Discover®
Innovative Battery Solutions

APPLICATION NOTE:

XANBUS ENABLED DISCOVER ADVANCED ENERGY SYSTEMS AND SCHNEIDER ELECTRIC CONEXT INTEGRATION

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03/22/2017	C	Brendon Sauer	Formatting and content update

OVERVIEW

This Application Note provides information about the integration of Discover Xanbus enabled AES batteries with the Schneider Electric Conext system and related components.

There are some notable performance and configuration differences when comparing your AES installation against conventional lead batteries.

Plug and play communications automatically configure the charge and discharge settings of the Inverters and charge controllers. When AES batteries are connected to the Conext system they will configure critical battery related settings, in most cases user configuration is not required.

The AES batteries provides significantly more accurate battery parameter readings then the inverter/chargers are capable of. Using these internal battery voltage, current, and temperature measurements the AES batteries will dynamically control the charge characteristics allowing for reduced charge times and intelligent battery balancing.

Supported Schneider Electric documents:

- Schneider Electric 975-0239-01-01 Conext XW+ Installation Guide
- Schneider Electric 975-0639-01-01 Conext SW Installation Guide

Discover Reference documents:

- Discover Energy 808-0004 42-48-6650 Data Sheet
- Discover Energy 808-0005 44-24-2800 Data Sheet
- Discover Energy 810-0016 42-48-6650 Charge Algorithm
- Discover Energy 810-0017 44-24-2800 Charge Algorithm
- Discover Energy 805-0001 GEN 2 Product Manual

Visit discoverbattery.com for the most recent version of published documents.

Certain configuration, installations, service, and operating tasks should only be performed by qualified personnel in consultation with local utilities and/or authorized dealers. Qualified personnel should have training, knowledge, and experience in:

- Installing electrical equipment
- Applying applicable installation codes
- Analyzing and reducing hazards involved in performing electrical work
- Installing and configuring batteries

No responsibility is assumed by Discover for any consequences arising out of the use of this material.

TABLE OF CONTENTS

1. SAFETY

1.1 Warnings, Cautions, Notes and Symbols

▲ WARNING
Important information regarding possible personal injury.

▲ CAUTION
Important information regarding possible equipment damage.

▲ NOTE
Additional information concerning important procedures and features of the battery.

1.2 General Warning

For battery handling, refer to Discover® AES Batteries Product Manual.

▲ WARNING
Use of accessories not recommended or sold by the manufacturer may result in a risk of fire, electric shock, or personal injury.

▲ CAUTION
The batteries do not have any user serviceable parts. Do not disassemble or modify the battery.

▲ CAUTION
Make sure that existing wiring and components are in good condition and that critical components are not undersized. Do not operate the system with damage or undersized wiring and components.

1.3 Fire and Electric Shock Risk

▲ WARNING
ELECTRICAL SHOCK AND FIRE HAZARD. Installation must be done by qualified personnel to ensure compliance with all applicable installation codes. Instructions for installing the batteries are provided in this installation guide for use by qualified installers only. FAILURE TO FOLLOW THESE INSTRUCTIONS WILL RESULT IN SERIOUS INJURY OR DEATH.

- Battery has monitoring and shut-off devices to reduce fire risk.
- Primary suppression for lithium battery fires is water. Secondary suppression is CO2, powder and halon.

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1.4 Chemical Risk

▲ WARNING
Lithium batteries are chemical risk if misoperated, mishandled or abused.

1.5 Do's

- **Do** protect terminals from short circuit before, during, and after installation
- **Do** wear electrically insulated gloves
- **Do** use electrically insulated tools
- **Do** wear eye protection
- **Do** wear safety toe boots / shoes
- **Do** read user manual for battery handling instructions
- **Do** secure battery safely

1.6 Do Not's

- **Do not** operate or store battery outside of operating limits
- **Do not** short circuit battery
- **Do not** puncture battery
- **Do not** expose battery to flames, or incinerate
- **Do not** open battery case or dissemble battery
- **Do not** wear rings, watches, bracelets or necklaces when handling or working near battery
- **Do not** drop or crush battery
- **Do not** lift battery by the terminal cables
- **Do not** expose battery to water or other fluids
- **Do not** expose battery to direct sunlight
- **Do not** dispose of battery
- **Do not** connect with other types of batteries
- **Do not** expose battery to high temperatures

2. OPERATING LIMITS

2.1 Battery Operating Limits

The BMS is designed to prevent operation outside of these limits.

Table 1. Operating limits

Operating Limits	42-48-6650	44-24-2800
Max Continuous Current	130 A	110 A
Operating Voltage (Min / Max)	44.8 V / 59.2 V	22.4 V / 29.6 V
Charge Temperature (Min / Max)	0°C / 45°C (32°F / 113°F)	0°C / 45°C (32°F / 113°F)
Discharge Temperature (Min / Max)	-20°C / 60°C (-4°F / 140°F)	-20°C / 60°C (-4°F / 140°F)
Storage Temperature (Min / Max)	-20°C / 45°C (-4°F / 113°F)	-20°C / 45°C (-4°F / 113°F)

▲ NOTE
Refer to published data sheets at discoverbattery.com for the most up to date specifications

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▲ CAUTION
Do not install batteries in series. Select the appropriate AES battery model for the voltage of your system.

▲ CAUTION
Intentional bypassing of BMS to operate battery outside maximum and minimum limits voids warranty.

3. BATTERY BANK SIZING

3.1 Depth of Discharge

Conventional lead acid batteries should be designed to discharge only 50% of their nominal capacity on a regular basis.

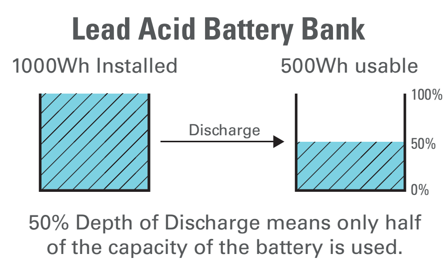

Figure 1. Lead Depth of Discharge

The figure above shows clearly that the size of a lead acid battery bank should be twice the size of the installations energy requirements to maximize the battery's life.

AES batteries will tolerate discharge cycles that consume 100% available capacity of the system. The capacity of a Lithium battery is related to temperature and discharge rates, Discover recommends sizing an AES battery system for 80% DOD.

3.2 Run Time and Size

The total number of AES batteries installed determines the overall battery backup energy and similarly the amount of time the inverter can supply AC output power. Recharge time of the battery system will also increase with the overall size of the battery bank.

