xStorage Compact
Customer Modbus TCP mapping

Powering Business Worldwide

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Content overview

1. Introduction

Before you start

Technical disclaimer

All drawings, descriptions or illustrations contained in this document serve to provide a clear overview and / or technical explanation of the presented product and its various components and accessories. In line with our goal to continuously improve the products and customer service we provide, all specifications contained in this document are subject to change without notice.

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1.1 Revision history

Modbus map version	Release date	Comments
1.6.6	04.2023	Initial documentation release

1.2 The scope of this document

This document provides Modbus TCP address mapping with a brief explanation of each register. It also describes the basic concepts of Eaton's implementation of the Modbus TCP API but does not detail the functional aspects of the product, focusing solely on register mapping and functions provided via Modbus TCP over Ethernet.

More information about the product itself including installation and operation, can be found in the corresponding technical documentation available from the product page at www.eaton.com/xstorage

1.3 Conventions used in this document

Table 1. Abbreviations

Term	Description
AC, XV	Eaton XV303 application controller
ADU	Application data unit
API	Application programming interface
BESS	Battery energy storage system
BMS	Battery management system
CAN	Controller area network (CAN network)
EMS	Energy management system
FC	Function code
FW	Firmware
HMI	Human-machine interface
LSB	Least significant bit (or byte, depending on the context)
MGE	Maximum grid export (grid injection)
MGI	Maximum grid import (grid consumption)
MSB	Most significant bit (or byte, depending on the context)
PCS	Power conversion system (bi-directional power inverter)
PDU	Protocol data unit
PF	Power factor
PLC	Programmable logic controller
PM	Power meter
SC, XC	Eaton XC303 system controller
TCP/IP	Transmission control protocol/internet protocol

Table 2. Sign conventions

Asset	Positive value	Negative value
Grid	Power consumed from the distribution grid	Power injected into the distribution grid
PCS	Power consumed by the BESS (measured on X11)	Power consumed from the BESS (measured on X11)
Batteries	Batteries being charged	Batteries being discharged
PV inverter	PV array producing electricity	--
Back-up	Power consumption on the X13 connector	--
Power factor	Leading PF, voltage lags behind the current	Lagging PF, current lags behind the voltage
Reactive power	Over-excited	Under-excited

Table 3. Glossary of terms

Acronym / Abbreviation	Negative value
Bank	A battery bank comprised of a set of battery strings available to the system.
Pack	A battery pack. Up to ten battery packs can fit in a standard IT rack.
Pool	A group of xStorage units connected in parallel, ready to be controlled via the Main XV303 AC. An xStorage Compact unit can participate in an energy pool depending on some specific prerequisites (is the unit available? Is it in fault or service mode?)
String	Battery string is made of five battery packs connected in series.
System	Complete installation with up to five connected xStorage Compact units.
X11	Input side of the PCS (connected to the grid)
X13	Output side of the PCS (connected to essential loads)

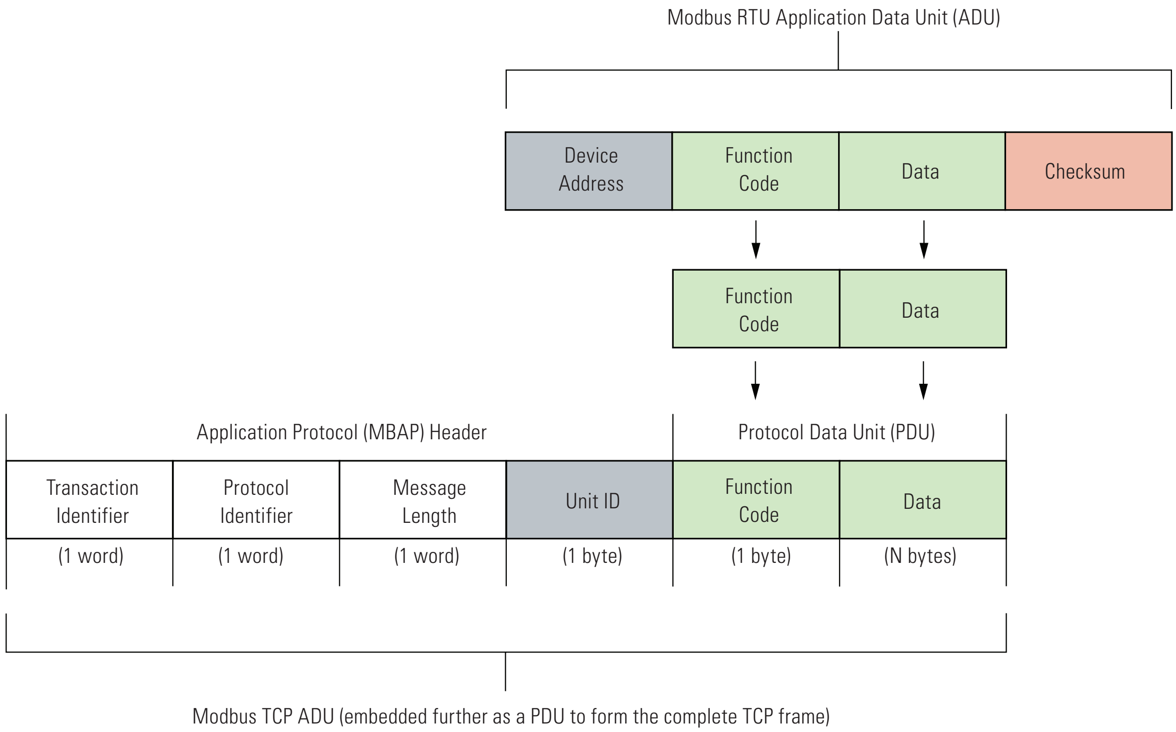
2. Implementation details

xStorage Compact energy storage unit is a device that relies on various components and functional blocks to control and monitor its operating parameters. This section describes some basic concepts needed to understand the specifics of the Modbus TCP implementation and register mapping scheme.

2.1 Modbus TCP/IP data format

Standard Modbus TCP/IP implementation retains the structure of the serial Modbus RTU data packet but with a few exceptions. The Unit ID field becomes the last field of the Modbus TCP server IP address. The same field is also repeated in the Modbus Application Protocol (MBAP) header. The CRC checksum is removed from the Modbus RTU data packet, as Ethernet already features a mechanism to ensure data integrity. Figure 1 illustrates the conversion of the Modbus RTU data packet (Modbus RTU Application Data Unit, or ADU) to Modbus TCP/IP ADU.

Figure 1. Construction of a Modbus TCP data packet



An example of the request/response Modbus TCP ADU is provided in Table 4. In this example, a Modbus TCP client sends a read request (FC0x04) for two adjacent registers, starting at address 0x0008 (0x0008 and 0x0009). A server (XV303 AC in this case) responds with the corresponding values (0x0120, 0x0055), as illustrated in Table 4.

Table 4. Modbus TCP/IP request and response example (FC 0x04)

Request		Response	
Data	**Field name**	**Data**	**Field name**
0x01	Transaction identifier (0x0102)	0x01	Transaction identifier (0x0102)
0x02		0x02	
0x00	**Protocol identifier (0x0000)**	**0x00**	**Protocol identifier (0x0000)**
0x00		**0x00**	
0x00	Message length, including Unit ID (0x06)	0x00	Message length, including Unit ID (0x07)
0x06		0x07	
0x00	**Unit ID (0x00)**	**0x00**	**Unit ID (0x00)**
0x04	Function code (0x04)	0x04	Function code (0x04)
0x00	Address of the first register (0x0008)	0x04	Number of bytes in response (0x04)
0x08		0x01	Value of the register 0x0008 (0x0120)
0x00	Total number of registers to read (0x02)	0x20	
0x02		0x00	Value of the register 0x0009 (0x0055)
--	--	0x55	

Some fields of the MBAP header are reserved and typically not used. If you develop your own Modbus TCP/IP implementation on the client side, be sure to clear both the Protocol Identifier and the Unit ID fields in the MBAP header (value = 0x00), as those fields are not used in the standard Modbus TCP implementation. If needed, the Unit ID field can also be set to 0xFF.

This document, however, provides vastly simplified request and response examples, showing only the Modbus Data fields.

2.1.1 Protocol implementation specifics

Unlike typical Modbus TCP/IP implementations where packets are exchanged over a single TCP port (502), the Modbus TCP/IP protocol implemented in xStorage Compact uses three different TCP ports for accessing each group of registers. Register address enumeration is restarted at each TCP port from address 0001. Refer to Table 5 for details.

