



Leading Conversion Technology for Power Resilience

STABILITI SERIES 30 KW

Quick Start Guide V1.0

SMART POWER CONVERSION FOR THE ENERGY REVOLUTION

- AVAILABLE IN MULTIPORT (AC/DC/DC) AND DUAL PORT (AC/DC) VERSIONS
Stabiliti 30C3: AC/DC/DC
Stabiliti 30C: AC/DC
- INTEGRATES SOLAR AND STORAGE IN ONE COMPACT ENCLOSURE
Simplifies system installation, maintenance and control
- SUPPORTS WIDE RANGE OF ENERGY MANAGEMENT APPLICATIONS
AC Microgrids
DC Microgrids
Peak Shaving and Energy Arbitrage
Electric Vehicle Support Equipment "EVSE"
- PROVIDES GALVANIC ISOLATION BETWEEN AC AND DC PORTS
Extends Battery Life
Enhances Safety



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Address: CE+T S.a, Rue du Charbonnage 12, B 4020 Wandre, Belgium
www.cet-power.com - info@cet-power.com



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1. Introduction to CE+T

CE+T Power designs, manufactures, and markets a range of products for industrial operators, with mission critical applications, who are not satisfied with existing AC backup system performances and related maintenance costs.

Our product is an innovative AC backup solution that unlike most UPS's available.

- Maximizes the operator's applications uptime;
- Operates with lowest OPEX;
- Provides best protection to disturbances;
- Optimizes footprint.

Our systems are:

- Modular
- Truly redundant
- Highly efficient
- Maintenance free
- Battery friendly

CE+T power puts 60+ years expertise in power conversion together with worldwide presence to provide customized solutions and extended service 24/7 - 365 days per year.

2. Glossary of Terms

Acronym or Term	Full Expression
AWG	American Wire Gauge
CEC	California Energy Commission
CPU	Central Processing Unit
Converter	CE+T Power Converter: Stabiliti 30C, Stabiliti 30C3
CSA	Canadian Standards Association
DMM	Digital Multi-Meter
FRU	Field Replaceable Unit
GFDI	Ground Fault Detection Current
IFM	Insulation Fault Measurement
IMI	Isolation Monitor Interrupter
Inverter	CE+T Power Inverter: 30PV+S
LCD	Liquid Crystal Display
MPPT	Maximum Power Point Tracking
PCB	Printed Circuit Board
PCS	Power Conversion System
PV	Photovoltaic

3. Introduction

3.1 Purpose, Scope, and Audience

This Quick Start Guide describes the features and capabilities of the Stabiliti 30C3 Multiport Power Conversion System (PCS or Converter), as well as the Stabiliti 30C Dual Port PCS. It should be used in conjunction with other product documentation provided by CE+T Power (“CE+T”), which are referenced throughout this Quick Start Guide.

The intended audience is engineering lab personnel familiar with high-voltage/high-power systems and the general safety issues related to the wiring and use of 3-phase AC power and high-voltage battery and PV systems.

The [Stabiliti Series 30 kW Installation and Operations Manual](#) should be used to ensure safe installation and operation of this Converter. Please review this entire document prior to starting your system evaluation. Many other CE+T PCS operation and application documents are referenced in this manual and highlighted with **bolded blue text**.

Contact tech.support@cetamerica.com for technical support as needed.

3.2 Important Notes Before Starting the PCS

- The PCS control system does not contain any built-in battery charge profiles or discharge algorithms for any battery types and does not communicate with any batteries directly. An external system controller must dictate battery charge & discharge levels in real-time with current or power commands according to your economic use-case of the overall Energy Storage System.
- The PCS includes many configuration limits to constrain operation including voltage limits, ramp rates and more. It is the operator’s responsibility to review the PCS configuration to ensure safe operation for their unique application. In particular, maximum voltage limits and maximum current limits should be updated from the factory default and saved to flash to reflect your battery or PV array safe operating voltage ranges. Refer to section 8, page 18 for more information.
- Before electrically connecting an energized, high-voltage battery to the PCS, the integral precharge circuit should be used to minimize current inrush into the PCS capacitors. Refer to the stand-alone battery scenario example in section 11, page 30 for more information.
- Ensure the emergency stop connection is made before attempting to start-up the PCS. Refer to section 6, page 11 for more information. If this connection is not made the PCS will immediately fail its Power-On Startup Test (POST) and/or exhibit a persistent E-Stop Fault.
- The factory default configuration of the DC power ports is 2-wire, unipolar, negatively grounded with a GFDI fuse. Before energizing any components ensure this is the desired setup for your application. Also note that the two DC ports of the 30C3 have opposite terminal layouts. Refer to section 7, page 14 for more information.



4. System Specifications

The Stabiliti Series PCS uses a novel Link Transformer coupled with CE+T’s proprietary Power Packet Switching Architecture™ (PPSA) to deliver full galvanic isolation between the AC and DC power ports. This isolation also delivers greater flexibility with regards to DC wiring options, either floating or grounded are supported which are hardware configured on the DC power connection board.

All ports support bi-directional power flows up to 30 kW max per port. Their highly flexible operating modes are managed via Modbus TCP over an Ethernet network connection. Modbus RTU is also supported.

4.1 Stabiliti 30C Dual Port

The 30C PCS uses PPSA to efficiently transfer and manage power flows among two power ports: AC1 and DC2

- AC1 is a 3-Wire, 3-Phase AC power port
- DC2 is a DC power port dedicated to battery-based energy storage systems and incorporates a battery bus pre-charge circuit

	Wiring	Voltage	Current	Power
AC Port 1	3-wire, 3-phase	480 Vac, 60 Hz	37 Aac	30 kW
DC Port 2	2-wire	100-1000 Vdc	60 Adc	30 kW

Refer to the latest Stabiliti PCS Specification Sheet for complete product specifications:

[CET - Datasheet - Stabiliti 30C - EN](#)

4.2 Stabiliti 30C3 Multiport

The 30C3 PCS uses PPSA to efficiently transfer and manage power flows among three power ports: AC1, DC2 and DC3

- AC1 is a 3-Wire, 3-Phase AC power port
- DC2 is a DC power port dedicated to battery-based energy storage systems and incorporates a battery bus pre-charge circuit
- DC3 is an auxiliary DC power port for use with a second battery system or a PV array

	Wiring	Voltage	Current	Power
AC Port 1	3-wire, 3-phase	480 Vac, 60 Hz	37 Aac	30 kW
DC Port 2	2-wire	100-1000 Vdc	60 Adc	30 kW
DC Port 3	2-wire	100-1000 Vdc	60 Adc	30 kW

Refer to the latest Stabiliti PCS Specification Sheet for complete product specifications:

[CET - Datasheet - Stabiliti 30C3 - EN](#)



4.3 Product & Port Interchangeability

The Stabiliti Series PCS 30C & 30C3 share a common hardware and firmware platform. This document describes the general case of the 30C3. Aside from the integral battery pre-charge circuit on DC2, the DC2 and DC3 ports on both products are operated and controlled identically and may be configured for either battery or PV. Descriptions of control sequences in this document may therefore be readily reflected to both ports and both products.

5. PCS Installation

5.1 Unpacking and Inspecting the PCS

The Stabiliti is pallet shipped, and is enclosed in a purpose-built heavy-duty cardboard box. Once unpacked, inspect the PCS for any obvious shipping damage. Immediately contact your shipper and CE+T regarding any damage noted. You may also save the box with foam in the event it is needed to transport the converter.

5.2 Mounting the PCS

The PCS, when installed on its wall mounting bracket weighs approximately 135 pounds. External dimensions are 20.5" W x 40" H x 16" D. The PCS must always be installed in a vertical upright position to ensure proper thermal management, this includes for any testing and evaluation purposes. Do not block cooling airflow to the bottom air intake filter or the exhaust output, which is located on the upper door face of the unit.

Clearance requirements:

18" underneath intake filter for air flow and splash resistance

36" in front to meet NEC code requirements

The PCS is hung on an included wall-mount bracket. The bracket has four (4) 13mm holes for fastening to a wall (fasteners not included). After hanging, the PCS is fastened to the bracket underneath with two (2) M6 socket cap screws. Complete the mounting and installation following instructions in the [Stabiliti Series 30 kW Installation and Operations Manual](#).

