Battery Test System Hardware User Manual

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Contents

Battery Test System

The Battery Test System provides a flexible and efficient solution for validating electric vehicle DUTs: battery packs, test stations, and modules. Built on NI adaptive open technology, the Battery Test System can be quickly reconfigured and customized to meet rapidly changing test requirements and provides for integrating your collection of test equipment.

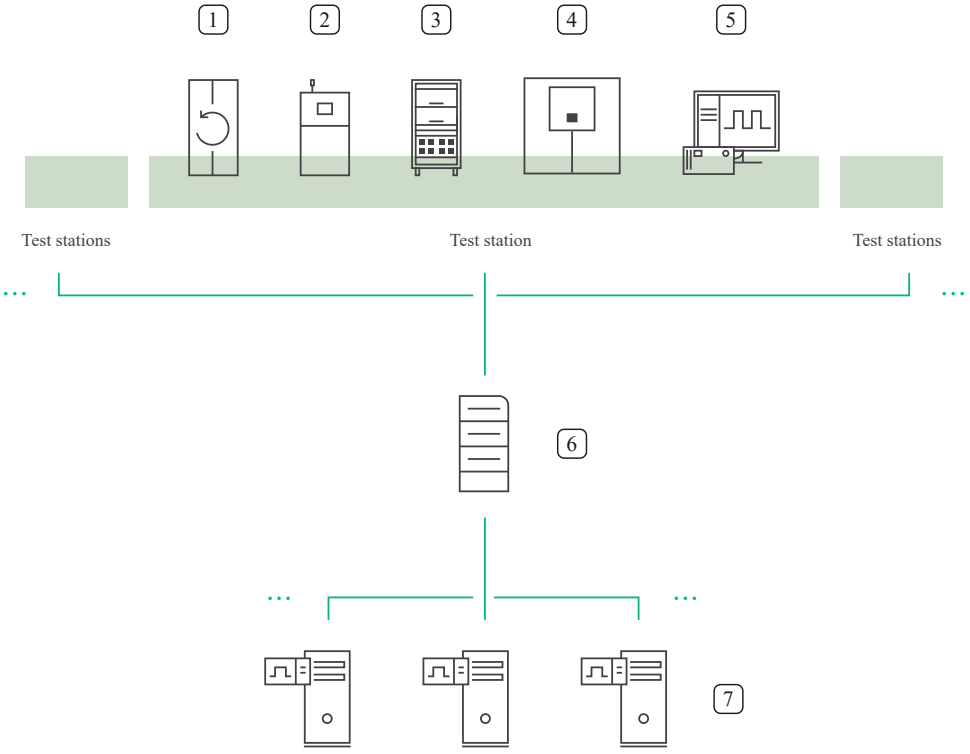
This manual contains hardware information, including an overview of the hardware components in your system.

System Overview

The Battery Test System is designed to perform measurement functions within your overall battery test environment. A complete test solution includes third-party equipment integration for battery cyclers, thermal chambers, and chillers, as well as software designed to control the test environment.

A typical Battery Test System integration for a large-scale deployment includes the following components:

Figure 1. Battery Test System Components: Large-Scale Deployment



1. Cycler
2. Chiller
3. BTS-16101 measurement rack
4. Environmental chamber
5. Lab PC
6. BTS Server
7. Engineering PC(s)

Note The figure depicts a single-DUT test station.

Each of these components is defined as follows:

- **Cycler**—Device to drive charge and discharge cycles of the DUT. Incorporate one cycler per DUT in each test station.
- **Chiller**—Device to control the temperature of components within the test station. Incorporate one chiller per DUT in each test station.
- **BTS-16101 measurement rack**—Core Battery Test System measurement hardware. Refer to ***Hardware Overview*** for more information.
- **Environmental chamber**—Thermal chamber that contains one or more DUTs.

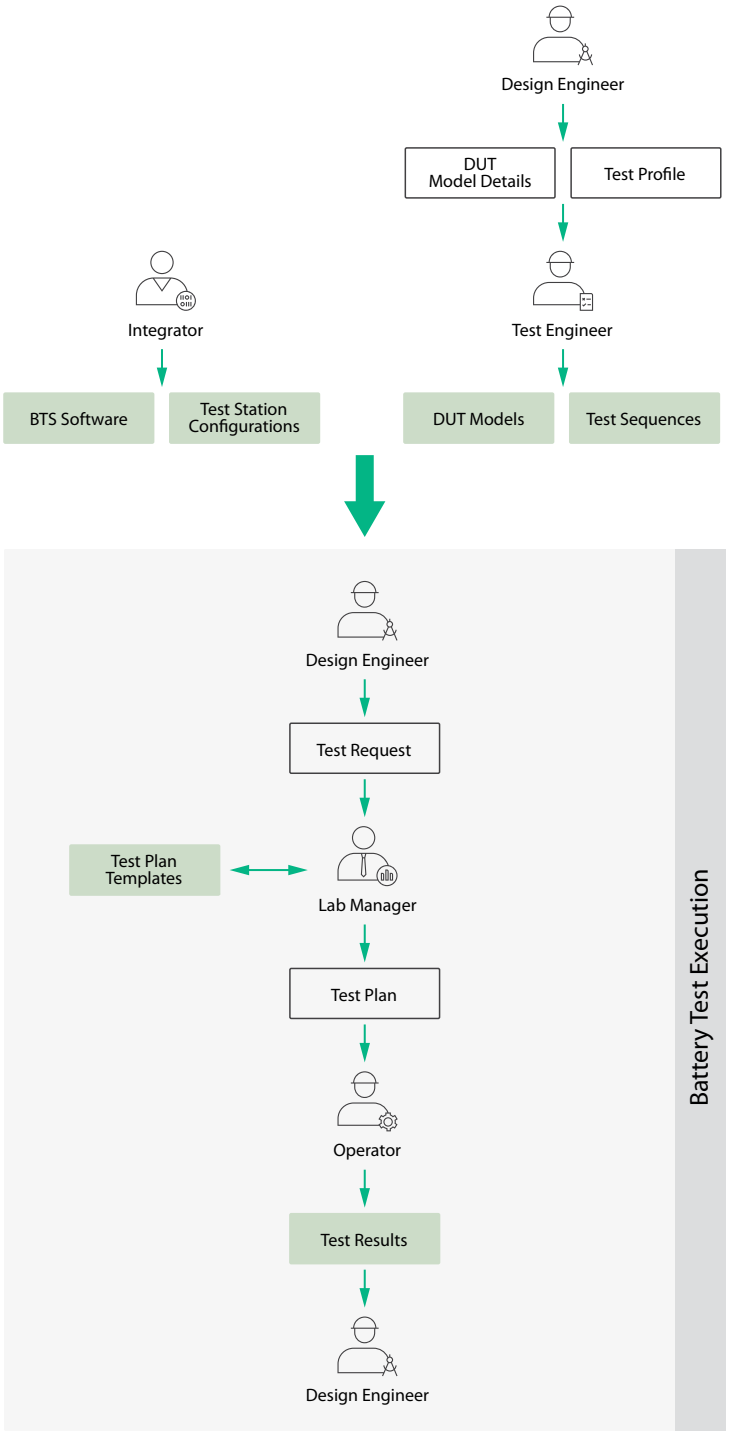
  The environmental chamber for your Battery Test System implementation may include optional FieldDAQ devices for in-chamber measurements. Refer to ***FieldDAQ Hardware for In-Chamber Measurements*** in the ***Battery Test System Hardware User Manual*** for more information.

- **Lab PC**—PC and monitor for controlling a single test station; runs the measurement and control software for the test station, such as TestStand and VeriStand.
- **BTS Server**—Central computer resource that provides storage for Battery Test System assets and runs the Battery Test System Web Server software that implements the Battery Test System Web UI. For purposes of this illustration, the BTS Server also functions as the SystemLink server for system management, user authentication, and test data collection. However, these can be different computers.
- **Engineering PC**—Machine(s) that define and submit assets to the BTS Server for the Battery Test System Web UI, such as test definitions and plugins developed by test engineers or test station definitions and plugins developed by integrators.
- **Test Station**—Overall single-instance set of test equipment.

Note For smaller deployments, the functionality of the Lab PC, BTS Server, and Engineering PC may be combined on fewer physical machines.

Battery Test System Workflow

The following image illustrates the battery test system workflow. It includes example roles as well, such as design engineers, test engineers, and integrators:



The design engineers specify the devices that need to be tested (the DUTs) as well as the tests to be run on them. Integrators and test engineers then take these requirements, and using the Web UI, create a custom UI that captures the various

elements of test environment such as the DUTs, test stations, and the I/O signals to monitor. The lab manager then uses the custom UI to create the actual test plans. A ***test plan*** is a combination of one or more DUTs, a test, and a test station. The Operator then executes the test plans and the design engineer evaluates the results.

Additional terms are defined as follows:

- **Test Sequence**—A reusable test (created in TestStand and VeriStand Stimulus Profile Editor) used to test DUT(s) in the test station.
- **DUT Model**—A specific battery pack, module, or cell to test.
- **Test Plan**—A specific combination of a parameterized test sequences to be run on a specific DUT on a specific test station. Refer to ***Architecture of Test Plans in the Battery Test System Web UI*** for more information.
- **Test Plan Template**—A base test plan that can be used to create a custom test plan.

Hardware Overview

The Battery Test System hardware comprises the BTS-16101 measurement rack, optional FieldDAQ devices for in-chamber measurements, and third-party equipment integration for battery cyclers, thermal chambers, and chillers.

BTS-16101 Measurement Rack Components

The BTS-16101 measurement rack is a low power ATE-116H-A 24U rack modified specifically for use in testing automotive electric batteries.

The BTS-16101 is designed for modularity and expansion and may include a combination of the following components depending on your specific test application needs.

Table 1. BTS-16101 Required Components

Component Type	Quantity	Part	Description
Measurement Rack	1	RMX-10011	Custom ATE Core Configurations assembly, low power 24U with included: • Emergency power off (EPO) panel • Power entry panel (PEP) • Remote EPO connector • Power distribution unit (PDU) • Uninterruptible power supply (UPS)
Controller	1	cRIO-9047	1.60 GHz Quad-Core CPU, 4 GB Storage,

Component Type	Quantity	Part	Description
			-40 °C to 70 °C, Kintex-7 70T FPGA, 8-Slot CompactRIO Controller
Ethernet Switch	Up to 2	cRIO-9805	4-port 802.1AS Time-Sensitive Networking (TSN) Ethernet Switch Expansion Module for CompactRIO
	1	EDS-316-T	MOXA 16-port Industrial Unmanaged Ethernet Switch
Power Supplies	Up to 12	RMX-4101	210 W, 60 V, 3.5 A, Programmable Power Supply
CAN/LIN	1 or more	NI-9860	2-port, C Series Vehicle Multiprotocol Interface Module
Analog Input Voltage Module	1 or more	NI-9224	8-channel, ±10 V, 1 kS/s/ch, 24-Bit, Simultaneous Input, C Series Voltage Input Module
		NI-9225	3-channel, 300 V RMS, 50 kS/s/ch, 24-Bit, Simultaneous Input, C Series Voltage Input Module
		NI-9228	8-channel, ±60 V, 1 kS/s/ch, 24-Bit, Simultaneous Input, C Series Voltage Input Module

Table 2. BTS-16101 Optional Components

Component Type	Part	Description
CompactDAQ	cDAQ-9189	8-Slot, TSN-Enabled Ethernet

Component Type	Part	Description
		CompactDAQ Chassis
GPIB/RS-232	GPIB-RS232	Serial, RS232 GPIB Instrument Control Device
RS-232	NI-9870	4-Port, RS232 C Series Serial Interface Module
NI-XNET CAN/LIN Transceiver Cable	TRC-8543	CAN High-Speed/Flexible–Data Rate or Low-Speed/Fault-Tolerant Transceiver Cable
	TRC-8546	LIN Transceiver Cable
Thermocouple	NI-9212	8-Channel, 95 S/s/ch Simultaneous, ±78 mV, C Series Temperature Input Module
	NI-9213	16-Channel, 75 S/s Aggregate, ±78 mV, C Series Temperature Input Module
HVIL Control: SPST Relay	NI-9482	4-Channel, 60 V DC (1 A)/250 V AC (1.5 A), C Series Relay Output Module
HVIL Monitor: AI Current	NI-9227	4-Channel, 50 kS/s/ch, 5 A RMS, 24-Bit, C Series Current Input Module
HVIL Monitor: Digital Input	NI-9422	8-Channel (Sinking/Sourcing Input), 24 V to 60 V, 250 µs, C Series Digital Module
HVIL Monitor: PWM Input	NI-9423	8-Channel (Sinking Input), 24 V, 1 µs, C Series Digital Module
	NI-9437	8-Channel (Sinking Input), 24 V DC to 250 V DC, 1 µs, C Series Digital Module
Digital Input	NI-9375	32-Channel (Sinking Input, Sourcing Output), 30 V, 7 µs (Input)/500 µs (Output), C Series Digital Module
Digital Output	NI-9475	8-Channel (Sourcing Output),

Component Type	Part	Description
		60 V, 1 µs, C Series Digital Module

Related reference:

- Measurement Rack Component Locations

Battery Cyclers

The Battery Test System integrates with various battery cyclers from NI and third parties. Refer to the user manual for your cycler for interfacing options. Refer to your integrator for detailed instructions on how to add and configure a battery cycler custom device.

Third-Party Equipment Integration

To further control your test environment, use the following instruments in the measurement rack to integrate and communicate with third-party battery cyclers, thermal chambers, and chillers.

- NI-9870 C Series Serial Interface Module—Adds RS232 or RS485/RS422 serial ports to CompactRIO systems.
- NI-9860 C Series Vehicle Multiprotocol Interface Module—Provides a hardware-selectable controller area network (CAN) and/or local interconnect network (LIN) interface for developing applications with the NI-XNET driver on CompactDAQ or CompactRIO. The NI-XNET platform includes a series of high-performance CAN and LIN interfaces that you can use to communicate with hardware using those protocols. NI-XNET is used to communicate with the battery management system and CAN-based instruments, some third party battery cyclers, chillers, and environmental chambers.
- GPIB-RS232 GPIB Instrument Control Device—Provides GPIB/serial communication to third-party instrument depending on the measurement rack configuration.

