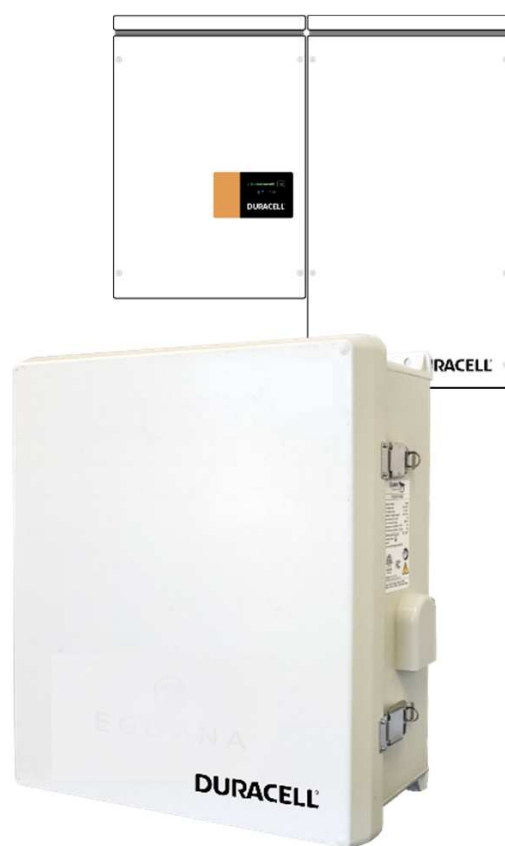


DURACELL®



Model: D-HUB
INSTALLATION MANUAL

For use with the DURACELL POWER CENTER 5KW

Revision History

Revision	Date	Status	Author	Comments
n/a	05/01/2022	Initial	Ian Grover	
01	08/30/2022	Released	Ian Grover	
02	04/05/2023	Released	Ian Grover	Removed TP-Link Kit

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

This manual contains important instructions for the DURACELL HUB as part of a complete home energy storage system. The DURACELL Hub is a peripheral of the DURACELL POWER CENTER 5KW energy storage system. The energy storage system will be referred to as the ESS throughout this manual.



CAUTION: Hazardous Voltages! This product contains hazardous voltage and energy that may be lethal. It may only be installed by qualified personnel who have read this manual and are familiar with its operation and hazards. The following safety procedures should be followed:

Only connect the DURACELL HUB to a compatible electrical service as defined in the model specifications.

Ensure proper electrical grounding in accordance with code requirements.

Ensure proper airflow path for active cooling.

Never operate system in a manner not described by this manual.

Only qualified personnel should service this product.

Ensure cover is securely fastened after installation is complete.

Do not attempt to operate this product if there is any physical evidence of damage to the enclosure or internal components.



CAUTION! This product contains an AGM lead acid battery. This product must be stored indoors in an environmentally conditioned location prior to installation, protected from rain and exposure to any hazardous chemicals. Inspect the battery case prior to installation. Do not install and power the product if there appears to be damage to the battery and contact your local product distributor.



Do not dispose of the system or any of the components within the cabinet. Batteries, electronics, cables, and metal parts are recyclable. Consult your municipal waste management authority to determine required methods of component recycling.

California Proposition 65







WARNING! This product can expose you to chemicals including bis (2-ethylhex-yl)phthalate, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to <https://www.p65warnings.ca.gov/>.

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1 Introduction

Throughout this manual, the following symbols will be used to highlight important information and procedures:

Symbol	Definition	Symbol	Definition
	WARNING! A dangerous voltage or other condition exists. Use extreme caution when performing these tasks.		Function performed by energy management system / controller.
	CAUTION! This information is critical to the safe installation and or operation of the product. Follow these instructions closely.		NOTE: This statement is important. Follow instructions closely.

1.1 About this manual – supporting documents

This manual is intended to be used by qualified service and installation personnel for the purposes of installation and startup only. The DURACELL HUB energy management system & gateway requires installer administration and device commissioning prior to operation of the ESS. Refer to the Fleet Installer Administration Guide and the DURACELL HUB Install & Commission Quick Guide for further details.

This product is permanently wired to the home electrical service, and must be installed by a licensed electrician only. This product is a power distribution peripheral intended to be operated with the ESS. Refer to the DURACELL POWER CENTER 5KW Installation & Startup Manual for installation of the ESS.

Go to www.duracellpowercenter.com for a complete list of installer resource materials.

1.2 Glossary

Term	Definition	Term	Definition
AC / DC	Alternating Current / Direct Current	NC/NO	Normally Closed / Normally Open
AHJ	Authority Having Jurisdiction	NEC/CEC	National (USA) Electric Code / Canadian Electric Code
ARC	Auto Recovery Control	PCS	Power Control System (Inverter)
DC	Direct Current	PE (GND)	Protective Earth
EMC	Energy Management Controller	PV	Photo-Voltaic
EMS	Energy Management System	RF	Radio Frequency
ESS	Energy Storage System	SOC	State Of Charge (Battery)
LED	Light Emitting Diode	SOH	State of Health (Battery)

1.3 Initial Inspection of Material List

The system components supplied with the DURACELL HUB are shown below. Each component should be inspected visually for any damage that may have been caused by shipment. If parts are missing or damaged, please contact your local distributor.

Item	Description
1	EMS-A DURACELL HUB
2	Current transformer – 200 Amp
3	Current transformer – 50 Amp
4	EMS to PCS RJ-45 cable
5	AK1 DURACELL HUB control cable
6	USB to Mini-USB service cable

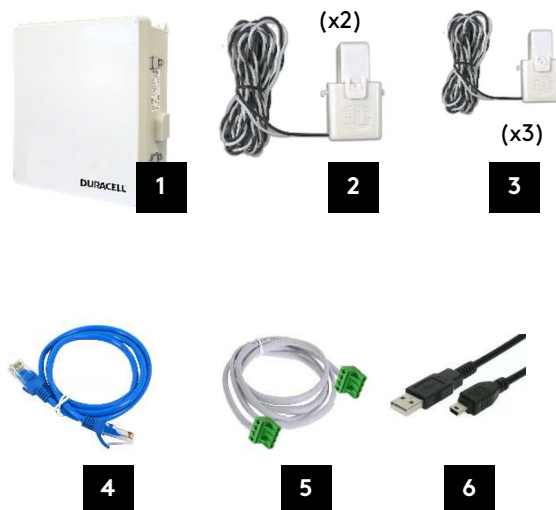


Figure 1: DURACELL HUB materials list.

1.4 Special Tools & Hardware

In addition to the standard tools required for enclosure mounting, the following tools should be readily available to complete the installation.

- Drill and hole saw kit
- RJ-45 crimp tool and RJ-45 connectors
- Wall mounting hardware.
- #0 flat screwdriver.
-

1.5 Functional Overview

The DURACELL HUB is equipped to support an AC coupled solar plus storage installation with backup power to a dedicated backup electrical panel. The DURACELL HUB is a power distribution center for the ESS, routing all AC power between the main and backup electrical panels. In the event of a grid outage, the DURACELL HUB will be energized by the ESS, which will island off the main electrical panel. As shown below, the PV inverter's AC output is connected to the backup panel to support solar charging of the battery during a grid outage.

