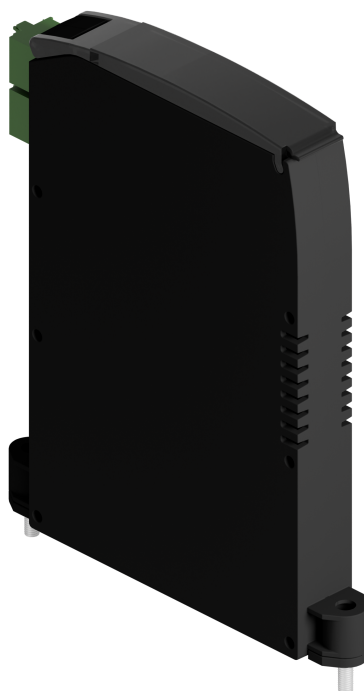


X1-GW-01



INSTRUCTION MANUAL

X1-Series Gateway for Module Configuration and Modbus TCP/IP or RTU RS485 Data Acquisition

Models: X1-GW-01

INTENDED USE

Gateway model X1-GW-01 is dedicated to X1 Series. It allows X1-TB board and X1 module Identification, as well as X1 smart module Configuration, Monitor & Diagnostics, and more sophisticated functions (Mission Time supervision, Proof Time testing for functional safety on specific modules, etc.). Up to 16(8) X1 modules can be accessed through a single X1-GW-01 Gateway installed on the same X1-TB. Gateway connectivity is possible point-to-point to a PC/IPC running SWCX1 dedicated software, or through industrial bus, MODBUS TCP/IP through RJ45 port or MODBUS RTU on RS485. A full network of X1 modules can be surveilled and controlled from a single access point, through different Gateways with dedicated addresses and external switches. Access to the Gateway can be limited through multi-user profiles with individual passwords, while an external boot loader allows firmware revision upgrade.

TECHNICAL DATA

General

Power dissipation: 0.65 W @ 24 Vdc, typical.

Power Supply

24 Vdc nom (18 to 28.8 Vdc), reverse polarity protected, provided through X1-TB.

Current consumption: 27 mA @ 24 Vdc, typical.

User interface

The Gateway can be connected through different interfaces:

- 1) point-to-point through USB-C connector;
- 2) industrial bus, MODBUS TCP/IP through RJ45 connector or MODBUS RTU through RS485.

Note that Gateway communication is limited to a single interface (session) at a time.

Module interface

The Gateway must be installed on X1-TB board, providing proprietary serial communication to X1 modules.

Max number of channels: 16.

Isolation

Module Interface/User Interface 500 V; Module Interface/Power Supply 500 V; User Interface/Power Supply 500 V.

Environmental conditions

Operating temperature: temperature limits –40 to +70 °C.

Max altitude: 2000 m a.s.l.

Storage temperature: temperature limits –45 to +80 °C.

Mounting

On custom X1-TB through captive screws.

Weight: about 105 g.

Location: Safe Area.

Dimensions: Width 16/20 mm, Depth 102 mm, Height 120 mm.

GENERAL DESCRIPTION

The following section gives essential preliminary information to correctly manage the Gateway activities.

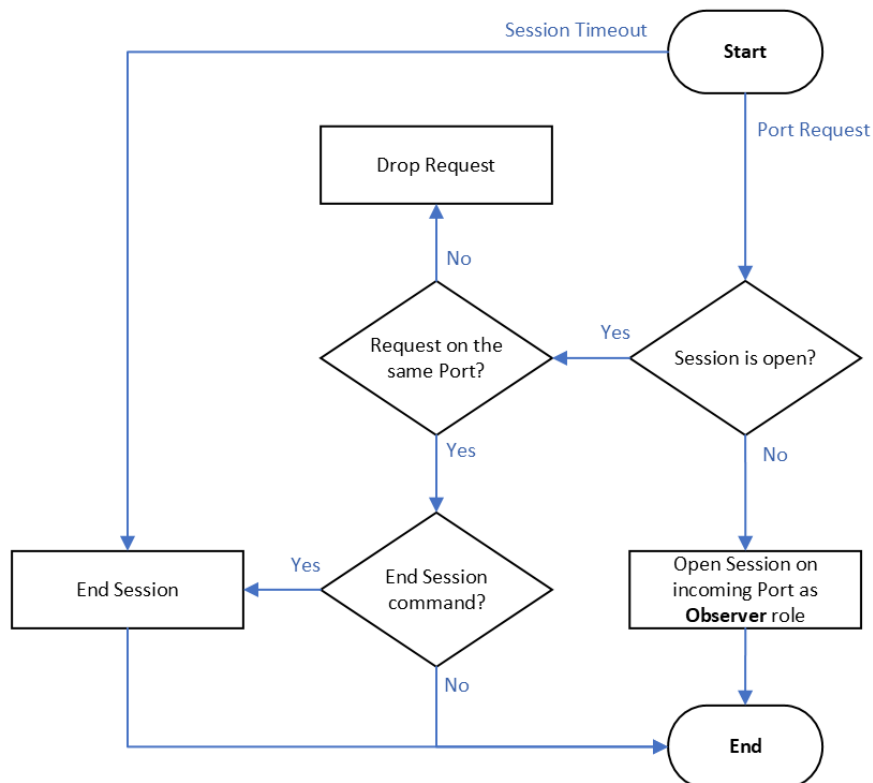
Session Management

The first received communication decides which port, among the following, opens the session:

- (1) RS485
- (2) USB
- (3) Ethernet/IP

Session management is depicted in the block diagram below and satisfies the following requirements:

- Only one session at a time can be open.
- The session closes:
 - After 10 minutes from the last communication on the open port (Session Timeout).
 - Through the End Session explicit command.
- During a session, only requests coming from the open port are executed, while other attempts to communicate are dropped.



