



User Manual

PowerShift® V1

*Document #7761739
Version B*



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CommScope, Inc. of North Carolina, December-2016

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1. General

About CommScope

CommScope is the foremost supplier of one-stop, end-to-end radio frequency (RF) solutions. Part of the CommScope portfolio are complete solutions for wireless infrastructure from top-of-the-tower base station antennas to cable systems and cabinets, RF site solutions, signal distribution, and network optimization. For patents related to this, and other CommScope products, see www.cs-pat.com.

CommScope has global engineering and manufacturing facilities. In addition, it maintains field service engineering offices throughout the world.

The declaration of conformity for our products is available upon request from the local sales offices or directly from CommScope www.commscope.com.

2. PowerShift® Technical Support

For technical assistance and support, please contact the PowerShift technical support team.

Website: <https://www.commscope.com/wisupport/>

United States and Mexico:

1-888-297-6433 (technical support)

1-888-235-5732 (main number)

International: +1-779-435-8579

3. References

It is important to review the applicable PowerShift® specifications, installation documents and installation kits when using this document to plan for product installation and to understand product operation after installation. Refer to the following CommScope PowerShift® product web page for more information:

<http://www.commscope.com/solutions/power-solutions/>

- DAS or macro site installation document
- Data sheets

Contact CommScope Technical Support to obtain:

- Graphical User Interface (GUI) software and manual

4. Introduction

This document provides instructions for operating PowerShift®, a patented and revolutionary product in DC power management for cellular networks and distributed antenna systems.



4.1. Purpose

The PowerShift system continuously regulates the supply output voltage in order to maintain a consistent input voltage where it is needed: at the remote radio.

4.2. Benefits

The PowerShift system provides the following benefits:

- **Lower operating costs:** The superior accuracy of the PowerShift system allows the radio input voltage to run closer to the maximum, thereby lowering radio load current demand and minimizing power loss in trunk cables.
- **Lower capital equipment costs:** Smaller gauge cables can be used for the same radio power requirement.
- **Increased backup battery uptime:** Higher radio input voltage and lower current demand results in optimal utilization of battery capacity and extended runtime.
- **Future proof:** Increase in radio power requirements may not require larger or additional power cables to be installed.
- **More Information:** Visit the PowerShift product web page and video overview:

<http://www.commscope.com/solutions/power-solutions/>

<https://www.youtube.com/watch?v=FSJR6aNzHO4>.

4.3. System Components

The PowerShift System consists of the following components:

Component Name	Part Number
Base Unit Shelf	PS-1-R
Base Unit Power Module	PS-1-73
Capacitive Jumper	DPJ-210CAP-3M

