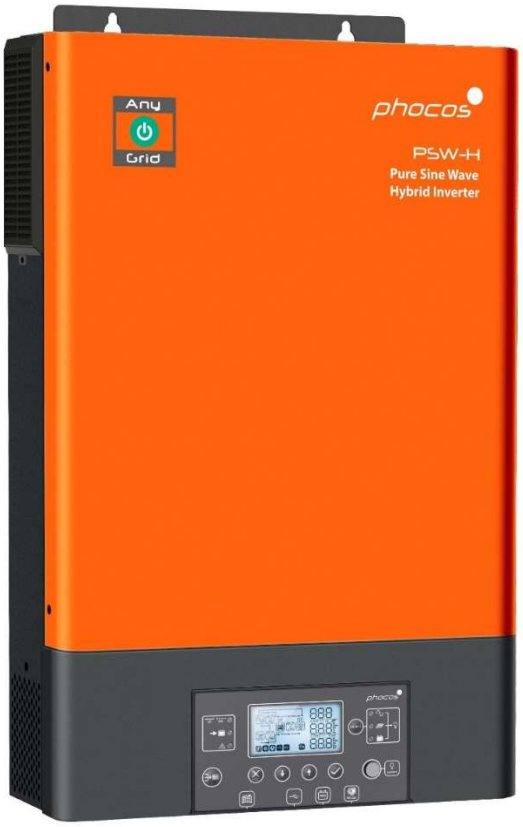
Phocos Any-Grid™ series

Pure Sine Wave Hybrid Inverter Charger with
MPPT Solar Charge Controller

PSW-H-5kW-230/48V
PSW-H-3kW-230/24V
PSW-H-5kW-120/48V
PSW-H-3kW-120/24V

RS-232 Protocol Description to Query Current Values



Contents

1.0 Introduction

This protocol description specifies the physical RS-232 interface to the Any-Grid PSW-H series of hybrid inverter chargers with MPPT solar charge controller, as well as the protocol and commands used to query the device. This serves to query the current measured values of the Any-Grid unit for use in industrial systems, data logging, etc.

2.0 Important Safety Information

WARNING: The installation of this unit may only be undertaken by qualified personnel with appropriate training. This document assumes the operator / installer has read and followed the "User and Installation Manual" shipped with every unit and available at www.phocos.com.
High voltages in and around the unit can cause serious injury or death. This unit must be installed in accordance with rules and regulations at the site of installation. While no high voltages are present on the contacts of the RS-232 port, it is important to work on a unit where no dangerous voltage-bearing components or terminals can be touched by the operator /installer by accident.
***This means all safety covers must be and remain installed while communicating with the unit for your own safety*.**

CAUTION: Using any cable other than the RS-232 cable (SUB-D to RJ-45) included with every unit may cause damage to the Any-Grid unit not covered under warranty. Up to 15 Vdc are present on some pins that will destroy the display unit and possibly further parts of the Any-Grid if short-circuited towards ground.

