OMRON

LD-series

AMR Battery Power Sharing

User's Guide

25240-000A

NOTE

Trademarks

Copyrights

Introduction

This guide is OMRON's original instructions describing the setup and operations of the product.
Please read this guide and make sure you understand the details and procedures before attempting to use the LD battery power.
Keep this guide in a safe place where it will be available for reference.

Intended Audience

This manual is intended for the following personnel, who must also have knowledge of factory automation (FA) systems and robotic control methods.

- Personnel in charge of introducing FA systems.
- Personnel in charge of designing FA systems.
- Personnel in charge of installing and maintaining FA systems.
- Personnel in charge of managing FA systems and facilities.

Applicable Battery Models

This manual provides information for all LD-series AMR batteries with a part number of 20452-700.

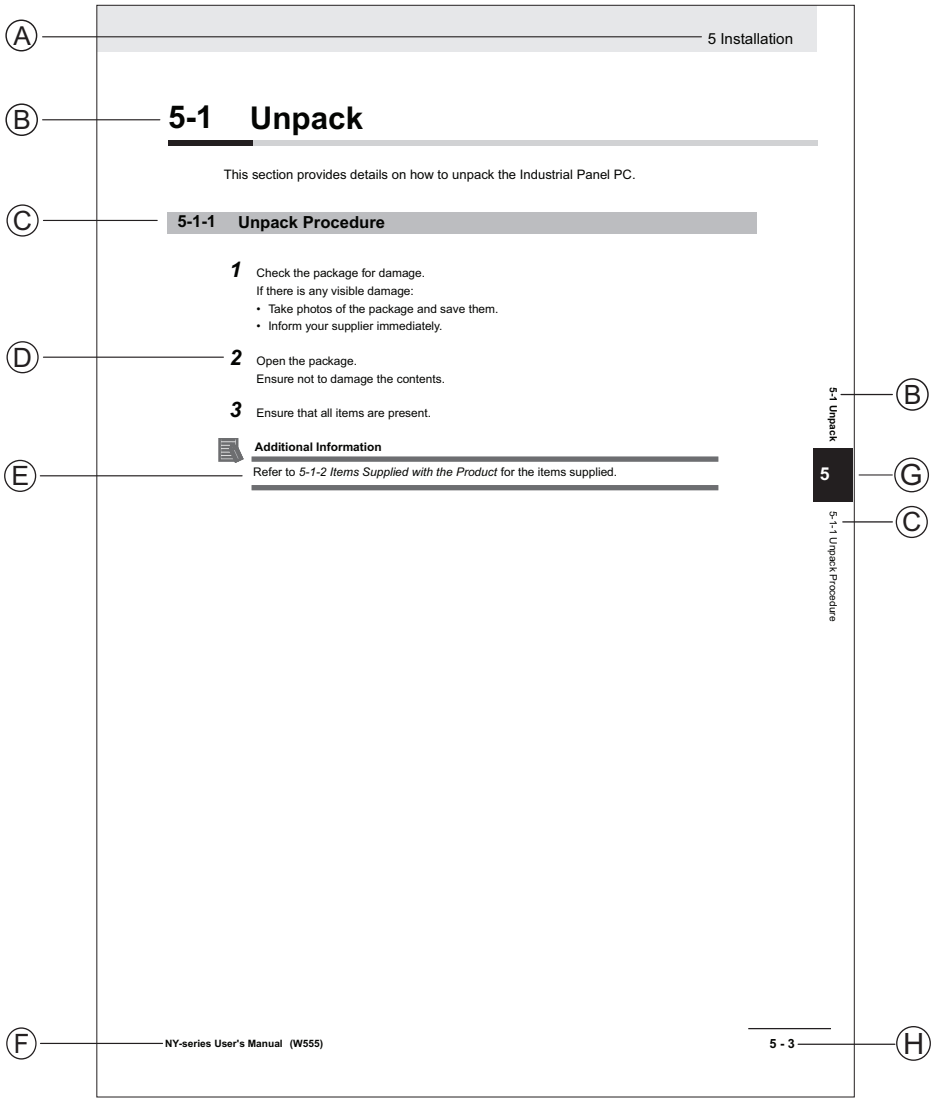
Units

All units are metric unless otherwise noted.

Manual Information

Page Structure

The following page structure is used in this manual.



Note: This illustration is provided as a sample. It will not literally appear in this manual.

Item	Explanation	Item	Explanation
A	Level 1 heading	E	Special Information
B	Level 2 heading	F	Manual name
C	Level 3 heading	G	Page tab with the number of the main section
D	Step in a procedure	H	Page number

Special Information

Special information in this manual is classified as follows:

Precautions for Safe Use

Precautions on what to do and what not to do to ensure safe usage of the product.

Precautions for Correct Use

Precautions on what to do and what not to do to ensure proper operation and performance.

Additional Information

Additional information to read as required.
This information is provided to increase understanding or make operation easier.

Version Information

Information on differences in specifications and functionality between different versions.

Sections in this Manual

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Section 2 Electrical Considerations

Section 3 Omron Techman Robot Connection

Appendices

Terms and Conditions Agreement

Warranty and Limitations of Liability

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Change in Specifications

Product specifications and accessories may be changed at any time based on improvements and other reasons. It is our practice to change part numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the Product may be changed without any notice. When in doubt, special part numbers may be assigned to fix or establish key specifications for your application. Please consult with your Omron's representative at any time to confirm actual specifications of purchased Product.

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Information presented by Omron Companies has been checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical or proofreading errors or omissions.

Safety Precautions

Definition of Precautionary Information

The following notation is used in this manual to provide precautions required to ensure safe usage of the LD-series AMR. The safety precautions that are provided are extremely important to safety. Always read and heed the information provided in all safety precautions.
The following notation is used.