3.2.1 Discover AES Battery Bank Size Limitations

The number of AES batteries installed with an inverter system is limited to 10 units.

▲ CAUTION
Installations of more than 10 AES batteries with one inverter cluster are not supported.

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3.3 Power and Energy Requirements

Energy (Wh) is calculated by multiplying the amount of power (W) used for a given amount of time (hours). This applies to both charging and discharging the battery.

Example:
A typical coffee pot draws 1000 W of power when in use. If the pot is on for 30 min (0.5 hours) the amount of energy used would equal 500 Wh:

$$\text{Coffee Pot Power (W)} \times \text{Time in use (hours)} = \text{Total Energy (Wh)}$$

$$1000\text{ W} \times 0.5\text{ hours} = 500\text{ Wh}$$

Table 2. Power requirements for common appliances

Appliance	Watts	Appliance	Watts
Fluorescent lamp	10	Blender	400
Computer	200-300	Toaster	1000
Microwave (full size)	1500	Washer/Dryer	375-1000
Stereo	50	3/8” Drill	500
Hair Dryer or Iron	1000	Vacuum Cleaner	1200
Refrigerator (3 cu ft)	180	Refrigerator (12 cu ft)	480
Coffee Maker	1000	Ceiling fan	50

3.4 Calculating Battery Bank Size

Table 3. Example worksheet for calculating daily energy requirements

Load	Watts	Hours Per Day	Days Per Week	Weekly Watt Hours
10 15W lights	150	6	7	6300
Coffee maker	1200	0.75	7	6300
Laptop	50	5	7	1750
			Total Weekly Watt-hours of AC load	14350 Wh
			Divided by Days per Week	÷ 7
			Average total watt-hours per day	2050 Wh

Table 4. Example calculations for required battery bank size

Average total watt-hours per day		2,050
Account for inverter efficiency (90%)	2,050 x 1.11	2,276
Account for battery efficiency (95%)	2,276 x 1.05	2,389
Account for battery DOD target (80%)	2,389 x 1.25	2,986
Total adjusted Wh required		**2,986**
Multiplied by days of autonomy	2,986 x 5	14,930
Total installed energy required		**14,930 Wh**

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Table 5. Worksheet for calculating daily energy requirements

Load	Watts	Hours Per Day	Days Per Week	Weekly Watt Hours
Total Weekly Watt-hours of AC load				
Divided by Days per Week				
Average total watt-hours per day				

Table 6. Calculations for required battery bank size

Average total watt-hours per day		
Divided by inverter efficiency	______ ÷ 90	
Divided by battery efficiency	______ ÷ 95	
Divide by DOD targets	______ ÷ 80	
Total adjusted Wh required		
Multiplied by days of autonomy	______ x 5	
Total installed energy required		

Table 7. System Energy (Wh)

Model	# of Batteries in Battery Bank									
	1	2	3	4	5	6	7	8	9	10
42-48-6650	6,656	13,312	19,968	26,624	33,280	39,936	46,592	53,248	59,904	66,560
44-24-2800	2,816	5,632	8,448	11,264	14,080	16,896	19,712	22,528	25,344	28,160

4. INSTALLATION

⚠ WARNING

FIRE AND BURN HAZARD. Do not use battery cables that are insufficiently sized for expected current. Failure to follow this instruction may result in personal injury or death.

⚠ CAUTION

Adhere to all local regulations and electrical codes.

⚠ NOTE

All batteries should be the same model number (Nominal Voltage and Nominal Capacity) and should be of the same state of health. All batteries should be fully charged before installation.

4.1 Balance of System Requirements

L-com TDS2167, 12 Way Bridging Adapter RJ45 (8x8) - Required for AEBus and Xanbus.
L-com TDS1881S, 6 Way Bridging Adapter RJ45 (8x8) - Required for AEBus and Xanbus.
L-com ECS204-1 Modular Y-Bridge RJ45 (8x8) - Required for AEBus and Xanbus.
* Quantity may vary depending on battery bank size. Refer to wiring diagrams (Section 10).

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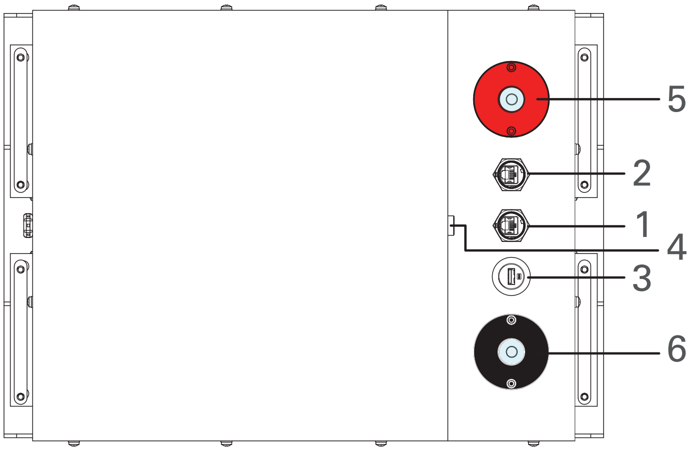
4.2 Battery DC and Communication Connections



ITEM	DESCRIPTION
1	COM1 AEBus interface to connect to AES enabled devices
2	COM2 Xanbus interface port to connect to Conext System
3	USB interface for PC connectivity
4	On-Off when battery is enabled blue power light will be illuminated
5	Battery Positive (+) (red) DC terminal connects to the positive bus bar of the DC Switchgear
6	Battery Negative (-) (black) DC terminal connects to the negative bus bar of the DC Switchgear

Figure 2. Xanbus enabled AES battery connections

▲ WARNING
FIRE AND BURN HAZARD. Without exception, product experiencing terminal burn out will not be warranted.

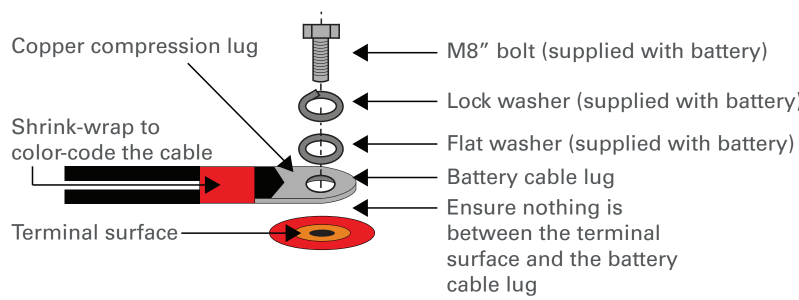


Figure 3. Correct Battery Cable and Terminal Connection

TERMINAL TORQUE
9 Nm / 6.64 ft-lb

4.3 Battery Location

Locate the batteries close to the inverter in order to minimize the length of the battery cables. However, care should be taken to ensure two feet of clearance above the batteries is maintained for access to both battery and inverter connections and disconnects.