FieldDAQ Hardware for In-Chamber Measurements

You can use the FD-11613 (8-channel) or FD-11614 (16-channel) Temperature Input

Devices for FieldDAQ to move instrumentation inside the thermal chamber, reduce cabling, and accelerate test setup. The FieldDAQ devices are external components to the BTS-16101 measurement rack.

Safety and Compliance

This section contains information on safe operation and modification of the Battery Test System, as well as on electromagnetic compatibility (EMC) compliance.

Safety Requirements

The following general safety requirements and specifications must be observed during all phases of operation of this equipment. Failure to comply with these precautions or with specific warnings elsewhere in the system documentation violates safety standards of design, manufacture, intended use, and could invalidate the warranty of the system. This equipment contains voltage hazardous to human life and safety, and is capable of inflicting personal injury. NI assumes no liability for the customer's failure to comply with these requirements.

Note Using the measurement rack, or any component within, in a manner not specified by the manufacturer may reduce or eliminate equipment and/or personnel safety measures.

Caution When this symbol is marked on a product, refer to the ***BTS-16101 Battery Test System Measurement Rack Safety, Environmental, and Regulatory Information*** document for information about precautions to take.

Attention Lorsque ce symbole figure sur un produit, reportez-vous au document ***BTS-16101 Battery Test System Measurement Rack Safety, Environmental, and Regulatory Information*** pour obtenir des informations sur les précautions à prendre.

Before connecting the system to a power source, read this section and verify that you have complied with all safety requirements and specifications.

Caution Before undertaking any bring up, troubleshooting, maintenance, or exploratory procedure, carefully read the following caution notices.

Attention Avant d'entreprendre toute procédure de mise en service, de dépannage, de maintenance ou d'exploration, lisez attentivement les avertissements suivants.

Note Refer to the ***APC UPS Operation Manual*** for detailed information and specifications for this accessory.

AC MAINs Cables

AC MAINs cables are available from NI under the following orderable part numbers:

Table 3. Low Power Configuration Power Cables

Cable	Part Number
Power Cord, AC, IEC C19 to NEMA 5-20P, 2.5 m - US/CA (16A/120V)	785708-01
Power Cord, AC, IEC C19 TO NEMA L6-20P, 2.5 m - US/CA (20A/250V)	786352-01
Power Cord, AC, IEC C19 to CEE7, 3P, 16 A, 2.5 m - EU	785714-04
Power Cord, AC, IEC C19 to GB3, 3P, 16 A, 2.5 m - China	785714-10
Power Cord, AC, IEC C19 to BS1363 2.5 m - UK	785714-06
Power Cord, AC, IEC C19, 2.5 m - Australia (15A/250V)	786344-01
Power Cord, AC, IEC C19, 2.5 m - Japan (15A/125V)	786345-01
Power Cord, AC, IEC C19, 2.5 m - India (15A/240V)	786346-01
Power Cord, AC, IEC C19, 2.5 m - Brazil (16A/250V)	786348-01

Cable	Part Number
Power Cord, AC, IEC C19, 2.5 m - Malaysia, Hong Kong, Singapore, Saudi Arabia (16A/250V)	786349-01
Power Cord, AC, IEC C19, 2.5 m - Taiwan (15A/250V)	787198-01

Refer to Battery Test System Replacement Parts for information about components and cabling for the measurement rack.

Removing Power

Caution The emergency power off (EPO) button, the Main Power Switch, and the Main Breaker (CB Outlet) do not fully remove power from the measurement rack. For full EPO functionality, refer to Measurement Rack Power States. To completely interrupt power to a single phase system, you must disconnect the AC power cable. Do not position equipment so that it is difficult to disconnect the cable.

Attention Le bouton d'arrêt d'urgence, l'interrupteur d'alimentation principal et le disjoncteur principal (CB Outlet) ne coupent pas complètement l'alimentation du rack de mesure. Pour en savoir plus sur la fonctionnalité complète de l'arrêt d'urgence, reportez-vous à la section Measurement Rack Power States. Pour interrompre complètement l'alimentation d'un système monophasé, vous devez déconnecter le câble d'alimentation CA. Veillez à positionner l'équipement de sorte qu'il soit facile d'en déconnecter le câble d'alimentation.

Caution You must turn the Main Power Switch on the EPO Panel to the Standby position to fully disable the UPS output power.

Attention Vous devez mettre l'interrupteur d'alimentation principal du panneau d'arrêt d'urgence en position de veille pour désactiver complètement l'alimentation de sortie de l'onduleur.

Operator Safety Information

Cables and connectors are considered inaccessible if a tool (screwdriver, wrench, socket, etc.) or a key (equipment in a locked cabinet) is required to gain access to a conductive surface connected to any cable conductor.

Caution Access is prohibited to operators and is to be done by a trained service person only.

Attention L'accès est interdit aux opérateurs et doit être effectué par un technicien qualifié uniquement.

Caution Filler panels shall be installed in all empty slots on the front of the rack so that operator access to interior equipment surfaces is restricted.

Attention Les caches de protection doivent être installés dans tous les emplacements vides à l'avant du rack afin de limiter l'accès de l'opérateur aux surfaces intérieures de l'équipement.

Caution Verify equipment under test has adequate insulation between the cable connections and any operator-accessible parts (doors, covers, panel shields, cases, cabinets, etc.).

Attention Vérifiez que l'équipement sous test a une isolation adéquate entre les connexions des câbles et toutes les pièces accessibles à l'opérateur (portes, capots, blindages de panneau, boîtiers, armoires, etc.).

Powering On After Thermal Shutdown

The measurement rack has four safety shutoff thermostats on the interior surface of the fan cooling panel located at the top of the rack. The thermostats are configured to move the system to Standby state in the event the rack is unable to provide adequate cooling, preventing a safety hazard to the user. When triggered by a severe over

temperature event, the thermostats shut down the system by cutting power at the Power Entry Panel AC outlet, immediately shutting off power to any downstream equipment: the PDU, UPS, cRIO-9047, PS-16, and components powered by the PS-16. The temperature controller remains on in Standby state.

If the thermostats have tripped it is likely a result of a fault in the system (such as a fan failure) and should be addressed before the system is allowed to resume normal operation.

To reset the thermostats after they have tripped, complete the following steps:

Caution Once the thermostats have tripped, any touchable or accessible surface should be allowed to cool to 65 °C before servicing the system. All service must be done by a trained service person.

Attention Une fois que les thermostats se sont déclenchés, toute surface accessible ou pouvant être touchée doit avoir refroidi à 65 °C avant la réparation du système. Toutes les réparations doivent être effectuées par un technicien qualifié.

Caution Do not attempt to reset the thermostats until their temperature is below 45 °C.

Attention N'essayez pas de réinitialiser les thermostats tant que leur température n'est pas inférieure à 45 °C.

Caution Turn the Main Breaker (CB Outlet) on the Power Entry Panel Off before attempting to reset the thermostats.

Attention Éteignez le disjoncteur principal (***CB Outlet***) du panneau d'entrée d'alimentation avant d'essayer de réinitialiser les thermostats.

1. Locate the thermostats on the interior surface of the fan panel at the top of the rack, and depress the red button located on the bottom facing surface of each

thermostat.
2. Power on the system using the Powering on the System procedure.
   The system should power on as normal once the powering on procedure is utilized.

Emergency Power Off Panel

Use the Emergency Power Off (EPO) Panel to disable the PDU and any equipment connected to it. Refer to Measurement Rack Power States for more information.

EPO Temperature Controller

The secondary EPO temperature controller on the EPO panel is user configurable and enables you to visually monitor the temperature of the system for thermal performance. The secondary temperature controller is not a safety temperature protective device.

> **Notice** When temperature setpoint is reached, the temperature controller does not move the system into a shutdown state.

Circuit Protection

Several layers of circuit protection are designed into the systems. The power entry panel has circuit protection to ensure the overall system does not draw current beyond the MAINs power limit.

Walls and Rear Door

The measurement rack comes with pre-installed removable side walls and locking rear door. Side panels utilize quarter-turn inset screws for easy serviceability. The rear door can be easily removed using the spring-loaded hinges that attach it to the rack frame.

Protective Earthing

High levels of leakage current may be present on the measurement rack. Connect the

measurement rack to the protective earth terminal before connecting to AC power. Refer to Connecting the Rack to Earth Ground for more information.

Additional Hardware Integration Requirements

This section covers the following topics regarding measurement rack modification and integration requirements:

- Mechanical Stability
- Power Consumption and Dissipation

Mechanical Stability

Each BTS-16101 configuration is designed to ensure physical stability of the measurement rack and to prevent overbalancing or tipping. When adding additional instruments or components to the BTS-16101, it is important to preserve stability.

Use the following guidelines to maintain mechanical stability when adding additional components to the BTS-16101:

- For IEC 61010-1 compliance, the BTS-16101 and all included components must weigh less than 453.5 kg (1,000 lb), evenly distributed among all caster wheels. Refer to the ***BTS-16101 Battery Test System Measurement Rack Safety, Environmental, and Regulatory Information*** for the maximum weight of the BTS-16101.
- To improve the safety and stability of the BTS-16101, you can install the steel ballast plate for the RMX-10011 Rack (NI part number 785805-01) at the bottom of the rack.
- Tether the BTS-16101 to the floor or wall for additional stability. Make sure to keep all cooling clearances open if the rack is to be tethered. Ensure your tether is sufficient for the weight of the rack. Tethering should be done in accordance with local practices, and any securement should be made between the rack frame and the surrounding structure by mechanical means able to support four times the load of the system.
- Any equipment that exceeds the following load weights and hangs permanently outside of the rack must have external support, such as legs.

Maximum drawer load	13.6 kg (30 lb)

Note Such modification, removal, or installation of equipment must be done by a qualified and trained service person.

Caution Stability is based on the specific configuration of the system ordered, when fully assembled. Your system may be shipped in separate crates or boxes. Use caution to ensure stability while moving your system, and prior to assembly of the configured system.

Attention La stabilité est basée sur la configuration spécifique du système commandé, une fois assemblé entièrement. Votre système peut être expédié dans des caisses ou des boîtes séparées. Prenez toutes les précautions nécessaires pour assurer la stabilité de votre système lorsque vous le déplacez et avant l'assemblage du système configuré.

Caution If you remove equipment from the rack, it may no longer be compliant with IEC 61010-1 stability standards. Ensure that any modifications you make to the rack configuration maintains sufficient stability in accordance with IEC 61010-1. Any modifications made to the system not specified by the manufacturer may reduce the personal safety measures employed and compliance with IEC 61010-1.

Attention Si vous retirez un équipement du rack, il peut ne plus être conforme aux normes de stabilité IEC 61010-1. Assurez-vous que toute modification apportée à la configuration du rack permette de conserver une stabilité suffisante conformément à la norme IEC 61010-1. Toute modification apportée au système non spécifiée par le fabricant peut réduire les mesures de protection personnelle utilisées et la conformité à la norme IEC 61010-1.

Power Consumption and Dissipation

The following table lists the maximum power that can be dissipated inside the rack for a given ambient environment and lowest rated equipment installed in the rack. Additional power beyond the rated levels can be passed through to equipment located externally to the rack (for example, using NI 2U RMX DC power supplies to power a device under test where the load is physically outside of the rack).

Caution Must be used only with certified equipment having ambient ratings that fall within the maximum internal air temperature ratings of the following table.

Attention Doit être utilisé uniquement avec des équipements certifiés dont les valeurs nominales ambiantes correspondent aux valeurs maximales de température de l'air interne figurant dans le tableau suivant.

Note The ambient temperature ratings and power dissipation limitations in the following table do not guarantee the thermal performance of equipment in the rack, only that the rack contains adequate cooling capacity to provide the rated internal rack ambient temperature needed to support properly rated and installed equipment. Ensure individual pieces of equipment installed in the rack are within their specified operational ranges.

Note All equipment inside the rack must be powered directly, or indirectly, through the rack power entry panel. Other sources of external power must not be used.

Table 4. Low Power (16 A, 50/60 Hz Input) (Watts)

Ambient Temperature	**Maximum Internal Temperature 50 °C**	
	100 VAC to 120 VAC	**200 VAC to 240 VAC**
40 °C (Maximum Manufacturing Environment)	664 W	614 W
28 °C (Typical Manufacturing Environment)	1,580 W	1,710 W
23 °C (Typical Room Environment)	1,580 W	1,710 W

Note The maximum power consumption is limited by the UPS: 1,800 W for the 120 V UPS, or 1,980 W for the 240 V UPS.

The power dissipation for each subsystem in the BTS-16101 is dependent on configuration and usage, as shown in the following table.

Table 5. Subsystem Maximum Power Consumption (Watts)

Subsystem	Maximum Consumption	Maximum Dissipation	Notes
CompactRIO	60 W	60 W	—
CompactDAQ	32 W, per chassis	32 W, per chassis	—
GPIB-RS232	9.6 W	9.6 W	—
PS-16	240 W	26.67 W	Power consumption of the CompactRIO, CompactDAQ, and GPIB-RS232 is included in the maximum power consumption of the PS-16. The actual power varies with instrumentation configuration and usage.
RMX-4101	210 W, per power supply	52.5 W, per power supply	Assumes load is external to the measurement rack.

Electromagnetic Compatibility

This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) stated in the product specifications. These requirements and limits provide reasonable protection against harmful interference when the product is operated in the intended operational electromagnetic environment.

This product is intended for use in industrial locations. However, harmful interference may occur in some installations, when the product is connected to a peripheral device or test object, or if the product is used in residential or commercial areas. To minimize interference with radio and television reception and prevent unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation.

Furthermore, any modifications to the product not expressly approved by NI could void your authority to operate it under your local regulatory rules.

EMC Notices

Refer to the following notices for cables, accessories, and prevention measures necessary to ensure the specified EMC performance.

Notice A ferrite bead must be installed on the input power cable nearest to the DC terminal blocks in the secondary drawer.

Notice Operate this product only with shielded cables and accessories. The DC power input cables may be unshielded.

Notice You must use an isolated cable with the RS-485 serial port.

Notice The USB device port is intended only for use in device configuration, application deployment, debug, and maintenance.

Notice Product installation requires either special considerations or user-installed, add-on devices.

Notice Refer to the individual instrument documentation for additional notices pertaining to specific cable, accessory, or other requirements to ensure specified EMC performance.