PowerShift Base Unit

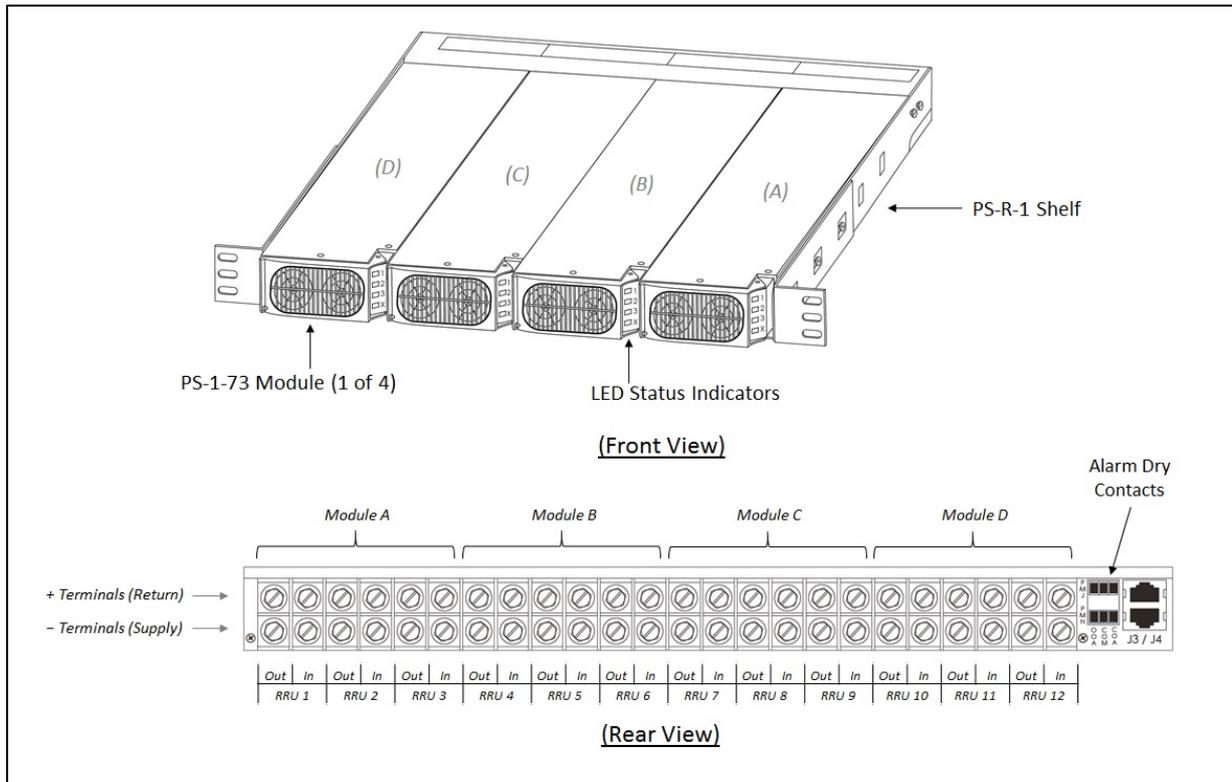


Figure 4-1 PowerShift Base Unit

Base Unit Features

- The Base Unit is typically collocated with the existing DC power plant (e.g., installed in or near the DC power plant cabinet)
- The Base Unit is comprised of the PS-R-1 shelf and PS-1-73 power modules
- The modules are plug-and-play for easy installation and site maintenance
- Each module has three individual DC input and DC output circuits that provide power for three Remotes (radios)
- The shelf accepts four modules, providing a total capacity for 12 Remotes
- The shelf has dry-contacts (Form C) for remote alarm monitoring
- Each module has LED indicators that provide status information: The “X” LED at the bottom provides overall status for the module, and the LEDs “1”, “2” and “3” provide status for each individual circuit