Table 5. TCP ports summary

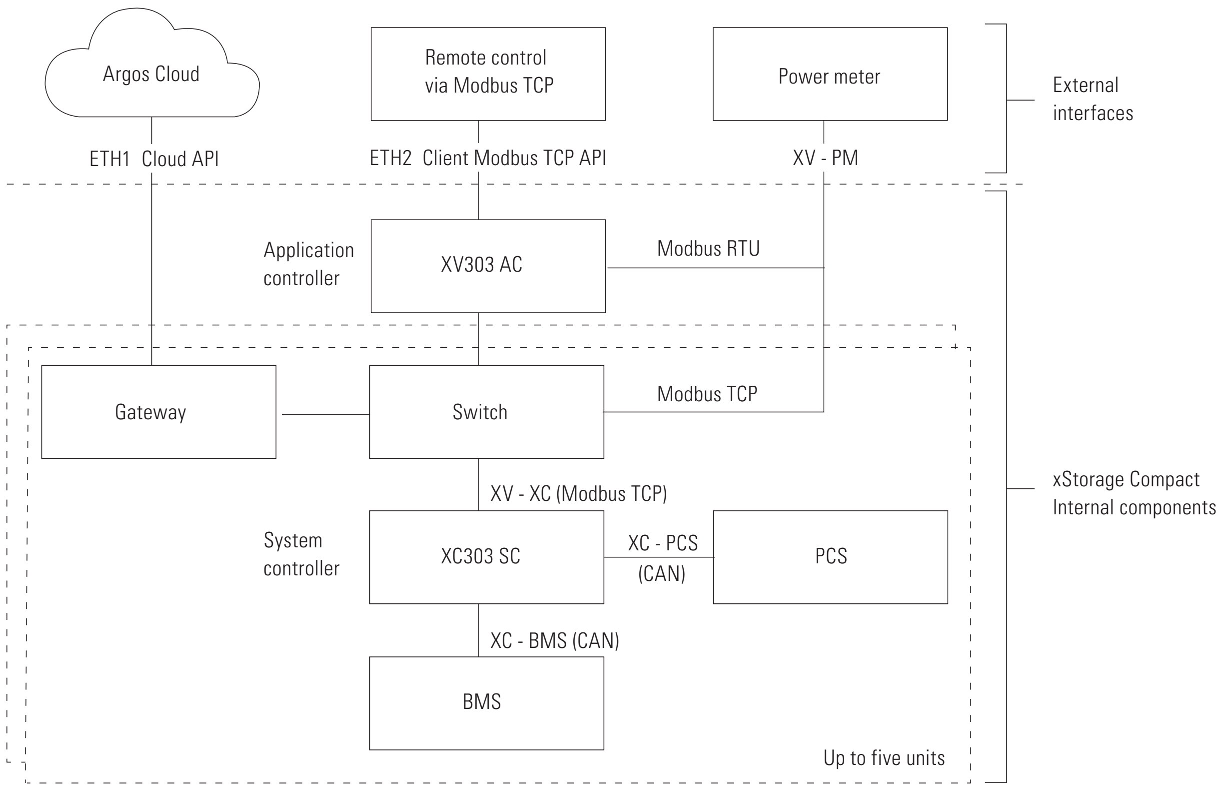
Register group	TCP Port	Notes and description
Monitoring		
System-wide registers	510	Used to monitor system summary values and PCS details
PCS-specific registers		Supported Function Codes (FC): 0x04 (Read Input Registers)
Power Meters	516	Used to read data from compatible power meters. The XV303 controller employs internal address remapping, allowing universal access to all compatible PMs
		Supported function codes (FC): 0x04 (Read Input Registers)
Control		
System-wide registers Timer0 (scheduler) settings	520	Used to write data to system control registers and Timer0 settings
		Supported function codes (FC): 0x10 (Write Multiple Registers)

2.2 Internal communication flow and available interfaces

The diagram in Figure 2 illustrates the connection topology of a single xStorage Compact unit. The XV303 application controller provides general control of the system, as well as the implementation of intelligent operating modes and user command interfaces. However, it does not directly control the entire system; it relies on other function blocks, such as the XC303 system controller, which directly manages some specific low-level functions, such as the battery management and the power conversion systems.

The XV303 AC exposes a Modbus TCP/IP interface, enabling an external (client) application to access the operating parameters via Ethernet. Modbus TCP/IP can be accessed via the ETH2 connector on the front panel of the unit.

Figure 2. Communication topology

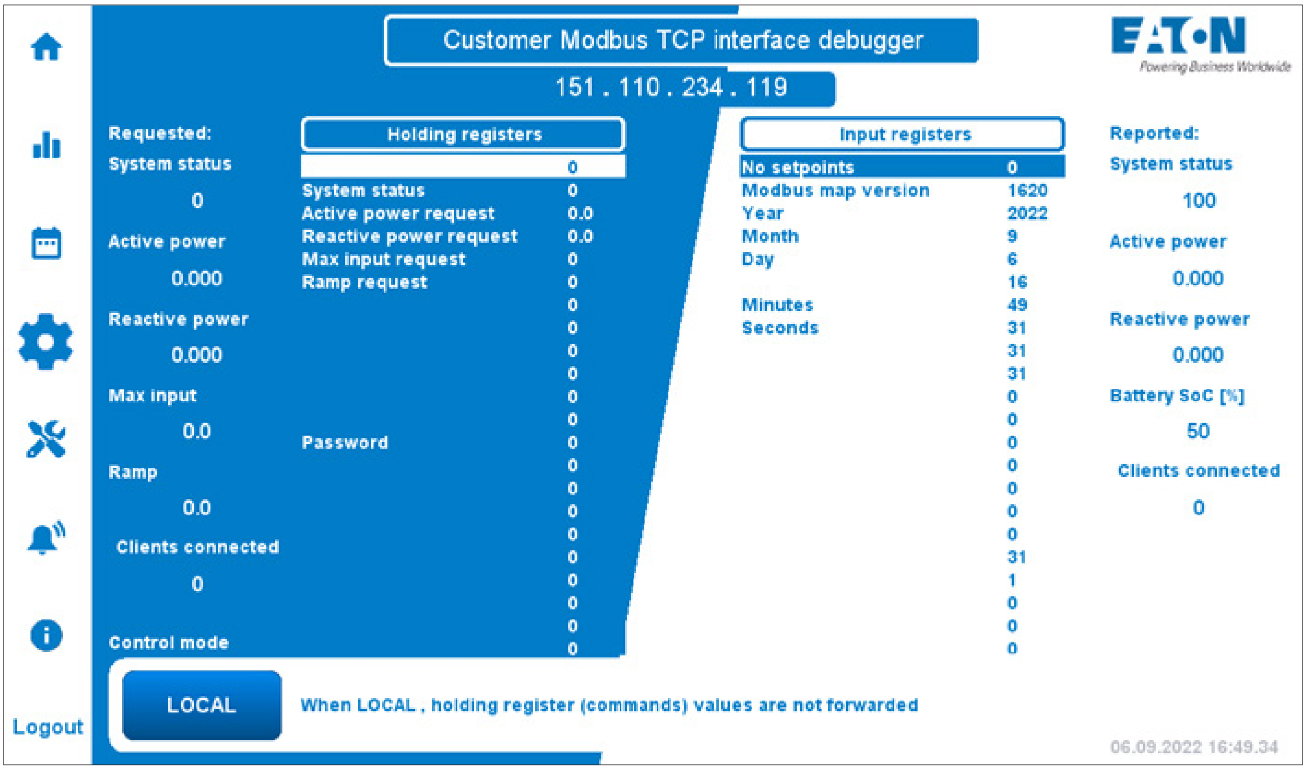


2.3 XV303 application controller as an HMI

One of the primary tasks of the XV303 AC is to expose a human-machine interface (HMI) via an embedded touchscreen. Further information about the commands available on the touchscreen can be found in the xStorage Compact user manual. However, it is necessary to point out that the Modbus TCP control will not work if not enabled via the touchscreen (set to "Remote" mode). Section 5 of this document describes the procedure to enable forwarding the holding registers to the input registers of the XC303 SC.

Another useful feature of the HMI is the "Customer Modbus TCP interface debugger" page, which shows the IP address to access the XV303 AC, as well as the values communicated via Modbus TCP (Figure 3).

Figure 3. Customer Modbus TCP interface debugger



2.4 The combined energy pool

The system can be expanded with up to five xStorage Compact units that can be configured to participate in a combined energy pool, thus increasing the energy storage, power, and capacity beyond what a single unit can provide. Electrical readings of each unit can be monitored individually via the PCS registers, as described in Section 3.5.

The units participating in the energy pool are controlled by the main XV303 AC. The configured units can always be added or removed from the pool. For more information on setting up the energy pool configuration, refer to the xCompact Storage installation manual.

3. Summary registers (port 510)

The registers discussed in this section are read-only (RO) registers that contain information related to system-wide operating parameters, as well as electrical measurements related to the X11 distribution grid connection, X13 essential loads connection, energy storage elements (batteries), and individual power converters (PCS) for each unit. These registers can be accessed through TCP port 510.