6. Low Voltage Comms and Control Wiring

6.1 Wiring Access

The PCS wiring compartments are accessed by eight (8) M4 socket cap screws which open the full-sized (20.5" x 40") hinged front door. All low-voltage wiring is directly terminated to connectors located on the Control Board, located on the upper left side of the enclosure.

- Other than Ethernet connections, low-voltage terminations are made bare wire in screw terminal blocks. Sourcing appropriate low-voltage cables, conductors and wiring are the customer's responsibility.
- Care should be taken when making up, routing, and connecting low-voltage cables. The PCS should be disconnected from AC and DC power sources and a grounding strap should be worn by the equipment installer. Refer to [Stabiliti Series 30 kW Installation and Operations Manual](#) for additional information regarding low-voltage wiring.

In all Stabiliti Series applications, an outside system controller is required to configure, control, and monitor the PCS in real-time via the Modbus TCP interface. These energy storage systems may also utilize other low-voltage interfaces shown in Figure 1.



Shown in Figure 1, there are nine (9) low-voltage interfaces on the Control Board.

From top to bottom:

1. AC Disconnect (J8)
2. E-Stop / Aux 24 V In (J9)
3. RS485 (J10)
4. Sync/CAN (J11)
5. Transfer Relay (J16)
6. Ethernet (J7)
7. USB (J13)
8. Aux 24 V Out (J15)
9. Arc Fault Interface (J12)

Figure 1: Control Board Low-Voltage Connectors

6.2 Low-Voltage Interface Overview

#1 - AC Disconnect

Not applicable, reserved for future use

#2 - E-Stop / Aux 24 V In

4-Pin terminal block connector

- Pin 4 is Auxiliary 24 Vdc in (Optional)
- Pin 3 is Ground
- Pin 2 is Emergency Stop
- Pin 1 is Ground

For normal PCS operation, the E-Stop input (pin 2) must be connected to ground (pin 1). If left open or tied to 24 Vdc, the E-Stop feature is activated and the PCS will cease exporting power and move to an idle state. The PCS will fail its initial power on self-test (POST) if the E-Stop input is not connected to ground.

The 24 Vdc auxiliary input will supply power to the PCS control board for communications and cooling fan operation. Connect a 100 W, 24 Vdc power supply between Ground (pin 3) and Aux 24 V (pin 4). Ensure the power supply is appropriately rated for the expected operating temperature range.

This external power supply should be supported by a UPS to keep the control board active during grid-outages, transitions to back-up power mode or when the PCS is black-starting a microgrid in grid-forming mode.

For applications that are only grid-tied (voltage-following) operation this power supply is not required as internal control board and fan power is also derived from 480 Vac grid input.

Note that for initial communications validation and read/write Modbus verification, use of the external supply is useful to avoid use of a 480 Vac grid connection.

#3 - RS-485

3-Pin terminal block connector

- Pin 3 is isolated ground (Common, also known as C/C', signal/power)
- Pin 2 is RS485 D1 (also known as B/B', negative half of differential pair)
- Pin 1 is RS485 D0 (also known as A/A', positive half of differential pair)

RS-485 serial communication is a legacy format in the inverter industry and CE+T offers this interface support for backwards compatibility. IPWR highly recommend operators employ Ethernet TCP communications for enhanced reliability, speed and functionality.

The RS-485 media layer employs 2-wire differential signaling to support the Modbus RTU protocol to monitor and control the PCS. External 120 Ohm termination resistors are sometimes necessary as determined by a number of factors including RS-485 wiring run length, wiring type, number of slave devices on the RS-485 bus and the baud rate parameters. IPWR recommends testing performance with a terminating resistor at the PCS connector in cases of long wire runs or multiple slave devices.

#4 - Sync/CAN

Not applicable, reserved for future use



#5 - Transfer Relay

Supports signaling input for rapid transfers to and from back-up power. For usage please refer to CE+T [Application Note 504: Rapid Backup Power Solution Guide with Stabiliti PCS](#).

#6 – Ethernet TCP

Standard 8-pin RJ45 Connector

Provides support for multiple TCP-based communications services:

- Modbus TCP at port 502
- HTTP webserver at port 80
- FTP at port 21
- Telnet at port 23

CE+T strongly recommends incorporating TCP-based communications into your Energy Storage System (ESS). Note that most ESS will involve remote communications for system operations and monitoring where these remote communications are also typically based on a TCP architecture.

The Modbus TCP interface is used to monitor and control the PCS. The HTTP webserver is used for downloading black-box historical fault logs. FTP is used for loading new firmware image files and is therefore crucial for timely PCS updates. Telnet is only used by trained CE+T Technicians for in-depth diagnoses. When configuring firewall permissions please make accommodations for TCP data transfer on the four (4) ports noted above.

Refer to section 8, page 18 of this document for more information on TCP Ethernet communications.

#7 – USB Connector

Not applicable, reserved for future use

#8 - Aux 24 V Out

Not applicable, reserved for future use

#9 - Arc Fault Interface

Not applicable, reserved for use with CE+T PV Combiner not included with Stabiliti.

7. High-voltage Wiring

During initial setup of the PCS and before connecting AC and DC power sources, it is recommended that the user first operate the PCS with only the Aux 24 Vdc power supply connected. Doing so enables validation of communications and access to the Modbus control interface and the various configuration, control, and monitoring features supported by the Stabiliti Series PCS and detailed later in this document.

7.1 Wiring Access

Once preliminary system communication is established, connect AC and DC power sources. The PCS high-voltage interconnect boards inside the enclosure are accessed by eight (8) M4 socket cap screws which open the full-sized (20.5" x 40") hinged front door. Punch-outs have been marked on the underside wiring access panel for conduit mounting.

- High-voltage AC1 connection points are located on the left bottom section of the converter enclosure.
- High-voltage DC2 and DC3 connections are located on the right bottom section of the converter's enclosure.

Note: Do not disturb or change the factory wiring connections, which are made to the top of the AC1 interconnect board, and the DC2/DC3 interconnect board shown below.

7.2 AC1 Interconnect Board

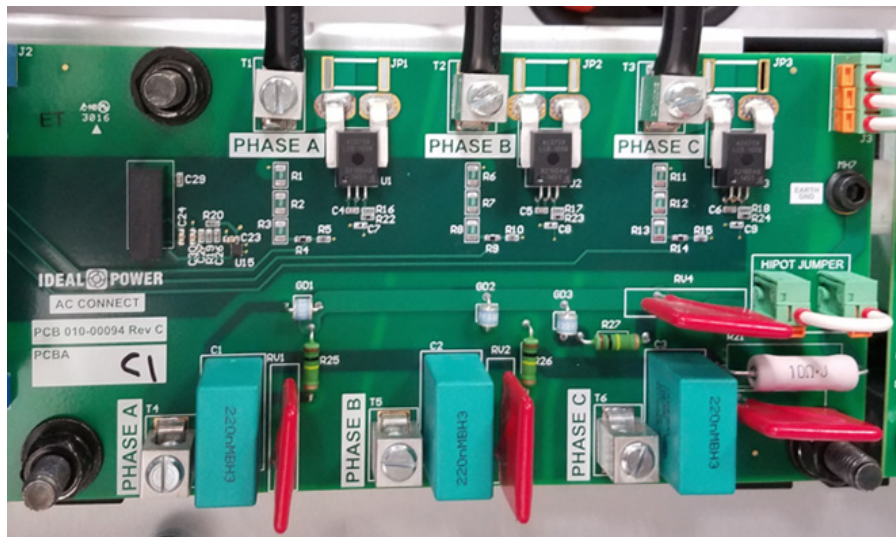


Figure 2: 30C3 AC1 Connect Board

The bi-directional AC1 port shown in Figure 2 is configured as a 3-wire delta interface. Factory defaults are set to support North American 3-phase grid standards: the operating frequency is 60 Hz and line-to-line operating voltage is 480 Vac.

For service voltages other than 480 Vac, a transformer will be necessary. Please refer to CE+T [Application Note 102: Stabiliti 30C/30C3 Grid Interconnection and Transformer Design Requirements](#). Contact tech.support@cetamerica.com regarding any questions you may have regarding available AC voltage and frequency options.