PowerShift Capacitive Jumper

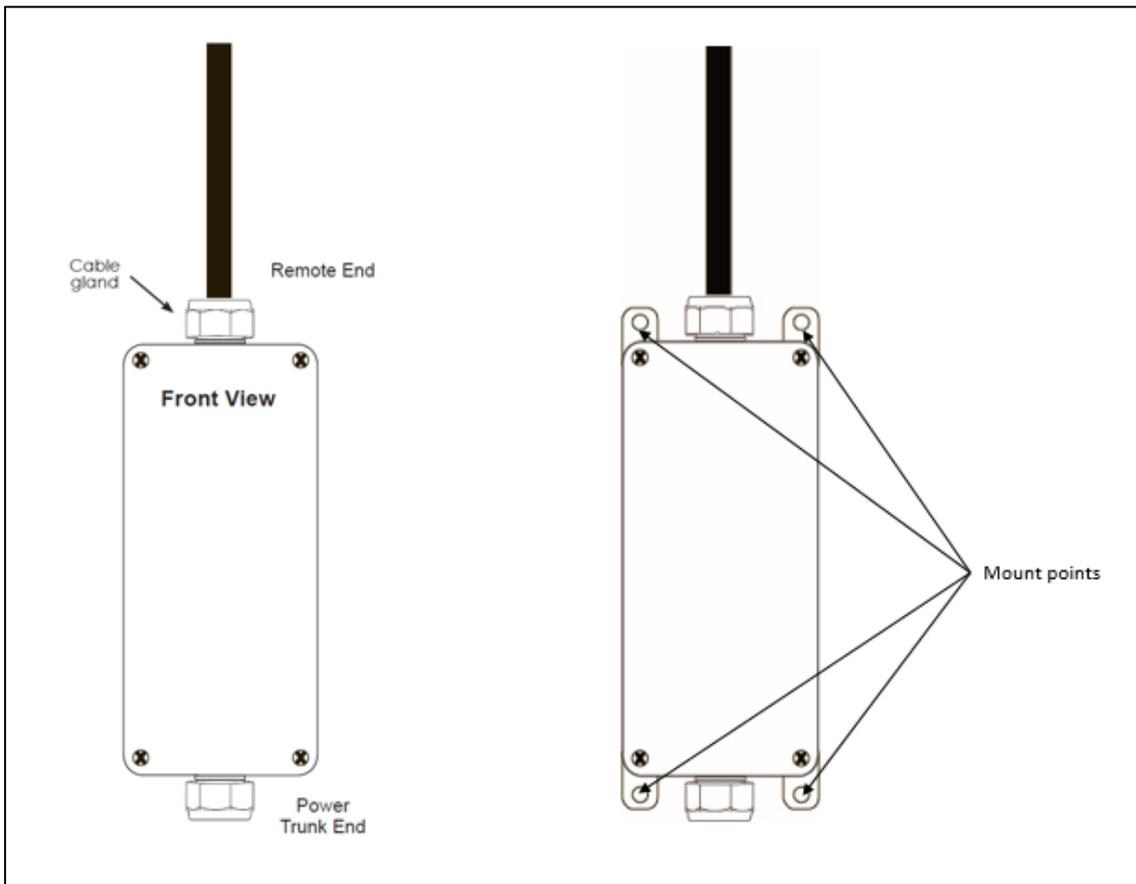


Figure 4-2 Capacitive Jumper

Capacitive Jumper Features

- The capacitive jumper is an inline device installed between the output of the trunk cable power conductor cable pair and the input to the Remote
- It is available either as a standalone device or integrated into a roof/tower top SPD/OVP (Surge Protection Device/Over Voltage Protection) package
- It is utilized by the Base Unit to determine the power cable impedance
- It also compensates for DC inductance of the power cable, further reducing power loss
- **Note:** The PowerShift Base Unit will not operate without the corresponding Capacitive Jumper. Each Remote requires one Capacitive Jumper;

4.4. Graphical User Interface (GUI)

The PowerShift V1 GUI is an executable file that is run on a Windows PC and connects to the PowerShift shelf via a custom RS485 interface cable. Contact customer technical support to obtain the software file and the document [PowerShift Graphical User Interface Manual](#) for additional details.

5. System Operation

5.1. General Operating Description

The diagram below provides a basic operating description of an installed PowerShift system.

Note that each Base Unit module has three circuits, and each circuit has its own input and output terminals; the three circuits operate independently from one another.

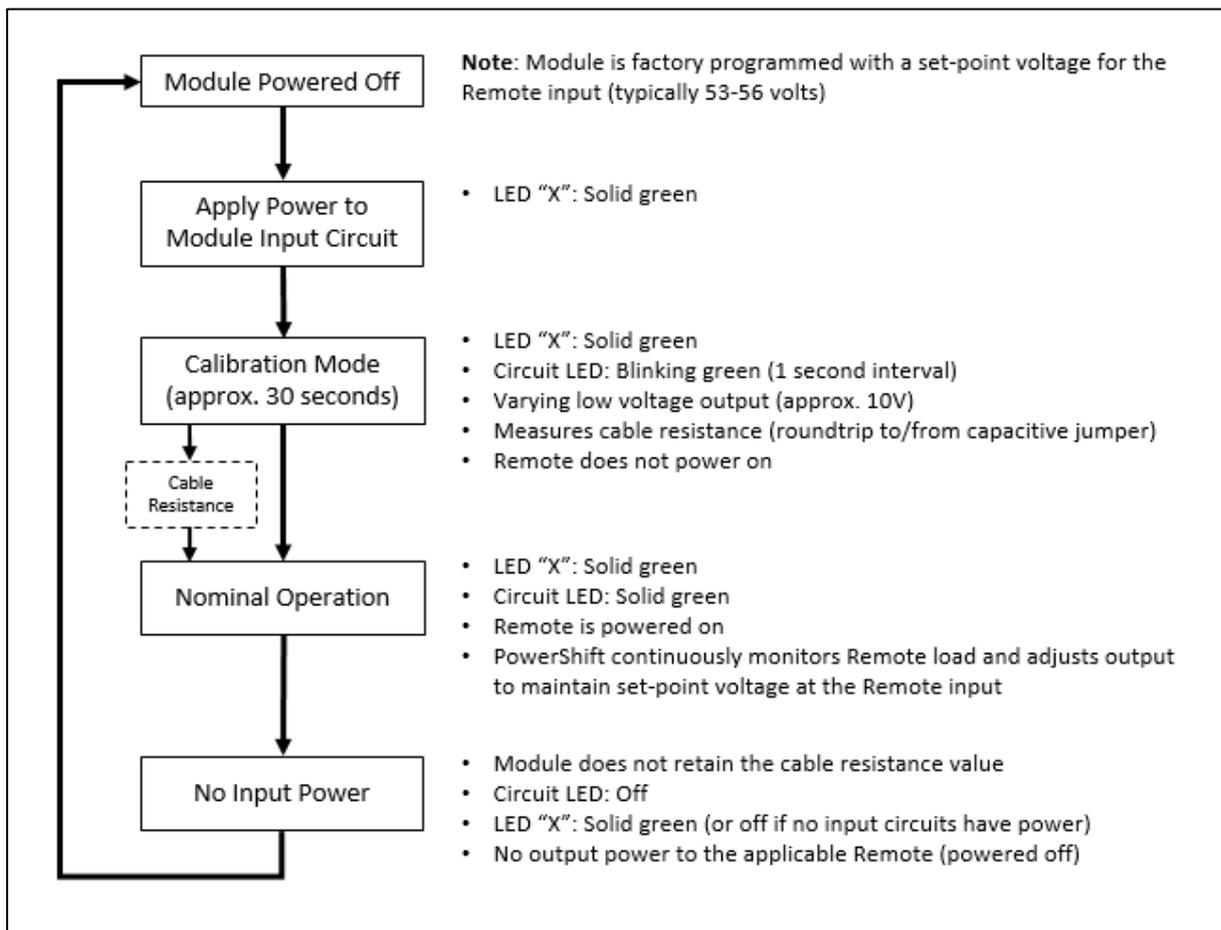


Figure 4-1 Operating Description

Operating Description

- The module is programmed at the factory with a set-point voltage for the Remote input (typically 53-56 volts)
- Whenever input power is active on one or more of the three circuits, the module "X" LED will be solid green
 - A red or yellow LED indicates a fault at the module level; see the next section for more information