Table 6. Address ranges

Address Range	Description
0001 - 0049	General purpose system summary
0050 - 0119	Electrical measurements summary
0120 - 0219	PCS details

The recommended polling interval for a block of registers should not be less than 500ms. Polling the registers too frequently can break communication.

3.1 General purpose system summary registers

The following subsections briefly describe general-purpose system summary registers and their purpose. Further information is available in the xStorage Compact user manual and installation manual.

Table 7. System summary registers (address 0001 to 0049)

Address	FC	Register Name	Valid range	Scale	Unit	Size	Type
0001	0x04	Modbus map version	1300…9999	-	X.X.XX	1	-
0002	0x04	Year	1…9999	-	yyyy	1	-
0003	0x04	Month	1…12	-	MM	1	-
0004	0x04	Day	1…7	-	dd	1	-
0005	0x04	Hours	0…23	-	HH	1	-
0006	0x04	Minutes	0…59	-	mm	1	-
0007	0x04	Seconds	0…59	-	ss	1	-
0008	0x04	Connected units	0…31	-	bitfield	1	-
0009	0x04	Units grid-tied	0…31	-	bitfield	1	-
0010	0x04	Units autonomous	0…31	-	bitfield	1	-
0011	0x04	Units in island/backup	0…31	-	bitfield	1	-
0012	0x04	Units in fault state	0…31	-	bitfield	1	-
0013	0x04	Units in startup state	0…31	-	bitfield	1	-
0014	0x04	Units in bypass state	0…31	-	bitfield	1	-
0015	0x04	Units in service state	0…31	-	bitfield	1	-
0016	0x04	Units offline	0…31	-	bitfield	1	-
0017	0x04	Units partaking in the pool	0…31	-	bitfield	1	-
0018	0x04	Entity currently in control	0…3	-	-	1	UINT16
0019	0x04	Remote control method	0…1	-	bit	1	UINT16
0020	0x04	Any alarms	0…8	-	-	1	UINT16
0021	0x04	Alarm by device	-	-	bitfield	1	-
0022	0x04	Pool operating mode	0…8	-	-	1	UINT16
0023	0x04	Requested active power	-2000…2000	0.1	kW	1	INT16
0024	0x04	Actual active power	-2000…2000	0.1	kW	1	INT16
0025	0x04	Requested reactive power	-2000…2000	0.1	kVAR	1	INT16
0026	0x04	Actual reactive power	-2000…2000	0.1	kVAR	1	INT16
0027	-	Reserved	-	-	-	-	-
0028	0x04	Ramp rate	0…2000	0.1	kW/s	1	UINT16
0029	-	Reserved	-	-	-	-	-
0030	0x04	Global PS limit	0…500	1	kW	1	UINT16
0031	0x04	Global MGE limit	0…500	1	kW	1	UINT16
0032	0x04	Global MGI limit	0…500	1	kW	1	UINT16
0033	0x04	Global charge power limit	0…200	1	kW	1	UINT16
0034	0x04	Global discharge power limit	0…200	1	kW	1	UINT16
0035	0x04	Global min SoC	0…100	1	%	1	UINT16
0036	0x04	Global max SoC	0…100	1	%	1	UINT16
0037	0x04	Application controller alarms		-		2	UINT16
0039	0x04	System controller relay status	0…1	-	bit	1	UINT16
0040	0x04	FW release number	0…65535	see description	X.X.XX	1	UINT16
0041	0x04	FW of the UI	0…65535	see description	X.X.XX	1	UINT16
0042	0x04	FW of the PLC	0…65535	see description	X.X.XX	1	UINT16
0043…0049	--	Reserved	-	-	-	-	-

3.1.1 Address 0001: Modbus map version

The Modbus map version number is contained in this register. The format described in the "Unit" field in the tables is applied to the register value to get the actual Modbus map version number:

Response example value: 0x0514
0x0514 = 1300; the Modbus map version currently used by the xCompact unit is 1.3.00

Always make sure you are using the version of this document that matches the version of the Modbus map you are using. The version of the Modbus map described in this document can be found in Section 1.1: Revision history.

3.1.2 Addresses 0002 to 0007: Date and time

These registers contain information about the current date and time. Values stored in the registers are directly translated to date and time with no formatting applied. An example response is provided for the Year register (address 0002), but the rest of the registers follow the same concept.

Response example value: 0x07E7
0x07E7 = 2023; the current year is 2023

3.1.3 Addresses 0008 to 0017: Status registers of the connected units

This set of registers provides the statuses of the connected units. Each unit is represented by a bit in a bitfield. Each register from the address range is related to a different status; see Table 6 for a list of registers and corresponding unit statuses.

The high-order byte of the data word (bits 8 to 15) is not used and is always 0x00.

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
--	--	--	PCS5	PCS4	PCS3	PCS2	PCS1

Response example value: 0x0005
0x0005 = 00000000 00000101b; PCS3 and PCS1 status is ON/TRUE.

3.1.4 Address 0018: Entity currently in control

The register at address 0018 reports the entity that is currently in control of the system. Typically, the XV303 application controller handles different operating modes (manual, scheduler, SoC balancing, backup, idle) but the control can also be switched to the XC303 SC (for service purposes) or a remote client via Modbus TCP.

Valid responses	
0x0000	Unknown state
0x0001	XV303 AC (normal operation)
0x0002	XC303 SC (service)
0x0003	Remote (customer Modbus TCP)

Response example value: 0x0003
0x0003 = 3; the system is controlled by the remote client via Modbus TCP

3.1.5 Address 0019: Remote control method

The unit can be monitored or controlled remotely by an external client (EMS or supervision system) via the Modbus TCP protocol. This register holds information related to the remote control method. Note that the remote control is not possible unless it is set via the HMI, as described in Section 5.

Valid responses	
0x0000	The unit is controlled locally by the XV303 AC
0x0001	The unit is controlled remotely via Modbus TCP

Response example value: 0x0001
0x0001 = 1; the xStorage Compact unit is controlled remotely via Modbus TCP

Refer to Section 5 of this document for more details on setting the system parameters via Modbus TCP.

3.1.6 Address 0020: Any alarms

This register reports the severity of alarm events triggered by AC, SC, and PCS. Status bits are mutually exclusive, so only a single bit will be set at a time.

The MSB of the data word (bits 8 to 15) is not used and is always 0x00.

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
--	--	--	--	CRITICAL	MAJOR	MEDIUM	LOW

Response example value: 0x0004
0x0004 = 00000000 00000100b; the alarm event reported by either AC, SC, or PCS is a major-severity level alarm.

3.1.7 Address 0021: Alarm by device

The register at the address 0021 reports the source of the alarm event. In combination with the register at address 0020, it provides complete information on the event that caused the alarm to be triggered on a particular device.

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8
--	--	--	--	--	XV	XC5	XC4

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
XC3	XC2	XC1	PCS5	PCS4	PCS3	PCS2	PCS1

Response example value: 0x0489
0x0489 = 00000100 10001001b; the alarm event was reported by XV, XC3, PCS1 and PCS4.

3.1.8 Address 0022: Pool operating mode

The pool operating mode is reported by the register located at address 0022. There are nine possible modes of operation:

Valid responses	
0x0000	Idle
0x0001	Service
0x0002	Local
0x0003	Manual
0x0004	Schedule
0x0005	Remote
0x0006	Backup
0x0007	SoC balancing
0x0008	Error

Response example value: 0x0004 = 4; the pool is operating in Schedule mode.

3.1.9 Addresses 0023 and 0025: Requested active and reactive power

The two registers at the addresses 0023 and 0025 provide information about the amount of active/reactive power requested by the Modbus TCP client in kW and kVAR respectively, following the sign convention in Table 2.

Response example value: 0x05A5
0x05A5 = 1445; The requested power (as per the matching register in the request) is 144.5 kW (or kVAR)

Refer to Section 5 of this document for more details on sending a request for a specific amount of active and reactive power via Modbus TCP.

3.1.10 Addresses 0024 and 0026: Actual active and reactive power

The two registers at the addresses 0024 and 0026 provide information on the amount of actual active and reactive power provided in response to the request from the Modbus TCP client side (as per registers at addresses 0023 and 0025) in kW and kVAR respectively, following the sign convention in Table 2.

Response example value: 0x04A2
0xFB5E = -1186; The power (as per the matching register in the request) is 118.6 kW (or kVAR)

3.1.11 Address 0028: Set Ramp

The ramp rate value for charging or discharging the batteries in kW/s can be obtained from the register at address 0028.

Response example value: 0x00A4
0x00A4 = 164; the power ramp rate is set to 16.4 kW/s

3.1.12 Address 0030: Global PS Limit

Address 0030 points to the register containing the global peak shaving (PS) limit setpoint at which peak shaving starts, as measured on the primary (mains) power meter.