The batteries performance and service life will be optimized when operating in an ambient temperature of 15°C-25°C (59°F-77°F).

4.4 Battery Connection and Configuration

Refer to wiring diagrams (Section 9). To ensure proper balancing and load sharing between parallel batteries ALL battery cable lengths should be kept the same.

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4.5 Xanbus Networking

Xanbus enabled devices communicate with each other over the Xanbus network sharing settings, activity and other updates. It is a requirement for one AES battery to be connected to the Xanbus network, this battery will communicate battery bank settings, activity and real time status to the other devices on the Xanbus network.

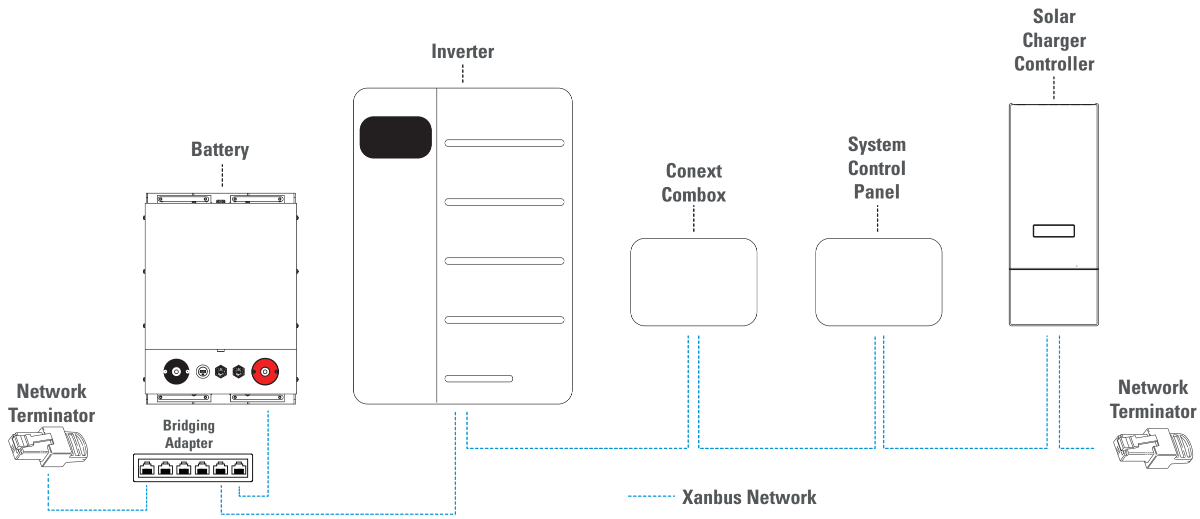

Figure 4. Xanbus Network

The Network Terminators are required for proper functionality of the Xanbus network. Care should be taken to ensure they are installed.

> **⚠ CAUTION**
>
> One AES battery is required to be connected to the Xanbus network. Failure to do so could result in reduced system performance.

4.6 AEBus Networking

The AEBus is utilized by all networked AES batteries to coordinate all voltage, temperature, and current data.

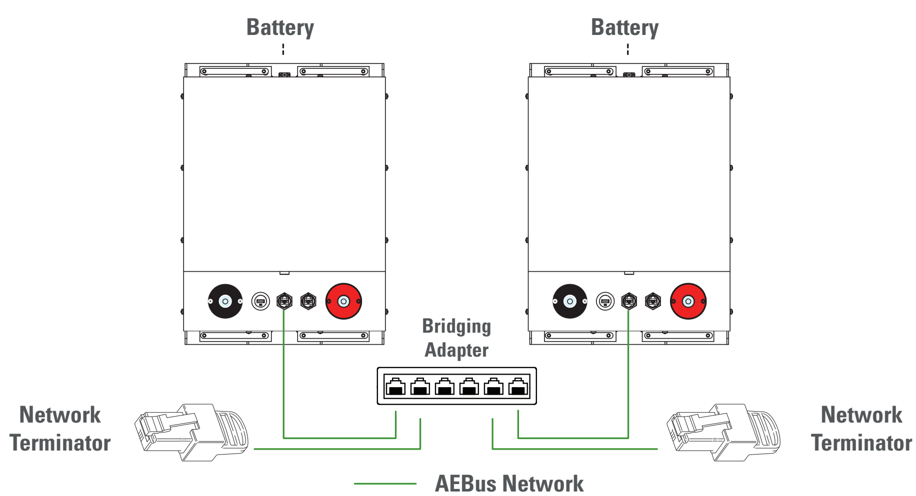

Figure 5. AEBus Network

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The Network Terminators are required for proper functionality of the AEBus network. Care should be taken to ensure they are installed.

▲ CAUTION
All AES batteries in a battery bank are required to be connected to the AEBus network. Failure to do so could result in equipment damage.

5. APPLICATION CONFIGURATIONS

5.1 Grid-Tie with DC Coupled Solar

This configuration will primarily keep the batteries fully charged from solar. When there is excess solar it will be sold back to the grid. In the event of a grid blackout the energy stored in the batteries will be used to power critical loads. To maximize self-consumption in a Grid Sell operation when there is no incentive to sell power back to the grid, the battery capacity should be sized to take into consideration: energy demands during non-daylight hours, size of PV array, and amount of back-up time desired during grid outages.

Typical operating modes for this configuration: Back-up/Off-grid, Grid sell, Peak-load shaving, and Grid charging.