AC connections are made to the bottom terminals designated as PHASE A, PHASE B, and PHASE C, refer to Figure 3. Torque these terminals to 45 in-lbf (5 Nm). Note that the PCS will automatically adapt to phase sequence (phase rotation) if operating in a grid-tied mode. For microgrid (backup power) operation it is necessary to ensure the PCS sees positive rotation. Confirm rotation via Modbus register 298 system_status bit 6 which should be zero indicating positive rotation.

An earth chassis grounding lug is located just below the PHASE A terminal, refer to Figure 3. Ensure that the chassis/enclosure is correctly grounded by utilizing this connector for earth ground from the AC service.

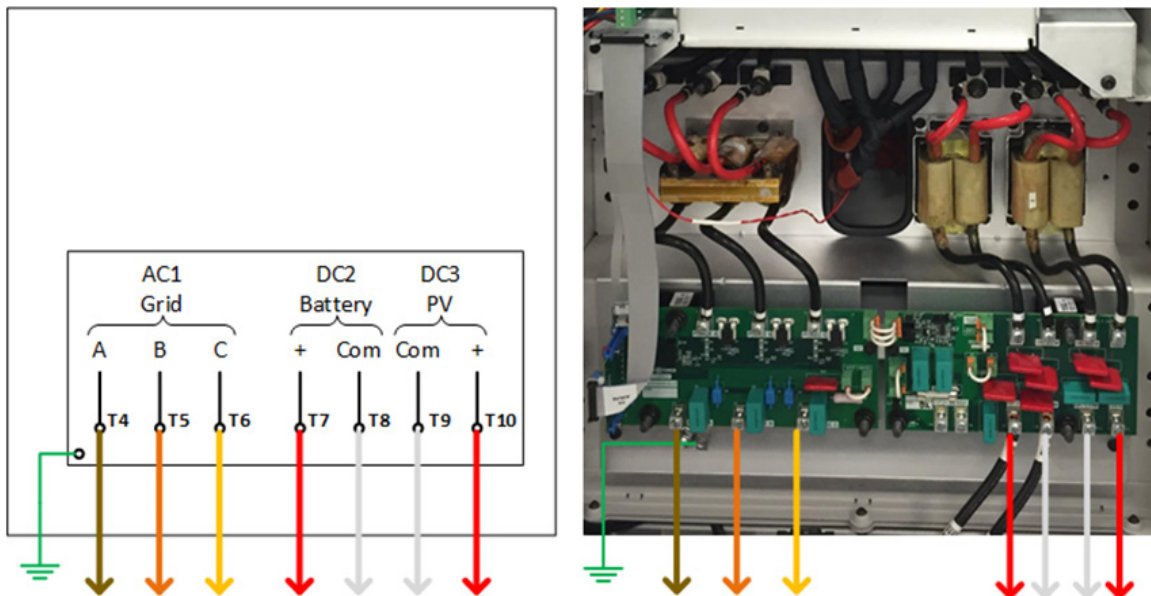


Figure 3: AC1, DC2 and DC3 power connection terminals

7.2.1 AC External Circuit Protection and Disconnect

The Stabiliti must be installed with external circuit protection. A 50 A 3-Phase 3-wire AC breaker, rated at 480 Vac, is recommended for this purpose. Refer to Figure 5. In some jurisdictions, this circuit breaker may also be approved for use as a safety disconnect. However, CE+T recommends that you confirm specific AC disconnect requirements with your local Authority Having Jurisdiction (AHJ). Some jurisdictions may require an external “red-handle” visible, lockable disconnect in addition to the protection breaker.

7.3 DC2/DC3 Connect Board

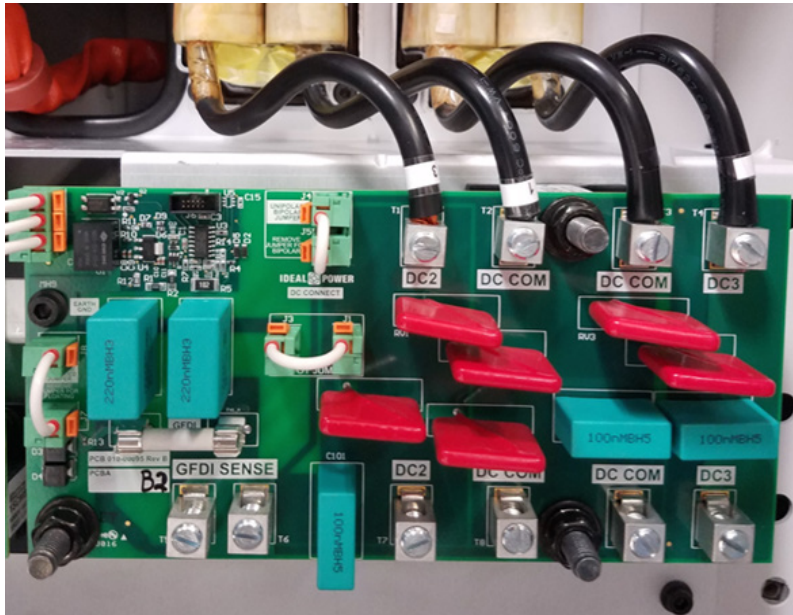


Figure 4: 30C3 DC2 and DC3 Connect Board

7.3.1 DC Grounding

The battery and PV array connections share a common negative connection via DC COM. They are not electrically isolated from one another. In the factory default configuration, this common negative DC connection is grounded within the PCS via a 1 A fuse. This is the recommended configuration for a solar plus storage multiport application.

7.3.2 Battery Wiring

The DC wiring interconnect board shown in Figure 4 reflects a 30C3 PCS with DC2 and DC3 components installed. DC cables are landed on the bottom terminals. The battery positive is connected to DC2 (T7, fourth from right) and the battery negative to the DC COM (T8, third from right). Torque these terminals to 45 in-lbf (5 Nm). Note that the two DC ports of the 30C3 have opposite terminal polarity layouts.

7.3.3 PV Wiring

Typically, a PV array installation for the 30C3 will employ a 3rd-party combiner box with a single MPPT output wire pair. The negative connection is made to DC COM (T9, second from right) and positive PV array connection to DC3 (T10, right-most). Torque these terminals to 45 in-lbf (5 Nm). Note that the two DC ports of the 30C3 have opposite terminal layouts.

Note that the Stabiliti PCS does not include arc-fault detection or rapid shutdown functionality for PV systems. External, third party equipment may be necessary to meet these requirements. Contact tech.support@cetamerica.com regarding any questions you may have regarding external arc-fault or rapid shutdown requirements.

Common Error: The two terminals labeled GFDI Sense on the lower left of the DC interconnect board are not used for standard 2-wire battery or PV connections. These accommodate legacy 3-wire or 4-wire bipolar DC configurations and are used in conjunction with the unipolar/bipolar jumper. Contact tech.support@cetamerica.com for questions regarding alternate DC2 and/or DC3 wiring options.

7.3.4 Alternate DC Wiring

There are numerous DC wiring options available on the 30C3, including support for floating, grounded unipolar and bipolar battery configurations. Refer to [Stabiliti Series 30 kW Installation and Operations Manual](#) to determine what configurations best fits your application.

7.3.5 DC External Circuit Protection and Disconnect

The 30C (DC2) and 30C3 (DC2 and DC3) must be installed with external fused circuit protection on their DC power ports. Refer to Figure 5. A 1000 Vdc rated, 75 A fused PV Disconnect with PV-type fuses is recommended for this purpose on both ports. However, CE+T recommends that you confirm specific DC disconnect and safety requirements with your local Authority Having Jurisdiction (“AHJ”).