Response example value: 0x005E
0x005E = 94; the peak shaving starts at 94 kW

3.1.13 Address 0031: Global Max Grid Export Limit

The value of the global maximum grid export limit register at the address 0031 represents the threshold setpoint for limiting the power injected back into the distribution grid. The unit will ramp down the battery discharge power until the limit condition is met.

Response example value: 0x0032
0x0032 = 50; The global MGE limit is set to 50 kW

3.1.14 Address 0032: Global Max Grid Import Limit

The value of the global maximum grid Import limit register at address 0032 represents the threshold setpoint for limiting the maximum power consumption from the grid (X11 connector). The unit will ramp down the battery charging power until the limit condition is met.

Response example value: 0x0040
0x0040 = 64; The global maximum grid limit is set to 64 kW

3.1.15 Addresses 0033 and 0034: Global charge/discharge power limit

The registers at the addresses 0033 and 0034 contain (soft) limit setpoints for the converter charge and discharge power, respectively.

Response example value: 0x096
0x0096 = 150; the global charge (or discharge) limit is set to 150 kW

3.1.16 Address 0035: Global min SoC

The global minimum SoC register contains the setpoint for the minimum allowed battery State of Charge. The battery will not be discharged below this value during normal operation. The remaining charge will be assigned as a backup power reserve.

Response example value: 0x0014
0x0014 = 20; the global minimum SoC is set to 20%

3.1.17 Address 0036: Global max SoC

The global maximum SoC register contains a setpoint that refers to the maximum allowed battery State of Charge. The battery will not be charged beyond the value contained in this register; when the SoC setpoint is reached, the battery charging process will be stopped.

Response example value: 0x005A
0x005A = 90; the global maximum SoC is set to 90%

3.1.18 Address 0037: Application controller alarms

The XV303 Application controller alarms can be obtained from this register. These alarms are used by Eaton support engineers for troubleshooting. The register is two words long.

3.1.19 Address 0039: System controller relay status

The status of the X7 system controller relay is reported by the register at address 0039. Refer to the documentation of the xStorage unit for more details.

Response example value: 0x0001
0x0001 = 1; the system controller relay is activated.

3.1.20 Addresses 0040 to 0042: Firmware release numbers

This group of registers contains the release numbers of firmware releases for specific devices, including the user interface (UI) and PLC firmware release numbers. The following formula is used to convert the raw values from the registers into FW release numbers:

Release_num = Project_major_num x 100 + Project_minor_num x 10 + project_build

Response example value: 0x0659
0x0659 = 1625; 1 x 100 + 15 x 10 + 25 = 1625. The release number of the FW package is 1.15.25

3.2 Electrical measurements summary (X11 connector)

This section briefly describes summary registers associated with electrical measurements at the X11 distribution grid connector.

Note that the X11 connectors can be used in parallel. Refer to xStorage Compact installation manual for details.

Table 8. Electrical measurements summary at the X11 connector (address 0050 to 0069)

Address	FC	Register Name	Valid range	Scale	Unit	Size	Type
0050	0x04	Ph1 Active Power	-32768…32767	0.1	kW	1	INT16
0051	0x04	Ph2 Active Power	-32768…32767	0.1	kW	1	INT16
0052	0x04	Ph3 Active Power	-32768…32767	0.1	kW	1	INT16
0053	0x04	Total Active Power	-32768…32767	0.1	kW	1	INT16
0054	0x04	Ph1 Apparent Power	0…65535	0.1	kVA	1	UINT16
0055	0x04	Ph2 Apparent Power	0…65535	0.1	kVA	1	UINT16
0056	0x04	Ph3 Apparent Power	0…65535	0.1	kVA	1	UINT16
0057	0x04	Total Apparent Power	0…65535	0.1	kVA	1	UINT16
0058	0x04	Ph1 Voltage (L-N)	0…65535	0.1	V	1	UINT16
0059	0x04	Ph2 Voltage (L-N)	0…65535	0.1	V	1	UINT16
0060	0x04	Ph3 Voltage (L-N)	0…65535	0.1	V	1	UINT16
0061	0x04	Ph1 Current	-32768…32767	0.1	A	1	INT16
0062	0x04	Ph2 Current	-32768…32767	0.1	A	1	INT16
0063	0x04	Ph3 Current	-32768…32767	0.1	A	1	INT16
0064	0x04	Total Current	-32768…32767	0.1	A	1	INT16
0065	0x04	Frequency	0…65535	0.01	Hz	1	UINT16
0066	0x04	Ph 1 PF	0…65535	0.001	-	1	UINT16
0067	0x04	Ph 2 PF	0…65535	0.001	-	1	UINT16
0068	0x04	Ph 3 PF	0…65535	0.001	-	1	UINT16
0069	0x04	System PF	0…65535	0.001	-	1	UINT16

3.2.1 Address 0050 to 0052: Ph (1 to 3) Active Power

Registers in the address range 0050 to 0052 provide measurements regarding the active power per phase consumed from or injected back into the distribution grid by the connected unit(s). Values from these registers should be interpreted as signed integers, following the sign convention in Table 2.

Response example value: 0x04E7
0x04E7 = 1255; active power consumption per phase (as per the matching register in the request) is 125.5 kW

3.2.2 Address 0053: Total Active Power

The register at address 0053 provides measurements regarding the total active power consumed from or injected back into the distribution grid by the connected unit(s). Values from these registers should be interpreted as signed integers, following the sign convention in Table 2.

Response example value: 0x0798
0x0798 = 1944; total active power consumption is 194.4 kW

3.2.3 Address 0054 to 0056: Ph (1 to 3) Apparent Power

Registers in the address range 0054 to 0056 provide measurements regarding the apparent power per phase at the X11 connector.

Response example value: 0x0114
0x0114 = 276; apparent power per phase (as per the matching register in the request) at the X11 connector is 27.6 kVA

3.2.4 Address 0057: Total Apparent Power

The register at address 0057 provides measurements regarding the total apparent power at the X11 connector.

Response example value: 0x01DC
0x01DC = 476; total apparent power at the X11 connector is 47.6 kVA

3.2.5 Address 0058 to 0060: Ph (1 to 3) Voltage

Registers in the address range 0058 to 0060 provide measurements regarding the voltage on the X11 connector between the phase (Ph1 to Ph3, as per the matching register) and the neutral conductor.

Response example value: 0x08FE
0x08FE = 2302; voltage between the phase (as per the matching register in the request) and the neutral conductor is 230.2 V

3.2.6 Address 0061 to 0063: Ph (1 to 3) Current

Registers in the address range 0061 to 0063 provide measurements regarding the current per phase consumed from or injected back into the distribution grid by the connected unit(s). Values from these registers should be interpreted as signed integers, following the sign convention in Table 2.

Response example value: 0x01F9
0x01F9 = 505; current consumption per phase (as per the matching register in the request) is 50.5 A

3.2.7 Address 0064: Total Current

The register at address 0064 provides measurements regarding the total current consumed from or injected back into the distribution grid by the connected unit(s). Values from these registers should be interpreted as signed integers, following the sign convention in Table 2.

Response example value: 0xFEFC
0xFEFC = -305; total current injected into the distribution grid is 30.5 A

3.2.8 Address 0065: Frequency

The register at address 0065 allows monitoring of the distribution grid AC voltage frequency at the X11 connector. Typically, it should be 50 or 60 Hz (depending on the region). Ensure that the AC voltage frequency complies with the operating limitations stated in the xStorage Compact technical datasheet.

Response example value: 0x13BC
0x13BC = 5052; the AC voltage frequency at the X11 connector is 50.52 Hz

3.2.9 Address 0066 to 0068: Ph (1 to 3) PF

Registers in the address range 0061 to 0063 provide measurements regarding the power factor per phase (Ph1 to Ph3).

Response example value: 0x0390
0x0390 = 912; the power factor per phase (as per the matching register in the request) is 0.912

3.2.10 Address 0069: System PF

The system power factor is reported by the register at address 0069 and represents the average value of the power factors per phase (registers 0066 to 0068).

Response example value: 0x0382
0x0382 = 898; system power factor on the X11 side is 0.898

3.3 Electrical measurements summary (X13 connector)

This section briefly describes the summary registers associated with the electrical measurements at the X13 connector.

Note that the X13 connectors cannot be used in parallel. Refer to xStorage Compact installation manual for details.