⚠ **DANGER**	Identifies an imminently hazardous situation which, if not avoided, is likely to result in serious injury, and might result in fatality or severe property damage.
⚠ **WARNING**	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.
⚠ **CAUTION**	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Symbols

	The circle and slash symbol indicates operations that you must not do. The specific operation is shown in the circle and explained in text. This example indicates prohibiting disassembly.
	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a precaution for electric shock.
	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a general precaution.
	The filled circle symbol indicates operations that you must do. The specific operation is shown in the circle and explained in text. This example shows a general precaution for something that you must do.
	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a precaution for high temperatures.

Warnings

⚠ WARNING

Cybersecurity

To maintain the security and reliability of the system, a robust cybersecurity defense program should be implemented, which may include some or all of the following:

Anti-virus protection

- Install the latest commercial-quality anti-virus software on the computer connected to the control system and keep the software and virus definitions up-to-date.
- Scan USB drives or other external storage devices before connecting them to control systems and equipment.

Security measures to prevent unauthorized network access

- Install physical controls so that only authorized personnel can access control systems and equipment.
- Reduce connections to control systems and equipment via networks to prevent access from untrusted devices.
- Install firewalls to block unused communications ports and limit communication between systems. Limit access between control systems and systems from the IT network.
- Control remote access and adopt multifactor authentication to devices with remote access to control systems and equipment.
- Set strong password policies and monitor for compliance frequently.

Data input and output protection

- Backup data and keep the data up-to-date periodically to prepare for data loss.
- Validate backups and retention policies to cope with unintentional modification of input/output data to control systems and equipment.
- Validate the scope of data protection regularly to accommodate changes.
- Check validity of backups by scheduling test restores to ensure successful recovery from incidents.
- Safety design, such as emergency shutdown and fail-soft operations in case of data tampering and incidents.

Additional recommendations

- When using an external network environment to connect to an unauthorized terminal such as a SCADA, HMI or to an unauthorized server may result in network security issues such as spoofing and tampering.
- You must take sufficient measures such as restricting access to the terminal, using a terminal equipped with a secure function, and locking the installation area by yourself.
- When constructing network infrastructure, communication failure may occur due to cable disconnection or the influence of unauthorized network equipment.
- Take adequate measures, such as restricting physical access to network devices, by means such as locking the installation area.
- When using devices equipped with an SD Memory Card, there is a security risk that a third party may acquire, alter, or replace the files and data in the removable media by removing or unmounting the media.
- Please take sufficient measures, such as restricting physical access to the Controller or taking appropriate management measures for removable media, by means of locking and controlling access to the installation area.
- Educate employees to help them identify phishing scams received via email on systems that will connect to the control network.

Precautions for Safe Use

- It is required that the terminal block-based splitter cable design be used as shown below instead of any other methods like soldering and splicing, as there is a chance that a cable with a poor contact can cause overheating in the cable that could lead to a fire.
- Ensure all electrical connections on terminal blocks are torqued to the manufacture’s specification.
- You can contribute to resource conservation and protecting the environment by the proper disposal of Waste Electronics and Electrical Equipment (WEEE). All electrical and electronic products should be disposed of separately from the municipal waste system according to local ordinances using designated collection facilities.

廢電池請回收

Related Manuals

Use the following related manuals for reference.

Manual Title	Description
LD-60/90 Platform User's Manual (Cat. No. I611)	Provides information about the setup, operations, and user maintenance of the LD-60/90 AMR Platform.
LD-250 Platform User's Manual (Cat. No. I642)	Provides information about the setup, operations, and user maintenance of the LD-250 AMR Platform.

1

Introduction

This section provides introductory information about LD-series battery power sharing.

1-1 Overview

This document describes how to use the LD battery to power user-supplied equipment that requires more than 10 amps. These connections are typically required when AMR payload devices (conveyors, lifts, etc.) require more power than can be provided by the LD Core USER PWR or AUX PWR connectors.

The LD battery is a lithium-ion (LifePO4) type, and has specific limitations. It is important to understand these limitations before attempting to connect loads directly to the LD-series battery.

If your equipment requires less than 10 amps, utilize the standard USER PWR and AUX PWR connections as described in the LD AMR User's Manuals.

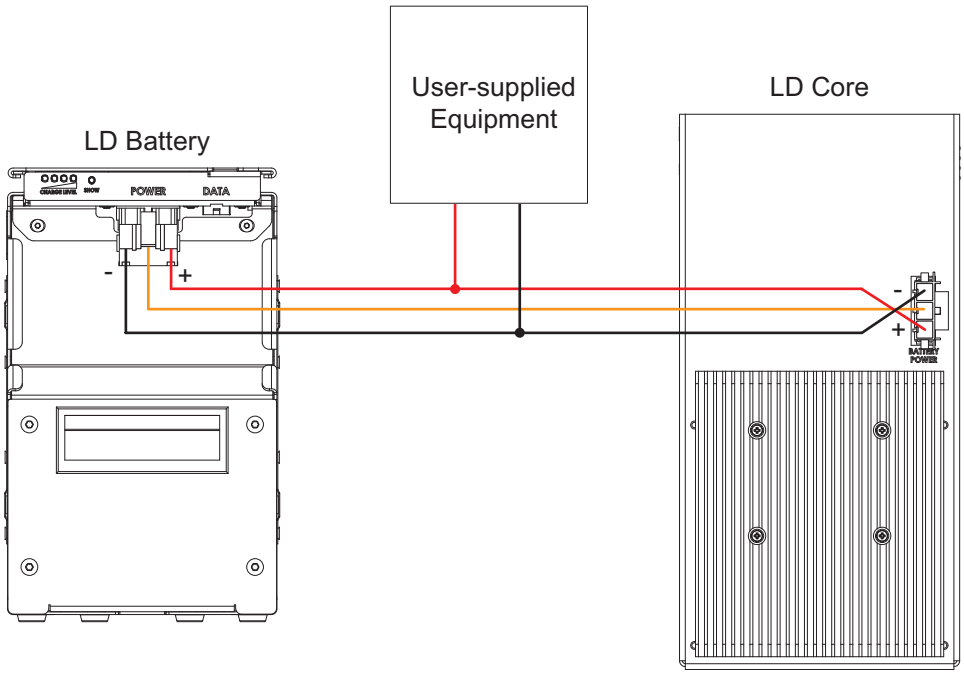
⚠ WARNING

Connecting loads directly to an LD battery that is not compatible can result in fires and will permanently damage equipment. Never connect electrical loads directly to LD batteries that are not compatible.