- c. When input power is applied to a circuit, the module executes a startup calibration mode only for that circuit (the other two circuits are not impacted); it calculates the round-trip resistance between the module output and the capacitive jumper at the far end of the cable
- d. The calibration mode is approximately 30 seconds in duration, during which time the applicable circuit LED (1, 2 or 3) will flash green (i.e., a slow flash with a one-second interval)
 - A red or yellow LED indicates a fault at the module level; see the next section for more information
- e. During calibration, the module outputs a varying low voltage (approximately 10 volts); this voltage is sufficiently low that it will not power on the Remote
- f. When the calibration is complete, the module outputs full nominal operating voltage to power on the Remote
- g. During nominal operation, the module continuously monitors the load current demanded by the Remote and dynamically varies its output voltage to deliver the set-point voltage at the Remote input
- h. Any time the input voltage to a module circuit falls below about 30V, the affected circuit will re-run the initialization sequence and re-calculate the round-trip resistance of the cable
 - **NOTE:** If a circuit is operating normally and the input power is removed, the capacitive jumper must discharge down to about 10 volts before the initialization sequence will start. This typically occurs within a few seconds, but if there is no remote radio connected (no load) then it can take a minute or two for the discharge to complete and the initialization sequence to start.
- i. The three circuits in the module operate independently from one another. Power cycling the input to one circuit of a module has no impact on the other two circuits.
- j. The module “X” LED will continue to be solid green if there is input power to at least one of the three module circuits

5.2. LED Status Indicators

The following is a description of the module LED status indicators.

- a. There are four LED status indicators on each PowerShift Module, they are labelled: 1, 2, 3 and X

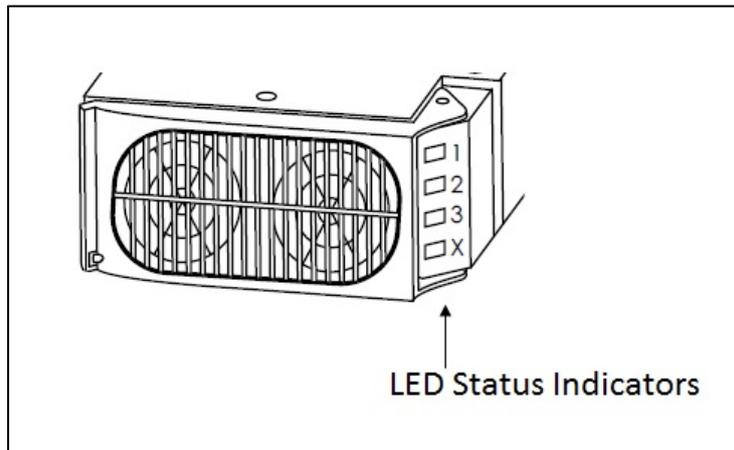


Figure 5-2 LED Status Indicators

- b. LEDs 1, 2 and 3 provides the individual status of each of the three power circuits in the module
- c. LED X represents the status of the overall module
- d. Intermittent or latent failures will be indicated by the LED X indicator, even if the individual circuit LEDs are functioning correctly
- e. See the alarm table in the next section for additional details

5.3. Form C Alarm Dry Contacts

As shown below, the alarm status of the unit is externally accessible with the terminal block located at the rear of the unit, on the far right.

