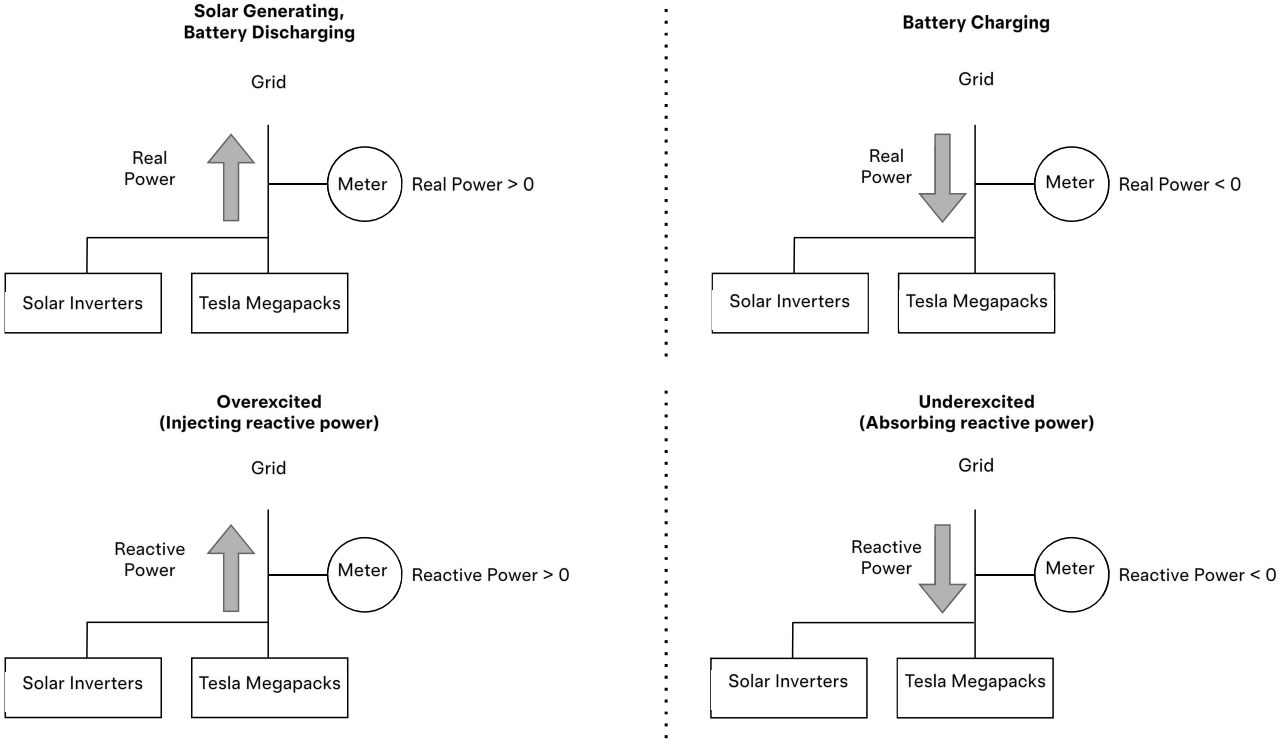


Table 15. Busway Meter Information

Metered Energy Source	Multiple generation assets, typically solar and battery.
Metering Convention	Solar generation and battery discharging lead to positive power at the meter.
Number of Meters Supported	Archetype-dependent, up to 10 maximum.

2.3.4.4 Net Load Meter

A net load meter monitors a facility's net load and is typically installed at the same location as the facility's utility meter used for billing.

Figure 30. Net Load Meter Wiring Convention

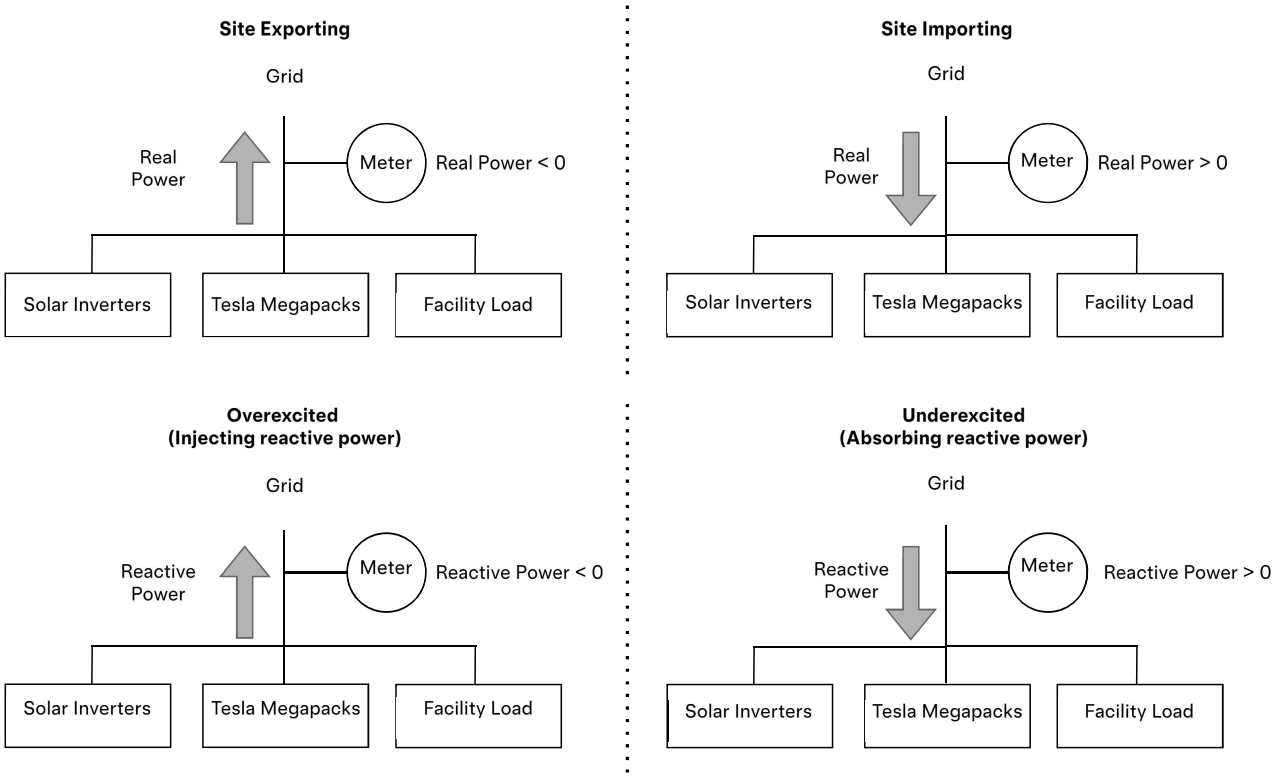


Table 16. Net Load Meter Information

Metered Energy Source	Grid (to facility load).
Metering Convention	Load (consumption) at the facility leads to positive power. Export from the facility due to on-site generation leads to negative power.
Number of Meters Supported	Archetype-dependent, up to 5 maximum.

2.3.4.5 Generator Meter

A generator meter monitors generator assets and can be installed when a conventional generator is used, typically as part of a microgrid.

Figure 31. Generator Meter Wiring Convention

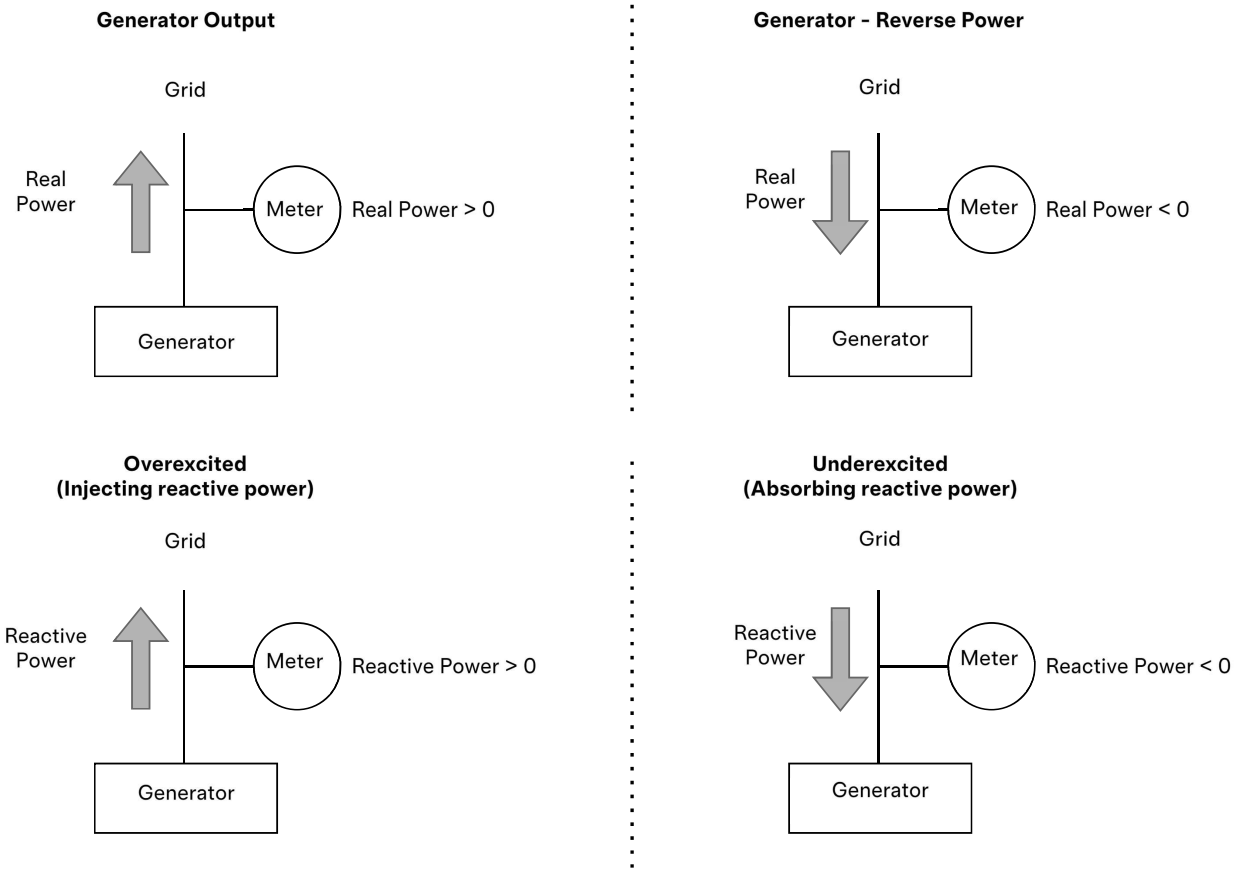


Table 17. Generator Meter Information

Metered Energy Source	Generator assets.
Metering Convention	Generation leads to positive power at the meter.
Number of Meters Supported	Archetype-dependent, up to 10 maximum.

2.3.4.6 Wind Meter

A wind meter monitors production from wind turbines on projects in which the Tesla System Controller interacts with wind generation.

Figure 32. Wind Meter Wiring Convention

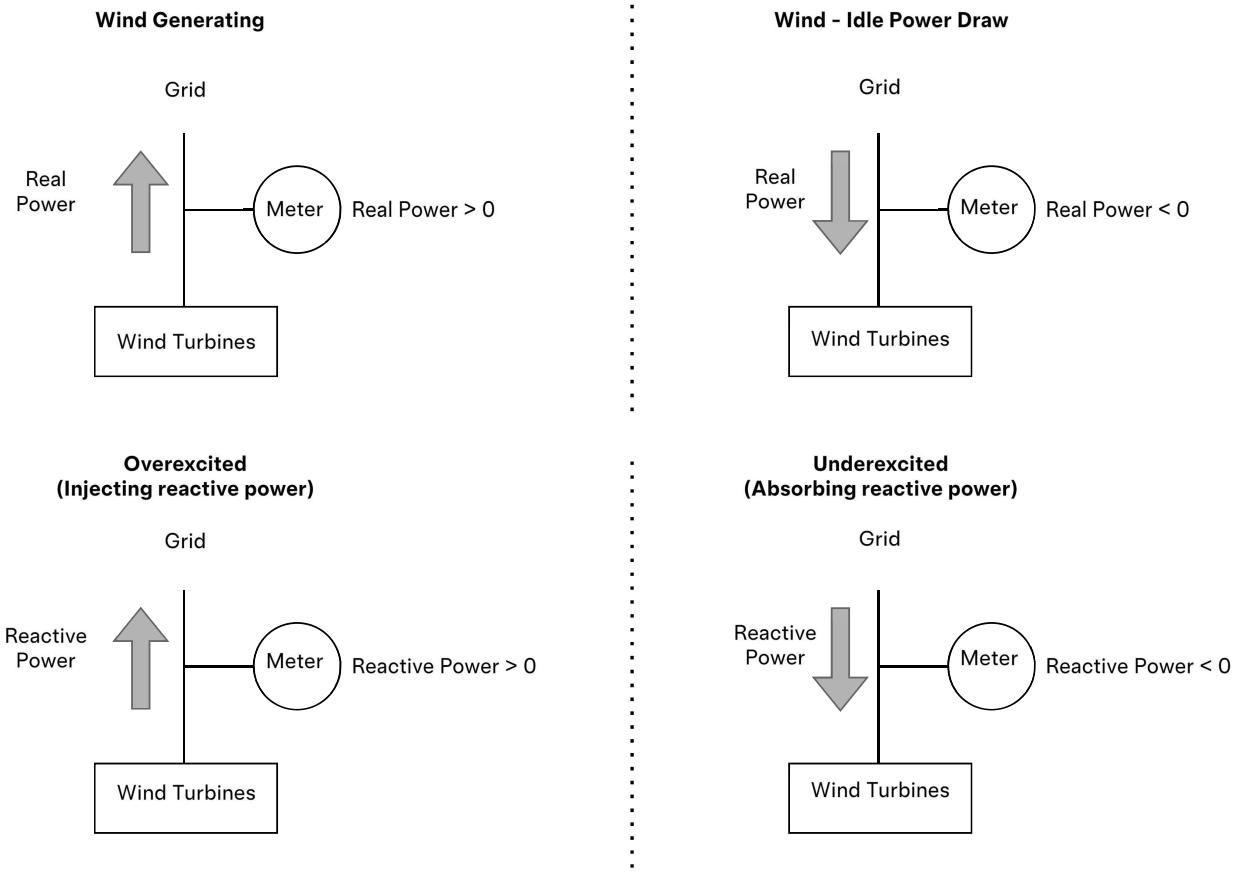


Table 18. Wind Meter Information

Metered Energy Source	Wind turbines.
Metering Convention	Generation leads to positive power at the meter.
Number of Meters Supported	Archetype-dependent, up to 10 maximum.

2.3.5 UL 1741 PCS Requirements

UL 1741 PCS compliance may be required by the interconnecting utility or site host. If UL 1741 PCS compliance is required according to applicable site design, follow the guidance in this section.

The Tesla battery system is certified to UL 1741 PCS for the energy storage system (ESS) operating mode of **import only**. Using this mode, the Tesla battery system will not export active power from the battery to the grid (Area EPS). Compliance with UL 1741 PCS can be achieved for system sizes under 20 MW with compatible meters according to the requirements below.

2.3.5.1 Meters

The Tesla battery system's UL 1741 PCS compliance is only compatible with the following meter:

- SEL-735 Power Quality and Revenue Meter (see *Energy Meter Design on page 38* for details)

2.3.5.2 Minimum Accuracy Requirements

Table 19. Minimum UL 1741 PCS Accuracy Requirements

Equipment	United States	Non-United States
Current Transformer (CT)	Class 0.6% Per ANSI/IEEE C57.13	Class 0.5S Per IEC 61869-2
Potential Transformer (PT) also known as Voltage Transformer (VT)	Class 1.0% Per ANSI/IEEE C57.13	Class 1.0 Per IEC 61869-3

2.3.5.3 Current Transformers

The Tesla battery system is UL 1741 PCS-compliant when a compatible meter operating as a site meter is installed in Form 9 configuration and has current transformers with a 5A secondary and between 86A and 24,000 A on the primary. To comply with the abnormal condition section of the PCS standard, installers shall ensure there is sufficient burden resistance on the current transformer circuit such there is no open circuit shock hazard. Furthermore, UL 2808, UL 61010, or IEEE 57.13 current transformer compliance is required based on the following table:

Table 20. Required Current Transformer Compliance Standards

Conductor Nominal Line-to-Line Voltage	Required CT Standard
≤600 V	CTs must be UL 2808 or UL 61010 compliant
601-1000 V	CTs must be UL 2808 or IEEE 57.13 compliant
>1000 V	CTs must be IEEE 57.13 compliant

Tesla suggests using the following Accuenergy AcuCT series models where possible. They are UL 2808 & UL 61010 compliance and have a built-in burden resistance.

- AcuCT-3135R
- AcuCT-4161R
- AcuCT-5170R

CT Labeling Requirements

You must post the following label near the installation of the CTs:

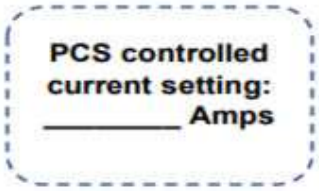
2.3.5.4 Voltage Sensing Configurations

The Tesla battery system's UL 1741 PCS compliance requires that the voltage sensing configuration be Form 9.

2.3.5.5 Bus Bar Labeling Requirements

The PCS-controlled current setting for each bus bar shall be indicated with a field-applied marking label on the conductor or in close proximity to the bus bars. Refer to the label below, filling the blank with the following value: (Maximum Nameplate Current)x(Number of installed Tesla units per site):

Figure 33. PCS Field Marking Label



2.3.5.6 Required UL 1741 PCS Compliance Information

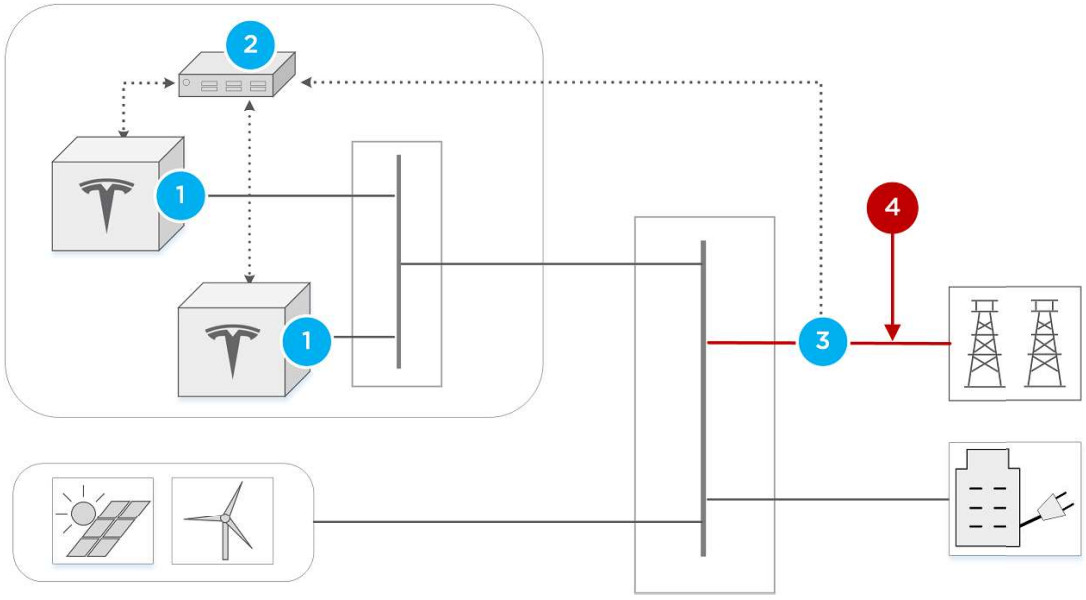
This system is equipped with a power control system (PCS). All PCS controlled busbars or conductors shall be protected with suitably rated overcurrent devices appropriately sized for the busbar rating or conductor ampacity.

Notice: The maximum operating currents in controlled busbars or conductors are limited by the settings of the power control system (PCS) and may be lower than the sum of the currents of the connected controlled power sources. The settings of the PCS controlled currents may be used for calculation of the design currents used in the relevant sections of NEC Article 690 and 705.

Warning: Only qualified personnel shall be permitted to set or change the setting of the maximum operating current of the PCS. The maximum PCS operating current setting shall not exceed the busbar rating or conductor ampacity of any PCS controlled busbar or conductor.

Maximum overcurrent protection rating per each PCS controlled conductor's location: 41,600 A.

Figure 34. Single Line Diagram for UL 1741 PCS-Compliant System



(Dashed lines indicate communication with Tesla System Controller)

1. Tesla battery system
2. Tesla System Controller
3. Site meter
4. PCS controlled conductors

The Tesla battery system must be configured before UL 1741 PCS controls are active. To configure the system for UL 1741 PCS, contact your Tesla representative.

2.4 Transformer Design

In order to operate, Megapack requires a solidly grounded circuit to ensure that the line-to-ground nominal voltage does not exceed 300 V AC during steady-state conditions.

Customers can parallel multiple Megapack units on a single secondary (low-voltage side) winding. Megapack does not require any additional transformer features such as K-factor or shielding requirements. Megapacks also do not require galvanic isolation from each other; therefore, a single-winding primary-to-single-winding secondary transformer is sufficient for connecting multiple Megapacks. One transformer grouped with several Megapacks is called a *transformer block*.

For operation and maintenance needs, the line-side bus bars and cables within the Megapack must be able to be isolated and locked out and should use a visually verifiable means. This can be generally performed with a no-load disconnecting means at the secondary of the transformer (due to the circuit breaker in the Megapack performing the load break functionality), or via a load break disconnect at the primary winding of the transformer. Arc flash, personal safety and operational procedures should be considered when selecting the means of disconnection.

The customer's engineer should ensure that the requirements listed in this section are met alongside other technical considerations such as utility compliance, protection, maintenance, certification and load requirements. For transformer configurations not discussed here, contact Tesla for review.

For more information about transformer design considerations, refer to the *Application Note: Grounding Conductor Recommendations for Megapack Applications* or reach out to your Tesla representative.

2.4.1 Site-Level High-Voltage Ride-Through Considerations

Megapack cannot be exposed to grid voltage greater than 1.3 per-unit for any period of time. This should be a consideration when designing transformers for use at the site.

2.4.2 Secondary-Side Fault Current Considerations

The maximum supply fault current rating of the Megapack is 85 kA_{rms}. Ensure that your transformer is designed to provide less than this fault current at the Megapack AC bus by following the guidance in this section.

To ensure that the maximum current flowing through Megapack does not exceed this value, maintain a minimum impedance value on the secondary side of the transformer such that in the event of a fault, the current does not exceed this value.

Even if there are multiple connected Megapacks, assume a single Megapack is subject to full fault current. In some circumstances, this increases the minimum allowable impedance of the transformer.

NOTE: Transformers manufactured to ANSI standards will always have +7.5% to -7.5% of impedance tolerance which must be taken into consideration.

Example

- Two 2,200 kVA Megapack connected to a transformer at 480 V
- Transformer has a rating of 4,400 kVA, or 5,292 amps at 480 V [`I=VA/(√3*V)`]
- Then, the max allowable short circuit current is given by:

$$I_{short\ circuit} = I_{rated} * \frac{100}{Z\%}$$

- From the above expression, base impedance is calculated as

$$Z\% = I_{rated} * \frac{100}{I_{short\ circuit}}$$

$$= 5292 * \frac{100}{85 * 10^3}$$

- The base impedance must be selected such that the available short-circuit current is less than 85 kA.

Result

The percentage transformer impedance value is calculated to be 6.2%. However, considering impedance tolerances, the base impedance of the transformer procured must be **at least 6.7% in accordance with ANSI standards.**

Per the example in *Site-Level High-Voltage Ride-Through Considerations on page 51*, the transformer impedance should be > 5.75%, and, per this example, for short-circuit current withstand, the transformer impedance should be > 6.7%.

Therefore, the final impedance of transformer should be at least 6.7%.

2.4.3 Using On-Load Tap Changers

If a Grid-Forming project includes an on-load tap changer (OLTC) between the meter used for control and the battery units, contact your Tesla representative about the available features.

2.5 Ground Reference Design

A ground reference is required for operation. Specific additional design considerations apply for certain Archetypes (*Equipment per Archetype on page 37*) according to the guidance below.

2.5.1 Battery Dispatch Only and Grid-Connected Only Archetype Considerations

The side of the transformer connected to Megapack must be a wye-grounded connection. The other side of the transformer may be a delta or wye connection for on-grid (grid-following) applications.

Provision the transformers accordingly for grid-following (mode 1) or grid-forming (mode 2) (refer to *Battery Switches* in the *Controls and Communications Manual – C&I Projects*) according to the guidance below:

Figure 35. Transformer Configuration for Grid-Following or Grid-Forming Operation

NOTE: The solidly grounded circuit may be provided by the utility transformer.

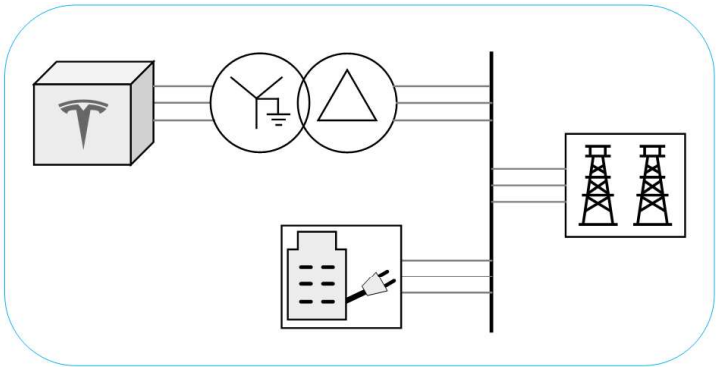
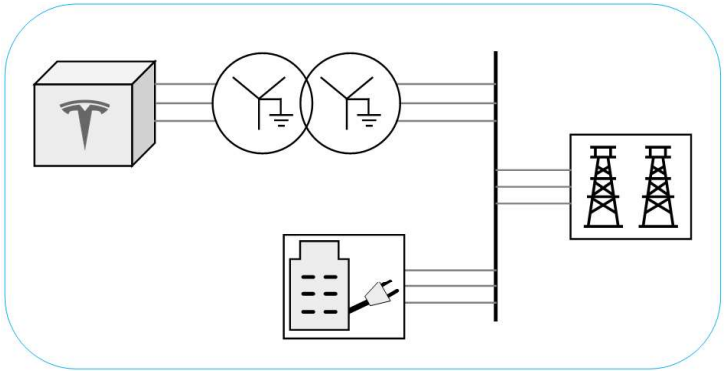


Figure 36. Transformer Configuration for Grid-Following Only Operation

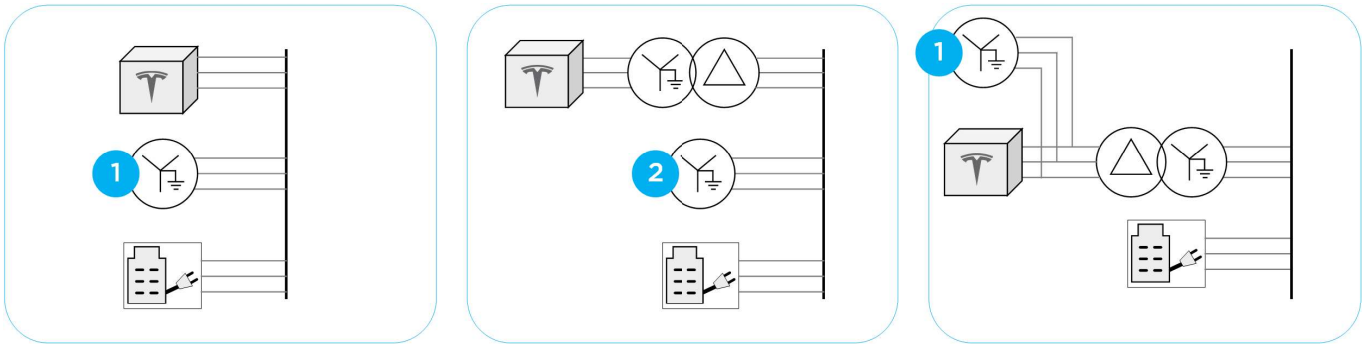
NOTE: The wye-wye transformer configuration is acceptable only for grid-following operation, and not acceptable for grid-forming operation.



2.5.2 Off-Grid Microgrid Archetype Considerations

The side of the transformer connected to Megapack must be a wye-grounded connection. The other side of the transformer must be a delta connection for off-grid (grid-forming) applications.

Figure 37. Off-Grid (Grid-Forming) Transformer Configurations

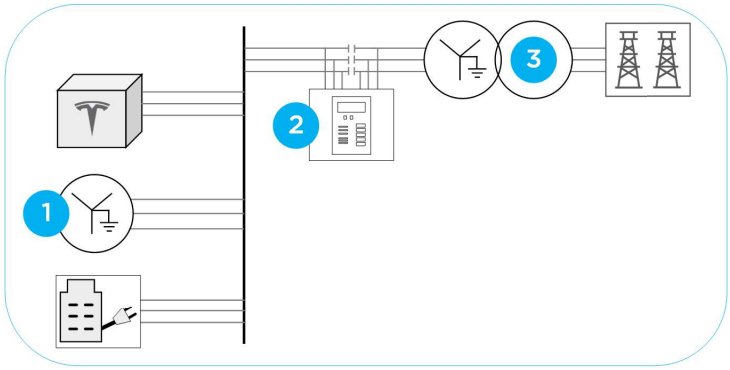


1. Grounding transformer
2. Optional grounding transformer (refer to *Ungrounded Bus Considerations on page 54*)

2.5.3 Backup and Grid-Connected Microgrid Archetype Considerations

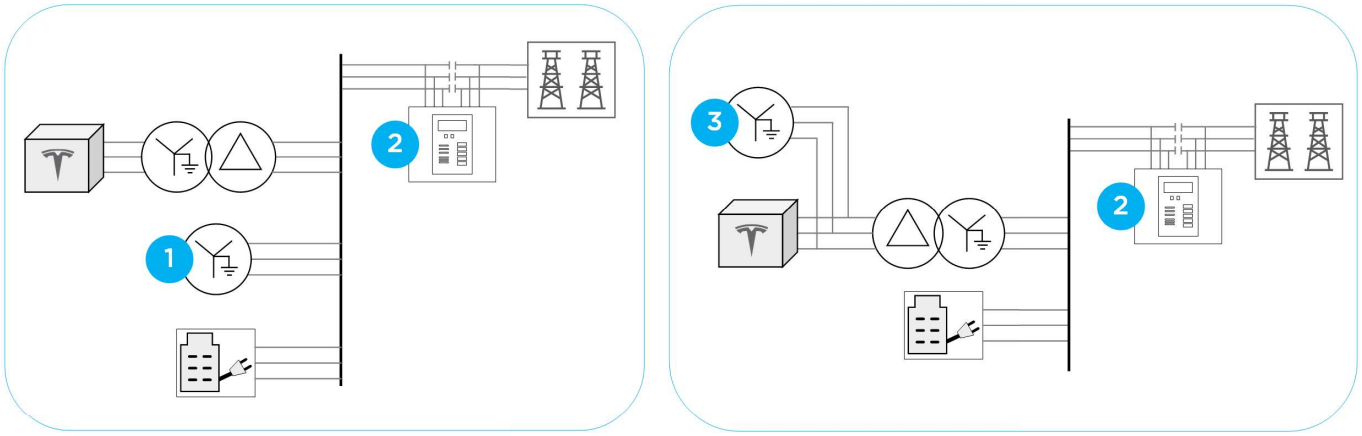
For islanding applications, ensure that a solidly grounded circuit exists during both on-grid and off-grid operation, as shown in the figures below. Depending on the project requirements, the grounding transformer may require disconnection when on-grid.

Figure 38. Islanding with a Utility Transformer and a Grounding Transformer



1. Grounding transformer
2. Islanding controller
3. Delta or wye

Figure 39. Islanding with a Step-up/Step-down Transformer



1. Optional grounding transformer (refer to *Ungrounded Bus Considerations on page 54*)
2. Islanding controller
3. Grounding transformer

2.5.4 Ungrounded Bus Considerations

An ungrounded bus does not require a grounding transformer, however, consider the following:

- Electrical protection requirements beyond the Tesla system
- There must be no line-to-neutral loads on ungrounded bus
- For all connected transformers, the delta winding configuration is connected to the ungrounded bus side
- All connected equipment is rated for the ungrounded configuration

NOTE: For more information, refer to the *Application Note: Grounding Conductor Recommendations for Megapack Applications*.

2.6 Solar Asset Design

A solar asset is a source that produces intermittent, renewable power from solar photovoltaic (PV) panels connected to an inverter. If your site is using an Archetype with solar assets, an approved solar inverter listed in the *Tesla Industrial Energy Approved Vendor List (AVL)* should be installed as indicated in the site's electrical topology.

2.6.1 Solar Asset Size Considerations

In systems coupled with solar assets, temporary overvoltage must not exceed the capability of Megapack as specified in *Maximum Overvoltage Withstand on page 97*.

1. Determine the solar inverter's AC overvoltage trip time. **If it does not exceed 150 ms,** proceed to step 2. If it is greater than 150 ms, reach out to your Tesla representative.
2. Determine the Megapack's EC and GT option codes by looking at the product label (*Megapack Labels on page 21*) or referring to your site contract.
3. Determine the *multiplier* for the formula using the table below together with the nominal DC voltage and AC voltage of the solar assets:

Table 21. Formula Multiplier

Nominal AC Voltage (V)	Multiplier		
	600 V DC	1000 V DC	1500 V DC
208	1.3	N/A	N/A
480	N/A	3.5	1
578	N/A	N/A	1.5
600	N/A	N/A	1.8
630	N/A	N/A	2
660	N/A	N/A	2.3

4. Apply these values to the following formula:

$$Maximum\ Recommended\ PV\ System\ Size = Multipler * \text{EC Variant} * \text{GT Variant} * 63\ \text{kVA} * \text{Number of Megapacks}$$

Contact your Tesla representative if the size of your solar assets exceeds Tesla's recommendation.

Example

Assume the following for this example:

- 600 V AC / 1500 V DC solar assets
- Megapack System with 10 Megapacks

1. Using the example in the *Megapack 2 XL Option Codes Quick Reference Guide*, the relevant option codes for this Megapack are: EC**24**, GT**01**
2. Use the *Formula Multiplier on page 55* table above together with the solar nominal voltage 600 V AC / 1500 V DC to determine the multiplier: **1.8**
3. Apply these values to the formula, including 10 for the number of Megapacks:

$$Maximum\ Recommended\ PV\ System\ Size = 1.8 * 24 * 1 * 63\ \text{kVA} * 10$$

Result

The maximum recommended size of the solar assets is **27,216 kVA**

2.7 Islanding Controller Design

An islanding controller is required for customers at sites that intend to switch between grid-connected and islanded configurations. Refer to (*Equipment per Archetype on page 37*) to determine if this equipment is required for the site's Archetype.

Supported islanding controllers are listed in the *Tesla Industrial Energy Approved Vendor List (AVL)*. SEL protection relays not listed in the AVL are incompatible due to divergences with the Modbus and C37 interface used to communicate with the islanding controller.

Customers may also choose to directly dictate the transitional behavior of the battery system. In this option, Tesla does not require an islanding controller to be integrated with the Tesla system. The customer is responsible for maintaining the system in the appropriate state relative to the status of the grid connection and handling conditions such as loss of communications. Contact your Tesla representative for additional details on this option.

For systems integrating with an approved islanding controller, Tesla requires that this controller have direct control over the system islanding contactor or circuit breaker (called *grid disconnect*). The islanding controller will manage the state and transitions of the islanded system, automatically isolating the battery system and loads from the grid during grid outages and providing reclose operations when the grid returns.

NOTE: For islanding controllers located on an ungrounded bus, delta-configured potential transformers (PTs) are required.

2.7.1 Provisioning the Islanding Controller

While the islanding controllers specified in the *Tesla Industrial Energy Approved Vendor List* (SEL-700G+ and SEL-751) are industry-standard power system protection relays, they have been adapted to function as an islanding controller for Tesla applications. Tesla's configuration is not intended to provide protection functionality, but customers are permitted to utilize the relay's existing protection functions as long as it does not interfere with Tesla's mandatory settings and required configurations.

The configuration of the islanding controller is site-specific. This section details its configuration, including those specifications that can be configured per customer site requirements. Specifications that are not customer-configurable are required by Tesla for the operation of the system and cannot be changed.

2.7.1.1 SEL-700G+ Model Options

Standard part number: 0700G02DCB0X74850301.

The model options used to integrate with the Tesla System Controller require the use of the "GEN 25" or 25 Synchronism Check element, which is available only on the (+) models.

- Default approved: 700G+
- Other approved models: 700G1+, 700GT+

Contact your Tesla representative if you plan to deviate from the standard part number.

Table 22. SEL-700G Model Options

Selected Options	Description
Model Options	700G+, Basic Generator Protection plus Gen 25, 64G, 21, 78, 78VS, Auto Synchronizer
User Interface	English
Front Panel	2x16 LCD With 8 Pushbuttons
Slot A Power Supply Voltage	24-48 Vdc
Slot A Digital Input Voltage	110 Vdc/Vac
Slot B Ethernet (Port 1)	Single 10/100BASE-T Ethernet
Slot B Rear Serial Port (Port 3)	EIA-485
IEC 61850 Protocol	No
DNP3 Protocol	No

Selected Options	Description
IEC 60870-5-103 Protocol	No
Ethernet/IP Protocol	No
Slot C	4 DI / 4 DO Fast High Current Hybrid (Form A)
Slot C Digital Input Voltage	24 Vdc/Vac
Slot D	Empty
Slot D Digital Input Voltage	N/A
Slot E	Vsync Input and Vn Input (300 Vac) (SELECT 2 AVI)
Slot E Digital Input Voltage	N/A
Slot Z Current and/or Voltage Inputs	3-Phase 5 Amp AC Current Input / 5 Amp Neutral AC Current Input / 3-Phase AC Voltage (300 Vac) (SELECT 4 ACI / 3 AVI)
Conformal Coat	No preference from Tesla

NOTE: The SEL-700G+ relay can be specified to accept different voltage inputs for the digital signals, but this option requires a change to the SEL-700G relay part number. This is a client design choice to ensure correct interface and operation of all islanding system components.

NOTE: Ensure Jumper B on Slot B card is installed to enable remote breaker control from manufacturer.