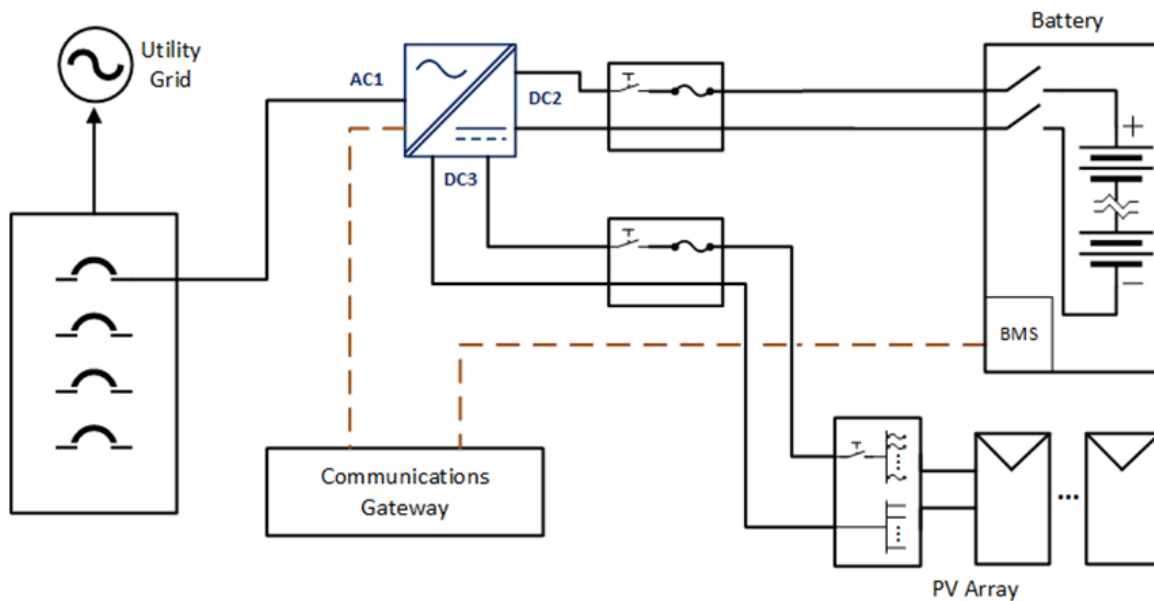


Figure 5: Typical PCS battery and PV system connections

8. Communications and Modbus Interface

8.1 PCS Configuration, Control and Monitoring

All Stabiliti Series Converters are configured, monitored, and controlled via the Modbus TCP (or Modbus RTU) interfaces. CE+T strongly recommends incorporating TCP-based communications into your Energy Storage System (ESS).

The Modbus interface consists of a series of 16-bit holding registers each with its own unique Modbus address. Many registers are enforced as read-only and are dynamically updated by the PCS to present system status, alarm conditions and telemetry values. The remaining core registers control system configuration including modes of operation and power levels. These registers are both readable and writable. A limited set of registers are read-only and present static values such as firmware version or the unit serial number.

Before applying AC or DC high-voltage to the unit, IPWR highly recommends that parties responsible for initial evaluation first familiarize themselves with the Modbus interface while supplying only 24 Vdc to the Converter's auxiliary power input.

8.2 IP Address Setup

As noted above, the Modbus TCP interface is used to monitor and control the PCS. Other TCP services are also provided through the Ethernet link on the PCS Control Board. Detailing these services is beyond the scope of this Quick Start Guide. Out of the factory PCS is configured with a static IP address as follows:

Default IP Address	192.168.0.240
Default Subnet Mask	255.255.255.0
Default IP Gateway	192.168.0.1
Default DNS Server	192.168.0.1

The PCS LCD display will indicate its IP address if the unit is connected and communicating to a wired Ethernet network. If there is no wired Ethernet connection present the display will indicate "No Link". To establish initial communication with the PCS CE+T recommends the following procedure via a Windows laptop:

1. Locate the Network Connections Adapter Options window via the control panel
2. Via the wired Ethernet adapter change properties of the TCP/IPv4 component
3. Select the static IP option and set your laptop IP address to 192.168.0.241 with subnet mask 255.255.255.0. No gateway or DNS configuration should be necessary
4. Make a wired Ethernet connection directly between the laptop and PCS. Using the command prompt ping 192.168.0.240 to confirm TCP communications

IP addresses for this product are in IPv4 format represented as a Modbus string of 16 ASCII characters: 8 registers 2030-2037 are concatenated. A single register represents a pair of characters. The string is terminated with one or more null characters or zero bytes to fill the 16 characters. To change the IP address all 8 registers must be written then saved to flash by writing the value 7 to register 2000. New settings will take effect after the next system reset either with a command or by a power cycle. Setting the PCS IP to 0.0.0.0 will enable DHCP.

Example IP configuration: 192.168.1.7

Register:	2030	2031	2032	2033	2034	2035	2036	2037
Desired IP:	19	2.	16	8.	1.	7		
Hex Value:	3139	322E	3136	382E	312E	3700	0000	0000

Refer to the [Modbus Programmers Guide](#) for more detail on IP addressing.

8.3 Modbus Protocol Parameters

The primary Modbus protocol parameters default as follows and are user configurable.

Register Address	Name	Register Name	Type	Default	Default Value
2026	Modbus RTU Address	mb_adr_rtu	uint16 R/W	240	240
2027	Modbus TCP Address	mb_adr_tcp	uint16 R/W	240	240
2028	Modbus RTU Baud Rate	mb_baud	uint16 R/W	192	19200 bps
2029	Modbus RTU Parity	mb_parity	uint16 R/W	2	Even

In addition to the configurable Modbus parameters above, the following parameters for Modbus RTU/Modbus TCP are NOT configurable:

- Modbus RTU Data bits: 8
- Modbus RTU Stop bits: 2
- Modbus TCP port: 502

Presently, two Modbus function codes are supported: function code 3 to read holding registers and function code 6 to write a single holding register. Refer to the [Modbus Programmers Guide](#) for more detail on the Modbus protocol.

8.4 Application Specific Register Setup

The Modbus interface is used to establish minimum and maximum allowable DC2 and DC3 (30C3 model only) port voltages, port soft-power limits, PV start and PV stop times, non-standard AC over/under voltage limits, non-standard AC over/under frequency limits, and other key system parameters.

Thoroughly review the [Stabiliti User Modbus Register Map](#) to understand all PCS configuration options and ensure safe operation for your situation. This QuickStart Guide only provides a snapshot of pertinent registers for initial evaluation, there are over 250 Modbus registers available to the system operator.

All converters shipped from CE+T have AC1, DC2, and DC3 set to the IDLE Control Method (ports asleep) for safety purposes. They cannot transfer power until configured and/or commanded to do so via the Modbus interface. Such configurations are detailed later in this document.

The DC2 and DC3 maximum voltage limits and maximum current limits should be updated from the factory default and saved to flash to reflect your battery or PV array safe operating voltage ranges. The PCS will fault and go offline if a voltage limit is reached. The PCS will attempt to soft limit current flow if a current limit is reached, otherwise it will fault and go offline.

Register Address	Name	Register Name	Type	Default	Default Value
141	DC2 max voltage	p2_v_pn_max_limit	int16 R/W	1050	1050 Vdc
142	DC2 min voltage	p2_v_pn_min_limit	int16 R/W	80	80 Vdc
154	DC2 max current	p2_current_limit	int16 R/W	640	64 Adc
205	DC3 max voltage	p3_v_pn_max_limit	int16 R/W	1050	1050 Vdc
206	DC3 min voltage	p3_v_pn_min_limit	int16 R/W	80	80 Vdc
218	DC3 max current	p3_current_limit	int16 R/W	640	64 Adc

Table 1: Operational safety configuration Modbus registers

Once changed from factory defaults, your application-specific configuration options are not automatically saved to flash and will not persist after a system power-cycle. IPWR suggests that they be saved to flash by writing the value 3 to register 2000 to ensure that your revised operating limits remain intact if power is cycled or lost.

Caution: Be very conscious of all registers that are saved to flash different from their defaults. Registers, such as those dedicated to port Control Methods and their related setpoints will be dynamically controlled by your external system controller. These registers should typically not be saved to flash. This ensures that if AC power is disrupted, or a hard system reset occurs, the Converter will safely revert to its default IDLE operating state, ensuring no unplanned power transfer occur.