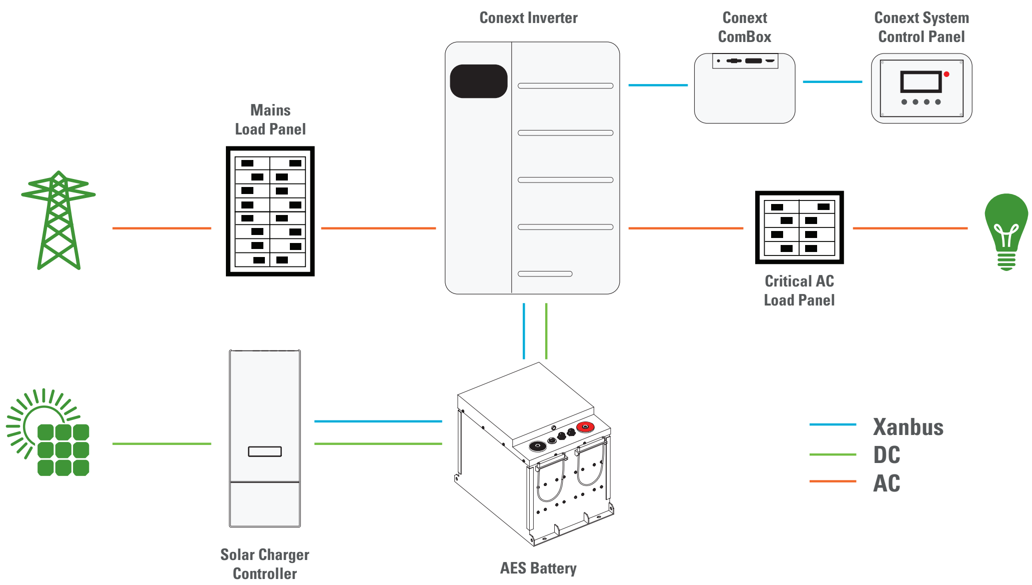

Figure 6. Grid-Tie with DC Coupled Solar diagram.

5.2 Grid-Tie with AC Coupled Solar

This configuration is typically a retrofit to existing grid tied (AC Coupled) solar systems. The Schneider Conext Inverter provides pass through for the solar grid-interactive inverter to sell to the grid. In island mode the Schneider inverter and grid-interactive inverter power critical loads. The primary source for battery charging is solar through the grid-interactive inverter.

Typical operating modes for this configuration: Back-up/Off-grid, Grid Sell, Peak-Load Shaving, Pass Through, AC Coupled Charging, and Grid Charging.

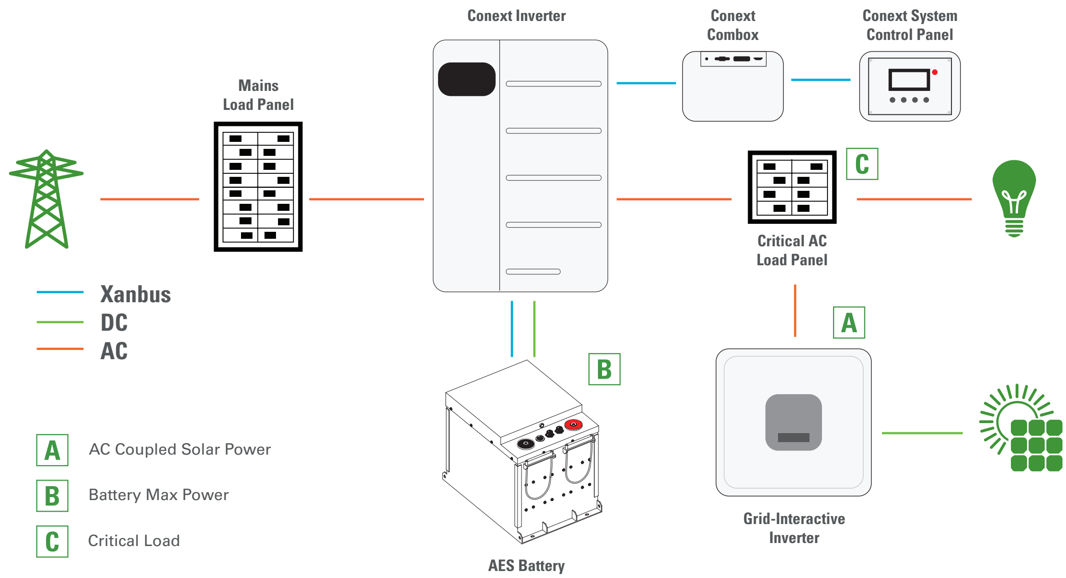

Figure 7. Grid-Tie with AC Coupled Solar diagram.

5.2.1 Considerations for Sizing of Discover AES Battery Banks in AC Coupled Systems

When retrofitting existing AC Coupled solar systems with Schneider Conext inverters and AES batteries the following sizing guidance should be followed:

Table 8. AC Coupled Solar System Battery Bank Sizing.

If the grid is disconnected:	If the grid is disconnected:
A - C = B	Grid-Interactive inverter power – critical load consumption = Power supplied to the battery based inverter
If C ~ 0 then:	**If critical load consumption ~ 0:**
A = B	Grid-Interactive inverter power = Power supplied to battery based inverter (limited to maximum battery power)
Therefore:	**Therefore:**
A must be < B	Grid-Interactive inverter power must be < Maximum rated power of the battery bank (Necessary to not fault battery system)
Guidelines for AC coupled system design:	
Battery capacity (energy) should > PV rating (STC)	

5.3 Off-Grid with DC Coupled Solar and Generator

This configuration is typically installed when there is no grid present. Normally the goal is to reduce diesel consumption. Solar and other auxiliary DC Charging sources such as hydro-electric are the primary battery charging source. A generator is used to charge during dark periods of the day, or when the primary sources are unavailable.

Typical operating modes for this configuration: Back-up/Off-Grid, Gen Charging, and Gen Support.

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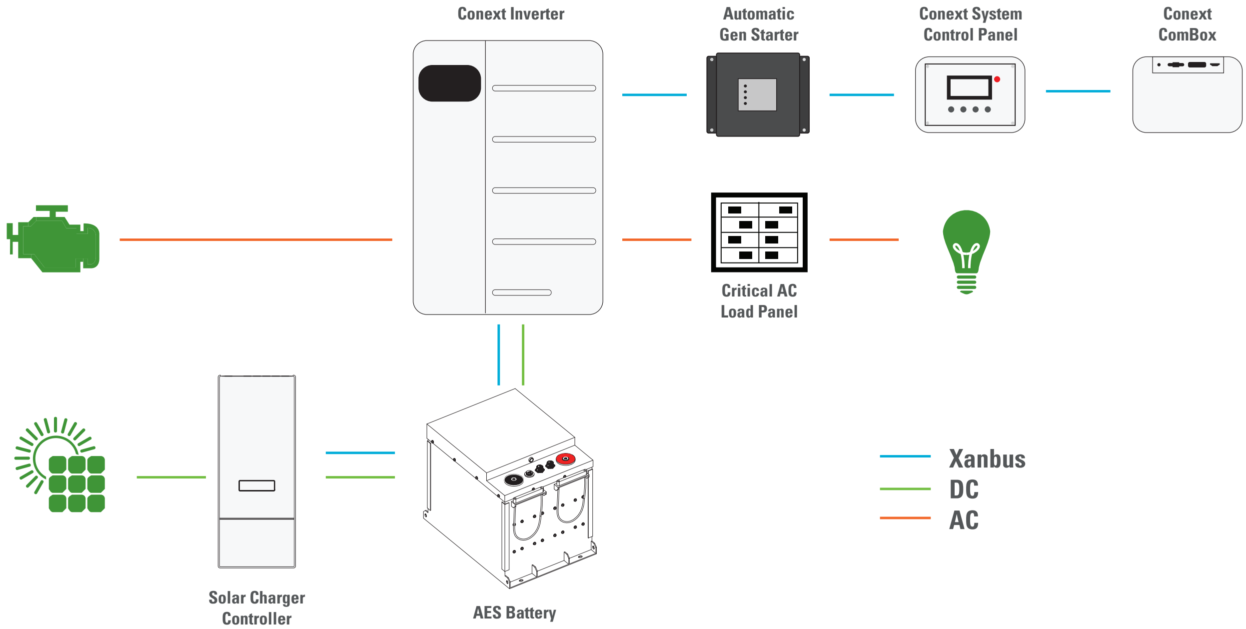