Hardware Reference

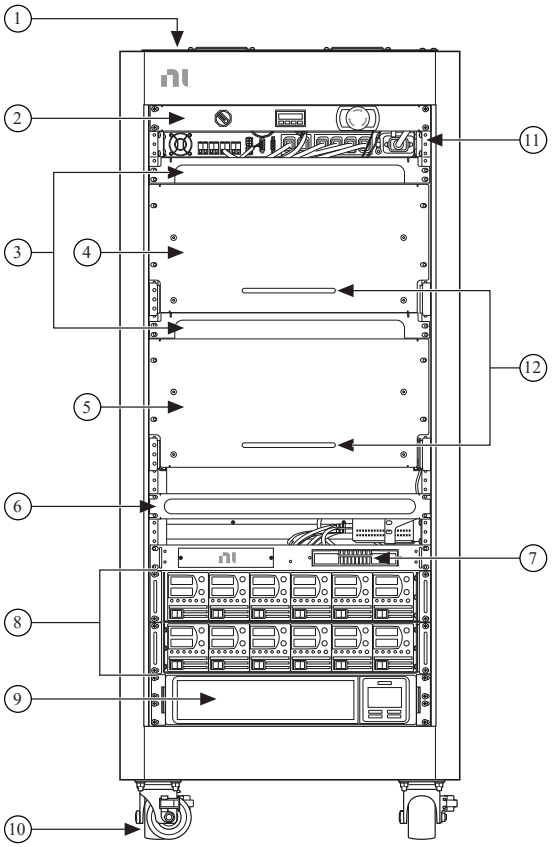
This section describes the location and function of hardware contained within the BTS-16101 measurement rack.

Measurement Rack Component Locations

Refer to the following figures to locate the BTS-16101 measurement rack components.

Note Your measurement rack configuration may vary from the following figures depending on the optional components in your system.

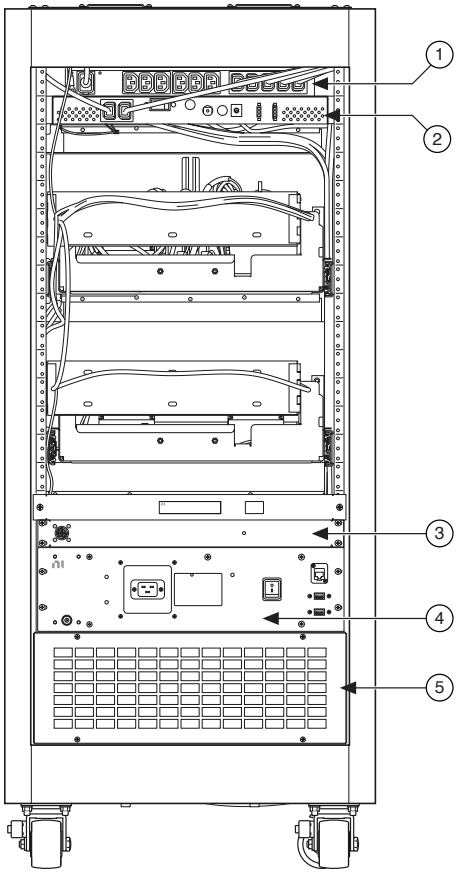
Figure 2. BTS-16101 Front View



1. Fan Panel

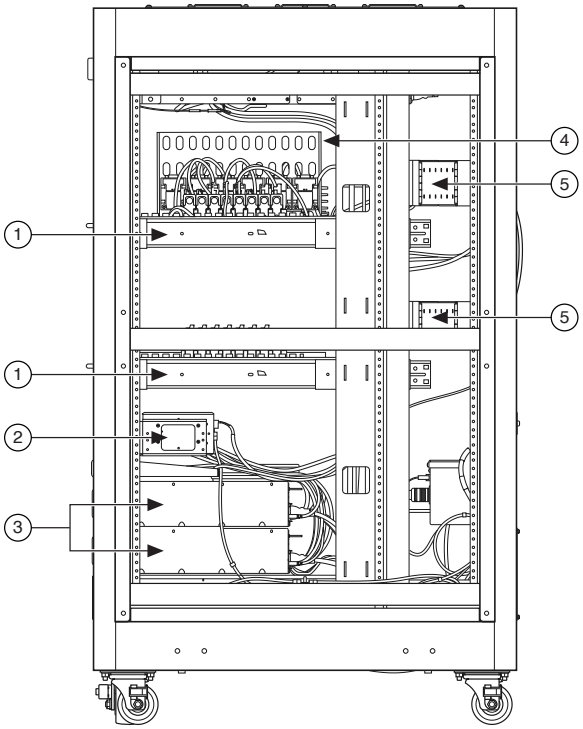
2. Emergency Power Off (EPO) Panel
3. 1U Open-Bottom Brush Panel Cable Entry
4. Primary Drawer
5. Secondary Drawer
6. 1U Brush Cable Entry
7. GPIB-RS232
8. RMX-4101 Power Supplies
9. Uninterruptible Power Supply (UPS)
10. Industrial Casters
11. Power Distribution Unit (PDU)
12. Drawer Handles

Figure 3. BTS-16101 Rear View



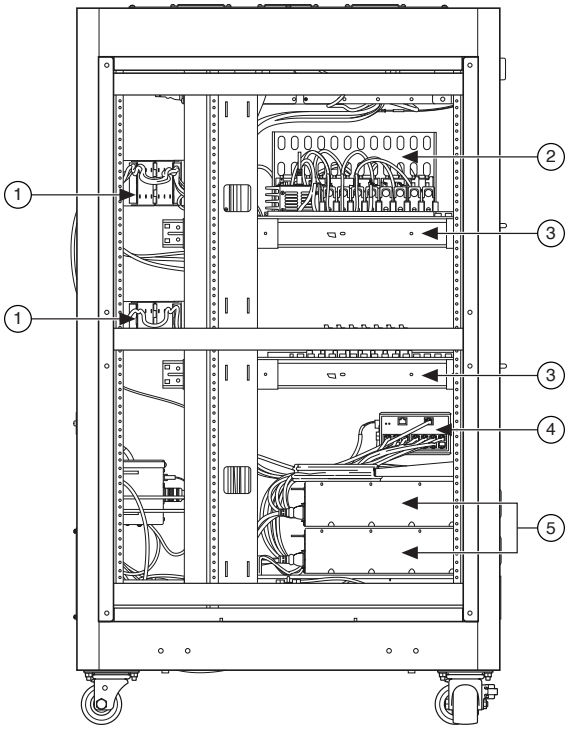
1. Auxiliary PDU
2. PDU
3. Remote EPO Connector Panel
4. 3U Power Entry Panel (PEP)
5. 4U Air Inlet Panel

Figure 4. BTS-16101 Right Side View



1. Drawer Slides
2. Ethernet Switch
3. RMX-4101 Power Supplies
4. Transceiver Cable (TRC) Mounting Brackets
5. Articulating Cable Arm

Figure 5. BTS-16101 Left Side View



1. Articulating Cable Arm
2. Transceiver Cable (TRC) Mounting Brackets
3. Drawer Slides
4. Ethernet Switch
5. RMX-4101 Power Supplies

Related concepts:

- BTS-16101 Measurement Rack Components

Measurement Rack Component Features

Refer to the following topics for information on function of the components in the BTS-16101 measurement rack.

- Power Entry Panel
- Emergency Power Off Panel
- Remote EPO Connector
- Measurement Rack Drawers

- Measurement Rack Power
- Measurement Rack Ethernet Networking

Power Entry Panel

Figure 6. Power Entry Panel (PEP) Front and Rear View

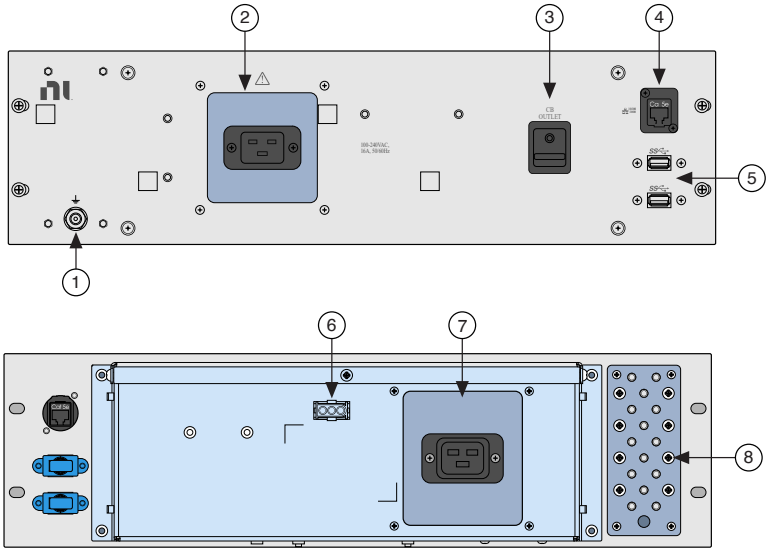


Figure Callout	Description	Use
1	Protective Earthing Ground Stud	Provides internal grounding plate connections with the external grounding lug for all rack mount equipment. High levels of leakage current may be present on the measurement rack. Connect the measurement rack to the protective earth terminal before connecting to AC power. Refer to the ***BTS-16101 Battery Test System Measurement Rack Safety, Environmental, and Regulatory Information*** document for specifications for protective earth terminal wiring.

Figure Callout	Description	Use
		Note The facility installation shall provide a means for connection to protective earth, and qualified personnel shall install a protective earthing conductor from the BTS-16101 protective earthing terminal to the protective earth wire in the facility.
2	Power Inlet Connector	Provides a low power (IEC 60320 C20) power entry.
3	Main Breaker (CB Outlet)	Provides circuit protection as a main breaker by controlling whether AC power will be allowed into the rack. If the Main Breaker switch is off, the rack cannot be powered on.
4	Ethernet Port	Facilitates network connectivity to internal equipment. The Gigabit Ethernet port connects to the cRIO-9047 controller.
5	USB 3.0 Ports (x2)	Provides access to extension cables within the rack. The internal USB extension cables ship unterminated for user-customizable connection to internal equipment. Use the USB cables that are included in the kit for external connection.
6	DC Output to EPO Panel	Provides DC power and inhibit control to/from the EPO panel.

Figure Callout	Description	Use
7	Output Connector	Provides AC output to the uninterruptible power supply (UPS).
8	Grounding Plate	Provides a connection point for the measurement rack ground.

The PEP also includes a line filter for EMI protection within the system.

Emergency Power Off Panel

When a test system encounters a serious issue or an emergency is taking place in the facility, operators need the ability to quickly and cleanly power off the test system. The emergency power off (EPO) panel mechanisms are included on the measurement rack to simplify connectivity and inhibit power switching.

Operators can use the EPO to reset a system in an error state, prevent damage to a DUT, or prevent harm to themselves.

Figure 7. EPO Panel

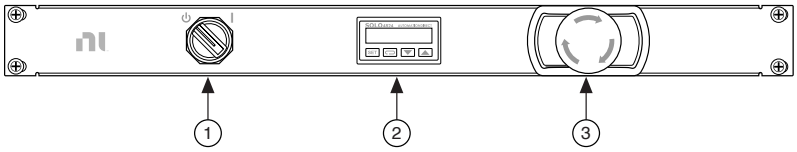


Figure Callout	Description	Use
1	Main Power Switch	Provides the primary way of controlling whether the system is active. It toggles between two positions—Standby (⏻) and On (I). Learn more about these states in Measurement Rack Power States.
2	Temperature Controller (AutomationDirect SL4824-RR-D)	Measures temperature based on the location of the attached thermocouple. **Notice** When temperature setpoint is reached, the temperature controller does not move the system into a shutdown state.

Figure Callout	Description	Use
3	Emergency Power Off Button	Provides a way to control whether the system is powered. The following behavior occurs when you press the EPO button: • The EPO immediately cuts AC power from the power entry panel (PEP) and power distribution unit (PDU) when a user or system monitor recognizes an unacceptable operating condition. The uninterruptible power supply (UPS) remains powered so that the measurement instruments in the rack continue logging data. DC power is passing out of the PEP and into the thermostat EPO panel, as described in Measurement Rack Power States. • The remote EPO connector is triggered to move external equipment to an EPO state, as described in Remote EPO Connector. To release the EPO button after it is pressed, rotate it clockwise.

Remote EPO Connector

The remote emergency power off (EPO) connector provides access to the power distribution unit (PDU) ***Disable*** loop. It also provides dry contacts for remote shutdown of external equipment. This connection allows immediate action to complete the following:

- When the EPO button on the measurement rack is depressed, the remote EPO connector switches all external equipment on the external safety loop to the EPO state.
- When an external instrument on the external safety loop enters an EPO state, the remote EPO connector switches the measurement rack into the Remote EPO state. For more information about this state, refer to Measurement Rack Power States.

When the external instrument exits its EPO state, the remote EPO connector switches the measurement rack out of the Remote EPO state into its previous state.

The Remote EPO connector has connections for the EPO button and the external safety loop.

Figure 8. Remote EPO Connector

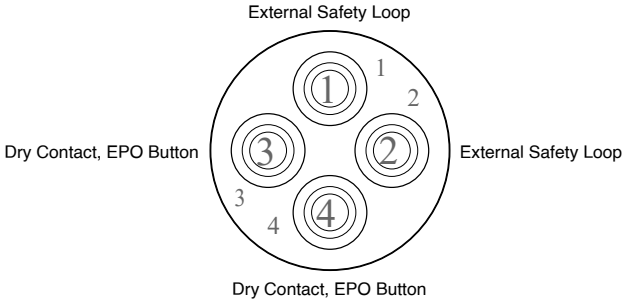


Table 6. Remote EPO Connector Terminals

Terminal	Connection	Normal State	EPO State
1	External safety loop	Closed	Open
2	External safety loop	Closed	Open
3	Dry contact, EPO button	Closed (default)	Open
4	Dry contact, EPO button	Closed (default)	Open

Use the following mating components to create interlock cabling for an external safety loop.

Table 7. Remote EPO Connector Mating Components

Component	Manufacturer/Part Number
Plug assembly, size 11 reverse sex series 1, CPC (1 ea)	TE connectivity 206429-1
Kit, cable clamp, standard shell sixe 11, CPC (1 ea)	TE connectivity 1-206062-4
Strip, III+SKT, 18-16, 30AU/FL (4 ea)	TE connectivity 66099-4

Note You must install the EPO loopback dongle included the accessory kit if you are not creating an external safety loop.