Table 9. Electrical measurements summary at the X13 connector (address 0075 to 0094)

Address	FC	Register Name	Valid range	Scale	Unit	Size	Type
0075	0x04	Ph1 Active Power	0…65535	0.1	kW	1	UINT16
0076	0x04	Ph2 Active Power	0…65535	0.1	kW	1	UINT16
0077	0x04	Ph3 Active Power	0…65535	0.1	kW	1	UINT16
0078	0x04	Total Active Power	0…65535	0.1	kW	1	UINT16
0079	0x04	Ph1 Apparent Power	0…65535	0.1	kVA	1	UINT16
0080	0x04	Ph2 Apparent Power	0…65535	0.1	kVA	1	UINT16
0081	0x04	Ph3 Apparent Power	0…65535	0.1	kVA	1	UINT16
0082	0x04	Total Apparent Power	0…65535	0.1	kVA	1	UINT16
0083	0x04	Ph1 Voltage (L-N)	0…65535	0.1	V	1	UINT16
0084	0x04	Ph2 Voltage (L-N)	0…65535	0.1	V	1	UINT16
0085	0x04	Ph3 Voltage (L-N)	0…65535	0.1	V	1	UINT16
0086	0x04	Ph1 Current	0…65535	0.1	A	1	UINT16
0087	0x04	Ph2 Current	0…65535	0.1	A	1	UINT16
0088	0x04	Ph3 Current	0…65535	0.1	A	1	UINT16
0089	0x04	Total Current	0…65535	0.1	A	1	UINT16
0090	0x04	Frequency	0…65535	0.01	Hz	1	UINT16
0091	0x04	Ph 1 PF	0…65535	0.001	-	1	UINT16
0092	0x04	Ph 2 PF	0…65535	0.001	-	1	UINT16
0093	0x04	Ph 3 PF	0…65535	0.001	-	1	UINT16
0094	0x04	System PF	0…65535	0.001	-	1	UINT16

3.3.1 Addresses 0075 to 0077: Ph (1 to 3) Active Power

Registers in the address range 0075 to 0077 provide measurements regarding the active power per phase consumed by the connected loads.

Response example value: 0x0500
0x0500 = 1280; active power consumption per phase (as per the matching register in the request) is 128.0 kW

3.3.2 Address 0078: Total Active Power

The register at address 0078 provides measurements regarding the total active power consumed by the connected loads.

Response example value: 0x0798
0x0798 = 1944; total active power consumption is 194.4 kW

3.3.3 Addresses 0079 to 0081: Ph (1 to 3) Apparent Power

Registers in the address range 0079 to 0081 provide measurements regarding the apparent power per phase at the X13 connector.

Response example value: 0x00FC
0x0FC = 252; apparent power per phase (as per the matching register in the request) at the X13 connector is 25.2 kVA

3.3.4 Address 0082: Total Apparent Power

The register at address 0082 provides measurements regarding the total apparent power at the X13 connector.

Response example value: 0x0160
0x0160 = 352; total apparent power at the X13 connector is 35.2 kVA

3.3.5 Addresses 0083 to 0085: Ph (1 to 3) Voltage

Registers in the address range 0083 to 0085 provide measurements regarding the voltage on the X13 connector between the phase (Ph1 to Ph3, as per the matching register) and the neutral conductor.

Response example value: 0x08FC
0x08FC = 2300; voltage between the phase (as per the matching register in the request) and the neutral conductor is 230.0 V

3.3.6 Addresses 0086 to 0088: Ph (1 to 3) Current

Registers in the address range 0086 to 0088 provide measurements regarding the current per phase consumed by the connected loads.

Response example value: 0x0154
0x0154 = 349; current consumption per phase (as per the matching register in the request) is 34.9 A

3.3.7 Address 0089: Total Current

The register at address 0064 provides measurements regarding the total current consumed by the connected loads.

Response example value: 0x01A9
0x01A9 = 425; total current consumption is 42.5 A

3.3.8 Address 0090: Frequency

The register at address 0090 allows monitoring of the AC voltage frequency at the X13 connector. Typically, it should be around 50 to 60 Hz (depending on the region).

Response example value: 0x1388
0x1388 = 5000; the voltage frequency at the X13 connector is 50.00 Hz

3.3.9 Addresses 0091 to 0093: Ph (1 to 3) PF

Registers in the address range 0091 to 0093 provide measurements regarding the power factor per phase (Ph1 to Ph3).

Response example value: 0x0358
0x0358 = 856; the power factor per phase (as per the matching register in the request) is 0.856

3.3.10 Address 0094: System PF

The system power factor is reported by the register at address 0094 and represents the average value of the power factors per phase (registers 0091 to 0093).

Response example value: 0x0382
0x0382 = 898; system power factor on X13 side is 0.898

3.4 Electrical measurements summary (battery bank)

As mentioned earlier, up to five units can be connected, forming a system that can be controlled from a single unit (the main controller). The summary registers described in this section refer to the electrical measurements of the batteries at the system level.

Table 10. Electrical measurements summary of the batteries (address 0100 to 0117)

Address	FC	Register Name	Valid range	Scale	Unit	Size	Type
0100	0x04	Power	-32768…32767	0.1	kW	1	INT16
0101	0x04	Voltage	0…65553	0.1	V	1	UINT16
0102	0x04	Current	-32768…32767	0.1	A	1	INT16
0103	0x04	Battery SoC	0…100	1	%	1	UINT16
0104	0x04	Max available power for charging	0…65535	0.1	kW	1	UINT16
0105	0x04	Max available power for discharging	0…65535	0.1	kW	1	UINT16
0106	0x04	Battery bank capacity	0…65535	0.1	kWh	1	UINT16
0107	0x04	Energy available to discharge	0…65535	0.1	kWh	1	UINT16
0108	0x04	Energy available to charge	0…65535	0.1	kWh	1	UINT16
0109	0x04	Max cell voltage of the strings online	0…10000	1	mV	1	UINT16
0110	0x04	Min cell voltage of the strings online	0…10000	1	mV	1	UINT16
0111	0x04	Max cell temperature of the strings online	-600…999	0.1	°C	1	INT16
0112	0x04	Min cell temperature of the strings online	-600…999	0.1	°C	1	INT16
0113	0x04	Number of strings configured	0…54	1	-	1	UINT16
0114	0x04	Number of strings online (connected)	0…54	1	-	1	UINT16
0115	0x04	Max cell voltage difference in the system	0…65535	1	mV	1	UINT16
0116	0x04	One-hour max cell difference in the system	0…65535	1	mV	1	UINT16
0117	0x04	Unit with the highest cell difference	0…65535	1	-	1	UINT16

3.4.1 Address 0100: Power

The register at the address 0100 reports the charging or discharging power of the battery bank. Values from this register should be interpreted as a signed integer, following the sign convention in Table 2.

Response example value: 0xFCAE
0xFCAE= -850; the battery bank currently discharges 85.0 kW to the connected loads (or the distribution grid)

3.4.2 Address 0101: Voltage

The battery bank voltage can be obtained from the register at address 0101.

Response example value: 0x0FD7
0x0FD7 = 4055; the measured (average) voltage of the battery bank is 405.5 V

3.4.3 Address 0102: Current

The delivered (or consumed) current from the battery bank can be obtained from address 0102. Values from these registers should be interpreted as signed integers, following the sign convention in Table 2.

Response example value: 0xFFCA
0xFFCA = -54; the battery bank discharges 5.4 A into the connected loads (or the distribution grid)

3.4.4 Address 0103: Battery SoC

The State of Charge (SoC) of the pool can be obtained from the register at address 0103.

Response example value: 0x0048
0x0048 = 75; the battery bank SoC is at 75%

3.4.5 Addresses 0104 and 105: Max available power charge and discharge

The registers at the addresses 0104 and 0105 are used to report the maximum available power that the system can draw for charging the battery bank, and the maximum available power that the system can discharge from the battery bank to the connected loads, respectively.

Note that the sign convention given in Table 2 does not apply here, since there are two separate registers reporting the maximum values as unsigned integers (UINT16).

Response example value: 0x00E1
0x00E1 = 225; the battery bank can be charged (or discharged, as per the matching register in the request) with a maximum of 22.5 kW

3.4.6 Address 0106: Battery bank capacity

The battery bank capacity register at address 0106 reports the total energy capacity of the battery bank. The total bank energy capacity depends on the combined energy capacities of each connected battery string in the system.

Response example value: 0x09C4
0x09C4 = 2500; the battery bank can store up to 250.0 kWh

3.4.7 Addresses 0107 and 0108: Energy available to charge and discharge

The registers at the addresses 0107 and 0108 are used to report the energy available to the system for charging the battery bank, and the energy available to the system that can be discharged from the battery bank to the connected loads, respectively.

Note that the sign convention given in Table 2 does not apply here, since there are two separate registers reporting the maximum values as unsigned integers (UINT16).

Response example value: 0x05DC
0x05DC = 1500; the battery bank can charge (or discharge, as per the matching register in the request) a maximum of 150.0 kWh

3.4.8 Addresses 0109 and 0110: Max and min cell voltage of the strings online

Although not able to provide readings for each battery cell in the battery bank, BMS can report the maximum and minimum cell voltages. The maximum and minimum cell voltage values can be read from the registers at addresses 0109 and 0110, respectively. The measurements are valid across online battery strings in the system.