Figure 8. Off-Grid with DC Coupled Solar and Generator diagram.

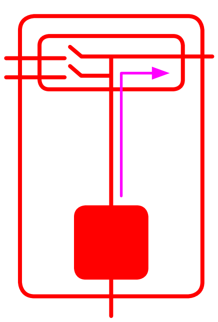
5.4 Back-Up with Peak Load Shaving

This configuration is typically installed in areas with weak and unstable grids that experience frequent blackouts, or installations that need to limit grid consumption due to tier based pricing based on power and energy tiers. (Refer to Figure 8).

Typical operating modes for this configuration: Back-up/Off-Grid, Peak Load Shaving, PassThrough, and Grid Charging.

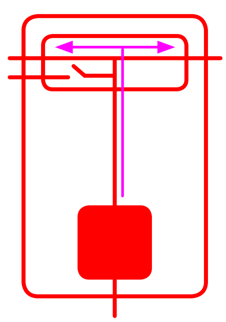
6. SYSTEM OPERATING MODES

6.1 Back-Up / Off-Grid



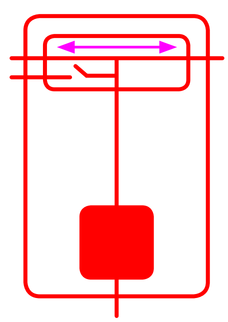
The inverter is inverting and power is being supplied from the energy stored in the batteries. The grid and generator are not able to power the loads.

6.2 Grid Sell



The system will sell back to the grid when the batteries are fully charged and there is excess solar power on the DC bus. The inverter is inverting to power the loads and will sell any excess to the grid. The amount of energy sold back to the grid can be set by the user through the inverter settings.

6.3 Pass Through



The system will enter pass through when charging from the grid or a generator is not desired. The loads are only powered through the AC sources. When there is an AC coupled grid-interactive inverter the system will send the solar power to the grid.

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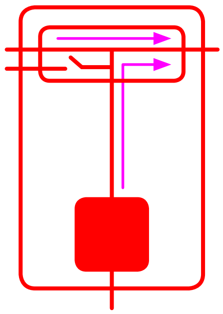
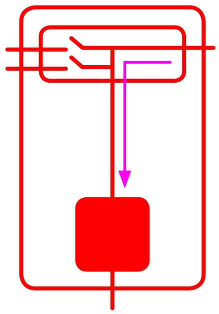
6.4 Peak Load Shaving



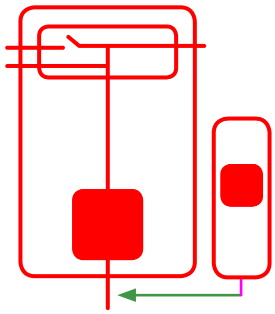
Peak Load Shaving can be used when the user wishes to limit the power consumed from the grid. The power to supply the loads is inverted from the batteries. The inverter can be set to consume energy from the batteries when the load demand exceeds the programed level during set hours of the day.

6.5 AC Coupled Charging



When the grid is lost the inverter will charge the batteries using the AC source from the grid-interactive inverter. When the batteries are fully charged the inverter can change the output frequency to instruct the grid-interactive inverter to reduce or cut out its output power.

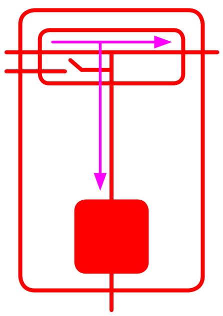
6.6 DC Coupled Charging / Auxiliary DC Charging



DC Coupled solar charge controllers or other DC sources such as micro hydroelectric can directly charge the batteries without interfacing with the inverter. The AES batteries can speak directly with Schneider charge controllers via Xanbus to control the charge voltage. In applications where there is no communication the DC charge voltage should be set to:

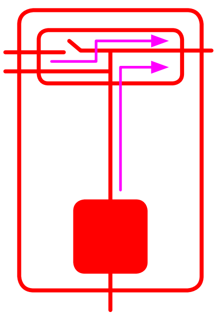
Nominal System Voltage	24V	48V
Charge Voltage Setting	27.2V	54.4V

6.7 Grid Charging



Grid Charging occurs when the batteries are at a low state of charge and the grid source is available, often after a blackout. The inverter will charge at a rate that will not exceed the programmed AC input current. If the loads draw more current then available the power used to charge the batteries will be reduced.

6.8 Generator Support



Generator Support will happen when the loads are drawing more power than the generator can support. In this scenario the inverter will stop charging and begin to invert from the batteries when the load rise above a programmed threshold.

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7. CONFIGURATION SETTINGS

7.1 Fixed Settings

AES fixed settings are automatically set by AES batteries when they are connected via Xanbus. These settings will automatically be reset by the AES battery if inadvertently adjusted by the user.

Table 9. Settings Auto Configured by AES Batteries through Xanbus Network.

Settings	Nominal System Voltage	
	24V	48V
Low Batt Cut Out (LBCO)	24 V	48 V
Batt Type	Custom	
High Batt Cut Out	29.2V	58.4 V
Low Batt Cut Out Hyst	1.8V	3.5 V
High Batt Cut Out Hyst	1.2V	2.4 V
High Batt Warning	28.8V	57.6
Low Batt Warning	24.8V	49.6
Low Batt Warning Hyst	1V	1.9 V
High Batt Warning Hyst	0.8V	1.6 V
Float Voltage	26.8V	53.6 V
Battery Capacity	Determined by number of AES batteries on the AEBus network. Eg. 2x 42-48-6650 = 260Ah	

7.2 Dynamically Controlled Settings

Table 10. Dynamically Configured by AES Batteries Through Xanbus Network.