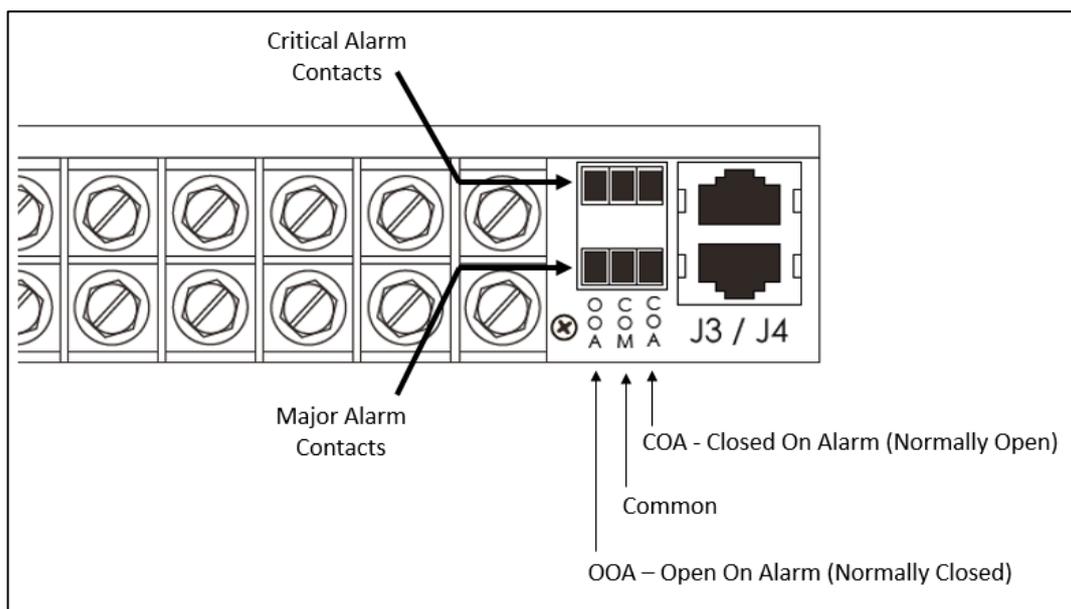


Figure 5-3 Alarm Relay Connections

5.4. DIP Switch and Data Interface

As shown below, each base unit has a DIP switch and RJ45 interface ports.

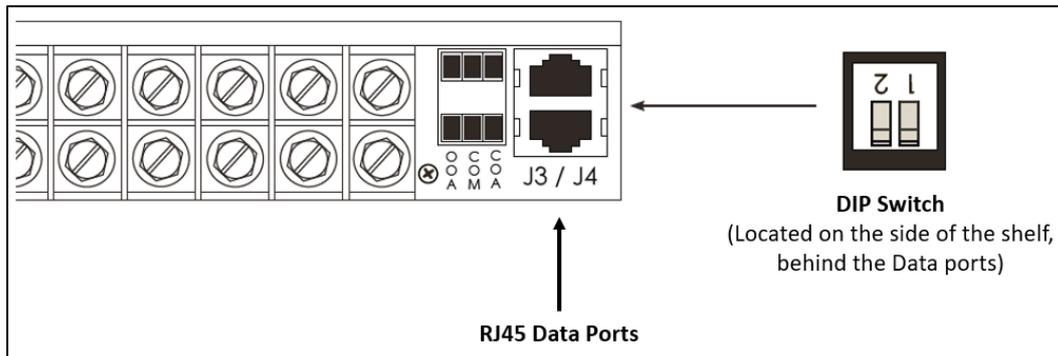


Figure 5-4 DIP Switch and Data Interface Ports

DIP Switches

- a. The DIP switches are not for customer use, they should be left in the down position (factory default setting)

RJ45 Data Ports

- a. The RJ45 data ports provide the communication connection point for a Windows PC running the GUI software.

5.5. Operating Faults & Alarms

The following table lists the possible states for the LED status indicators, shows the corresponding state of the Form C alarm dry contacts, and provides troubleshooting comments for understanding resolving alarm conditions.

Table 5-1 LED States and Alarm Contact Closures

Circuit 1, 2 or 3 LED	Module “X” LED	Alarm Condition (GUI & Relay)	Description
Off	Off	Critical and Major	No input power on any module/circuit GUI will not be able to connect, but alarm relays will be active for both critical and major
Solid Green	Solid Green	None	Circuit and module are functioning normally

Circuit 1, 2 or 3 LED	Module "X" LED	Alarm Condition (GUI & Relay)	Description
Green Blink	Solid Green	<p>None (<30 sec)</p> <p>-Or-</p> <p>Major (>60 sec)</p>	<p>Circuit is performing line resistance measurement</p> <p>Nominal condition (no alarm) – 30 second duration</p> <ul style="list-style-type: none"> - Circuit is measuring the line resistance, it takes ~30 seconds to complete - Occurs whenever circuit input power is applied or is cycled off/on - Remote is not powered during this time - After ~30 seconds the circuit LED should change to solid green - No alarm is raised during or after if the measurement is successful <p>Alarm condition (Major) – line resistance measurement unsuccessful</p> <ul style="list-style-type: none"> - If circuit LED continues to blink green after 60 seconds this indicates the module could not successfully measure the line resistance of the affected circuit - A major alarm condition is raised - PowerShift will use a default line resistance (0.15 Ohms) in order to provide voltage to the radio so that it can operate <p>Possible cause – Capacitive Jumper disconnected or failed</p> <ul style="list-style-type: none"> - If there is no power to the radio there may be a break in the trunk cable or a failure in the capacitive jumper; perform a continuity check - If there is power to the radio then the capacitive jumper may have failed in a closed condition