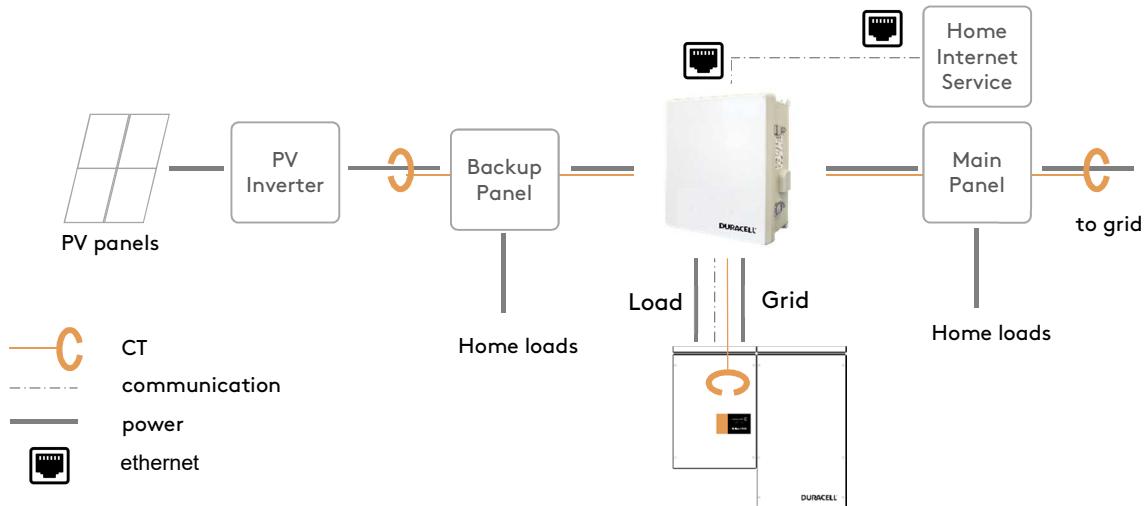


Figure 2: DURACELL HUB with DURACELL POWER CENTER 5KW.

1.5.1 Grid Connected Solar plus Storage

The DURACELL HUB routes power from the main electrical panel to the backup panel through the ESS Grid/Load transfer circuit when the grid is live and the battery system is in service (normal operation). The EMC commands the battery system to charge or discharge the battery as demanded by the energy management algorithm. In a self-consumption algorithm, for example, the EMC calculates the difference in total load vs. solar PV, and routes the balance of power to/from the battery as needed. When the battery is full, PV power bypasses the battery to grid/loads. When the battery is at minimum reserve, all home loads are supplied entirely by the grid. The following diagram outlines the power flow possibilities while grid connected.

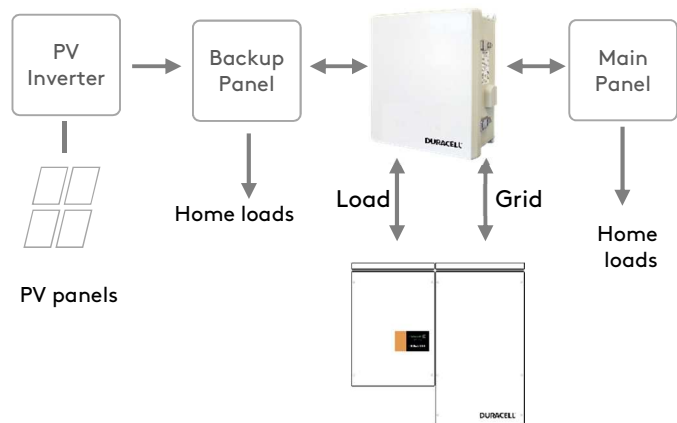


Figure 3: Grid connected solar plus storage.



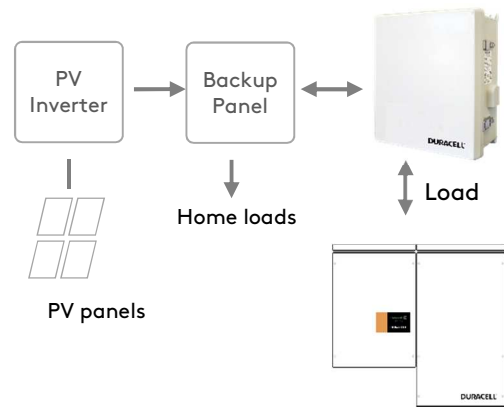
Note: The DURACELL HUB is equipped with an internal automatic bypass switch which provides uninterrupted service to the backup electrical panel when the ESS is either not powered (installed but pending permission to operate) or out of service.

1.5.2 Backup Solar plus Storage

During a grid outage, the DURACELL HUB isolates the battery system and backup electrical panel from the grid. In this mode, the EMC is in a monitoring state, with most control handed over to the ESS. The ESS curtails PV when the battery is either full or exceeds the charge limit of the battery. On low SOC, the battery system goes into a standby state until either the solar resource or the grid returns.



IMPORTANT! Shutting off the DURACELL HUB circuit breaker at the main electrical panel will place the ESS into backup mode and continue to energize the backup panel.



1.5.3 Backup Solar PV curtailment method: Frequency Shift Power Control (FSPC)

During backup power operation of the ESS, PV curtailment is achieved by shifting the frequency up or down to trip the PV inverter. This curtailment method, defined as frequency shift power control (FSPC), is required to prevent solar from over-charging the battery. By default, the ESS will ramp up frequency to a PV trip range of 62.1 Hz, but this is adjustable depending on the regulatory frequency trip limits within the jurisdiction.



IMPORTANT! PV inverters connected to the backup panel must have frequency trip settings programmed within the following ranges: PV low frequency trip range: 57.0 to 59.3 Hz, PV high frequency trip range: 60.5 to 62.0 Hz. If the PV inverter cannot be adjusted within the range specified, the PV inverter must not be connected to the backup panel.



NOTE: The DURACELL HUB is not suitable for use in applications where the electric utility prohibits PV power export to the grid. For non-export applications, consult your DURACELL POWER CENTER 5KW dealer for alternate EMS panel solutions.

1.5.4 Circuit and system sizing for 100 / 125 / 150 Amp electrical panels

Line side tapping the main electrical panel is required for ESS installations where the electrical service rating is under 200 Amp. Refer to section 2.3, figure 11.

1.5.5 Circuit and system sizing for 200+ Amp electrical panels

The DURACELL HUB may be connected to a 200+ Amp electrical panel using a single 40A breaker. For this configuration, the total solar PV output connected to the backup electrical panel will depend on the curtailment features of the solar PV inverter. If the PV inverter is equipped with its own curtailment controls that can limit PV output to 5kW or less in backup mode, the maximum rating of the PV inverter connected to the DURACELL HUB is 7.6 kW AC. For PV inverters without internal curtailment methods, the 5 kW PV restriction applies. Regardless of PV size, this configuration permits the DURACELL HUB EMS to limit continuous combined solar plus storage output to 7.6 kW AC (32 Amp).

1.5.6 Over-sized PV systems

For installations with PV systems that are larger than the DURACELL HUB and ESS can accommodate, the PV inverters must be split up such that the balance of PV is wired directly to the main electrical panel.



NOTE: An additional CT must be added to the main panel connected PV inverter.

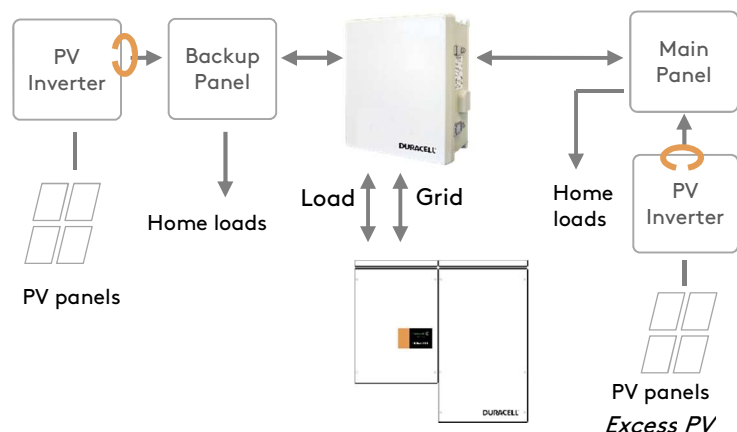


Figure 5: Over-sized PV systems connected to main panel.