Settings	Nominal System Voltage	
	24V	48V
Bulk Voltage Absorption Voltage	Max 28.4V to charge and balance efficiently without causing over voltage fault	Max 56.8V to charge and balance efficiently without causing over voltage fault

7.3 Recommended User-Adjustable Battery Related Settings

Table 11. Recommended User-Adjustable Settings for XW+ Inverter/Charger.

Settings	Description	Nominal System Voltage
		48V
Grid Supp Volts (GSV)	Setting GSV below 51.5V will likely cause under voltage protection before LBCO setting. Set above Conext MPPT Solar Charge Controllers equalization voltage for enhanced grid support	64V
ReCharge Volts	Setting ReCharge Volts Higher allows for more back-up capacity. Setting lower helps maximize self consumption. See Table 15 for further guidance	Min 51.5 V
Max Chg Rate	Limited to maximum battery bank current	1C
Charge Cycle	2-Stage	

Table 12. Recommended User-Adjustable Settings for the SW Inverter/Charger.

Settings	Description	Nominal System Voltage	
		24V	48V
AC Supp on SoC	Enables the SOC monitoring for AC support mode	Enabled	Enabled
AC Supp Start SoC	Sets high SOC value required for AC support to engage	80%	80%
AC Supp Stop SoC	Sets low SoC value for AC support to disengage	20%	20%
ReCharge Volts	Setting ReCharge Volts Higher allows for more back-up capacity. Setting lower helps maximize self consumption	Min 25.8V	Min 51.5 V
Max Chg Rate	Limited to maximum battery bank current	< 1C	< 1C
Charge Cycle	3-Stage		

Table 13. Recommended User-Adjustable Settings for Solar Charge Controllers.

Settings	Description	Nominal System Voltage	
		24V	48V
Max Chg Rate	Limited to maximum battery bank current	< 1C	< 1C
Charge Cycle	3-Stage		

Table 14. Recommended User-Adjustable Settings for Automatic Generator Start (AGS).

AGS Triggers	Nominal System Voltage	
	24V	48V
Start DCV 30 sec	25V (LCBO +1V)	49V (LCBO +1V)
Stop Absorb	Disabled	Disabled
Start SoC	> 10%	> 10%
Stop SoC	< 95%	< 95%

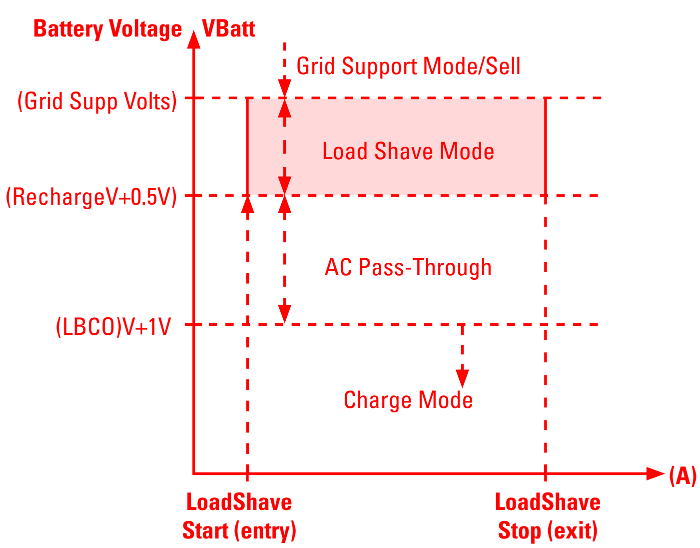


Figure 9. Grid Support Load Shave Mode.

Table 15. ReCharge Voltage Setting Guidance

Remaining Capacity	Nominal System Voltage	
	24V	48V
10-15%*	24.5V*	49V*
15-20%	25V	50V
20-30%	25.8V	51.5V
40-50%	26V	52V
80-90%	26.3V	52.5V
90-100%	27V	54V

* Not recommended. Inverter may display Low Batt Warning.

8. BATTERY OPERATION

8.1 Monitoring

Discover AES reports to the Conext SCP and/or Combox as a battery monitor (BATTMON) device. The AES batteries provide significantly more accurate battery parameter readings than the inverters and charge controllers are capable of.

8.2 Battery Charging

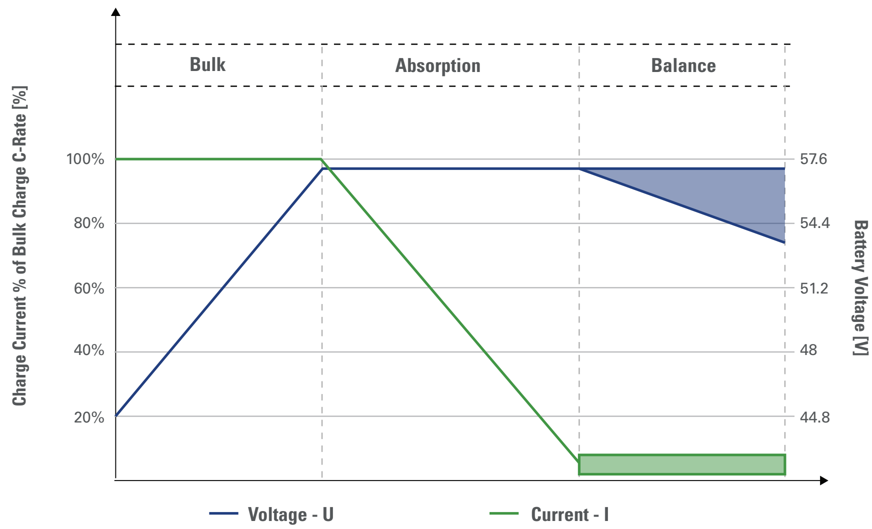


Figure 10. Smart Battery Charging Algorithm for 48V AES batteries with Conext Systems

The charging voltage during Balance phase is a dynamic value determined by the state of all connected AES batteries. Voltage and current values may vary between system to system.

> **▲ NOTE**
>
> When charging with Conext systems, AES charging voltages may be up to 2.88V higher than specified in published Discover Charge Algorithms.

8.3 Battery Maintenance

Batteries should be carefully inspected on a regular basis in order to detect and correct potential problems before they can do harm. This routine should be started when the batteries are first received.