Roles & Passwords Management

User can login according to three alternative roles:

- (1) OBSERVER: can perform only read operations. No password is required.
- (2) MAINTENANCE: can perform read and application-oriented write operations. Password can be required (by Administrator).
- (3) ADMINISTRATOR: can perform all the read and write operations carried out by Maintenance. Password can be required (by Administrator himself). Additionally, the role can:
 - Activate and change Maintenance and Administrator passwords.
 - Write Communication and Cyber Security related parameters.
 - Synchronize the internal realtime clock (especially for logging purposes).

Passwords are strings with up to 16 alphanumeric characters.

Factory settings are that Maintenance and Administrator do not require any password.

If a new login is requested, the Gateway checks if a password for the role is active. If not, the role is immediately switched,

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otherwise the password keyed in by the user is compared to the one stored in the Gateway internal memory and role change is performed only in case of positive test. Note that any time the introduced password is wrong (no matter the role), a dedicated counter is incremented. When this counter exceeds the maximum number of allowed retries (configurable by Administrator, 5 by default), a 1-minute timer is started. During the timer countdown, any introduced password is dropped. The error counter is automatically reset after that the 1-minute timer has expired or when the correct password is inserted.

When the session expires, the role is automatically switched back to Observer.

Gateway Operations

The Gateway can perform different operations:

- (1) NETWORK DISCOVERY & FULL BUILDING: it maps, at start-up and any time it is required, the termination board type and the corresponding number of supported channels. Then, it identifies all the modules installed aboard the termination board.
- (2) SINGLE BUILDING: a specific module is identified.
- (3) COMMUNICATION: read/write/command operations to a specific channel or broadcast to all connected channels.
- (4) SCAN: the Gateway scans all the populated channels, in turn, to verify the presence and the status of each module, while copying the main monitor information to a specific memory location. The user can then access this memory section at full speed to gather all meaningful field data at once.

Realtime Internal Clock

The Gateway supports an internal real-time clock, mainly for logging purposes. However, since it is reset at power cycle, it is possible to synchronize it at start-up, through a dedicated command with specific time parameters (year, month, day, hour, minute and second).

General Recommendations

- (1) USER FIRST ACCESS: If access control is required, it is recommended that the user, at first access, enters as Administrator and introduces Maintenance (if required) and Administrator passwords, while forcing their usage for future accesses.
- (2) USER STANDARD ACCESS: Maintenance and Administrator enter with their own passwords, while Observer login is always free. It is recommended that the user “logs out” by invoking the End Session command when he is done with his job, so that the Gateway is always protected.
- (3) PASSWORD RECOVERY: If Maintenance forgets his password, Administrator can help him. If Administrator forgets his password, he should contact GMI customer care, which will communicate the Master unlocking password based on the Gateway S/N, upon identification of the user.
- (4) AT EACH POWER CYCLE: If required for logging, Administrator should synchronize the internal real-time clock after each power cycle.
- (5) MODULE CONFIGURATION: It is recommended to configure the modules through GMI SWCX1 software, which allows simple operations with guided role changes, unless the application requires remote reconfiguration.
- (6) DATA ACQUISITION: The Gateway can be used for continuous field data acquisition. For this purpose, switch on the Scan Enable and read data. Note that, while Scan is active, it is not possible to perform operations (configuration, etc.) on single modules.

USER INTERFACE

Front Panel

The Front Panel hosts the operation LEDs, USB and Ethernet communication ports, and the External Boot Loader Switch.

Green/Red LED: indicates the presence of power supply; when blinking, it signals that a communication session is open.

- (1) Green/Red LED OFF: no power supply or External Boot Loader Switch active
- (2) Green LED ON: presence of power supply, no active communication session
- (3) Green LED fast blinking: presence of power supply, MODBUS TCP/IP session is open
- (4) Green LED slow/fast blinking: presence of power supply, USB session is open
- (5) Green LED slow blinking: presence of power supply, MODBUS RTU RS485 session is open
- (6) Red LED ON: internal hard fault