Related tasks:

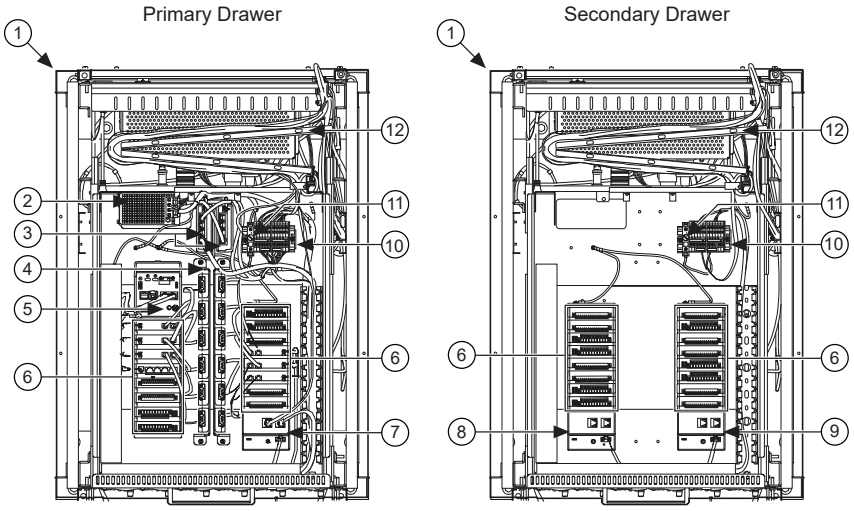
- Configuring the Remote EPO Connector

Measurement Rack Drawers

The measurement rack features up to two sliding drawers which allow for easier cable routing and improves the utilization of space within the rack.

Note The secondary drawer is an optional feature and the optional components in each drawer may vary depending on your configuration. The following figure is an example of a measurement rack configuration that includes the secondary drawer.

Figure 9. Internal Top-Down View of Drawers



1. Sliding Drawer
2. PS-16 Power Supply
3. cRIO-9805 Ethernet Switch
4. Transceiver Cable Mounting Brackets (Optional)
5. cRIO-9047 Controller
6. C Series Modules (Optional)
7. cDAQ1 (Optional)
8. cDAQ2 (Optional)
9. cDAQ3 (Optional)
10. Terminal Block

11. DC Power Fuse
12. Articulating Cable Arm

Note In the preceding figure, cDAQ1, cDAQ2, and cDAQ3 refer to the cDAQ-9189 chassis.

The drawers contain the following features:

- Articulating arm that enables the full range of motion of the drawer and organizes cables from the drawer components to other components within the rack
- Wire ducts for easier cable routing and organization
- Optional mounting brackets for TRC-8543/8546 NI-XNET CAN/LIN transceiver cables that can be mounted in either drawer
- DC power fuse and terminal block

Notice To ensure the specified EMC performance, a ferrite bead must be installed on the input power cable nearest to the DC terminal blocks in the secondary drawer.

Related concepts:

- DC Power Fuse
- BTS-16101 Measurement Rack Components

Related tasks:

- Opening the Drawers

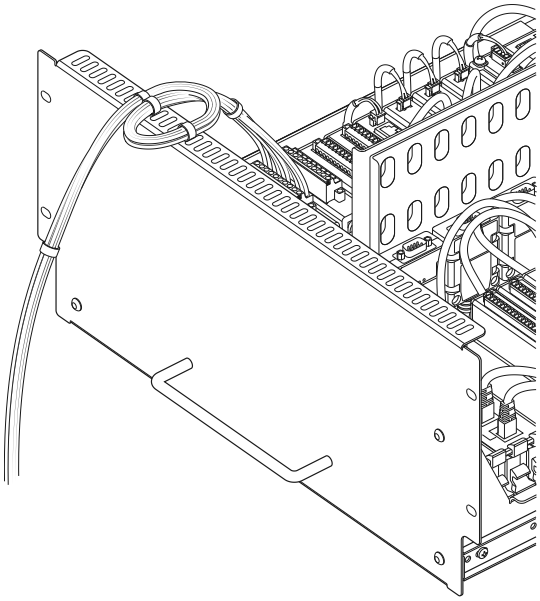
Related reference:

- PS-16 Power Supply

Cable Management

To reduce strain on the instrumentation connectors, NI recommends that you provide extra cable length or a service loop on the side of the instrument or at the tie-down points on the drawer front panel, as shown in the following figure.

Figure 10. Sliding Drawer Tie-Down Points



Measurement Rack Power

This section covers the following power-related components and topics:

- Measurement Rack Power States
- Connecting Power and Powering Up
- Power Distribution Unit
- Uninterruptible Power Supply
- PS-16 Power Supply

Measurement Rack Power States

Table 8. Measurement Rack States of Operation

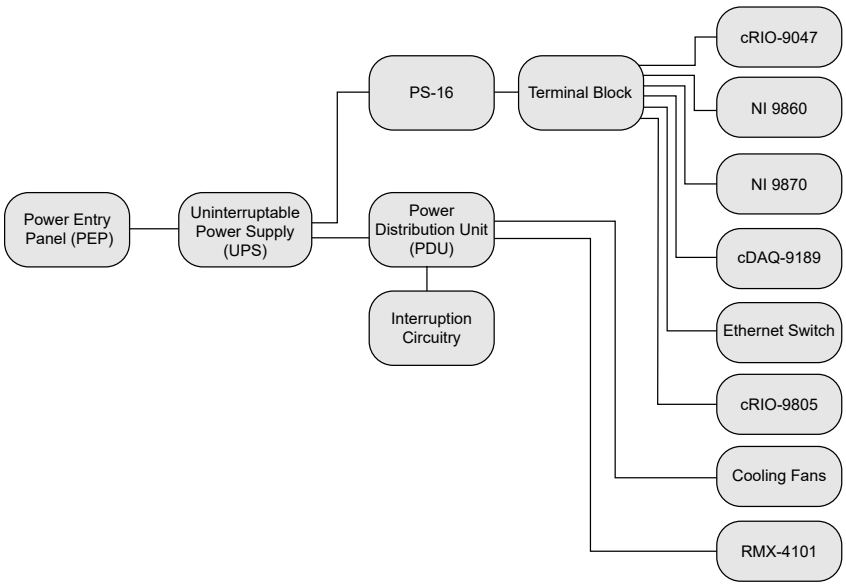
Power State	PEP	PDU	UPS	Temperature Controller
Off	Off	Off	Off	Off
Standby	On (AC)	Off	Off	On
EPO	DC only	Off	On	On
Remote EPO	On (AC)	Off	On	On
On	On (AC)	On	On	On

Table 9. Power State Descriptions

Power State	Description	Action
Off	The system is entirely disabled with no power passing through the line filter or any internal test system components.	To enter Off state: 1. Switch the main breaker (CB outlet) on the power entry panel (PEP) to the OFF position. 2. Disconnect MAINs power from the PEP. To exit Off state, follow the process in Powering on the Measurement Rack.
Standby	Power to the power distribution unit (PDU) and uninterruptible power supply (UPS) is shut off. Power is passing out of the PEP and into the thermostat emergency power off (EPO) panel.	To enter Standby state: 1. Move the main power switch on EPO panel to the Standby (⏻) position. 2. Safety shutoff thermostats on fan panel detect an unsafe air exit temperature. To exit Standby state, move the main power switch to the ON (I) position.
EPO	Immediately cuts AC power from the PEP and PDU. The UPS remains powered so that the measurement instruments in the rack continue logging data. DC power passes out of the PEP and into the thermostat EPO panel. Entering this state also triggers the remote EPO connector, which, when connected to an external safety loop, automatically shuts off external	To enter EPO state, press the EPO button. To exit EPO state, turn clockwise to release the EPO button.

Power State	Description	Action
	equipment.	
Remote EPO	Immediately cuts power from the PDU. The UPS remains powered so that the measurement instruments in the rack continue logging data. Power passes out of the PEP and into the thermostat EPO panel.	The system enters Remote EPO state when other equipment connected to an external safety loop through the remote EPO connector enter an EPO state. The system exits Remote EPO state after the external instrument exits its EPO state. The rack switches into its previous state.
On	A change to this state begins the main power on sequence of the test system. The PDU receives AC power through the UPS from the PEP and enables outlets to other system equipment. The EPO panel is powered.	To enter the On state, follow the process in Powering on the System.

Figure 11. Power Block Diagram



Connecting Power and Powering Up

Refer to AC MAINs Cables for information about connecting power to the rack. Refer to Powering on the System for information about powering up the system.

Power Distribution Unit

A power distribution unit (PDU) takes an input power signal and distributes it to several outlets that can power components of the system. These internal power outlets from the PDU have a rated voltage and current for both alternating and direct current.

The measurement rack features a single-phase PDU that supports global voltages (100 V to 240 V, 50 Hz to 60 Hz) and has a 20 A (IEC C19) input connector which cables directly to the uninterruptible power supply (UPS).

Refer to the ***MPD 41145X Family Product Manual***, which ships with the Battery Test System, for more information about the PDU.

Uninterruptible Power Supply

Use the uninterruptible power supply (UPS) to power critical components in your system during power loss, brownouts, EPO state, and during normal operation.

The UPS delivers power with a dependable voltage and current supply. It acts as a battery power supply after a power outage or significant brownout. The UPS is available as the following model options:

- APC SRT 2200XLA—120 V
- APC SRT 2200XLI—240 V

Refer to the ***APC UPS Operation Manual***, which ships on disc with the Battery Test System, for more information about the UPS.

Powering On/Off the UPS

Press the POWER ON/OFF button to power on the UPS. The button LED color indicates

power status.

Table 10. UPS POWER ON/OFF LED Indications

LED State/Color	Status
Off	The UPS and the output power are off.
White	The UPS and the output power are on.
Red	The UPS is on and the output power is off.

PS-16 Power Supply

The PS-16 is located in the primary drawer in the measurement rack and powers the following components:

- cRIO-9047 controller
- Measurement rack internal Ethernet switch
- cDAQ-9189 chassis
- cRIO-9805 Ethernet switches
- NI-XNET (CAN/LIN) C Series modules
- Serial C Series modules

The PS-16 can also power remote temperature input devices in your system.

Related tasks:

- Connecting Devices to the PS-16 Power Terminal Block

DC Power Fuse

The DC power fuse in the primary and secondary drawer provide protection for your system components from short circuits. When a fuse opens, all instruments connected to the terminal block in a drawer—cRIO-9047, cDAQ-9189, all C Series modules, cRIO-9805, GPIB-RS232, and FieldDAQ devices—lose power.

The DC power fuse is a Schurter 8020.50755 A, 500 V AC(6.3×32 mm)fast-acting fuse.

Related tasks:

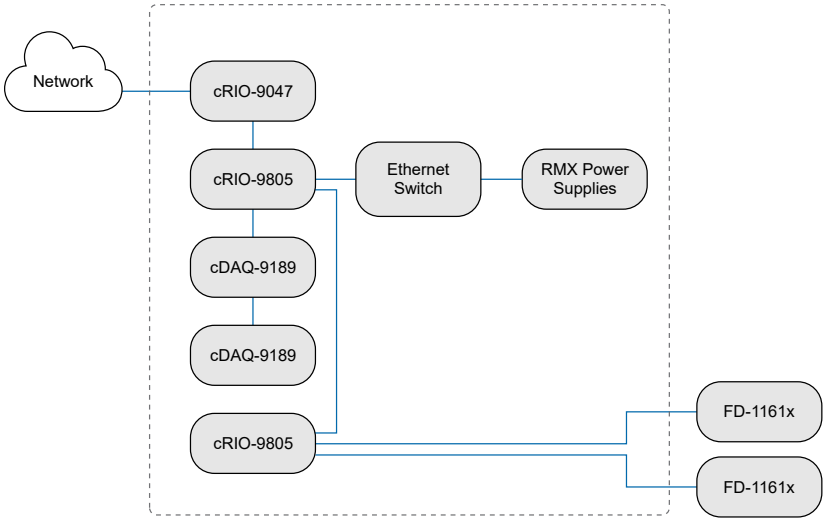
- Replacing the DC Power Fuse

Measurement Rack Ethernet Networking

The measurement rack contains up to three Ethernet switches to network the components in your system:

- Ethernet Switch—The 16-port Moxa Ethernet switch provides networking connection between the cRIO-9047 controller and RMX-4101 power supplies. Refer to the ***EDS-205A/208A Series Quick Installation Guide***, which ships with the Battery Test System, for more information.
- cRIO-9805—Up to two, four-port TSN-enabled Ethernet switches provide time-sensitive networking (802.1AS) connection between the cRIO-9047 controller, cDAQ-9189 chassis, and FieldDAQ devices enabling sub-microsecond-level synchronization between measurement I/O devices.

Figure 12. Ethernet Networking Block Diagram



Troubleshooting Network Issues

cRIO-9047 is Not Communicating with the Network

- Ensure that the Ethernet connections between the cRIO-9047 and the host computer, and between the host computer and the router are secure.
- Configure the IP and other network settings by completing the following steps.
  1. Use the USB-to-Type-A cable (included in the Battery Test System kit) to

connect the cRIO-9047 USB device port to a host computer. The USB driver creates a virtual network interface card and assigns an IP address to the cRIO-9047 in the format of 172.22.11.x.

2. In Measurement & Automation Explorer (MAX), expand your system under Remote Systems.

> **Note** If you do not see the cRIO-9047 under **Remote Systems**, right-click **Remote Systems**, and select **Troubleshoot Remote System Discovery** to walk through troubleshooting steps.

3. Select the Network Settings tab to configure the IP and other network settings.
4. (Optional) Use the standard measurement rack Ethernet port to reconnect the cRIO-9047 to the host computer. The cRIO-9047 attempts to initiate a DHCP network connection at power up.

> **Note** If the cRIO-9047 cannot obtain an IP address, it connects to the network with a link-local IP address with the form 169.254.x.x. The host computer communicates with the cRIO-9047 over a standard Ethernet connection.

- Temporarily disable any network firewalls or other security software.

Verify the cRIO-9047 controller IP configuration by completing the following steps:

1. Put the cRIO-9047 in safe mode and enable the RS-232 serial port by holding down the RESET button on the controller front panel for 5 seconds.

   The STATUS LED starts blinking three times every few seconds. Refer to the ***cRIO-904x User Manual*** for more information about safe mode.