2.7.1.2 SEL-751 Model Options

Standard part number: 751002ACB0X70851D00

The model options used to integrate with the Tesla System Controller require the use of C37 communication over Ethernet, which is available only on the SEL-751 model.

- Default approved: SEL-751
- Not approved: SEL-751A (C37 communication only available over serial)

Contact your Tesla representative if you plan to deviate from the standard part number.

Table 23. SEL-751 Model Options

Selected Options	Description
Advanced Features	None
User Interface	English
Front Panel	2x16 LCD With 4 Pushbuttons
Slot A Power Supply Voltage	24-48 Vdc
Slot A Digital Input Voltage	125 Vdc/Vac
Slot B Ethernet (Port 1)	Single 10/100BASE-T Ethernet
Slot B Multimode Fiber ST (Port 2)	No
Slot B Rear Serial Port (Port 3)	EIA-485
IEC 61850 Protocol	No
DNP3 Protocol	No

Selected Options	Description
IEC 60870-5-103 Protocol	No
EtherNet/IP Protocol	No
Slot C	4 DI / 4 DO Fast High Current Hybrid (Form A)
Slot C Digital Input Voltage	24 Vdc/Vac
Slot D	Empty
Slot D Digital Input Voltage	N/A
Slot E	Vsync (300 Vac) / Vbat (300 Vdc) / 4 Arc-Flash Detection Inputs
Slot E Digital Input Voltage	N/A
Slot Z Voltage Inputs	3-Phase AC Voltage (300 Vac)
Slot Z Current and/or Voltage Inputs	5 Amp Phase, 5 Amp Neutral
Conformal Coat	No preference from Tesla

2.7.1.3 Islanding Controller Considerations

The following table outlines specific aspects of the SEL relays and their incorporation into performing the islanding controller functions.

Table 24. Considerations for Key Relay Behaviors

Feature	Consideration
Remote Grid Disconnect Control	The Tesla System Controller requires control of the grid disconnect using the OPEN or CLOSE commands and output contact control. This allows the battery system to disconnect from the grid when a grid outage occurs, and reconnect upon grid return.
Digital I/O	The islanding controller reads a pair of auxiliary status contacts from the grid disconnect, so at least two (2) digital inputs are required for grid disconnect status. The islanding controller must also provide dry contact output(s) (one for contactor or two for breaker).
Passive Anti-Islanding Trips	In order to comply with local Authority Having Jurisdiction (AHJ) utility interconnect requirements, the islanding controller must have basic protection elements and basic functions that include: • Over- and undervoltage elements • Over- and underfrequency protection • Power elements (not applicable for some AHJ's) • Rate-of-change-of-frequency (ROCOF) protection (not applicable for some AHJs)
Synchronism Check	The islanding controller requires a synchronism-check element in order to verify that the microgrid frequency, voltage magnitude, and phase angle match the grid frequency, voltage magnitude, and phase angle before permitting the grid disconnect to be closed.
Control Logic	The islanding controller requires the ability to set latches, timers, counters, and math variables, and to report important statuses to the Tesla System Controller.
Communication Capability	The Tesla System Controller uses Modbus TCP/IP as the communication protocol when sending controls commands to the SEL-700 and SEL-751 relays. Monitoring data published by the relays is received by the Tesla System Controller using the C37 synchrophasor communication protocol.

2.7.1.4 Additional Recommendations

The power supply for the islanding controller, grid disconnect control power, and auxiliary status sense lines should be backed up using a UPS to protect against power interruptions in order to ensure the islanding controller is accurately reporting the status of the grid disconnect. Power supply during transition and failure modes of each source of power should be considered during the site design to ensure correct operation. If the Tesla System Controller loses communications with the islanding controller, the system reverts to grid-following operation as a failsafe.

CAUTION: Exceeding the current rating of the islanding controller digital outputs could result in welding the contact in the closed position. The customer is responsible for verifying that voltage and current are maintained within islanding controller limits and introducing interposing relays if required.

Given the high inrush associated with solenoid coils, the 24 V DC supply from the battery system is not suitable for grid disconnect control. Breaker coils are normally indicated as a 120 V AC source; however, this is dependent on the specific grid disconnect being used.

Consider the availability of the power supply source used to power trip and close coils, to ensure that power is available when needed:

- Generally, the close coil power can be provided from the grid side of the grid disconnect, given that the disconnect will not be closed onto a dead grid under any circumstances.
- During a low impedance grid fault scenario (in other words, a hard short circuit just upstream of the customer's facility), the line voltage may sag too low to energize shunt trip solenoid and island the system. To ensure that the grid disconnect can be opened during a low impedance grid fault, the trip coil should be supplied by a UPS or the breaker should be outfitted with an under-voltage relay.

2.8 Generator Asset Design

A generator asset is a grid-forming source that produces power by rotating and is powered by burning fuel. Generators are integrated assemblies that include a fuel reservoir or tank, engine, alternator, and generator controller. Generator controllers control the generator asset and synchronizing breaker, and disconnect the generator from the bus during a fault.

If your site is using an Archetype with generator assets, an approved generator controller listed in the *Tesla Industrial Energy Approved Vendor List (AVL)* should be installed as indicated in the site's electrical topology.

Droop is Tesla's required operational mode for generators for optimal operation and enhanced reliability.

2.9 Common Site Considerations

Common design considerations regardless of site Archetype are detailed below.

2.9.1 Resonance of Devices Connected to Common 480 V AC Bus

Excessive resonance is expected when Megapack is connected to a common 480 V AC bus with power electronics inverters (such as solar inverters) or loads (such as variable frequency drives (VFDs) or data center power supplies) that fulfill both conditions:

1. The total apparent power rating of the power electronics exceeds 20% of the apparent power rating of the Megapack.
2. The equivalent switching frequency at the AC bus of the power electronics is less than 35 kHz.

In order to mitigate the risk of resonance, you must design for one of the following:

- Relocate the equipment
- Provide a line reactor
- Provide an isolation transformer

2.9.1.1 Line Reactor

If using a line reactor, it must meet the minimum specifications below:

Table 25. Minimum Reactor Specifications

Specifications	Minimum Requirement
Inductance	0.022 mH per phase
Current Capacity	Exceeds continuous current rating of the Megapack(s) connected to this reactor
Location	In series between Megapack(s) and common AC bus

2.9.1.2 Isolation Transformer

If using an isolation transformer, it must meet the minimum specifications below. Refer to *Transformer Design on page 50* for additional details.

Table 26. Minimum Transformer Specifications

Specifications	Minimum Requirement
Impedance	Between 3% and 7%
Current Capacity	Exceeds continuous current rating of the Megapack(s) connected to this transformer
Location	In series between Megapack(s) and common AC bus

2.9.2 Network and Internet Considerations

The Tesla System Controller and meters communicate using TCP/IP with Modbus and C37.118 protocols, therefore connectivity requirements must be part of the design.

Tesla requires communication between the Tesla System Controller and all meters and Megapacks onsite. Every Megapack requires a wired Ethernet connection to the Tesla System Controller. In multi-Megapack sites, this often requires the use of customer-supplied Ethernet switches and may require the use of fiber.

The Tesla System Controller requires an internet connection. It has a built-in cellular connection that can provide a communication link between the Tesla System Controller and Tesla via the internet. If the cellular network is not sufficient, a hardwired internet connection is mandatory. Additionally, if the customer wants a network connection for a control interface, the Tesla System Controller is also the customer point of connection to the Megapack.

The Tesla System Controller requires network connectivity to control the Megapack. Ensure adequate connectivity by installing a permanent external antenna at sites where the Tesla System Controller is installed inside metal enclosures such as switchgear cabinets, in concrete buildings such as parking structures, or in areas with poor coverage.

See *Relocating the Antenna* in the *Standard Tesla System Controller Enclosure Installation Manual* for instructions on external antenna installation, and see *Terminating Auxiliary DC Power Conductors and Communications Cables on page 138* for required installation procedures.

NOTE: Refer to the *Controls and Communications Manual* for complete control details.

NOTE: Some projects may use external cell antennas different from the included external antenna. The Standard Tesla System Controller computer has an RP-SMA female connector (outer threading and pin) and requires an antenna with an RP-SMA male connector (inner threading and hole).

NOTE: Removing any component from the Standard Tesla System Controller Enclosure other than the antenna (for example, to mount the backplane in a different enclosure or control room) must meet the environmental requirements on the Tesla datasheet and is not covered in the certified installation configuration. Discuss any modifications with Tesla prior to installation.

NOTE: For more information or with specific questions, contact your Tesla representative.

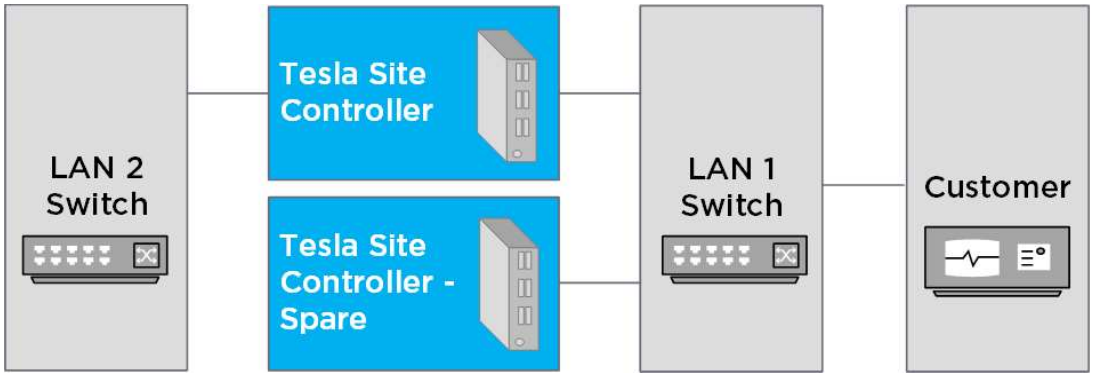
2.9.2.1 Computer Networking

The Standard Tesla System Controller Enclosure may have one or two controllers (Standard Tesla System Controllers). Large-scale sites typically ship with two controllers (Large Tesla System Controllers).

The Tesla System Controller has two (2) RJ45 LAN ports: LAN 1 and LAN 2, and an integrated cellular modem (where equipped) (*Tesla System Controller on page 17*).

For Standard Tesla System Controller Enclosures including two Standard Tesla System Controllers or for sites including dual Large Tesla System Controllers, LAN 1 of each computer may be connected in parallel, as indicated in the diagram below:

Figure 40. Dual Computer Networking



CAUTION: Contact Tesla before attempting to connect LAN 2 of both controllers in parallel.

NOTE: If you are connecting through a firewall, see the *Firewall Rules* table in the *SCADA Design Manual* for important connection information.

2.9.3 Maximum Arc Flash Incident Energy

The Megapack arc flash incident energy is largely determined by the available short circuit current and the protective clearing device that isolates the Megapack. The table below lists the maximum allowable arc flash incident energy at the Megapack AC bus bars.

Table 27. Maximum Allowable Arc Flash Incident Energy

All Regions
14 cal/cm^2

Customers must employ a protection scheme that does not exceed the maximum allowable energy. Tesla recommends designing the protection such that arc flash incident energy is minimized to the greatest extent that is practical. The engineer of record must provide an arc flash label including this information to installation contractors (*Providing the Arc Flash Label on page 141*). For more information, see *Required Protective Studies on page 102* and the *Application Note: Electrical Protection Architecture*.

2.9.4 SCADA

For many applications, Megapack can be operated as a stand-alone system as detailed in the *Controls and Communications Manual*. However, for custom solutions, Megapack can be integrated with a supervisory control and data acquisition (SCADA) system to expand its functionality.

The *SCADA Design Manual* further outlines what items to consider when designing a SCADA system, what additional features may be supported by Tesla, and how to integrate them with the Tesla System Controller.

2.9.5 Water Supply

If required by the AHJ, the site may need a water supply per NFPA 855 Section 4.13 or applicable local codes and regulations. For more information, refer to *Application Note: Onsite Water Supply Sizing For Exposure Protection*.

If required by on-site maintenance infrastructure, your site may need a potable water source. Refer to the *Application Note: On-Site Maintenance Infrastructure*.

2.9.6 On-Site Maintenance Infrastructure

Maintenance infrastructure is essential to the rapid and effective maintenance of Megapack sites. The required infrastructure should be incorporated into site design, made available to Tesla during construction and for the life of the project, and should be completed no later than 2 weeks prior to the commissioning start date.

For details, refer to the *Application Note: On-Site Maintenance Infrastructure Requirements*.

2.9.7 Augmentation Design

The Megapack System can be configured to be augmented to maintain power and energy capacity over the life of the project, if arranged for at the time of contracting. To support augmentation, the original site must be designed in accordance with the language in this section.

Augmentation units may be connected into:

- The low-voltage (LV) side of each Megapack, behind each Megapack AC circuit breaker
- The medium-voltage (MV) system, at the MV level of a Megapack site

NOTE: Refer to voltage classifications at *Voltage Classification on page 4*.

As illustrated below, sites may provide for LV augmentation, MV augmentation, or both. The site should provide adequate space to allow for the additional augmentation units and additional balance of plant equipment as required. It is up to the customer to consider all relevant design and construction details (such as additional lighting, foundations, roadways, and security).

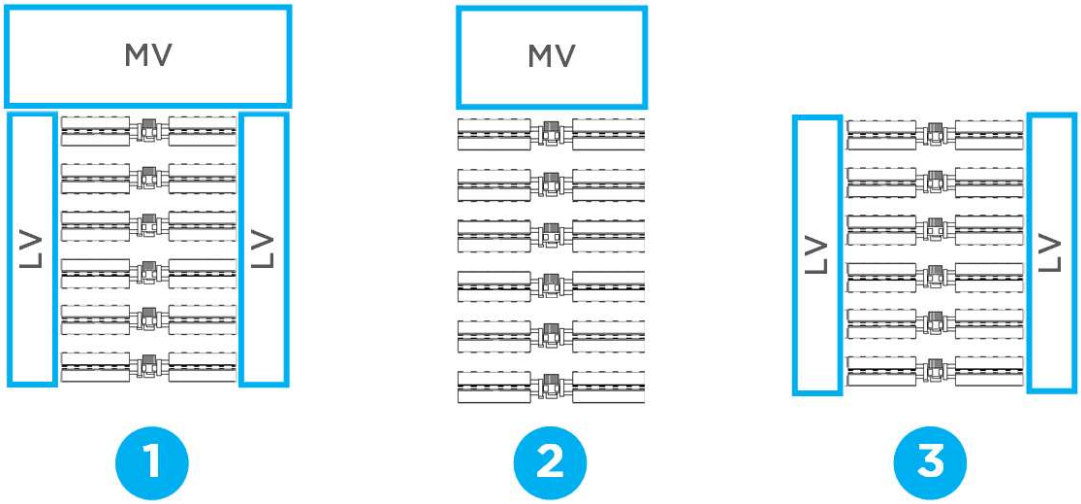
Clearance requirements include:

- Augmentation unit side-to-side and back-to-back clearance
- Clearance for an overhead lift to access the site at a later date
- Clearance for service

- Other clearances as required (such as exposure and fire clearances)

Contact your Tesla representative for more information relevant to your site.

Figure 41. Augmentation Layout Examples



1. LV and MV augmentation
2. MV augmentation only
3. LV augmentation only

The customer is responsible for overall integration of the system with third-party products and for ensuring that the site meets the requirements of the local jurisdictions. For more information the available options, refer to the sections below:

- *Low Voltage Augmentation on page 63*
- *Medium Voltage Augmentation on page 64*
- *Capacity Maintenance Agreement Augmentation on page 64*

2.9.7.1 Low Voltage Augmentation

For any site planning to provision for LV augmentation, Tesla recommends that the site layout provide adequate space to allow for the addition of LV augmentation units and foundations constructed at the same time as the original Megapack foundations. Up to three units can be connected to augment each Megapack, following the requirements below:

- Space must be reserved upon the foundation to place 1-3 augmentation units on either side of the Megapack (see concept below)
  - The foundation from the Megapack enclosure to the augmentation units should be continuous
  - This portion of the foundation must be capable of supporting the same magnitude of force as the rest of the Megapack foundation
  - Nothing can be on the foundation pad other than the Megapack enclosures or augmentation units
- 250 mm (10 in) side clearance is recommended to be reserved between Megapack enclosures and augmentation units. This clearance minimizes installation time and optimizes project cost.

- At a minimum, 150 mm (6 in) clearance must be observed to all objects (including Megapack, other augmentation units, or other exposures)

Figure 42. LV Augmentation Area Example

Approximate kWh	Additional Length Required (Minimum)	Additional Depth Required
500	1700 mm (5 ft 6 in)	N/A
1,000	3050 mm (10 ft)	N/A
1,500	4400 mm (14 ft 5 in)	N/A

2.9.7.2 Medium Voltage Augmentation

For any site planning to provision for MV augmentation, the site designer must determine the approximate number of augmentation units required. Tesla strongly recommends, for each planned augmentation unit, that the site provide the following at time of original site construction:

- Reserved foundation area with adequate space to allow for the addition of augmentation equipment roughly the size of a Megapack enclosure and its associated clearances (*Megapack Clearance on page 84*)
- Reserved foundation area with adequate space for required medium voltage equipment such as transformers and switchgear
- Reserved electrical capacity. Either:
  - Additional empty feeder capacity reserved for MV augmentation units
  - Additional empty transformer capacity reserved for MV augmentation units

NOTE: Foundations for MV augmentation do not need to be constructed at time of original site construction because the foundations will be separate from the original Megapack enclosure foundations.

2.9.7.3 Capacity Maintenance Agreement Augmentation

NOTE: A Capacity Maintenance Agreement is a legacy offering available only if already contracted.

A Capacity Maintenance Agreement (CMA) guarantees power and energy capacity over the life of the product. A capacity-maintained system adds CMA units (battery enclosures) over time to maintain power and energy. To support this, the site and foundation designs and the electrical infrastructure must pre-allocate space for the additional units during initial construction. This prevents the need to re-permit the entire site later in its lifecycle. A CMA must be contracted at the beginning of the project.

Guidance must be given to installation partners to ensure they understand the purpose of the space left for future CMA units, and they do not attempt to optimize layout during initial construction. Access must also be provided for a crane so that the supplementary CMA units can be added or removed as needed.

Upon request, Tesla can provide specifications for CMA lengths of 10, 15, or 20 years. If a site intends to use a CMA, contact Tesla for additional site design assistance.

For any site that has signed a Capacity Maintenance Agreement (CMA), the site layout must provide adequate space to allow for the addition of CMA units for the duration of the contract. Up to three CMA units may be required per Megapack as determined by Tesla. Tesla will, at a later date, install the units upon the space provided.

NOTE: Contact your Tesla Project Engineer to see if your site has a CMA requirement and for more information about the design requirements below.

Foundation design requirements include:

- Space must be reserved upon the foundation to place 1–3 augmentation units on either side of each Megapack (refer to dimensions below)
  - The foundation from the Megapack enclosure to the augmentation units should be continuous
  - Nothing can be on the foundation pad other than the Megapack enclosures or augmentation units
- Allowance for construction requirements
  - CMA unit anchoring plan
  - Clearance for an overhead lift to access the site

Figure 43. CMA Augmentation Dimensions

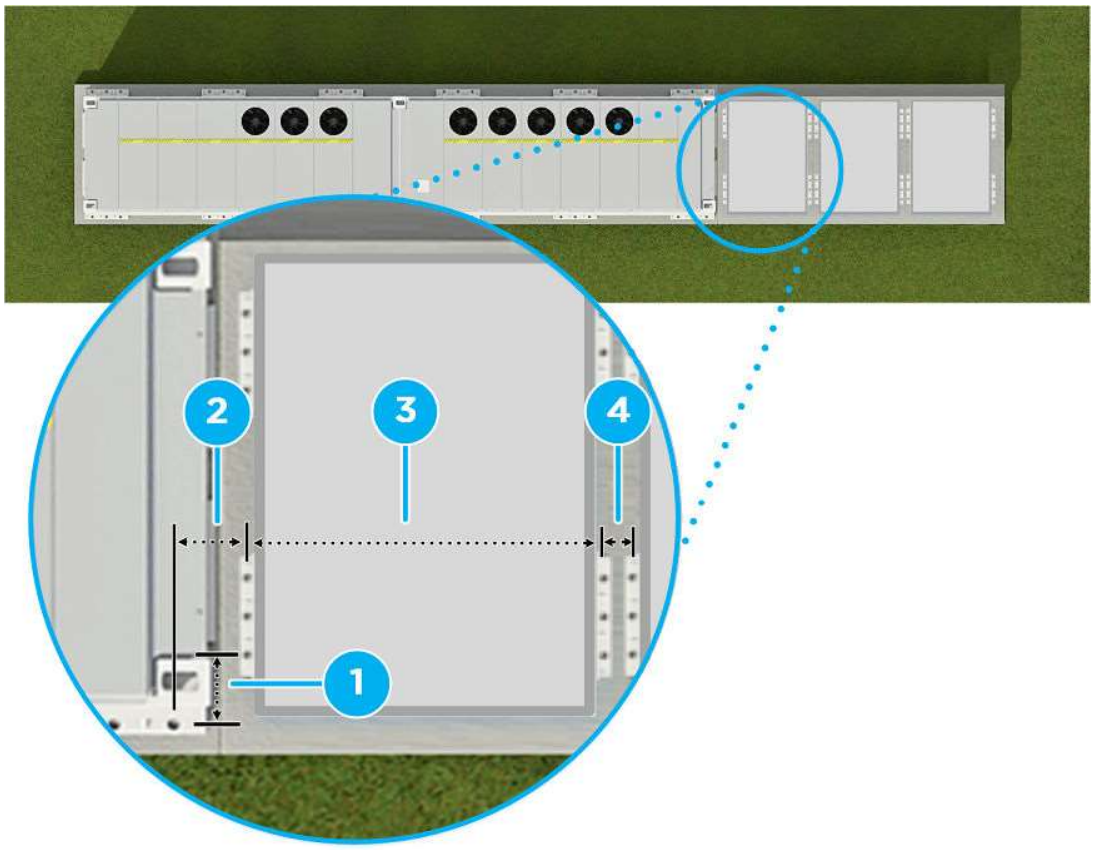


Figure Reference	Description	Dimension	Details
1	Depth to first anchor hole	225 mm (8 ¾ in)	Hole center to hole center
2	Width to first unit	300 mm (11 ¾ in)	Hole center to hole center
3	Unit width	1160 mm (45 ⅝ in)	Hole center to hole center
4	Spacing between units	140 mm (5 ½ in)	Hole center to hole center

3 Mechanical Design

3.1 Mechanical Specifications

While Megapack's dimensions remain fixed, its mass and center of gravity vary depending on its energy rating, corresponding to the number of battery modules installed. The maximum mass is displayed below. For precise values per configuration, refer to *Megapack Center of Gravity on page 68* and *Megapack Mass on page 67*.

Table 28. Megapack Dimensions and Mass (Weight)

Width	Depth	Height	Max. Shipping Mass
8800 mm (346 ½ in)	1650 mm (65 in)	2785 mm (110 in)	38,100 kg (84,000 lb)

CAUTION:

- Enclosure dimensions are provided for nominal design guidance. Do not use the dimensions above as anchoring specifications. For precise dimensions and structural and anchoring details, see the *Megapack 2 XL Drawings* on the Partner Portal.
- Dimensions as listed are as measured for the enclosure envelope exclusive of anchor brackets.
- Mass (weight) as listed is maximum shipping mass. Mass changes depending on product configuration and can be configured lighter based on project-specific requirements.

Table 29. Standard Tesla System Controller Enclosure Dimensions and Mass

Width	Depth	Height	Max. Mass (Weight)
560 mm (22 in)	255 mm (10 in)	724 mm (29.2 in)	22.4 kg (49.4 lb)

Table 30. Enclosure Specifications or Capabilities

Corrosion Resistance	Compliant with ISO 12944: C5I (industrial) and C5M (coastal) standards
Impact Rating	IK09
Ingress Rating	IP66/NEMA 3R (Megapack enclosure – including rain and sprinkler test immunity) IP20 (Thermal system)
AC Bus Bar Area Floor Live Load	Can support a person of up to 300 lb (136 kg) gross weight
Roof Live Load	Can support a person of up to 300 lb (136 kg) gross weight in clearly designated areas (Megapack enclosure)
Roof Snow Load	732.3 kg/m^2 (150 psf, or 7.18 kN$_{Earth}$/m^2) If the site may experience greater snow loading, contact Tesla to discuss.
Salt Fog Rating	Able to withstand over 1,000 hours of salt fog application per a C5M system

Seismic, Shock, and Vibration Rating	Qualification Level - IEEE 693-2018 High PL: *ZPA*=1.0 g 5% damping Certification Level - ICC-ES AC 156-2018 S_{DS}=2.50 g *z/h*=0 I_p=1.5
Thermal System	Coolant and refrigerant in capacities as specified in *Thermal Specifications on page 69* (each Megapack unit)
Wind Rating	Able to withstand Category 5 hurricane sustained wind speeds of up to 157 mph (252 km/h)
Operating Temperature	-30°C to 50°C (-22°F to 122°F) Megapack provides full rated power in all ambient temperature conditions and at maximum elevation under up to 1200 W/m2 solar loading, in any direction. See the *Megapack 2 XL System Specification* for more information.
Humidity	Up to 100% condensing
Storage	-30°C to 50°C (-22°F to 122°F) See *Megapack 2 XL Transportation and Storage Guidelines* for more information.
Maximum Elevation	3000 m (9840 ft) above sea level

3.1.1 Noise Specification and Guidance

Each Megapack unit has rooftop fans as part of its thermal system. Megapack's main source of noise comes from these fans, for which there are two related option codes:

- FN## (fan type)
- TC#H (thermal configuration manufacturing option code that represents number of fans)

The maximum audible noise specification is expressed as the sound pressure level (SPL) in decibels, and measured at a 10-meter (33-foot) distance from the enclosure at maximum thermal system operation.

Refer to the relevant combination of option codes for the Megapack unit's specification:

Table 31. Maximum Audible Noise Specification

FN##	TC2H	TC4H
FN01 / FN02	71.2 dB(A)	68.9 dB(A)
FN03	66.3 dB(A)	63.8 dB(A)

NOTE: In addition to Megapack unit differences, noise emission is affected by site-specific conditions such as ambient temperature and system dispatch profile. Maximum audible noise may generally only be reached under specific operating conditions. For the majority of the time, noise emitted by Megapack will be much lower. Tesla can provide more details around sound power and sound pressure if required for the project site.

3.2 Megapack Mass

To calculate Megapack's precise mass, use its energy rating (number of battery modules) together with a formula as described below.

1. Determine Megapack's number of battery modules using the two numbers in the EC option code (see *Megapack Labels on page 21*). For example, the option code **EC14** indicates a Megapack with 14 battery modules.
2. Apply that number in place of *nn* in the formula as indicated:

   38,100 – 1,270*(24–*nn*)

   The solution indicates Megapack mass in kg.

   For example, a Megapack with option code **EC14** has **14 battery modules**, and its mass is calculated as follows:

   38,100 – 1,270*(24–14) = 38,100 – 1,270*(10) = 38,100 – 12,700 = **25,400 kg**

3.3 Megapack Center of Gravity

Megapack's center of gravity is located close to the geometric center of the enclosure on the X and Y axis for all product configurations. For the precise location for a fully populated Megapack, see below.

Figure 44. Center of Gravity Dimensions

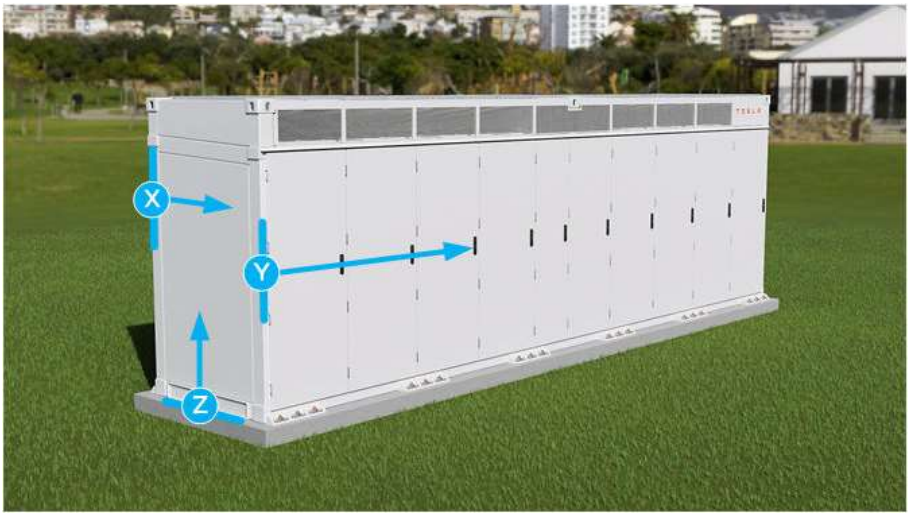


Table 32. Center of Gravity Location

System Duration	X (Distance from Rear Panel)	Y (Distance from Left Panel)	Z (Distance from Base)
2–Hour	791 mm (31 in)	4395 mm (173 in)	1202 mm (47 ¼ in)
4–Hour	791 mm (31 in)	4395 mm (173 in)	1199 mm (47 ¼ in)

3.4 Enclosure Colors

Megapack's exterior paint color code is *RAL 9016 Traffic White*. Touch–up paint ships as a Megapack accessory (see *Touch–Up Paint on page 129*).

Figure 45. Megapack Enclosure Color

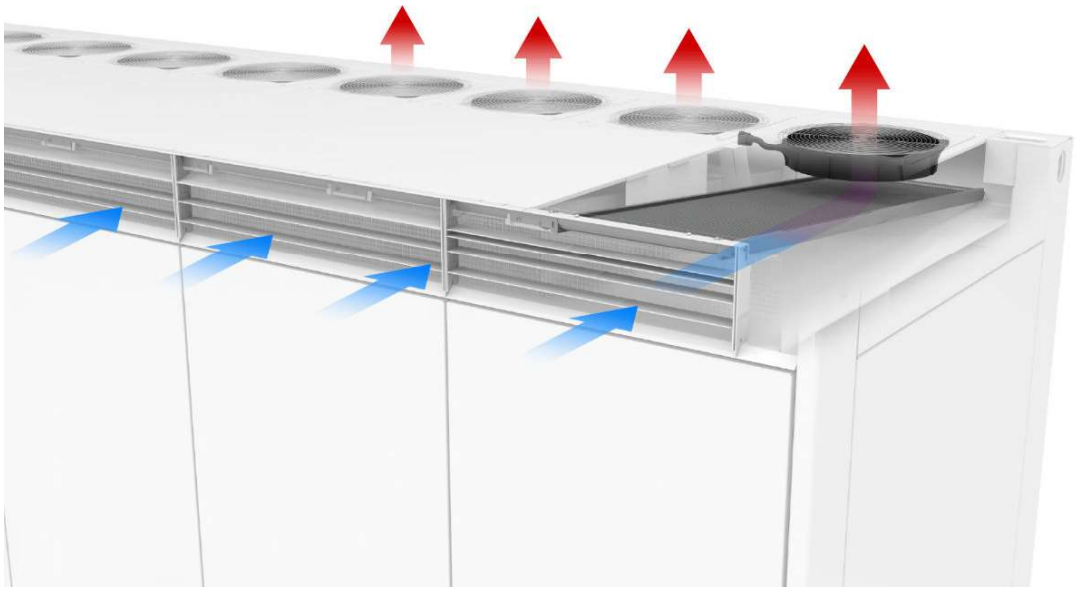
The Standard Tesla System Controller Enclosure is unpainted and is a flat grey color.

Figure 46. Standard Tesla System Controller Enclosure Color

3.5 Thermal Specifications

Air flows through the enclosure as shown below:

Figure 47. Megapack Airflow



The thermal system includes coolant and refrigerant in a sealed system. Megapack ships with the necessary coolant and refrigerant included as specified below.

Table 33. Thermal Capacities

	Composition	Max Quantity (Approx)	
Coolant	50–50 ethylene glycol–water	380 L / 100 gal	
Refrigerant	R-134a (1,1,1,2-Tetrafluoroethane)	4-Hour thermal configuration (TC4H option code)	Up to 1.5 kg / 3.3 lb
		2-Hour thermal configuration (TC2H option code)	Up to 3 kg / 6.6 lb

NOTE: Depending on the number of Megapacks installed on a site, storage, use and handling of these substances may require reporting, hazard management plans, or containment procedures as required by local codes and regulations.

Since the thermal subsystem is a fully closed-loop system with a compressor, the refrigerant line includes a pressure relief valve that can activate if incorrect maintenance or operation creates excessive pressure. The system operates autonomously and does not require user feedback.

Megapack is designed to be installed outdoors within the rated operating temperature specifications. Indoor installations are not allowed without consulting Tesla.

CAUTION: Do not install batteries in areas where temperatures routinely approach or exceed 50°C (122°F).

NOTE: The physical characteristics of the project site may cause localized heating effects (rise above ambient) adjacent to Megapack – for example, an installation in a location with a strong heat island effect, black pavement (parking lots), or in full direct sunlight. Although not required by Tesla, shade structures or canopies may help mitigate local environmental heating effects. Ultimately, the customer must understand the risk to performance of localized heating effects and take responsibility for any mitigation. Any shade structures must conform to the distances detailed in *Megapack Clearance on page 84*.

3.6 Safety Certification and Hazard Mitigation

In addition to providing product safety features (*Hazard Mitigation Features on page 20*), Tesla conducts extensive analysis and testing to assess hazardous conditions related to Tesla products. Megapack includes multiple layers of protection to mitigate hazardous electrical and fire conditions. Megapack has been reviewed and validated by an Independent Engineer, both at the product level and for the results of large-scale fire testing.

Megapack neither contains nor needs built-in smoke, gas, or fire detection or suppression devices. When required by the AHJ, third-party multi-spectrum IR heat or flame detectors can be installed externally at the site-level.

Refer to *Environmental Compliance on page 151* for environmental containment features.

Refer to the *Industrial Lithium-Ion Battery Emergency Response Guide* on the Tesla First Responders Information page at *https://www.tesla.com/firstresponders* for detailed hazard and response information.

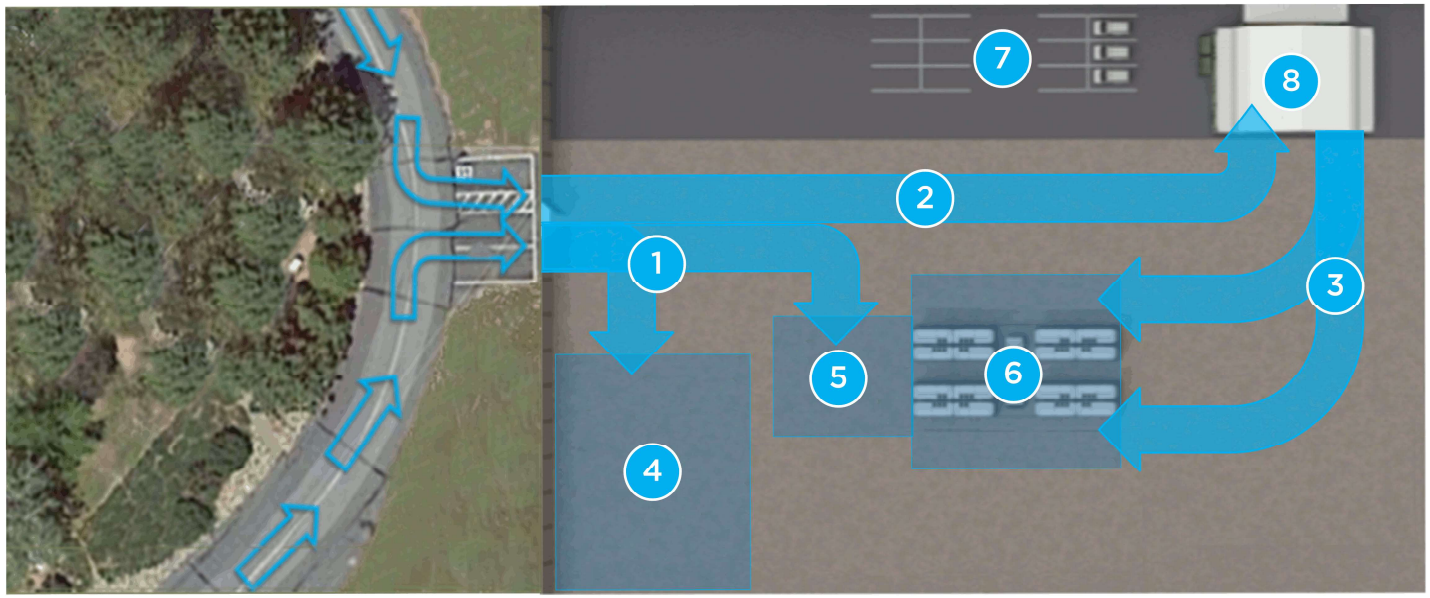
4 Civil Design

Planning for optimal foundation and clearance design, delivery, serviceability, and other site functionality requires attention to civil design including consideration of various routes and zones at the site. Geotechnical, civil, structural, and transportation engineering specialties should be consulted about route and zone civil design early in the site design process.

4.1 Routes and Zones

A site generally consists of routes and zones as indicated below. A **route** is defined as the full path between two or more locations and includes the surface being traveled upon. A **zone** is a defined area of the site that is typically distinguished by function. A zone can be in multiple locations on a site and is dependent on the site layout. Routes and zones are generally allowed to overlap as needed.

Figure 48. Routes and Zones -- Example



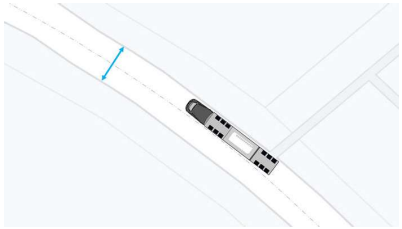
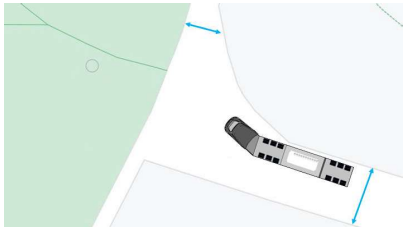
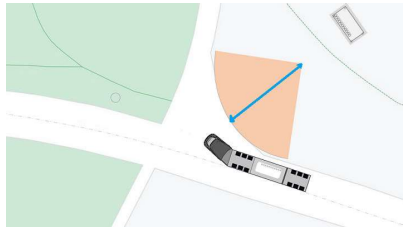
1. Delivery Route
2. Service Access Route
3. Battery Service Route
4. Construction Staging Zone
5. Crane Zone
6. Battery Zone:
    - Foundation Zone
    - Battery Service Zone
7. Parking Zone
8. Service Staging Zone

4.1.1 General Requirements

The design of routes and zones must abide by the requirements described in this section. Due care must be taken to engineer and install appropriate surfaces in all routes and zones for the full duration of the project's life. For vehicle descriptions and specifications, refer to *Typical Vehicles on page 79*.