Precautions for Correct Use

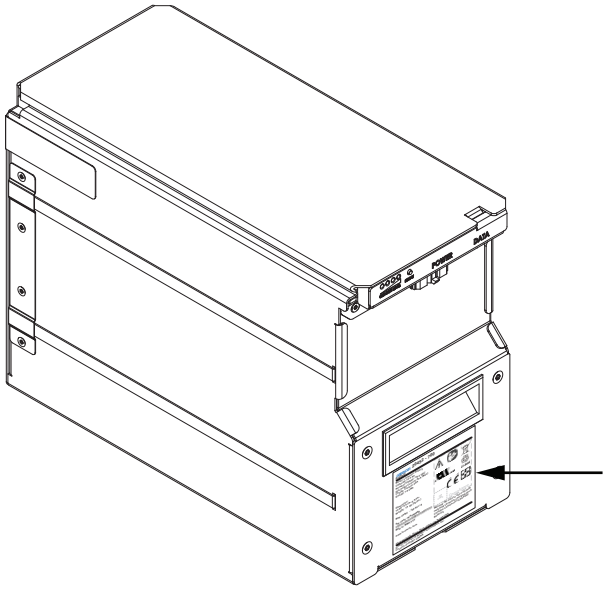
Information in this document applies to the new generation LD battery only. Refer to *1-2 LD Battery Compatibility* on page 1-3 to determine if an LD battery is compatible with this connection method.

The basic connection method is represented in the following diagram.

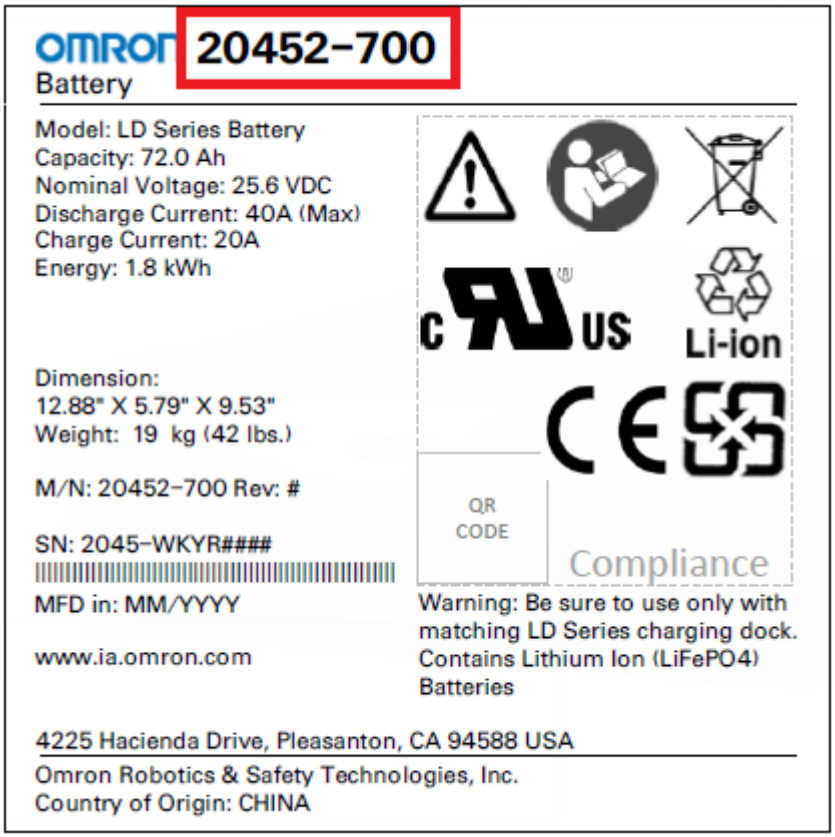


1-2 LD Battery Compatibility

Check the LD battery label to determine if an LD battery is compatible with direct electrical connections.



A compatible LD battery will have a part number 20452-700 as shown below.



If your battery has a part number 20452-000, it is not compatible and does not support connections described in this document.

2

Electrical Considerations

Electrical consideration information is provided in this section.

2-1 Battery Characteristics

The behavior of the battery during typical AMR operation is characterized in the following sections.

2-1-1 AMR Current Consumption

AMR current consumption during typical operation states is provided below.

- 1.5 amps when the AMR is powered ON and stationary.
- ~4.8 amps when moving in a straight line at a constant speed on a level surface (average).
- 62 amps maximum, momentarily while accelerating under extreme conditions (high payload, high acceleration rate, inclined surface, etc.).

User-supplied equipment connected directly to the battery should not be active while the AMR is moving to avoid unexpected AMR shutdown and other problems. If this equipment must be active while the AMR is moving, reduce translational and rotational accelerations to minimize current draw by the AMR drive motors.