Response example value: 0x1068
0x1068 = 4200; the maximum (or minimum, as per the matching register in the request) cell voltage is 4200 mV

3.4.9 Addresses 0111 and 0112: Max and min cell temperature of the strings online

BMS can report the maximum and minimum cell temperatures from the thermal sensors. The maximum and the minimum cell temperature values can be read from the registers at addresses 0111 and 0112, respectively. The measurements are valid across online battery strings in the system.

Response example value: 0x0138
0x0138= 315; the maximum (or minimum, as per the matching register in the request) cell temperature is 31.5 °C

3.4.10 Address 0113: Number of strings configured

The number of configured battery strings (but not necessarily set online) can be obtained from the register at the address 0113.

Response example value: 0x0006
0x0006 = 6; the number configured battery strings in the system is 6

3.4.11 Address 0114: Number of strings online (connected)

The number of online battery strings actively participating in the energy exchange at the system level (pool) can be obtained from the register at the address 0114.

Response example value: 0x0004
0x0004 = 4; the number of connected battery strings in the system is 4

3.4.12 Address 0115: Max cell voltage difference in the system

Maximum cell voltage difference in a battery string within the system can be obtained from the register at address 0115. This information is vital for understanding battery-related problems. A difference larger than 100 mV can have a detrimental effect on discharge capabilities and the lifespan of battery packs. The measurement includes only the online battery strings.

Response example value: 0x0040
0x0040 = 64; the maximum cell voltage difference in the system is 64 mV

3.4.13 Address 0116: One-hour max cell difference

The register at address 0116 reports the maximum value of the cell voltage difference over one hour. The register at address 0116 reports the maximum cell voltage difference in the system that was measured during the last one hour.

Response example value: 0x002A
0x002A = 42; the maximum cell voltage difference in the last hour was 42 mV

3.4.14 Address 0117: Unit with the highest cell voltage difference

If there is a significant difference in voltage between the battery cells in the bank, it is good to know which unit has the most pronounced problem. This information is vital in determining a problematic battery pack that may adversely affect the entire system. The register at address 0117 identifies the unit with the largest cell difference, considering readings from the register at address 0116 (One-hour max value of max cell difference).

Response example value: 0x0004
0x0004 = 4; unit 4 had the highest maximum value of cell voltage difference in the last one hour.

3.5 PCS details

The bi-directional PCS drives AC loads and charges DC batteries from the grid. The PCS also discharges the DC batteries and supplies power to the AC grid when specified.

The following section describes the PCS registers of a single xStorage compact unit. The same applies to all the individual units in the system (from unit 1 to unit 5).

Table 11 provides the address ranges for each group of PCS-related registers, as seen from the main controller unit.

Table 11. PCS register groups

Address Range	Description
0120 - 0139	PCS1 details register group
0140 - 0159	PCS2 details register group
0160 - 0179	PCS3 details register group
0180 - 0199	PCS4 details register group
0200 - 0219	PCS5 details register group

Table 12. PCS 1 details (address 0120 to 0133)

Address	FC	Register Name	Valid range	Scale	Unit	Size	Type
0120	0x04	Input power	-32768...32767	0.1	kW	1	INT16
0121	0x04	Output power	-32768...32767	0.1	kW	1	INT16
0122	0x04	Battery Voltage	0…65535	0.1	V	1	UINT16
0123	0x04	Battery Current	-32768...32767	0.1	A	1	INT16
0124	0x04	Battery power	-32768...32767	0.1	kW	1	INT16
0125	0x04	Battery SoC	0…100	1	%	1	UINT16
0126	0x04	Number of strings configured	0…54	1	-	1	UINT16
0127	0x04	Number of strings connected	0…54	1	-	1	UINT16
0128	0x04	Number of strings available	0…54	1	-	1	UINT16
0129	0x04	PCS Active alarm 0	0…500	1	-	1	UINT16
0130	0x04	PCS Active alarm 1	0…500	1	-	1	UINT16
0131	0x04	PCS Active alarm 2	0…500	1	-	1	UINT16
0132	0x04	PCS Active alarm 3	0…500	1	-	1	UINT16
0133	0x04	System controller alarm	0…65535	1	-	1	UINT16
0134…0139	-	Reserved	-	-	-	-	-

3.5.1 Address 0120: Input power

This register reports the power at the input side of the PCS (X11 connector), with respect to the sign convention provided in Table 2.

Response example value: 0x0072
0x0072 = 114; the power consumption of the PCS is 11.4 kW

3.5.2 Address 0120: Output power

This register reports the power at the output side of the PCS (X13 connector), with respect to the sign convention provided in Table 2.

Response example value: 0x0120
0x0120 = 288; the output power of the PCS is 22.8 kW

3.5.3 Address 0122: Battery Voltage

The register at address 0122 reports the voltage of the connected battery string(s)

Response example value: 0x1000
0x1000 = 4096; the battery voltage is 409.6 V

3.5.4 Address 0123: Battery Current

The register at the address 0123 reports current consumption from the connected battery string(s)

Response example value: 0x02C1
0x02C1 = 705; the battery current consumption is 70.5 A

3.5.5 Address 0124: Battery Power

The register at address 0124 reports the power consumption from the battery string(s), derived as a product of the current and voltage (registers 0122 and 0123).

Response example value: 0x0072
0x0072 = 114; the current battery power consumption is 11.4 kW

3.5.6 Address 0125: Battery SoC

The State of Charge (SoC) of the connected battery strings can be read from the register at address 0125.

Response example value: 0x0048
0x0048 = 75; the State of Charge of the batteries is 75%

3.5.7 Address 0126: Number of strings configured

Information on the number of battery strings with which the unit is configured to operate can be obtained from the register at address 0126. Note that the number of configured battery strings may be less than or equal to the number of available battery strings; otherwise, an alarm event will be raised.

Response example value: 0x0002
0x0002 = 2; the number of configured battery strings is 2

3.5.8 Address 0127: Number of strings connected

The number of connected (online) battery strings actively participating in the energy exchange at the unit level can be obtained from the register at the address 0127.

Response example value: 0x0001
0x0001 = 1; the number of battery strings currently connected (online) is 1

3.5.9 Number of strings available

The number of battery strings physically available but not necessarily connected can be obtained by reading the value from the register at address 0128.

Response example value: 0x0002
0x0002 = 2; the number of battery strings available in the unit is 2

3.5.10 Address 0129 to 0132: PCS Active Alarm (0 to 3)

The block of registers at addresses 0129 to 0132 reports the node-bit number of the active alarm. A value of 0x03E7 (999) means there is no PCS active alarm pending.

Response example value: 0x03E7
0x03E7 = 999; there is no PCS active alarm pending (as per the matching register)

3.5.11 Address 0123: System controller alarm

The alarm reported by the XC303 system controller can be obtained from the register at address 0123.

Valid responses		Description
0x0000	No fault condition	**No acknowledged error in the system**
0x0001	GENERAL_DANGER	**Critical overtemperature or overvoltage event. Immediate inspection is required.**
0x00C7	GENERAL_ESS_ALARM	**General Alarm conditions. The system is not functioning.**
0x00C8	GENERAL_BATTERY_ALARM	Alarm triggered by the battery packs. Replacement of the offending battery pack is required.
0x012C	GENERAL_PCS_ALARM	Alarm triggered by the power converters. Replacement of the offending component is required.
0x0190	GENERAL_COMMUNICATION_ALARM	Alarm triggered by loss of communication with a subsystem. Closer inspection and replacement of the offending component is required.
0x04AF	GENERAL_ESS_FAULT	**General fault conditions. The system may not be functioning properly.**
0x04B0	GENERAL_BATTERY_FAULT	Fault reported by the battery packs. Closer inspection is required.
0x0514	GENERAL_PCS_FAULT	Fault triggered by the power converters. Closer inspection is required.
0x0578	GENERAL_COMMUNICATION_FAULT	Fault triggered by degraded communication with a subsystem. Closer inspection and replacement of the offending component is required.
0x0833	GENERAL_ESS_WARNING	**General warning conditions. The system is currently still operational.**
0x0898	GENERAL_BATTERY_WARNING	Warning reported by the battery pack. Battery sensor readings are outside the safe limits, closer inspection is required.

Response example value: 0x0514
0x0514 = 1300; "GENERAL_PCS_FAULT" error reported by the XC303 system controller

4. Power meters (port 516)

The xStorage Compact energy storage system (ESS) can be connected to the distribution grid via a grid power meter (PM), which can communicate the readings back to the xStorage Compact unit via the Modbus TCP interface. In the case of parallel connection, only the main controller unit is connected to a distribution grid PM. A detailed multi-unit wiring diagram can be found in the xStorage Compact Installation Guide.

4.1 Additional power meters

In case of an additional PV generator connected to the X11 side (typically for peak shaving or to enable off-grid mode), an additional photovoltaic (PV) power meter can be used to read the power. There are two groups of registers to read the values from both the upstream grid power meter and the local PV power meter (inverter).