1.6 Internal Component Overview

The DURACELL HUB is equipped the following components as identified in the diagram below:

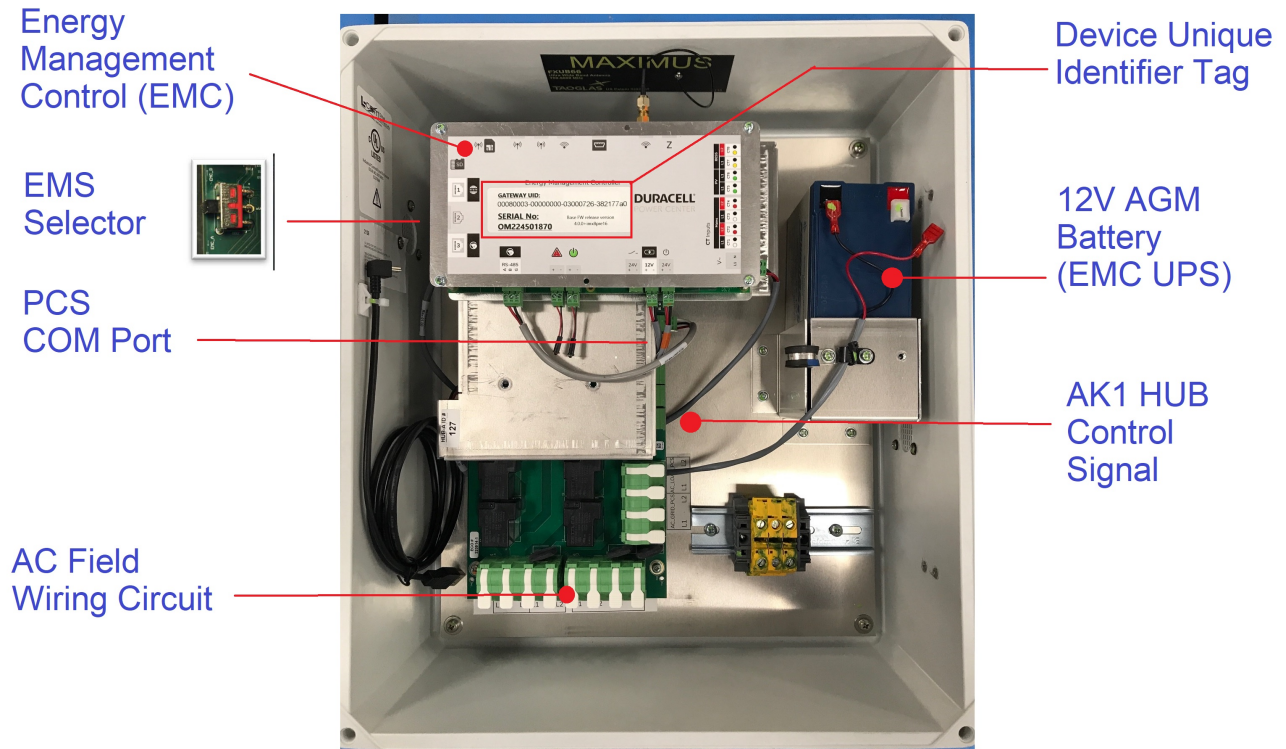


Figure 6: DURACELL HUB internal component overview.

1.6.1: Energy management controller (EMC)



IMPORTANT! The device unique identifier (UID) & serial number (S/N) tag attached to the front of the EMC is required to register the device to the cloud so that it may be monitored via the Fleet Installer monitoring system. Record this information for online registration.

The EMC performs the following functions:

- Commands the battery system to charge and discharge as defined by the selected control algorithm.
- Monitors the home loads, solar PV, and battery power via on-board 8 channel power meter.
- Provides the Internet gateway to customer supplied internet router via wired Ethernet.

A 12V AGM UPS backup battery supplies uninterrupted power to the EMC.

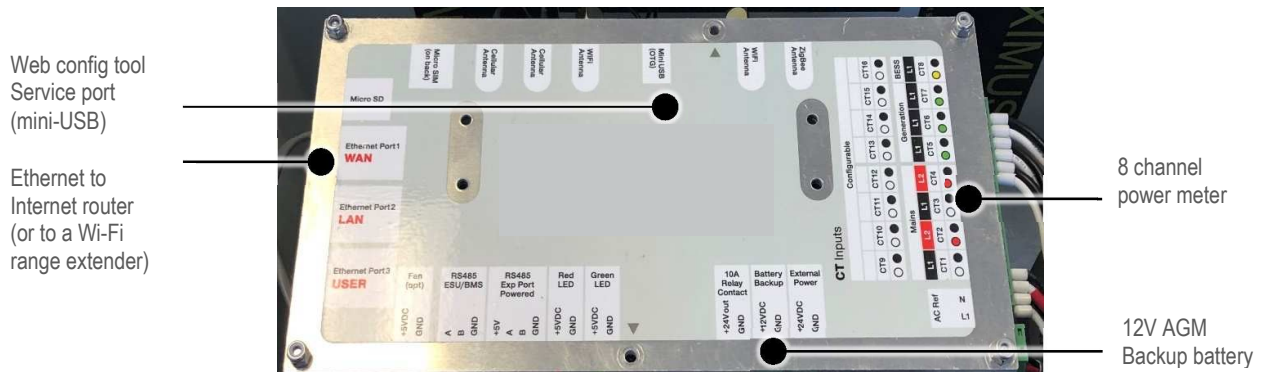


Figure 7: EMC feature overview – rev1 EMC faceplate label.

2 Installation Planning

Before installing the DURACELL HUB, read all instructions and warnings in this manual. The DURACELL HUB can be installed in an indoor and outdoor non-corrosive environment (not marine environment). Wall mounting hardware is not included.



CAUTION! All electrical installation work should be performed in accordance with local building and electrical codes.



WARNING! Isolate the DURACELL HUB from all energy sources prior to electrical installation by means of disconnects, breakers or connectors. Failure to properly isolate either AC or DC sources may result in serious injury or death.



NOTE: Communication cables between the DURACELL HUB and the battery system are limited in length. The DURACELL HUB should be installed within 2 ft of the battery system.



CAUTION! Do not install in direct sunlight.

2.1 Installation clearances between the DURACELL HUB and the battery system

The DURACELL HUB includes a 10 foot communication cable that connects the hub to the battery system. If the installation is constrained such that the DURACELL HUB must be located greater than 24" from the battery system, consult the DURACELL POWER CENTER 5KW Installation & Startup Manual for instructions on creating an extended communication cable.

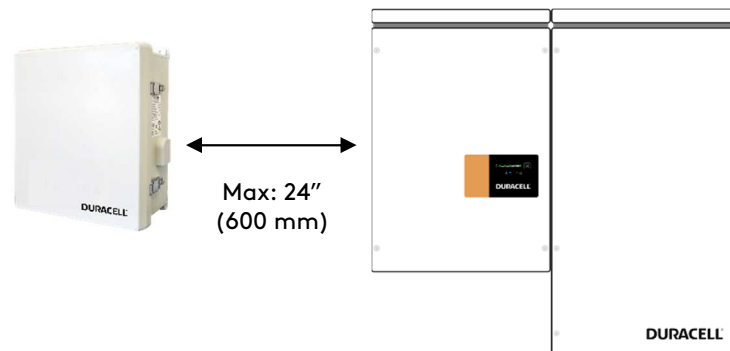


Figure 8: Installation clearances between the DURACELL HUB and the ESS.