The Converter’s default AC over/under voltage limits, AC over/under frequency limits, AC Surge, and fault reconnect timers all comply with applicable UL 1741 SA and California Rule 21 standards. To retain full compliance with these grid safety standards, these registers should NOT be updated, without the review and approval of the local utility responsible for approving your grid interconnection. For support with other grid interconnect standards please contact tech.support@cetamerica.com

8.5 Scaling Factors

To represent values in logical Engineering Units, a scaling factor is utilized for many of the Modbus registers noted above. This has been done to limit the values written to and read from the Converter within the 16-bit range of 0-65535 for unsigned and -32768 to 32767 for signed values.

These scaling factors apply to read only telemetry registers, as well as read/write setpoint registers used to set desired output voltage, current, or power levels.

Type	Scaling Factor	Register Read/Write	Actual Value
AC / DC Port Voltage	1 unit = 1.0 V	480	480 Vac / 480 Vdc
Frequency	1 unit = 0.001 Hz	60000	60 Hz
DC Port Current	1 unit = 0.1 A	100	10.0 A
DC Port Power	1 unit = 10 W	1300	13000 W
AC Port Real Power	1 unit = 10 W	1400	14000 W
AC Port Reactive Power	1 unit = 10 var	700	7000 var
DC Port Current Ramp Rate	1 unit = 0.1 A per second	2000	200 A/second
AC/DC Port Power Ramp Rate	1 unit = 10 W per second	100	1000 W/second

Table 2: Modbus register scaling factors & examples

8.6 Power Flow Sign Convention

The 30C3 and 30C PCS use the following sign convention for power flows: positive power represents power being exported from the PCS while negative power represents power being imported into the PCS. This is summarized on a port-by-port basis in Table 3 below.

Port	Power/Current Sign	Meaning
AC1 Real Power	Positive	Exporting to grid
AC1 Real Power	Negative	Importing from grid
DC2 Battery Power	Positive	Exporting to battery (charge)
DC2 Battery Power	Negative	Importing from battery (discharge)
DC3 PV Power	Positive	N/A
DC3 PV Power	Negative	Importing from PV

Table 3: Power flow sign convention

8.7 Modbus Register Assignments

Register Address	Register Name	Type	Default	Comments
64	p1_port_type	uint16x R/W	0x0103	0x0103 – AC1 DELTA 3-Wire

Register Address	Register Name	Type	Default	Comments
65	p1_control_method	uint16x R/W	0x0000	0x0000 - IDLE 0x0001 - NET 0x0402 - GRID POWER (GPWR) 0x0502 - FACILITY POWER (FPWR)
68	p1_real_pwr_setpt	uint16 R/W	0	If p1_control_method = 0x0402 or 0x502: real power setpoint while voltage-following
71	p1_voltage_setpt	int16 RW	480 (480 V)	If p1_control_method = 0x502: line-to-line voltage setpoint for voltage-forming mode, otherwise unused.
72	p1_frequency_setpt	int16 RW	60000 (60 Hz)	If p1_control_method = 0x502: output frequency setpoint for voltage-forming mode, otherwise unused.
90	p1_current_limit	int16 RW	440	Soft Current Limit (port maximum is 44 A)
119	p1_real_power	int16 RO		AC1 real power

Table 4: AC1 basic Modbus registers

Register Address	Register Name	Type	Default	Comments
129	p2_control_method	uint16x R/W	0	0x0000 - IDLE 0x0001 - NET 0x0002 - MPPT 0x0301 - DC CURRENT 0x0401 - DC POWER
132	p2_current_setpt	int16 R/W	0	If p2_control_method = 0x0301: DC Current setpoint
133	p2_power_setpt	int16 R/W	0	If p2_control_method = 0x0401: DC Power setpoint
141	p2_v_pn_max_limit	int16 RW	1050	Maximum port DC operating voltage: for safety, set according to expected battery Vdc maximum
142	p2_v_pn_min_limit	int16 RW	80	Minimum port operating voltage: for safety, set to expected battery Vdc minimum on battery port.
152	p2_discharge_pwr_lim	int16 RW	-3200	DC2 discharge (import) soft power limit (maximum -32 kW)
153	p2_charge_pwr_lim	int16 RW	3200	DC2 charge (export) soft power limit (maximum 32 kW)
154	p2_current_limit	uint16 RW	620	DC2 soft current limit (maximum 60 A, absolute value)

Register Address	Register Name	Type	Default	Comments
173	p2_v_pn	int16 RO		DC2 voltage, positive to negative
185	p2_power	int16 RO		DC2 power
186	p2_current	int16 RO		DC2 current

Table 5: DC2 basic Modbus registers, used with a battery

Register Address	Register Name	Type	Default	Comments
193	p3_control_method	uint16x R/W	0	0x0000 - IDLE 0x0001 - NET 0x0002 - MPPT 0x0301 - DC CURRENT 0x0401 - DC POWER
199	p3_pv_start_tod_setpt	uint16 R/W	0	If p3_control_method = 0x0002: PV/MPPT start time in minutes from midnight (1 to 1440)
200	p3_pv_stop_tod_setpt	uint16 R/W	1440	If p3_control_method = 0x0002: PV/MPPT stop time in minutes from midnight (1 to 1440)
202	p3_pv_min_v_setpt	uint16 RW	100	If p3_control_method = 0x0002: PV Array Voc must exceed this minimum DC voltage to enable MPPT morning start
205	p3_v_pn_max_limit	int16 RW	1050	Maximum port DC operating voltage: set according to expected PV Vdc maximum
206	p3_v_pn_min_limit	int16 RW	80	Minimum port operating voltage: set to -50 Vdc to eliminate nuisance under-voltage faults for port configured to support PV
216	p3_discharge_pwr_lim	uint16 RW	-3200	DC3 soft discharge (export) power limit (maximum -32 kW)
218	p3_current_limit	uint16 RW	620	DC3 soft current limit (maximum 60 A, absolute value)
237	p3_v_pn	int16 RO		DC3 voltage, positive to negative
249	p3_power	int16 RO		DC3 power
250	p3_current	int16 RO		DC3 current

Table 6: DC3 basic Modbus registers, as used for a PV array

Register Address	Register Name	Type	Default	Comments
263	user_start	uint16x R/W	0	Manual Mode start, set to 1 to start
264	user_stop	uint16x R/W	0	Manual Mode stop, set to 1 to stop
267	sys_op_mode	uint16x R/W	0x0000	0 = operate in Manual Mode; 1 = operate in Automatic Mode
298	system_status	uint16x RO		b0 = 1 = Self-test mode b1 = 1 = Reconnect timer 0 countdown b2 = 1 = Reconnect timer 1 countdown b3 = 1 = Reconnect timer 2 countdown b4 = 1 = Precharge active b5 = 1 = Bad control method b6 = 1 = AC1 rotation error b7 = 1 = MPPT enabled based on voltage b8 = 1 = MPPT enabled based on time b9 = 1 = PPSA link converting power b10 = 1 = Shutdown active b11 = 1 = System lockdown b12-14 ≠ 0 = Abort active b15 = 1 = GFDI fault
438	system_info			b0 = 1 = Fault occurred since last reset b1 = 1 = Arc Fault Alarm b2 = 1 = GFDI faulting b3 = 1 = Self-test mode b4 = 1 = Self-test failure b5 = 1 = Shutdown b6 = 1 = PLL Locked b7 = 1 = System faulting b8 = 1 = IMI faulting (floating DC) b9 = 1 = System reconnecting b10 = 1 = PPSA link converting power b11 = 1 = Grid contactor Ack Fault b12 = 1 = Abort active b13 = 1 = Lockdown active b14 = 1 = Emergency stop shutdown b15 = 1 = Undervoltage shutdown
260-262	Timestamp Set	uint16 RW		Employs 32 bit Unix standard time as two lower and upper 16 bit registers. Write to both time set registers then write a 1 to the update register.