- Look for cracks in the case
- Check the battery, terminals and connections to make sure they are clean, free of dirt, fluids and corrosion
- All battery cables and their connections should be tight, intact, and NOT broken or frayed
- Replace any damaged batteries
- Replace any damaged cables
- Check torque on terminal bolts

9. RECYCLING AND DISPOSAL

Advanced Energy Systems are recyclable and must be processed through a recognized recycling agency or dealer. Please contact Discover or your servicing dealer for details.

10. WIRING DIAGRAMS

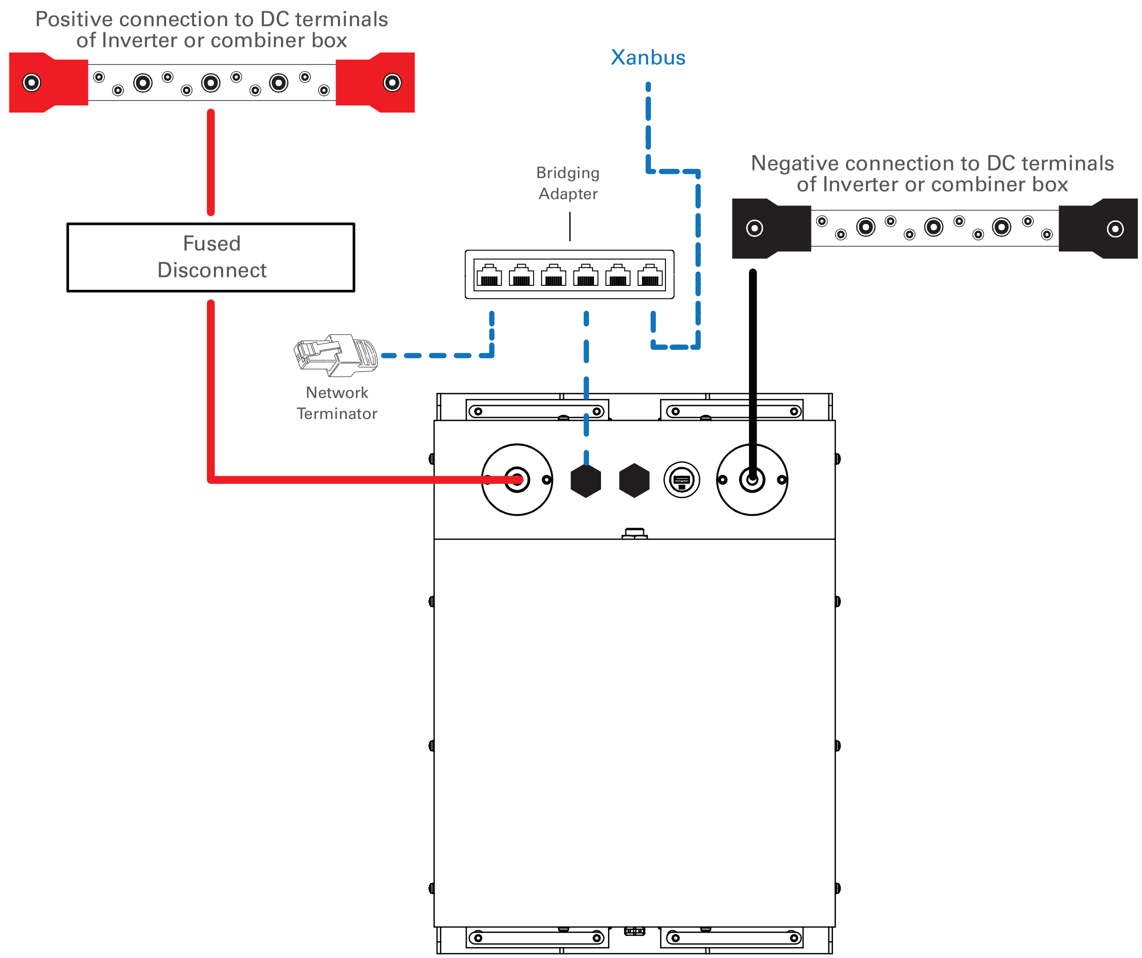
10.1 Single Battery Wiring Diagram

▲ WARNING

ELECTRICAL SHOCK AND FIRE HAZARD

Installation must be done by qualified personnel to ensure compliance with all applicable installation codes. Instructions for installing the batteries are provided in this installation guide for use by qualified installers only.

FAILURE TO FOLLOW THESE INSTRUCTIONS WILL RESULT IN SERIOUS INJURY OR DEATH



Actual wiring requirements may vary, consult with your local authority having jurisdiction.