3.0 Overview

3.1 Product Overview

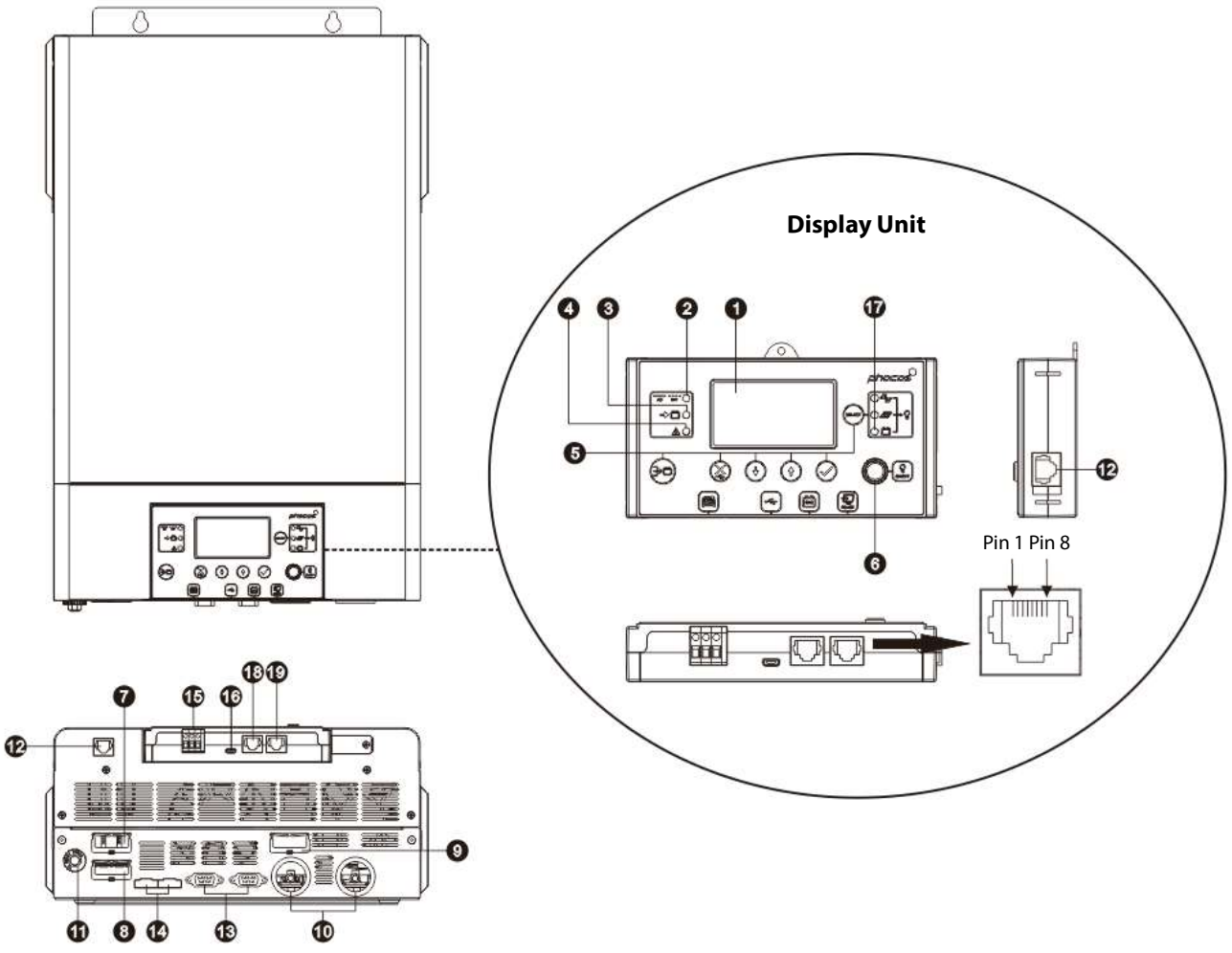


Fig. 1: Product Overview

1. LC-display
2. Inverter status indicator
3. Charging indicator
4. Fault indicator
5. Function buttons
6. AC output on/off switch (solar charging still functions when the AC output is powered off)
7. AC input terminals (public grid or AC generator connection)
8. AC output terminals (load connection)
9. PV terminals
10. Battery terminals
11. Resettable circuit breaker
12. Remote display unit communication port
13. Parallel communication port (for inter-connecting multiple Any-Grid units)
14. Current sharing port (for inter-connecting multiple Any-Grid units)
15. Relay contact
16. USB-OTG communication port
17. Output source indicators and USB function indicators
18. Battery Management System (BMS) communication port
19. **RS-232 communication port**

3.2 RS-232 Cable Pin Definition

The included RS-232 cable (SUB-D to RJ-45), referred to herein as "RS-232 cable" has the following pin definition:

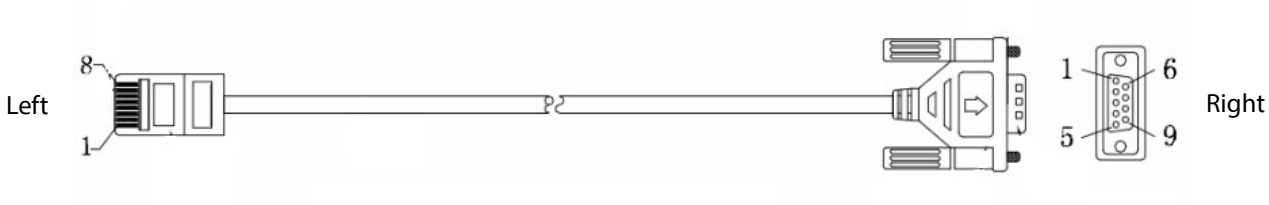


Fig. 2: RS-232 cable pin definition

Pins "Left"	Wire Color	Pins "Right"	Function
1	White & orange	2	Transmit (TXD)
2	Blue	3	Receive (RXD)
8	White & green	5	Ground (GND)

4.0 Installation

4.1 Prerequisites

The RS-232 communication with the Any-Grid unit is possible with any computer, PLC or microcontroller that supports RS-232, referred to herein as "host".