All routes must be wide enough to support the wheel swept-path of designated vehicle types and strong enough to support the designated vehicle axle loads. Other infrastructure crossing routes at or below grade (water, electrical, or drainage) should be reviewed in detail to make sure there are no conflicts. It is recommended to include geotechnical engineering stakeholders and craning and logistics providers early in the site design process to ensure all other considerations (such as crane type or delivery vehicle needs) are incorporated. Refer to the *Megapack 2 XL Sample Engineered Template* for assistance with calculations and vehicle blocks to support swept-path analysis. Contact your Tesla representative with any deviations.

Table 34. Example Route Design Considerations

		
Minimum Route Width: Linear Driving	Minimum Route Width: Around Turns	Minimum Intersection Turn Radius

CAUTION: Standing water in any routes or zones may impact serviceability or structural integrity and should be mitigated as much as possible.

NOTE: The requirements for routes and zones generally apply at any site regardless of whether it is a single- or multiple-battery site. Contact your Tesla representative for more information.

Table 35. General Requirements for All Routes and Zones

Slope	Vehicle Requirements	Surface Conditions
Battery Service Zone: • Maximum 5% in any direction Foundation Zone: • Refer to *Foundation Design on page 81* All other routes and zones: • Maximum 5% cross slope	• Support for axle loads for designated vehicle types. • Support for adequate width for designated vehicle travel. • Support for minimum turning radii of designated vehicle types.	Required: • No potholes, ruts, or standing water. • Adequately compacted and safe for people to work on and for designated vehicle types to operate on (*Ground Surface Conditions on page 75*). • Engineered with sufficient grip to provide tire traction.

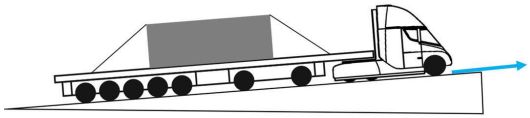
Slope	Vehicle Requirements	Surface Conditions
• Maximum 10% slope (grade) 		Recommended: • All-weather surfaces that will not require major upkeep and resurfacing after significant weather events. • A material that has been specified by the local or regional Department of Transportation. • Graded or crowned surface to shed water and prevent ponding.

Figure 49. Ground Surface Conditions

For additional information, refer to *Ground Surface Design Considerations on page 80*.

4.1.2 Route Requirements

Uses and additional requirements and recommendations specific to each route are described below.

Table 36. Route Uses and Requirements

Route or Zone	Use	Designated Vehicle Types	Requirements and Recommendations
Delivery Route	Transport between the public right-of-way, the designated project entrance, and the vehicle unloading point (Crane Zone or Construction Staging Zone).	• Megapack delivery vehicle • Crane • Utility vehicle • Telescopic forklift • Fixed-mast forklift • Service delivery vehicle	Required: • Delivery vehicles and cranes must have a valid route to all designated Crane Zones and/or Construction Staging Zones for installation.
			Recommended: • Looped route or cul-de-sac to avoid needing to reverse the delivery vehicle for long distances. • Ability for delivery vehicle to back into or pull alongside the Crane Zone for greatest efficiency.
Service Access Route	Transport between the public right-of-way and the Service Staging Zone.	• Megapack delivery vehicle • Crane • Utility vehicle • Telescopic forklift • Fixed-mast forklift • Service delivery vehicle	No additional requirements.
Battery Service Route	Transport between the Service Staging Zone and each Battery Service Zone.	• Fixed-mast forklift • Utility vehicle	Required: • Designated vehicle types must have a valid route from the public right of way to the Service Staging Zone to **every** Battery Service Zone.

4.1.3 Zone Requirements

Descriptions and additional requirements and recommendations specific to each zone are described below.

Table 37. Zone Descriptions and Requirements

Route or Zone	Description	Designated Vehicle Types	Requirements and Recommendations
Construction Staging Zone	Portions of the site set aside for construction activities. Typical uses include material handling and temporary stockpiling, equipment and contractor parking, and occasionally the storage of battery units.	• Megapack delivery vehicle • Crane • Utility vehicle • Telescopic forklift • Fixed-mast forklift	Recommended: • Consider that it is common for the construction staging zone to overlap with the service staging zone.
Crane Zone	Portions of the site that have been allocated for the set up or operation of a crane.	• Crane	Required: • Depending on the delivery logistics plan, additional clearances or surface load considerations may be required if delivery vehicles need to be within close proximity of the crane.
Battery Zone – Foundation Zone	The area upon which the battery unit is installed.	• None	Refer to *Foundation Design on page 81*.
Battery Zone – Battery Service Zone	The area in which service actions take place, as defined in *Clearance - Battery Service Zone on page 86*.	• Utility vehicle • Fixed-mast forklift	Required: • Supporting at least two egress routes, one in each direction, for people to vacate the zone on foot in the event of an emergency.
Parking Zone	Vehicle parking, required at all stages of the project life, but the quantity and usage of the parking will vary.	• Utility vehicle	Required: • Cannot overlap with listed equipment clearances on site. • Does not obstruct any of the delivery or service routes. • Parking stalls no smaller than 5.5 m x 2.75 m (18 ft x 9 ft).

Route or Zone	Description	Designated Vehicle Types	Requirements and Recommendations
			Recommended: • Temporary parking may be a good option for the surge in parking need during the construction of the project.
Service Staging Zone	Portions of the site set aside for service preparation activities. Typical uses include material handling and temporary stockpiling, and occasionally the storage of supplies. **NOTE:** Details of this zone are provided in the *Application Note: On-Site Maintenance Infrastructure Requirements*.	• Utility vehicle • Telescopic forklift • Fixed-mast forklift • Service delivery vehicle	Required: • Must be able to support a service delivery vehicle being unloaded by a forklift with sufficient room for the forklift and load to maneuver around the delivery vehicle.

4.1.4 Typical Vehicles

Various vehicles are required to access routes and zones at the site as designed by the engineer of record.

The figure below shows the relative scale of typical vehicles compared to the Megapack:

Figure 50. Typical Vehicle Scale Compared to Megapack (Examples)

Examples of vehicles that may require access during construction, delivery, and for serviceability are listed below.

Table 38. Typical Vehicle Examples and Requirements

Type and Usage	Design Gross Vehicle Weight	Design Axle Weight	Approx. Dimensions	Vehicle (Example) - Not to Scale
Utility vehicle Van or truck. Transports personnel and supplies.	4,545 kg (10,000 lb)	2,723 kg (6,000 lb)	Length: 6.7 m (22 ft) Height: 2.7 m (9 ft) Width: 2.4 m (8 ft)	 
Service delivery vehicle Transports personnel and supplies for service and maintenance activities.	15,000 kg (33,000 lb)	8,165 kg (18,000 lb)	Length: 8 m (26 ft) Height: 4.2 m (13.6 ft) Width: 2.6 m (8.5 ft)	
Fixed-mast forklift Used during certain service activities to move components, most notably the battery module, as well as to unload service delivery vehicles.	6,350 kg (14,000 lb)	3,629 kg (8,000 lb)	Length: 3.8 m (12.4 ft) Height: 2 m (6.8 ft) Width: 1.6 m (5.4 ft)	

Type and Usage	Design Gross Vehicle Weight	Design Axle Weight	Approx. Dimensions	Vehicle (Example) - Not to Scale
				Shown with battery module removal tool for context.
Telescopic forklift Typically used during construction to move various materials or components. Not typically used by Tesla during service.	5,910 kg (13,000 lb)	3,175 kg (7,000 lb)	Length: 5.8 m (19 ft) Height: 6 m (20 ft) Width: 3 m (8 ft)	
Crane Lifts heavy equipment such as Megapack units and other units for system augmentation or other construction activities.	112,000 kg (246,918 lb)	9,072 kg (20,000 lb)	Length: 15.7 m Height: 4 m (13.1 ft) Width: 3 m (9.3 ft)	
Megapack delivery vehicle Brings Megapack units to a Construction Staging Zone or a Crane Zone.	63,200 kg (139,000 lb)	9,072 kg (20,000 lb)	Length: 24.1 m (79 ft) Height: 4.2 m (13.5 ft) Width: 2.6 m (8.5 ft)	

4.1.5 Ground Surface Design Considerations

When designing or maintaining ground cover and ground improvements within the site's routes and zones, consider the *Typical Vehicles on page 79* that will be traveling the site in addition to the following recommendations:

- Structural fill to be compacted to minimum 95% of maximum dry density as determined by a Standard Proctor (ASTM D698) and placed in loose lifts not exceeding 200 mm (8 in) to within 4 % of the optimal moisture content or as specified in the geotechnical report.
- Moisture content and compaction to be within the value determined by in the geotechnical report.
- Recommended compaction testing shall be performed on each lift of the compacted material at a rate of one test for every 460 m^2 (5000 ft^2) within the Foundation Zone and 920 m^2 (10,000 ft^2) elsewhere.
- Test recommendations: ASTM D698, ASTM D1557, California Bearing Ratio (CBR).

NOTE:

- Always consult a geotechnical engineer and have a site-specific geotechnical investigation performed prior to design and construction.
- All recommended guidance does not constitute approval of site-specific geotechnical conditions.

4.2 Foundation and Clearance Design

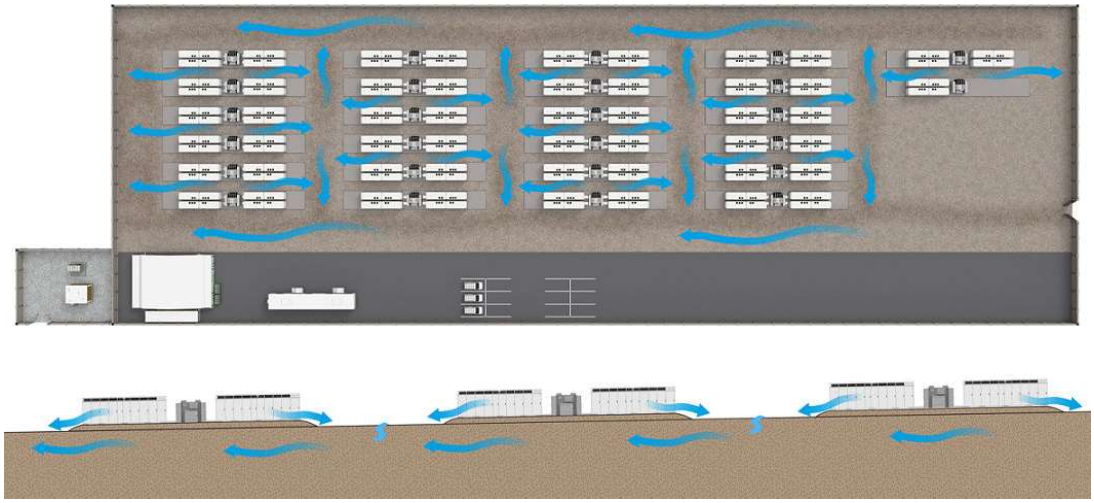
4.2.1 Foundation Design

Megapacks must be installed on a foundation or base strong enough to support the weight of the equipment listed in *Mechanical Specifications on page 66* and to resist all anchor loads. Observe equipment clearances per *Megapack Clearance on page 84*.

Figure 51. Megapack Foundation Zone - Side View

Foundation or base examples include, but are not limited to, concrete pad, grade beams, structural steel deck or skid. The following considerations must be respected:

- The Megapack unit must be installed on a single planar surface.
- If using non-concrete pad designs, review first with Tesla before work begins.
- Consider how water flow affects the Megapack enclosures and foundations. When using monolithic foundations, where possible, design your site so that water flows around Megapack foundations along their length, rather than perpendicular to them:



4.2.1.1 Foundation Installation Requirements

NOTE: Foundation requirements apply to Megapack units as well as any augmentation units (*Augmentation Design on page 62*). Foundations for augmentation must be installed at the same time as Megapack foundations.

- Foundation finish must have a smooth, even surface of uniform texture and appearance, free from bulges, depressions, and other imperfections that would impact equipment anchorage or foundation/base drainage.
  - If the foundation top surface is concrete, it must have a Class B finish.

- The top of the foundation must be above adjacent grade, 305 mm (12 in) maximum, with the edge of the foundation a maximum of 305 mm (12 in) from the front of Megapack. If the site does not allow this foundation height, contact Tesla. The foundation may not be below grade and must conform to local construction standards and regulations.
- A maximum of 13 mm (0.5 in) differential settlement is permitted.
- Ensure that the foundation is designed to prevent animals and insects from accessing Megapack's underside or debris from accumulating under Megapack.
- The area around the Foundation Zone must be designed to prevent standing water.
    - Any walls must be designed with sufficient clearance and be provisioned with features such as drains or weep holes to allow for proper drainage.
    - Megapack can withstand no more than 13 cm (5 in) of standing water for up to 30 minutes.
- Ensure that the foundation observes all clearance requirements as listed in *Megapack Clearance on page 84*.
- For anchoring requirements, see *Anchor Requirements on page 83*.
    - Concrete pad and equipment anchorage design shall meet ACI 318 and ASCE 7 requirements or the local building code requirements as required by the Authority Having Jurisdiction (AHJ).
    - Post-installed anchors (anchors installed into existing hardened concrete) must be approved to resist seismic loads in the installation jurisdiction and have a current ICC-ES or IAPMO report. Where anchoring conditions require an engineered design, it must be performed in accordance with the ICC-ES or IAPMO report and the cracked concrete provisions of ACI 318-11, Appendix D.

> ⚠ **CAUTION:** Modification of anchor brackets is not permitted in any way.

If the foundation has areas of unevenness that violate any conditions above:

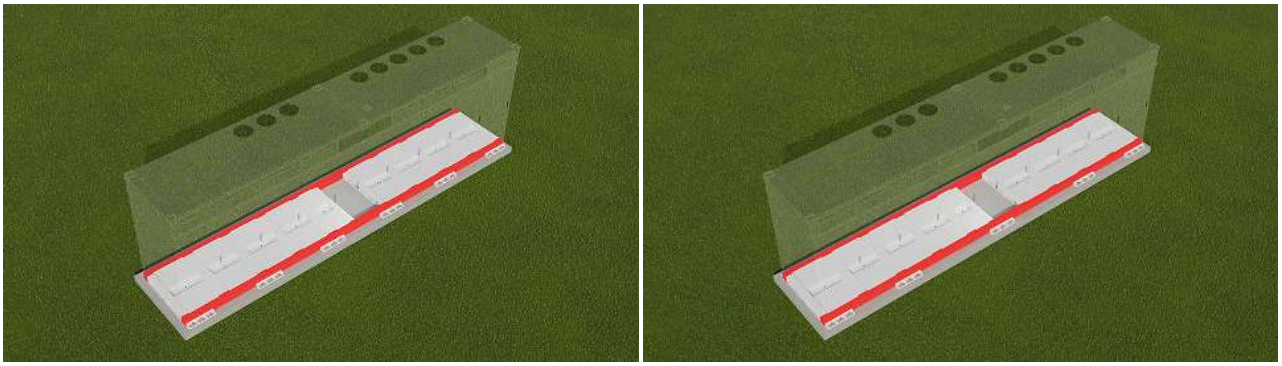
- For concrete foundations, use grout to even the surface
- For other foundation materials, use shims to even the surface
- In all cases, have a structural engineer approve the modification before implementing

If any aspect of the foundation inspection does not pass after remediation, contact Tesla before proceeding.

4.2.1.2 Equipment Bearing Areas and Anchoring

Megapack requires support along the length of the long sides to a width of 200 mm (8 in). Note that this support does not need to be continuous. Refer to the *Megapack 2XL Sample Engineered Template* for acceptable support locations. The foundational sections that must be supported are shown below:

Figure 52. Ground Support (-C Enclosure, -D Enclosure)



Megapacks may be anchored to their foundations using their anchor brackets, which are steel flanges welded to the base of Megapack. The use, quantity, and location of anchors (*Anchor Requirements on page 83*) is determined by the engineer of record and must conform to the laws, regulations, codes, and standards applicable in the jurisdiction of installation. Refer to clearance requirements in *Megapack Clearance on page 84*.

Anchors are needed if either of the following conditions are true:

- Uplift due to lateral forces such as wind or seismic cannot be effectively resisted by the Megapack's weight
- Sliding due to lateral forces such as wind or seismic cannot be effectively resisted by friction

NOTE: For anchor locations per Megapack installation type and complete anchor installation instructions, refer to *Anchoring Megapack on page 130*.

Figure 53. Anchor Brackets (-C Enclosure, -D Enclosure)

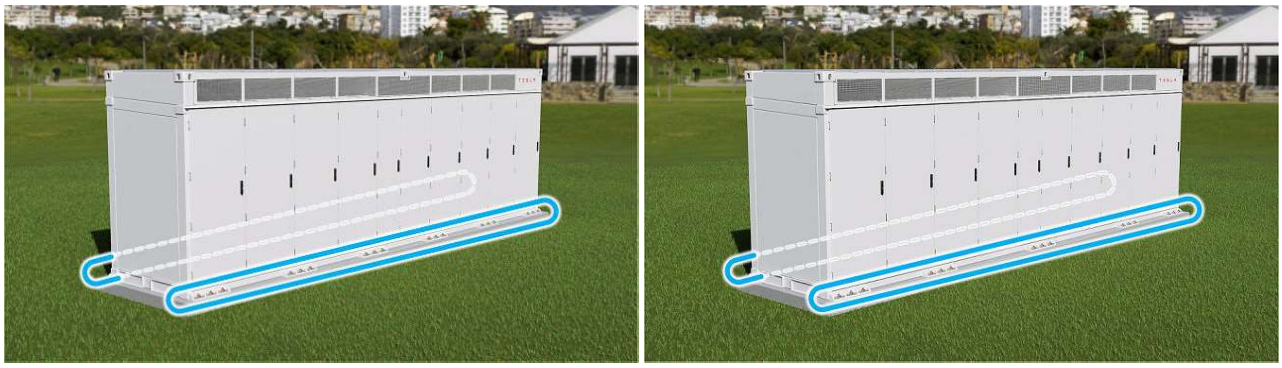


Table 39. Anchor Bracket Specifications

Description	Length	Depth	Thickness
Steel flanges welded to base of Megapack	610 mm (24 in)	102 mm (4 in)	16 mm (⅝ in)

4.2.1.2.1 Anchor Requirements

Anchors must be provisioned by the customer as selected by the structural engineer of record per site- and foundation-specific requirements according to the guidelines in this section.

NOTE: Refer to *Anchoring Megapack on page 130* for additional information.

When provisioning anchor hardware for Megapack, consider the following:

Table 40. Enclosure Anchoring Specifications

Anchor brackets (-C enclosure)	12 (6 in front; 6 in rear)
Anchor brackets (-D enclosure)	10 (5 in front; 5 in rear)
Anchor provisions	3 per bracket
Anchor hardware material	Stainless steel
Max. allowable anchor diameter	27 mm (1 in)
Anchor hole diameter	40 mm (1 1/2 in)
Anchor position tolerance	± 11 mm (7/16 in)

CAUTION: If using a concrete foundation, the structural engineer must provide the minimum allowable distance from the installed anchor to the edge of the foundation.

NOTE: Anchor hardware must not protrude above foundation surface greater than specified in *Anchor Protrusion on page 133*.

CAUTION: Modification of anchor brackets is not permitted in any way.

4.2.1.2.1.1 Additional Anchoring Considerations

- If installing back-to-back Megapacks and rear anchors are required, Tesla recommends that Megapacks are spaced with enough distance between them in order to install and access each Megapack's rear anchors. Refer to *Equipment Clearance Requirements - Side View on page 84* for back-to-back spacing requirements. Contact Tesla for more information if these requirements cannot be met.
- Hilti KB-TZ SS wedge anchors or HAS-R 304/316 SS and Hilti HIT-HY 200 epoxy anchor system are recommended.
- The final anchor selection must be made by the structural engineer of record.
- Refer to the seismic and wind specification values in *Enclosure Specifications or Capabilities on page 66*.

4.2.1.2.1.2 Additional Considerations for Concrete

If using concrete foundations, follow these guidelines in addition to the above:

- Concrete rebar reinforcement location must be coordinated with equipment anchor locations to avoid overlap.
- The pad thickness and size shall be sufficient to accommodate Megapack anchoring as required per ACI 318 or equivalent local standards.
- Specify rebar with a minimum and maximum allowed spacing, to allow the contractor to adjust rebar spacing to avoid conflicts with equipment anchoring.
- Alternately, the minimum concrete cover over the rebar can be increased to exceed anchor embedment depth, to avoid rebar conflicts with equipment anchoring.

4.2.2 Megapack Clearance

The clearances listed in this section are as required by the product. Additional clearances to non-Megapack equipment may be required per local codes and regulations.

Equipment clearances must be maintained throughout the operating life of the system. See the *Equipment Clearance Requirements on page 85* table below for dimensions. Shaded areas indicate the Battery Service Zone.

Figure 54. Equipment Clearance Requirements - Side View

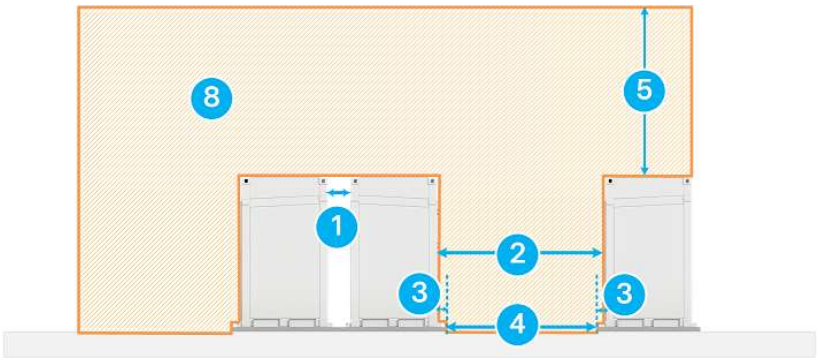


Figure 55. Equipment Clearance Requirements – Front View

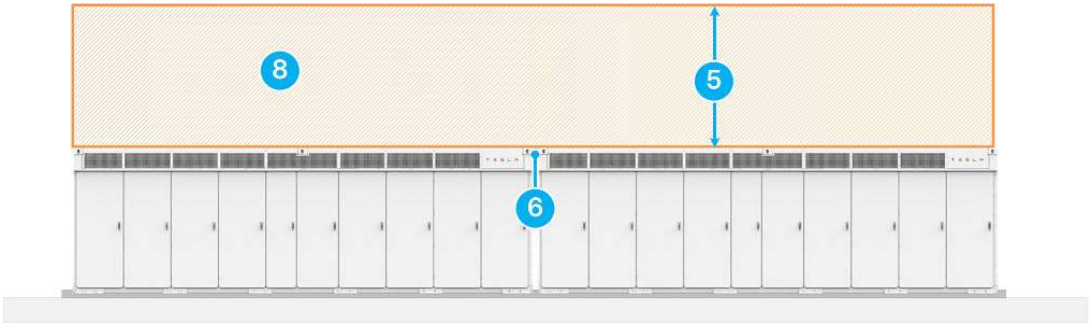
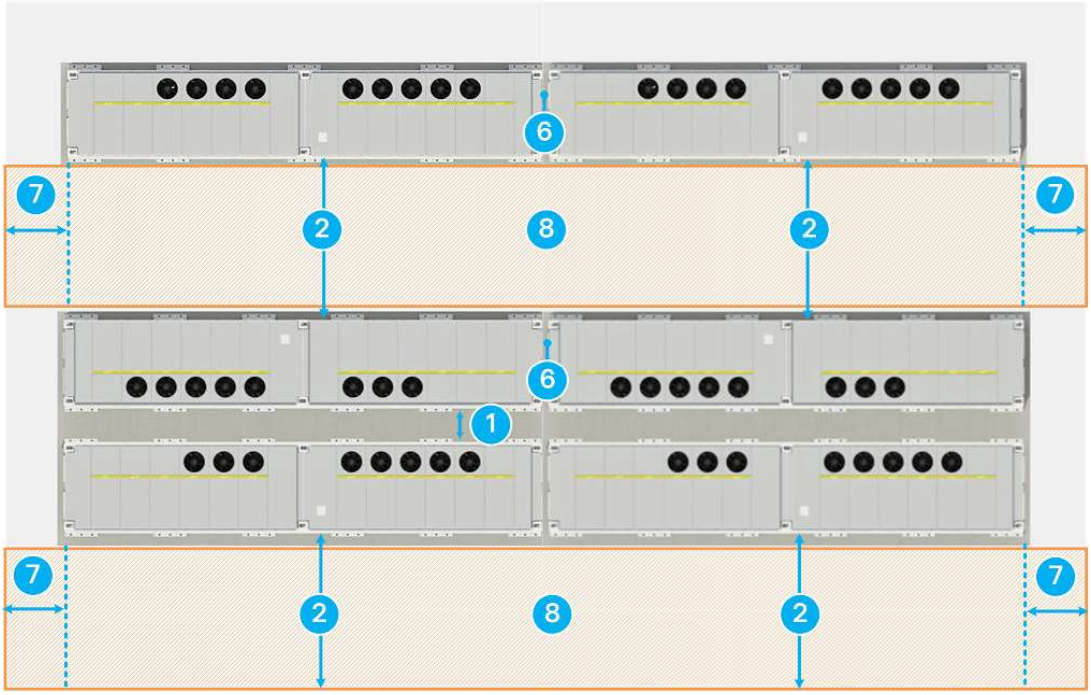


Figure 56. Equipment Clearance Requirements – Plan View



NOTE: All clearances listed must be observed from Megapack to any obstruction, including customer equipment or structures as well as other Tesla-provided components such as the Standard Tesla System Controller Enclosure.

Table 41. Equipment Clearance Requirements

Callout	Type	Minimum	Maximum	Notes
1	Back-to-back clearance	460 mm (18 in) *recommended* for access purposes. 230 mm (9 in) with prior Tesla review.	None	Measured from the back faces of the Megapacks. See also *Additional Anchoring Considerations on page 84*.
2	Front clearance	2440 mm (96 in)	None	Measured from the face of the door(s). Tesla-required clearance for maintenance access.

Callout	Type	Minimum	Maximum	Notes
				NOTE: Removable bollards may be installed within this area with prior Tesla approval. No permanent obstructions are allowed.
3	Foundation overhang	100 mm (4 in)	305 mm (12 in)	Varies depending on anchor and site design but must fall within this range. See *Equipment Bearing Areas and Anchoring on page 82* for more information.
4	Drive aisle clearance	1960 mm (77 in)	None	Measured from foundation. Tesla-required clearance for maintenance access.
5	Vertical clearance	2440 mm (96 in)	None	Must extend across the Battery Service Zone, as some service equipment extends beyond the roof of the enclosure. Megapack may only be installed by a crane, thus actual clearance during installation will be greater.
6	Side-to-side clearance	150 mm (6 in)	None	Measured from the side faces of each Megapack.
7	Service side clearance	915 mm (36 in)	None	Measured from the face of each side of the Megapack, except where side-by-side with another Megapack.
8	Battery Service Zone	--	--	The Battery Service Zone, shown shaded above, consists of the *Front* **(2)**, *Vertical* **(5)**, and *Service side* **(7)** clearances. **NOTE:** Small inclusions for foundations are allowed as long as the foundation does not infringe on the *Foundation overhang* **(3)** and *Drive aisle* **(4)** clearances.

4.2.2.1 Augmentation Clearance

For any site that requires augmentation, refer to *Augmentation Design on page 62* for clearance requirements.

4.2.3 Exposures and Fire Clearances

The dimensions and requirements as specified below are the product minimums and persist throughout the design, installation, and operating life of the system. Many jurisdictions have guidelines or restrictions about how close potentially combustible objects can be located to battery systems. Designers, owners, and operators are responsible for ensuring that the site meets the requirements of the local jurisdictions.

Figure 57. Exposure Clearances - Isometric View / Side View

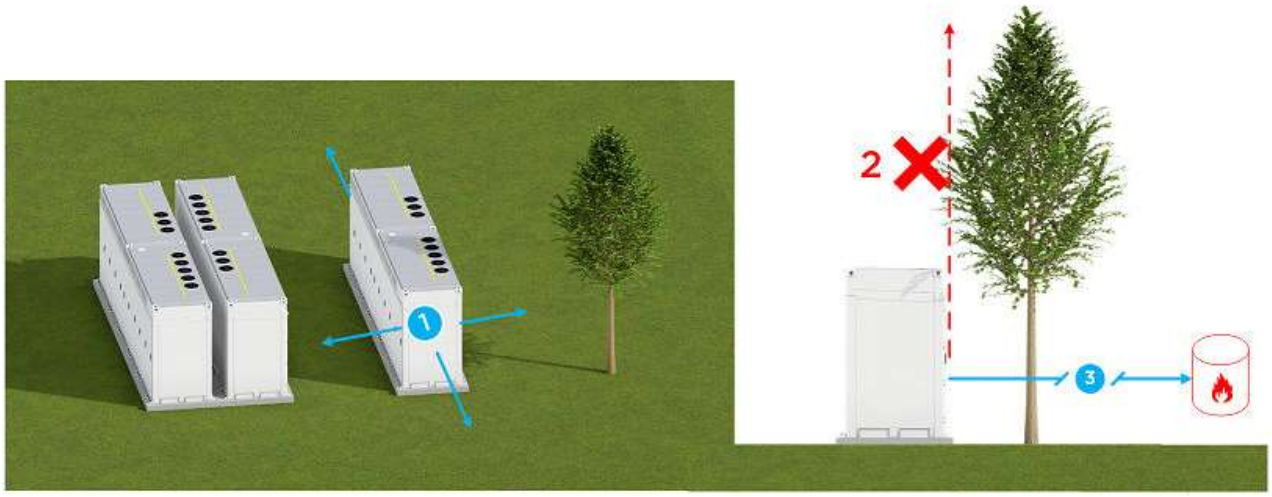


Table 42. Exposure Clearance Requirements

Callout	Type	Minimum	Maximum	Notes
1	Ordinary combustibles	1530 mm (60 in)	None	Minimum clearance as noted is required on all sides to ordinary combustible objects including trees, wooden fences, and other combustible structures.
2	Vertical combustible or ignitable	NA	NA	**Do not install Megapack under combustible or ignitable objects, at any distance.**
3	Ignitable liquids	6096 mm (240 in)	None	Minimum clearance as noted is required on all sides to ignitable liquids sources.

NOTE:

- Megapack is not intended to be installed within 3050 mm (120 in) from accessible means of egress and exposures (such as buildings, public ways, and hazards not associated with electrical grid infrastructure as defined by the clearance requirements in the International Fire Code and NFPA 855).
- Any installation that requires clearances of less than 3050 mm (120 in) to accessible means of egress or exposures may require a freestanding fire barrier per requirements in the International Fire Code and NFPA 855.

4.2.4 Fencing and Barriers

Megapack shall be installed in a manner that deters access by persons who are not qualified. When deterring access, fences, screens, walls, or other barriers no shorter than 2.1 m (7 ft) in height are suggested. The distance from any barrier to the equipment shall match the clearance requirements listed in *Megapack Clearance on page 84*, or as noted per the exceptions below. Associated access points shall be locked and posted with a placard stating "Authorized Users Only," or similar. If applicable, see 2021 IFC 1207.4.9.

Exception: If the installation is located within a property that already contains perimeter barriers to prevent unauthorized public access, additional barriers might not be required.

4.3 Delivery Considerations

A Megapack unit is a large, overweight load. In order to prepare for successful delivery, all relevant routes and zones must be capable of supporting the loaded Megapack delivery vehicle. Refer to *Mechanical Design on page 66* for details on the estimated equipment gross weight of the Megapack unit.

Tesla recommends that a ***site movement and crane unloading plan*** be created as part of the design process prior to construction. Reach out to Tesla for more information about creating this plan.

For delivery checklist and process flow across responsible parties, refer to the *Megapack 2 XL Transportation and Storage Guidelines*.

Ensure that the installation contractor prepares for day-of-delivery access as specified in *Preparing for Installation on page 127*.

CAUTION: Failure to follow the recommended guidelines may result in damage to delivery vehicle or Megapack.

NOTE: Tesla is not responsible for unloading Megapack. The installation contractor together in consultation with the site designer shall provide a site movement and crane unloading plan.

NOTE: Failure to meet these requirements can lead to project delays.

4.4 Service and Maintenance Considerations

To service Megapack, Service Providers will require frequent access to the site and to the Megapacks themselves, over the full duration of the project's life. Routes and zones at the site must allow for year-round access, including for support of all vehicles as designated by the site's engineer of record. Refer to *Routes and Zones on page 72* for more information.

NOTE: For installations not at grade, owners must provide the ability for Service Providers to safely service Megapack and the Tesla System Controller. A written agreement must be approved by Tesla before commissioning for installations not at grade.

4.4.1 Megapack Access

- The Service Provider must be allowed to have the ability to remove any locks preventing access. Refer to *Megapack Door Security on page 126* for information on securing and locking doors while retaining Service Provider access.
- You must keep the doors of all enclosures free of all obstructions such as snow, sand, and blown debris during system operation. With any concerns, contact Tesla during the site design phase.
- You must ensure the area in front of each Megapack can support any of the vehicles described in *Typical Vehicles on page 79*.

5 Electrical Design

5.1 Interconnection Data

The inverter modules in Megapack are current-limited sources. Refer to the *Megapack 2 XL Interconnection Data* publication for additional information

Table 43. Interconnection Data

Specification	Value
Max Continuous Output Current	Factory-configurable
Overload Capability	120% of rated current (10 s max)
Nominal Voltage	480 V AC (configurable)
Output Voltage Range	422-552 V AC
Nominal Frequency	50 or 60 Hz (configurable)
Frequency Range	45-66 Hz
Phases	3
Configuration	3-wire, Wye **Note:** Grounded Wye required at transformer secondary
Full Load Efficiency	98.3%
California Energy Commission Weighted Efficiency	98.5%
Power Factor at Full Load	> 99%
Power Factor Range	-1 to +1
Total Current Harmonic Distortion (THD)	< 5% (at real power capability)
Power Regulation Accuracy	< 2%
Overvoltage Category	Category III up to 3000 m
Maximum Supply Fault Current	85 kA_{rms}

WARNING: In order to operate, Megapack requires a solidly grounded circuit such that the line-to-ground nominal voltage does not exceed 300 V AC.

NOTE: The per-unit short circuit current in the case of a three-phase-to-ground bolted fault is 1.2 per unit.

Table 44. Grid-Forming Additional Electrical Specifications

Specification	Value
Total Voltage Harmonic Distortion (THD)	< 8% (Individual Harmonic: Max 6%)

5.1.1 Peak Power

The 2-Hour Megapack can be requested to be configured by Tesla to discharge for up to one hour at higher power than its real power capability (kW) and apparent power capability (kVA) by enabling Peak Power Mode. Megapack must be configured by Tesla for Peak Power Mode to be available.

To understand the peak apparent power capability and peak real power capability when Peak Power Mode is enabled, refer to the *Megapack 2 XL System Specification*.

5.2 Megapack Wiring

5.2.1 Wiring Interface Summary

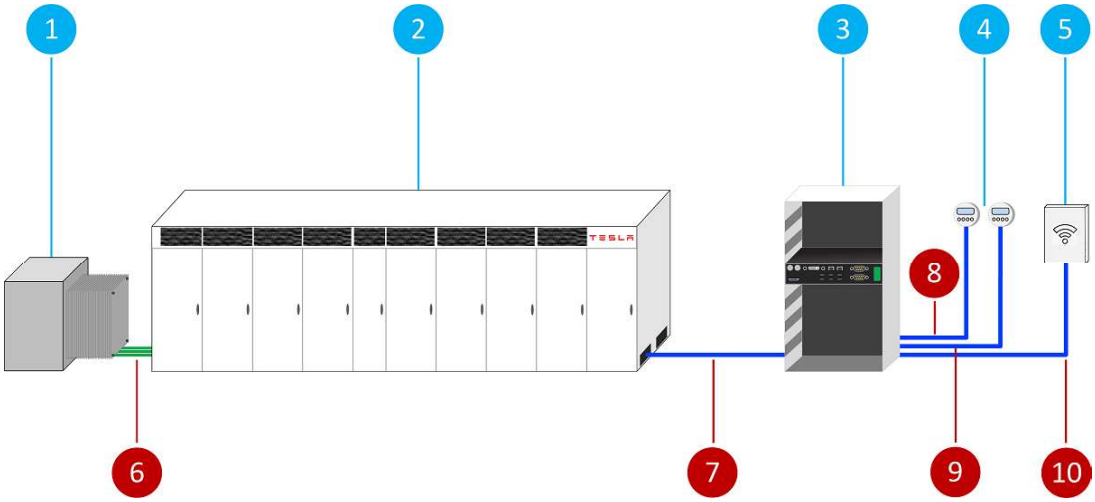
Megapack requires power and communications wiring between system components and to the site's main AC panel. The table below summarizes the wiring interfaces needed. All materials are supplied by the contractor.