Register Address	Register Name	Type	Default	Comments
0-63	Fault Management Group			The use of fault monitoring and management registers is detailed in Application Note 303 .
40	Watchdog	int16 RW	0	Countdown value in seconds Reads -1 if countdown fault occurs; factory default = 0 = watchdog disabled
512- 699	Grid Interconnect Group			UL 1741 SA Smart Inverter features and grid interconnection standards configuration. Consult Operating Manual Appendix “UA”
2000	Command	uint16 RW		1=Reset; 3=Save (Reg <2000); 7=Save Settings (Reg >2000)
296	firmware_version	uint16 RO		Major FPGA FW version
297	build_version	uint16 RO		Minor FPGA FW version
2087	comms_version	uint16 RO		Major Comms FW version
2088	comms_build	uint16 RO		Minor Comms FW version
2001-2008	serial	string16 RO		PCS serial number: 8 registers concatenated, 2 ASCII characters per register

Table 7: Basic system operation Modbus registers

8.8 Fault Management & Watchdog Timer

IPWR strongly recommends the operator familiarize themselves with the Fault Management sub-system on the PCS by reading [Application Note 303: Fault Monitoring & Management with Stabiliti Series PCS](#), in particular the automatic reconnect feature of Automatic Mode. IPWR also recommends that the watchdog timer function be utilized in all production converters deployed by your company and also during lab evaluation if possible. The watchdog function at register 40 operates as follows: after a user writes a value in seconds to the register, the timer will count down and upon reaching zero the Converter will be automatically set to a faulted, offline state. This ensures that if a system controller or operator fault occurs, or a communications failure occurs between your system controller and the converter, the system will automatically idle itself after watchdog countdown. **The converter is shipped with the watchdog feature disabled.**

9. Power Flow Control Methods

There are numerous and flexible means to transfer power between PCS power ports using the Modbus interface. These port-specific operating modes are collectively known as “Control Methods” for power flow and include: MPPT, Grid Power (GPWR), Facility Power (FPWR), DC Power (POWER), DC Current (CURRENT), NET, and IDLE. There is a dedicated Control Method register to configure each individual port of the PCS.

NOTE: The PCS control system does not contain any built-in battery charge profiles or discharge algorithms for any battery types and does not communicate with any batteries directly. An external system controller must dictate battery charge & discharge levels in real-time with current or power commands according to your economic use-case of the overall Energy Storage System.

Each Control Method may have one or two associated setpoint registers to govern the real-time current or power flow within the bounds of the Control Method, as well as ramp rate register which specifies how fast to move from one setpoint level to a new setpoint target. The programmable ramp rate allows the PCS to smoothly ramp up or ramp down port power over a programmable time period ranging from tens of milliseconds to minutes. Power flows will be automatically limited according to the soft power limits and soft current limits.

The Control Methods supported in the Stabiliti Series PCS are listed below.

9.1 AC1 Available Control Methods

IDLE (0x0000)	Power conversion disabled, factory default
NET (0x0001)	Import/export remainder of power flow, grid-tied applications
GPWR (0x0402)	Grid-tied power transfer applications
FPWR (0x0502)	Interactive grid-forming/grid-following applications (requires external islanding switchgear to support transitions between voltage-following and voltage-forming mode)

9.2 DC2/DC3 Available Control Methods

IDLE (0x0000)	Power conversion disabled, factory default
NET (0x0001)	Import/export remainder of power flow
MPPT (0x0002)	Maximum power point tracking of solar PV array
DC A (0x0301)	Constant current import/export
DC PWR (0x0401)	Constant power import/export

9.3 Automatic Mode and Manual Mode

The PCS has two overall operating modes which are selected with register 267 `sys_op_mode`. In Manual Mode, power flow is only activated by writing 1 to the `user_start` register 263 as a command after valid Control Methods have been configured. Power flow is stopped either when a fault occurs or by writing a 1 to the `user_stop` register 264. Manual Mode is intended for a human operator in a laboratory or field service situation. In Automatic Mode, power flow is activated as soon as a valid set of Control Methods are written. Power flow is stopped by sequentially setting Control Methods to IDLE. As discussed below, the NET port is the most critical configuration and should be written first when starting up in Automatic Mode and Idled last when shutting down (Idling) the PCS. Manual Mode is intended for full deployment situations where an automatic controller is supervising the PCS.

9.4 Control Method Uses and Restrictions

9.4.1 IDLE Control Method (0x0000)

If a port is not in use it should be set to the IDLE Control Method to disable power flow into or out of that port. All Converters are shipped with IDLE as their factory default for safety purposes.

9.4.2 NET Control Method (0x0001)

To move power between 2 or 3 active ports, one and only one port on the PCS must ALWAYS be set to the NET Control Method. The NET method and port accommodates any remaining power flow necessary, whether import or export, to balance out other fixed or variable power flows on the remaining port(s) which are operating with other Control Methods. This way the power flows in and out of the PCS will always sum nominally to zero (neglecting efficiency losses). Refer to Figure 6 for an example with AC1 as NET and a variable PV resource. If a power or current limit is reached on a NET port, it will attempt to throttle or push back on another port. The throttling mechanism and configuration is beyond the scope of this document. Refer to the [Modbus Programmers Guide](#) for more information.

9.4.3 DC Power Control Method (0x0401)

The DC Power Control Method (POWER) is paired with a power setpoint register which uses a sign to indicate direction of DC2 or DC3 port power flow with a scaling factor of ten (10) Watts. The operator or system controller will write a value to the power setpoint register and the PCS will ramp power flow to that new requested level. The PCS will automatically adjust to changing battery voltage to maintain a constant power flow during extended steady-state operation.

9.4.4 DC Current Control Method (0x0301)

The DC Current Control Method (CURRENT) is paired with a current setpoint register which uses a sign to indicate direction of DC2 or DC3 port current flow with a scaling factor of 0.1 A. The operator or system controller will write a value to the current setpoint register and the PCS will ramp current flow to that new requested level. Current flow is maintained by the PCS independent of battery voltage unless a voltage limit is reached causing a fault.

9.4.5 MPPT Control Method (0x0002)

The Maximum Power Point Tracking Control Method (MPPT) is used only when a PV array is connected to DC3 (or DC2) to export the maximum available output of the array. This Control Method is paired with PV start and stop time configuration registers to enable operation on a time-basis or a minimum voltage configuration register to enable operation on that basis. Refer to power flow example below for more information on usage.

9.4.6 Grid Power Control Method (0x0402)

The Grid Power Control Method (GPOWER) commands the PCS to follow the utility voltage in a grid-tied mode. This Control Method is paired with real and reactive power setpoint registers which use a sign to indicate direction of DC2 or DC3 port power flow with a scaling factor of 10 Watts or 10 var. The operator or system controller will write a value to the power setpoint register and the PCS will ramp power flow to that new requested level. In this configuration, with factory defaults unchanged, the converter responds to all grid-fault conditions in a manner that is compliant with California Rule 21.

9.4.7 Facility Power Control Method (0x0502)

The Facility Power Control Method (FPOWER) is used for two (2) possible applications:

1. Interactive grid-following/grid-forming transfer applications: in this use-case external third-party islanding switchgear is incorporated into the system design to facilitate rapid and transfers between grid-following and grid-forming modes while also ensuring the PCS remains safe and never back-feeds the utility grid while in grid-forming mode. While in grid-following mode the PCS can be operated and will behave as with GPOWER.
2. Stand-alone grid-forming mode: this is sometimes described as a “free-standing” microgrid or nanogrid. No interaction with a utility-grid is enabled or allowed.

Refer to [Application Notes 503 and 504](#) for more information on FPOWER microgrid and rapid transfer applications with the Stabiliti PCS.

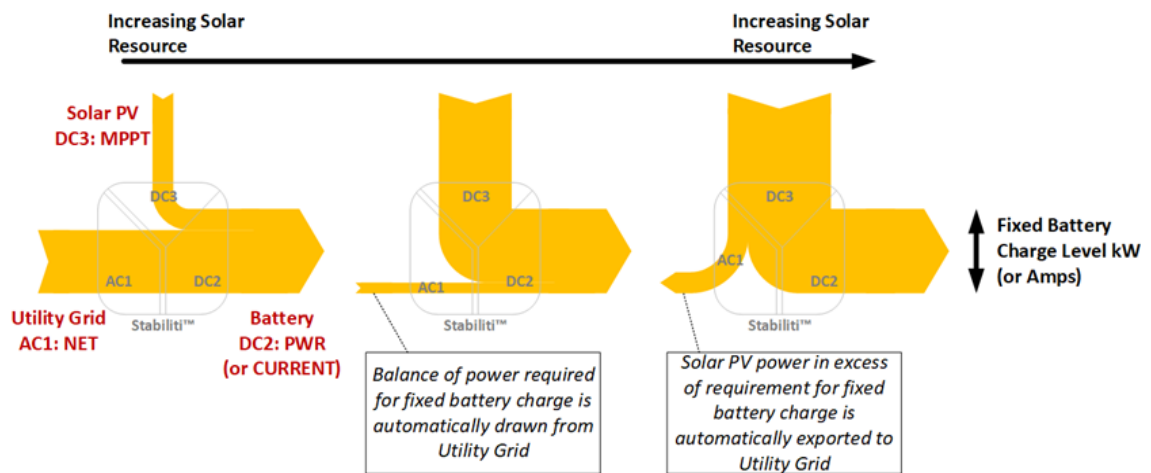


Figure 6: Three port power flow example with utility grid at AC1 as = NET

10. Initial Startup and Basic Commissioning

CE+T recommends the following set of initial commissioning tasks to validate your installation and PCS functionality before attempting to fully exercise the system.