2.3 SLD - AC Coupled PV System with Back-up Power Operation

The single line diagram shown below is a representation of a typical installation configured for utility interactive and back-up power operation, with AC coupled PV connected to a backup panel. This drawing is a guideline only and is not a substitute for a code compliant installation. All components required for a code compliant installation are the responsibility of the licensed installer, including any additional circuit protection requirements not shown here.

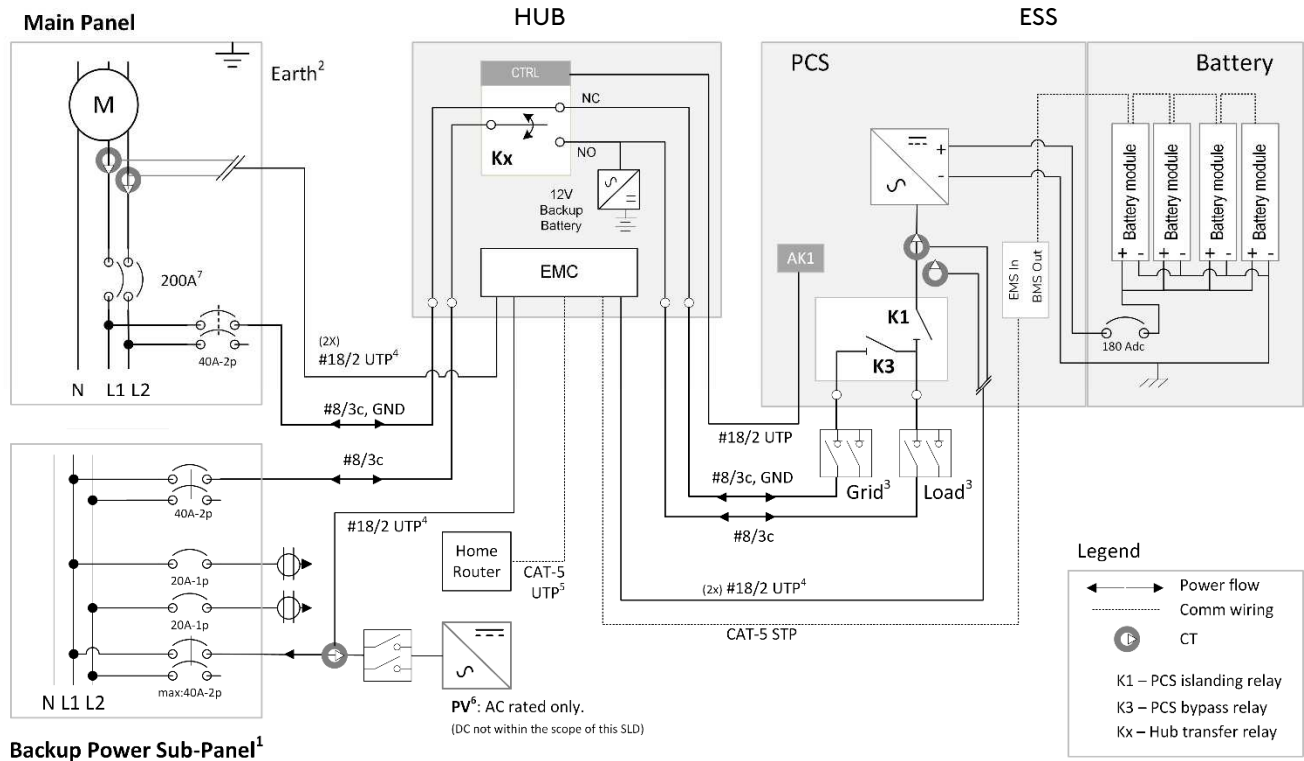


Figure 10: Sample single line diagram of an AC coupled solar plus storage installation (base model shown).

NOTES

- 1 - The backup power bus must be electrically isolated from the main electrical bus. Do not tap the neutral wires of the main and backup buses. Refer to the installation manual for wiring details. Load circuits are shown for demonstration. Maximum number of circuits determined by sub-panel rating. Loads connected to circuits must not exceed nominal power ratings (continuous/surge) of the inverter.
- 2 - The battery system must be earth bonded to the building ground to meet lightning protection requirements.
- 3 - The battery system load and grid ports are independently controlled circuits. Should the electrical code require additional "line-of-sight" or dedicated disconnects, a separate disconnect must be used for each of the grid and load ports. The disconnects and/or circuit breakers must operate independently of each other, and rated for the branch circuit.
- 4 - CTs are equipped with 8 ft pigtails. Twisted pair extensions can be run up to 30 ft. CT extensions should not be required if the DURACELL HUB is within 4 ft of the PCS.
- 5 - Ethernet connection between router and EMC is optional. EMC can communicate using Wi-fi or cellular.
- 6 - PV cannot exceed 5kW AC output in backup mode. PV systems larger than 5kW AC must have a self-curtailment mechanism (software or hardware) to ensure limit is within the 5kW AC rating. If curtailment means are not available, the balance of PV (if applicable) must be routed directly to the main panel.
7. For electrical services rated less than 200A, the ESS system must be line side tapped as shown in figure 11.

Disclaimer:

Manufacturer supplied components represented here are limited to the PCS/Battery, DURACELL HUB, and CTs for PV, battery, and mains. All other materials and components represented are customer supplied. CEC/NEC electrical code compliance is the responsibility of the designer and/or electrical permit holder.

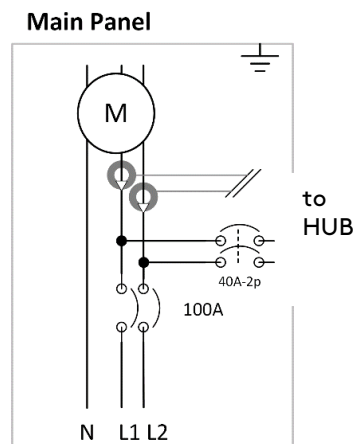


Figure 11: 100 Amp main panel line side tap to the DURACELL HUB.

3 Installation Instructions

1. Mount the DURACELL HUB on the wall using the 4 mounting screw holes on the top and bottom flanges. (Mounting hardware not included).
2. Using the conduit plan in section 2.2, drill the knockout holes required for the conduit runs on the bottom face of the enclosure. Constrain the drill area as shown.
3. Route all conduit as cabling as required.

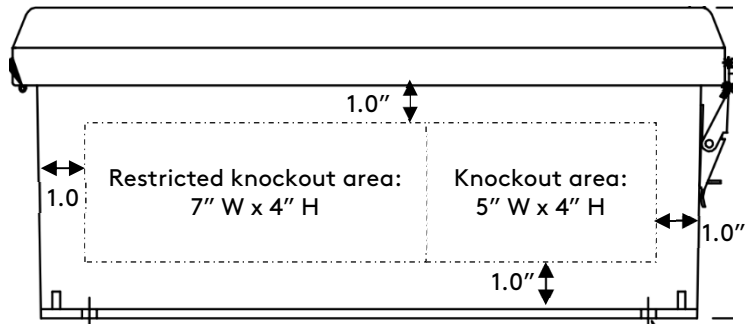


Figure 12: Recommended knock-out area.



CAUTION! All knockout holes must be sealed to maintain the Type 3R environmental rating of the enclosure after the installation is complete.



CAUTION! The restricted knockout area is near the DURACELL HUB circuitry, so extra care must be taken to avoid internal components when the knockout holes are being drilled.



CAUTION! Ensure that the DURACELL HUB enclosure door is properly seated such that the gasket becomes compressed when the door is securely closed.