Table 45. System Wiring Interface Summary

From Equipment	To Equipment	Wiring Interface	Minimum Conduit Size
Megapack	Controller or field network enclosure	Communications cable (see *Communications Cable Requirements on page 92*)	N/A
		DC power conductors (for communication control power or microgrid applications)	N/A
	Grid interconnection	AC power conductors (3-phase and ground)	N/A
Controller	AC power supply	AC power conductors (2-phase and ground)	25 mm (1 in)
	Meters	Communications cable (see *Communications Cable Requirements on page 92*)	25 mm (1 in)

An example interface plan is shown below:

Figure 58. Example Wiring Interface Plan



1. Transformer
2. Megapack
3. Tesla System Controller
4. Meters
5. Customer communications
6. AC power conductors between Megapack and transformer
7. Communications cable between Megapack and Tesla System Controller
8. Communications cable from Tesla System Controller to site meter as applicable
9. Communications cable from Tesla System Controller to battery meter
10. Communications cable from Tesla System Controller to customer communication interface

Each Megapack requires a 3-wire circuit (3 phases, ground) connection, terminated according to the instructions in *Wiring the AC Conductors on page 135*. If equipped, you may use the external ground interface, available on some Megapack units as indicated below:

Figure 59. External Ground Interface (If Equipped)

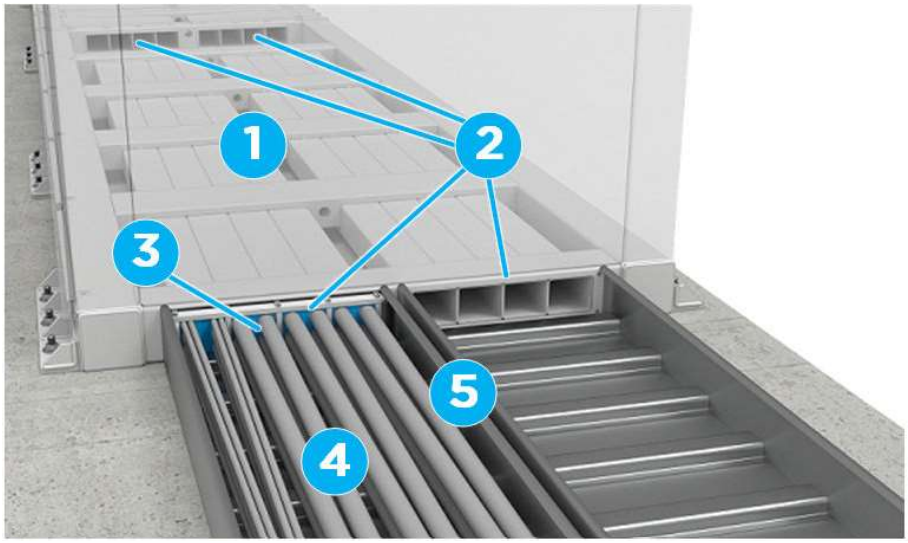
Conductors enter Megapack via the above-ground wireway, and terminate on the AC bus bars (*AC Bus Bar Area on page 112*) in the Customer Interface Bay.

Megapack is designed with two above-ground wireways through which to route AC cabling to LV transformer termination and communications cabling. The wireways do not require any site trenching construction. Each wireway runs from each side of the Megapack into the AC bus bar area in the Customer Interface Bay. Circuits using wireways must be designed and installed in accordance with local code. For more information on wireway design, refer to the *Application Note: Megapack Integrated Wireway*. For more details on wireway dimensions, refer to the *Megapack 2 XL Layout* drawings in the *Megapack 2 XL Drawings* package.

Table 46. Wireway Opening Dimensions

Enclosure Variant	Width	Height	Channel Width
-C variant	410 mm (16 ¼ in)	96 mm (3 ¾ in)	NA
-D variant	502 mm (19 ¾ in)	96 mm (3 ¾ in)	4 channels, 121 mm (4 ¾ in)

Figure 60. Megapack Integrated Wireway (-D Enclosure)



1. Two four-channel (single-channel in the -C enclosure) wireways, integrated into the Megapack base
2. Wireway openings
3. Roxtec seal in the wireway opening
4. AC power conductors or other cables such as communications cables
5. Two cable trays

5.2.2 Communications Cable Requirements

Communications wiring for the battery system requires special attention to network cabling. Follow the requirements in this section when wiring communications between any components of the system.

5.2.2.1 Cable Specification

Observe the following minimum required or recommended cable specifications:

Table 47. Communications Cable Specifications

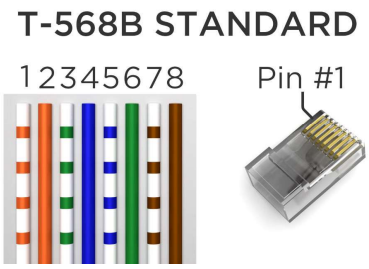
Specification	Required	Recommended
Ethernet Standard	Cat 5e	Cat 6a
Outer Jacket	Outdoor-rated (UV stable)	Direct burial
Shielding	Yes	Yes: F/UTP

Specification	Required	Recommended
Voltage Rating	600 V	600 V
Maximum Circuit Distance (If exceeded, consult the *SCADA Design Manual* or project designer.)	100 m (330 ft)	75 m (250 ft)

5.2.2.2 Connection Specification

Communications cables must be terminated according to the T568B wiring standard.

Figure 61. T568B Wiring Standard



In addition, ensure the following for proper cable termination:

- Crimp with the tool and forming die that match the connector used
  - Tesla recommends pass-through style RJ45 connectors (such as EZ-38 or VDV826)
- Use **metal** connectors into the network switch
- Use **plastic** connectors into the battery system
- Use strain relief on both ends
- Test all cables with a LAN tester prior to connecting

Figure 62. Metal (1) and Plastic (2) Ethernet Connectors

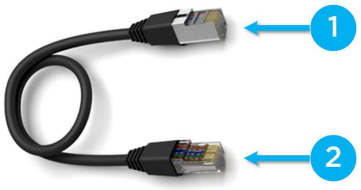


Figure 63. Ethernet Cables with Metal Connectors into the Tesla System Controller Network Switch

5.2.3 AC Power Requirements

Dedicate a separate 3-phase circuit for each Megapack. Tesla requires copper or aluminum conductors with a minimum insulation temperature rating of 90°C. For details on the bus bars provided to connect the circuit to the Megapack, see *AC Bus Bar Area on page 112*.

NOTE: Each Megapack's power rating is displayed on its label (see *Megapack Labels on page 21*). The contractor and engineer of record are responsible for sizing conductors accordingly.

Provide an equipment grounding connection for each power circuit. The grounding conductor size depends on local requirements and the Megapack AC circuit breaker rating.

CAUTION: All conductors, including the grounding conductor, must consider Megapack's IP66 enclosure rating (*Enclosure on page 16*) and obey this level of protection against water ingress. Consider jacketed conductors, as bare metal conductors may not be able to maintain this rating.

CAUTION: If an equipment grounding connection is not provided as part of the power circuit, an appropriate low-resistance ground fault path must be supplied. This solution must be compliant with local requirements and reviewed by Tesla.

Megapack does not require a separate auxiliary power circuit. Megapack auxiliary load – power drawn from the grid and/or battery modules to support the Megapack internal controls and thermal management loads – is supplied through the Megapack AC bus bars.

5.2.4 Uninterruptible Power Supply

Below are the options when designing backup power, such as an uninterruptible power supply (UPS), for a microgrid or for the Standard Tesla System Controller Enclosure (see *Standard Tesla System Controller Wiring on page 95*). Contact your Tesla project engineer for more information about backup power design.

1. **Customer-provided DC power** – Customers can provide a 24 V DC UPS that terminates into the 24 V DC redundancy module in the Standard Tesla System Controller Enclosure.
2. **Customer-provided AC power** – Customers can supply power from a UPS or other backed-up power supply (strongly recommended for microgrids and high-reliability sites). This supply must terminate upstream of the AC transformer in the Standard Tesla System Controller Enclosure. Do not add components to or modify the Standard Tesla System Controller Enclosure.

5.2.4.1 DC Power Requirements

For microgrids and high-reliability sites, a UPS or other backed-up power supply is strongly recommended. If DC power is used, it must be provided at 24 V DC with the wiring circuit designed as specified below.

Wiring Specification:

- Wire length of 45 m or less
- 2 mm^2 [14 AWG]
- Maximum power consumption: 100 W

5.3 Tesla System Controller Wiring

5.3.1 Standard Tesla System Controller Wiring

The Standard Tesla System Controller Enclosure must be powered from a dedicated 120-480 V circuit. Its internal transformer adjusts voltage as required. The engineer of record must design the means and methods of installing this circuit.

Table 48. Standard Tesla System Controller Wiring

Specification	Value
Input Voltage Range	120 V AC +/- 12 V AC 240 V AC +/- 24 V AC 480 V AC +/- 48 V AC
Operating Power Consumption	100 W maximum

To provide an uninterruptible power supply (UPS) to the Standard Tesla System Controller Enclosure, types of power supply are available as described in *Uninterruptible Power Supply on page 94*.

5.3.2 Large Tesla System Controller Wiring

Table 49. Large Tesla System Controller Wiring

Specification	Value	
Large Tesla System Controller (part number 1700130)		
Input Voltage Range	9-48 V DC	
Operating Power Consumption	100 W maximum	
Large Tesla System Controller (part number 1459155-02-A)		
Input Voltage Range	180-310 V DC	100-240 V AC (50-60 Hz)
Operating Power Consumption	450 W maximum	
Large Tesla System Controller (part number 1459155-03-A)		
Input Voltage Range	36-72 V DC	
Operating Power Consumption	450 W maximum	

5.4 Megapack Unit Capabilities

5.4.1 Overload

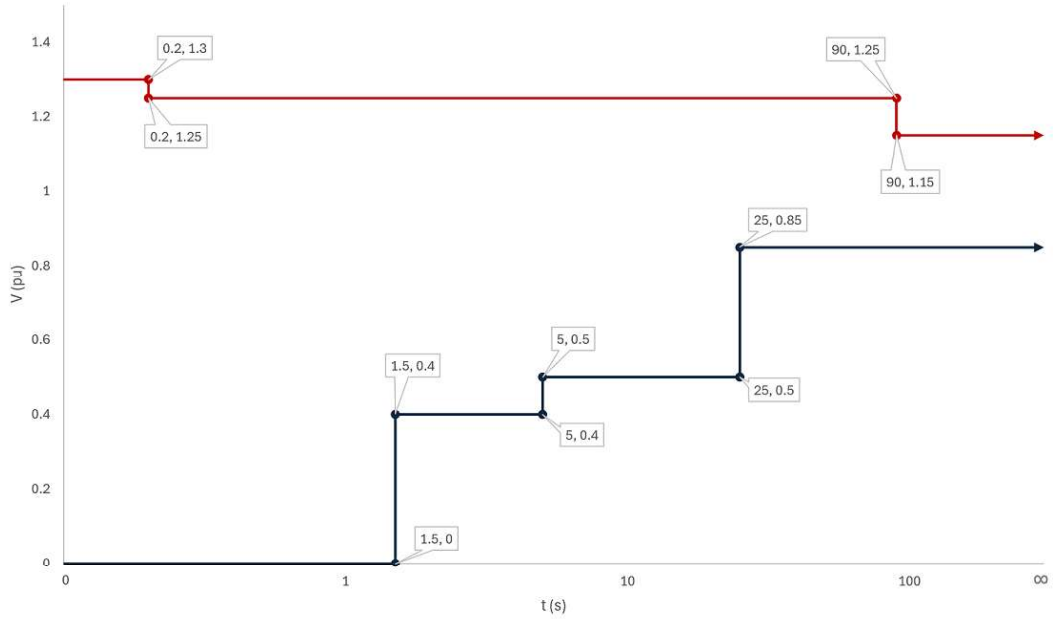
Megapack is capable of providing an additional 20% current overload for up to 10 seconds when followed by and preceded by a minimum of 10 minutes of operation at rated power or lower. In other words, Megapack can handle one equivalent full overload every 10 minutes if running at 100% current. This is purely a feature of the Megapack hardware.

Overload capability can be configured by Tesla at the customer's request, with an allowed percentage of overload from 0–20%.

5.4.2 Voltage Ride-Through

Megapack voltage ride-through (VRT) settings – high-voltage ride-through (HVRT) and low-voltage ride-through (LVRT) – are adjustable and programmed during the commissioning process to meet IEEE 1547-2018 or IEEE 2800-2022 requirements, and/or to comply with applicable grid code. The curve in *Megapack Non-Cumulative and RMS-Based HVRT and LVRT Capabilities on page 96* specifies the per-unit HVRT and LVRT non-cumulative capability of Megapack. All per-unit (pu) voltages are defined with respect to 480 V AC L-L.*

Figure 64. Megapack Non-Cumulative and RMS-Based HVRT and LVRT Capabilities



HVRT
LVRT

Table 50. Ride-Through Setting Ranges

Parameter	Setting Range	Resolution
Voltage	0.00 – maximum HVRT capability	0.01 pu
Time	0.001 – 60000 s*	0.001 s

** Time allowed at a specific per-unit voltage depends on the nominal voltage rating. Typically, default settings and acceptable ranges are tested as part of a specific certification. For deviations from certified settings in a region, contact your Tesla representative for more information.*

The table below specifies the maximum per-unit overvoltage (OV) withstand non-cumulative capability of Megapack:

Table 51. Maximum Overvoltage Withstand

Parameter	Per-Unit Maximum Value, Nominal Voltage of 480 V AC, Non-Cumulative and RMS-Based
Maximum OV withstand	130% @ 0.2 s

Megapack has adjustable abnormal voltage settings parameters. For details on configuring Megapack to comply with IEEE 1547, refer to *IEEE 1547 on page 99*.

In addition to ride-through capability, Megapack is capable of adding or removing VARs during VRT events to help support voltage regulation during a fault event. K-factor (reactive current support coefficient) adjusts the amount of reactive current supplied to support grid voltage during a fault. This coefficient is multiplied by the per-unit voltage sag/swell to determine the amount of reactive current (up to rated current) supplied to support the voltage. There are separate coefficients for sag and swell. Setting a K-factor to 0 disables reactive current support.

As part of the commissioning process, Megapack can be configured to prioritize real or reactive current during VRT (grid fault) events. Megapack can supply negative sequence reactive current (up to rated current per phase) to support voltage imbalance due to grid faults.

5.4.3 Frequency Ride-Through

Megapack frequency ride-through (FRT) settings are adjustable and programmed during the commissioning process to comply with IEEE 1547-2018 or IEEE 2800-2022 Table 15 requirements, and/or to comply with applicable grid code. High-frequency ride-through (HFRT) and low-frequency ride-through (LFRT) parameters are configurable to the limits of the capability curves shown in *Megapack HFRT and LFRT Capabilities (50 Hz) on page 97* and *Megapack HFRT and LFRT Capabilities (60 Hz) on page 98* below.

Figure 65. Megapack HFRT and LFRT Capabilities (50 Hz)

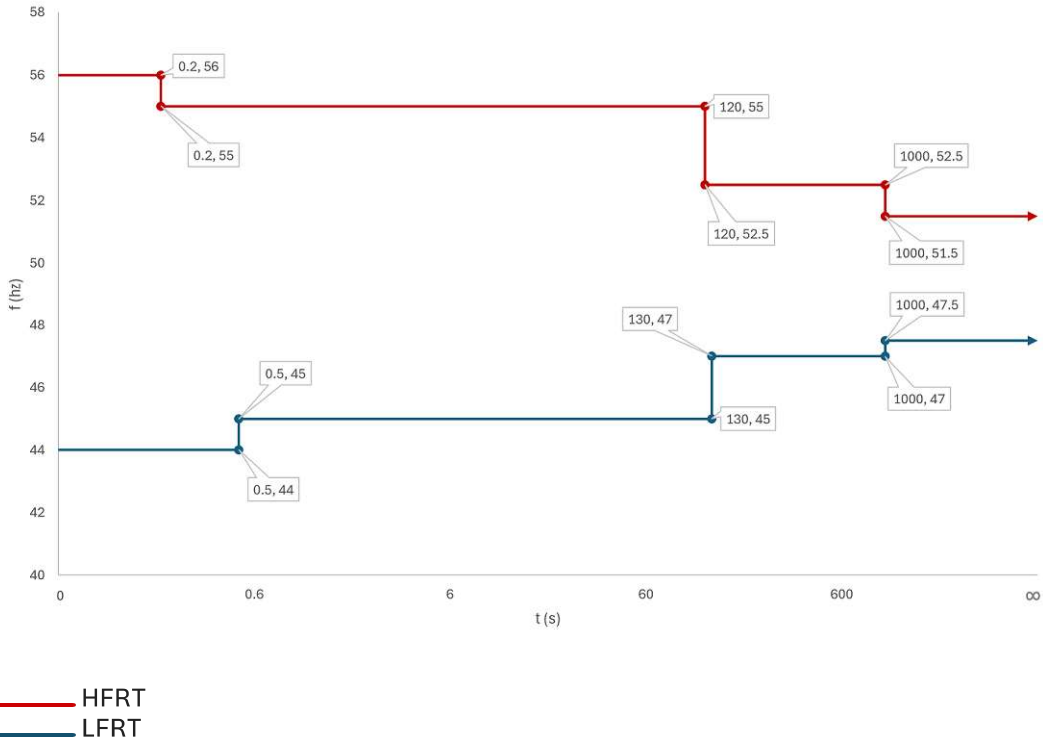
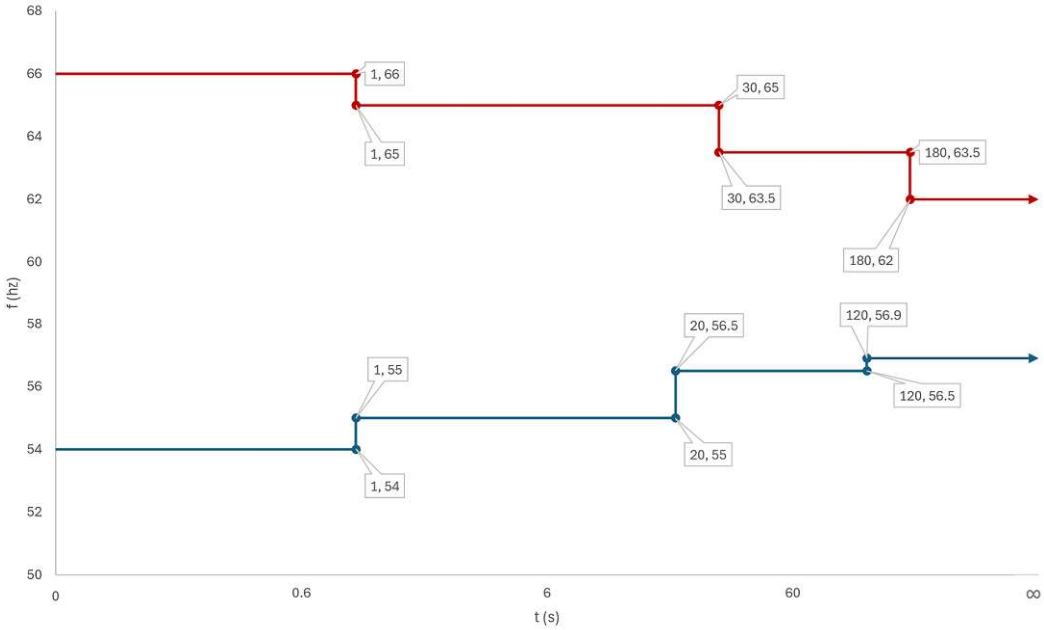


Figure 66. Megapack HFRT and LFRT Capabilities (60 Hz)



HFRT
LFRT

Megapack has three underfrequency (UF) and three overfrequency (OF) trip points and times. These are configured during commissioning to comply with the relevant grid code. The limits and resolution of frequency setpoints are enumerated in *Frequency Trip Point Settings on page 98* below.

Table 52. Frequency Trip Point Settings

Trip Point	Frequency Range	Time (s)	Resolution
UF Trip Time 1 - 3	44 – 66 Hz	0.001-60000	0.01 Hz/0.001 s
OF Trip Time 1 - 3			

5.4.4 Ride-Through Operation Alerts

Megapack exposes four ride-through alerts to the customer interface. A Megapack unit will assert an alert that it has entered VRT or FRT mode when any threshold has been crossed that would, if sustained, result in a Megapack trip. For example, if the HVRT settings were set according to the capability curve in *Megapack Non-Cumulative and RMS-Based HVRT and LVRT Capabilities on page 96*, a HVRT alert would be asserted without delay when voltage exceeds 1.15 per-unit. Underfrequency, overfrequency, and undervoltage alerts will be issued when their respective most-stringent thresholds are exceeded.

To reduce the risk of nuisance alerting, the Megapack unit ride-through alert is asserted when at least 50% of its inverters report that they have entered ride-through. The alert will remain asserted until less than 50% of the inverters are in ride-through.

The *Controls and Communications Manual* contains a list of ride-through points and other DNP3 points provided by Tesla.

5.4.5 IEEE 1547

Megapack meets the requirements of normal performance category B and abnormal performance category II & III of IEEE 1547-2018 IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces. The settings in the tables in this section will enable Megapack to meet the voltage and frequency ride-through requirements of IEEE 1547-2018.

CAUTION: Programming to values outside of the ranges in this section falls outside the scope of IEEE 1547-2018.

NOTE: When in grid-connected mode, Megapack complies with the IEEE 1547 harmonic current distortion requirements.

Table 53. Compliant HVRT Settings

Voltage Range (% of Base Value)	Response Time
Category II	
117.5<V<=120	0.2 s
115<V<=117.5	0.5 s
110<V<=115	1 s
Category III	
110<V<=120	0.083 s - 12 s

Table 54. Compliant LVRT Settings

Voltage Range (% of Base Value)	Response Time
Category II	
65<=V<88	Linear slope of 8.7 s / 1 per-unit voltage starting at 3 s @ 0.65 per-unit
45<=V<65	0.32 s
30<=V<45	0.16 s
Category III	
70<=V<88	20 s
50<=V<70	10 s
V<50	0.083 s - 1 s

Table 55. Compliant FRT Settings

Default Frequency (Hz)	Default Clearing Time (s)	Adjustable Frequency (Hz)	Adjustable Clearing Time Range (s)
>62	0.16	61.8-66	.16-1000
>61.2	300	61-66	180-1000
<58.5	300	50-59	180-1000
<56.6	0.16	50-57	.16-1000

Table 56. Interconnection System Response to Abnormal Voltages

Default Voltage Range (% of Base Value)	Default Clearing Time (s)	Adjustable Voltage Range (% of Base Value)	Adjustable Clearing Time Range (s)
V<45	0.16	0-50	0.16-2

Default Voltage Range (% of Base Value)	Default Clearing Time (s)	Adjustable Voltage Range (% of Base Value)	Adjustable Clearing Time Range (s)
			Response faster than 1 s
45<V<50	2	0–50	2–21 Response faster than 1 s
50<V<70	10	0–88	2–21
70<V<88	21	0–88	21–50
110<V<120	2	110–120	1–13
V>120	0.16	Fixed at 120	Fixed at 0.16

5.4.6 Trip Accuracy

Table 57. Trip Accuracy

Trip Setting	Accuracy
Voltage	+/– 1% of nominal voltage
Frequency	+/– 0.01 Hz
Reconnection time	1% of setpoint
Trip time	.16 s for < 5 s 1% of setpoint for > 5 s
Active power	+/– 5% of apparent power capability
Reactive power	+/– 5% of apparent power capability

5.4.7 Grid-Connected Features

5.4.7.1 Active Anti-Islanding

All systems are equipped with active anti-islanding using the Sandia Frequency Shift methodology. Megapack can autonomously and automatically detect an island condition, in which case it isolates from the grid and reports a trip to the user. Megapack can detect the island condition and trip within 2 seconds of island creation. An island condition is detected even if multiple Megapacks are connected on the same island area.

5.4.7.2 Passive Anti-Islanding

Megapack also optionally includes a rate of change of frequency (ROCOF) trip, which is configurable to site and user requirements. ROCOF is disabled by default, but Megapack detects an island condition and trips regardless of whether or not this feature is enabled. The ROCOF parameters available include:

Table 58. ROCOF Settings

Feature Name	Effect	Setting Range	Default
ROCOF Enable	Turns ROCOF on or off.	n/a	Off
ROCOF Fault Limit	Sets the rate of change required for a trip.	0.1–100.0 Hz/s	1 Hz/s
ROCOF Time Delay	Sets how long the rate of change has to be present for the inverter to trip.	0–1 s	1 s

NOTE: Anti-islanding can be disabled by a qualified Tesla technician or personnel only.

5.4.7.3 Automatic Grid Reconnection

Megapack automatically reconnects to the grid after a serious grid fault event which causes inverter trip. Megapack's configurable settings determine when and under what conditions it automatically reconnects to the grid.

Table 59. Reconnection Delay Timer Default Settings

Feature Name	Effect	Setting Range	Default
Reconnect Time Delay	The amount of time Megapack waits before reconnection, after the grid returns within the frequency and voltage ride-through windows defined above.	0–600 s	300 s
Reconnect Min. Voltage	The minimum voltage at which Megapack interprets the grid is within tolerable conditions.	0–150%	88.33%
Reconnect Max. Voltage	The maximum voltage at which Megapack interprets the grid is within tolerable conditions.	0–150%	105.83%
Reconnect Min. Frequency	The minimum frequency at which Megapack interprets the grid is within tolerable conditions.	44 – 66 Hz	59.3 Hz
Reconnect Max. Frequency	The maximum frequency at which Megapack interprets the grid is within tolerable conditions.	44 – 66 Hz	60.5 Hz

The reconnect voltage and frequency parameters are also used to determine whether it is safe for Megapack to synchronize to the grid upon initial start-up. Megapack has no time delay to connect to the grid after initial start-up.

5.4.8 Island Grid Controls

Megapack is capable of generating an island grid voltage. Its algorithm has been designed to be compatible with generators, renewable energy sources, and other microgrid assets. There are practical and sizing restrictions with microgrids that must be considered during site design.

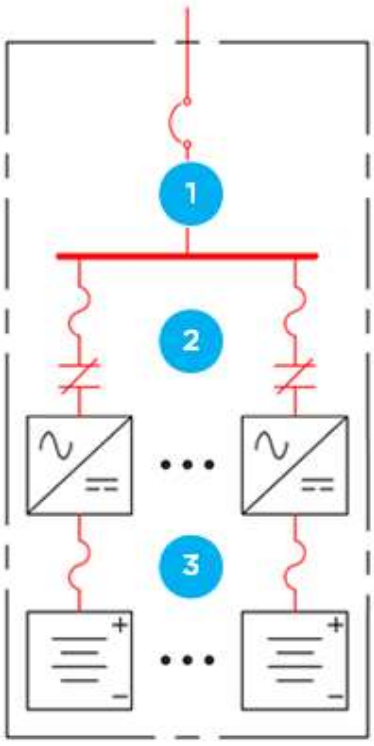
Islanding may require additional hardware. For further design questions on this feature, talk to your Tesla representative.

5.5 System Protection Features

Megapack has both hardware and software system protection features as described in this section.

At a high level, the system is protected as illustrated below:

Figure 67. System Protection Features



1. Megapack AC circuit breaker
2. AC fuse and contactor
3. Battery module fuse

Protection features include:

- **Battery module overcurrent protection:** The battery modules contain DC single-use fusible links.
- **Inverter DC protection:** Each inverter module is equipped with its own high-speed DC disconnect.
- **Inverter AC protection:** Each inverter module is equipped with its own AC contactor and AC fuses.
- **Ground fault protection:** Megapack is provided with a DC ground fault detection system. Megapack measures insulation resistance prior to operation and looks for excessive leakage current during operation. Megapack also contains an AC circuit breaker with ground-fault trip settings. See *Megapack AC Circuit Breaker on page 106* for more information.

5.5.1 Required Protective Studies

While Megapack provides system protection features as outlined above, the system design engineer is responsible for providing Tesla the following information based on site conditions and protection studies for Tesla's review:

- Arc flash calculations showing the available energy at the Megapack AC bus
- Isolating methods plan or switching scheme identifying the order of opening and who is responsible for each step
- See the *Megapack Deployment Checklists* for more information on submitting switching scheme information

5.5.2 Lightning Protection Design

Protection from direct lightning strike: Megapack enclosures have internal frames that act like a Faraday cage, diverting currents to flow around the internal components but not through them to ground. There is no expected significant impact to Megapack functionality due to a direct lightning strike. Hence, air terminations or lightning masts are not required to protect Megapack enclosures.

Protection from indirect lightning strike: Megapacks are designed with adequate power electronic component sizing and creepage clearance in addition to monitored surge protection on the load side of the Megapack breaker. Tests in accordance with IEEE C62.41.2 and IEEE C62.45 demonstrate that internal circuits and components of Megapack are protected from induced overvoltage from indirect lightning strikes. There is no expected impact on Megapack functionality due to an indirect lightning strike.

5.5.3 Electrical Control Plan

An Electrical Control Plan is a document that outlines the design, implementation, and operation of an energy site's electrical system, its hazards, and how any parties on site are expected to control the electrical hazards. For Tesla sites, such plans are required to include control of the battery system's electrical hazards (for example, those detailed in *Electrical Hazard Mitigation on page 20*).

Generally, an Electrical Control Plan may include details on how the site's electrical components, such as inverters, transformers, batteries, and protection relays, are properly integrated and function according to requirements. Such details may be communicated in the plan using wiring diagrams and schematics, operational and safety sequences, fault response, and documentation of compliance with regulatory standards. The Electrical Control Plan is typically provided by the customer's electrical engineer of record, implemented by the installation contractor, and approved by the site owner or operator. It then serves as an electrical safety plan for the site in order to ensure the safety of any parties on site including customer and Tesla parties.

For Tesla systems, the Electrical Control Plan should be created by the site designer or electrical engineer of record, and must include the following key elements:

- **Levels of isolation:** The approved levels (for example, block, feeder, site) at which isolation can be established, and the identified lockout device for each level
- **Control procedures:** Detailed procedures for isolating power supplies, including automatic switching devices and circuit reclosers, particularly at the medium-voltage transformer (MVT) and any interconnect power supplies
- **Responsible parties:** The name of the party responsible for executing each step in each of the procedures
- **Verification of isolation:** Detailed procedures for confirming isolation, such as using open viewing windows or designated testing points
- **Lockout participation:** Description of how Tesla will engage in the owner / operator lockout process, specifically using a group lock box to ensure multiple personnel can secure the system

5.6 Safety Disconnect Features

5.6.1 Megapack AC Circuit Breaker

The Customer Interface Bay contains an AC circuit breaker that can be locked in the open position.

WARNING: Operating the Megapack AC circuit breaker does not completely remove potential electrical hazards from the Megapack unit. See *Performing Lockout/Tagout on page 118* for more information.

5.6.2 Enable Circuit

Megapack includes an internal safety circuit called an *enable circuit* (also known as *HVIL – high-voltage interlock loop*) that isolates all major power components whenever the circuit is opened. Certain factors trigger opening this circuit, including opening bay doors or turning the enable switch (*Enable Switch on page 104*) off. The Customer Interface Bay door is not part of the enable circuit, as it does not provide direct access to high-voltage equipment. The enable circuit does not trip the Megapack AC circuit breaker.

The Megapack internal monitoring system uses the enable circuit to monitor for critical system faults and prevent operation of the Megapack unit if needed. It is not recommended to open a Megapack door during operation.

WARNING: Opening the enable circuit does not completely remove potential electrical hazards from the Megapack unit. See *Performing Lockout/Tagout on page 118* for more information.

Figure 68. Enable Circuit Examples

1. The enable circuit is closed. Megapack is able to operate.
2. The enable circuit is open due to an open bay door that is not the Customer Interface Bay door. Megapack is unable to operate.
3. The enable circuit is open because the enable switch in the off position. Megapack is unable to operate.

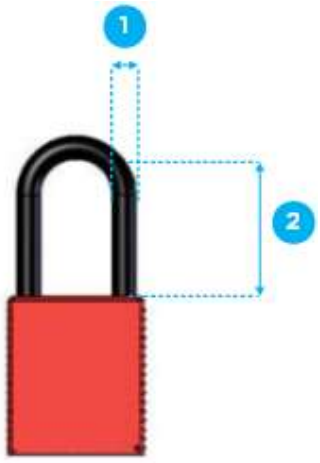
5.6.3 Enable Switch

The customer I/O area in the Customer Interface Bay includes an enable switch that can interrupt the enable circuit and prevent the system from energizing. This switch is part of the enable circuit, and provides a lockable isolation point for procedures that involve actively working inside Megapack. It is the recommended customer interface to the enable circuit. When the switch is turned off, the enable circuit is open and the product will not actively operate.

WARNING: The enable switch must be turned off at any time when working inside Megapack. See *Performing Lockout/Tagout on page 118* for more information.

If applying a lock to the enable switch, the lock must observe the specifications indicated below:

Figure 69. Lock Specifications



1. Nominal shackle diameter: 6.4 mm (¼ in)
2. Minimum shackle clearance: 38.1 mm (1 ½ in)

5.6.4 Remote Shutdown Terminals

The customer I/O area in the Customer Interface Bay contains a pair of terminals used to perform a remote shutdown, which commands the inverter to cease operation (isolating the Megapack AC bus from the battery DC source) and opens the Megapack AC circuit breaker. These terminals may be used by the customer to provision an E-Stop button, for example, which can be activated to place the system in a standby state. Refer to *Controlling the Circuit Breaker on page 110* for more information.

NOTE: Remote shutdown is software-driven functionality that may not comply with emergency stop regulations in all locales. Check with the local codes and AHJ before using this functionality to provision an E-Stop button.

5.6.5 Remote Shutdown in Islanding Applications

Systems used in islanding applications may be configured to provide an additional source of power in the absence of utility power. Therefore, an additional means may be required to prevent the Megapack System from creating a hazardous situation by introducing unexpected power to interconnected equipment during emergency response.

Using the remote shutdown terminals or a locally accessible human machine interface (HMI), an E-Stop button shall prevent the connected Megapack unit from providing an additional source of power to interconnected equipment. Tesla strongly recommends the E-Stop be readily accessible to emergency responders.

NOTE: As a best practice, add any E-Stop information to the *Emergency Response Site Information Form* and use that to inform local fire authorities about this functionality at your site.

5.7 Customer Interface

All of the interface customers require for installation, operation, and maintenance is located in the Customer Interface Bay, which contains:

Figure 70. Customer Interface Bay

1. *Megapack AC Circuit Breaker on page 106*
2. *Customer I/O Area on page 111* – where all terminations aside from AC bus bars are made
3. *AC Bus Bar Area on page 112* – where terminations to the site distribution transformer or AC distribution panel are made
4. Wireway openings

Installation procedures within the Customer Interface Bay are described in *Installing Customer Connections on page 134*. Safety disconnect features are described in *Safety Disconnect Features on page 103*.

5.7.1 Megapack AC Circuit Breaker

The Customer Interface Bay contains the Megapack AC circuit breaker, a pre-installed circuit breaker that provides distribution system protection.

NOTE: Additional protection or switching means at the output of the Megapack may be required depending on the jurisdiction. Protection and switching philosophy must be verified by the customer's engineer of record and should comply with regional and local codes.

Figure 71. Megapack AC Circuit Breaker – UL 489

Table 60. Megapack AC Circuit Breaker Specifications – UL 489

Model	UL 489 Siemens WL model with an ETU745 programmable protection unit
Manufacturer Documentation	Siemens Low Voltage WL Circuit Breakers: *https://new.siemens.com/us/en/products/energy/low-voltage/low-voltage-circuit-breakers/wl-power-circuit-breakers.html*→ *UL 489* content
Control Power	A separate power source is not required. While operating normally (above 0% state of energy and not faulted), power is provided by the battery modules. If a separate power source is desired, jumpstart power can also be used.
Button Location	1818 mm (71.6 in) from the base of the Megapack. If the chosen foundation will place these buttons outside of local regulatory height requirements, ensure that another method of compliance is provided (such as raised workstation or remote open/close terminals).
Spring Charge	Megapack comes standard with motor to allow automatic charging of the spring-loaded breaker. The circuit breaker spring may also be manually charged for actuation.
Part Number	• Option code BB02: L2F330WGJAXEACN • Option code BB01: L2F316TGJAXEACN Refer to the unit's label (*Megapack Labels on page 21*) for the option code and the *Megapack 2 XL Option Codes Quick Reference Guide* for more information.

Figure 72. Megapack 2 XL Circuit Breaker – UL 1066

Table 61. Megapack AC Circuit Breaker Specifications – UL 1066

Model	UL 1066 Siemens WA model with an ETU600 programmable protection unit
Manufacturer Documentation	Siemens Low Voltage WA Circuit Breakers: *https://www.siemens.com/us/en/products/energy/low-voltage/low-voltage-circuit-breakers/3wa-power-circuit-breakers.html*→ *UL 1066* content
Control Power	A separate power source is not required. While operating normally (above 0% state of energy and not faulted), power is provided by the battery modules. To view the ETU600 screen, power must be supplied from laptop and/or portable power supply via USB-C port.
Button Location	1818 mm (71.6 in) from the base of the Megapack. If the chosen foundation will place these buttons outside of local regulatory height requirements, ensure that another method of compliance is provided (such as raised workstation or remote open/close terminals).
Spring Charge	Megapack comes standard with motor to allow automatic charging of the spring-loaded breaker. The circuit breaker spring may also be manually charged for actuation.
Part Number	• Option code BB02: 3WA3232-5AF02-2KA5-Z B30+D80+F40+P61+S40 • Option code BB01: 3WA3216-5AF02-2KA5-Z B30+D80+F40+P61+S40 Refer to the unit's label (*Megapack Labels on page 21*) for the option code and the *Megapack 2 XL Option Codes Quick Reference Guide* for more information.

5.7.1.1 Programming the Circuit Breaker

The circuit breaker is pre-configured with default trip settings. **At no point should settings greater than the defaults indicated in the table below be programmed without Tesla's permission.** If settings less than the table below are to be used for additional system protection, these settings may be programmed on-site according to site-specific plans or engineering guidance from the engineer of record. The electronic trip unit (ETU) has configurable settings for LSIG trip functionality – long-time overcurrent protection (L), short-time delayed overcurrent protection (S), instantaneous overcurrent protection (I), and ground-fault protection (G) – and other features as noted below.