Circuit 1, 2 or 3 LED	Module "X" LED	Alarm Condition (GUI & Relay)	Description
Solid Green	Yellow Solid	Major	<p>Circuits are functioning, but a module-level fault has occurred.</p> <p>The condition may not require immediate attention and can be corrected in the next available service window (e.g., the module can continue to run with the failure of one fan, until the module can be replaced).</p> <p>Possible cause – Fan failure or other module-level failure</p> <ul style="list-style-type: none"> - Use the GUI to obtain additional status details for the module failure, or replace the module
Yellow Blink	Yellow Blink	Critical	<p>Circuit is in alarm, no output power on the alarmed circuit</p> <p>Possible cause - Overload or Short-Circuit</p> <ul style="list-style-type: none"> - Circuit is shut down to protect itself from over-current condition - Possible causes: Excess current demand (failed radio), a short in the trunk cable, etc. - Module will sense the circuit condition about every 3 seconds (the circuit LED briefly flashes green) to see if the fault condition has cleared - After 20 minutes if condition is not cleared then circuit latches off; fault must be cleared and input power cycled to re-enable output

Circuit 1, 2 or 3 LED	Module "X" LED	Alarm Condition (GUI & Relay)	Description
			<p>Possible cause – Module is over temperature</p> <ul style="list-style-type: none"> - Module shuts down affected circuit(s) to protect itself from high temperature condition - Possible causes: Module fan intake is blocked, site shelter cooling system has failed, module fan has failed - If the problem resolves itself (shelter cooling is restored) and module drops below threshold, then output power is restored and LED status changes (see next row below) <p>Possible cause – Input Voltage out of range</p> <ul style="list-style-type: none"> - Circuit is shut down due to its input voltage being out of range (see specification table) - Possible causes: DC rectifier plant output voltage out of range, DC plant on batteries that have discharged to a low voltage - If input voltage is brought back into range the circuit will immediately re-enable its output
Green Blink	Yellow Solid	Major	<p>A latent module failure has occurred, circuit was likely previously shut down but is now providing output power</p> <p>Possible cause – Module was previously over temperature</p>

Circuit 1, 2 or 3 LED	Module “X” LED	Alarm Condition (GUI & Relay)	Description
			<ul style="list-style-type: none"> - Module was previously shutdown to protect itself from high temperature condition, but the high temperature subsequently cleared - The circuit output power is re-enabled, but alarm is latched to provide site technician with clarity on which module and circuits were impacted - Possible causes: Module fan intake were temporarily blocked, site shelter cooling system was temporarily failed - To clear the alarm, use the GUI “clear” button or cycle the input power for each affected circuit
Red Solid	Red Solid	Critical	<p>The indicated circuit is shut down.</p> <p>Internal module hardware failure (e.g., internal fuse failure).</p> <p>Replace the module. The module is not user serviceable, contact customer technical support.</p>
Red Blink	Red Blink	Critical	<p>The indicated circuit is shut down.</p> <p>Fault condition may be internal to the module or in the external circuit.</p> <p>Confirm the circuit integrity as described in Section 7.</p> <p>Reset the circuit/module using the GUI clear button or by cycling the DC plant circuit breakers.</p> <p>If the fault recurs, replace the module. The module is not user serviceable, contact customer technical support.</p>

Circuit 1, 2 or 3 LED	Module “X” LED	Alarm Condition (GUI & Relay)	Description
			<p>Note: A red blink circuit LED can occur if the input power is cycled off and immediately back on, and there is no load (radio) connected to the circuit. In this case the capacitive jumper retains a small amount of voltage, and the module must allow it to discharge down before it can start the line resistance measurement. Allow 1-2 minutes for the discharge to occur, the LED will then change to green blink to indicate the line resistance measurement is in progress.</p>

6. Installation Planning

Following are general guidelines to plan the installation of the PowerShift system. For detailed, site-specific installation planning see the product web page referenced in Section 3.

6.1. Reference Schematic

The following schematic provides a general reference for PowerShift installation planning.