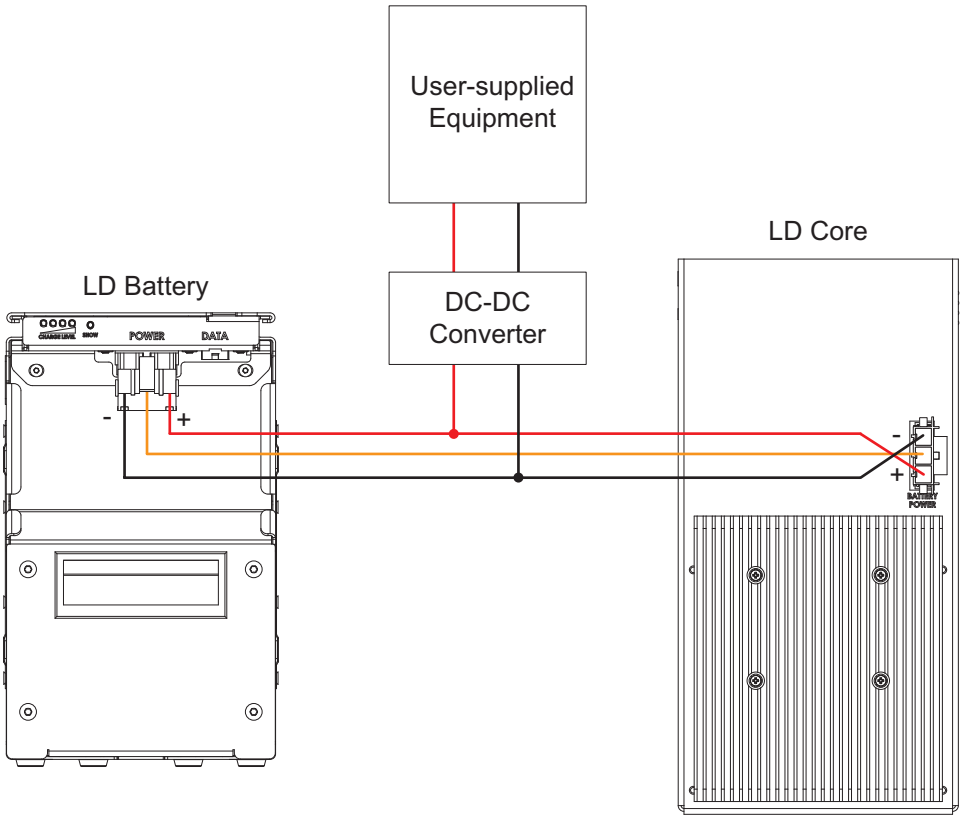
Additional Information

The current consumed by the AMR while autonomously navigating a workspace will fluctuate significantly due to obstacle avoidance, turning, floor surface, and other variability in the environment.

2-1-2 Battery Voltage Fluctuations

The LD battery is a lithium battery pack that outputs a nominal voltage of 25.6V. However, the battery operating voltage will vary between 22 and 30 VDC depending on the charge level and the instantaneous load.

A user-supplied DC-to-DC converter may be necessary if the connected equipment is affected by voltage fluctuations.


User-supplied Equipment
DC-DC Converter
LD Battery
LD Core
POWER
DATA
-
+
-
+

2-2 Battery Overvoltage

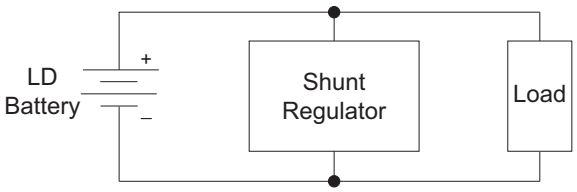
Use the information in the following sections to understand and mitigate battery overvoltage conditions.

2-2-1 Regenerative Loads

Some load types may generate electricity during certain operations. For example, a motorized lifting mechanism may generate electricity while lowering, or a motorized arm may generate electricity while decelerating to a stop.
The LD Battery can accept some regenerative electricity, but it depends on the regenerative current profile and the charge state of the battery itself.
Voltage at the battery terminals cannot exceed 35 VDC. Exceeding this limit can result in battery errors or damage to the battery. Refer to the AMR user's manual for more information about battery errors.
Mitigate regenerative loads by installing shunt regulator devices. Shunt regulators dissipate energy when a specific voltage (clamping voltage) is exceeded, to protect the battery from excessive voltage. A recommended set point for a shunt regulator is 30 VDC.

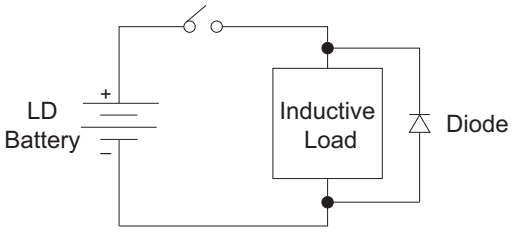
Additional Information

The RoboteQ SR2K69V25R is an example of a shunt regulator. Select a comparable product suitable for your application.



2-2-2 Inductive Loads

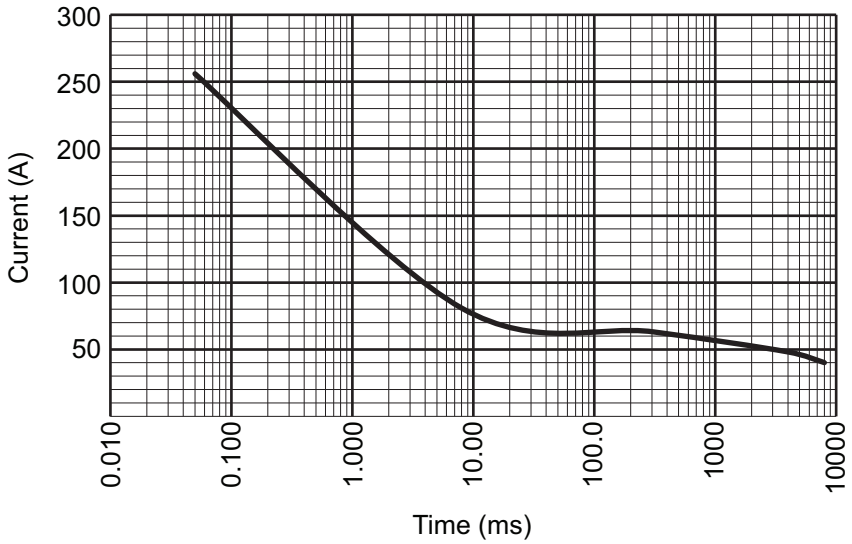
Inductive loads that are connected to the LD Battery may cause harmful transient voltage spikes when power is removed. Devices such as contactors, relays, DC motors, and coils typically exhibit this behavior known as counter-electromotive force, EMF, CEMF, or inductive kickback. Any device that exhibits this behavior may also introduce electromagnetic interference to nearby equipment.
Mitigate these transient voltages by adding a diode across the positive and negative terminals of the inductive load. These diodes are also known as flyback / snubber diodes. Select a diode that is capable of conducting the maximum load current.