Table 62. Default Circuit Breaker Trip Settings – UL 489

Trip Setting	Option Code BB02	Option Code BB01
Frame size	II - (3000 A)	II - (1600 A)
I_n (plug rating) (Uses the same delay as t_r, long-time delay)	3000 A	1600 A
I_r (long-time current)	1 (3000 A)	1 (1600 A)
t_r (long-time delay)	2 sec (18000 A)	2 sec (9600 A)
I_{sd} (short-time current)	1.25 (3750 A)	1.25 (2000 A)
t_{sd} (short-time delay)	0.1 sec (I^2t=On)	0.1 sec (I^2t=On)
I_i (instantaneous current)	1.5 (4500 A)	1.5 (2400 A)
I_g (ground-fault current)	A (100 A)	A (100 A)
t_g (ground-fault delay)	0.1 sec (I^2t=Off)	0.1 sec (I^2t=Off)
Ground-fault toggle switch	Σ*I*	Σ*I*

Table 63. Default Circuit Breaker Trip Settings – UL 1066

Trip Setting	Option Code BB02	Option Code BB01
Frame size	II - (3000 A)	II - (1600 A)
I_n (plug rating) (Uses the same delay as t_r, long-time delay)	3000 A	1600 A
I_r (long-time current)	1 (3000 A)	1 (1600 A)
t_r (long-time delay)	2 sec (18000 A)	2 sec (9600 A)
I_{sd} (short-time current)	2.5 (7500 A)	2.5 (4000 A)
t_{sd} (short-time delay)	0.1 sec (I^2t=On)	0.1 sec (I^2t=On)
I_i (instantaneous current)	1.5 (4500 A)	1.5 (2400 A)
I_g (ground-fault current)	A (100 A)	A (100 A)
t_g (ground-fault delay)	0.1 sec (I^2t=Off)	0.1 sec (I^2t=Off)
GF residual (ground-fault detection method)	On	On

5.7.1.2 Controlling the Circuit Breaker

A circuit breaker is either closed, allowing electricity to flow, or it is open, preventing the flow of electricity. Upon fault detection, the circuit breaker will trip to open state to isolate the Megapack. Megapack will only close the circuit breaker if the system has been deemed safe by Megapack firmware, based on the information provided by its status circuits:

- Enable circuit (*Enable Circuit on page 104*)
- Remote shutdown circuit
- Breaker close circuit

Generally, if all three of these status circuits are closed, the Megapack AC circuit breaker will close. Conversely, if any one of these status circuits are open, the breaker will not close.

A Megapack's circuit breaker can be controlled in three ways:

Table 64. Control Method Summary

Control Method	Open Circuit Breaker	Close Circuit Breaker
Manual (*Opening and Locking the Megapack AC Circuit Breaker on page 120*)	Open button	Close button
DNP3 (*Controlling the Circuit Breaker using DNP3 on page 110*)	Point = Open Megapack Breaker	Point = Close Megapack Breaker
Remote (*Customer Interface Board on page 111*)	Remote shutdown terminals	Breaker close terminals

5.7.1.3 Controlling the Circuit Breaker using DNP3

When enabled by Tesla at commissioning, customers can control the Megapack AC circuit breaker on each unit. This feature is only available on the DNP3 interface, not on REST API and Modbus. The Tesla System Controller uses the DNP3 Latch model.

Work with your project engineer while designing the site to understand the ramifications for your project. You can also view the status of the Megapack AC circuit breaker over DNP3. For more information, see the *Controls and Communications Manual*.

Table 66. Breaker Control Points

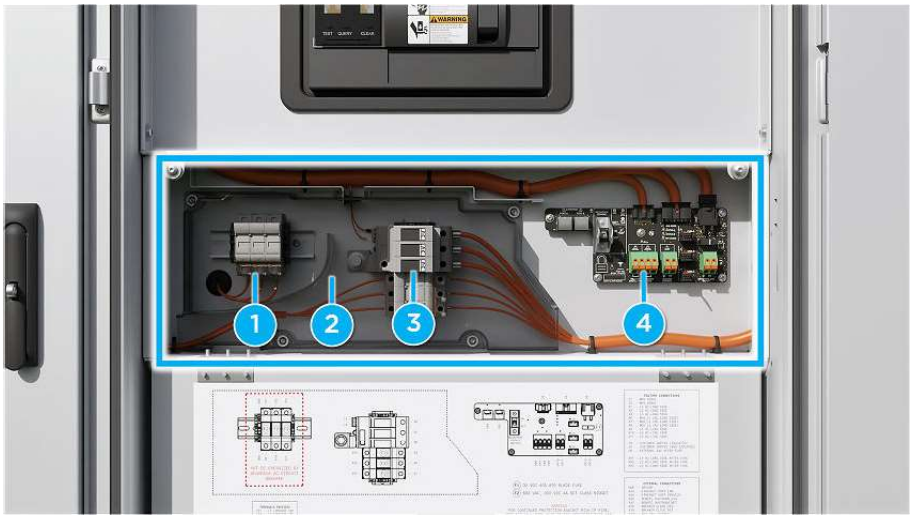
Point Label	Usage
Open Megapack Breaker	Write to 1: Opens the Megapack AC circuit breaker. Must be configured by Tesla at commissioning.
Close Megapack Breaker	Write to 1: Closes the Megapack AC circuit breaker.
Disable Megapack	Write to 1: Brings all battery modules into standby state and brings the thermal HVDC bus down **Warning:** This does not replace the need for operators to follow proper de-energization procedures. Refer to *Performing Lockout/Tagout on page 118* for more information

5.7.2 Customer I/O Area

Each Megapack includes a single customer interface (I/O) area consisting of a wiring compartment inside the Customer Interface Bay. This compartment contains all the necessary non-power connections to be made to the Megapack. The compartment is behind a tool-accessible door and shall only be accessed during operation while following site safety procedures. See *Terminating Auxiliary DC Power Conductors and Communications Cables on page 138* to terminate wiring in this area.

The customer I/O area is partially pre-wired. Only some on-site wiring is needed depending on the project needs as referenced below.

Figure 73. Customer I/O Area Components



1. Line-side (grid-side) tap (see *Performing Lockout/Tagout on page 118*)
2. Touch-safe cover
3. Load-side (inverter-side) tap (see *Performing Lockout/Tagout on page 118*)
4. Customer interface board (see *Customer Interface Board on page 111*)

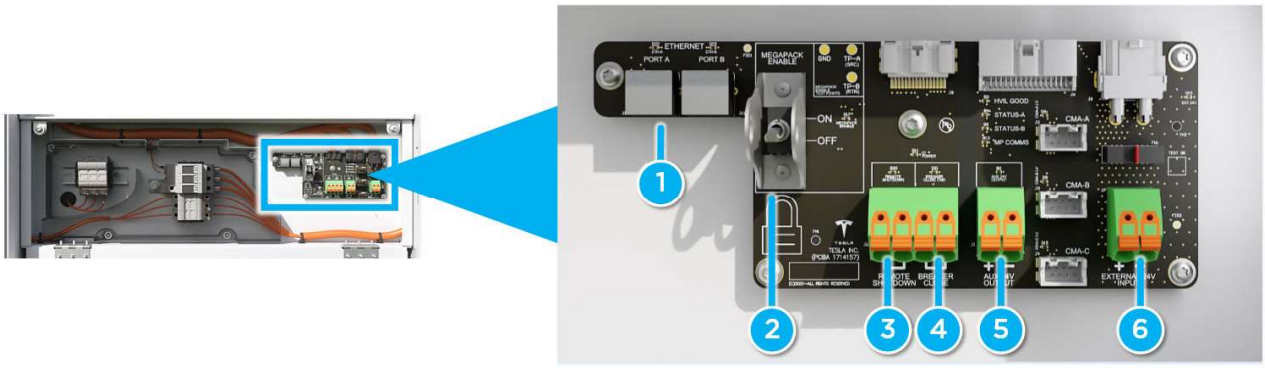
5.7.2.1 Customer Interface Board

The customer interface board contains terminals for Tesla use, terminals for external connections, and the Megapack enable switch.

CAUTION: All terminals in this area should be limited to 24 V. **Do not wire higher voltage in this area.** Wiring higher voltage into this area risks damage to terminals and internal components.

CAUTION: Certain terminals have polarity as indicated on the board. Failure to observe polarity when wiring risks damage to terminals and internal components.

Figure 74. Customer Interface Board Detail



1. **Ethernet ports A (communications) and B (service):** See *Network and Internet Considerations on page 60* and *Terminating Auxiliary DC Power Conductors and Communications Cables on page 138*.
2. **Enable switch:** See *Enable Switch on page 104* and *Performing Lockout/Tagout on page 118*.
3. **Remote shutdown:** A pair of terminals that create an integrated 20 mA DC signal circuit used to enable remote shutdown capability. See *Safety Disconnect Features on page 103* and *Controlling the Circuit Breaker on page 110*.

   These terminals ship with a jumper installed, meaning the circuit is closed by default. Removing the jumper commands a remote shutdown by opening the circuit. Closing the circuit must be done in a manner that mimics a jumper.

   NOTE: Do not apply a wetting voltage, as the remote shutdown circuit cannot share a common/return with other circuits.

4. **Breaker close:** A pair of terminals that create an integrated 20 mA DC signal circuit used to close the Megapack AC circuit breaker. See *Controlling the Circuit Breaker on page 110*.

   These terminals ship without a jumper installed. Installing a jumper will close the circuit and allow the Megapack AC circuit breaker to close, if the Megapack deems it safe to do so. Opening the circuit will NOT trip the breaker. Closing the circuit must be done in a manner that mimics a jumper.

   NOTE: Do not apply a wetting voltage, as the breaker close circuit cannot share a common/return with other circuits.

5. **Auxiliary 24 V DC output:** A pair of terminals used to supply 24 V DC power to external devices. See *DC Power Requirements on page 95* for wiring design.
6. **External 24 V DC input:** A pair of terminals that accept input of 24 V DC. Fused at 40 A. Wiring specification: Maximum 10 AWG (6 mm^2); minimum 100 W power supply.

5.7.3 AC Bus Bar Area

Megapack is provided with three tin-plated aluminum AC bus bars to connect three phases with conductors with a maximum of 1000 MCM (500 mm^2) per connection using NEMA 1.75-in, 2-hole studs, with a maximum pad thickness of 16 mm (⅝ in). Quantities of connections differ per configuration:

- 2-Hour Megapack: Up to 9 connections per phase
- 4-Hour Megapack: Up to 6 connections per phase

NOTE: Per ANSI/NEMA CC 1, the distance between studs is 45 mm (1 ¾ in). For detailed drawings, refer to the *Megapack 2 XL Drawings* on the Partner Portal.

The procedure to connect conductors is described in *Wiring the AC Conductors on page 135*.

6 Transporting Megapack

These sections provide high-level information and warnings about transportation. Refer and adhere to instructions in *Megapack 2 XL Transportation and Storage Guidelines* to ensure safety of personnel and equipment during transit, staging and storage.

6.1 Logistics and Shipping Guidance

The Megapack enclosure is similar to an ISO standard shipping container despite its custom dimensions. Megapack has six compliant ISO 1161-type lifting points called *ISO fittings* for effective rigging and to aid transportation and logistics (see *Megapack 2 XL Drawings* for reference). Megapack arrives on-site on a trailer pulled by a truck, and can be offloaded by lifting from these six ISO fittings. Depending on site constraints and lifting equipment, additional rigging (such as spreader bars and shackles) may be required.

Refer to the *Megapack 2 XL Transportation and Storage Guidelines* for additional details, including guidance on shipping and transportation, packaged dimensions and weights, allowed storage conditions, and shipping guidance for land and sea. Air transportation is not currently possible with Megapack.

Refer to *Emergency Response Guide on page 25* for additional critical shipping information.

CAUTION: Tesla battery systems are subject to specific transportation and storage conditions. Failure to adhere to the conditions listed in the system-specific transportation and storage guidelines may void the warranty.

6.2 Unloading

The installation contractor is responsible for arranging for unloading Megapack at the site (*Roles and Responsibilities on page 8*). Refer to *Megapack 2 XL Transportation and Storage Guidelines* for additional details about the requirements in this section.

DANGER: Do not attempt to load or unload Megapack without reading, understanding, and following all instructions. Failure to use proper equipment and procedures may result in improper loading, severe damage to equipment, and injury or death to personnel.

WARNING: Ensure proper working at heights procedures are followed if personnel need to work on the Megapack roof.

WARNING: When loading and unloading equipment, use suitable lifting equipment and lifting techniques for the weights as specified.

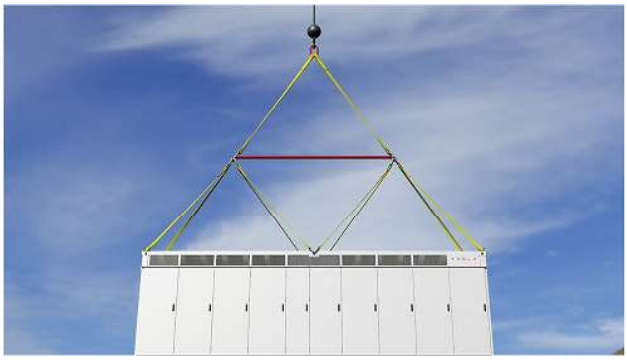
WARNING: Prior to installation, inspect the unit to ensure the absence of transport or handling damage which could affect the integrity of the product. Failure to do so could result in safety hazards. Unauthorized removal of necessary protection features, improper use, or incorrect installation or operation may lead to serious safety and shock hazards and/or equipment damage.

CAUTION: Megapack must be kept upright at all times. Equipment cabinets contain coolant that could leak and sensitive equipment that could become damaged if not positioned upright.

6.2.1 Craning

When lifting by a crane, Megapack must be lifted using all top six (6) ISO fittings ONLY. Straps, shackles, and a spreader bar should be used as deemed necessary by the crane operator.

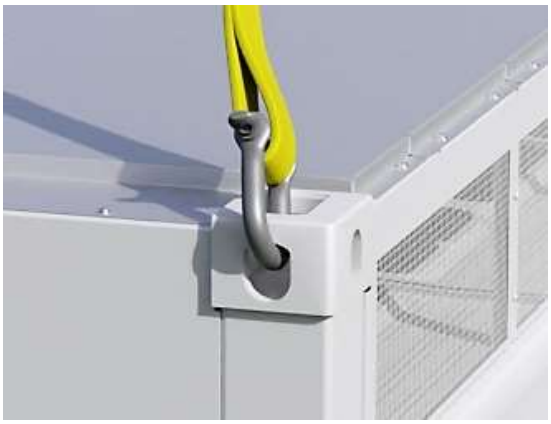
Figure 75. Lifting Using Straps and a Spreader Bar



Some appropriately rated shackles may not fit within the ISO fittings. In this case, crane operators may use straight rather than curved shackles, drop-in ISO fitting lifting adapters such as the Tandemloc 20901AA series, or other appropriately rated devices.

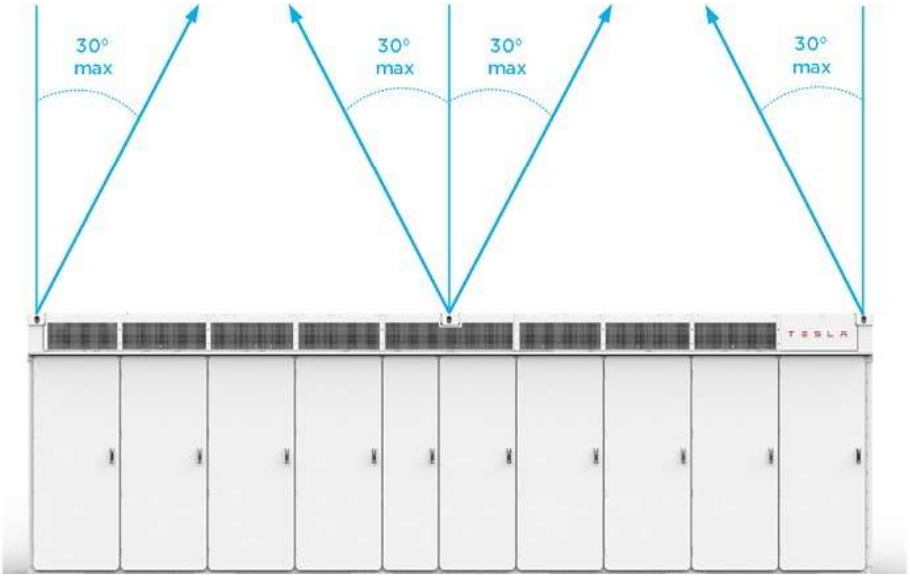
As a best practice, the shackle should be pointed in the upwards direction, as illustrated below.

Figure 76. Shackles Installed in the ISO Fittings in the Upward Direction



Rigging angles from the Megapack connections should not exceed 30 degrees from vertical, as shown in the figure below. Megapack should not be tilted more than five (5) degrees from horizontal at any point during the lifting process.

Figure 77. Rigging Angles



WARNING: Ensure lifting equipment is rated appropriately for lifting and moving Megapack. Use of insufficiently rated/designed equipment will result in failure to move the Megapack properly, and may cause damage to equipment or injury/death to personnel.

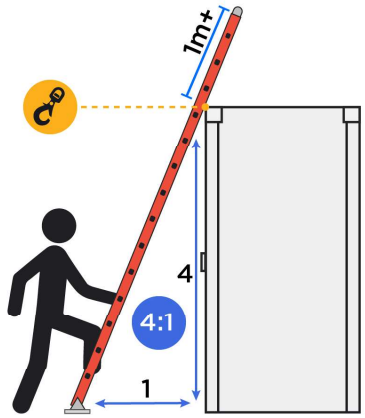
6.2.2 Accessing the Lifting Points

Megapack's ISO fittings are located on the roof of the Megapack unit. Reaching these lifting points requires ladders or other equipment. Lifting points are typically accessed when using a crane to lift the unit directly from the trailer.

When using an extension ladder in order to access Megapack's roof, observe the following guidance:

- The top of the ladder must extend at least 1000 mm (40 in) beyond the top of Megapack, as illustrated below
- The base of the ladder must be secure, with its feet on a firm, level surface
- The ladder must be positioned with a 4:1 ratio in accordance with the 4-to-1 rule
- The ladder should be secured to the Megapack or held in place by a second person

Figure 78. Proper Extension Ladder Placement



6.3 Staging

Schedule Megapack delivery to minimize long-term storage on-site. Refer to the requirements in the *Megapack 2 XL Transportation and Storage Guidelines*.

If short-term storage is required before the Megapack can be installed, refer to the procedure in *Configuring for Short-Term Storage on page 149*.

WARNING: Do not store or operate Megapack in temperatures over 50C (122F).

7 Accessing the Megapack Enclosure

Megapack is an IP66-rated enclosure (*Enclosure on page 16*) and affords high protection against particle and water ingress. This section contains critical information about when and how to properly access Megapack in order to both maintain its high protection rating and to provide a safe work environment.

After preparing site infrastructure and before beginning work on installing Megapack that involves accessing its enclosure, or any time you need to access the enclosure, ensure that all information in this section is taken into account.

7.1 Critical Door-Opening Considerations

Do NOT open a Megapack's doors in any of the conditions below.

CAUTION: Megapack doors should never be opened when it is actively raining or snowing, with no exceptions, to prevent damage to Megapack.

Do NOT Open Megapack Doors When:		
Actively raining or snowing. 	Wind speeds 25 MPH or higher. Wind speed must be monitored. 	Airborne dust and debris present on site. 

CAUTION: When opening a Megapack door, do not force its door handle. Excessive torque could damage the handle. If the handle does not readily rotate, contact Tesla for assistance.

7.2 Performing Lockout/Tagout

If you need to work inside a Megapack, you must first de-energize the unit by performing the lockout/tagout procedure (LOTO). The LOTO procedure for Megapack consists of the tasks below, which must be performed in order:

1. *Isolating Megapack from Upstream AC Sources on page 119*
2. *Opening and Locking the Megapack AC Circuit Breaker on page 120*
3. *Turning the Enable Switch Off on page 122*
4. *Verifying Load-Side De-Energization on page 123*
5. *Verifying Line-Side De-Energization on page 124*

DANGER: Refer to *IMPORTANT SAFETY INFORMATION on page 3* for information on safety warnings and PPE recommendations before beginning any work on Megapack.

NOTE: Only Service Providers shall perform any corrective maintenance within the Megapack.

NOTE: Some equipment isolation can be performed by sending commands using the Tesla System Controller or other SCADA devices. For more information, see the *SCADA Design Manual* or the *Controls and Communications Manual – Tesla System Controller*, or reach out to your Tesla project engineer.

NOTE: When active work is **not** being performed, and AC grid power can be restored to the AC output terminals, Tesla recommends that the enable switch remains **on**.

7.2.1 Isolating Megapack from Upstream AC Sources

Megapack may need to be isolated from upstream AC sources, including other Megapacks, before performing work. Isolating Megapack is required if work is being performed in the AC bus bar area or if the arc flash incident energy values exceed the maximum allowed.

To determine arc flash incident energy, check the arc flash label on the outside of the Customer Interface Bay door (*Providing the Arc Flash Label on page 141*). The arc flash label contains information about expected arc flash incident energy and recommended PPE.

Figure 79. Arc Flash Label -- Danger and Warning Examples

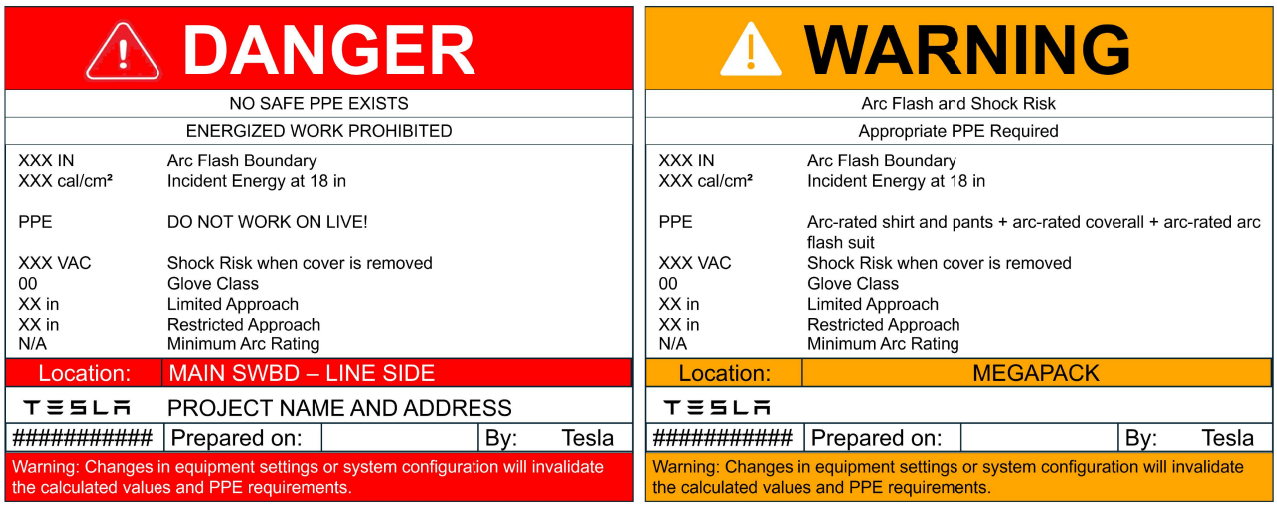


Table 67. Maximum Allowable Arc Flash Incident Energy

All Regions
14 cal/cm^2

If the label specifies either that no safe PPE exists or the arc flash incident energy exceeds the maximum allowed per the table above, you must first ensure that external AC power is removed from the Megapack by opening the upstream AC disconnect before continuing the LOTO procedure.

Customers must employ a protection scheme that does not exceed maximum allowable energy. For recommended protection schemes, refer to the *Application Note: Electrical Protection Architecture*. Customers must adhere to Telsa-required administrative controls when using relays as the protection scheme. For more information, refer to the *Application Note: Medium-Voltage Transformer Relay Program*.

If the label specifies that the arc flash incident energy falls below the maximum allowed, opening an upstream AC disconnect is not required unless work is being performed in the AC bus bar area or if it is required by a Service Provider. Follow the recommended PPE and other details on the label and then continue the LOTO procedure.

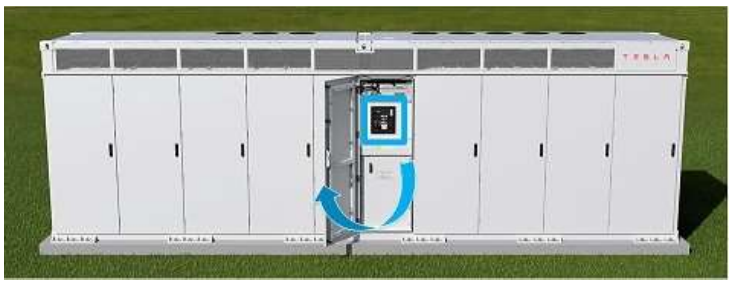
NOTE: Arc flash labels are applied after installation and wiring have taken place. If the AC conductors have not yet been terminated per *Wiring the AC Conductors on page 135*, Megapack does not need to be isolated before proceeding with LOTO.

DANGER: If no arc flash label exists and Megapack has already been commissioned and is operating, all upstream devices must be completely de-energized before work can take place. Contact your site owner or Tesla about the arc flash label requirement.

7.2.2 Opening and Locking the Megapack AC Circuit Breaker

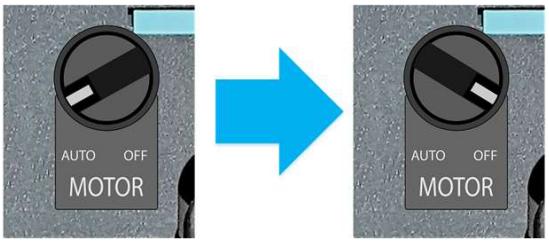
Perform this procedure only after *Isolating Megapack from Upstream AC Sources on page 119*.

1. Assess the steps in *Critical Door-Opening Considerations on page 118* and proceed if conditions allow.
2. Open the Customer Interface Bay door to access the Megapack AC circuit breaker:

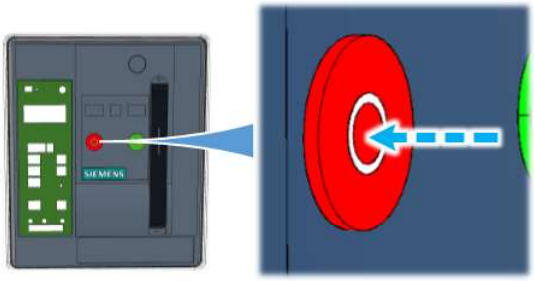


1 – Lock ring. 2 – Motor switch (some models). 3 – Contacts window. 4 – Open button. 5 – Spring-loaded lever.

3. If present, turn the motor switch from **auto** to **off**:

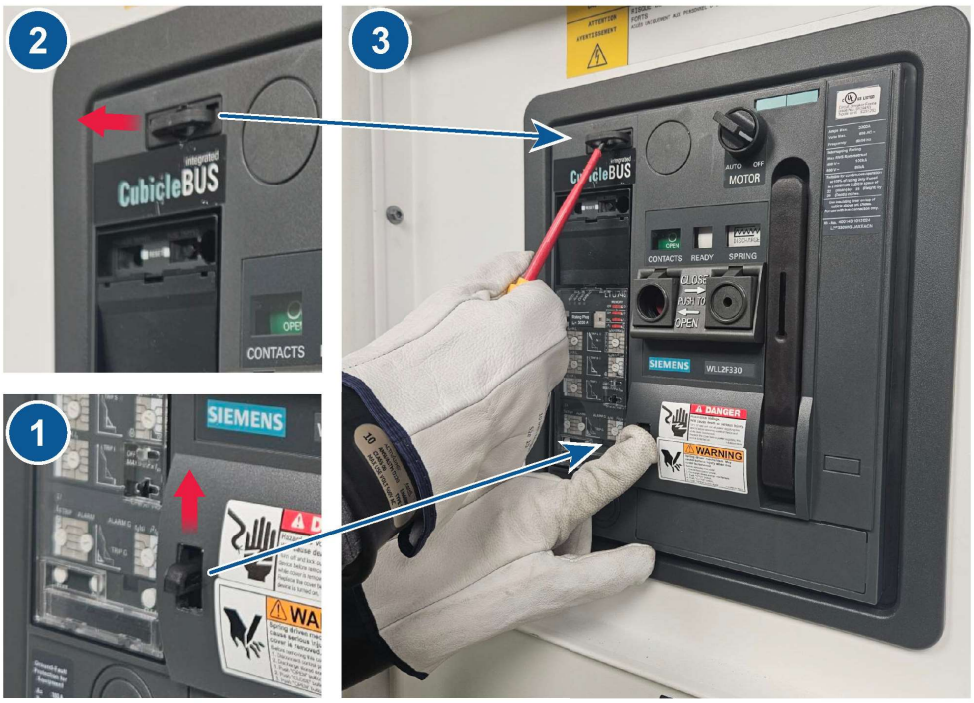


4. Open the breaker by pressing the red open button firmly until it clicks. When the breaker is open, the contacts window displays green and **OPEN**:

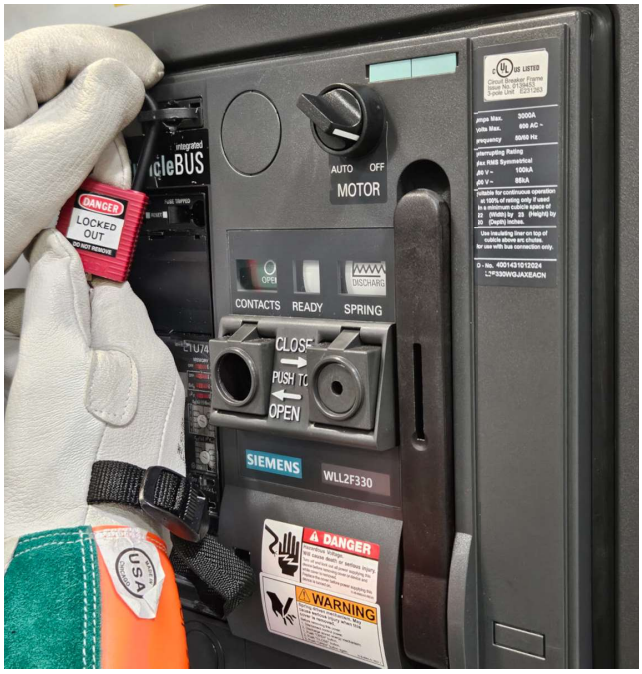


NOTE: Pressing the button manually opens the breaker. You may use other methods to open the Megapack AC circuit breaker (*Controlling the Circuit Breaker on page 110*).

5. Push up on the spring-loaded lever (1) to unlock the lock ring (2), and use a flat-head screwdriver to pull out the lock ring: (3):



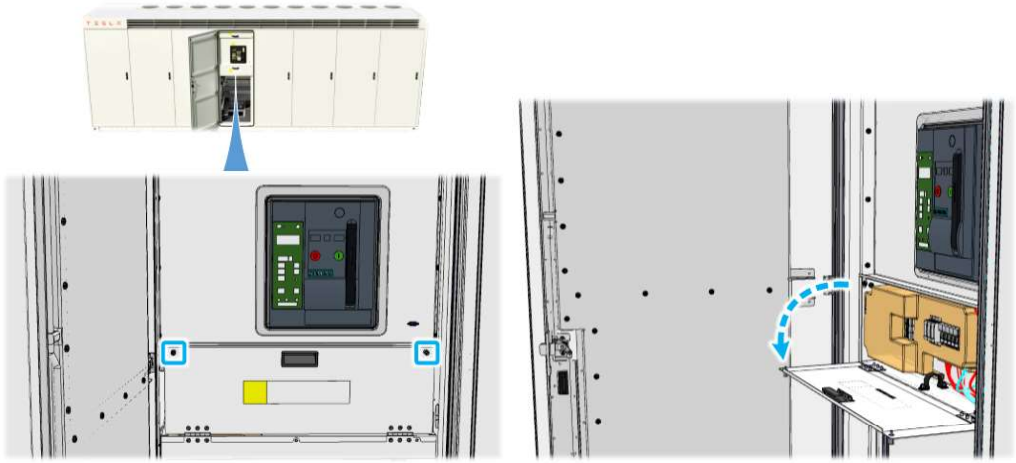
6. Insert the lock and lock it to secure the Megapack AC circuit breaker:



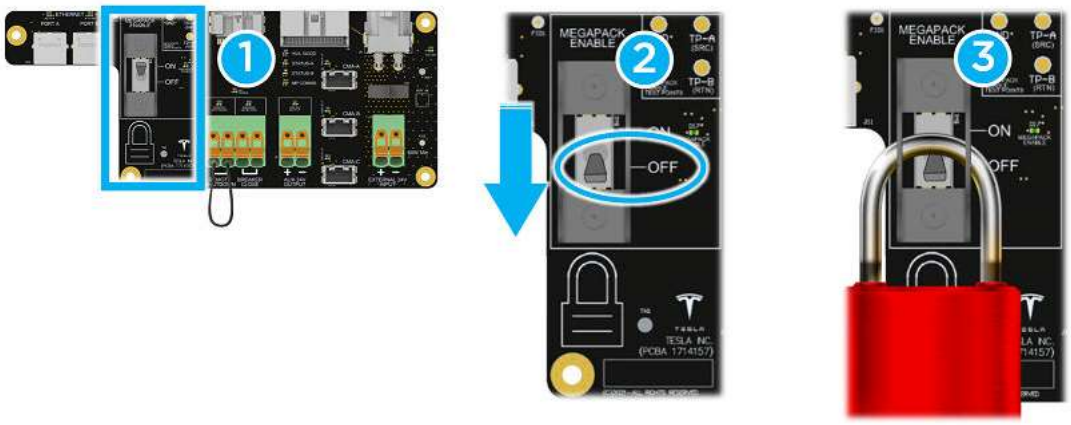
7. If isolation is required per *Isolating Megapack from Upstream AC Sources on page 119* and more than one Megapack is connected to the same circuit or transformer, repeat this procedure for each Megapack.

7.2.3 Turning the Enable Switch Off

1. Use a T30 Torx bit to remove the 2 screws securing the customer I/O area cover to the enclosure. Grab the handle and pull outward, then downward to expose the customer I/O area:



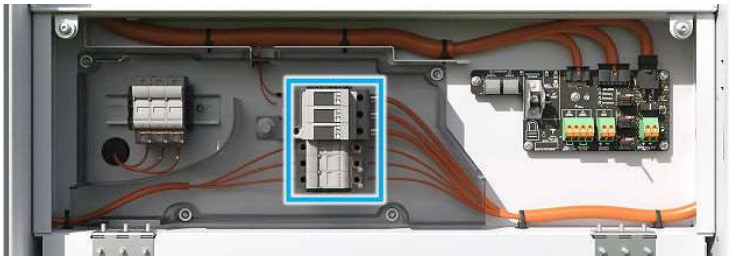
2. The Megapack enable switch is located on the customer interface board (1). Press **down** to turn the enable switch to the **off** position (2), and apply a lock (3):



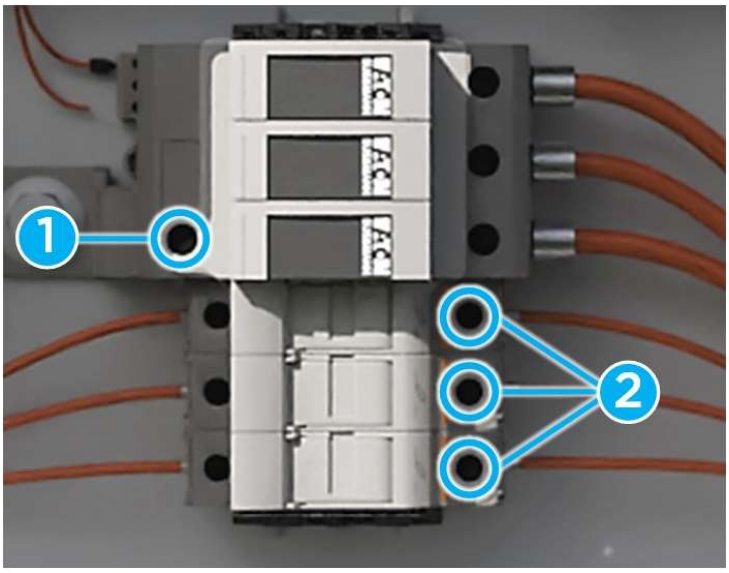
7.2.4 Verifying Load-Side De-Energization

NOTE: This check for dead should only take place after all previous steps were successfully completed.

Check the load-side (inverter-side) voltage in the customer I/O area at the terminals indicated below:



1. Using a CAT IV voltmeter rated for 1000 V AC, first verify the voltmeter on a known live source.
2. Measure AC phase-to-phase and phase-to-ground voltage at the load-side test points as shown below:



1 – Ground. 2 – Phase test points.

3. Confirm that the voltage is 0 V AC.

> **WARNING:** You may initially measure greater than 0 V AC due to residual capacitive energy. Stop and wait five minutes before testing again. **Do not proceed unless you have measured 0 V AC.**

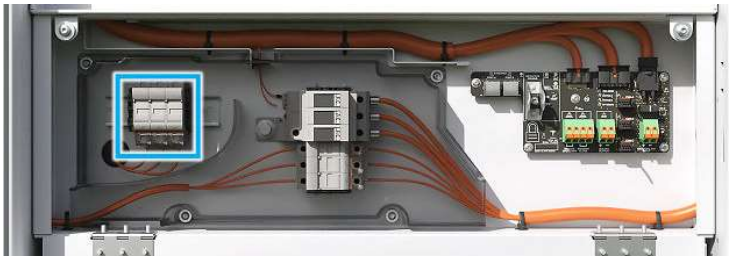
4. Re-verify the voltmeter on known live source.
5. Repeat the above, now measuring DC voltage.

> **NOTE:** You will measure a voltage of up to 50 V DC. This is normal and expected. If voltage above 50 V DC is detected, stop and contact Tesla.

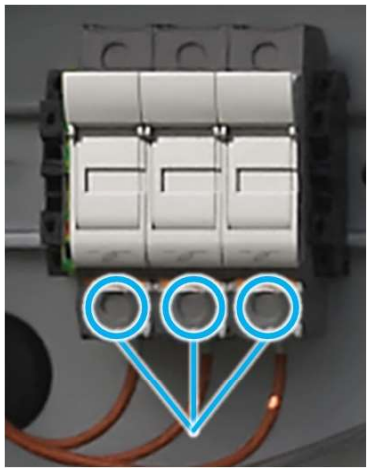
7.2.5 Verifying Line-Side De-Energization

> **NOTE:** This check for dead should only take place after all previous steps were successfully completed.

If isolation is required per *Isolating Megapack from Upstream AC Sources on page 119*, check the line-side (grid-side) voltage at the line-side tap in the customer I/O area:



1. Open the fuse holder for the line-side tap.
2. Using CAT IV voltmeter rated for 1000 V AC, first verify the voltmeter on a known live source.
3. Measure AC phase-to-phase and phase-to-ground voltage at the line-side test points as shown below:



4. Confirm that the voltage is 0 V AC.

   WARNING: You may initially measure greater than 0 V AC due to residual capacitive energy. Stop and wait five minutes before testing again. **Do not proceed unless you have measured 0 V AC.**

   NOTE: If upstream isolation was **not** required per *Isolating Megapack from Upstream AC Sources on page 119*, you may measure a nominal voltage.