4 Electrical Wiring Instructions



IMPORTANT! Wiring methods must be in accordance with local electrical codes. The installer is responsible for ensuring that over-current protection is installed and sized appropriately for the AC circuits, in accordance with the National Electrical Code, ANSI/NFPA 70, Canadian Electrical Code and local codes

The patch cables provided in section 4.1 and 4.2 below have pre-assembled connectors at both ends. It is strongly recommended that these cables are pulled in conduit prior to the power cables.



CAUTION! Do not install cables if any wires appear damaged or are not terminated improperly. Contact your distributor for support.

4.1 EMC Cable Connection

1. Terminate the EMC CAT 5 patch cable in the RJ-45 port as shown.



NOTE: If a longer extension is required, shielded CAT 5/6 cable must be used.

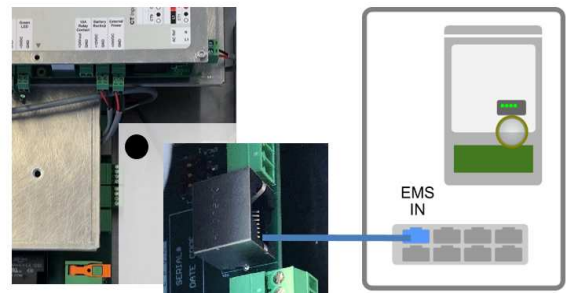


Figure 13: EMC cable connection to RJ-45 port.

4.2 AK1 Cable Connection

1. Plug in the AK1 DURACELL HUB control cable connector into the terminal block.



NOTE: If an AC source disconnect was installed between the DURACELL HUB's grid port and the ESS as described in section 2.4 of this manual, leave the AK1 terminal block unplugged until the system has permission to operate.



Figure 14: AK1 cable connection.

4.3 AC Power Connections

All AC power connections to L1, L2, and Neutral are terminated with a hinged pressure clamp connector. Observe the connector termination instructions for the clamp connector as shown in figure 15. Recommended strip length is 18 mm (11/16").



IMPORTANT! Do not terminate fine stranded cable in the connector without the use of ferrules.



IMPORTANT! Do not operate this product if the hinge clamp does not close completely as shown. Improper terminations can result in fire and/or permanent damage.



CAUTION! To reduce the risk of fire, connect only to a dedicated circuit provided with appropriate branch circuit over-current protection in accordance with local electrical codes.



WARNING! Improper connection of the wiring panel may result in equipment damage and cause personal injury. Disconnect all AC and DC Sources prior to installation.



CAUTION! The AC grid and load ports are independent circuits, controlled internally by an automatic bypass and transfer switch. Each port must be connected to electrically isolated panels. Tapping line or neutral wires from the main electrical panel to the backup panel will result in permanent damage to the product.

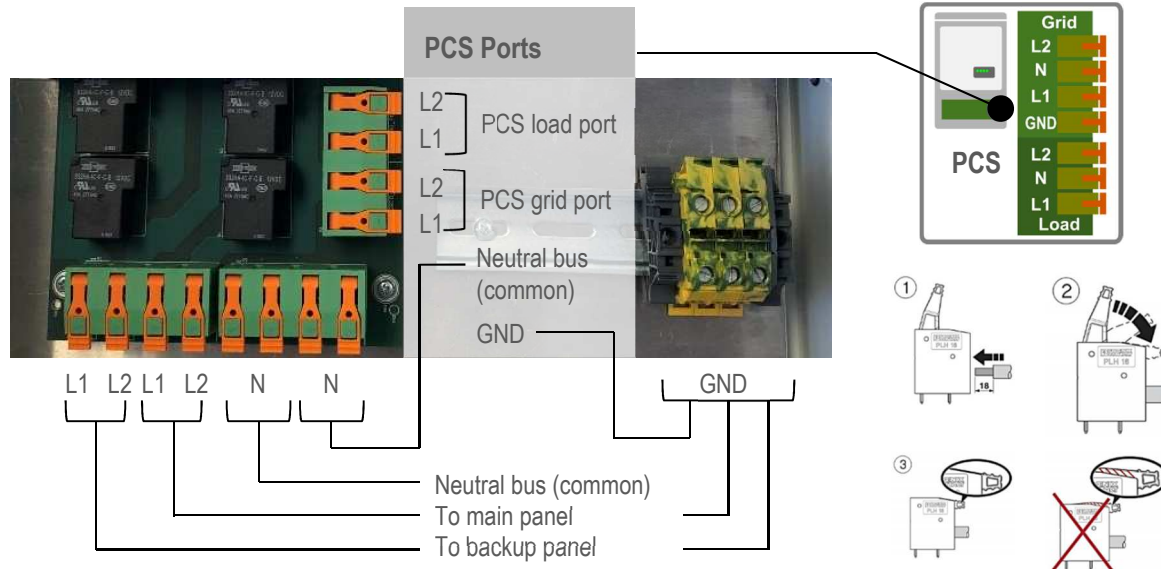
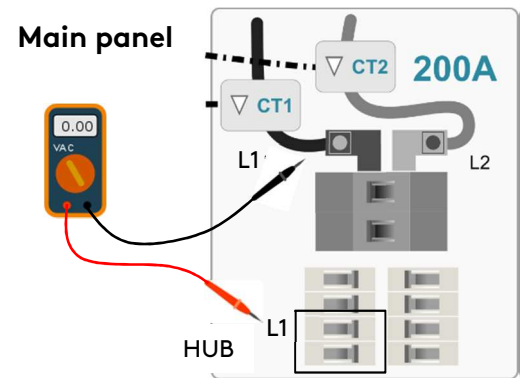


Figure 15: AC power wiring.

4.3.1 Phase Orientation in Split Phase 120/240 Systems

The EMC derives power measurement at the main service, the solar PV inverter AC output, and the ESS. Consistent phase voltage orientation through the entire installation is critical to proper control of the system. The initial selection of the phase voltage defined as L1 is established by the placement of the CT referenced as CT1 on the main feeder to the panel. To ensure the phase wiring to the DURACELL HUB maintains consistent polarity, measure the AC voltage between L1 of the main feeder and the Grid terminals of the DURACELL HUB. The pole that measures 0.0 VAC is defined herein as L1 for the AC wiring instructions that follow.



4.3.2 Main Electrical Panel Connection

Route "AC Grid" L1, L2, Neutral, and Ground to a dedicated 2-pole backfeed rated breaker in the main electrical panel.



Figure 16: Main panel connection.

4.3.3 Backup Panel Connection

Route “AC Load” L1, L2, Neutral, and Ground to a dedicated 2-pole backfeed rated breaker in the backup electrical panel.



Figure 17: Backup panel connection.

4.3.4 ESS: PCS Grid Port Connection

Route “AC_Grid_PCS” L1, L2, Neutral, and Ground to the PCS Grid port inside the ESS.

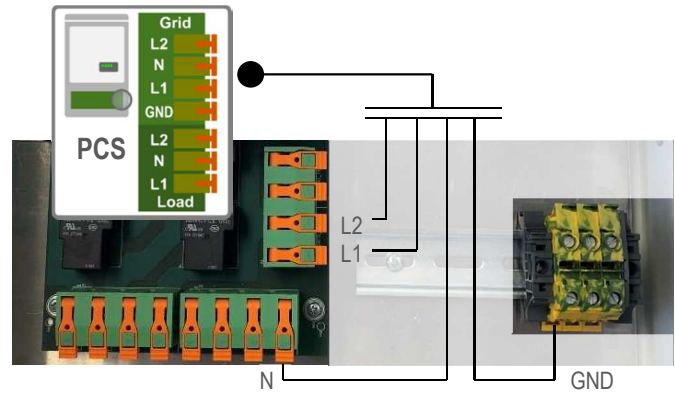


Figure 18: DURACELL HUB to PCS grid port connection.