2-3 Battery Current Limits

The LD battery is rated to deliver up to 40 amps continuously. It can deliver higher current momentarily, as shown in the current output duration graph below.
If the battery current limit is exceeded, a battery protection feature is activated and battery power output will stop. Refer to the AMR user's manual for more information about battery errors.

Battery Current Output Duration Limits



Precautions for Correct Use

Battery output is shared between AMR functions and user-supplied equipment. Refer to *2-1-1 AMR Current Consumption* on page 2-2 for more information about typical AMR current draw. Make considerations for this when selecting electrical equipment that shares the AMR battery power.

2-4 Power-up and Inrush

Some user-supplied equipment may consume large amounts of current during power up for a short duration, which may lead to battery protection shutdown. Devices such as transformers, coils, inductive loads, or other equipment with capacitors may exhibit this behavior. It is essential to know the inrush requirements of the user-supplied equipment and take measures to ensure that it does not exceed the battery's overload capacity.

Additional Information

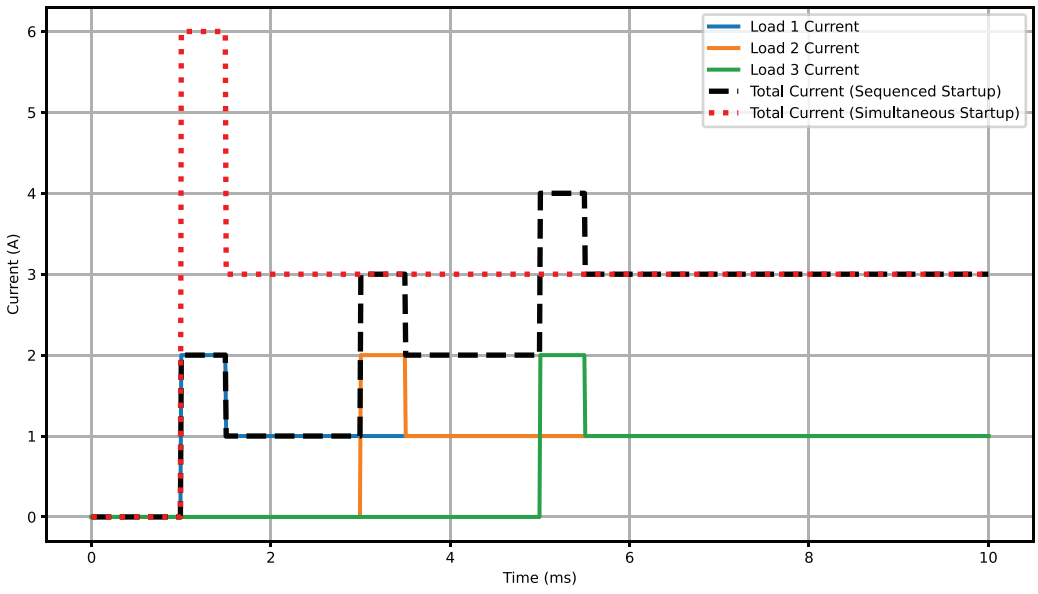
If the battery shuts down immediately when the load is turned on, it suggests that the load is either drawing an inrush current exceeding the battery's overload specifications or there may be a short in the circuit.

Mitigate high inrush currents during equipment power up with the following methods.

2-4-1 Sequenced Power-up

If multiple user-supplied devices must be powered up, use a power-up sequence to avoid turning all equipment on at the same moment.

Timing Diagram - Sequenced Startup vs Simultaneous Startup



Implement a time delay between each device's connection to the battery circuit to keep the inrush current below allowable limits. Check equipment inrush current specifications to establish a timing and sequencing profile.

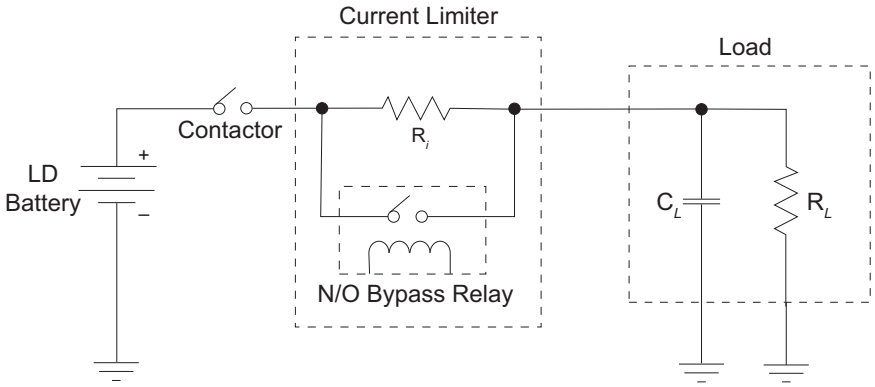
2-4-2 Inrush Current Limiter

An inrush current limiter is a circuit that limits the current to a lower value during the inrush period. Once past the inrush period, the limiter is bypassed to allow the load to be directly connected to the battery.

Additional Information

Reducing current supplied to a load may impact operation or functionality. Always consider the effect of reducing current to the load before implementing inrush current limiting.

An example of an inrush current limiter is shown below.



Current Limiting Resistor Sizing

At power up, the current limiter resistance (R_i) is in series with the load while the (normally open) bypass relay is open.