2. Connect a monitor to the mini DisplayPort to view the IP address.

> **Note** The controller also broadcasts the IP address through the RS-232 serial port. Refer to the ***cRIO-904x User Manual*** for more information about serial port configuration on the cRIO-9047 controller.

3. Set a new DHCP connection by holding the RESET button on the controller front panel down for 5 seconds. The STATUS LED repeats the same behavior from Step 1.

If the cRIO-9047 fails to set a new DHCP address, it assigns itself a link-local IP address. If the DHCP connection is successful and appropriate for your application, skip to Step 6.

4. In MAX, expand your system under **Remote Systems**.
5. Select the Network Settings tab to configure the IP and other network settings.
6. Reboot the cRIO-9047 by pressing the RESET button on the controller front panel.

cDAQ-9189 Chassis Disconnects from Network

If your cDAQ-9189 chassis becomes disconnected from the network, try the following solutions:

- After moving the chassis to a new network, NI-DAQmx may lose connection to the chassis. In this case, click **Reconnect** to provide NI-DAQmx with the new hostname or IP address.
- The cDAQ chassis icon indicates whether it is recognized and present on the network. If a connected chassis appears as disconnected in the configuration tree in MAX, select **Self-Test** or **Reset Chassis**. If successful, the chassis icon changes to blue/grey.

For additional troubleshooting resources for the cDAQ-9189 chassis, refer to ***Finding a Network DAQ Device in MAX*** in the ***Measurement & Automation Explorer Help for NI-DAQmx***.

Site Preparation

You must follow all safety and site requirements and instructions in this manual to properly set up, configure, and use the Battery Test System.

Ensure the facility meets the following environmental, physical, and interface requirements before the system arrives.

Power Connection

Power connections must meet the power requirements listed in the ***BTS-16101 Battery Test System Measurement Rack Safety, Environmental, and Regulatory Information*** document. The measurement rack contains a power entry panel (PEP) for AC MAINs and a corresponding power plug.

The system must meet the following power connection requirements:

- AC MAINs power must be supplied to the system power plug.
- Power cord(s) must meet the following criteria:
  - Cable/wires must be insulated for the highest voltage based on the input rating of the system, and properly sized for current rating.
  - Wire gauge specifications must meet or exceed requirements and in compliance with all applicable local codes and requirements.
  - Wired by a qualified electrician.

Power Recommendations

NI recommends the following the following power considerations:

- Provide separate AC branch for the system due to the current requirements of the system.
- Copper wire for the system drop between the AC source and system.
- Before servicing the measurement rack, physically remove the MAINs plug from the power outlet.

Caution You must turn the main power switch on the EPO panel to the Standby position to fully disable the UPS output power.

Attention Vous devez mettre l'interrupteur d'alimentation principal du panneau d'arrêt d'urgence en position de veille pour désactiver complètement l'alimentation de sortie de l'onduleur.

Caution Verify the AC source and service conductor are sized correctly before connecting the system.

Attention Vérifiez que la source CA et la ligne de service sont correctement dimensionnées avant de connecter le système.

Caution Do not position equipment so that it is difficult to disconnect the AC power cable from the rear of the rack. To completely interrupt power to a single phase system, you must disconnect the AC power cable.

Attention Prenez soin de placer l'équipement de sorte qu'il soit facile de déconnecter le câble d'alimentation CA de l'arrière du rack. Pour interrompre complètement l'alimentation d'un système monophasé, vous devez déconnecter le câble d'alimentation CA.

Ventilation and Cooling

The measurement rack includes several features to help facilitate proper cooling, but due to instrumentation layout, third-party devices, cabling, and mass interconnect, it is important to do a thorough thermal assessment of the final system assembly.

The measurement rack includes the following features to help facilitate cooling:

- Low-speed fan panel with six 120 mm fans capable of driving a total of 540 CFM. You can add additional airflow with a 1U rack mount fan panel that utilizes three 4 in. fans (270 CFM) for targeted areas within the rack.
- 4U air inlet panel to facilitate airflow into the rack.

NI recommends that the air filters are properly maintained based on environmental conditions. These filters are user serviceable and replacement kits are available; refer to Battery Test System Replacement Parts for more information.

Note Do not block the top (exhaust vent) or air intake of the low-speed fan panel.

Ventilation Recommendations

NI makes the following ventilation recommendations:

- Maintain 2U of open space directly above and below the power entry panel (PEP) to allow for proper airflow through the panel.
- Do not add equipment to the top 1U of the rack or modify the position of the power distribution unit (PDU) located on the top of the rack. NI has validated sufficient cooling with the PDU and Ethernet switch in their pre-installed locations.

Exhaust

The exhaust air from all instruments should have an unobstructed pathway to exit the rack. Arrange instruments to provide a continuous airflow path from all instrument outlets.

Getting Started

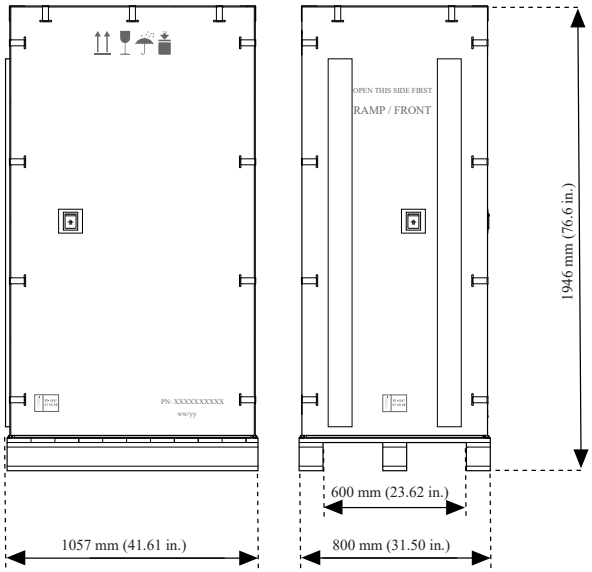
This section contains information on properly receiving the Battery Test System and performing first-time system setup.

Receiving the Measurement Rack

When the measurement rack shipping crate arrives at the facility, store the crate indoors in an area that meets environmental conditions listed in the ***BTS-16101 Battery Test System Measurement Rack Safety, Environmental, and Regulatory Information*** document.

Ensure the facility can accommodate the shipping crate, which has the following dimensions and maximum weight.

Figure 13. Shipping Crate Dimensions



The crate and contents have a maximum weight of 308.9 kg (681 lb) . A suitable lifting apparatus, such as a pallet jack, is recommended for transporting the shipping crate around the facility.

If the facility cannot accommodate the shipping crate, unpack the shipping crate and move the measurement rack using its mounted casters.

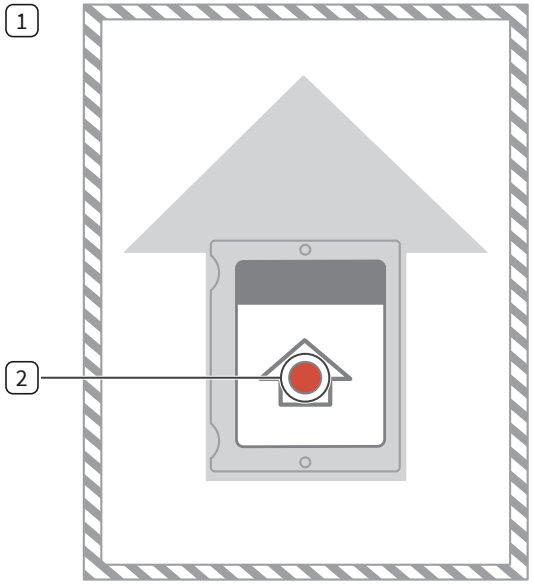
Inspecting the Shipment

Notice Do not discard any parts or packaging until you complete the Battery Test System bring-up and setup process. Do not reject the Battery Test System shipment.

1. Before you open the crate, inspect the tilt sensors on the sides of the crate.

Note A red sensor indicates that the sensor was activated during delivery.

Figure 14. Battery Test System Shipping Crate Sensors



1. Tilt Sensor Sticker
2. Tilt Sensor

2. Inspect the crate for any damage.
3. Review the packing list attached to the crate.
4. Accept the shipment.

Contact NI if the tilt sensor on the crate is activated or the crate is damaged.

Unpacking the Shipping Crate

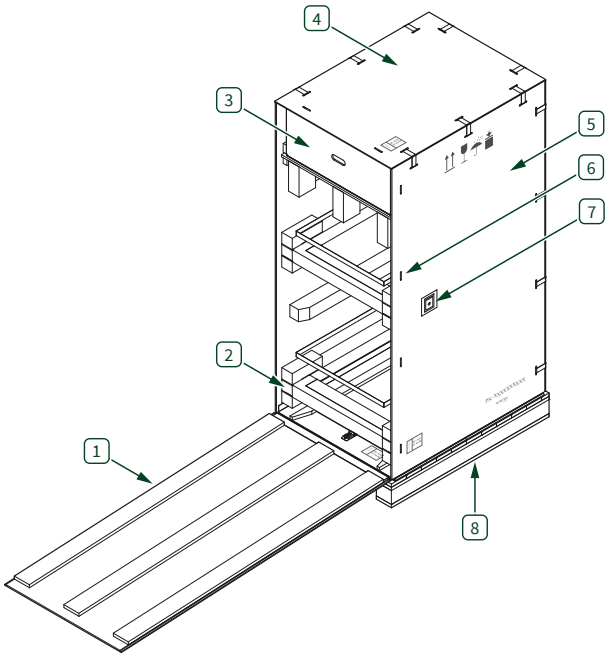
Ensure you have the following equipment before unpacking the shipping crate:

- Large size flathead screwdriver
- Scissors, knife, or box cutter

Complete the following steps to remove the measurement rack from the shipping crate.

Note Do not discard any parts or packaging until you complete the system bring-up and setup process.

Figure 15. Shipping Crate Assembly



1. Ramp Assembly
2. Removable Plywood Fitment
3. Accessory/Documentation Compartment
4. Top Panel
5. Side Panel (x3)
6. Clamp (x22)
7. Tilt Sensor (x2)
8. Base Assembly

Caution Deploying the rack from the shipping crate requires moving it in a back-to-front direction. Never stand directly in front of the rack when loading or unloading from a shipping carton.

Attention Le déploiement du rack à partir de la caisse d'expédition nécessite de le déplacer de l'arrière vers l'avant. Ne jamais se tenir directement devant le rack lors de son chargement dans son emballage d'expédition ou lors de son déchargement.

1. Remove the clamps securing the front panel using a flathead screwdriver.
2. Lower the top of the front panel onto the base of the shipping crate to form a ramp.
3. Verify the crate ramp is secure.
4. Remove all accessories and documentation from the top accessory/documentation compartment of the shipping crate.
5. Inspect the accessories for any physical damage.
6. Remove the foam padding securing the measurement rack.
7. Remove the plywood fitment located at the bottom of the crate.
8. Slowly roll the measurement rack out of the crate and down the ramp using the green, horizontal straps.
9. Cut and remove the polyester straps from the measurement rack.
10. Open and remove the poly antistatic bag from the measurement rack.
11. Inspect the measurement rack for any physical damage.

Note Contact NI if the measurement rack is physically damaged, any additional materials or boxes are physically damaged, or the contents of the shipping crate do not match the sales agreement or packing list.

Setting Up the Measurement Rack

The measurement rack arrives pre-assembled and wired. Before system bring up, visually inspect the measurement rack and ensure that the following are true:

- All hardware components are installed.
- All internal Ethernet wiring is connected.

- All internal power wiring is connected.
- All internal ground wiring is connected.
- All GPIB-serial converter boxes are connected (if applicable).

Follow all installation requirements listed in the following topics before connecting the hardware:

- Safety Requirements
- Electromagnetic Compatibility
- Site Preparation
- Ventilation and Cooling

Preparing the Uninterruptible Power Supply

Complete the following steps to remove the screen cover and install the front panel bezel (included in the system kit) on the uninterruptible power supply (UPS).

1. Locate the orange screen cover on the UPS.
2. Remove the four screws labeled on the screen cover to remove the cover from the unit.
3. Align the bezel with the front panel and install it on the UPS. Refer to the ***APC UPS Operation Manual***, which ships on disc with the Battery Test System, for bezel installation orientation.

Opening the Drawers

Complete the following steps to open the drawers to access and make signal connections to the cRIO-9047 controller, cDAQ-9189 chassis, C Series modules, and cRIO-9805 Ethernet switches.

1. Remove the four #10-32 Phillips pan head mounting screws on the front panel of the drawer using a #2 Phillips screwdriver.
2. Pull the drawer out using the handle.

Note The drawers lock into place when fully extended. Press the lock-in disconnect tab on each slide to close the drawers.

Connecting the Rack to Earth Ground

Complete the following steps to connect the measurement rack to earth ground.

1. Connect the ground lug, located on the power entry panel (PEP) of the measurement rack, to the facility earth ground.

   Note The ground lug connection requires 2.1 mm^2(14 AWG) copper wire with a minimum torque of 1.29 N · m (11.5 lb · in).

2. Verify that there is electrical continuity between the measurement rack functional earth ground lug and the facility earth ground using a handheld digital multimeter.

Connecting the Rack to Power

1. Use the power cable included in your kit to connect the measurement rack to power.
2. Attach the cable to the IEC 60320 C20 power inlet connector on the power entry panel (PEP).

   Notice Adhere to all safety requirements in Safety Requirements.

Configuring the Remote EPO Connector

You must configure the remote emergency power off (EPO) connector before using the system. The system will not power on unless you configure the remote EPO connector.

1. Use mating components to create an external safety loop with all external instruments in your measurement rack.
2. Use the EPO loopback dongle included your kit if you are not creating an external safety loop.
3. Align the connectors and attach by tightening the captured nut.

Related reference:

- Remote EPO Connector

Connecting Devices to the PS-16 Power Terminal Block

Complete the following steps to connect devices to the PS-16 terminal block. Use 0.14 mm^2 to 4 mm^2 gauge (12 AWG to 26 AWG) power signal wires.