4.3.5 ESS: PCS Load Port Connection

Route “AC_Load_PCS” L1, L2, and Neutral to the PCS Load port inside the ESS.

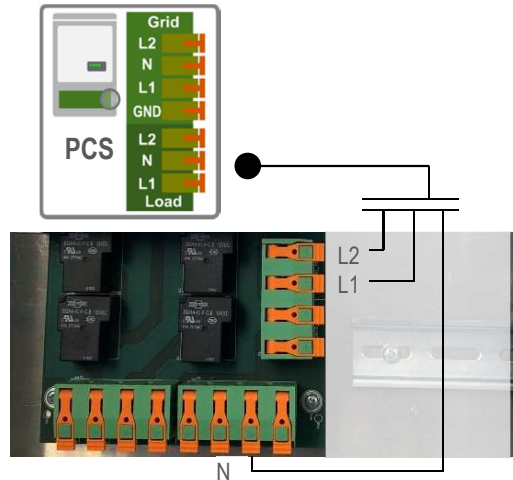


Figure 19: DURACELL HUB to PCS backup port connection.

4.4 CT Connections

IMPORTANT! The energy management system relies on the correct CT orientation for each of the measured loads, PV, and ESS. Follow these instructions with care.



NOTE: white= [+], black= [-] for all CT models.



IMPORTANT! Use the CT's supplied with the system. Consult technical support for approved alternatives of the same type and scalar value as required.

4.4.1 Main Electrical Panel CT Connections

CT direction faces into the home loads (away from the utility meter). Current measurement is positive when load exceeds generation.

1. Terminate CT1 at the L1 feeder of the main electrical panel.
2. Terminate CT2 at the L2 feeder of the main electrical panel.

4.4.2 Solar PV CT Connection

CT direction faces into the solar PV inverter. Current measurement is negative when PV is generating.

1. Terminate CT5 at the L1 input of the solar circuit within the backup electrical panel.

4.4.3 PCS CT Connections

CT direction faces into the ESS.

Current measurement is positive when battery is charging and negative when discharging.

1. Terminate CT7 at the X1 power wire of the PCS.
2. Terminate CT8 at the X2 power wire of the PCS.

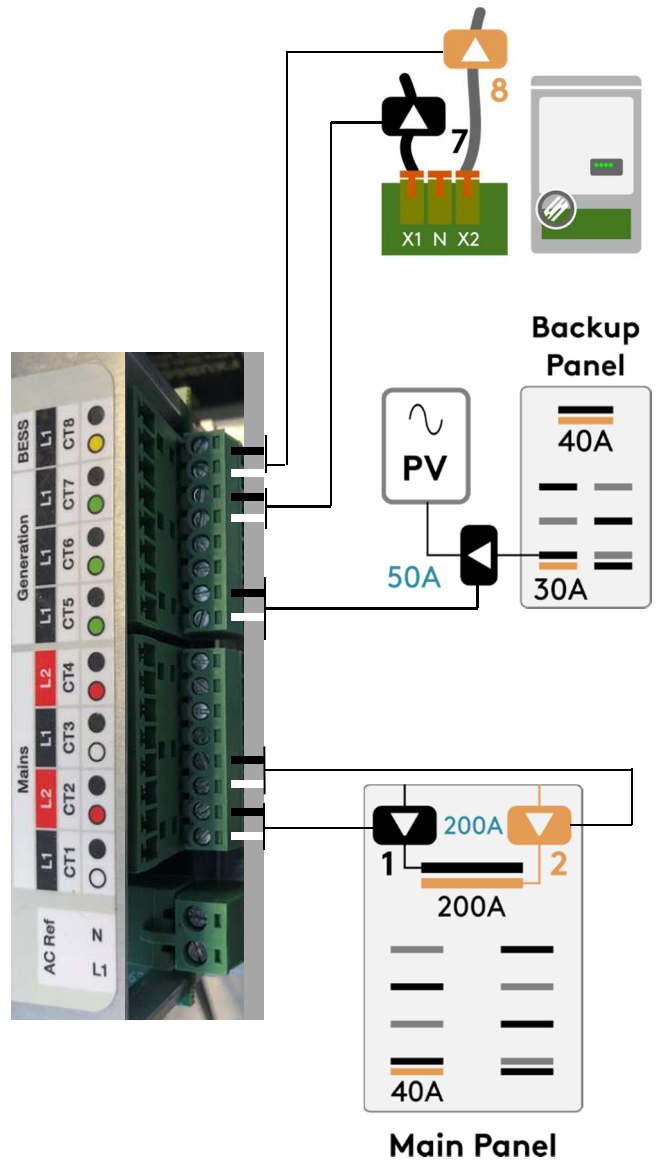


Figure 20: CT connections for main, PV, and PCS circuits.

4.5 12V Backup Battery Connection



IMPORTANT! Do not complete this connection until the customer receives permission to operate the system, and the main panel DURACELL HUB breaker is ON. The EMC will be powered when the 12V battery is connected. Failure to comply with this instruction may cause irreversible damage to the battery due to battery drainage without a charge source.

1. Terminate the positive wire on the AGM battery.



Figure 21: Connecting the AGM battery after permission to operate.

5 Operation



The EMC inside the DURACELL HUB is commissioned using a web browser. Refer to the DURACELL HUB Install & Commission Quick Guide for complete instructions on setup for the DURACELL POWER CENTER 5KW. The operation instructions within this manual are limited to the power up and commissioning test sequence of the DURACELL HUB only.

5.1 EMC selector switch

Confirm that the EMC selector switch is in the position [B].

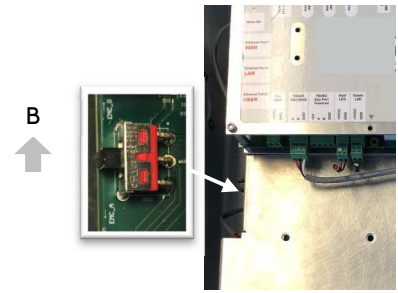


Figure 22: EMS selector switch.

5.2 Pre-startup checklist

The following is a recommended quality inspection checklist prior to power up of the system.

Status (✓)	Inspection	Reference
	AC power terminal clamps closed.	Figure 15
	EMS selector switch set to position B.	Figure 22
	Ground continuity test – inspect and test ground continuity between the DURACELL HUB and ESS.	

5.3 Startup



IMPORTANT! The DURACELL HUB must be commissioned as part of the ESS. The startup procedure provided below presumes that the PCS contained within the ESS is powered from the battery (DC source), and that the PCS is currently displaying a valid SOC range and is operating in sleep/standby mode. Refer to the startup sequence of the DURACELL POWER CENTER 5KW Installation & Startup Manual for instructions on startup (turning on DC source only). If AC disconnects or the optional breaker kit has been installed between the PCS grid / load ports and the battery system, leave them in the OFF position until the power up of the hub has been completed.

1. Turn ON the DURACELL HUB breaker in the main panel.

Powering up the DURACELL HUB will supply power to the on-board EMC. The red and green lights on the bottom of the EMC will flash for approximately 30 seconds, indicating initialization of the EMC. Following initialization, the lights will remain solid.



CAUTION! Following initial power up of the ESS, shutting OFF the DURACELL HUB breaker at the main electrical panel will automatically engage the ESS backup power source. **The Hub will remain energized at the PCS Load and Load ports while the ESS is in backup mode.**

5.4 Post-startup checklist

The following is a recommended quality inspection checklist following power up of the system.