Before energizing the grid, battery or PV connections to the PCS:

- **Torques:** confirm all wiring terminals are properly torqued.
- **Polarity:** confirm polarity of the battery and PV at their respective disconnect with a multimeter. Confirm wiring polarity through the disconnects to the PCS. Recall that the negative wire will be connected at the terminal labeled COM.
- **Voltage:** confirm with a multimeter that the battery and PV Voc are within the operating range of the PCS (maximum 1000 V) and that all hardware is rated appropriately as well.
- **Communications:** confirm ability to read and write data to the Modbus interface. Preferred with an external 24 Vdc power supply but alternatively with the grid supply.
- **Emergency stop and fault check:** Ensure the emergency stop connection is made before attempting to start-up the PCS. Refer to section 6, page 11 for more information. While the PCS is energized but not converting power, remove the emergency stop connection (ex. remove terminal plug) and confirm a fault is displayed. Use the Modbus interface to query the faults status. Return the connection and reset the fault via Modbus. Refer to [Application Note 303: Fault Monitoring & Management with Stabiliti Series PCS](#). Preferred with an external 24 Vdc power supply but alternatively with the grid supply ensuring user safety when disconnecting the emergency stop.
- **Precharge:** Start and stop a precharge of the PCS DC2 bus capacitors without connecting the battery. After stopping the precharge note the natural discharge time of the PCS capacitors. Refer to the stand-alone battery scenario example in section 11, page 30 for more information on setting up a precharge.

After energizing the 480 Vac grid supply but before energizing the battery or PV connections to the PCS:

- Perform an AC-only Power Factor Correction power test as described at the beginning of section 11, page 30. Confirm power, voltage, current telemetry data and system status information from the Modbus interface matches expectation.
- Check and record the phase rotation of the grid supply to the PCS terminals. Register 298 system_status bit 6 will be asserted to 1 if phase rotation is A-C-B and bit 6 will read 0 if phase rotation is A-B-C. If the application involves FPOWER grid forming, the PCS produces an A-B-C rotation and must therefore observe an A-B-C rotation on the native grid. Swap two phase cables into the PCS if necessary to align rotation.

After pre-charging the DC2 bus, energizing the battery and PV connections to the PCS:

- Confirm applicable voltage telemetry information from the Modbus interface matches expectation.

11. Power Flow Scenarios

The Stabiliti Series PCS has numerous options with regards to system configuration and power transfer options. Reviewing the following use cases will demonstrate the flexibility and capabilities of the 30C3 Multiport PCS. Note that only Manual Mode is employed in these examples assuming lab operation by the user.

The noted roles of DC2 and DC3 may be reversed in the scenarios below. Both DC power ports have the same Control Method capabilities although DC2 is intended for battery use due to its integral precharge circuit as noted previously.

11.1 AC-Only Power Factor Correction (Power recycling)

1. After physically installing the PCS as described earlier in this document, energize the 480 Vac grid supply to the PCS.
2. Connect to the Modbus interface and configure the following registers:
 - a. R65 p1_control_method = 0x0001 (NET)
 - b. R129 p2_control_method = 0x0000 (IDLE, factory default)
 - c. R193 p3_control_method = 0x0000 (IDLE, factory default)
 - d. R276 system_op_mode = 0 (Manual, factory default)
3. Write R263 user_start = 1 to enable power transfer
4. Notice while power transfer is enabled in this scenario that the Converter's reactive power is reduced resulting in a near-unity power factor compared with the default factory idle state. A few hundred watts of real power is drawn from the grid to perform the power factor correction.
 - a. R119 p1_real_power
 - b. R120 p1_reactive power
5. Notice the feedback state indicated by R298 system_status
6. Write R264 user_stop = 1 to disable power transfer

NOTE: this is not a normally useful operating scenario except for during initial product evaluation. It serves to demonstrate power conversion activation, without a battery connected and system feedback status and telemetry.

11.2 Stand-alone Battery Charge/Discharge on DC2

1. After physically installing the PCS as described earlier in this document, energize the 480 Vac grid supply. Do NOT yet close the connection between the battery and the PCS (DC disconnect switch or contactor).
2. Perform the DC2 PCS bus (capacitors) precharge
 - a. R276 precharge_hi_lim → current battery voltage +5 Vdc
 - b. R277 precharge_lo_lim → current battery voltage -5 Vdc
 - c. Write R275 precharge_control = 1 to enable the precharge circuit
 - d. Monitor DC2 voltage via R173 p2_v_pn until it is in the range of your battery and within the precharge limits set above
 - e. Close external battery contactors or DC disconnect switch to connect the battery and PCS buses with minimal DC voltage difference and minimal current inrush
 - f. Write R275 precharge_control = 2 to disable the precharge circuit

3. Configure the following registers:
 - a. Configure DC2 voltage limits and current limits according to your battery as described in section 8, page 18 Application Specific Register Setup.
 - b. R65 p1_control_method = 0x0001 (NET)
 - c. R129 p2_control_method = 0x0401 (POWER)
 - d. R193 p3_control_method = 0x0000 (IDLE)
 - e. R133 p2_power_setpt = 0
4. Enable power conversion and command power flows
 - a. Write R263 user_start = 1 to enable power transfer. The internal PPSA conversion link will begin operation but no appreciable power will be transferred since the power setpoint is zero.
 - b. Write R133 p2_power_setpt = 100 to command a 1 kW charge into the battery from the grid. The PCS will quickly ramp and maintain a 1 kW charge to the battery, from the grid.
 - c. Write R133 p2_power_setpt = -100 to command a 1 kW discharge from the battery to the grid. The PCS will quickly ramp and hold a 1 kW discharge.
 - d. As with other setpoints and other Control Methods R133 p2_power_setpt may be changed on-the-fly based on battery or site application requirements.
 - e. Observe telemetry feedback during power transfer cases.
 - i. R119 p1_real_power
 - ii. R185 p2_power
 - f. Write R264 user_stop = 1 to disable power transfer.

11.3 Stand-alone Solar PV export on DC3

1. After physically installing the PCS as described earlier in this document energize the 480 Vac grid supply to the PCS and also energize the PV connection to the PCS.
2. Connect to the Modbus interface and configure the following registers:
 - a. Configure DC3 voltage limits and current limits according to your PV array as described in section 8, page 18 Application Specific Register Setup.
 - b. R65 p1_control_method = 0x0001 (NET)
 - c. R129 p2_control_method = 0x0000 (IDLE)
 - d. R193 p3_control_method = 0x0002 (MPPT)
 - e. R199 p3_pv_start_tod_setpt = 0 (midnight, for evaluation purposes)
 - f. R200 p3_pv_stop_tod_setpt = 1440 (midnight, for evaluation purposes)
 - g. R202 p3_pv_min_v_setpt → According to the minimum level of your array
 - h. R206 p3_v_pn_min_limit = -50 (to be functionally superseded by R202, see table)
3. Enable power conversion
 - a. Write R263 user_start = 1 to enable power transfer. The internal PPSA conversion link will begin operation and PV export to the grid will ramp up to the maximum power point of the array.