1. Ensure that no wires are connected to live power.
2. Connect the power signal wires to the device.
3. Strip 9 mm (0.35 in.) from one end of the wires.
4. Twist wires leaving 60 mm (2.36 in.) from the end of the wires at the terminal block.
5. Connect the positive lead (V) of the device to the +24 V terminal of terminal block and tighten the terminal screw to a torque of 0.5 N · m to 0.6 N · m (4.43 lb · in. to 5.31 lb · in.).
6. Connect the negative lead (C) of the device to the COM terminal of the terminal block and tighten the terminal screw to a torque of 0.5 N · m to 0.6 N · m (4.43 lb · in. to 5.31 lb · in.).

If the power source is connected to the power connector using long wiring with high DC resistance, the voltage at the power connector may be significantly lower than the specified voltage of the power source.

Related reference:

- PS-16 Power Supply

Connecting the cRIO-9047 to the Lab PC

NI recommends using the USB-to-Type-A cable included in the kit for easy discovery of the cRIO-9047. Complete the following steps to connect the cRIO-9047 to the Lab PC.

1. Connect the Type-C connector of the USB cable to the USB Type-C Dual Role port on the cRIO-9047.
2. Connect the Type-A connector of the USB cable to the Lab PC.

After system bring up, the instrument driver software automatically detects the cRIO-9047. The USB driver creates a virtual network interface card and assigns an IP address to the cRIO-9047 in the format of 172.22.11.x.

Note After the cRIO-9047 is discovered and configured in Measurement & Automation Explorer (MAX), you can remove the USB cable.

Related tasks:

- Discovering the cRIO-9047 Controller

Setting Up Temperature Input Devices

Complete the following steps to set up the FD-11613/11614 temperature input devices.

1. Align and connect one end of the Ethernet cable to an Ethernet port on the temperature input device, and the other end to the cRIO-9805 Ethernet switch or cDAQ-9189 chassis Ethernet port in the measurement rack.
2. Power on the device. You can connect the device power to your own external power supply or use the PS-16 in the measurement rack.

Related reference:

- PS-16 Power Supply

Connect Signals

Refer to the documentation for your instrument at ni.com/manuals for more information about signal connections.

Table 11. System Hardware Components Signal Connection Information

Type	Example	Device	Connection Information Location
AI current	HVIL monitor	NI-9227	***NI-9227 Operating Instructions and Specifications***
AI voltage	Cell/module voltage measurements	NI-9224	***NI-9224 Getting Started Guide***
		NI-9225	***NI-9225 Operating Instructions and Specifications***
		NI-9228	***NI-9228 Getting Started Guide***

Type	Example	Device	Connection Information Location
CAN/LIN	BMS communication	NI-9860	***NI-9860 Getting Started Guide***
DC power supply	BMS supply voltage	RMX-4101	***RMX-410x User Manual***
Digital input	Contactor state, etc.	NI-9375	***NI-9375 Getting Started Guide***
Digital input	HVIL monitor	NI-9422	***NI-9422 Operating Instructions and Specifications***
Digital output	Ignition signal, etc.	NI-9375	***NI-9375 Getting Started Guide***
		NI-9475	***NI-9475 Getting Started Guide***
GPIB/RS-232	Third party instrument communication	GPIB-RS232	***NI GPIB-Serial Converter Help*** [1]
PWM input	HVIL monitor	NI-9423	***NI-9423 Getting Started Guide***
		NI-9437	***NI-9437 Getting Started Guide***
PWM output	Crash signal	NI-9475	***NI-9475 Getting Started Guide***
RS-232	Third party instrument communication	NI-9870	***NI-9870 Getting Started Guide***
SPST, relay	HVIL control	NI-9482	***NI-9482 User Manual and Specifications***
Thermocouple	DUT temperature measurements	NI-9212	***NI-9212 and TB-9212 Getting Started Guide***

Type	Example	Device	Connection Information Location
		NI-9213	***NI-9213 Getting Started Guide***
		FD-11613	***FD-11613 User Guide***
		FD-11614	***FD-11614 User Guide***

NI includes required backshell and terminal block kits for C Series modules in your system kit. You can find these kits in the accessory/documentation compartment of the shipping crate.

Table 12. C Series Module Terminal Blocks and Backshells

C Series Module	Accessory
NI-9212	TB-9212—Isothermal terminal block
	TB-9212 with mini-TC—Isothermal terminal block
NI-9213	NI-9940—Backshell for 36-position spring terminal connector
NI-9224	NI-9939—Backshell for 16-position screw terminal connector
NI-9228	
NI-9422	
NI-9225	NI-9971—Backshell for 2-position connector
NI-9227	
NI-9375	NI-9923—Front-mount terminal block for 37-pin DSUB
NI-9423	NI-9927—Strain relief and operator protection
NI-9437	
NI-9482	
NI-9475	NI-9924—Front-mount terminal block for 25-pin DSUB

C Series Module	Accessory
NI-9860	TRC-8543—NI-XNET CAN XS transceiver cable
	TRC-8546—NI-XNET LIN transceiver cable

Bringing Up the Measurement Rack

This section describes powering on and configuring the Measurement Rack for the first time.

Powering on the Measurement Rack

Caution Do not proceed unless qualified personnel has reviewed all installation instructions, written warnings, and cautions.

Attention Ne pas commencer avant que du personnel qualifié ait examiné toutes les instructions d'installation, les avertissements écrits et les mises en garde.

Notice Before powering on your system, ensure all equipment is present. Make sure all system components are properly connected before proceeding.

Complete the following steps to power on the measurement rack.

1. Connect an active network cable to the Ethernet port on the power entry panel (PEP).
2. Ensure that the power inlet connector on the power entry panel (PEP) is connected to AC MAINs.
3. Ensure that the main breaker (CB outlet) on the PEP is in the ON position.
4. Ensure that the emergency power off (EPO) button on the EPO panel is not depressed.
5. Ensure that the EPO button on the EPO panel is not depressed.
6. Ensure that the PDU power switch is in the Remote position.
7. Ensure that all RMX-4101 AC power switches are in the ON (I) position.

8. Rotate the main power switch on the EPO panel to the ON (I) position.
9. Power on the uninterruptible power supply (UPS):
   a. Press the power button (⏻) on the front panel to power on the UPS.
   b. When the display shows **EPO Activated Press OK to Clear EPO**, press the OK button.
   c. Press the power button (⏻).
   d. Use the up or down button to select **Turn On Immediately** on the display, then press OK.

Configuring the RMX-4101 Power Supplies

Complete the following steps to configure each RMX-4101 power supply in the measurement rack.

1. Ensure that the AC power switch is in the ON position.
2. Set the Communication Interface Selection to LAN for Ethernet communication. The LAN option automatically detects whether it is connected or disconnected from a network. It automatically looks for a network server and retrieves or creates an IP address, and broadcasts its IP address and hostname to all other devices on the network.
   a. Press the REM button. The REM LED lights.
   b. Press the VOLTAGE encoder; the display shows `INtF`.
   c. Rotate the CURRENT encoder to select `LAn`.
   d. Press the CURRENT encoder to enter selected parameter to memory. When the parameter is accepted, the display blinks once and returns to the previous level. The rear panel LAN LED lights green and the power supply receives the IP address.
3. View the IP address.
   a. Press the REM button and rotate the VOLTAGE encoder to select `IP`.
   b. Press the VOLTAGE encoder and rotate it to view the IP address. The VOLTAGE display scrolls through `IP1` and `IP4` as you rotate the encoder. The CURRENT display shows the required IP address.
4. Change the IP address to a static IP address. When you change the IP address from the front panel or through software, the RMX-4101 LAN switches to static addressing (and DHCP and auto-IP addressing are then disabled).
   a. Press the REM button and rotate the VOLTAGE encoder to select `IP`.
   b. Press the VOLTAGE encoder and rotate it to view the IP address. The VOLTAGE

display scrolls through `IP1` and `IP4` as you rotate the encoder. The CURRENT display shows the required IP address.

c. Rotate the CURRENT encoder to change the IP address and then press the encoder to set it. The VOLTAGE display shows `LAn` and the CURRENT display shows `HOLd` for about 1 s.

> **Note** If you set the IP address to one another device is using, the front panel LED blinks, and the address reverts to its previous status. Press any button to stop the blinking.

Software Installation, Activation, and Setup

Download the Battery Test System Software on each Lab PC and each Engineering PC from ni.com/downloads. Refer to the ***Battery Test System Software Readme*** at ni.com/r/btsreadme for more information about installing and activating the software included in the Battery Test System Software.

> **Note** After downloading the Battery Test System Software, be sure to check for and install any recommended software updates.

> **Note** After installing the Battery Test System Software, open and close BTS Test Executor, NI TestStand, and VeriStand to complete the setup of these applications.

Download the Battery Test System Web Server and install on the BTS Server. Additionally, you must have a dedicated SystemLink server, which could be the same machine as the BTS Server or a different one.

For more information on setting up the SystemLink Server and Client, refer to SystemLink Configuration.

SystemLink Configuration

To begin using SystemLink, you must first configure the SystemLink Server and

SystemLink Client.

> **Note** SystemLink Server is backwards compatible with older SystemLink Client versions, but is not forwards compatible.

Refer to the ***Battery Test System Software Readme*** for information about compatible SystemLink Client versions.

Configuring the SystemLink Server

Refer to Installing and Configuring SystemLink Server and Clients in the ***SystemLink Manual*** for complete information about configuring the SystemLink Server.

> **Note** Refer to the ***SystemLink Readme*** for details about minimum requirements for the server.

Configuring the BTS Server to Communicate with the SystemLink Server

Complete the following steps to configure the SystemLink Client on the BTS Server PC.

1. Configure the BTS Server PC. Refer to Setting Up a SystemLink Client for Windows Targets in the ***SystemLink Manual*** to configure your BTS Server.
2. Open `%PROGRAMFILES%\National Instruments\Battery Test System\WebApplication\appsettings.json` in a text editor, and edit the SystemLink property so that it contains the URL of the SystemLink Server. Example:

   ```
   "SystemLink": {

   "Url": https://mySystemLinkServer

   }
   ```

3. Restart the BTS Server. To do so, start the Windows Services application, find and select **NI Battery Test System Server** in the list, and click **Restart**.

Configuring the Lab and Engineering PCs to Communicate with the SystemLink Server

Complete the following steps to configure the SystemLink Client on each Lab PC and Engineering PC.

1. Configure the BTS Server PC. Refer to Setting Up a SystemLink Client for Windows Targets in the ***SystemLink Manual*** to configure your lab PC.
2. Configure the Lab and Engineering PCs. Refer to Integrating Test Monitor with TestStand in the ***SystemLink Manual*** to set up Test Monitor. Use Test Monitor to track test progress and view test reports.

> **Note** In the NI SystemLink Test Monitor Client Options window ( ), select the option to **Enable Store and Forward when Disconnected from Server** to ensure your test sequences continue running if the connection to the SystemLink server is interrupted. Refer to Storing and Forwarding Test Data in the ***SystemLink Manual*** for more information.

BTS Server Login Authorization

The BTS Server uses SystemLink server for login authorization. Any user that has permission to log into the SystemLink server is recognized by the BTS Server. SystemLink Administrators automatically are assigned the role of Adminisrator in the BTS Server. All other users are initially assigned the role of an Unauthorized User. Users must attempt to log into the Web UI before their name appears in the Users list to have a role assigned. The BTS Administrator can change the role of users in the Web UI Users page. The available roles include:

- Administrator. By default, the SystemLink Administrator. Can change the roles (login authorization) for any users and has access to create, edit, and execute test plans.
- Lab Manager. Has access to create, edit, and execute test plans.
- Operator. Has access to viewing and executing submitted test plans.
- Unauthorized User. Does not have access to the BTS Web UI.

Generating a BTS Server Certificate

To generate a BTS server certificate, do the following:

1. Generate a self-signed certificate. It must be a `.pfx` file.
2. Import the certificate on the BTS Server.
3. Open `%PROGRAMFILES%\National Instruments\Battery Test System\WebApplication\appsettings.json` in a text editor. Add the following XML section to the appsettings.json file, modified to specify your certificate's endpoint url, certificate url, path, and password.

```
"Kestrel": {
  "Endpoints": {
      "Http": {
        "Url": http://0.0.0.0:60001
      },
      "HttpsInlineCertFile": {
        "Url": https://0.0.0.0:60002,
        "Certificate": {
          "Path": "C:\\bts\\certificates\\bts.pfx",
          "Password": "xxxxxxx"
        }
    }
},
"Certificates": {
  "Default": {
    "Path": "C:\\bts\\certificates\\bts.pfx",
    "Password": "xxxxxxx"
    }
  }
}
```

4. Restart the BTS Server. To do so, start the Windows Services application, find and select **NI Battery Test System Server** in the list, and click **Restart**.

MAX Configuration

Use Measurement & Automation Explorer (MAX) to get information and install software to the target.

Discovering the cRIO-9047 Controller

Ensure the following tasks are complete before you discover the cRIO-9047 controller:

- Setting Up the System
- Powering on the System

1. Launch Measurement & Automation Explorer (MAX) on the Lab PC.
2. Expand **Remote Systems** in the configuration tree and locate your system.
3. Select your target.

> **Note** MAX lists the system as NI-cRIO-9047-<serial number> by default.

4. Configure the network and user settings according to the standard practices of your facility and within the IP address setting restrictions.

> **Note** By default, the cRIO-9047 controller attempts to initiate a DHCP network connection the first time you connect using Ethernet.

Related tasks:

- Connecting the cRIO-9047 to the Lab PC

Installing Software on the cRIO-9047 Controller

Installing the full software stack to the target requires installing the base CompactRIO driver set followed by installation of custom application components. Complete the following steps to install software on the cRIO-9047 controller using Measurement & Automation Explorer (MAX).

1. Launch MAX on the host computer.
2. In the MAX configuration tree, expand **Remote Systems** and locate the cRIO-9047 controller.
3. On the System Settings tab, click the **Update Firmware** button.

> **Note** You must update to the latest version of the firmware before you install software on the controller.

By default, the file dialog window opens to the location of your firmware files, `<Program Files (x86)>\National Instruments\Shared\Firmware\cRIO\78E9`.

4. Select the most recent firmware version and click **Open**.
5. When the Update Firmware window appears, click **Begin Update**. Make sure the date and time are correct.
6. In the configuration tree, right-click the controller and select **Format Disk**.

> **Note** You must log in to configure the cRIO-9047. The default user name for the cRIO-9047 is `admin`. There is no default password for the cRIO-9047. To set a password for your system, refer to ni.com/r/linuxrtpword for detailed instructions.