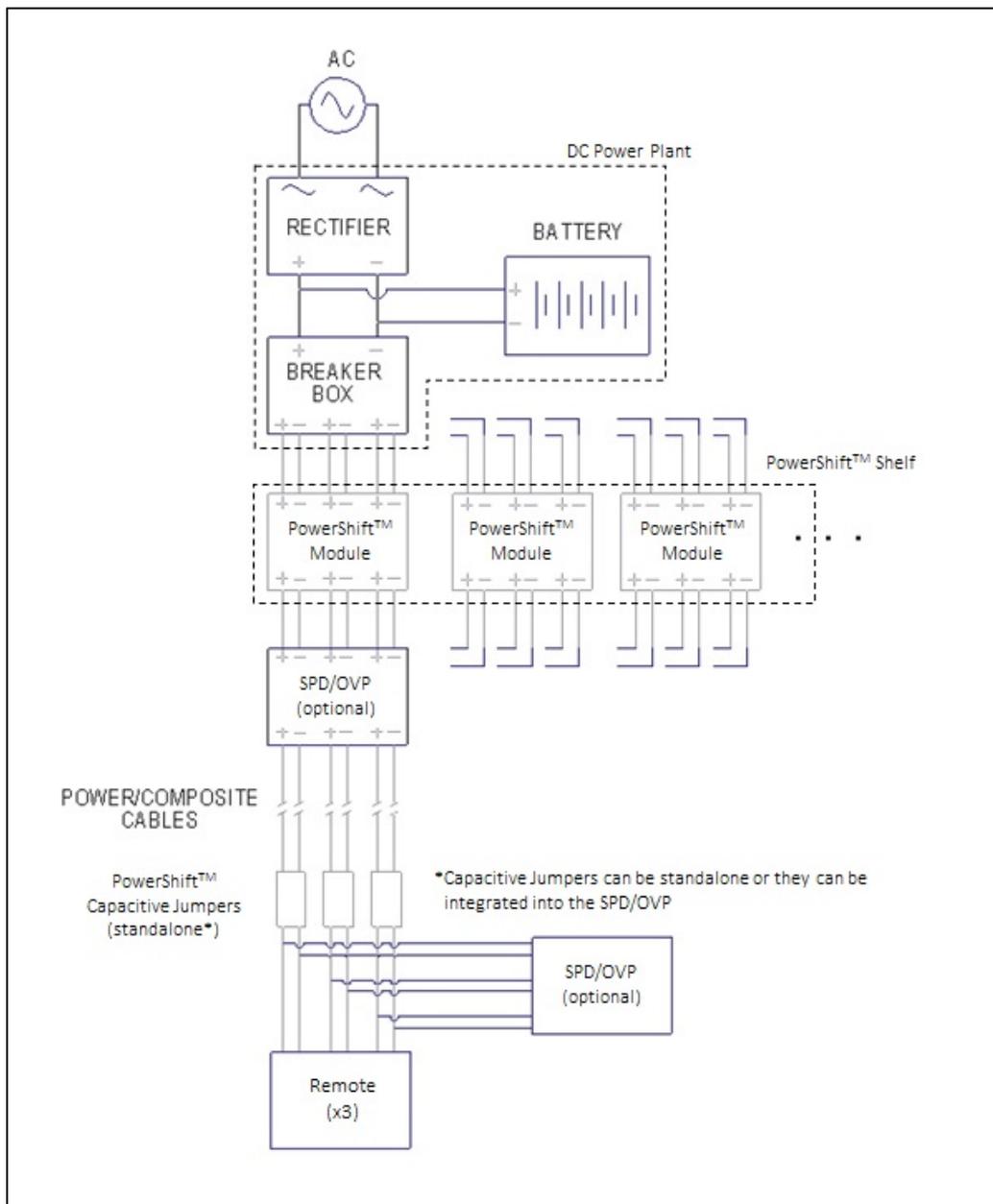


Figure 6-1 Reference Schematic for Installation Planning

6.2. PowerShift Web Site

- a. Check the CommScope website referenced in Section 3 to familiarize yourself with the different installation kits and options as part of your planning process

6.3. Perform A Site Walk

- a. Perform a site walk to evaluate and plan for the installation of the PowerShift system
- b. Plan to install the Base Unit inside the DC power plant cabinet or as close to the plant as practical
- c. Plan to re-terminate existing cables and fabricate new cables as needed, noting that the Base Unit input terminal and output terminals will be connected as follows:
 - The input terminals connect to the DC power plant breakers
 - The output terminals connect to the power cable trunks that feed the Remotes, or to the input of the SPD/OVP device if present
- d. Noting that each Base Unit holds up to 4 modules and each module connects up to 3 Remotes, decide on a connection scheme for the Remotes and sectors vs the modules and circuits (e.g., organize by sectors, etc)
- e. At the Remotes determine a suitable location to mount the standalone capacitive jumpers, or if applicable to install an SPD/OVP box with integrated capacitive jumpers (refer to OEM installation instructions for the specific SPD/OVP box)
- f. Make note of the gauges of existing cables and the lugs required for re-terminating existing cables or for fabricating new cables
- g. Ensure the existing power supply system has proper ground reference:
 - Visually confirm the return bus of the DC plant is bonded to earth ground
 - Use an inductive DC clamp meter to measure current amplitude on the supply lines vs return lines for each Remote; any significant differences in measured current on supply vs return lines may indicate a possible ground-return issue