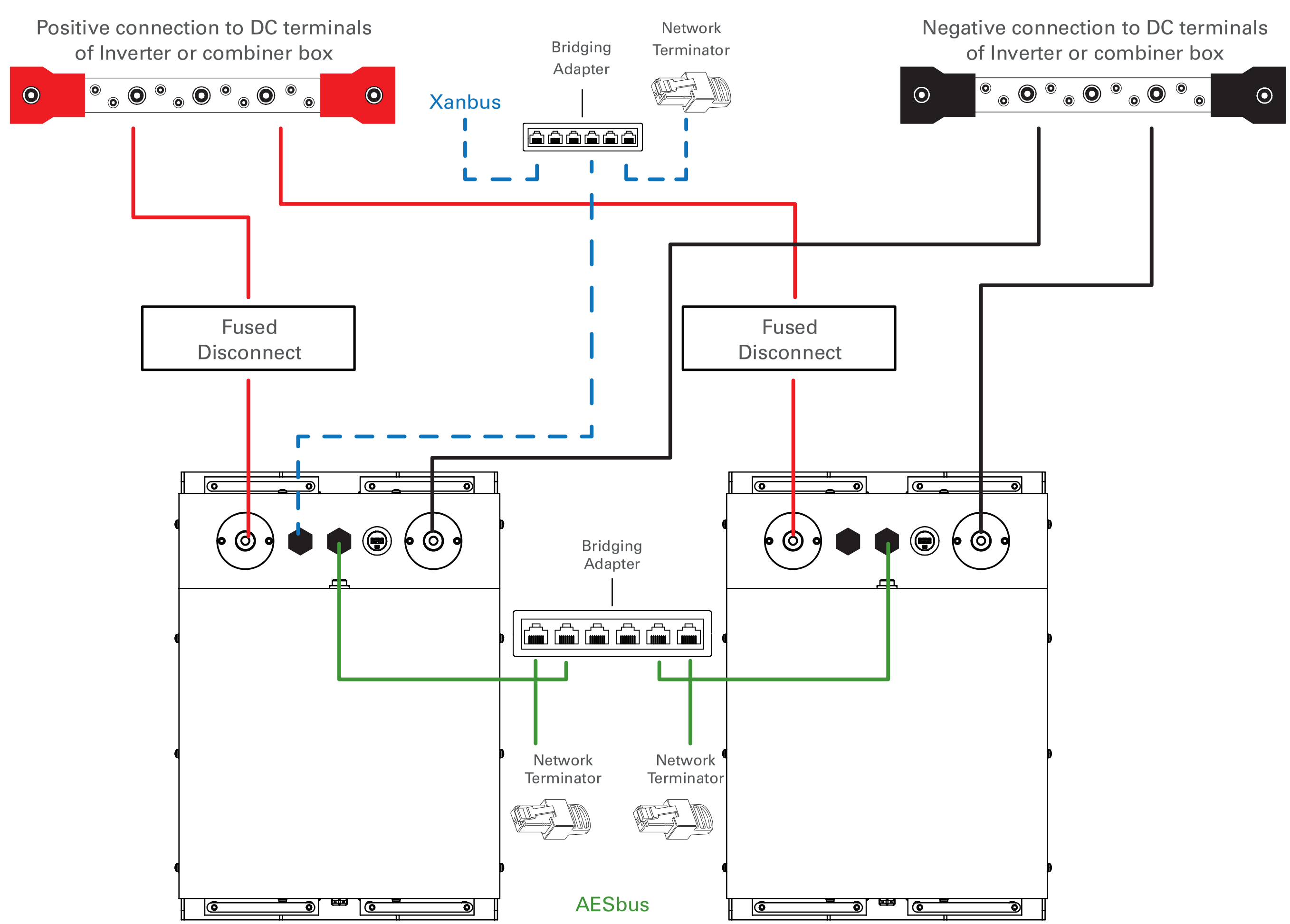
10.2 Dual Battery Wiring Diagram

▲ WARNING

ELECTRICAL SHOCK AND FIRE HAZARD

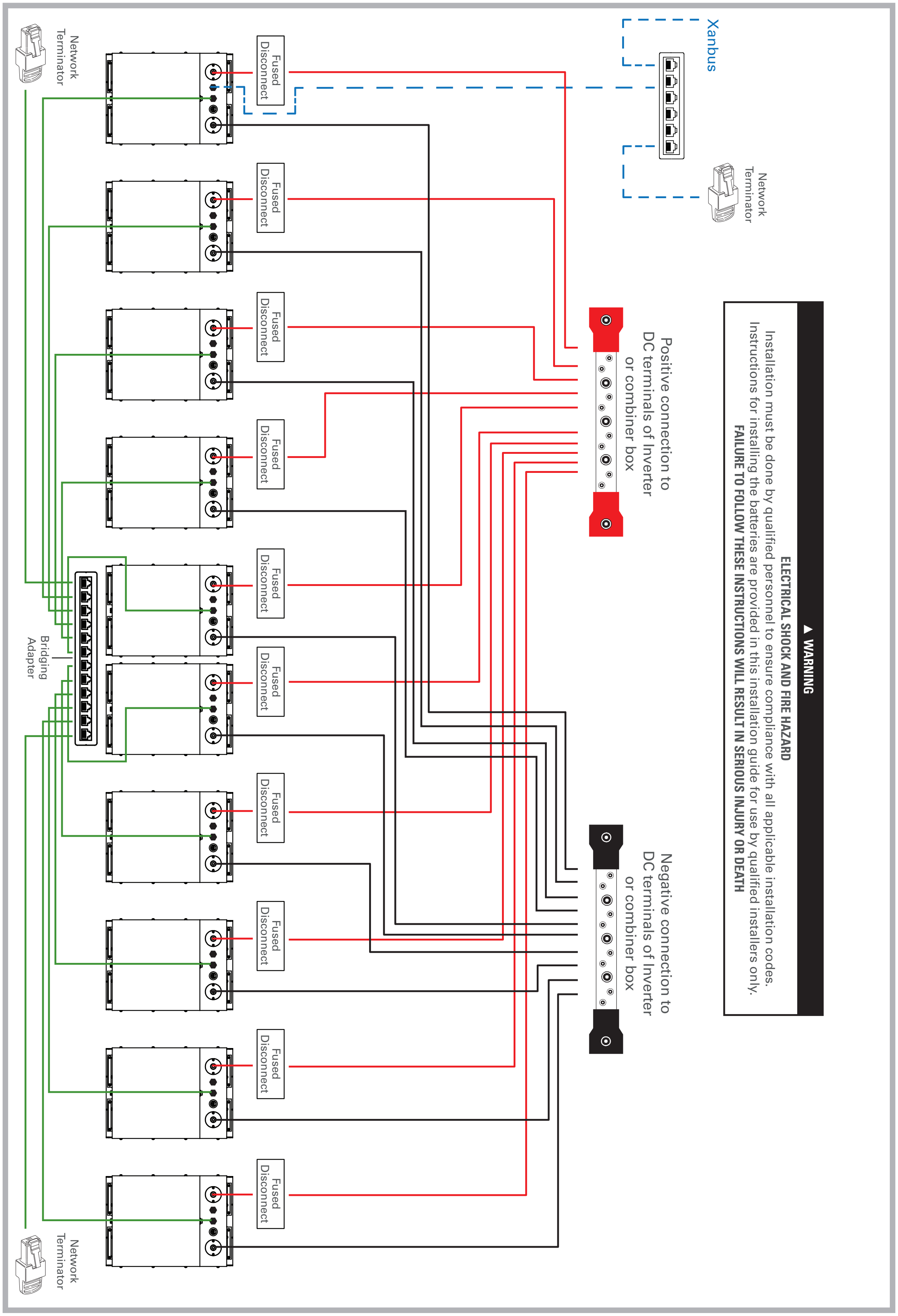
Installation must be done by qualified personnel to ensure compliance with all applicable installation codes.
Instructions for installing the batteries are provided in this installation guide for use by qualified installers only.

FAILURE TO FOLLOW THESE INSTRUCTIONS WILL RESULT IN SERIOUS INJURY OR DEATH



Actual wiring requirements may vary, consult with your local authority having jurisdiction.

10.3 Multi Battery Wiring Diagram



▲ WARNING

ELECTRICAL SHOCK AND FIRE HAZARD

Installation must be done by qualified personnel to ensure compliance with all applicable installation codes. Instructions for installing the batteries are provided in this installation guide for use by qualified installers only.

FAILURE TO FOLLOW THESE INSTRUCTIONS WILL RESULT IN SERIOUS INJURY OR DEATH

Actual wiring requirements may vary, consult with your local authority having jurisdiction.

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