As mentioned in Section 2, the Modbus mapping of the compatible PMs is handled by the XV303 AC, so power readings from different PM models can always be obtained from the register addresses listed in this document.

4.2 Power meter registers

The registers for both types of PMs have the same meaning; only the address ranges are different. For this reason, all addresses for reading values from upstream grid PM are listed in Table 14, while the address ranges for both types of PM are provided in Table 13.

Table 13. Address ranges for different PMs

Address Range	Description
0001 - 0029	Grid Power Meter
0051 - 0079	PV Power Meter

Table 14. Grid Power Meter

Address	FC	Register Name	Valid range	Scale	Unit	Size	Type
0001	0x04	Ph1 Current	0…65535	0.1	A	1	UINT16
0002	0x04	Ph2 Current	0…65535	0.1	A	1	UINT16
0003	0x04	Ph3 Current	0…65535	0.1	A	1	UINT16
0004	0x04	Ph1 Voltage P-N	0…65535	0.1	V	1	UINT16
0005	0x04	Ph2 Voltage P-N	0…65535	0.1	V	1	UINT16
0006	0x04	Ph3 Voltage P-N	0…65535	0.1	V	1	UINT16
0007	0x04	Ph1-Ph2 Voltage	0…65535	0.1	V	1	UINT16
0008	0x04	Ph2-Ph3 Voltage	0…65535	0.1	V	1	UINT16
0009	0x04	Ph3-Ph1 Voltage	0…65535	0.1	V	1	UINT16
0010	0x04	Frequency	0…65535	0.01	Hz	1	UINT16
0011	0x04	Ph 1 PF	-32768…32767	0.001	-	1	INT16
0012	0x04	Ph 2 PF	-32768…32767	0.001	-	1	INT16
0013	0x04	Ph 3 PF	-32768…32767	0.001	-	1	INT16
0014	0x04	System PF	-32768…32767	0.001	-	1	INT16
0015	0x04	Ph1 Active Power	-32768…32767	0.1	kW	1	INT16
0016	0x04	Ph2 Active Power	-32768…32767	0.1	kW	1	INT16
0017	0x04	Ph3 Active Power	-32768…32767	0.1	kW	1	INT16
0018	0x04	Total Active Power	-32768…32767	0.1	kW	1	INT16
0019	0x04	Ph1 Apparent Power	0…65535	0.1	kVA	1	UINT16
0020	0x04	Ph2 Apparent Power	0…65535	0.1	kVA	1	UINT16
0021	0x04	Ph3 Apparent Power	0…65535	0.1	kVA	1	UINT16
0022	0x04	Total Apparent Power	0…65535	0.1	kVA	1	UINT16
0023	0x04	Ph1 Reactive Power	0…65535	0.1	kVAR	1	UINT16
0024	0x04	Ph2 Reactive Power	0…65535	0.1	kVAR	1	UINT16
0025	0x04	Ph3 Reactive Power	0…65535	0.1	kVAR	1	UINT16
0026	0x04	Total Reactive Power	0…65535	0.1	kVAR	1	UINT16
0027	0x04	Imported Energy	$0 \dots 2^{32} - 1$	1	kWh	1	UINT32
0029	0x04	Exported Energy	$0 \dots 2^{32} - 1$	1	kWh	1	UINT32

4.2.1 Addresses 0001 to 0003: Current per phase (Ph1 to Ph3)

Registers in the address range 0001 to 0003 provide measurements regarding the current flow per phase.

Response example value: 0x0142
0x0142 = 322; current flow per phase (as per the matching register in the request) is 32.2 A

4.2.2 Addresses 0004 to 0006: Ph (1 to 3) Voltage P-N

Registers in the address range 0004 to 0006 provide measurements regarding the voltage between the phase (Ph1 to Ph3, as per the matching register) and the neutral conductor.

Response example value: 0x08EE
0x08EE = 2286; the voltage between the phase (as per the matching register in the request) and the neutral is 228.6 V

4.2.3 Address 0007 to 0009: Ph to Ph Voltage

A group of three registers at address range 0007 to 0009 provides voltage values between two different phases. The register at the address 0007 reports voltage between phases 1 and 2, the register at the address 0008 reports voltage between phases 2 and 3, and the register at the address 0009 reports voltage between phases 1 and 3.

Response example value: 0x0F73
0x0F73 = 3955; the voltage between the two phases (as per the matching register in the request) is 395.5 V

4.2.4 Address 0010: Frequency

The voltage frequency of the distribution grid can be obtained from the register at address 0010.

Response example value: 0x1405
0x1405 = 5125; the AC voltage frequency is 51.25 Hz

4.2.5 Address 0011 to 0013: Ph (1 to 3) PF

Registers in the address range 0011 to 0013 provide measurements regarding the power factor per phase (Ph1 to Ph3). Values from these registers should be interpreted as signed integers, following the sign convention in Table 2.

Response example value: 0xFC59
0xFC59 = -935; the power factor per phase (as per the matching register in the request) is -0.935

4.2.6 Address 0014: System PF

The system power factor is reported by the register at address 0014 and represents the average value of the power factors per phase (registers 0011 to 0013). Values from this register should be interpreted as a signed integer, following the sign convention in Table 2.

Response example value: 0x03DC
0x03DX = 988; the system power factor is 0.988

4.2.7 Address 0015 to 0017: Ph (1 to 3) Active Power

Registers in the address range 0015 to 0017 provide measurements regarding the active power per phase consumed from or injected back into the distribution grid by the connected unit(s). Values from these registers should be interpreted as signed integers, following the sign convention in Table 2.

Response example value: 0x01E7
0x01E7 = 487; active power consumption per phase (as per the matching register in the request) is 48.7 kW

The active power per phase cannot be injected back into the PV inverter grid, so in the case of a PV meter, the active power per phase will only be consumed (positive values).

4.2.8 Address 0018: Total Active Power

The register at address 0018 provides measurements regarding the total active power consumed from or injected back into the distribution grid by the connected unit(s). Values from these registers should be interpreted as signed integers, following the sign convention in Table 2.

Response example value: 0x0291
0x0291 = 657; total active power consumption is 65.7 kW

Active power cannot be injected back into the PV plant, so in the case of a PV meter, the total active power values can only be positive.

4.2.9 Addresses 0019 to 0021: Ph (1 to 3) Apparent Power

Registers in the address range 0019 to 0021 provide measurements regarding the apparent power per phase at the connected PM.

Response example value: 0x0114
0x0114 = 276; apparent power consumed per phase (as per the matching register in the request) is 27.6 kVA

4.2.10 Address 0022: Total Apparent Power

The register at address 0022 provides measurements regarding the total apparent power at the connected PM.

Response example value: 0x01DC
0x01DC = 476; total apparent power consumed is 47.6 kVA

4.2.11 Addresses 0023 to 0025: Ph (1 to 3) Reactive Power

Registers in the address range 0023 to 0025 provide measurements regarding the apparent power per phase at the connected PM.

Response example value: 0x00F8
0x00F8 = 248; reactive power consumed per phase (as per the matching register in the request) is 24.8 kVAR

4.2.12 Address 0026: Total Reactive Power

The register at address 0026 provides measurements regarding the total apparent power at the connected PM.

Response example value: 0x011D
0x011D = 285; total apparent power consumed is 28.5 kVAR

4.2.13 Address 0027: Imported Energy

Energy imported from an external source (the distribution network in this case) can be read from the register at address 0027. The register 0027 is two words (four bytes) long, and the received value is big-endian (the high word is transmitted first).

Response example value: 0x0002 0x10FD
0x0002 10FD = 135421; the imported (consumed) amount of energy is 135421 kWh

4.2.14 Address 0029: Exported Energy

The energy injected back into the distribution grid can be read from the register at address 0029. The register 0029 is two words (four bytes) long, and the received value is big-endian (the high word is transmitted first).

Response example value: 0x0001 0x0040
0x0001 0040 = 65600; the exported (grid-injected) amount of energy is 6560.0 kWh

The exported energy register is not valid for the PV Meter register table, as no energy can be injected back into the PV plant.

5. Control registers (port 520)

Registers accessible via TCP port 520 are used to configure some system parameters. The exact procedure for entering data into specific registers and describing their impact on the system will be described in the corresponding section of this document.

5.1 System control registers

System control registers are used to set the operating modes of the units in the system, configure power setpoints, and set ramp rates. The values written in these registers affect all the connected units that form the energy pool.