The current limiter resistance reduces the inrush current to a desired value within the battery current allowance. Once the load is sufficiently powered and the load is charged, the bypass relay closes to bypass R_i to protect it from overheating during operation or affecting the delivered voltage.

The following example calculates the value of R_i based on a load capacitance of 1000µF.

Resistor size can be determined with the following calculations. Example values for the calculations are provided below.

- Battery voltage of 30 VDC
- Load capacitance of 1000µF
- Load resistance of 7.5 Ω
- Maximum current limit of 40 A

R_i = 30 VDC / 40 A = 0.75 Ω

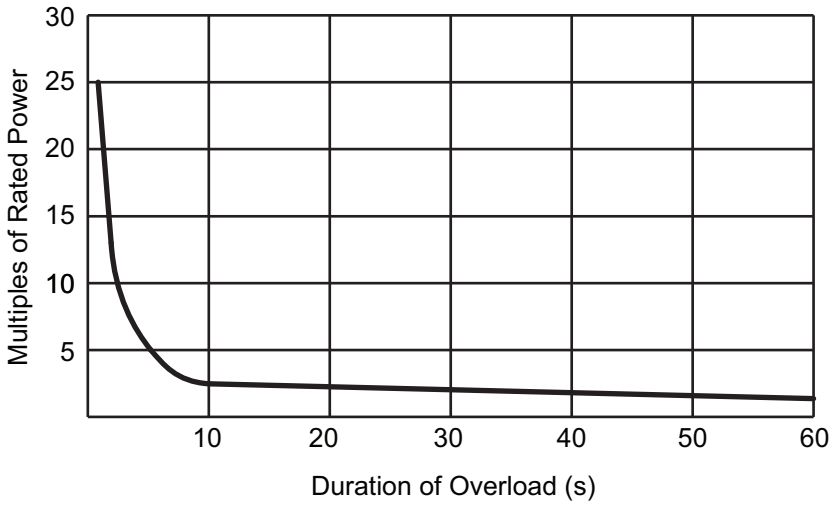
Power = $(40\ A)^2$ x 0.75 Ω = 1200 W

The load will take 2.25 ms to reach a 95% battery voltage during this inrush period as shown in the calculation below.

-0.75 Ω x 1000µF x ln(0.05) = 2.25 ms

Energy dissipation resistors can be downsized from 1200 W because they can typically manage power several times the rated value for short a short duration. Check the power overload curve specifications to select an appropriately sized dissipation resistor.

An example power overload curve specification is provided below. This applies to the resistor family HSA50 manufactured by TE Connectivity.



Based on this power overload curve above, a dissipation resistor with 0.75 resistance can withstand 25 times its rated power for a duration of 1 second or less. A 50 W rated resistor (TE Connectivity HSA50R75J) would be sufficient based on the following calculation.
1200 W / 25 = 50 W

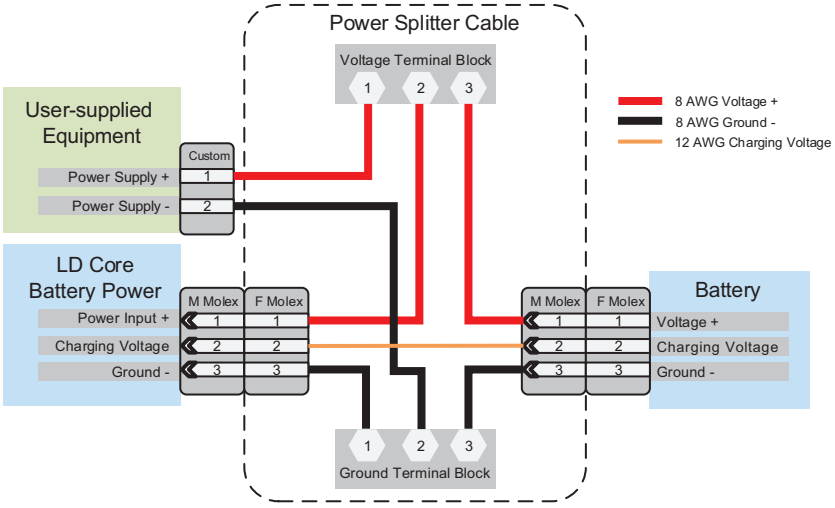
Inrush Protection Time-Delay Equipment

To use an inrush protection circuit, a bypass relay must be open during the inrush period duration. The duration will vary based on the load type, size, and other electrical properties. If the inrush period cannot be calculated, measure the load's voltage from the moment electricity is applied to the moment it reaches 95% battery voltage. Use this amount of time for the time-delay circuit to close the bypass relay.
The time-delay is typically controlled using a PLC or time delay relay.
The bypass relay must be sized properly if the load fails to charge in the predetermined amount of time. Consider adding voltage level detection and error handling measures to account for a load that fails to charge properly.

2-5 Accessing the Battery Power

A cable must be created to access the LD Battery power. This cable preserves the LD Core power connections while providing a connection point for LD Battery power. This cable can be considered as a power splitter cable, to split power from the LD Battery to the LD Core and to user-supplied equipment.

A basic diagram of the cable and connection points is provided below.



Additional Information

Refer to *A-1 Example Equipment List* on page A-2 for more information about cable connectors and other equipment.

2-5-1 Battery Power Sharing Cable Creation and Installation Procedure

Use the following procedure to assemble the battery power sharing cable and install it.

Precautions for Safe Use

- Carefully follow the circuit diagram to ensure the pins are positioned correctly in the connectors. Incorrect assembly may cause a short circuit or reversed polarity, which could damage the electrical components.
- It is required that the terminal block-based splitter cable design be used as shown below instead of any other methods like soldering and splicing, as there is a chance that a cable with a poor contact can cause overheating in the cable that could lead to a fire.
- Ensure all electrical connections on terminal blocks are torqued to the manufacture's specification.