WARNING: Be careful not to use hosts that only support UART / USART as these use TTL (positive-only) voltages for communication. RS-232 is bi-polar and works with both positive and negative voltages up to ± 15 Vdc. Use on a host with only TTL voltage capability is likely to cause damage.

If the host has a standard SUB-D socket for RS-232, it may be used directly with the RS-232 cable. Alternatively, a USB

to RS-232 converter may be used if the host only has USB ports available. These converters are available at virtually any computer store. Be sure to install the drivers (if necessary) for your operating system. The remainder of this document assumes the RS-232 port on the host is functioning correctly.

To continue, choose a serial terminal for your operating system or communicate with the Any-Grid via any programming language that supports RS-232 communication. When using a terminal, ensure that it is capable of sending both ASCII characters and raw data / bytes in the same command. An example is HTerm, available for both Windows and Linux at **www.der-hammer.info/pages/terminal.html**. *Phocos is not affiliated with HTerm, nor responsible for external internet links or the HTerm software.*

Next, configure the RS-232 port as follows in the serial terminal or your programming language:

Baud Rate	Start Bit	Data Bit	Parity Bit	Stop Bit
2400	1	8	N	1

4.2 Connecting to the Any-Grid

Plug the left end of the RS-232 cable (**Fig. 2**) into the RS-232 port on the Any-Grid unit (**Fig. 1** → ⓳). Plug right end of the RS-232 cable (**Fig. 2**) into the host.

5.0 Querying the Any-Grid

For querying the Any-Grid unit a single command is required. The response to this command contains all relevant real-time values measured by the Any-Grid and can be used for datalogging. It is recommended to query the unit no more than once a second.

5.1 QPGSn Command

The command to be sent from the host via RS-232 to the Any-Grid is as follows for a single Any-Grid:

```
QPGS0<CRC><cr>
```

Where:

- <CRC> = Two raw bytes equivalent to 3FDA in hex or 0011 1111 1101 1010 in binary. If you wish to calculate the CRC yourself, see chapter 5.2.
- <cr> = Carriage-return ASCII character

Note: The command is QPGS0 (ending with zero), not QPGSO (ending with a capital o).

The Any-Grid will respond as follows:

```
(A BBBBBBBBBBBBB C DD EEE.E FF.FF GGG.G HH.HH IIII JJJJ KKK LL.L MMM NNN
OOO.O PPP QQQQQ RRRRR SSS b7b6b5b4b3b2b1b0 T U VVV WWW XX YY.Y ZZZ<CRC><cr>
```

The fields are separated / delimited by spaces and the number of letters between spaces indicates the length of each data field. The various fields have the following meanings:

Position	Description	Notes
(	Start byte	
A	Other Any-Grid units connected	Integer 0 = A single unit is connected (settings menu 28 set to "SIG") 1 = Multi-unit system with more than one unit (settings menu 28 not set to "SIG")
BBBBBBBBBBBBB	Serial number	Integer

C	Operation mode	Alphabetic letter P = Powered on S = Stand-By mode L = Grid / Line mode B = Off-grid / Battery mode F = Fault mode D = Shutdown mode
DD	Fault code	Integer 01 = Fan locked while inverter off 02 = Over-temperature 03 = Battery voltage too high 04 = Battery voltage too low 05 = AC output short-circuit 06 = AC output voltage too high 07 = AC output overload 08 = Internal bus voltage too high 09 = Internal bus soft-start failed 10 = PV over-current 11 = PV over-voltage 12 = Internal DC converter over-current 13 = Battery discharge over-current 51 = Over-current 52 = Internal bus voltage too low 53 = Inverter soft-start failed 55 = DC over-voltage at AC output 57 = Current sensor failed 58 = AC Output voltage too low 60 = Reverse-current protection active 71 = Firmware version inconsistent 72 = Current sharing fault 80 = CAN communication fault 81 = Host loss 82 = Synchronization loss 83 = Battery voltage detected inconsistent 84 = AC in. voltage/frequency inconsistent 85 = AC output current imbalance 86 = AC output mode inconsistent
EEE.E	AC input voltage	Decimal number in Vac
FF.FF	AC input frequency	Decimal number in Hz
GGG.G	AC output voltage	Decimal number in Vac
HH.HH	AC output frequency	Decimal number in Hz
IIII	AC output apparent power	Integer in VA
JJJJ	AC output active power	Integer in W
KKK	Percentage of nominal output power	Integer in %
LL.L	Battery voltage	Decimal number in Vdc
MMM	Battery charging current	Integer in Adc
NNN	Battery state of charge (approx..)	Integer in %
OOO.O	PV input voltage	Decimal number in Vdc
PPP	Total charging current*	Integer in Adc
QQQQQ	Total AC output apparent power*	Integer in VA
RRRRR	Total output active power*	Integer in W
SSS	Total percentage of nominal output power*	Integer in %