5. Re-verify the voltmeter on known live source.

7.3 Accessing the AC Bus Bar Area

The AC bus bar area is located behind the bus bar access panel, which must be removed with a tool using the procedure below.

1. Assess the steps in *Critical Door-Opening Considerations on page 118* and proceed if conditions allow.
2. Lockout/tagout (*Performing Lockout/Tagout on page 118*).

   DANGER: BATTERIES ARE ALWAYS LIVE. Even before installation, any time you are actively working on Megapack, you must take the proper precautions to ensure that you have controlled electrical hazards using the Megapack lockout/tagout procedure.

3. Use a 13 mm socket ratchet to remove the 10 screws securing the bus bar access panel to the enclosure.
4. Remove the bus bar access panel.

5. Wait at least five minutes before entering the AC bus bar area.

CAUTION: At all times when performing work inside the AC bus bar area, leave the access panel off and bay door open.

7.4 Handling Desiccant

The AC bus bar area ships with several large bags of desiccant. Remove the bags while working in the area. After work is complete, return as many bags to the area as possible, and dispose of excess bags normally.

CAUTION: Do not place desiccant bags in direct contact with or secured to the AC bus bars.

7.5 Megapack Door Security

All Megapack doors have the provisions for the use of a padlock. The Customer Interface Bay (*Customer Interface Bay on page 16*), as the primary customer interface for Megapack, is recommended to be locked. The other doors do not need regular access and should remain closed and locked.

NOTE: Access to the Customer Interface Bay may be subject to local codes and regulations.

Installing Locks

Combination locks are shipped with Megapack, either pre-installed on Megapack doors or delivered in the accessory kit (see *Accessory Kit on page 128*). Install these locks to ensure doors are not left open unnecessarily:

- **Set combination to 4585** for coordinated access with Service Providers. Tesla must have ability to unlock doors. If you choose a different combination, advise your Tesla contact in writing.
- For keyed locks, a double hasp is required to allow Tesla access by unlocking Tesla's lock.

8 Installing Megapack

CAUTION: Do not modify the outer enclosures of any Megapack component. Modification of any sort voids the warranty, as well as the certification and UL/NRTL listing provided with the product.

NOTE: For an abridged, mobile-friendly version of the installation instructions, refer to the *Megapack 2 XL Installation Guide*.

8.1 Preparing for Installation

Before beginning installation procedures, the installation crew must validate aspects of site design and ensure that the site is prepared, minimally as described in this section. Always refer to your engineer of record and plans for each specific site.

Table 68. Site Validation

Site Consideration	Task
IP66 Enclosure Integrity	Ensure that installation crew is advised of critical enclosure access considerations (*Accessing the Megapack Enclosure on page 118*) and of enclosure sealing requirements during work (*Sealing the Wireway Openings on page 140*) **CAUTION:** If any evidence of moisture is present inside the enclosure, reach out to your Tesla representative.
Tools and Accessories	Ensure that required tools and accessories are available including *Installation Accessories on page 128*
Foundation	Validate foundation per *Foundation Design on page 81*
Clearance	Validate clearance requirements per *Megapack Clearance on page 84*
Wiring Infrastructure	Inspect the wiring infrastructure as per *Wiring Interface Summary on page 90*. If connections cannot be provided as planned, contact Tesla to discuss alternatives. Tesla must review the non-standard installation before work begins.
Electrical Control Plan	Review the *Electrical Control Plan on page 103*.
Service Accessibility	Validate service accessibility per *Service and Maintenance Considerations on page 88*
Road Condition Requirements	Verify that site roads along the delivery route are in good working order and free of potholes, rutting, washouts, vehicle traffic, and any other surface hazards of concern (*Delivery Considerations on page 87*)
Fencing and Barriers	Inspect fencing and barriers per *Fencing and Barriers on page 87*
Emergency Response Guide	Ensure that the latest revision of the Emergency Response Guide (ERG) is available at the site (*Emergency Response Guide on page 25*)
Compliance	**CAUTION:** Ensure that all installations comply with the appropriate local fire, electrical, and building code requirements.

8.2 Inspecting Delivered Units

Transportation, installation, and operation of the Megapack unit can result in minor or cosmetic imperfections on the unit. Such imperfections are not damaging to the unit and do not usually require remediation. The following table provides guidance to help determine what conditions may be considered minor, what should be considered for remediation, and how to respond.

Table 69. Megapack Imperfection or Damage Classifications

Condition	Classification	Possible Remediation
Imperfections in color or finish, or dirt on the Megapack unit.	Minor imperfection	None required. Customer may wash unit with automotive grade soap or automotive buffing compound for persistent discolorations.
Areas of bare metal less than 25 mm (1 in) diameter in size.	Medium damage	Customer should report to Tesla or remediate using touch up paint (*Touch-Up Paint on page 129*).
Leaking coolant, apparent water ingress, structural damage, mechanical failures.	Major damage	Contact Tesla if not already advised (*Contact Information on page 27*). Tesla to investigate on site or return unit.

DANGER: Refer to the *Industrial Lithium-Ion Battery Emergency Response Guide* for details on response to a hazardous event (*Emergency Response Guide on page 25*).

8.3 Installation Accessories

These accessories are shipped with Megapack and used in the installation process.

8.3.1 Installation Template

This template indicates the anchoring points of a single Megapack for easier anchor hole drilling for either stand-alone or back-to-back configurations. Refer to *Anchoring Megapack on page 130* for further instructions.

Table 70. Installation Template Part Numbers

Enclosure Variant	Part Number
-C enclosure	1807226-00-A
-D enclosure	1807226-00-B

8.3.2 Accessory Kit

Each Megapack ships with an accessory kit in a box inside the Customer Interface Bay (see *Preparing the Enclosure on page 129*). The items inside the kit and what they are used for are detailed below:

Table 71. Accessory Kit Contents

Part Number	Description	Use Case	2-Hour Quantity	4-Hour Quantity
1507926	M12 Bolt	Bolts for attaching lugs to external ground interface	8	8
1531223	M12 Nut	Nuts for attaching lugs to AC bus bars	70	52
1008644	M6 Bolt	Extra bolts for Customer Interface Bay door	2	2
1023878	Padlock	Padlocks for all doors	10	10

Part Number	Description	Use Case	2-Hour Quantity	4-Hour Quantity
1075744	40 A Blade Fuse	Spare fuses for customer interface board	2	2
1493272	Push Mount Cable Tie	Cable ties for harness routing in Customer Interface Bay	10	10
1553361	M8 Bolt	Extra bolts for bus bar access panel	2	2

8.3.3 Anchoring Hardware

Anchor washers ship in an additional box inside the Customer Interface Bay (see *Anchoring Megapack on page 130*).

Table 72. Anchoring Hardware Part Numbers

Part Number	Description	QTY
1531294-00-B	Anchor washers	24

8.3.4 Touch-Up Paint

Each site will be provided with touch-up paint in case of cosmetic damage during the installation process. The paint should only be used on external metal surfaces – do not apply paint to internal components or non-metal components. If damage is observed beyond what the touch-up paint can fix, please contact Tesla.

Table 73. Paint Part Numbers

Part Number	Description
1509391-00-A	Primer
1117378-00-A	Paint

See color information in *Enclosure Colors on page 68*.

8.4 Preparing the Foundation

After preparing the site infrastructure including inspecting the foundation, prepare the foundation for installation, using the Megapack installation template as a guide (see *Installation Template on page 128*).

Many common foundation anchors require a hole to be drilled in the foundation. Depending on the tool used, this may need to be done prior to lifting and placing Megapack (see *Anchoring Megapack on page 130*).

8.5 Preparing the Enclosure

Prepare the enclosure before lifting, positioning, and anchoring Megapack.

NOTE: Refer to *Megapack 2 XL Drawings* on the Partner Portal for exact dimensions.

CAUTION: Megapacks are available in many configurations and can differ based on characteristics such as power or energy rating and weight.

To prepare the enclosure, first locate and validate the enclosure configuration to be installed at the given site location.
The Megapack enclosure is now ready to be lifted and set onto the foundation.

8.6 Lifting and Positioning the Enclosure

Use these instructions to lift and position the enclosure. Follow the procedures in *Megapack 2 XL Transportation and Storage Guidelines* for additional details on lifting and positioning.

CAUTION: Modification of ISO fittings in any way is not permitted.

To lift and position the enclosure:

1. Using a lifting rig and crane, lift Megapack using the top six ISO fittings and locate it over the intended foundation in its designated area.

   CAUTION: Ensure that the lifting hardware has enough clearance to be removed once Megapack is properly positioned. Shackle pins may bind on neighboring Megapack if installed pin-side down.

2. Position the enclosure, taking any required anchor locations into account (see *Anchoring Megapack on page 130*).

8.7 Anchoring Megapack

Megapack may require anchoring to its foundation. If required by site design or the engineer of record, follow these instructions to anchor Megapack.

NOTE:

- Anchors can differ by site and are therefore not provided by Tesla. Stainless steel is required. Hilti KB-TZ SS wedge anchors or HAS-R 304/316 SS and Hilti HIT-HY 200 epoxy anchor system are recommended.
- Anchor washers are Tesla-provided, and are shipped in a box inside the Customer Interface Bay.
- Many common anchors can require holes to be pre-drilled into the foundation before anchoring. Ensure that the foundation has been properly prepared, if so (see *Preparing the Foundation on page 129*).
- Use the *Installation Template* to assist in this process (see *Installation Template on page 128*).
- Refer to the *Megapack 2 XL Drawings* on the Partner Portal for exact anchor and bracket specifications and dimensions.

8.7.1 Anchoring to Foundation

Anchor brackets are flanges welded on to the base of Megapack that can be used to hold it to its foundation. To anchor Megapack to its foundation:

1. Identify the required anchors and anchor brackets per site design, using the Installation Template and images below as a guide.

   CAUTION: Ensure that the Installation Template is thoroughly extended, with its ends pulled tight and the surface smoothed and wrinkle-free.

Figure 80. Available Anchor Brackets (-C Enclosure, -D Enclosure)

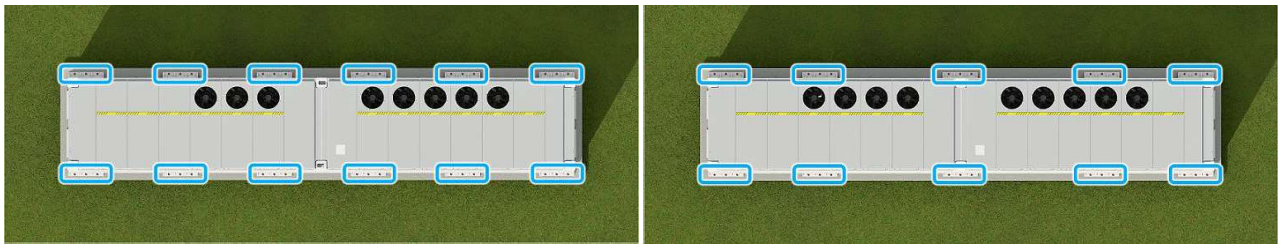
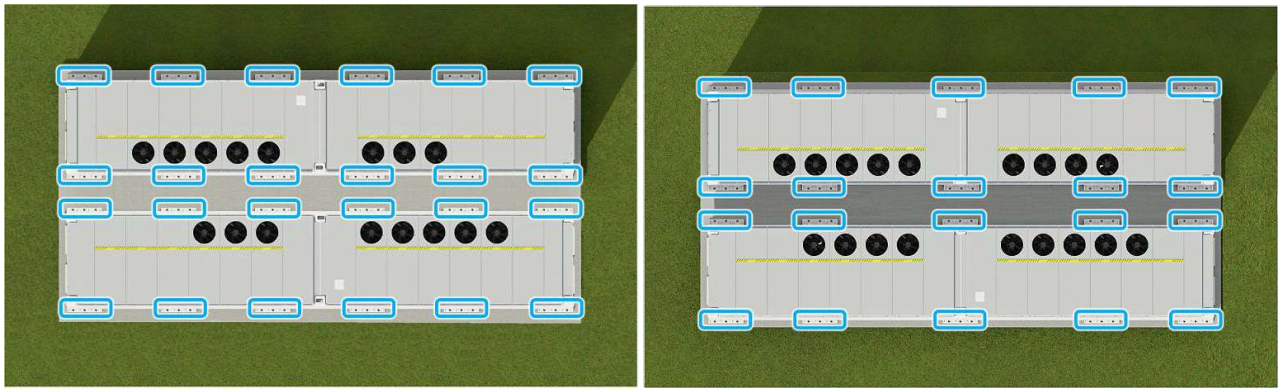
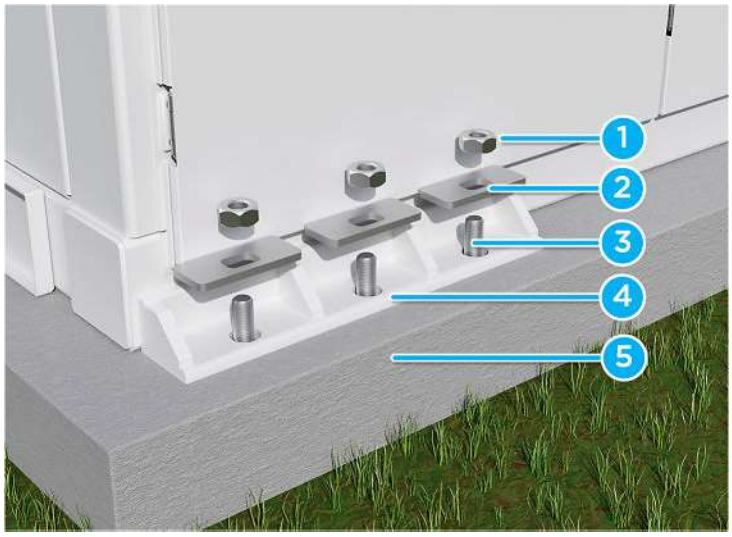


Figure 81. Available Anchor Brackets: Back-to-Back Installation (-C Enclosure, -D Enclosure)



2. Secure the required anchors through the washer, the bracket, and into the foundation:

Figure 82. Megapack Anchoring Detail



1 - Anchor nut (customer-provided); 2 - Anchor washer (Tesla-provided); 3 - Anchor (customer-provided); 4 - Anchor bracket (steel, welded to Megapack); 5 - Megapack foundation. For anchor specifications, refer to *Anchor Requirements on page 83*.

NOTE: Megapack can support up to three anchors per anchor bracket depending on site design.

- For each anchor bracket, ensure that the anchor and anchor washer are secure such that the bracket touches the foundation with no gaps. If a gap is present, the bracket MUST be shimmed to ensure there is no gap.
- Epoxy overflow or other debris can prevent the anchor washer from sitting flush on the anchor bracket. Ensure any debris is chipped away so that the washer sits flush to the bracket:

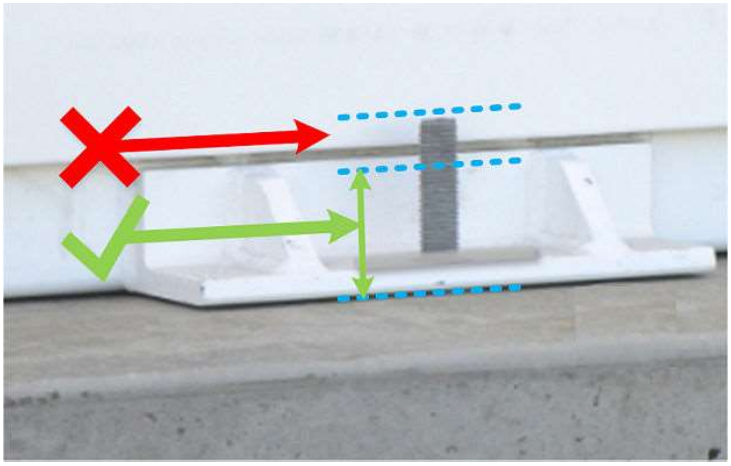
Figure 83. Epoxy Overflow

3. Using the anchor washer (note this washer is eccentric to provide as much mounting tolerance as possible), install and torque the anchor, then leave a paint mark:

   Figure 84. Torque and Leave Paint Mark

   - Ensure that anchor hardware does not protrude greater than 76 mm (3 in) above the foundation surface:

Figure 85. Anchor Protrusion



4. Repeat this process for all required anchors.

9 Installing Customer Connections

All of the wiring and customer connection tasks after installing Megapack take place in the Customer Interface Bay and wireways.

Watch the *Megapack 2 XL - Installing Customer Connections* video (*https://partners.tesla.com/home/content/video/4724*) for more information.

9.1 Preparing the Area

1. Perform lockout/tagout (*Performing Lockout/Tagout on page 118*).
2. Identify the wireway(s) that will be used to route cabling according to the plan of record.
3. Remove the covers for the required wireway(s):
    a. Use a T30 Torx bit to remove the 4 fasteners per wireway cover.
    b. Using a knife, carefully cut the sealant around the edges of the wireway cover.
    c. Using a pry bar, gently pry and remove the wireway cover.
    d. Using a plastic scraper, remove any remaining sealant.
4. Access the AC bus bar area (*Accessing the AC Bus Bar Area on page 125*).
5. Verify that the conduit or conductor wireway is prepared for the circuit conductors, including ensuring that nothing can damage the conductors during work.
    - If applicable, check for sharp edges around the wireway openings in the AC bus bar area by both visual inspection and touch test. **Install protection if sharp edges exist that could damage the conductors:**

9.2 Wiring the AC Conductors

AC conductors route from the medium-voltage (MV) transformer through the Megapack enclosure's wireway openings and into the AC bus bar area. The enclosure and AC bus bar area have wireway openings on either side, with the conductors using the side closest to the transformer.

DANGER: Each Megapack requires a 3-wire circuit (3 phases, ground) connection, and the transformer secondary is required to be a grounded wye.

9.2.1 Terminating the Conductors

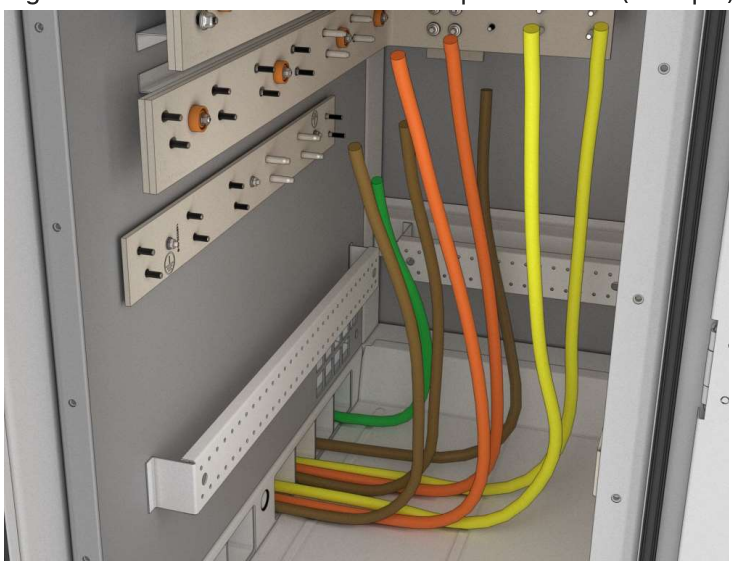
NOTE: Each Megapack accessory kit includes the M12 hardware for attaching the AC lugs to the AC bus (see *Installation Accessories on page 128*).

1. Ensure that the area is prepared (*Preparing the Area on page 134*).
2. Pull conductors through the wireway and into the AC bus bar area.

   NOTE: The example renders in this section depict cables entering the AC bus bar area from the left side, but all procedures and cautions must be observed regardless of entry side.

3. Train the conductors by bending them into a shepherd's hook or gentle bend, where the bend radius is large enough such that the cables will be able to sit flush to the bus bars without using excessive force.

   Figure 86. Conductors Trained into Shepherd's Hook (Example)

   NOTE: Where possible, to prevent strain and reduce installation effort, arrange the conductors to ensure that the bend radii are larger than the minimum specified by the conductor manufacturer.

   CAUTION: Before proceeding, you must ensure that the conductors are trained so that each conductor's lug will land properly on the bus bar studs. Failure to do so may result in damage to the enclosure or bus bar.

4. Trim, strip, and dress the conductors to prepare them for termination. Apply anti-oxide coating to each lug in the Megapack and switchgear if required by the AHJ. Attach the lug to the conductor using an approved connection method (compression lugs are recommended).
5. Precisely align both holes in each lug with both studs on the bus bar. If properly aligned and with as large a bend radius as possible, no more than gentle pressure is required to seat lugs on to bus bars.

Figure 87. Lug Holes Aligned with Studs (Example)

CAUTION: Do not force or use prying tools when seating lugs onto bus bars.

6. Use an 18 mm socket to connect all conductors to the bus bars with the M12 hardware provided in the accessory kit.

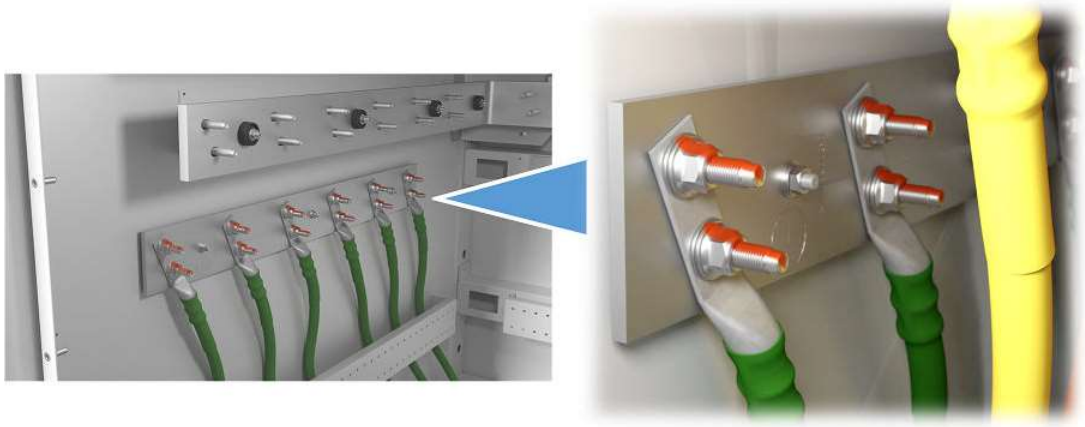
CAUTION: The lugs must be parallel to the bus bars.

NOTE: As a best practice, to prevent galling the bus studs and potentially damaging the Megapack, use of impact drivers or impact wrenches is not recommended.

NOTE: Ground terminations may use the external ground interface, if equipped (*External Ground Interface (If Equipped) on page 91*).

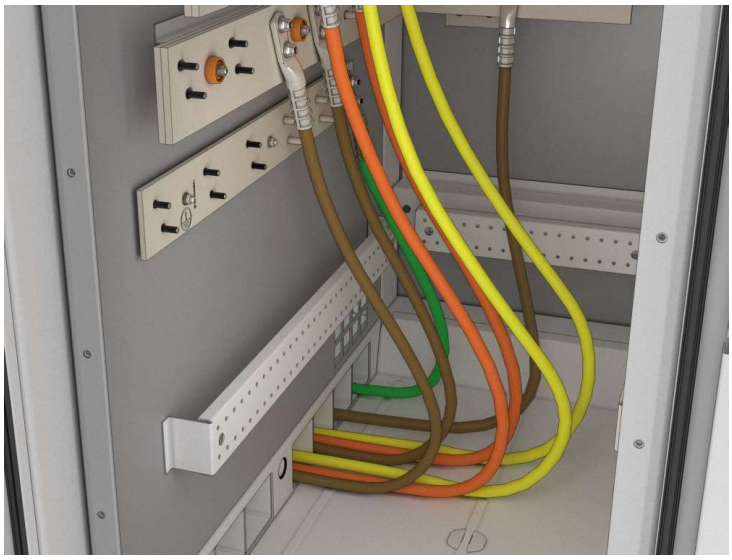
7. Torque all termination hardware to 55 Nm (40 ft lb) and mark each thread and nut with paint pen.

Figure 88. Ground Lugs with Paint Pen Mark (Example)



8. Gently pull on the conductors to verify that there is no bus bar movement and that the conductors are not being strained.
9. Check for a consistent gap between the bus bars and ensure that the minimum electrical clearance between one bus bar and the next bus bar, including fasteners, is at least 13 mm (½ in).

Figure 89. Terminated Conductors (Example)



CAUTION: Megapack output AC voltage is phase-rotation sensitive. All Megapacks at a given site must have the same phase rotation, either clockwise or counter-clockwise.

9.2.2 Checking and Testing

1. Prepare for testing:
   a. Ensure that there is no debris in the Customer Interface Bay.
   b. Verify that the Megapack AC circuit breaker is still locked in the open position.
   c. Secure (close and reattach) the bus bar access panel.
   d. Secure the customer I/O area cover.
   e. Close the Customer Interface Bay door.
2. Proceed to the location where the conductors terminate outside of Megapack, and test:
   a. Verify that the conductors have not been terminated.
   b. Test conductors' insulation resistance at 1000 V with every conductor separated.

      NOTE: Testing one conductor per phase is enough to confirm bus passes insulation resistance.

   c. Perform continuity tests.
3. Terminate the conductors.
4. Check that each conductor is correctly connected to the corresponding utility phase.
5. Perform a grounding resistance test. The system should show:
   - < 1 Ohm between each earth bar and the main system earth bar.
   - < 1 Ohm between the system's exposed metal and the local earth bar.
   - Only one neutral earth bond per system, at the transformer secondary.
6. Open the Customer Interface Bay door if conditions allow (*Critical Door-Opening Considerations on page 118*).
7. Open the customer I/O area cover and turn the enable switch ON on the customer interface board (removing the lock if necessary).

NOTE: If conditions or site-specific requirements do not allow these steps, refer to *Configuring for Short-Term Storage on page 149*.

8. Unless more work is required, close and secure the customer I/O area cover, and close the Customer Interface Bay door.

The AC conductors are now wired and tested. Do not modify the AC conductors without repeating this testing procedure.

9.3 Terminating Auxiliary DC Power Conductors and Communications Cables

Terminate auxiliary DC power conductors and communications cables by following a routing path into the customer I/O area as described below.

Figure 90. Customer I/O Routing

1. Customer I/O area panel
2. Screws securing the panel
3. Customer I/O area
4. Routing path
5. AC bus bar area
6. Wireway openings

To begin these procedures, access the AC bus bar area and customer I/O area:

1. If needed, prepare the area (*Preparing the Area on page 134*).
2. Using a T30 Torx bit, remove the two screws (callout #2) that secure the panel covering the customer I/O area, and open the panel.

To terminate auxiliary DC power conductors:

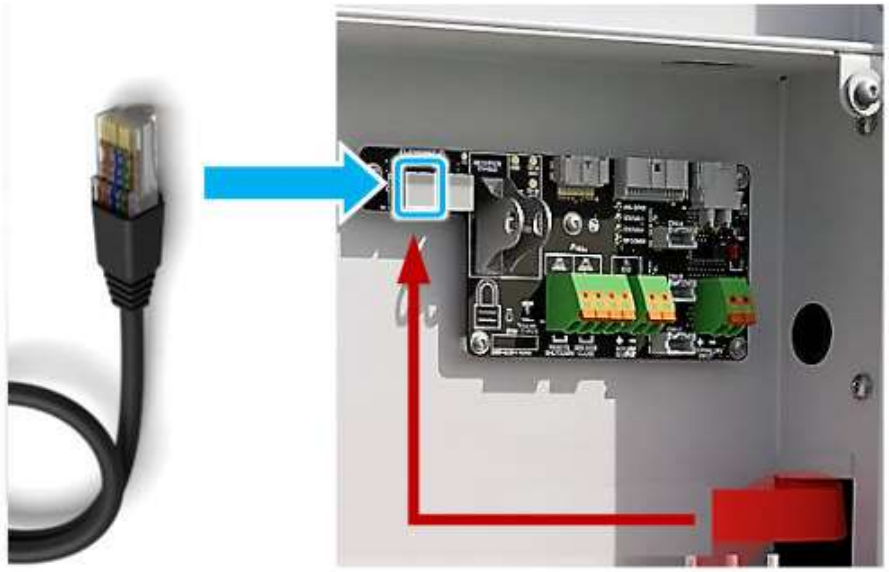
1. Route the cable from the AC bus bar area along the wall as indicated (callout #4).

2. Pull the cable into the customer I/O area (callout #3).
3. Connect it to the desired terminal.

To terminate communications cables:

Tesla requires Megapack to be connected to the Tesla Network along with the LAN 2 port of the Tesla System Controller.

1. Route the Tesla Network Ethernet cable into the AC bus bar area and along the wall as indicated (callout #4).
2. Pull the cable into the customer I/O area.
3. Terminate the cable with a plastic RJ45 connector using an EZ-RJ45 crimp tool or equivalent (see *Communications Cable Requirements on page 92* for more information).
4. Test the connection using a Fluke CIQ-100 tool or equivalent. Leave a paint pen mark on the cable once it passes.
5. Install the cable into the communications port (*Port A*, or the **left** Ethernet port) on the customer interface board (*Customer Interface Board Detail on page 112*).



6. Unless more work is required, secure (close and reattach) the bus bar access panel, secure the customer I/O area panel, and close the Customer Interface Bay door.

9.4 Securing Conductors External to Megapack

Conductors installed in wireway cable trays from the Megapack to the transformer or similar equipment shall be securely bound to prevent excessive movement due to fault-current magnetic forces. The cables must be secured using cable cleats. The engineer of record is responsible for ensuring that the cable restraints are capable of withstanding the fault current magnetic forces during a worst-case short circuit scenario. For more information, refer to the *Megapack Integrated Wireway Application Note*.

9.5 Sealing the Wireway Openings

As an IP66 enclosure (*Enclosure on page 16*), care must be taken to prevent particle and water ingress. At a minimum, this means the following conditions must be observed during the installation process and after installation is complete:

- **Megapack must remain sealed:** While actively working on Megapack, ensure that all Megapack doors are closed and conduit or wireway openings are sealed **before you leave the site each day** to keep the Megapack interior dry and clean.
- **Megapack's interior must remain dry:** Do not perform any work on Megapack that requires opening its doors when there is a possibility of moisture (from precipitation or excess humidity) entering the enclosure.
- **Megapack must remain protected from dust and debris:** At all times when doors are open, ensure that dust or debris of any kind does not enter the enclosure. For example, do not operate a leaf blower near an open door and ensure that doors are closed when wind may blow debris.

WARNING: Failure to properly seal the Megapack openings and enclosure may violate the integrity of the IP66 enclosure and allow moisture, particles, rodents or other objects to enter the enclosure and cause significant damage to equipment.

CAUTION: Some foaming agents such as plumbing foam can degrade conductor insulation and PVC conduit pipes. Ensure all sealants are compatible with site materials.

Depending on the site condition, one or more of the options below may be appropriate to properly seal Megapack wireway openings. Always defer to project-specific sealing details or the engineer of record.

NOTE: Megapack enclosures, including their wireway covers, are made of ferrous materials.

- Reinstall the wireway covers, if they were previously removed.
- If the wireway covers have been modified, ensure that the IP66 rating is maintained using appropriate products before reinstalling.

  NOTE: If necessary, the wireway covers can be replaced using non-ferrous materials.

- If reinstalling the wireway covers is not possible due to construction conditions, temporarily seal the openings using an impermeable membrane and tape until a permanent seal is installed.
- If wireway cover cannot be permanently reinstalled after Megapack construction is completed, install an alternate permanent seal:
  - Seal the wireway openings using a material identified by the sealant manufacturer as compatible with conductors.
  - Ensure that the wireway openings are completely sealed from moisture, dirt, and pest ingress.
- After commissioning, maintain this seal for the life of system.
- **If any of the above is not possible or you have any questions about maintaining Megapack's required IP66 rating, contact your Tesla project engineer.**

WARNING: It is common for there to be a lag in the time between when Megapack is placed on the foundation and when conductors are pulled and terminated. It is critical for the installer to ensure that wireway openings are sealed whenever work is not actively being performed per requirements above.

NOTE: Use a T30 Torx bit for the M6 screws that secure the wireway covers.

NOTE: Photos will be required to be sent to Tesla when completing the *Megapack Deployment Checklists* to verify all Megapack openings are sealed correctly.

9.6 Providing the Arc Flash Label

An arc flash label must be affixed on the outside of each Megapack. The label must be applied to the outside of the Customer Interface Bay door (on the exterior of the enclosure), where it must be clearly visible to personnel prior to opening Megapack doors. The label and the information it records are to be provided by the engineer of record and must reflect the conditions of the AC bus bar area. The label must conform to local requirements and at a minimum must designate:

- Working distance
- Expected incident energy
- Recommended PPE
- Nominal voltage

Figure 91. Example Location of Arc Flash Label

NOTE: Arc flash labels are required for Service Providers to perform any work on Megapack. If the label is not present, Tesla will require Megapack and upstream devices to be completely de-energized before any work on Megapack can take place.

NOTE: Labels must be provided in accordance with local codes and standards, examples of which include:

- NFPA70E & IEEE 1584
- CSA Z462-12
- AS -1319

9.7 Removing the Circuit Breaker Panel

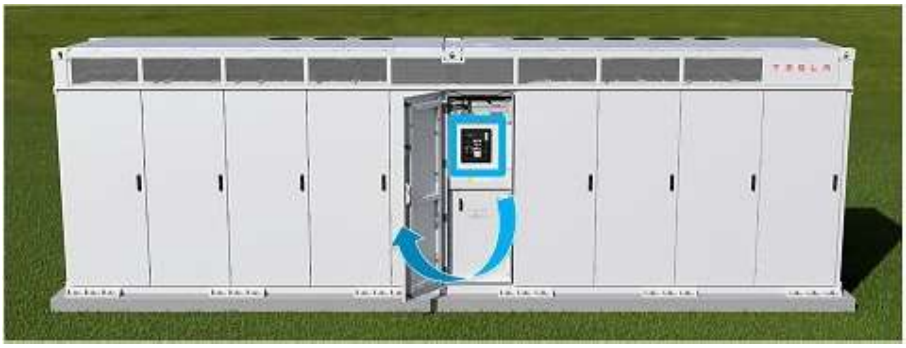
Follow this procedure to remove the panel surrounding the Megapack AC circuit breaker in order to perform field retrofits of breaker components.

WARNING: This procedure requires opening the Megapack enclosure. Only perform this procedure if conditions allow and per guidance in *Accessing the Megapack Enclosure on page 118*.

1. Lockout/tagout, ensuring that all incoming energy sources have been removed (*Performing Lockout/Tagout on page 118*).

2. Open the Customer Interface Bay door to access the Megapack AC circuit breaker area.

   Figure 92. Megapack AC Circuit Breaker in Customer Interface Bay



3. Use a T30 Torx bit to remove the 8 screws securing the circuit breaker panel to the enclosure:

   Figure 93. Removing Circuit Breaker Panel

4. Remove the circuit breaker panel.

10 Installing the Tesla System Controller

To install the Tesla System Controller (*Tesla System Controller on page 17*):

- For systems with the Standard Tesla System Controller, install the Standard Tesla System Controller Enclosure per the instructions in the *Standard Tesla System Controller Enclosure Installation Manual*, then terminate communication wiring per the guidance below.
- For systems with the Large Tesla System Controller, the customer can choose to follow the guidelines of the *SCADA Design Manual* to design and install their enclosure, then also observe the communication wiring guidance below.

10.1 Communication Wiring

For cable requirements, see *Communications Cable Requirements on page 92*.

10.1.1 Terminating Ethernet Cables

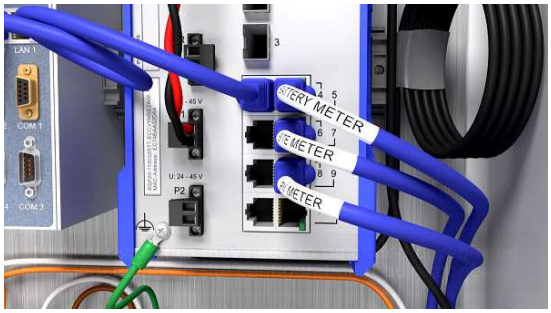
Review the following and set up Ethernet connections and terminations as needed per site requirements.

Both the Standard Tesla System Controller and Large Tesla System Controller provide two Ethernet ports for communication: LAN 1 and LAN 2.

Figure 94. LAN 2 and LAN 1 Ports on the Standard Tesla System Controller

- LAN 1 is typically reserved for connection and communication over the Customer Network.
- LAN 2 is typically pre-wired to a network switch for communication on the Tesla Network.

  Figure 95. Ethernet Connections to the Network Switch



For networking considerations in dual-controller configurations, see *Computer Networking on page 61*.

11 Connecting Energy Meters

These sections provide instructions on connecting energy meters. Energy meters must be provided by the contractor.

Every site requires, at a minimum, a battery meter, but the types and number of meters used vary based on Megapack's intended use. Always verify that the meters being installed match the plan of record for the site. See *Energy Meter Design on page 38* for details on meter hardware.

Failure to install all meters included in the approved plan of record may result in incorrect system performance or inability to meet reporting requirements.

NOTE: Tesla is not responsible for the correct installation of energy meters. The battery system will not operate correctly with incorrect CT installation or wiring to the meters. This is a common point of installation failure and requires careful installer attention.

NOTE: When communication to any of the meters is lost during on-grid normal operation, the system may cease to operate, depending on the control mode, until communication is resumed. If communication is lost, the values reported are the last values read from the meter until communication is resumed.

11.1 Connecting Meters to the Tesla System Controller

Connect a direct line between the meter(s) and the Tesla System Controller per the instructions in *Terminating Ethernet Cables on page 143*.

NOTE: All meters must be connected to the Tesla System Controller using Ethernet cable terminated according to the T568B Wiring Standard (see *Communications Cable Requirements on page 92*.

NOTE: If the site is using multiple external communication devices that use LAN 1 (such as a customer interface, utility monitoring device, or external-network meter), a second Ethernet switch is required. Contact Tesla for details.

11.2 Wiring Voltage Sense Inputs

For each energy meter, tap **all available bus bars**, including neutral if it exists, into the voltage inputs on the meter. Designs vary based on site-specific transformers and meters, so ensure that you follow the guidelines relevant for your site plan:

- **If using potential transformers (PTs):** You should be using a type that has the same number of outputs on its secondary side as the inputs on the primary side. If a neutral bus exists, it should connect to the PT, and a neutral line should flow through to the meter.
- **If the neutral exists (three-phase Wye):** Set the meter's voltage mode to a line-to-neutral type (*Form 9*).
- **If there is no neutral - only three active phases and ground (three-phase Delta):** Set the meter's voltage mode to a line-to-line type (*Form 5*).