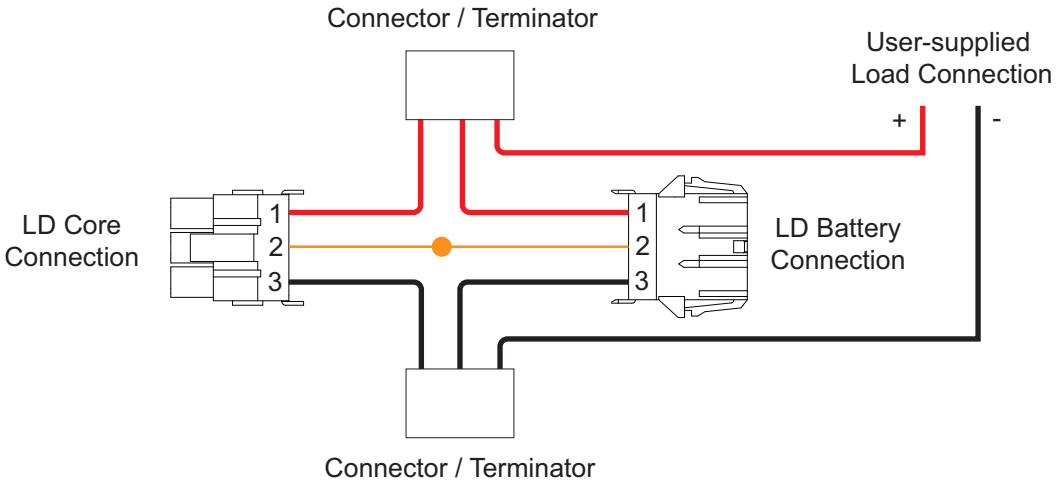
Make the following considerations before beginning this procedure:

- Access to LD Core connectors near the top surface of the AMR is required. Removal of any user-supplied payload equipment may be necessary to access this area.
- The AMR must be powered OFF with the battery removed before attempting this procedure.
- All cable routing and positioning must avoid sharp edges to prevent wire insulation damage that may lead to short circuits or other equipment damage.

The following tools and equipment are required to complete this procedure.

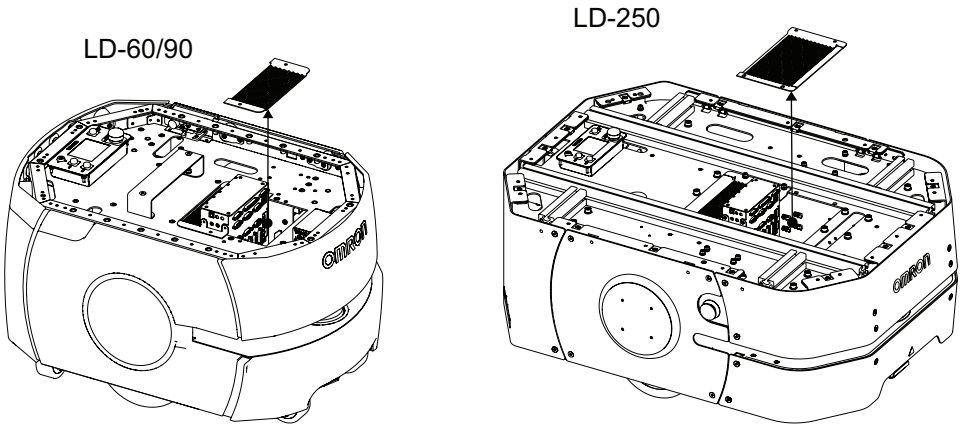
- All cable assembly equipment. Refer to *A-1 Example Equipment List* on page A-2 for a sample list of compatible equipment.
- 4 mm hex bit (LD-60/90) or 5 mm hex bit (LD-250).
- Torque wrench.
- Drill with 25 mm metal bit.
- Rubber grommet to fit 25 mm diameter hole.
- Wire management and securing devices such as cable ties or similar hardware.
- Terminator for the load power leads (if the user-supplied load is not available).

1 Assemble the battery power sharing cable as shown below.
Ensure all terminals of the battery power sharing cable assembly are not exposed by using covers or other insulators.

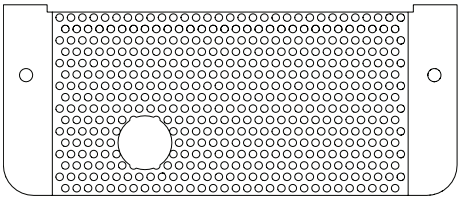


2 Turn OFF the AMR and then remove the battery.
Refer to the AMR manual for details about turning the AMR OFF and how to remove the battery.

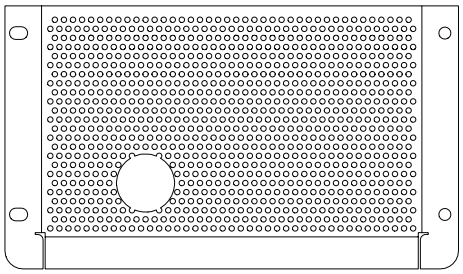
3 Remove the LD Core guard plate as illustrated below using a 4 mm hex bit (LD-60/90) or 5 mm hex bit (LD-250).



4 Drill a 25 mm hole in LD Core guard plate at the approximate location shown below.



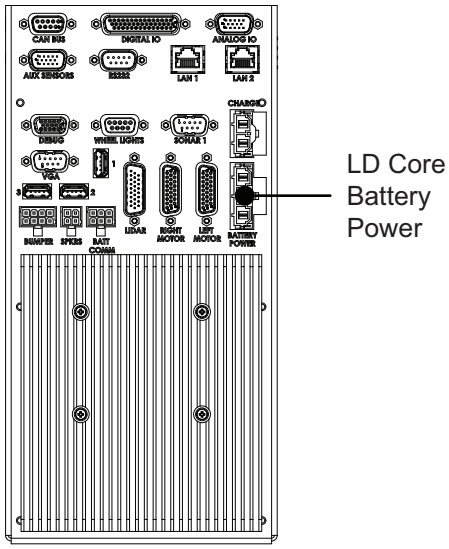
LD-60/90



LD-250

5 Insert the rubber grommet into the hole.
This grommet will protect the battery power sharing cable from chafing and damage to the insulation that could cause shorts or other damage to equipment.