Table 15. System control registers

Address	FC	Register Name	Valid range	Scale	Unit	Size	Type
0001	0x10	System Status Request	0…1000	1	-	1	UINT16
0002	0x10	Active Power Request	-2000…2000	0.1	kW	1	INT16
0003	0x10	Reactive Power Request	-2000…2000	0.1	kVAR	1	INT16
0004	0x10	Maximum Input Power Request	0…3000	0.1	kW	1	UINT16
0005	0x10	Ramp Rate Request	0…2000	0.1	kW/s	1	UINT16
0006…0011	-	Reserved	-	-	-	-	-
0012	0x10	System Control Method	0…65535	1	-	1	UINT16

5.1.1 Address 0001: System Status Request

The register at address 0001 is used to send a request command to the system to switch to the specified operating state:

Command ID		Description
0x0064	GRID_TIED	Go/remain in the grid-tied mode
0x015A	AUTONOMOUS	Go/remain in autonomous mode
0x00AF	BACKUP/ISLAND	Go/remain in battery backup mode
0x0166	STARTUP	Start up the system
0x00D3	BYPASS	Go into bypass mode
0x01DE	DROP	Drop the loads (shutdown mode)

Request example value: 0x0064
0x0064 = 100; the system will go (or remain) in a grid-tied state.

Before setting the power setpoints, ensure the system is in grid-tied state. Start the write cycle by setting the System Status Request register at address 0001 to 0x0064 (100 decimal).

5.1.2 Address 0002: Active Power Request

The register at address 0002 is used to set the active power setpoint value. The requested value should be interpreted as a signed integer, following the sign convention in Table 2.

Request example value: 0x0120
0x0120 = 288; the Modbus TCP client requested an active power setpoint of 28.8 kW

5.1.3 Address 0003: Reactive Power Request

The register at address 0003 is used to set the reactive power setpoint value. Note that 10% of active power is needed to control reactive power. The limit is a power factor of 0.2. The requested value should be interpreted as a signed integer, following the sign convention in Table 2.

Request example value: 0x0066
0x0066 = 102; the Modbus TCP client requested an active power setpoint of 10.2 kVAR

5.1.4 Address 0004: Maximum Input Power Request

The client application can set the maximum input power using the register at address 0004. It is recommended to set the maximum input power as 600 x the number of units in the pool.

Request example value: 0x0708
0x0066 = 1800; the Modbus TCP client requested the maximum input power setpoint at 180.0 kW

For safety reasons, the system will always truncate the requested maximum input power setpoint to the acceptable (nominal) value.

5.1.5 Address 0005: Ramp Rate Request

The ramp rate value can be requested using the register at address 0005. The ramp rate applies to a power surge in both directions, so the value is an unsigned integer. It is recommended to set the ramp rate as 400 x the number of units in the pool.

Request example value: 0x0640
0x0640 = 1600; the Modbus TCP client requested the ramp rate of 160.0 kW/s

5.1.6 Address 0012: System Control Method

The register at address 0012 controls the behavior of the XV303 AC. If the register 0012 value is set to 0x7AB7 (31415 decimal), the request registers (address 0001 to 0005) will be written to the XC303 SC directly, and XV control will be temporarily disabled. After the timeout interval of five minutes, the value of register 0012 will be reset, and the system control will return to the XV303 AC.

Request example value: 0x7AB7
0x7AB7 = 31415; the Modbus TCP client can write request registers to the XC303 SC within the timeout interval

Although the XV303 AC will be temporarily disabled when using the register 0012 as described, power requests exceeding the permitted threshold will be still limited to their nominal values by the system.

5.1.7 Using Modbus TCP to write data to system control registers:

To write values to the system control registers via Modbus TCP, proceed as follows:

Step 1: Set the control mode to manual:

- Make sure the remote control is allowed from the HMI: "Settings" > "Customer Modbus TCP" > "Control mode" set to "Remote".
- Stop Timer0 if activated by writing 0x0002 to register 0033.

Step 2: Write all the registers in the range 0001 to 0012 at once to avoid timeout after 60 seconds.

Step 3: Keep running in manual mode:

- Write 0x7AB7 (31415 decimal) to register 0012 periodically, to avoid timeout after 60 seconds.

Step 4: Changing parameters:

- Rewrite the registers of your choice.
- Keep the manual mode running as described in Step 3.

Step 5: When done, exit the manual control mode:

- Write any value other than 0x7AB7 (31415 decimal) to register 0012 or let the session expire after 60 seconds of inactivity.

5.2 Timer0 control registers (scheduler events)

Although the user can configure the scheduler via the HMI, the Modbus TCP interface allows for remote adjustment of scheduler parameters. The default timer (Timer0) is used to keep the scheduler in the selected operating mode. It is strongly recommended to refer to the xStorage Compact user manual for additional information regarding the use of the parameters listed in this section.

Table 16. Default timer control registers

Address	FC	Register Name	Valid range	Scale	Unit	Size	Type
0020…0032	-	Reserved	-	-	-	-	-
0033	0x10	Start Default Timer	1…2	1	-	1	UINT16
0034	0x10	Timer Default Max Charge	0…200	1	kW	1	UINT16
0035	0x10	Timer Default Max Discharge	0…200	1	kW	1	UINT16
0036	-	Reserved	-	-	-	-	-
0037	0x10	Timer Default Min SoC	0…100	1	%	1	UINT16
0038	0x10	Timer Default Max SoC	0…100	1	%	1	UINT16
0039	0x10	Timer Default Operating Mode	1…4	1	-	1	UINT16
0040	0x10	Timer Default Peak Shave Limit	0…200	1	kW	1	UINT16

5.2.1 Start Default Timer

The register at address 0033 is used to start the default timer. Write 0x0001 to start the timer and 0x0002 to stop the timer. The default timer (Timer0) control can only be used when the System Control Method register at address 0012 is set to a value other than 0x7AB7.

Request example value: 0x0002
0x0002 = 2; the default timer has been stopped

5.2.2 Timer Default Max Charge

Maximum charging power applied to the PCS for charging the batteries can be set via the register at address 0034.

Request example value: 0x0098
0x0098 = 152; maximum charging power is limited to 152 kW

To maximize power efficiency, avoid power values lower than 5% of the rated battery power. Charging the batteries at a charging rate (C-rate) less than 1C is beneficial for extended battery lifespan.

5.2.3 Timer Default Max Discharge

Maximum discharging power applied to the PCS for discharging the batteries can be set via the register at address 0035.

Request example value: 0x0082
0x0082 = 130; maximum discharging power is limited to 130 kW.

To maximize power efficiency, avoid power values lower than 5% of the rated battery power. Discharging the batteries at a charging rate (C-rate) less than 1C is beneficial for extended battery lifespan.

5.2.4 Timer Default Min SoC

The timer will keep the scheduler running in the selected mode until the minimum State of Charge (SoC) of the batteries is reached. The minimum SoC value can be set in the register at address 0037.

Request example value: 0x000F
0x000F = 15; the minimum SoC level of the batteries to keep the scheduler in the selected mode is 15%

5.2.5 Timer Default Max SoC

The timer will keep the scheduler running in the selected mode until the maximum State of Charge (SoC) of the batteries is reached. The minimum SoC value can be set in the register at address 0038.

Request example value: 0x005C
0x005C = 92; maximum SoC level of the batteries to keep the scheduler in selected mode is 92%

5.2.6 Timer Default Operating Mode

A set of four operating modes can be applied to the scheduler, depending on the specific use case. The register at address 0039 allows setting up the operating mode:

Request value	Operating mode
0001	Charge
0002	Discharge
0003	Peak shaving
0004	Self-consumption

Request example value: 0x0003
0x0003 = 3; the default timer will keep the scheduler in peak shaving mode.

Each of the mentioned operating modes uses the energy stored in the batteries. While the system runs in the selected operating mode, the power and SoC settings in registers 0034 to 0038 will be respected. For some modes (Charge and Discharge), the default timer will be stopped upon reaching target values.

5.2.7 Timer Default Peak Shave Limit

The peak shaving limit can be set using the register at address 0040. This register allows setting the threshold at which the peak shaving mode is activated.

Request example value: 0x0010
0x0010 = 16; the peak shaving threshold is set to 16 kW

5.2.8 Using Modbus TCP to write data to Timer0 registers:

To write values to the default timer registers via Modbus TCP, proceed as follows:

Step 1: Start the timer:

- Make sure the remote control is allowed from the HMI: "Settings" > "Customer Modbus TCP" > "Control mode" set to "Remote".
- Stop manual Modbus TCP control by writing a value other than 0x7AB7 (31415 decimal) to register 0012.

Step 2: Write all the registers in the range 0033 to 0040 at once to avoid timeout after 60 seconds.

Step 3: Start the timer and keep it running:

- Write value 0x0001 to register 0033 periodically to avoid timeout after 60 seconds.

Step 4: Changing parameters:

- Stop the timer by writing 0x0002 to register 33
- Rewrite the registers of your choice as described in Step 2

Step 5: When done, stop the timer by writing 0x0002 to register 0033 or let the session expire after 60 seconds of inactivity.

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