Status (✓)	Inspection	Reference
	EMC power up status: Green/Red LEDs flashing up to 30 seconds, then solid.	Figure 22
	Measure AC voltage at the AC_Grid_PCS port. (L1-N, L2-N)	Figure 19
	Measure AC voltage at the AC_Load_PCS port. (L1-N, L2-N)	Figure 20
	Measure AC voltage at the load (backup panel connection) port. (L1-N, L2-N)	Figure 18
	Test the DURACELL HUB automatic bypass switch: (start with AK1 relay connected).	Figure 14
	1. Switch DURACELL HUB breaker at the main panel to the off position.	
	2. Switch the feeder breaker of the backup panel to the off position. Wait 4 seconds for the ESS to transition the PCS into Offgrid mode.	
	3. Measure voltages (L1-N, L2-N) at the Load terminals of the Hub (~120VAC).	Figure 18
	4. Pull the AK1 terminal (will switch the automatic bypass switch off)	Figure 14
	5. Measure the voltages (L1-N, L2-N) at the Load terminals of the Hub (0 VAC).	Figure 18
	6. Reconnect the AK1 terminal (after permission to operate (see sec. 5.5)	Figure 14

5.5 Permission to operate checklist

The following is a recommended quality inspection checklist following approval by AHJ inspector to operate the energy storage system.

Status (✓)	Inspection	Reference
	12V battery positive lead connection to the lead acid battery completed.	Figure 22
	AK1 relay connection completed.	Figure 14

6 Maintenance

The DURACELL HUB is a maintenance free product. Inspect the enclosure ventilator annually to ensure it is free from obstruction. For heavy soiling use a soft, dry brush to clean. Do not use any solvents, scouring, or corrosive materials to clean the unit. Never remove or unplug connections or plugs during cleaning.

7 Troubleshooting

The following is a troubleshooting guide for the DURACELL HUB. Refer to the DURACELL POWER CENTER 5KW Installation & Startup Manual for troubleshooting of the ESS.

Mode	Condition	Check
Grid connected	No power to DURACELL HUB and backup panel.	Check DURACELL HUB breaker circuit at the main panel.
Grid connected	No PV power output	Check PV breaker in the backup panel.
Commissioning / Grid connected	Battery does not charge when PV is operating	<ol style="list-style-type: none">1. Check CT configuration. PV measurement is negative when operating.2. Check battery SOC (battery does not charge when full).3. EMS operating in solar self-consumption mode, and home loads are greater than PV.
Grid connected & Backup	Monitoring system not displaying information in web portal.	Check internet connection. Check power (Green LED) on EMC panel.
Backup (grid outage)	No power to backup loads	Check status of the ESS on the front of the PCS panel. Refer to the DURACELL POWER CENTER 5KW Installation & Startup Manual for more details.

8 Technical Data

8.1 Electrical specifications



NOTE: About these ratings - The DURACELL HUB is a peripheral component of the DURACELL POWER CENTER 5KW. It is a power distribution center with an on-board energy management system. As such, this product is defined under the category of Interconnection System Equipment (ISE) for use in utility interactive and/or stand-alone power systems under the scope of the UL1741 Standard, and is intended to be operated in parallel with an electric power system (EPS) to supply power to common loads. The DURACELL HUB as a standalone device does not provide grid-interactive functionality. Where necessary, the ratings included below are listed both as a standalone product, as well as in conjunction with the Standard for Interconnecting Distributed Resources With Electric Power Systems, IEEE 1547, and the Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems, IEEE 1547.1.

AC ratings – Power distribution circuits	
Nominal Grid voltage	240V/120V split phase
Nominal Grid frequency	60 Hz
Maximum continuous operating current (or Rated current), AC	40.0 Amps
Maximum continuous operating power (or Rated power), VA	9600 VA
Maximum AC fault current and duration (short circuit)	14.0 Apk, 2.5 Arms (duration 63.5 ms)
AC connections, number - type	4 – Grid, Load, PCS Grid, PCS Load
AC voltage operating range	Max: 100 to 264 Vac. Note: UL 1741SA compliant operating limits are determined by the D-5kW PCS configuration settings
AC frequency operating range	Max: 47 to 63 Hz. Note: UL1741SA compliant operating limits are determined by the D-5kW PCS configuration settings
Maximum output overcurrent rating, grid & backup connection	40.0 Amps
Protective Class (I, II, or III)	Class I
Over-Voltage Category (OVC I, II, III, or IV)	OVC III
Pollution Degree	3
Lightning protection	IEEE 62.41.2, location category B, low exposure
General data	
Width x height x depth	15.3" x 17.3" x 6.7" (389 x 440 x 170 mm)
Weight	23 lbs (10.5 kg)
Protection type	Type 3R
Ambient temperature, relative humidity, altitude	-20 °C to +50 °C, 95%, 2000 m
Cooling method	Natural convection
Installation type	Wall-mount (upright)
Enclosure material	Halogen free, self extinguishing fiberglass reinforced polyester
For use only with the DURACELL POWER CENTER 5KW	

8.2 Wire and torque ratings

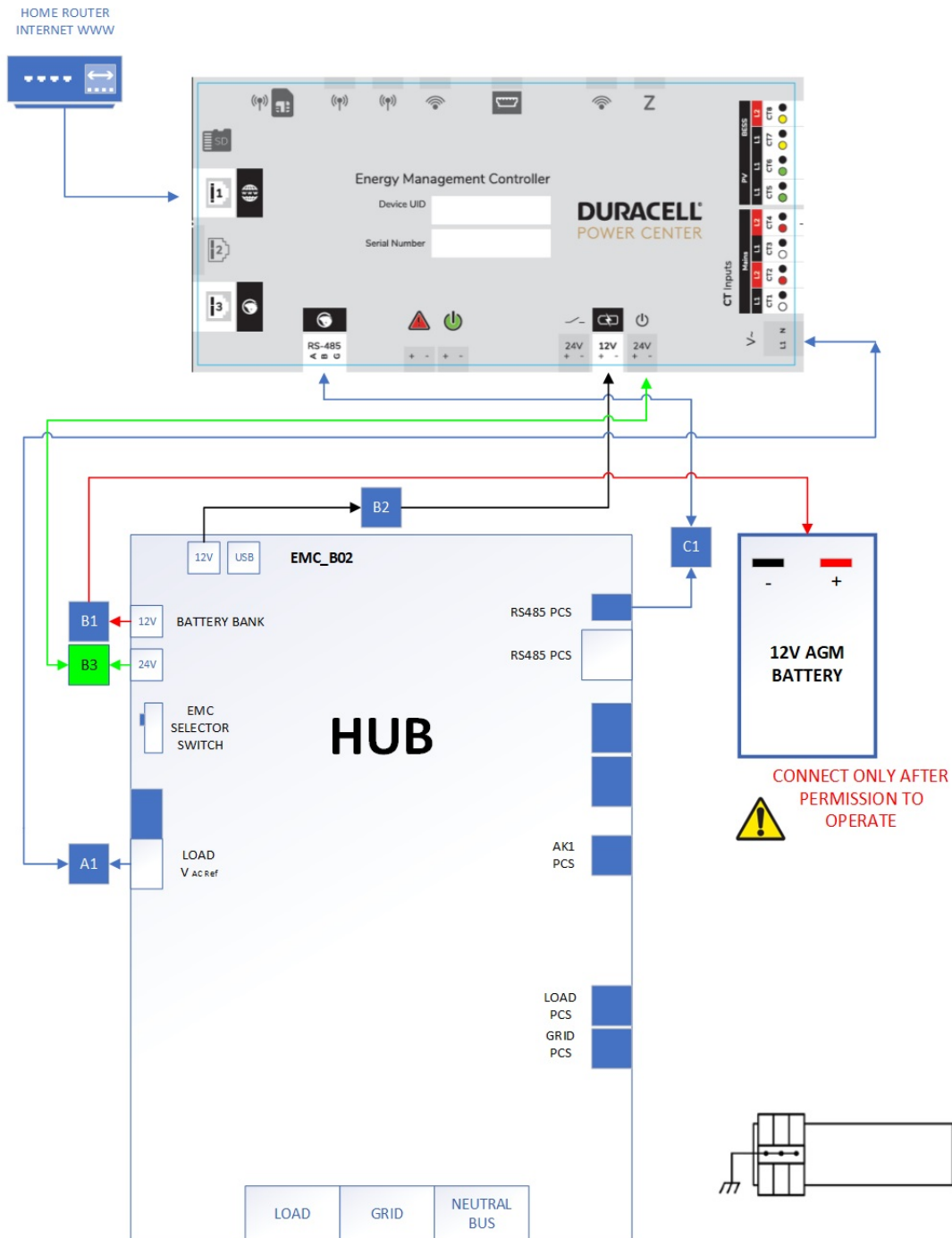
Use solid copper only, 90 °C or higher rating