7. Expand the controller and right-click **Software**, then select **Add/Remove Software** to launch the Real-Time Software Wizard and install the base system image on the controller.
8. Select the recommended Base System Image, Linux RT System Image.
9. Click **OK** to apply the system image.
10. Select **LabVIEW** and the current version for the programming environment.
11. Click **Next**.
12. Click **Review changes** to verify that the summary of software to install is correct.
13. Click **Continue** to start the installation.
14. Click **Close**.
15. Right-click **Software** to install the Battery Test System Software components on the controller.
16. Select **Add/Remove Software** to launch the Real-Time Software Wizard.

> **Tip** You can use the Real-Time Software Wizard at any time to install additional software.

17. Select the following items on the Add tab:
    - HTTP Client with SSL Support
    - I/O Variable Remote Configuration Web Service
    - NI Scan Engine
    - NI VeriStand Engine
    - NI-Industrial Communications for EtherCAT
    - NI Serial 9870 and 9871 Scan Engine Support

18. Select **Include recommended packages**.
19. Click **Review changes** and verify that the summary of software to install is correct.
20. Click **Continue** to start the installation.
21. Click **Close**.

If you used the USB-to-Type-A cable to discover the cRIO-9047 in Connecting the cRIO-9047 to the Host Computer, remove the USB cable.

Setting Up the SystemLink Configuration on the cRIO-9047 Controller

Make sure you have installed software on the cRIO-9047 using MAX as explained in Installing Software on the cRIO-9047 Controller.

1. In MAX, on the System Settings tab under SystemLink Settings, select the cRIO-9047 and set the **Server** value to the same value set in Configuring the SystemLink Server.
2. Click **Save**. The status reads as `Not Approved`.
3. Launch and log in to NI SystemLink Web Application.
4. Click **Systems Manager**, then click **Pending systems**.
5. Click **Approve** next to the name of the target. The target is now a client connected to your SystemLink server.
6. In MAX on the System Settings tab under SystemLink Settings, select the cRIO-9047 and verify that the **Status** is `Connected`.

Upgrading the Firmware on cDAQ Chassis

To upgrade the firmware on your cDAQ chassis, complete the following steps.

1. Turn your system off, and disconnect the Ethernet cable to the cDAQ chassis.
2. Connect the Ethernet cable from the cDAQ chassis to either your computer or the facility's network.
3. Turn the system back on.
4. Open NI MAX.
5. In NI MAX, locate your cDAQ chassis by expanding **My System** » **Devices and Interfaces** » **Network Devices**.
6. Click **Upgrade Firmware**.
7. Login with an administrator account. By default, the username is admin and the password is left blank.

8. Select the latest firmware file, and click it to begin updating the firmware on your cDAQ chassis.
9. After the firmware update is complete, turn off the system, and disconnect the Ethernet cable from the computer or network.
10. Reconnect the Ethernet cable from the cDAQ chassis to the system.
11. Turn on the system.

Changing the C Series Module Programming Modes

Complete the following steps to deploy all C Series modules in the cRIO-9047 controller to the Real-Time Scan (IO Variables) program mode.

1. Launch Measurement & Automation Explorer (MAX) on the Lab PC.
2. Expand **Remote Systems** » **cRIO-9047** » **Devices and Interfaces** » **cRIO-9047** in the configuration tree.
3. Select a C Series module.
4. In the Settings pane, set the Program Mode to **Real-Time Scan (IO Variables)**.
5. Click **Save**.
   The module is deployed in the Real-Time Scan program mode and the module icon () changes in the configuration tree.
6. Repeat Steps 3 through 5 for all C Series modules in the cRIO-9047.

Discovering Network Devices (cDAQ-9189, FieldDAQ Devices)

Discover and configure the cDAQ-9189 chassis and FieldDAQ devices in the Battery Test System.

1. Launch Measurement & Automation Explorer (MAX) on the Lab PC.
2. Expand **Remote Systems** » **cRIO-9047** » **Devices and Interfaces** » **Network Devices** in the configuration tree.
3. From the **Add Network Devices** drop-down, select **Find Network NI-DAQmx Devices**.
4. When the Find Network NI-DAQmx Devices dialog box opens, complete one of the following options:
   - Check the box that corresponds to your network device in the Hostname column.
   - If you know the chassis IP address—such as 192.168.0.2—enter it into the **Add Device Manually** field, and click the **+** button.

- Enter the hostname of the network device:
  - The default hostname for the cDAQ-9189 is `cDAQ9189-<serial number>`
  - The default hostname for the FD-11613 is `FD11613-<serial number>`.
  - The default hostname for the FD-11614 is `FD11614-<serial number>`.

> **Note** If your network device does not appear in Available Devices, click **Refresh List**. If the network device still does not appear, contact your system administrator to confirm that the network is working and that a firewall is not interfering with discovery. For additional troubleshooting resources for the network devices, refer to Troubleshooting Network Issues.

5. Click **Add Selected Devices**.
   The cDAQ-9189 chassis and FieldDAQ device are added under the cRIO-9047 controller in the configuration tree. If the cDAQ-9189 or FieldDAQ device are not reserved automatically, select the device and click **Reserve Network Device**. After the chassis is reserved by the real-time controller, the modules in the chassis are visible in the MAX configuration tree.
6. Self-test your network devices in MAX:
   a. Expand **NI cRIO-9047** » **Devices and Interfaces** » **Network Devices**, and right-click the cDAQ-9189 chassis or the FieldDAQ device.
   b. Select **Self-Test**
      Self-test performs a brief test to determine successful installation. When the self-test finishes, a message indicates successful verification or if an error occurred. If an error occurs, refer to ni.com/support/daqmx.
7. (Recommended) Rename the C Series modules in the cDAQ-9189 chassis by selecting the module and entering a new name in the Name field.

> **Note** NI recommends renaming the C Series modules in the cDAQ-9189 by removing the serial number dependency. This enables you to reuse VeriStand projects across systems. NI recommends the following naming scheme: <Module_Number>-<Slot>-<Purpose>, for example, `NI_9213-Mod1-Temperature`.

8. Run a Test Panel in MAX:
   - To test a module in the **cDAQ-9189**, expand **NI cRIO-9047** » **Devices and Interfaces** » **Network Devices** » **NI cDAQ-9189**, right-click the C Series module,

and select **Test Panels** to open a test panel for the selected module.
- To test a FieldDAQ device, expand **NI cRIO-9047** » **Devices and Interfaces** » **Network Devices** » **FD-1161x**, right-click the bank of connectors in your FieldDAQ device, and select **Test Panels**.

If the test panel displays an error message, refer to ni.com/support. Click **Close** to exit the test panel.

Creating a System Report

Use the Measurement & Automation Explorer (MAX) Report Wizard to document your Battery Test System.

1. Launch MAX on the host computer.
2. Expand **Remote Systems** » **NI cRIO-9047** in the configuration tree.
3. Right-click **NI cRIO-9047** and select **Create Report**.
4. In the Custom Report Wizard window, select **Custom report**, then click **Next**.
5. Ensure all items that you want to include in your report are selected, then click **Next**.
6. Specify the location of the generated files. The MAX Report Wizard remembers the last location entered. The file name must have either a `.htm` or `.html` file extension.
7. Click **Generate** to generate the report. Depending on the complexity of the selected system, the MAX Report Wizard may take a few minutes to complete.
8. Click **Finish** to close the wizard and launch the report in your default browser.

Refer to the generated report as you configure VeriStand.

Maintenance and Service

This section describes preventative maintenance procedures, how often to perform the procedures, and where to find further maintenance details.

Cleaning

Caution Always disconnect the AC power cable, and switch the Main Breaker (CB Outlet) to the OFF position, before cleaning or servicing the system.

Attention Débranchez toujours le câble d'alimentation CA et mettez le disjoncteur principal (***CB Outlet***) en position OFF avant de nettoyer ou de réparer le système.

The required maintenance schedule is as follows:

- Cleaning the exterior—As needed
- Cleaning air intake filters—Monthly, as needed

Cleaning the Exterior

Notice Do not wash the front- or rear-panel connectors or switches. Cover these components while cleaning the measurement rack.

Notice Do not use harsh chemical cleaning agents or abrasive compounds on any part of the measurement rack; they may damage the system. Avoid chemicals that contain benzene, toluene, xylene, acetone, or similar solvents.

1. Clean exterior surfaces with a dry lint-free cloth or a soft-bristle brush.
2. If any dirt remains, wipe with a cloth moistened in a mild soap solution.

> **Notice** Avoid getting moisture inside the system during exterior cleaning. Use only enough moisture to dampen the cloth.

3. Remove any soap residue by wiping with a cloth moistened with clear water.

Cleaning Air Intake Filters

1. Remove the four screws securing the 4U air inlet panel located on the rear of the measurement rack.
2. Remove the air intake filters from the air inlet panel.
3. Clean the air intake filters using warm water with a mild soap solution.
4. Air dry the filters to remove moisture.

> **Notice** Avoid installing wet filters into the measurement rack. Verify that the filters are thoroughly dry before installing.

5. Replace the air intake filters in the air inlet panel.
6. Secure the 4U air inlet panel to the measurement rack with the four screws.

Related reference:

- Measurement Rack Component Locations

Maintenance

Maintenance includes fuse replacement and calibration.

Replacing the DC Power Fuse

Complete the following steps to replace the DC power fuse on the PS-16 terminal block.

1. Using a flathead screwdriver, turn the fuse holder cap counter-clockwise to release it from the terminal block.
2. Gently pull the fuse to release it from the fuse holder cap.
3. Slide the replacement fuse into the fuse holder cap.
4. Screw the cap clockwise to replace it.

Customer-Accessible System-Level Compensation

There is no system-level calibration for the Battery Test System measurement rack. However, you can access calibration reports in VeriStand; refer to ***Calibrating a Hardware Channel at Run Time*** in the ***VeriStand Manual***.

Instrument Calibration

NI provides calibration services for instruments in the Battery Test System that require calibration. NI recommends that you adhere to the calibration interval for all supported instruments in your system. For the latest information about available calibration service levels for your instrument, refer to ni.com/r/nical.

Table 13. Instrument Calibration Intervals

Component	Recommended Calibration Interval (Years)
cDAQ-9189	1
FD-11613	1
FD-11614	1
NI-9212 + TB-9212	1
NI-9213	1
NI-9224	2
NI-9225	1
NI-9227	1
NI-9228	2

Factors such as shelf life and storage temperature can affect an instrument's recommended calibration interval. Refer to the specifications document for your instrument at ni.com/manuals to calculate the appropriate calibration interval.

The following Battery Test System instruments and components do not require calibration:

- cRIO-9047
- cRIO-9805

- Ethernet Switch
- GPIB-RS232
- NI-9375
- NI-9422
- NI-9423
- NI-9437
- NI-9475
- NI-9482
- NI-9860
- NI-9870
- PDU
- PS-16
- RMX-4101
- UPS

Battery Test System Replacement Parts

Refer to the tables of replacement parts for the Battery Test System to identify replaceable parts and to determine the level of replacement service NI provides for those parts.

Notice Ensure that Battery Test System repair procedures are performed only by qualified personnel.

Notice The AC power cords used in the Battery Test System are specially designed for the Battery Test System. Do not use these power cords in other electrical appliances.

Notice To prevent damage to cables inside the Battery Test System, use caution when sliding the mass interconnect from the test rack.

Note NI provides Advanced Replacement Service for replacement parts in the following table unless otherwise noted.

Listed part numbers are NI part numbers unless otherwise indicated.

Replacement Instrumentation

Table 14. Battery Test System Replacement Parts: Instrumentation

Model	Description	Part Number
cDAQ-9189	CompactDAQ Chassis (8-Slot Ethernet)	785065-01
cRIO-9047	8-Slot CompactRIO Controller with Kintex-7 70T FPGA	785621-01
cRIO-9805	4-Port 802.1AS Ethernet Switch Expansion Module for CompactRIO	786993-01
NI-9977*	Slot Filler Module	196917-01
NI-9860	C Series Vehicle Multiprotocol Interface Module	787687-01
TRC-8546	LIN Transceiver Cable, 18 in.	783702-02
TRC-8543 NI-XNET	CAN XS (LS/FT, HS/FD) Transceiver Cable, 18 in.	783701-02
ISO-5B31-10	Analog Isolation Module, Voltage/Current Input, ±40 V Input, 0 V to 5 V Output	ISO-5B31-10
NI-9870	C Series 4-Port RS232 Serial Interface Module	787688-01
NI-9482	C Series 4-Channel SPST Relay Output Module	782999-01
NI-9475	C Series 8-Channel High-Speed Sourcing Digital Output Module	780132-01
NI-9437	C Series 8-Channel High-Voltage Digital Input Module	783393-01
NI-9423	C Series 8-Channel Sinking Digital Input Module	779009-01
NI-9422	C Series 8-Channel Sinking/Sourcing Digital Input Module	779522-01

Model	Description	Part Number
NI-9375	C Series 32-Channel Digital Input/Output Module	781030-01
NI-9228	C Series 8-Channel, Channel-to-Channel Isolated Analog Input Module	783861-01
NI-9227	C Series 4-Channel Current Input Module	781099-01
NI-9225	C Series 3-Channel Analog Input Module	780159-01
NI-9224	C Series 8-Channel, Channel-to-Channel Isolated Analog Input Module	783862-01
NI-9213	C Series 16-Channel Thermocouple Module	785185-01
NI-9212 with Screw Terminal	C Series 8-Channel, Channel-to-Channel Isolated Thermocouple Module	782975-01
NI-9212 with Mini-TC Terminal	C Series 8-Channel, Channel-to-Channel Isolated Thermocouple Module	785259-01
GPIB-RS232	GPIB Instrument Control Device	787689-01
* Customer Responsible. Customer Responsible means that these components are not covered products as per NI Terms of Service, and customers need to purchase such system parts individually and replace them by themselves.		