Refer to the *Application Note: Using SEL-735 Meters With Tesla Products* for more information.

CAUTION: Failure to follow these guidelines will void any guarantee of accurate readings and accurate power control.

11.3 Wiring Current Transformer Inputs

To wire current transformer (CT) inputs:

1. Use core CTs only.
   Figure 96. Core CT (Example)

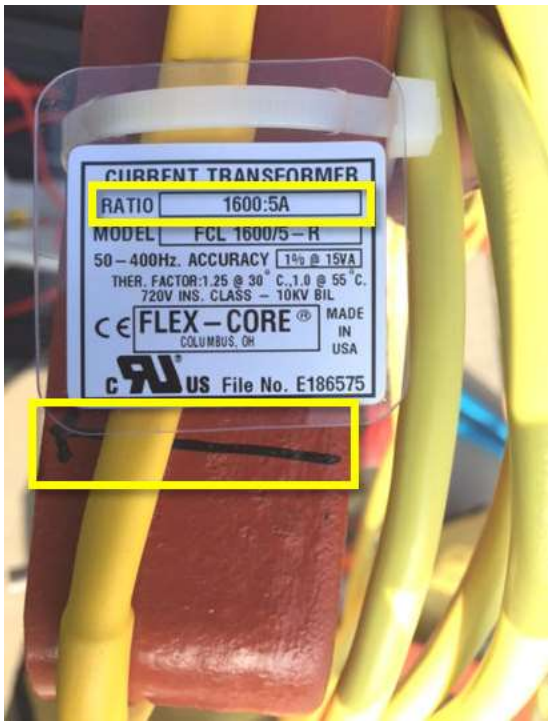
2. Verify that the CTs used match the chosen meter's specifications and the plan of record.

   NOTE: Tesla is not responsible for the correct installation of meters. The system will not operate correctly with incorrect CT installation or wiring to the meters. This is a common point of installation failure and requires careful installer attention.

   NOTE: Tesla is not responsible for the accuracy of the energy meters. Please consult with the energy meter manufacturer in the event of faulty communications from the energy meters.

3. Read the label on each CT to verify the CT ratio and the arrow that indicates the direction of flow. Record each meter's make, model, serial number, and CT ratio on the *Megapack Deployment Checklists*.

Figure 97. CT Ratio and Arrow



4. Ensure each phase's voltage wiring corresponds to the same phase of current wiring, and the positive and negative polarity of each phase are installed correctly to match the design information in *Meter Locations on page 41*.

   NOTE: All meters are phase-sensitive. The battery meter & battery system phase rotations must match.

5. For each meter, perform a resistance check between the positive and negative terminals from each CT:
   - Ensure resistance between each CT pair is ~0 Ohms.

6. On the meter UI, set the CT ratio per the installed CTs and document in the *Megapack Deployment Checklists*.

11.4 Configuring Meters

Once meter installation is complete, refer to the *Application Note: Using SEL-735 Meters with Tesla Products* for details on configuring the SEL-735 meter.

NOTE: Tesla is not responsible for the correct configuration of energy meters. The battery system will not operate correctly with incorrect input parameters.

12 Test Energization

Once the Megapack System has been installed, the site is mechanically complete, and the installation contractor believes the site is ready for first energization, Tesla recommends checking and testing the distribution interface by performing the black start procedure, which energizes the distribution system from the Megapack unit rather than from the grid.

Using this test energization procedure rather than energizing for the first time from the grid mitigates electrical hazards and potential for equipment damage. While grid energization exposes the distribution system to full available fault current, test energization limits fault current to 120% of the Megapack product nameplate current, which allows for electrical equipment to be verified under a lower fault current. At a minimum, equipment tested during this procedure includes:

- Megapack internal 480 V AC connections
- 480 V AC terminations
- Phasing in the AC bus bar area

CAUTION: Energization of the Megapack is not allowed prior to contacting your Tesla representative to discuss this procedure.

CAUTION: Large amounts of available fault current during initial grid energization could lead to equipment damage if there are issues with the components being energized.

13 Energizing, Site Isolation, and Storage

For all procedures, follow the guidelines in the site's *Electrical Control Plan on page 103*. Work with the site owner or operator with any questions related to the Electrical Control Plan.

13.1 Energizing the Megapack

After Tesla has completed the commissioning and initial start-up of Megapack, the system is ready for operation. You should not need to perform extra steps to start the system.

If a Service Provider gives the direction to re-energize a Megapack during installation or after upstream maintenance or short-term storage, the steps below must generally be performed to energize the Megapack.

WARNING: Notify operations and on-site personnel and clear working areas as necessary before re-energizing.

NOTE: These are general steps. The procedure may vary during specific installation or operational phases or at specific sites.

1. Verify that the equipment and area, including the inside of the Customer Interface Bay and AC bus bar area, is clear of tools, materials, workers, equipment, and debris.
2. Secure the bus bar access panel to the AC bus bar area, if it has been removed.
3. Reinstate the remote shutdown contact on the customer interface board, if it had been removed.
4. Turn the enable switch ON on the customer interface board (removing the lock if necessary) and close and secure the customer I/O area cover.
5. Remove the lock on the Megapack AC circuit breaker, if needed.
6. If present, turn the Megapack AC circuit breaker motor switch from OFF to AUTO.
7. Close the Megapack AC circuit breaker (*Controlling the Circuit Breaker on page 110*).
8. Close the Customer Interface Bay door.
9. Close any upstream external circuit breakers that had been opened.

13.2 Isolating the Site from Megapack

Follow the isolation procedures below to prevent Megapack(s) from providing energy to other components at the site.

13.2.1 Isolating a Single-Megapack System

Perform this procedure at sites with a single Megapack:

1. Command an off state using the Tesla System Controller or other SCADA equipment. If the site operator or system owner does not have the means to send commands, contact Tesla (*Contact Information on page 27*).
2. Isolate the Megapack from upstream AC if required (*Isolating Megapack from Upstream AC Sources on page 119*).
3. Open and lock the Megapack AC circuit breaker (*Opening and Locking the Megapack AC Circuit Breaker on page 120*).

13.2.2 Isolating a Multiple-Megapack System

Perform this procedure at sites with multiple Megapacks:

1. Determine whether all Megapacks should be isolated or only one Megapack:
   - If isolating all Megapacks, send the appropriate command using the Tesla System Controller or other SCADA equipment. The appropriate command varies depending on whether this is an on-grid or a microgrid site. If the site operator or system owner does not have the means to send commands, contact Tesla (*Contact Information on page 27*).
   - If isolating only one Megapack, the power commands do not require a change (but a change is permitted if desired).
2. Isolate AC power at the appropriate circuit breaker:
   - If isolating all Megapacks, open the site-wide external circuit breaker or disconnect to remove grid power.
   - If isolating only one Megapack, open the upstream AC disconnect.

13.3 Configuring for Short-Term Storage

This procedure is only to be performed when a Megapack needs to be shut down and removed from grid power **for more than 24 hours and up to 14 days**.

NOTE: Contact Tesla for assistance with configuring Megapack for storage periods of longer than 14 days.

WARNING: Active work cannot be performed inside Megapack while it is in storage. If active work is required, ensure the Megapack is de-energized per *Performing Lockout/Tagout on page 118*.

1. Ensure that conditions, including duration and temperature range, will abide by the requirements in the *Megapack 2 XL Transportation and Storage Guidelines* for the duration of storage.
2. Charge Megapack to at least 50% state of energy.
3. Open a ticket using Tesla's online support portal (*Contact Information on page 27*) and note the following in the ticket:
   a. Inform that the system will be shut down soon.
   b. State the amount of the time the system is expected to be idle.
4. Command to off state using the Tesla System Controller or other SCADA equipment. If the site operator or system owner does not have the means to send commands, contact Tesla (*Contact Information on page 27*).
5. Open the site or external circuit breaker or disconnect (if one is present).
6. Assess the steps in *Critical Door-Opening Considerations on page 118* and open the Customer Interface Bay door if conditions allow.
7. Turn the enable switch off (*Turning the Enable Switch Off on page 122*).
8. Wait five minutes.
9. Open and lock the Megapack AC circuit breaker (*Opening and Locking the Megapack AC Circuit Breaker on page 120*).
10. **Turn the enable switch back on.**
11. Close and secure the customer I/O area cover, and close the Customer Interface Bay Door.
12. Up to 14 days later, proceed with re-energization (*Energizing the Megapack on page 148*).

CAUTION: The enable switch must remain on during storage.

14 Regulatory Compliance

14.1 Signage Requirements

Signage must be posted in approved locations in accordance with local codes and standards.

14.2 General Compliance Information

Megapack is designed to be compliant with the industry's most stringent global safety standards for energy storage systems as well as with major market grid codes. *Megapack 2 XL Compliance Packet*, a full compliance packet of completed certifications in all regions, is available on the Tesla Partner Portal.

14.3 Environmental Compliance

Each Megapack contains coolant and refrigerant in its thermal system (*Thermal Specifications on page 69*). These substances are built into the Megapack and do not need to be added at the time of installation at site. Depending on the number of Megapacks installed on a site, storage, use and handling of these substances during maintenance events may require reporting, hazard management plans, or containment procedures as required by local codes.

Megapack's enclosure is designed with an integrated 900 L gravity-fed secondary coolant containment basin in its enclosure base in accordance with Title 40 CFR 264.175.

Should an internal coolant leak occur, a gutter system directs coolant away from the batteries to the base of the enclosure to a central location in the AC bus bar area of the Customer Interface Bay. In addition, Megapack has a coolant reservoir level indicator that will alert Service Providers to be dispatched for investigation.

14.3.1 Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)

The Regulation (EC) No 1907/2006 of the European Parliament and of the Council of December 18, 2006 concerning the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) entered into force on June 1, 2007. Tesla agrees with the purpose of REACH, which is to ensure a high level of protection of human health and the environment. Tesla is compliant with all applicable requirements of REACH.

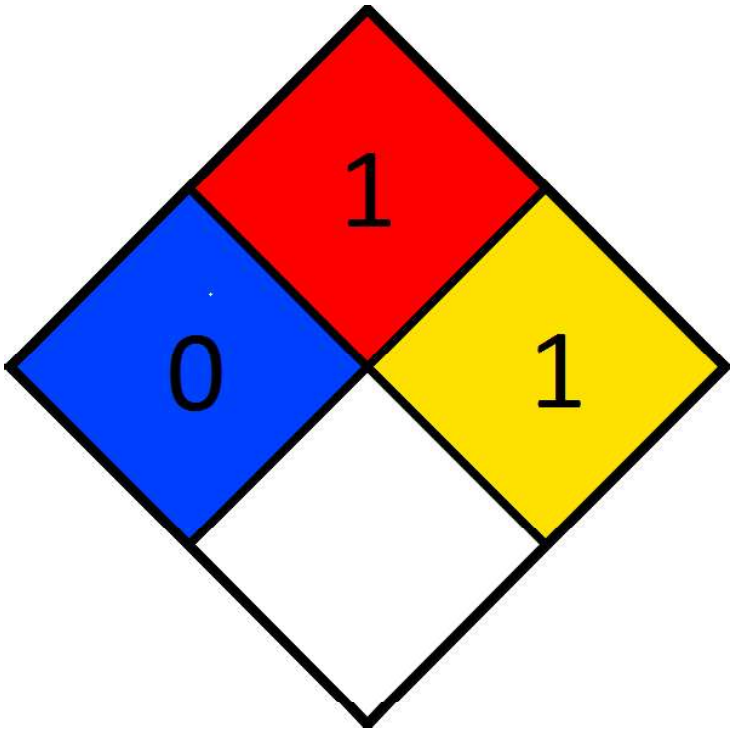
The registration requirements do not apply to Tesla, since it is neither a manufacturer nor an importer of preparations into Europe.

However, product (article) manufacturers or importers into Europe are obligated under Article 33 of REACH to inform recipients of any articles that contain chemicals on the Substances of Very High Concern (SVHC) candidate list above a 0.1% concentration (by weight per article). As of July 2021, Megapacks manufactured and marketed by Tesla do not contain substances on the REACH SVHC candidate list in concentrations greater than 0.1% by weight per article. Tesla continues to monitor the developments of the REACH legislation and will communicate with our customers according to the requirement above.

14.4 NFPA Compliance

For installations that require an NFPA placard, please refer to the figure below:

Figure 98. NFPA Placard



CAUTION: Water is the recommended suppressant in case of a fire involving a lithium-ion battery. Lithium-ion batteries **do not contain any solid metallic lithium** (a water reactive material); thus, the use of water is appropriate, and will not exacerbate a fire involving lithium-ion cells. For comprehensive fire response information, refer to the *Industrial Lithium-Ion Battery Emergency Response Guide*.

14.5 Electromagnetic Compatibility (EMC)

The Standard Tesla System Controller has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case users will be required to correct the interference at their own expense.

14.6 Cybersecurity

Tesla is continually assessing Megapack System security and its compliance with various cybersecurity standards applicable to battery energy storage systems. Tesla has programs, policies, and processes that cover critical cybersecurity items, including the following:

- Personnel risk assessment, training, background checks, awareness
- Access management and control
- Electronic security perimeters and electronic access methods
- Incident response
- Continuity of operations (recovery and business continuity)
- Configuration change management
- Vulnerability assessments and patching process

- Transient cyber assets and removable media

In addition, Tesla provides a list of cybersecurity mandates and recommendations to ensure vulnerabilities within the overall SCADA network are mitigated. Mandatory items include changing default passwords, disabling unused wireless interfaces, access control and review, and system change management.

Recommended items include network scanning, password strengthening, disabling unused ports and services, timely patch implementation, and multifactor authentication.

For more information, see the *Application Note: NERC CIP Low Impact Facility Cybersecurity Compliance* and the *SCADA Design Manual*.

Revision History

Revision	Date	Details
2.8	May 29, 2025	• Updated the maximum allowable arc flash incident energy from 8 to 14 cal/cm^2 for all regions. Updated the protection scheme requirements to ensure admin controls related to relays are clearly defined (*Performing Lockout/Tagout on page 118*) • Clarified ride-through behavior (*Site-Level High-Voltage Ride-Through Considerations on page 51*) and included applicability for IEEE 2800-2022 (*Megapack Unit Capabilities on page 96*) • Updated reconnection delay timer setting ranges (*Grid-Connected Features on page 100*) • Updated *Tesla System Controller on page 17*, *Tesla System Components on page 9*, *Product Labels on page 21*, and *Large Tesla System Controller Wiring on page 95* to include additional Large Tesla System Controller • Provided details about the Electrical Control Plan (*Electrical Control Plan on page 103*) • Changed external 24 V DC input power supply minimum rating (*Customer Interface Board on page 111*) • Updated list of accessories with external ground interface bolts (*Accessory Kit on page 128*) • Clarified conductor routing procedures and proper termination in the AC bus bar area (*Terminating the Conductors on page 135*) • Clarified black start equipment arrangement in *Utility Battery Only on page 30* and *Utility Hybrid on page 33* projects • Provided guidance for systems using on-load tap changers (*Using On-Load Tap Changers on page 52*) • Provided GF residual (ground-fault detection method) settings for the UL 1066 breaker (*Default Circuit Breaker Trip Settings – UL 1066 on page 109*)
2.7	February 12, 2025	• Provided additional considerations for ground surface design (*Ground Surface Design Considerations on page 80*) • Provided guidelines about inspecting delivered units (*Inspecting Delivered Units on page 128*) • Provided recommendations regarding checking and testing the distribution interface (*Test Energization on page 147*) • Provided external ground interface details (*Wiring Interface Summary on page 90*) • Introduced the C011 cell option (*Battery Modules on page 14*, *Standard Configurations on page 14*, *Product Configurations on page 12*) • Introduced fan type options (*Megapack Options on page 12*) • Modified the maximum audible noise specification (*Noise Specification and Guidance on page 67*)
2.6	December 2, 2024	• Provided product configuration, option, and variant descriptions (*Product Configurations on page 12*)

Revision	Date	Details
		• Introduced the C012 cell option (*Battery Modules on page 14*, *Standard Configurations on page 14*) • Clarified accessing the lifting points (*Accessing the Lifting Points on page 116*) • Clarified thermal capacity configuration descriptions (*Thermal Specifications on page 69*)

2.5	October 23, 2024	• Introduced Archetypes and updated design information throughout Site Architecture accordingly (*Site Architecture on page 28*):
		  ◦ Provided *Archetypes on page 28* and *Equipment per Archetype on page 37*
		  ◦ Provided *Generator Asset Design on page 59*, *Islanding Controller Design on page 55*, and *Ground Reference Design on page 52*
		  ◦ Updated *Energy Meter Design on page 38*, *Transformer Design on page 50*, and *Solar Asset Design on page 54*
		• Provided service side clearance (superseding door swing clearance) and updated diagrams with Battery Service Zone highlight (*Megapack Clearance on page 84*)
		• Updated safety features to provide improved context (*Hazard Mitigation Features on page 20*)
		• Clarified that foundation support does not need to be continuous (*Equipment Bearing Areas and Anchoring on page 82*)
		• Removed guidance about turning enable switch back on when active work pauses for 1 hour or longer (*Turning the Enable Switch Off on page 122*)
		• Provided considerations for turning the enable switch back on under conditions described in this *Note on page 119*
		• Simplified conductor testing instructions (*Checking and Testing on page 137*)
		• Provided site water flow guidance (*Foundation Design on page 81*)
		• Updated I_{sd} (short-time current) defaults for UL 1066 (*Default Circuit Breaker Trip Settings – UL 1066 on page 109*)

2.4	May 31, 2024	• Included additional details about wireway covers when preparing to install customer connections (*Preparing the Area on page 134*) • Reorganized Civil Design section to better address civil design specialties (*Civil Design on page 72*) • Added a topic describing routes and zones to aggregate and better clarify site civil design requirements and considerations (*Routes and Zones on page 72*) • Provided examples of typical vehicles requiring access to the site (*Typical Vehicles on page 79*) • Corrected anchor bracket length (*Equipment Bearing Areas and Anchoring on page 82*) • Updated mechanical specifications (*Enclosure Specifications or Capabilities on page 66*) • Updated circuit breaker part numbers (*Megapack AC Circuit Breaker on page 106*) • Added -D enclosure installation template part number (*Installation Accessories on page 128*) • Clarified that THD is at real power capability (*Interconnection Data on page 89*)

Revision	Date	Details
		• Clarified that each Megapack unit must be installed on a single planar surface (original language: "Equipment must all be installed on a single level surface.") (*Foundation Design on page 81*)
2.3	March 6, 2024	• Clarified requirement for cable cleat usage in wireways (*Securing Conductors External to Megapack on page 139*) • Clarified that conductors must obey Megapack's IP66 rating (*AC Power Requirements on page 94*) • Updated (decreased) coolant volume (*Thermal Specifications on page 69*) • Clarified applicability of the procedure in *Solar Asset Size Considerations on page 54* • Updated owner responsibilities (*Site Owner on page 9*)
2.2	January 30, 2024	• Provided UL 1066 circuit breaker information (*Megapack AC Circuit Breaker on page 106*) • Clarified supply fault current rating (*Interconnection Data on page 89*) • Corrected clearance legends (*Megapack Clearance on page 84*)
2.1	November 8, 2023	• Clarified testing details in *Wiring the AC Conductors on page 135* • Emphasized preparing wireway openings in the AC bus bar area during installation (*Preparing the Area on page 134*) • Modified door-opening guidance and removed the requirement to contact Tesla before opening doors (*Critical Door-Opening Considerations on page 118*) • Provided PV system size considerations (*Solar Asset Size Considerations on page 54*) • Improved de-energization terminology and procedures, including isolation and performing lockout/tagout (*Performing Lockout/Tagout on page 118*, *Energizing, Site Isolation, and Storage on page 148*) • Improved clarity of Megapack AC circuit breaker content (*Megapack AC Circuit Breaker on page 106*) • Updated guidance for maximum number of Megapacks for a single Large Tesla System Controller (*Tesla System Controller on page 17*) • Clarified auxiliary load power supply (*AC Power Requirements on page 94*) • Changed "backup power" term to "uninterruptible power supply" (*Uninterruptible Power Supply on page 94*) • Updated *Fencing and Barriers on page 87* with 2021 IFC code • Clarified low-voltage augmentation foundation requirements (*Low Voltage Augmentation on page 63*) • Added islanding information to remote shutdown design (*Remote Shutdown in Islanding Applications on page 105*) • Updated Asia hotline information (*Contact Information on page 27*)
2.0	July 21, 2023	• Introduced the -D enclosure variant (*Enclosure on page 16*) • Added -D enclosure variant anchor bracket specification (*Anchor Requirements on page 83*)

Revision	Date	Details
		• Added -D enclosure variant wireway opening dimensions (*Wiring Interface Summary on page 90*) • Modified backup power guidance (*Uninterruptible Power Supply on page 94*, *DC Power Requirements on page 95*) • Provided minimum clearance guidance to ignitable liquids sources (*Megapack Clearance on page 84*) • Changed default ground fault circuit breaker values (*Programming the Circuit Breaker on page 109*) • Added cybersecurity overview (*Cybersecurity on page 152*) • Improved and simplified language in topic previously called *Electrical Specifications* (*Interconnection Data on page 89*) • Underscored the need to properly secure conductors external to Megapack (*Securing Conductors External to Megapack on page 139*) • Clarified ratings terminology (*Standard Configurations on page 14*) • Simplified auxiliary section of schematic (*Megapack on page 10*) • Added craning guidance (*Craning on page 115*) • Corrected label names (*Megapack Labels on page 21*) • Corrected augmentation dimensions (*Capacity Maintenance Agreement Augmentation on page 64*)
1.9	April 7, 2023	• Revised maximum allowable arc flash incident energy requirement (*Maximum Arc Flash Incident Energy on page 61*) • Provided additional details about augmentation design (*Augmentation Design on page 62*) • Added 4-Hour system refrigerant capacity (*Thermal Specifications on page 69*) • Added Megapack AC circuit breaker part number (*Megapack AC Circuit Breaker on page 106*) • Updated compliance information with Megapack containment details (*Environmental Compliance on page 151*). • Added criteria for dust, debris, and wind to *Critical Door-Opening Considerations on page 118* • Added instructions on *Removing the Circuit Breaker Panel on page 141* • Added Site Owner to *Roles and Responsibilities on page 8* • Updated Tesla Site Controller name to Tesla System Controller
1.8	December 20, 2022	• Added *Peak Power on page 90*
1.7	December 19, 2022	• Updated contact information (*Contact Information on page 27*) • Clarified role of spare Tesla Site Controller (*Computer Networking on page 61*) • Updated procedure to shut down for storage (*Configuring for Short-Term Storage on page 149*) • Added UL 1741 compliance CT information (*UL 1741 PCS Requirements on page 47*)

Revision	Date	Details
1.6	November 15, 2022	• Updated kVA ratings (*Standard Configurations on page 14*) • Added UL 1741 compliance information (*UL 1741 PCS Requirements on page 47*) • Added *Maximum Arc Flash Incident Energy on page 61* • Clarified clearance table applicability (*Megapack Clearance on page 84*) • Clarified back-to-back clearance requirements (*Megapack Clearance on page 84*) • Added extension ladder guidance (*Accessing the Lifting Points on page 116*) • Provided enable switch lock specifications (*Enable Switch on page 104*) • Provided material details in *Sealing the Wireway Openings on page 140* • Provided CMA support guidelines (*Augmentation Clearance on page 86*) • Modified SDS language to reflect latest guidance (*Emergency Response Guide on page 25*)
1.5	October 6, 2022	• Provided fastener pitch specification (*AC Bus Bar Area on page 112*) • Expanded information about noise emission factors (*Noise Specification and Guidance on page 67*) • Removed flatbed nomenclature to clarify that Megapack is typically shipped on a lower trailer (*Logistics and Shipping Guidance on page 114*) • Updated Voltage Ride Through specifications (*Voltage Ride-Through on page 96*) • Removed preliminary ratings caveats
1.4	September 16, 2022	• Added note about removable bollards (*Megapack Clearance on page 84*) • Clarified minimum allowable temperature rating of AC conductors (*AC Power Requirements on page 94*) • Provided maximum allowable pad thickness. Increased maximum number of connections for 2-Hour system. (*AC Bus Bar Area on page 112*) • Clarified when on-site maintenance infrastructure needs to be completed (*On-Site Maintenance Infrastructure on page 62*) • Fixed (swapped) width x height dimensions labels for the Standard Tesla Site Controller Enclosure (*Mechanical Specifications on page 66*) • Removed pre-production watermark
1.3	August 23, 2022	• Added isolation transformer guidance for resonance mitigation (*Resonance of Devices Connected to Common 480 V AC Bus on page 59*) • Modified on-site maintenance infrastructure topic to point to new app note (*On-Site Maintenance Infrastructure on page 62*)
1.2	August 8, 2022	• Added guidance on using line reactors (*Resonance of Devices Connected to Common 480 V AC Bus on page 59*) • Added water supply design reference (*Water Supply on page 62*) • Decreased wireway height (*Wiring Interface Summary on page 90*) • Provided circuit breaker option codes for default settings (*Megapack AC Circuit Breaker on page 106*) • Modified voltage ride through settings (*Voltage Ride-Through on page 96*)

Revision	Date	Details
		• Updated label renders (*Megapack Labels on page 21*) • *This revision was not published to Partner Portal.*
1.1	June 20, 2022	• Clarified support for multiple meters of the same function (*Energy Meter Design on page 38*) • Clarified *Advanced SEL-735* meter requirement for projects with specific response time requirements (*Energy Meter Design on page 38*) • Added reference to Megapack AC circuit breaker control over DNP3 (*Controlling the Circuit Breaker using DNP3 on page 110*) • Modified specifications and language in *On-Site Maintenance Infrastructure on page 62* • Provided center of gravity location (*Megapack Center of Gravity on page 68*) • Provided mass calculation (*Megapack Mass on page 67*) • Reduced total mass of refrigerant (*Thermal Specifications on page 69*) • Updated installation template part number (*Installation Accessories on page 128*) • Updated enable circuit example graphics (*Safety Disconnect Features on page 103*) • Updated example wiring interface graphic and key (*Wiring Interface Summary on page 90*) • Clarified that the arc flash label must be affixed to the outside of the Customer Interface Bay Door (*Providing the Arc Flash Label on page 141*)
1.0	April 22, 2022	Initial revision. PRE-PRODUCTION INFORMATION - SUBJECT TO CHANGE.

CONFIDENTIAL INFORMATION – SHARED UNDER NDA ONLY

Megapack 2 XL Design and Installation Manual – Revision 2.8

Last Updated May 29, 2025

EXHIBIT V

ESS COMMISSIONING TESTS

Commissioning Tests

A. Automatic Generation Control (AGC) Functionality Test (or equivalent)
B. SCADA Functionality Test (or equivalent)
C. Owner Control and Data Link Functionality Tests (See Exhibit A-1, Section 2.16)
D. ESS Solar Capacity Firming Test
E. ESS Unit Capabilities Tests
F. Tesla's Performance Testing

The following tests shall be conducted and satisfied as a requirement to achieve Substantial Completion

A. Automatic Generation Control (AGC) Functionality Test

Purpose:
This test will demonstrate the ability of the ESS to synch to AGC.

System starting state:
The ESS will be in the on-line state at between 15% and 85% SOC and at an initial active power level of 0 MW and reactive power level of 0 MVAR. The Energy Management System ("**EMS**") shall be configured to follow a predefined, agreed-upon active power profile.

Procedure:

1. Record the ESS active power level at the ESS "**Electric Metering Device**" (defined for purposes of this Agreement as an ION meter that meets the current PNM Interconnection Metering Standard along with a GPS clock with IRIG output, and this meter shall be used for closed loop control of the System to fulfill IEEE 1547:2018 compliance as well as to measure the performance metrics. The meter refresh time shall be the fastest allowable polling rate. ESS supplier to provide design recommendations on meter part number and CT/PT accuracy class requirements).
2. Command the ESS to follow a simulated AGC discharging signal every four (4) seconds for ten (10) minutes.
3. Command the ESS to follow a simulated AGC charging signal every four (4) seconds for ten (10) minutes.
4. Record and store the ESS active power response (in seconds).

System end state:
The ESS will be in the on-line state and at a commanded active power level of 0 MW.

B. SCADA Functionality Test

Contractor shall prepare and submit to Owner a SCADA Functionality Test procedure no later than 60 Days prior to the expected Substantial Completion Date. Contractor shall perform and successfully demonstrate the SCADA functionality in accordance with such test procedure as a requirement to achieve Substantial Completion.

C. Owner Control and Data Link Functionality Test

Contractor shall prepare and submit to Owner an Owner Control and Data Link Functionality Test procedure no later than 60 Days prior to the expected Substantial Completion Date. Contractor shall perform and successfully demonstrate the Owner Control and Data Link functionality in accordance with such test procedure as a requirement to achieve Substantial Completion.

D. Commissioning Tests

The following tests shall be conducted as a requirement to achieve the Substantial Completion Date.

E. ESS Unit Capabilities Testing

E.1 ESS Capacity Test

E.1.1 General

The ESS Capacity Test ("**ESS Capacity Test**" or "**ECT**") is a test performed to determine the ESS Capacity and Roundtrip Efficiency (RTE). The ESS Capacity Test performed prior to Substantial Completion shall be conducted in accordance with Industry Standards and the provisions of this

Exhibit V. Owner or its representative may be present for ECT and may, for informational purposes only, use its own metering equipment (at Owner's sole cost).

E.1.2 Requirements Applicable to all ESS Capacity Tests

A. Purpose of Test. ECT shall:

(1) verify compliance with the Guaranteed ESS Capacity or otherwise determine any lower ESS Capacity for the purposes of this A; and

(2) determine the Roundtrip Efficiency (RTE) of the ESS;

B. Parameters. During each ECT, the following parameters shall be measured and recorded simultaneously for the ESS:

(1) discharge time (minutes);

(2) ESS Charging Energy measured at the ESS Electric Metering Device prior to any compensation, in MWh ("**ESS Meter Energy In**");

(3) ESS Discharge Energy measured at the ESS Electric Metering Device prior to any compensation, in MWh ("**ESS Meter Energy Out**");

(4) ESS Discharge Energy measured at the ESS Electric Metering Device including the accounting of losses from the ESS Electric Metering Device to the Point of Delivery, in MWh ("**Point of Delivery Energy Out**"); and

(5) ESS Charging Energy measured at the ESS Electric Metering Device accounting for losses from the Point of Delivery to the ESS Electric Metering Device, in MWh ("**Point of Delivery Energy In**");

C. Site Conditions. During each ECT, the ambient air temperature (°C) at the Site shall be measured and recorded at thirty (30)-minute intervals.

D. Test Elements and Sequence. Each ECT shall include the following test elements:

(1) the discharging of the ESS from a 100% State of Charge at a power discharge setpoint rate equal to the Guaranteed ESS Capacity (MW);

(2) the determination of Point of Delivery Energy Out, as measured by the ESS Electric Metering Device, that is discharged from the ESS to the Point of Delivery until either a 0% State of Charge is achieved or Four (4) hours have elapsed from commencement of the ECT. The Point of Delivery Energy Out divided by the actual discharge time or Four (4) shall determine the ESS Capacity. The ESS Electric Metering Device shall be programmed to correct for losses between the ESS Electric Metering Device and the Point of Delivery, not including any losses from other facilities that share the common Point of Delivery with this ESS;

(3) the discharging of the ESS to a 0% State of Charge or such State of Charge achieved after Four (4) hours of discharging the Guaranteed ESS Capacity;

(4) starting at a 0% State of Charge, the charging of the ESS at a constant power charge rate equal to the Guaranteed ESS Capacity; and

(5) the determination of Point of Delivery Energy In, as measured by the ESS Electric Metering Device, that is required to charge the ESS until a 100% State of Charge is achieved as of the commencement of the ESS Capacity Test.

E. Test Conditions.

(1) General. At all times during an ECT, the ESS shall be operated in compliance with Industry Standards, the ESS Operating Restrictions and all operating protocols required by the manufacturer for operation. The ESS shall have charged and discharged at least 80% of one (1) Equivalent Full Cycle in the twenty-four (24)-hour period prior to the ECT, charged to a 100% State of Charge using Charging Energy on the day of the ECT and maintained at a 100% State of Charge for at least two (2) hours prior to commencement of the ECT. The ECT shall commence within one (1) hour after sunset or other such time as mutually agreed by the Parties, and the PV Power Plant shall be disconnected prior to commencement of such ECT. Owner, in coordination with customer and the transmission provider, may regulate the ESS power factor between 0.95 leading or lagging during the ECT as needed for the sole purpose of grid reliability and the ESS shall otherwise be at unity (1.00) power factor.

(2) Abnormal Conditions. If abnormal operating conditions that prevent the recording of any required parameter occur during an ECT, Owner may postpone or reschedule all or part of such ECT in accordance with Section E.1.2.F of these ESS Capacity Test Procedures.

(3) Weather Conditions. Ambient outside dry bulb air temperature of 25°C. Seasonal weather patterns may prevent the occurrence of an ECT. In such circumstances, Contractor shall supply adjusted performance metrics for the ESS at a range of ambient conditions for Owner's review and approval (such approval not to be unreasonably conditioned, delayed or withheld) ninety (90) Business Days prior to the scheduled ECT to determine whether the scheduled ECT is feasible.

(4) Instrumentation and Metering. Contractor shall provide all instrumentation, metering and data collection equipment required to perform the ECT. The instrumentation, metering and data collection equipment, and electrical meters shall be calibrated in accordance with prudent operating practice and Section 5 of the ESA.

F. Incomplete Test. If any ECT is not completed in accordance herewith (including as a result of any conditions specified in Section E.1.2.E(2) of this ESS Capacity Test Procedure), Contractor may, in its sole discretion: (i) accept the results up to the time the ECT was suspended; provided, however, that to the extent Owner reasonably objects to such results, Owner may

require that the ECT be repeated or that the portion thereof that was not completed, be completed within a reasonable specified time period; (ii) require that the portion of the ECT that was not completed to be completed within a reasonable specified time period; or (iii) require that the ECT be entirely repeated. Notwithstanding the foregoing, if Contractor is unable to complete an ECT due to a Force Majeure event or the actions or inactions of Owner or the Transmission Provider, Contractor shall be permitted to reconduct such ECT on dates and at times reasonably acceptable to the Parties.

G. Final Report. Within ten (10) Business Days after the completion of any ECT, Contractor shall prepare and submit to Owner a written report of the results of the ECT, which report shall include:

(1) A record of the personnel present during the ECT that served in an operating, testing, monitoring or other such participatory role;

(2) the measured data for the ESS Electric Metering Device readings as well as each parameter set forth in this ESS Capacity Test Procedure, as applicable, including copies of the raw data taken during the ECT and plant log sheets verifying the operating conditions and output of the ESS;

(3) The ESS Capacity as determined by the ECT, including supporting calculations; and

(4) Contractor's statement of either Contractor's acceptance of the ECT or Contractor's rejection of the ECT results and reason(s) therefor.

Within ten (10) Business Days after receipt of such report, Owner shall notify Contractor in writing of either Owner's acceptance of the ECT results or Owner's rejection of the ECT and reason(s) therefor.

If either Party reasonably rejects the results of any ECT, such ECT shall be repeated in accordance with Section E.1.2.F of this ESS Capacity Test Procedure.

H. Supplementary ESS Capacity Test Protocol. No later than one hundred twenty (120) days prior to the Substantial Completion Date, Contractor shall deliver to Owner for its review and approval (such approval not to be unreasonably conditioned, delayed or withheld) a supplement to this Exhibit F with additional and supplementary details, procedures and requirements applicable to ESS Capacity Tests based on the then-current design of the ESS Facility (collectively, the "**Supplementary ESS Capacity Test Protocol**"). Thereafter, from time to time, Contractor may deliver to Owner for its review and approval (such approval not to be unreasonably conditioned, delayed or withheld) any Contractor-recommended updates to the then-current Supplementary ESS Capacity Test Protocol. The initial Supplementary ESS Capacity Test Protocol (and each update thereto), once approved by Owner, shall be deemed an amendment to this Exhibit F.

I. Adjustment to ESS Capacity. The total amount of the Point of Delivery Energy Out (expressed in MWh-AC) during the first Four (4) hours of discharge of any ECT (up to, but not in excess of, the product of (i) the Guaranteed ESS Capacity, as such Guaranteed ESS Capacity may have been adjusted (if at all) under this ESA, multiplied by (ii) Four (4) hours) shall be divided by Four (4) hours to determine the new ESS Capacity to the extent

such new ESS Capacity is less than the Guaranteed ESS Capacity. The actual capacity determined pursuant to an ESS Capacity Test, not to exceed the Guaranteed ESS Capacity, shall become the new ESS Capacity at the beginning of the day following the completion of the ESS Capacity Test for all purposes under this ESA.

J. ESS Roundtrip Efficiency Test Calculations. The ESS Roundtrip Efficiency shall be calculated as a result of the ECT measurements. The ESS Roundtrip Efficiency shall be calculated as the ratio of ESS Meter Energy Out (MWh-AC) and the ESS Meter Energy In (MWh-AC) as below:

$$Roundtrip\ Efficiency\ (\%) = \frac{ESS\ Meter\ Energy{-}Out\ (MWh{-}AC)}{ESS\ Meter\ Energy{-}In\ (MWh{-}AC)} \times 100\%$$

E.2 ESS Response Delay Test

Purpose of Test:

1. Determine the Charge Ramp Rate of the ESS
2. Determine the Discharge Ramp Rate of the ESS

Test Conditions:
The ESS Facility will be in the on-line state at between 15% and 85% SOC and at an initial active power level of 0 MW and reactive power level of 0 MVAR. This test shall not cause the ESS to charge from the grid.