6.4. Base Unit Installation Planning

- a. Reference the installation documents
- b. Requires minimum of 1 RU (rack unit) height
- c. Rack mount ears are included for standard 19" wide rack; adapters (not included) are required for installation in 23" wide or other rack widths
- d. The shelf is 17" deep:

- Allow additional space for at least 1” clearance in the front of the Base Unit (for fan air flow)
 - Evaluate whether straight, right-angle or 45-deg angle lugs are required in order for cables to clear any other rack hardware mounted directly below the Base Unit; plan accordingly for additional clearance space needed behind or below the shelf to accommodate cable routing. See below for the proper lug types.
- e. The Base Unit has dry-contact (Form C) alarm terminals, plan for routing of twisted-pair cables if the contacts are to be integrated into the site alarm infrastructure
- f. **IMPORTANT:** If the existing site uses SPD/OVP devices then it may be necessary to order Base Unit modules that have a lower maximum output voltage limit (i.e., they will be factory set to -65VDC max output instead of -73VDC). Please contact the PowerShift technical support team for additional guidance.
- g. **Following is a list of part numbers for the compression lug terminals needed to connect cables to the Base Unit shelf**

Table 6-1 Part Numbers for Compression Cable Lugs

Panduit Part Number	T&B Part Number	Burndy Part Number	One Hole Standard Barrel	Conductor Wire Size	Hole Size
LCA10-10-L		YAV10BOX	Straight	#10-14 AWG	#10
LCA8-10-L	54104	YA8CLBOX	Straight	#8	#10
LCA6-10-L	54134	YA6CL1BOX	Straight	#6	#10
LCA8-10H-L	54104UF	YA8CL45	45 Degree	#8	#10
LCA6-10H-L	54134UF	YAV6CLTC10FX45	45 Degree	#6	#10

6.5. Capacitive Jumper Installation Planning

- a. The installation will utilize either the stand alone capacitive Jumper unit (DPJ-210CAP) or an SPD/OVP box with an integrated capacitive circuit. Plan accordingly for mounting hardware, cable terminations, etc
- b. If standalone capacitive jumpers are to be installed, then plan for power cable splicing or cable re-termination as appropriate
- c. If existing remote radios are being retrofit, then new radio power connectors are recommended (the grommets for the existing connectors may not properly fit the power cable from the capacitive jumper)

7. Installation Guidelines

IMPORTANT: For detailed installation procedures see the product web page referenced in Section 3.

The following information provides general guidelines for on-site installation of the PowerShift system.

7.1. Test Tools

In addition to the standard tools used for hardware installation, the following additional tools are useful for PowerShift installation testing.

- a. DC voltmeter or multi-meter
- b. DC inductive (clamp-on) current meter

7.2. General Installation Approach

If practical, start by installing the cable connections for just one Remote initially and perform a power up test. This provides a sanity check of some basic things such as confirming proper voltage polarity and confirming the system can perform a successful cable resistance calibration.

Following is a general approach to performing the installation.

- a. After mounting the Base Unit and capacitive jumper, select one Remote to test (e.g., a Remote with easy access for disconnecting/reconnecting the input power cable)
- b. For the selected Remote, make the required cable connections between the Base Unit input terminals and output terminals
- c. Connect the trunk cables to the capacitive jumper at the far end, but do not connect the capacitive jumper output to the Remote
- d. Make sure the power connector (or exposed cable ends) at the output of the capacitive jumper are safe from being shorted, and prepare to make a measurement with the DC volt-meter
- e. Close the applicable DC power plant breaker to apply input power to the Base Unit module, then wait approximately 30 seconds for the cable resistance calibration sequence to successfully complete
- f. Using the volt-meter, check for proper voltage and polarity at the end of the Remote power cable
 - The voltage value will depend on the factory set-point for the module, but should generally be around 53 to 56 volts (without the Remote connected to the capacitive jumper output)

- g. To troubleshoot any issues or when ready to connect the Remote, it will be necessary to power off the circuit. Note the following:

NOTE: After powering off the circuit, wait about 2-3 minutes for the capacitive jumper to discharge before proceeding. The capacitor voltage will always be less than 60VDC safety limit (and thus there is no personal safety issue), but waiting a few minutes will minimize any negligible spark that may occur when the cable is reconnected to the RRU.

- h. Connect the capacitive jumper output cable to the Remote (when the connection is made there may be a negligible spark due to any small charge remaining on the capacitive jumper)
- i. Close the applicable DC power breaker to power the circuit, confirm the calibration sequence completes successfully, and confirm the Remote powers up
- j. Continue with the cabling and power up of the remaining Remotes

8. Product Specifications

For product specifications see the product web page referenced in Section 3.

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