6 Remove the connector of the pre-existing LD power cable from the LD Core BATTERY POWER port.



7 Connect the female Molex connector of the battery power sharing cable to the LD Core BATTERY POWER port.

8 Connect the male Molex connector of the battery power sharing cable to the pre-existing female connector on the LD power cable

9 Route the load power leads through the LD Core guard plate hole created in the previous step.

10 Secure the battery power sharing cable and terminals to the AMR with cable ties or similar hardware.
Make sure the battery power sharing wires and terminals are secure and will not move during AMR operation. Secure things properly to prevent vibrations from loosening terminals or damaging wire insulation.

11 Place the LD Core guard plate in the original position and then fasten it. Apply a torque of 10 N-m (LD-60/90) or 16 N-m (LD-250).

12 Connect the battery power sharing cable load power leads to the user-supplied load.
If the user-supplied load is not available, terminate the battery power sharing cable load power leads to prevent shorting.

13 Check that all connections are secured to complete this procedure.

3

Omron Techman Robot Connection

This section provides information about connecting an Omron Techman robot to the LD AMR battery.

3-1 Techman Robot Power Connection Details

This section provides details about supplying power to an Techman Robot from an LD AMR battery. Make the following considerations before attempting to power an Techman Robot from an LD AMR battery.

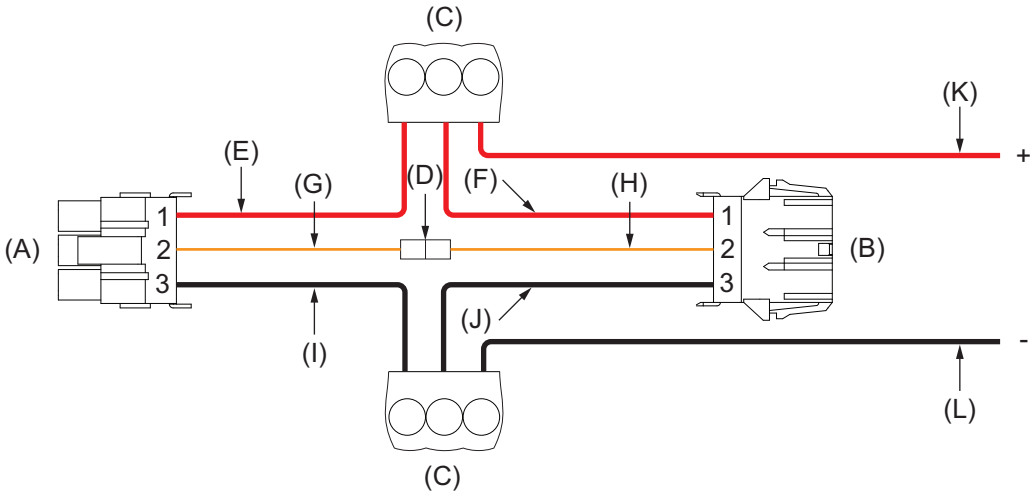
- Inrush Current
  The Techman TM5S/7S/12S/14S DC models have inrush power requirements that fall within the specifications of the LD Battery. No additional inrush equipment is necessary for these models.
- AC Models
  An DC to AC inverter is required for AC models. This is not ideal because inverters create large inrush currents, and some mitigation may be necessary for these power-up conditions. The use of additional power conversion equipment will consume additional LD Battery power and will diminish overall system runtime.
- Output Power Limitations
  The total output power of the Techman robot axis motors will be reduced by 30% when powered by the LD Battery, as the battery cannot supply the 48V required for full power output. The peak acceleration and maximum payload for robot will be de-rated. The robot *time to top speed (ms)* parameter is lowered below the default 500 ms setting.
  If maximum performance is required, a DC-to-DC converter can be added to the system to provide 48 VDC from the battery's nominal voltage. The use of additional power conversion equipment will consume additional LD Battery power and will diminish overall system runtime.
- Techman Controller Power Cable
  A power cable that is supplied with all models must be available. This cable provides power leads that will be used to connect to the Battery Power Sharing Cable described in the *2-5-1 Battery Power Sharing Cable Creation and Installation Procedure* on page 2-9.

A

Appendices

A-1 Example Equipment List

A list of batter power sharing cable equipment is provided below as an example. Use this list as a guide for comparable equipment needed to make this cable.



Item	Image	Quantity	Manufacturer	Part Number	Description
(A)		1	Molex	428160312	Minifit Sr 3 Position (Female)
(B)		1	Molex	428180312	Minifit Sr 3 Position (Male)
(C)		2	Polaris	IPLG6-3B	Multi-tap Single Side Entry Connector (3 port)
(D)		1	Wago	221-612/ VE00-1000	Terminal Butt Splice, Closed End, Individual Openings Connector Push In
(E)		1	Molex	2174812225	Precrimped Minifit Sr Female Pin 8 awg Red 450 mm
(F)		1	Molex	2174832225	Precrimped Minifit Sr Male Pin 8 awg Red 450 mm
(G)		1	Molex	2174812215	Precrimped Minifit Sr Female Pin 10 awg Red 450 mm
(H)		1	Molex	2174832215	Precrimped Minifit Sr Male Pin 10 awg Red 450 mm

Item	Image	Quantity	Manufacturer	Part Number	Description
(I)		1	Molex	2174811225	Precrimped Min-ifit Sr Female Pin 8 awg Black 450 mm
(J)		1	Molex	2174831225	Precrimped Min-ifit Sr Male Pin 8 awg Black 450 mm
(K)	User-supplied wire, 8 awg minimum*1				
(L)					

*1. Use the power cable that is supplied with the Omron Techman robot as shown below.

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