Test procedure:

Measured Charge Ramp Rate:

1. Send an active power charge command of PMAX to charge the batteries
2. The time measured from when the ESS receives the PMAX charge command until the power measured at the ESS Electric Metering Device changes from 0MW to at least 1% of charge PMAX shall be the Charge Ramp Latency
3. The time measured to ramp from 1% to charge PMAX with a plus-or-minus two and one-half percent (2.5%) tolerance on the commanded power shall be the Actual Charge Ramp Rate

Measured Discharge Ramp Rate:

1. Send an active power discharge command of PMAX to discharge the batteries
2. The time measured from when the ESS receives the PMAX discharge command until the power measured at the ESS Electric Metering Device changes from 0MW to at least 1% of discharge PMAX shall be the Discharge Ramp Latency
3. The time measured to ramp from 1% to discharge PMAX with a plus-or-minus two and one-half percent (2.5%) tolerance on the commanded power shall be the Actual Discharge Ramp Rate

Determination of ESS Response Delay:
The calculation below will demonstrate the determination of the ESS Response Delay used to determine ESS Response Delay Damages according to Section 15.4.1.

a) An "Actual System Latency" shall be calculated, which shall be equal to:

$$Actual\ System\ Latency = Max(Charge\ Ramp\ Latency, Discharge\ Ramp\ Latency)$$

b) An "Actual System Latency Delay" shall be calculated, which shall be equal to:

$$\begin{aligned}&Actual\ System\ Latency\ Delay\\&= Max(Guaranteed\ System\ Latency, Actual\ System\ Latency)\\&- Guaranteed\ System\ Latency\end{aligned}$$

c) An "Actual Discharge Ramp Rate Delay" shall be calculated, which shall be equal to:

$$\begin{aligned}&Actual\ Discharge\ Ramp\ Rate\ Delay\\&= Max(Guaranteed\ Discharge\ Ramp\ Rate, Actual\ Discharge\ Ramp\ Rate)\\&- Guaranteed\ Discharge\ Ramp\ Rate\end{aligned}$$

d) An "Actual Charge Ramp Rate Delay" shall be calculated, which shall be equal to:

$$\begin{aligned}&Actual\ Charge\ Ramp\ Rate\ Delay\\&= Max(Guaranteed\ Charge\ Ramp\ Rate, Actual\ Charge\ Ramp\ Rate)\\&- Guaranteed\ Charge\ Ramp\ Rate\end{aligned}$$

e) The "Charging ESS Response Delay" shall be calculated, which shall be equal to:

$$\begin{aligned}&Charging\ ESS\ Response\ Delay\\&= Actual\ Charge\ Ramp\ Rate\ Delay\\&+ Actual\ System\ Latency\ Delay\end{aligned}$$

f) The "Discharging ESS Response Delay" shall be calculated, which shall be equal to:

$$\begin{aligned}&Discharging\ ESS\ Response\ Delay\\&= Actual\ Discharge\ Ramp\ Rate\ Delay\\&+ Actual\ System\ Latency\ Delay\end{aligned}$$

g) The "ESS Response Delay" shall be calculated, which shall be equal to:

$$\begin{aligned}&ESS\ Response\ Delay\\&= Max(Charging\ ESS\ Response\ Delay, Discharging\ ESS\ Response\ Delay)\end{aligned}$$

For any instance in which the ESS Response Delay, as measured by the ESS Electric Metering Device is a positive value during an ESS Unit Capabilities Test, Contractor shall pay to Owner the ESS Response Delay Damages identified in Section 15.4.1.

Performance Testing

1. Overview.

(a) *Overview*. This outlines the standard performance testing protocol ("Test") used to evaluate the System.

(b) *Key Terms*. The following Key Terms will apply to this:

Performance Guarantees per site:	
Guaranteed Power Capacity:	6,000 kW at the Point of Measurement.
Guaranteed Energy Capacity:	24,000 kWh at the Point of Measurement.
Guaranteed Roundtrip Efficiency:	87.1% at the Point of Measurement.

Roundtrip Efficiency Floor:	78% at the Point of Measurement.	
Energy Cost:	$50/MWh	
Roundtrip Efficiency Buydown:	Has the meaning given in Section 2(f), below.	
Roundtrip Efficiency Buydown: Cap:	$460,000	
Additional Key Terms:		
Apparent Power Capacity:	6,300 kVA at the Point of Measurement	
Line and Transformation Losses:	No more than: 1.25% real power and 7.00% reactive power losses. Note: % real power and % reactive power loss is function of the Apparent Power Capacity specified above. For example, 1.5% real power loss is equivalent to 1.5 kW for 100 kVA System. Similarly, 6.5% reactive power loss is equivalent to 6.5 kVAR for 100 kVA System.	
Point of Measurement (POM):	Contractor furnished and installed ION Meter battery meter located at 12.47 kV (the "System Meter")	
Grid Voltage:	Nominal Grid Voltage (at Megapack's inverter terminals)	480 V_{AC}
	Voltage Requirement for full power operation (at Megapack's inverter terminals)	1.0 p.u. minimum 1.0 p.u. maximum
Maximum Design Temperature:	40.0°C as determined from ASHRAE Climatic Design Conditions 2017.	
Weather Station	ALBUQUERQUE INTL, NM, USA (WMO: 723650) . Used to monitor Relative Humidity, Pre-Test Hourly Average Ambient Temperature and Maximum Hourly Average Ambient Temperature. The weather station can be any station in the vicinity of the site and should be agreed upon between the Parties prior to the test.	

(c) Additional Definitions.

The terms in this Section 1(c) have the following meanings, when used in connection with the Test.

Available Charge Power	The estimated power that can be charged into the batteries, as reported by the Tesla System Controller.
Available Discharge Power	The estimated power that can be discharged from the batteries, as reported by the Tesla System Controller.
Battery Energy Exported	The System's export energy as measured at the Point of Measurement by the System Meter and reported by the Tesla System Controller.
Battery Energy Imported	The System's import energy as measured at the Point of Measurement by the System Meter and reported by the Tesla System Controller.

Battery Real Power	The System's instantaneous total 3 phase real power as measured by the System Meter at the Point of Measurement and reported by the Tesla System Controller.
CT Error	The error of the current transformer during the Test according to its accuracy class.
Maximum Hourly Average Ambient Temperature	The maximum of hourly average ambient temperature recorded during the Test.
Actual Charge Power Capacity	The average of the Battery Real Power values measured during the charge portion of the Test excluding ramping period.
Actual Energy Capacity	The total energy (in MWh) discharged by the System when it is charged and discharged in accordance with the below procedure.
Actual Discharge Power Capacity	The average of the Battery Real Power values measured during the discharge portion of the Test excluding ramping period.
Actual Roundtrip Efficiency	The ratio of the energy discharged by the System to the energy used to charge the System when the System is charged and discharged in accordance with the below procedure.
Meter Error	The error of the System Meter during the Test according to its accuracy class.
Metering System Error	The error of all meters used during the Test according to its accuracy class and is calculated as follows $\text{Metering System Error} = \sqrt{(Meter\ Error^2 + CT\ Error^2 + PT\ Error^2)}$
Pre-Test Hourly Average Ambient Temperature	The hourly average ambient temperature recorded prior to the commencement of the Test as measured by Weather Station.
PT Error	The error of the potential transformer during the Test according to its accuracy class.
Real Power Ramp Rates	The maximum rate of change of the Battery Real Power (kW) set for the System.
Relative Humidity	The ratio, expressed in percent, of the amount of atmospheric moisture present relative to the amount that would be present if the air were saturated as measured by Weather Station.
State of Energy (SOE)	The state of energy as calculated by dividing the "Energy Remaining" by the "Full Pack Energy" signals as reported by the Tesla System Controller.

2. General Requirements.

(a) *Meters*.

Contractor shall procure and install ION meter along with a GPS clock with IRIG output, and this meter shall be used for closed loop control of the System to fulfill IEEE 1547:2018 compliance as well as to measure the performance metrics. The meter refresh time shall be the fastest allowable polling rate. Tesla to provide design recommendations on meter part number and CT/PT accuracy class requirements.

To the extent possible, Tesla reasonably requests that the Contractor validates the individual accuracy of the System Meter and its CTs and PTs. Contractor shall promptly recertify the individual accuracy of the System Meter and its CTs and PTs and provide evidence of same to Tesla.

Contractor shall provide all instrumentation, metering, and external data collection equipment required for the Test. Instrumentation shall include all instruments permanently installed at the Project and the temporary instruments suggested by Tesla or deemed necessary by Contractor in its sole judgement.

(b) Line and Transformation Losses.

Contractor shall ensure that the Line and Transformational Losses between the AC terminals of the System and the POM shall not exceed the real power and reactive power losses set forth in Section 1(b), taking into account all electrical losses, including cabling, switchgear, impacts of specified Voltage Requirement and transformer losses (load and no load).
If the actual Line and Transformational losses exceed either or both of real power and reactive power losses defined above, Tesla shall be entitled to reductions in the Performance Guarantees to the extent the combination of real and reactive components of actual Line and Transformational Losses compromises the System's ability to meet respective Performance Guarantees.

(c) Voltage Requirement.

Test should be conducted in accordance with the Voltage Requirements specified in the Key Terms. If the Nominal Grid Voltage is lower or higher than specified, Contractor shall try to adjust the voltage at the POM and System AC terminals to be equivalent to the specified values in the Key Terms. Tesla shall be entitled to reductions in the Performance Guarantees to the extent the change in Voltage Requirement compromises the System's ability to meet the respective Performance Guarantees. The methodology for determining such reductions shall be agreed upon between both parties ahead of the Test following detailed design of the System.

(d) Data Collection and Recording.

The values indicated in the Test shall be collected and recorded by the Tesla System Controller with timestamps at a frequency of at least once per second. The data collected and recorded by the Tesla System Controller are used to calculate whether the Performance Guarantees are met.

(e) *Test Procedures*.

All Tests shall be performed by a Tesla employee or a third party approved by Tesla. If any Performance Guarantee is not met the first time a Test is performed, the Test may be repeated until such Performance Guarantee is achieved. Once a Performance Guarantee is met, it shall be deemed met regardless of achievement of other Performance Guarantees. Contractor shall bear the cost of energy to charge the System in connection with a Test, and shall be entitled to any revenue resulting from the Test.

(f) *Test Report*.

Tesla shall provide a Performance Test Report documenting the results of each Test within five (5) Business Days of Test completion.

3. Performance Test Protocol.

(a) *Purpose*.

Demonstrate that the Actual Charge Power Capacity, Actual Discharge Power Capacity, Actual Energy Capacity, and Actual Roundtrip Efficiency of the System equals or exceeds the Guaranteed Power Capacity, Guaranteed Energy Capacity, and Guaranteed Roundtrip Efficiency, respectively.

(b) *Pre-Test Conditions*.

Prior to the commencement of the Test:

1. The Pre-Test Hourly Average Ambient Temperature shall be between 20°C (68°F) and 30°C (86°F) and hourly average Relative Humidity shall be less than 70% for at least 12 hours. This condition can be waived at Tesla's sole discretion.

2. If the forecasted or actual Pre-Test Hourly Average Ambient Temperature is below 20°C (68°F) during the 12 hours prior to the Test, the System shall be pre-heated for 8 hours prior to the test (Heat Mode is activated).

3. If the Pre-Test Hourly Average Ambient Temperature is above 30°C (86°F) and the hourly average Relative Humidity is greater than 70% during the 12 hours prior to the Test, then the Test shall be postponed until a time when such conditions have subsided for at least 12 hours.

4. The System shall be kept idle for 2 hours between 10% - 25% SOE to allow SOE calibration.

5. If during the Test, the Maximum Hourly Average Ambient Temperature is higher than Maximum Design Temperature, then following temperature adjustments shall be applied to Guaranteed Energy Capacity.

(a) Maximum Design Temperature < Maximum Hourly Average Ambient Temperature <= 50°C (122°F): 99.0% of Guaranteed Energy Capacity

6. If during the Test, the Maximum Hourly Average Ambient Temperature is higher than 25°C (77°F), then the following temperature adjustments shall be applied to the Guaranteed Roundtrip Efficiency of the System:

(a) 25°C (77°F) < Maximum Hourly Average Ambient Temperature <= 30°C (86°F): 99.7% of Guaranteed Roundtrip Efficiency

(b) 30°C (86°F) < Maximum Hourly Average Ambient Temperature <= 35°C (95°F): 99.0% of Guaranteed Roundtrip Efficiency

(c) 35°C (95°F) < Maximum Hourly Average Ambient Temperature <= 40°C (104°F): 98.0% of Guaranteed Roundtrip Efficiency

(d) 40°C (104°F) < Maximum Hourly Average Ambient Temperature <= 50°C (122°F): 97.0% of Guaranteed Roundtrip Efficiency

7. If the Maximum Hourly Average Ambient Temperature > 50°C (122 °F), then the Test will be postponed until a time when the temperature is expected to remain below 50°C (122°F) for a minimum of 24 hours.

8. If the Contractor, utility, or independent system operator requires a specified ramp rate, the ramp rate shall be so configured, and the energy charged and discharged during the ramp shall be accounted for in the calculation of the Actual Roundtrip Efficiency and Actual Energy Capacity.

9. Reactive Power control mode is set to OFF. If not possible, Tesla shall be entitled to reductions in the Guaranteed Values to the extent keeping reactive power control turned ON compromises the System's ability to meet the applicable Performance Guarantee. The methodology for determining such reductions shall be agreed upon between both parties ahead of the Test following detailed design of the System.

10. Frequency Support shall be disabled. If not possible, Tesla shall be entitled to reductions in the Guaranteed Values to the extent the change in grid frequency compromises the System's ability to meet the applicable Performance Guarantee. The methodology for determining such reductions shall be agreed upon between both parties ahead of the Test following detailed design of the System.

11. The System reports Available Discharge Power that is equal to or greater than the Guaranteed Power Capacity, adjusted to account for Line and Transformational Losses.

12. The System reports Available Charge Power that is equal to or greater than the Guaranteed Power Capacity, adjusted to account for Line and Transformational Losses.

(c) *Test Procedure*.

1. Discharge until the System's SOE reaches 0% or the Available Discharge Power is zero.

2. Allow the System to idle fully discharged for 5 minutes. The System shall remain grid-connected during the rest period.

3. Send a charge command equal to the Guaranteed Power Capacity. As the Tesla System Controller receives the charge command, record time T1: start of charge.

4. Hold the charge command. Once the System's Battery Real Power first reaches the Guaranteed Power Capacity, record time T2: end of the ramp (charge).

5. Hold the charge command. As the System gets close to end of charge, the absolute value of the System's Battery Real Power will drop and remain below 98% of the Guaranteed Power Capacity (for example, if command is -100 MW, the Battery Real Power should be between 0 MW and -98 MW continuously). Once the System's Battery Real Power is 98% or less of the Guaranteed Power Capacity continuously, record time T3: end of steady state charge.

6. Hold the charge command. Once the System's Available Charge Power is equal to zero, record time T4: end of charge.

7. Allow the System to idle fully charged for up to 5 minutes. The System shall remain grid-connected during the rest period.

8. Send a discharge command equal to the Guaranteed Power Capacity. As the Tesla System Controller receives the discharge command, record time T5: start of discharge.

9. Hold the discharge command. Once the System's Battery Real Power first reaches the Guaranteed Power Capacity, record time T6: end of ramp (discharge).

10. Hold the discharge command. As the System gets close to end of discharge, the System's Battery Real Power will drop and remain below 98% of the Guaranteed Power (for example, if command is 100 MW, the Battery Real Power should be below 98 MW continuously). Once the System's Battery Real Power is 98% or less of the Guaranteed Power Capacity continuously, record time T7: end of steady state discharge

11. Hold the discharge command. Once the System's Available Discharge Power is zero, record time T8: end of discharge.

(d) *Recorded Values*.

1. Average of Battery Real Power (kW), as measured at the System Meter from T2 to T3

2. Average of Battery Real Power (kW), as measured at the System Meter from T6 to T7

3. Battery Energy Imported (kWh), as measured at the System Meter at T1

4. Battery Energy Imported (kWh), as measured at the System Meter at T4

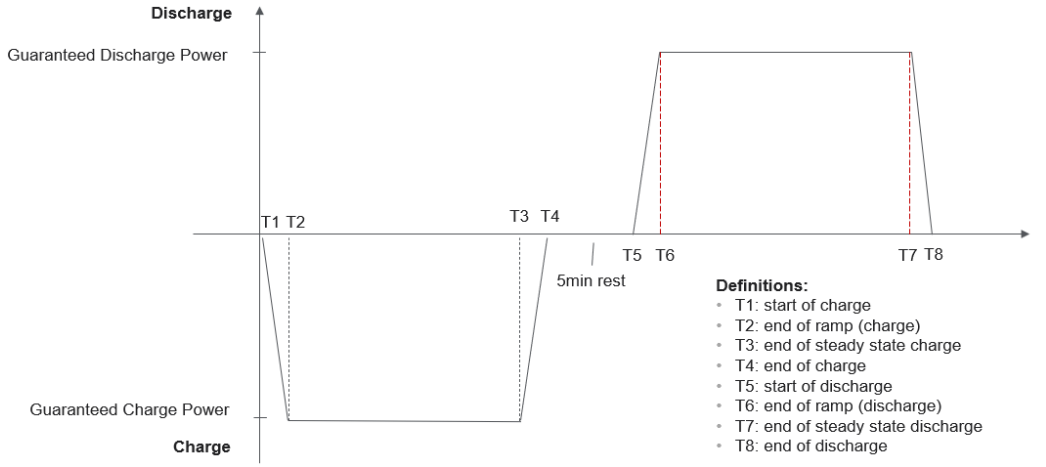
5. Battery Energy Exported (kWh), as measured at the System Meter at T5

6. Battery Energy Exported (kWh), as measured at the System Meter at T6

7. Battery Energy Exported (kWh), as measured at the System Meter at T7

8. Battery Energy Exported (kWh), as measured at the System Meter at T8

Timestamps T1 to T8 as represented below:



(e) *Acceptance Criteria*.

1. Guaranteed Power Capacity

$$|Actual\ Charge\ Power\ Capacity| \geq Guaranteed\ Power\ Capacity * (1 - Metering\ System\ Error)$$

$$Actual\ Discharge\ Power\ Capacity \geq Guaranteed\ Power\ Capacity * (1 - Metering\ System\ Error)$$

Where:

Actual Charge Power Capacity is the average of the Battery Real Power between times T2 and T3
Actual Discharge Power Capacity is the average of the Battery Real Power between times T6 and T7

2. Guaranteed Energy Capacity

$$Actual\ Energy\ Capacity \geq Guaranteed\ Energy\ Capacity * (1 - Metering\ System\ Error)$$

Where, if no Real Power Ramp Rates are configured:

$$Actual\ Energy\ Capacity = Battery\ Energy\ Exported\ (T7) - Battery\ Energy\ Exported\ (T6)$$

Where, if Real Power Ramp Rates are configured:

$$Actual\ Energy\ Capacity = Battery\ Energy\ Exported\ (T8) - Battery\ Energy\ Exported\ (T5)$$

If the Contractor, utility, or independent system operator require that Real Power Ramp Rates are applied during the Test, the energy discharged during the ramp up and ramp down times shall be included in the Actual Energy Capacity.

3. Guaranteed Roundtrip Efficiency

$$Actual\ Roundtrip\ Efficiency \geq Guaranteed\ Roundtrip\ Efficiency$$

Where:

$$Actual\ Roundtrip\ Efficiency = 100\% * \frac{Battery\ Energy\ Exported\ (T8) - Battery\ Energy\ Exported\ (T5)}{Battery\ Energy\ Imported\ (T4) - Battery\ Energy\ Imported\ (T1)}$$

(f) *Acceptance Criteria*.

If the Acceptance Criteria for Guaranteed Roundtrip Efficiency are not met, then Tesla shall have the option to buy down the Guaranteed Roundtrip Efficiency. The "Roundtrip Efficiency Buydown" shall be calculated as follows

$$Roundtrip\ Efficiency\ Buydown\ [USD] = \sum_{t=1}^{Warranty\ Years} \frac{\left(\frac{1}{Actual\ RTE} - \frac{1}{Guaranteed\ RTE}\right) \times (Total\ Throughput\ Limitation_t - Total\ Throughput\ Limitation_{t-1}) \times Guaranteed\ Energy\ Capacity \times Energy\ Cost}{(1+i)^t}$$

Where,

t = Operating Year of the Megapack Limited Warranty
Energy Cost has the meaning given in the Key Terms
i = discount rate of 10%

Tesla's liability for the Roundtrip Efficiency Buydown will be limited to the Roundtrip Efficiency Buydown Cap

EXHIBIT W

GUARANTY OF PAYMENT AND PERFORMANCE

This Guaranty of Payment and Performance (this "Guaranty") dated as of **[*]** (the "Effective Date"), is entered into by Public Service Company of New Mexico ("Guarantor"), in favor of Gridworks Inc., a corporation organized under the laws of the State of New Mexico ("Beneficiary") (Beneficiary and Guarantor, individually a "Party" and collectively, the "Parties").

RECITALS

A. Guarantor's affiliate, Public Service Company of New Mexico (the "Owner"), and Beneficiary have entered into that Engineering, Procurement and Construction Agreement dated **[*]** (as it may be amended, restated or otherwise modified pursuant to its terms from time to time, the "Agreement"), pursuant to which the Owner has agreed, among other things, to (i) purchase a battery energy storage system to be built by Beneficiary (as defined in the Agreement) and (ii) perform certain related obligations in connection therewith.

B. Guarantor acknowledges that it will indirectly benefit from the terms and conditions of, and the performance by Owner and Beneficiary of their respective obligations under, the Agreement.

NOW, THEREFORE, in consideration of Beneficiary's agreement to enter into the Agreement with Owner, the premises, covenants and agreements contained in this Guaranty and other good and valuable consideration (the receipt and sufficiency of which the Parties acknowledge), Guarantor agrees with Beneficiary as follows:

AGREEMENT

1. Defined Terms. Except as otherwise provided herein, all capitalized terms used herein but not defined herein shall have the respective meaning assigned to such term in the Agreement.

2. Guaranty.

(a) In consideration of, and as an inducement for, Beneficiary's entering into the Agreement as of the date hereof, and in respect of the other consideration described herein, Guarantor, as of the Effective Date, irrevocably and unconditionally guarantees to Beneficiary the full and timely payment when due of all sums due and payable by Owner to Beneficiary in accordance with the terms and conditions of the Agreement, up to the amount of $_____, plus applicable taxes, and the full and faithful performance of all non-monetary obligations and responsibilities of Owner under the Agreement (collectively, the "Guaranteed Obligations").

(b) The Guaranteed Obligations shall include, without limitation, all reasonable costs and expenses (including reasonable attorneys' fees), if any, incurred in enforcing Beneficiary's rights under this Guaranty.

(c) To the extent that Owner shall fail to pay or fulfill any Guaranteed Obligation, as applicable, when due under the Agreement, Guarantor shall promptly pay or fulfill such Guaranteed Obligation, as applicable, for the benefit of Beneficiary, and in any event no later than on or before 5:00 p.m. prevailing Mountain Time on the fifth (5th) business day following a written justified demand therefor (a "Demand") furnished by Beneficiary to Guarantor.

(d) Notwithstanding anything contained herein to the contrary, in the event of any claim under this Guaranty, Guarantor shall be entitled to assert any defense, set-off or counterclaim Owner could assert had such claim been made directly against Owner, except for defenses arising out of bankruptcy, insolvency, receivership, reorganization, dissolution or liquidation of Owner, the power or authority of Owner to enter into the Agreement and the lack of validity or enforceability of the Agreement.

3. Nature of Guaranty. This Guaranty constitutes a guarantee of payment and performance and not of collection. This Guaranty is a continuing guarantee of payment and performance, is binding as a continuing obligation of Guarantor and shall be absolute and unconditional as if Guarantor were the principal obligor in respect of the Guaranteed Obligations.

4. Guaranty Absolute. To the fullest extent permitted by applicable law, the obligations of Guarantor are absolute and unconditional (except in the event of Owner's satisfaction of all its obligations under the terms of the Agreement) and Guarantor shall have no right to be released, relieved or discharged, in whole or in part, from its obligations referred to in this Guaranty for any reason whatsoever, including:

(a) any change in the time, manner or place of the payment or performance of the Guaranteed Obligations or in any other term of the Agreement or Owner's failure to carry out any of its obligations under the Agreement;

(b) any change in the financial condition of Guarantor or Owner;

(c) any change in the corporate existence, structure or ownership of, or cessation of existence of, Guarantor or Owner (whether by way of merger, amalgamation, transfer, sale, lease or otherwise);

(d) the bankruptcy, winding-up, liquidation, dissolution, insolvency, reorganization or other similar proceeding affecting Owner or its assets or any resulting rejection, release, stay or discharge of any Guaranteed Obligations;

(e) any lack or limitation of power, incapacity or disability on the part of Owner or of its directors, officers or agents;

(f) any amendment, supplement or modification to, waiver of, consent to or departure from, or failure to exercise any right, remedy, power or privilege under or in respect of, the Agreement, the Guaranteed Obligations or any other agreement or instrument relating thereto;

(g) the existence of any claim, set-off, or other rights which Guarantor may have at any time against Beneficiary in connection with any matter unrelated to the Agreement; or

(h) any defense arising by reason of any failure of Beneficiary to make any presentment, demand for performance, notice of non-performance, protest, or any other notice, except as expressly set forth herein.

5. Demands. Each Demand shall be in writing and shall (i) specify the nature of Owner's default in payment or performance of the Guaranteed Obligation that Owner has failed to pay or perform and (ii) demand that Guarantor pay or perform, as applicable, such Guaranteed Obligation in accordance with this Guaranty. A Demand satisfying the foregoing requirements shall be required with respect to Guaranteed Obligations before Guarantor is required to pay or perform such Guaranteed Obligation and shall be deemed sufficient notice to Guarantor that it must pay or perform the Guaranteed Obligation to the extent required hereunder.

6. No Exhaustion of Remedies. Subject to the requirement that Beneficiary provide a Demand in accordance with Section 2(c), Beneficiary is not obligated to exhaust its remedies against Owner or any other persons or take any other action before being entitled to make a demand for payment or performance from Guarantor.

7. Representations and Warranties. Guarantor represents and warrants to Beneficiary that, as of the Effective Date:

(a) Guarantor has full power and authority to execute, deliver and perform its obligations under this Guaranty;

(b) The execution, delivery and performance of this Guaranty have been duly authorized by all necessary action on behalf of Guarantor and do not contravene any provision of applicable law or of Guarantor's organizational documents or any contractual restriction binding on Guarantor or its assets;

(c) This Guaranty constitutes the legal, valid and binding obligation of Guarantor enforceable against Guarantor in accordance with its terms, subject to bankruptcy, insolvency, reorganization, moratorium and other laws of general application relating to or affecting creditors' rights and to general equitable principles (whether considered in a proceeding at law or in equity);

(d) No consent, approval, authorization or permit of, or filing with or notification to, any person or entity is required for or in connection with the execution and delivery of this Guaranty by Guarantor or for or in connection with the consummation of the transactions and performance of the terms and conditions contemplated hereby by Guarantor; and

(e) Guarantor has full knowledge of the financial condition of Owner.

8. Financial Condition of Owner. Guarantor shall be responsible for maintaining its knowledge of Owner's financial condition during the term of this Guaranty. Beneficiary shall have no duty to advise Guarantor of information known to Beneficiary regarding such financial condition or any circumstances bearing upon the risk of nonpayment or nonperformance of the Guaranteed Obligations by Owner.

9. Termination. This Guaranty shall automatically terminate upon the expiration of all surviving obligations of Owner under the Agreement (the "Guaranty Termination Date"). Any Demand submitted by Beneficiary after the Guaranty Termination Date shall not be effective or create any liability of Guarantor and is not guaranteed under this Guaranty. No such termination or release shall affect, release or discharge Guarantor's liability with respect to any Demand claimed by Beneficiary submitted by Beneficiary prior to the Guaranty Termination Date, and this Guaranty shall remain in full force and effect until such Demand submitted prior to the Guaranty Termination Date is paid in full, fulfilled or Guarantor is otherwise discharged from liability.

10. Subrogation. Guarantor will not exercise any rights that it may acquire by way of subrogation under this Guaranty by any payment made hereunder or otherwise, until all the Guaranteed Obligations have been paid in full, performed or otherwise satisfied. If any amount shall be paid to Guarantor on account of such subrogation rights at any time when all the Guaranteed Obligations shall not have been paid in full, performed or otherwise satisfied, such amount shall be held in trust by Guarantor for the benefit of Beneficiary and shall forthwith be paid to Beneficiary, to be credited and applied to the Guaranteed Obligations.

11. Waivers. Guarantor hereby waives (a) notice of acceptance of this Guaranty; (b) presentment, demand, notice of non-performance, protest, notice of protest and notice of dishonor concerning the liabilities of Guarantor, except for a Demand as expressly set forth in Section 2(c) above; and (c) any right to require that any action or proceeding be brought against Owner or any other person to require that Beneficiary seek enforcement of any performance against Owner or any other person. Guarantor consents to the renewal, compromise, extension, changes in the time of payment of or other changes in the terms of the Guaranteed Obligations, or any part thereof or any changes or modifications to the terms of the Agreement.

12. Benefit of the Guaranty. This Guaranty shall be binding on the executors, administrators and successors of Guarantor and shall inure to the benefit of Beneficiary and its executors, administrators, successors and permitted assigns.

13. Entire Agreement. Notwithstanding anything else stated in this Guaranty, this Guaranty constitutes the entire agreement between Beneficiary and Guarantor with respect to the Guaranty's subject matter and supersedes all other agreements and understandings between the Parties, whether written or oral, with respect to the subject matter hereof. There are no representations, warranties, terms, conditions, undertakings or collateral agreements, expressed, implied or statutory, between the Parties, with respect to the subject matter of this Guaranty, other than as expressly stated in this Guaranty.

14. Remedies. No delay of Beneficiary in the exercise of, or failure to exercise, any rights or remedies hereunder shall operate as a waiver of such rights or remedies, a waiver of any other rights or remedies or a release of Guarantor from any obligations hereunder, and no single or partial exercise by Beneficiary of any right or remedy shall preclude any further exercise thereof or the exercise of any other right or remedy. The remedies in this Guaranty are cumulative and not exclusive of any remedies provided by law or equity.

15. Severability. If any provision of this Guaranty is determined to be invalid or unenforceable in whole or in part, such invalidity or unenforceability shall apply only to such provision and all other provisions of this Guaranty shall continue in full force and effect.

16. Amendment. This Guaranty shall not be amended, changed or modified except by a subsequent agreement in writing which indicates that such writing is intended to amend the terms of this Guaranty and is signed by duly authorized officers of both Parties. The Parties agree that this Guaranty shall not be amended in any manner by any course of dealing between the Parties.

17. Notices. Any notice, demand, request or other communication to be given in connection with this Guaranty must be addressed to the receiving Party at:

To Beneficiary:

Gridworks Inc.
3900 Singer Blvd. NE
Albuquerque, NM 87109
Attention: Legal
Telephone: +1 505.944.4220
Email: legal@gridworks.com

And to Guarantor at:

Public Service Company of New Mexico
414 Silver Avenue SW
Albuquerque, NM 87102
Attention: General Counsel

Any notice, Demand, request or other communication may be delivered, and shall be effective upon delivery by certified mail. Each Party may notify the other of any change of address in the manner provided therein.

18. Assignment. Guarantor may not assign its rights under this Guaranty without the prior written consent of Beneficiary. For avoidance of doubt, Beneficiary shall be permitted to freely assign its rights and obligations under this Agreement in connection with a valid assignment by Beneficiary of the Agreement. Any purported assignment which fails to comply with the requirements of this Section 18 shall be null and void and shall have no force or effect.

19. Governing Law. This Guaranty and the rights and obligations of the Parties hereunder and the transactions contemplated hereby shall be governed by, enforced and interpreted in accordance with the laws of the State of New Mexico, without regard to conflicts of laws rules that require or permit the application of the laws of another jurisdiction.

IN WITNESS WHEREOF, the Parties have caused this Guaranty to be executed by their authorized representatives as of the Effective Date.

GUARANTOR:
Public Service Company of New Mexico

By:_____
Name:_____
Title: _____

BENEFICIARY:
Gridworks Inc.

By:_____
Name:_____
Title: _____

EXHIBIT X

EXPEDITED PAYMENT

Contractor shall specify and arrange for the purchase of:

1. ESS Units sufficient to meet the requirements in Exhibit A-1, Contractor's Statement of Work from approved suppliers described in Exhibit K, Specified Suppliers and Specified Subcontractors.

Contractor shall provide to Owner copies of supply agreements with such supplier (currently anticipated to be Tesla for the ESS Units) and will provide a schedule of payment to such supplier as design is finalized. Owner agrees that within 10 days of Contractor's submission of invoices for ESS Units to Owner and consistent with the above, Owner shall pay such invoices (without duplication in the Contract Price).

Appendix X-1 BESS Sale & Purchase Agreement by and between Tesla, Inc. and Gridworks, Inc.

EXHIBIT Y

LIMITED NOTICE TO PROCEED AGREEMENT

LIMITED NOTICE TO PROCEED AGREEMENT

This LIMITED NOTICE TO PROCEED for the **PNM Distribution Battery Phase II** Project ("LNTP") is issued as of **XXXX XX, 202X** (the "Effective Date"), by PUBLIC SERVICE COMPANY OF NEW MEXICO ("Owner"), to GRIDWORKS INC. ("Contractor") pursuant to the EPC of the same date.

This LNTP authorizes Contractor to:

Execute the Tesla Megapack Sale and Purchase Agreement. (See Exhibit X in EPC Agreement)

Procure and initiate purchases of other long lead items:

- BESS medium-voltage transformers

Prepare and submit up to 90% project engineering packages for Owner reviews

LNTP Amount. The amount authorized by this LNTP shall not exceed $_____M. The payment schedule will follow the payments in Exhibit I of the EPC Agreement (the "Payment Schedule"). Supply agreements obtained under this LNTP will be shared with Owner as soon as executed and will be assignable to Owner or its designee. No additional expenditures are authorized until Owner issues full Notice to Proceed.

Payment. Contractor shall invoice Owner the portions of the LNTP Amount specified in the payment schedule set forth in Exhibit I upon providing Owner evidence of satisfactory progress of the preliminary work. Payment terms will follow Section 6 of the EPC.

EPC Contract Wrap. This LNTP – including any payments made – shall be incorporated into the EPC Contract and the rights and obligations of the Parties under this LNTP (including the Parties' rights upon Termination of obligations hereunder) shall be governed by the terms of the EPC Contract. In the event of a conflict between this LNTP and the EPC Agreement, all of both Parties' rights, obligations and remedies under this LNTP will be superseded by the rights, obligations and remedies of the EPC Contract.

[SIGNATURES ON THE FOLLOWING PAGE]

IN WITNESS WHEREOF, the Parties have caused this LNTP to be duly executed as of the Effective Date.

OWNER:

Public Service Company of New Mexico

By: _____

Name: _____

Title: _____

CONTRACTOR:

Gridworks Inc.

By: _____

Name: _____

Title: _____

EXHIBIT Z - Tesla Lithium Indexation Formula, Assumptions and Illustrations (Price Adjustment)

The Contract Price shall be adjusted to the extent the Final Price for the Tesla ESS (Megapack) units changes pursuant to the following:

Final Price = Megapack System Price + Price Adjustment

Price adjustment is based on $/kWh of installed energy capacity

Price Adjustment = (LCEm - LCEb) * MPx * (1/Fx) / 1000

- Fx - RMB/USD rate at the time of Final Price Calculation
- MPx - Megapack cost factor
- LCEb - baseline lithium carbonate price
- LCEm - market lithium carbonate price = the average lithium carbonate price of the LCE Observation Period in accordance with the table below.

Defined by SMM Shanghai Metals Market (99.5% Battery Grade)

- Minimum value of 67,500 RMB

Delivery Period Midpoint*	LCE Observation Period**
Dec — Feb	Mar — May
Mar — May	Jun — Aug
Jun — Aug	Sep — Nov
Sep — Nov	Dec — Feb

Details on Delivery and associated LCE Observation Quarter subject to final confirmation
*Median date between Earliest Permitted Delivery Date and Guaranteed Delivery Date
**Year prior to median delivery date
Example: For median delivery date in November 2024, the LCE Observation Period for Continental North America would be Dec 2023 - Feb 2024

Tesla's LCE Indexation Illustration

Project/Configuration	MP2XL 4hr C012
Installed Capacity (kWh)	25,020
Exchange (RMB/USD)***	7.244
LCEb (RMB/mt)	100,000
MPx	1.180

% Change in LCE	LCEm (RMB/t)	($/kWh)
-32%	67,500	-5.29
50%	150,000	8.14
150%	250,000	24.43
250%	350,000	40.71
350%	450,000	56.99

EXHIBIT AA

Prevailing Wage Certificate

This Prevailing Wage Certificate is being given pursuant to that certain engineering, procurement and construction agreement (the "EPC Contract"), dated as of *[*date*]*, between ("Owner") and *[ ]* ("Contractor") for the construction of the facility (the "Project"). Capitalized terms not defined in this certificate have the same meaning as in the EPC Contract.

The undersigned, in his or her capacity as an officer of Contractor, hereby certifies as follows:

1. Contractor's Prevailing Wage Requirements and Apprentice Requirements for the Project have been fulfilled as of Final Completion.

2. All PWA Records required to be retained by Contractor and its Subcontractors, whose workers performed Work subject to the Prevailing Wage and Apprenticeship requirements at the Site or any secondary construction site or support site, have been retained by Contractor and, to the best of Contractor's knowledge as of the date of this certificate, its Subcontractors.

The undersigned declares that I have examined the information contained in this Prevailing Wage Certificate, am aware that the Owner plans to use the information as a basis for certifying compliance with the Prevailing Wage Requirements and Apprentice Requirements to the Internal Revenue Service, and, to the best of my knowledge and belief and based on appropriate internal diligence, the information is true, correct and complete.

*[*Contractor*]*

By: _____

Name: _____

Title _____

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF PUBLIC SERVICE COMPANY OF NEW MEXICO'S APPLICATION FOR A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY TO CONSTRUCT, OWN, AND OPERATE 30 MEGA WATTS OF BATTERY ENERGY STORAGE FACILITES	)	
PUBLIC SERVICE COMPANY OF NEW MEXICO	)	**Case No. 25-00055-UT**

AFFIDAVIT

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

GARY B. BARNARD, Executive Director, Renewable Generation and Contracts for PNMR Services Company, upon being duly sworn according to law, under oath, deposes and states: I have read the foregoing **Direct Testimony of Gary B. Barnard,** and it is true and accurate based on my own personal knowledge and belief.

DATED this 6th day of August, 2025.

/s/ *Gary B. Barnard*
GARY B. BARNARD

GCG #533975