- b. Observe telemetry feedback during power transfer cases
 - i. R119 p1_real_power
 - ii. R249 p3_power
- c. Write R264 user_stop = 1 to disable power transfer

The PV time of day registers p3_pv_start_tod_setpoint and p3_pv_stop_tod_setpoint define when the MPPT Control Method is enabled on a time basis. Start/stop values in the range of 0 to 1440 reflect the use of an internal “minute clock”, where 0 corresponds to midnight. For example, programming 450 in the start register reflects a start time of 7:30 AM. Register system_status bit 8 will be flagged when MPPT is active based on the time of the day.

Additionally, a minimum operating PV voltage can be set at register 202 p3_pv_min_v_setpt which will set the threshold for MPPT deactivation. Register system_status bit 7 will be flagged when MPPT is active based on the voltage. Correspondingly set p3_v_pn_min_limit = -20 Vdc to minimize nuisance trips of the converter separate from the minimum activation threshold. The MPPT will attempt to restart the PV every five (5) minutes by default after deactivating on the minimum activation threshold. IPWR recommends usage of both time and voltage thresholds when operating PV systems with the 30C3 PCS.

11.4 PV + Battery Sum for Grid Export: Battery on DC2, PV Array on DC3

This is an example of PV firming and demand charge management battery discharging. The export to the grid will be held firm irrespective of the available PV resource.

1. After physically installing the PCS as described earlier in this document energize the 480 Vac grid supply to the PCS and also energize the PV connection to the PCS.
2. Connect to the Modbus interface and perform the DC2 PCS bus precharge sequence as described above in the stand-alone battery example, then electrically connect the battery to the PCS.
3. Connect to the Modbus interface and configure DC2 and DC3 voltage limits and current limits according to your battery and PV array as described in section 8, page 18 Application Specific Register Setup.
4. Connect to the Modbus interface and configure the following registers
 - a. R129 p2_control_method = 0x0001 (NET)
 - b. R65 p1_control_method = 0x0402 (GPWR)
 - c. R193 p3_control_method = 0x0002 (MPPT)
 - d. R68 p1_real_pwr_setpt = 0
 - e. R199 p3_pv_start_tod_setpt = 0 (midnight, for evaluation purposes)
 - f. R200 p3_pv_stop_tod_setpt = 1440 (midnight, for evaluation purposes)
5. Enable power conversion
 - a. Write R263 user_start = 1 to enable power transfer. The internal PPSA conversion link will begin operation and PV export to the battery will ramp up to the maximum power point of the array.
 - b. Write R68 p1_real_pwr_setpt = 500 to ramp to a fixed 5kW AC export to the utility grid. Note that this scenario is most illustrative if the AC power export level is fixed and the PV power varies around the AC power level.
 - c. Observe telemetry feedback during power transfer cases. Observe that while the PV power varies, the AC power exported is constant and the power flow to/from the battery varies as the difference between the PV and the grid export. The battery will charge if PV > p1_real_pwr_setpt and the battery will discharge if PV < p1_real_pwr_setpt, always making up the difference in the power flow.
 - i. R119 p1_real_power

- ii. R185 p2_power
- iii. R249 p3_power
- d. As with other setpoints and other Control Methods R68 p1_real_pwr_setpt may be changed on-the-fly based on battery or site application requirements.
- e. Write R264 user_stop = 1 to disable power transfer.

11.5 Battery Charging from PV and/or Grid: Battery on DC2, PV Array on DC3

This is an example of “battery friendly” steady rate charging. Refer to Figure 6.

1. After physically installing the PCS as described earlier in this document energize the 480 Vac grid supply to the PCS and also energize the PV connection to the PCS.
2. Connect to the Modbus interface and perform the DC2 PCS bus precharge sequence as described above in the stand-alone battery example, then connect the battery to the PCS.
3. Connect to the Modbus interface and configure DC2 and DC3 voltage limits and current limits according to your battery and PV array as described in section 8, page 18 Application Specific Register Setup.
4. Connect to the Modbus interface and configure the following registers:
 - a. R65 p1_control_method = 0x0001 (NET)
 - b. R129 p2_control_method = 0x0401 (POWER)
 - c. R193 p3_control_method = 0x0002 (MPPT)
 - d. R133 p2_power_setpt = 0
 - e. R199 p3_pv_start_tod_setpt = 0 (midnight, for evaluation purposes)
 - f. R200 p3_pv_stop_tod_setpt = 1440 (midnight, for evaluation purposes)
5. Enable power conversion
 - a. Write R263 user_start = 1 to enable power transfer. The internal PPSA conversion link will begin operation and PV export to the grid will ramp up to the maximum power point of the array.
 - b. Write R133 p2_power_setpt = 300 to ramp to a fixed 3 kW battery charge (PCS export). Note that this scenario is most illustrative if the battery charge power level is fixed and the PV power varies around the charge power level.
 - c. Observe telemetry feedback during power transfer cases. Observe that while the PV power varies, the battery charge power is constant and the power flow to/from the grid varies as the difference between the PV and the battery charge. There will be grid export if $PV > p2_power_setpt$ and there will be grid import if $PV < p2_power_setpt$, the grid will always make up the difference in the power flow.
 - i. R119 p1_real_power
 - ii. R185 p2_power
 - iii. R249 p3_power
 - d. Write R264 user_stop = 1 to disable power transfer

NOTE: The DC Constant Current Control Method (CURRENT) along with R132 p2_current_setpt may be an appropriate substitute for the POWER Method when applied to the DC2 Port.

11.6 AC Standalone Battery-Supported Microgrid

This is an example of a battery supplying power as demanded in real time to support and hold an AC microgrid output at 480 Vac, despite variations in load.

1. After physically installing the PCS as described earlier in this document disconnect and isolate the PCS from the 480 Vac grid supply.
2. Connect a variable AC load bank to AC1 either directly or via a distribution panel. Set to a low initial power level.
3. Use a 500 Vdc (or higher) battery connected to DC2 with sufficient capacity to support the load bank.
4. Supply 24 Vdc external power to the PCS to enable communications and setup.
5. Connect to the Modbus interface and perform the DC2 PCS bus precharge sequence as described above in the stand-alone battery example, then electrically connect the battery to the PCS.
6. Connect to the Modbus interface and configure DC2 voltage limits and current limits according to your battery as described in section 8, page 18 Application Specific Register Setup.
7. Connect to the Modbus interface and configure the following registers:
 - a. R193 p3_control_method = 0x0000 (IDLE)
 - b. R129 p2_control_method = 0x0001 (NET)
 - c. R65 p1_control_method = 0x0502 (FPWR)
 - d. R71 p1_voltage_setpt = 480 (480 Vac line-to-line)
 - e. R72 p1_frequency_setpt = 60000 (60 Hz)
 - f. R95 p1_fpwr_island_detection = 0 (stand-alone microgrid without grid transfers)
8. Enable power conversion. Use caution when forming a microgrid!
 - a. Write R263 user_start = 1 to enable power transfer. The internal PPSA conversion link will begin operation and rapidly ramp up the AC voltage on its AC1 output terminals thereby performing a blackstart of the microgrid with the load bank. It will immediately support the initial load and draw down on the battery accordingly.
 - b. Vary the AC load bank level and observe telemetry feedback during power transfer cases.
 - i. R119 p1_real_power
 - ii. R109 p1_v_ab_ext_rms
 - iii. R110 p1_v_bc_ext_rms
 - iv. R111 p1_v_ca_ext_rms
 - v. R185 p2_power
 - c. Write R264 user_stop = 1 to disable power transfer and shut down the microgrid.



12. Labview Modbus Tool

Upon request, IPWR can provide a simple Modbus LabView application (“Modbus Tool”) for evaluating the PCS. The application runs on all modern versions of Windows and is delivered as a software executable via a Dropbox account that IPWR will set up on your behalf.

The Modbus Tool allows the evaluator the ability to manually set default system configurations, program operating modes, and monitor PCS telemetry. Comprehensive fault status and fault management is also supported.

Please note that a secure ethernet network connection at the site is a mandatory requirement for meeting our warranty requirements and providing quality technical support.

For additional questions, please contact:

tech.support@cetamerica.com

<https://www.cet-america.com>

[300 Shawnee North Drive, Suite 700, Suwanee-Atlanta, 30024 Georgia](#)

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