b7b6b5b4b3b2b1b0	Inverter status	Each character may be an integer between 0 and 3 as shown: b7 = MPPT, 1: active, 0: inactive b6 = AC charging, 1: on, 0: off b5 = Solar charging, 1: on, 0: off b4b3 = 03: Battery charging and discharging disabled by battery attached to BMS port of unit 02: Battery disconnected 01: Battery voltage low 00: Battery voltage normal b2 = AC input, 1: not available, 0: available b1 = AC output, 1: on, 0: off b0 = Reserved
T	AC output mode	Integer 0 = Single Any-Grid unit 1 = Parallel output 2 = Phase 1 of 3-phase output 3 = Phase 2 of 3-phase output 4 = Phase 3 of 3-phase output
U	Battery charger source priority	Integer 1 = Solar first 2 = Solar and Utility 3 = Solar only
VVV	Max. charging current set	Integer in Adc
WWW	Max. charging current possible	Integer in Adc
XX	Max. AC charging current set	Integer in Adc
YY.Y	PV input current	Decimal number in Adc
ZZZ	Battery discharge current	Integer in Adc

* "Total" values represent the sum of the field value for all inter-connected Any-Grid units.

If more than one Any-Grids are being used in parallel, 3-phase or split-phase mode and are connected by their parallel communication cables, each further unit can be queried individually. As up to 9 units can be synchronized, the first unit can be queried with QPGS0 as mentioned above. The remaining units can be queried through the same RS-232 interface (all data is routed to the same RS-232 port the host is connected to) and the same methods as follows:

Unit number	**Command**	**CRC**	**End-of-line**
Currently connected unit	QPGS0	3FDA	<cr>
1	QPGS1	2FFB	<cr>
2	QPGS2	1F98	<cr>
3	QPGS3	0FB9	<cr>
4	QPGS4	7F5E	<cr>
5	QPGS5	6F7F	<cr>
6	QPGS6	5F1C	<cr>
7	QPGS7	4F3D	<cr>
8	QPGS8	BED2	<cr>
9	QPGS9	AEF3	<cr>

Keep in mind that the unit number order may change if using multiple Any-Grids and they are restarted. For this reason, it is advisable to tie the collected data to the serial number, rather than the unit number for datalogging purposes. If the serial number is composed of zeroes, this indicates that this particular unit does not exist. For example, in a 3-unit system, `QPGS4` through `QPGS9` will return zeroes as the serial number (and most other values).

5.2 Cyclic Redundancy Check (CRC) calculation

If you wish to implement the 16-bit CRC calculation method to either send the QPGSn command (the pre-calculated CRCs for that are already shared in the chapter "**QPGSn Command**", so this is not necessary) or to check the Any-Grid response for integrity, please find the corresponding C code function below:

```
word calculateCRC(byte *pos, byte len)
{
    word crc = 0;
    byte data;
    byte crcHigh;
    byte crcLow;
    const word crcTable[16] =
    {
        0x0000, 0x1021, 0x2042, 0x3063, 0x4084, 0x50a5, 0x60c6, 0x70e7,
        0x8108, 0x9129, 0xa14a, 0xb16b, 0xc18c, 0xd1ad, 0xe1ce, 0xf1ef
    };
    while (len-- > 0)
    {
        data = ((byte)(crc >> 8)) >> 4;
        crc <<= 4;
        crc ^= crcTable[data^(*pos >> 4)];
        data = ((byte)(crc >> 8)) >> 4;
        crc <<= 4;
        crc ^= crcTable[data^(*pos & 0x0f)];
        pos++;
    }
    crcLow = crc;
    crcHigh = (byte)(crc >> 8);
    if (crcLow == 0x28 || crcLow == 0x0d || crcLow == 0x0a)
    {
        crcLow++;
    }
    if (crcHigh == 0x28 || crcHigh == 0x0d || crcHigh == 0x0a)
    {
        crcHigh++;
    }
    crc = ((word)crcHigh) << 8;
    crc += crcLow;
    return crc;
}
```

6.0 Liability Exclusion

The manufacturer shall not be liable for damages, especially on the battery, caused by use other than as intended or as mentioned in this document or if the recommendations of the battery manufacturer are neglected. The manufacturer shall not be liable if there has been service or repair carried out by any unauthorized person, unusual use, wrong installation, or incorrect system design.

Specifications are subject to change without notice.

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