PCS (AC)	# conductors	AWG (min to max)	Torque
AC grid, load	3 conductor + PE	10 AWG to 6 AWG	Push-lock, spring cage
AC PCS grid, PCS load	3 conductor + PE	10 AWG to 6 AWG	Push-lock, spring cage
Ground Lug	1 conductor	10 AWG to 6 AWG	15.9 in-lbs
Optional breakers	2 pole	10 AWG to 6 AWG	17.7 in-lbs

Appendix A: Electrical Block Diagram of Internal Components

The following reference diagram outlines the internal wiring of the DURACELL HUB.

Reference	P/N	Title	Notes
A1	801003652	Voltage Sense Cable	120VAC L1 to N power meter reference
B1	801003644	Backup Battery Cable	12V AGM battery power
B2	801003650	EMS-A 12V-24V Power Cable	12V UPS power for EMC
B3	801003650	EMS A 24V Power Cable	24V Power Cable
C1	801003658	Comm Cable	EMC to PCS internal communication patch cable



Appendix B: Multi-mode transfer / bypass relay operation

The DURACELL HUB and PCS within the DURACELL POWER CENTER 5KW provide fully automated multi-mode operation, including utility interactive and backup (off-grid) operating modes. The diagram below highlights the three main relay controls used to transfer the backup panel supply source and island the PCS to a micro-grid during a grid outage. The battery portion of the DURACELL POWER CENTER 5KW is not shown.

Note: while the EMS is responsible for monitoring PCS states and controlling the battery discharge / charge rates, the PCS is responsible for the relay controls, and thus does not rely on EMS communication for transfer of the backup panel source.

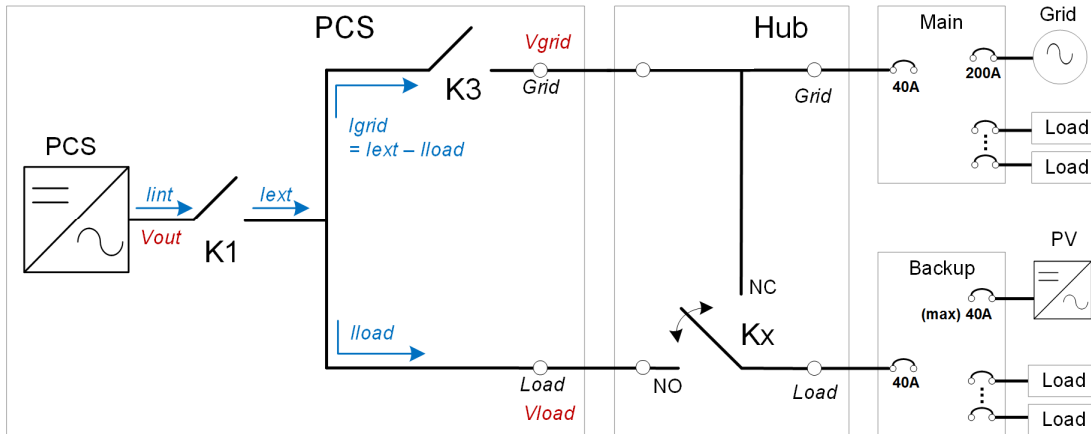


Figure 24: DURACELL HUB and PCS relay protection definitions in an AC coupled solar plus storage installations.

There are three main protection relays within the complete system, defined below, all of which have internal fail-safe fault verification circuitry to prevent an unsynchronized PCS load to grid output connection.

Kx: DURACELL HUB bypass / transfer relay

The DURACELL HUB bypass / transfer relay ensures the backup panel is connected to the main panel with or without an operating ESS. When standalone, the Kx relay bypasses the energy storage system to power the backup panel from the main supply. It remains in the NC or bypass state until powered up with the ESS initialized and ready for control. Once the energy storage system's PCS is in a "ready" mode, the PCS will take over control of the backup supply source by transferring Kx to NO, and closing K3 for an uninterrupted transfer. Kx will revert to an NC state with or without a valid grid if the PCS reports a critical service state which prevents it from safely operating the K3 transfer relay.

Fail-safe: Critical failure of the Kx relay will prevent PCS operation and will result in loss of power to the backup panel.

K3: PCS transfer relay

This relay operates with Kx as defined above when the ESS is in a "ready" state. See the table below for a complete list of PCS states. This relay opens upon a grid outage to island the backup panel from the main panel. This relay acts as the PCS grid timing / synchronization grid connect relay when the grid supply returns from an outage, allowing seamless connection of the battery system and the backup panel circuits to the grid.

Fail-safe: Critical failure of the K3 relay will prevent operation of the PCS, but will allow the backup panel to be supplied by the main panel via the DURACELL HUB.

K1: PCS islanding relay

This relay operates as the IEEE1547 islanding relay for grid interactive disturbances (self-clearing), as well as internal and/or system faults (critical, service mode: non-clearing).

Fail-safe: Critical failure of the K1 relay will prevent operation of the PCS, but will allow the backup panel to be supplied by the main panel via the DURACELL HUB.

PCS and Hub relay state map

The following table summarizes the PCS operating states in both utility interactive and offgrid operating modes. The corresponding relay states and backup panel supply source are also identified. The "PCS ready" column indicates the PCS states of operation where the PCS has control over the relays.

PCS "ready"	PCS State	K1 State	K3 State	Kx State	Backup Panel Supply Source
Utility Interactive					
	Initializing (power-up)	O	O	NC	Grid
*	Sleep/Standby (default state following initialize)	O	C	NO	PCS
*	Active Sleep (EMS commanded)	C	C	NO	PCS
*	Grid connected, no charge/discharge (EMS	C	C	NO	PCS
*	Charging/Discharging (EMS commanded)	C	C	NO	PCS
*	Fault (self-clearing)	O	C	NO	PCS
*	Service mode (resettable)	O	C	NO	PCS
Offgrid					
*	Offgrid voltage control	C	O	NO	PCS
*	Sleep/Standby – Overcurrent	O	O	NO	None
*	Service mode – Overcurrent	O	O	NO	None
	Sleep/Standby – No Grid	O	C	NC	Grid
	Service – No Grid	O	C	NC	Grid
	PCS Unavailable - No grid or battery supply	O	O	NC	Grid

O – open, C – closed NO – normally open, NC – normally closed

Backup supply interruption period during grid outage / return to grid

A grid outage results in a four second power interruption to the backup panel. On return of the grid supply, the energy storage system and PV inverters sync and grid connect without interruption to the backup panel.

Appendix C: Internet Connection Options

C.1 Hard-wired Ethernet

Hard-wired ethernet is recommended for a permanent installation, as it is not subject to interference, drop-outs, or ISP changes.

Connecting the EMC gateway to the customer's internet router via ethernet cable:

Note: Refer to figure 2, page 6 for the following instructions / cable references.