Replacement Cables and Accessories

Table 15. Battery Test System Replacement Parts: Hardware Assembly Components

Model	Description	Part Number
Fan Top Kit for RMX-10011	19 in. Rack, 6-Fan, Low-Power (540 CFM), Gray	787441-01
3U Filler Panels for RMX-10011*	19 in. Rack, QTY 3, Gray	787443-01
1U Filler Panels for RMX-10011*	19 in. Rack, QTY 5, Gray	787442-01

Model	Description	Part Number
Spare Panel Kit for Battery Test System Shelf, Front, Electronics, Slide Clearances*	19 in. Rack, Gray	133983-01
Spare Panel Kit for Battery Test System Front, Slide-Mounted Electronics Tray*	Full Height, Blank, 19 in. Rack, Gray	134780-01
Blank Panel for RMX Power Supplies*	Filler Panel for RMX-410x Rackmount Kit	786187-01
Rackmount Kit for Power Distribution Unit*	Rackmount Kit for 1U RMX Power Distribution Unit	787261-01
Rackmount Kit for Uninterruptable Power Supply*	Rackmount Kit for APC SRT2200RMXLI UPS	785599-01
E/NS 35 N*	DIN Rail End Clamp, 9.5 mm, Gray	Phoenix Contact 0800886
UT 2.5-Twin*	DIN Rail Terminal Blocks, 2.5 $mm.^2$ rated cross section, Gray	Phoenix Contact 3044513
UK 10-DRESHI (6.3×32)*	DIN Rail Fused Modular Terminal Block, Black	Phoenix Contact 3005507
RMX 10040 Power Entry Panel*	1-Phase, 16 A, Gray	787471-01
Mounting Bracket for ECUTS 24U*	Mounting Bracket for Ethernet Switch	132876-01
Rackmount Kit for RMX-410x 2U DC Power Supplies*	Holds up to 6 Supplies	786186-01
GPIB Rack Mount*	Rackmount Kit for GPIB-120B, GPIB-RS232, GPIB-RS485/422	194906-01
Slide Rail Kit*	Fits 22 in.–26 in. Deep Racks, Supports 180 lbs	788130-01
1U Brush Cable Entry Panel for RMX-10011*	19 in. Rack, Gray	787470-01
* Customer Responsible. Customer Responsible means that these components are not covered		

Model	Description	Part Number
products as per NI Terms of Service, and customers need to purchase such system parts individually and replace them by themselves.		

Table 16. Battery Test System Replacement Parts: System Cables

Description	Part Number
Spare Kit, Cable Assembly, Equipment Ground, 3 m	156690-03
Spare Kit, Equipment Ground, 2.5 m, Cable	861167-01
Spare Kit, BTS, Cable Assembly, Equipment Ground, 0.25 m	156690-0R25
Spare Kit, BTS, Cable Assembly, Twisted Pair, 16 AWG, 2.5 m	132844-2R5
Spare Kit, BTS, Cable Assembly, Twisted Pair, 16 AWG, 0.5 m	132844-0R5
Spare Kit, BTS, Cable Assembly, Twisted Pair, 22 AWG, 2.5 m	131294-2R5
Spare Kit, Cable Assembly, Twisted Pair, 22 AWG, 1.5 m	131294-1R5
Spare Kit, BTS, Cable Assembly, Twisted Pair, 22 AWG, 1.0 m	131294-01
Spare Kit, BTS, Cable Assembly, Twisted Pair, 22 AWG, White and Black, 0.5 m	131294-0R5
Spare Kit, BTS, Cable Assembly, PDU, ACOK, 3.75 m	132843-3R75
Spare Kit, BTS, Cable Assembly, PDU, ACOK, 2.5 m	132843-2R5
Spare Kit, Cable Assembly, 16 AWG, 0.15 m	132884-0R15
Spare Kit, BTS, Cable Assembly, EPO, External, EV, 2.5 m	132847-2R5
Grounding Cable, 1 m	785631-01
Spare Kit, BTS, Cable Assembly, 2POS Female, Microfit to Pigtail, 1.5 m	132890-1R5

Description	Part Number
RS232 Null-Modem Cable, DB-9 Female to DB-9 Female, 1 m	182238-01
Cable Assembly, Serial, 10POS Modular Plug to 9POS DSUB Plug, Type S8, 1 m	182845-01
Cable Assembly, CAT-5E Ethernet, Thin Profile, 5 m*	151733-05
Spare Kit, BTS, Cable Assembly, CAT-5E Ethernet, Thin Profile, 3 m	151733-03
Cable Assembly, CAT-5E Ethernet, Thin Profile, 2 m*	151733-02
Cable Assembly, CAT-5E Ethernet, Thin Profile, 1 m*	151733-01
Cable Assembly, CAT-5E Ethernet, Thin Profile, 0.3 m*	151733-0R3
* Customer Responsible. Customer Responsible means that these components are not covered products as per NI Terms of Service, and customers need to purchase such system parts individually and replace them by themselves.	

Table 17. Battery Test System Replacement Parts: Miscellaneous

Model	Description	Part Number
Ethernet Switch for NI Test Systems	16-Port Unmanaged Ethernet Switch	132788-01
Rack Safety Thermostat	Safety Thermostat Spare for ATE Core Configurations	787002-01
EV Battery Test System 2.0	Accessory Kit, Fuses and Fasteners	133440B-01
Cable Holders, Style S	For ½" Maximum Bundle Diameter, Push-In, Nylon*	McMaster 7565K76
Screw-In Mount Cable Holders, Style Q	For 1" Maximum Bundle Diameter and Number 10 Screw, Screw-in Mount*	McMaster 7572K27
Screw-In Mount Cable Holders,	For ½" Maximum Bundle	McMaster 7572K24

Model	Description	Part Number
Style Q	Diameter and Number 10 Screw, Screw-in Mount*	
Screw-In Mount, Style B	Screw-In Hook and Loop Cable Tie Mount, for ¾" Maximum Cable Tie Width and Number 10 Screw, Nylon Plastic*	McMaster 1256N1
Slotted Wire Duct with Snap-On Cover	2-1/4" High × 1-1/2" Wide, 6-1/2" Long, Gray*	McMaster 7578K17
RMX Cable Wrap Roll	Cable Management Strips, for RMX-1001119 in. Rack, 8 in., QTY 10*	785519-01
Light Duty Blended EPDM Foam Strip with Adhesive Back	1" Wide, 1/8" Thick, 50 ft.Long, Black*	McMaster 8694K68
RMX-10060	Emergency Power Off Panel for RMX-1001119 in. Rack, 1U, Gray*	787440-01
ZB 5: UNBEDRUCKT	Zack Marker Strip for Terminal Block,5.2 mm Width, 5.1 × 10.5 mm Lettering Field Size, 10 Individual Labels, White*	Phoenix Contact 1050004
FBS 5-5	Plug-In Bridge, 5.2 mm Width, Red*	Phoenix Contact 3030190
FBS 2-5	Plug-In Bridge, 5.2 mm Width, Red*	Phoenix Contact 3030161
D-UT 2.5/4-TWIN	End Cover, 56.8 mm Length × 2.2 mm Width × 39.8 mm Height, Gray*	Phoenix Contact 3047141
Threaded-Hole Round Pull Handle	Dull Black Anodized Aluminum, 6" Center-to-Center Width*	McMaster 1568A47

* Customer Responsible. Customer Responsible means that these components are not covered products as per NI Terms of Service, and customers need to purchase such system parts individually and replace them by themselves.

Table 18. Battery Test System Replacement Parts: Power Supplies and Cords

Model	Description	Part Number
PS-16	Power Supply, 24 VDC, 10 A, 100-120/200-240 VAC Input, Spring-Clamp Terminals	781094-01
RMX-10050	1-Phase Power Distribution Unit with DC (1U, 100–240 V, 16 A. 12/24/24/48 VDC)	785341-01
Spare PDU for NI Test Systems	Rack PDU, Basic, 0U/1U, 100–240 V/20 A, 220–240 V/16 A, (13) C13	788138-01
Spare Power Cord for NI Test Systems	NEMA 5-15P to C13 - 10 A, 125 V, 18 AWG, 1 ft., Black	788140-0R3
Power Cable for NI Test Systems	Spare Kit, BTS, PC-MF4-PTC Series Microfit Power Cable Female to Pigtail, 1.5 m	132845-1R5
Spare Power Cord for NI Test Systems	14 AWG, 250 V, ZLOCK C14 to ZLOCK C15, 1.5 m	133084-1R5
Spare Power Cord for NI Test Systems	17 AWG, ZLOCK C14 to Open, Ferrule Tips, 2.5 m	133114-2R5
RMX-4101	2U DC Power Supply, 1/6 Rack width	786008-01
Power Cable for NI Test Systems	Spare Kit, DC Power Cords 2 m PWR CBL Straight 2.0 mm Lock STIP/TIN	787690-01
IEC Power Cord	AC, IEC C20 To C19, 100–240 V, Universal 2.5 m	785710-02
IEC Power Cord	AC, IEC C20 To NEMA 5-20R, 100–125 V, 0.25 m	785707-01
IEC Power Cord	AC, IEC C19 To NEMA 5-20P, 100–125 V, 2.5 m	785708-01
Spare Power Cord for NI Test Systems	AC, IEC C14 to C19, 100–240 V, 2 ft	788139-01
APC Uninterruptible Power	2 kW, 120 V	784834-01

Model	Description	Part Number
Supply		
APC Uninterruptible Power Supply	2 kW, 240 V	784835-01

Where to Go Next

This section lists where you can find example programs and relevant documentation for the Battery Test System.

Example Files

You can extend your system capabilities, including prototyping and debugging test execution, using simulated DUTs and instrumentation. The Battery Test System Software Suite includes example files that serve as a starting point or reference for your tests. The example files are installed on your host computer at `%Public%\Documents\National Instruments\Battery Test System Toolkit\Examples`.

Related Documentation

Refer to the following documents to learn more about the Battery Test System, Battery Test System Software, and hardware components. You can find this documentation on your host computer at `%Public%\Documents\National Instruments\Battery Test System Toolkit\Documentation` unless otherwise noted.

- ***BTS-16101 Battery Test System Measurement Rack Specifications***—Lists specifications for the system.
- ***Battery Test Software Readme***—Provides software components, installation considerations and instructions, system compatibility, and known issues.
- ***BTS-16101 Battery Test System Measurement Rack Safety, Environmental, and Regulatory Information***—Packaged with the measurement rack, includes important compliance precautions and connection information for your measurement rack.
- ***VeriStand Manual***—Provides detailed information for setting up and using VeriStand. Access in VeriStand from the Help menu, **Help » Show VeriStand help**.
- ***TestStand Help***—Provides information about programming concepts, step-by-step instructions, and reference information. Access in TestStand from the Help

menu, **Help » NI TestStand Help**.

- ***SystemLink Manual***—Provides contains instructions and reference information that enables you to manage systems and leverage data services to communicate with your server with SystemLink. Access through the NI website at ni.com/r/systemlinkmanual.
- Component documentation—Refer to the following list for user guide and specifications documentation for each component in the Battery Test System. Access this documentation through the NI website at ni.com/manuals unless otherwise noted.
  - **cDAQ-9189**—cDAQ-9185/9189 User Manual and cDAQ-9189 Specifications
  - **cRIO-9047**—cRIO-904x User Manual and cRIO-9047 Specifications
  - **cRIO-9805**—cRIO-9805 Getting Started Guide and cRIO-9805 Specifications
  - **FD-11613**—FD-11613 User Guide and FD-11613 Specifications
  - **FD-11614**—FD-11614 User Guide and FD-11614 Specifications
  - **GPIB-RS232**—***NI GPIB-Serial Converter Help*** (accessed on your host computer through **Start » National Instruments**) and NI GPIB-Serial Converter Specifications
  - **NI-9212**—NI-9212 and TB-9212 Getting Started Guide and NI-9212 and TB-9212 Datasheet
  - **NI-9213**—NI-9213 Getting Started Guide and NI-9213 Datasheet
  - **NI-9224**—NI-9224 Getting Started Guide and NI-9224 Datasheet
  - **NI-9225**—NI-9225 Operating Instructions and Specifications
  - **NI-9227**—NI-9227 Operating Instructions and Specifications
  - **NI-9228**—NI-9228 Getting Started Guide and NI-9228 Datasheet
  - **NI-9375**—NI-9375 Getting Started Guide and NI-9375 Datasheet
  - **NI-9422**—NI-9422 Operating Instructions and Specifications
  - **NI-9423**—NI-9423 Getting Started Guide and NI-9423 Datasheet
  - **NI-9437**—NI-9437 Getting Started Guide and NI-9437 Datasheet
  - **NI-9475**—NI-9475 Getting Started Guide and NI-9475 Datasheet
  - **NI-9482**—NI-9482 User Manual and Specifications
  - **NI-9860**—NI-9860 Getting Started Guide
  - **NI-9870**—NI-9870 Getting Started Guide
  - **PS-16**—NI PS-16 Power Supply User Manual
  - **RMX-4101**—RMX-410x User Manual and RMX-410x LAN Interface User Manual

NI Services

Visit ni.com/support to find support resources including documentation, downloads, and troubleshooting and application development self-help such as tutorials and examples.

Visit ni.com/services to learn about NI service offerings such as calibration options, repair, and replacement.

Visit ni.com/register to register your NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

NI corporate headquarters is located at 11500 N Mopac Expwy, Austin, TX, 78759-3504, USA.

Contacting NI for Support

You can request support from NI if the available online resources do not meet your needs. Provide as much information as possible in your support request so NI service representatives fully understand the issue you are experiencing. NI can work with you to gather all the necessary information but preparing it ahead of time can reduce the amount of time it takes to process the support request.

Note NI cannot ensure support for any items added to the system's original shipping configuration, such as from a second-tier integrator, because they were not provided by NI. Contact the responsible party first if you suspect the issue involves any of these items.

System Information

Before submitting any type of support or service request, collect the following information about your system from the system sticker.

- Serial number
- Part number
- Model name
- Configuration name
- System tag

Submitting a Request for Calibration Services

To submit a request for calibration, complete the following steps.

1. Collect your system information.
2. Collect the applicable component model name and serial number.
3. Contact your assigned NI Hardware Services Program Manager or the support channel defined in your service agreement to discuss service options.

Submitting a Request for RMA, Repair Services, or Replacement Parts

To submit a request for return materials authorization (RMA), repair, or to order replacement parts, complete the following steps.

1. Collect your system information.
2. Collect the applicable component part number and serial number.
3. Contact your assigned NI Hardware Services Program Manager or the support channel defined in your service agreement to discuss service options.

Submitting a Request for Technical Support

To submit a request for general technical support, complete the following steps.

1. Collect your system information.
2. Visit ni.com/support, and select **Submit or Manage a Service Request**.
3. Use the Service Request Manager to request technical support.