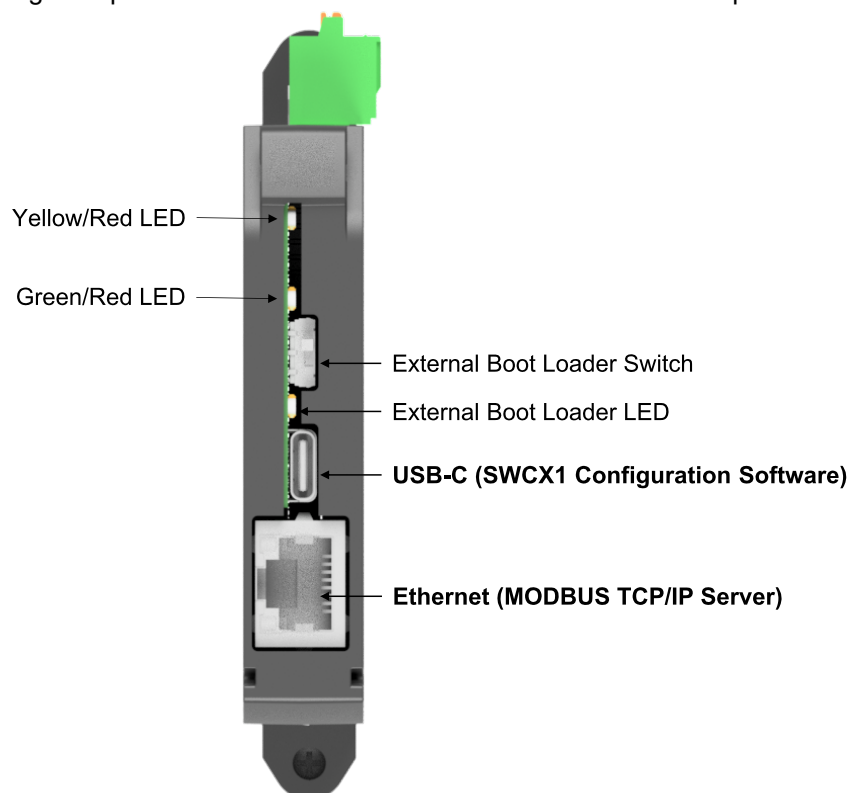
Yellow/Red LED: indicates the specific Gateway operation.

- (1) Yellow LED OFF: no activity
- (2) Yellow LED ON: Building operation on going
- (3) Yellow LED fast blinking: Scan operation active, no faults
- (4) Red LED fast blinking: Scan operation active, with faults (disconnected or mismatched modules)

USB-C Port: connect a PC/IPC to this port to run the SWCX1 dedicated software.

Ethernet RJ45 Port: connect to this port for MODBUS TCP/IP communication.

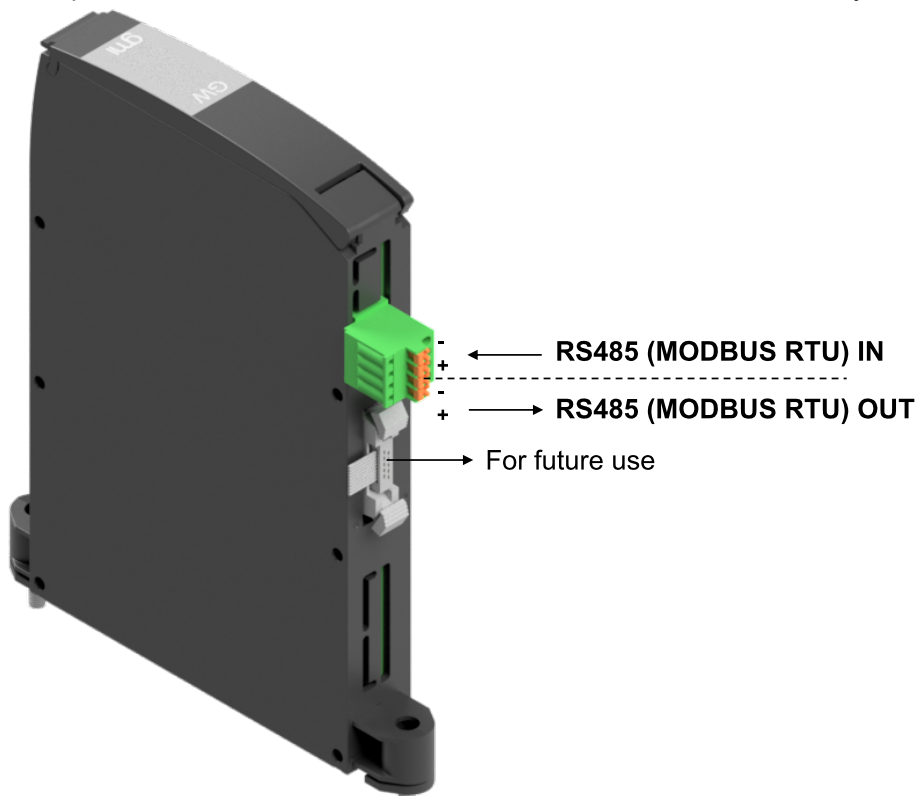
External Boot Loader Switch: the External Boot Loader Switch allows a new firmware revision upload. When activated, the corresponding red LED lights up, while the power green LED switches off: the firmware can be updated through the SWCX1 software. During regular operation the External Boot Loader Switch must be kept off.



Lateral Panel

The Lateral Panel hosts the RS485 communication port.

RS485 Port: connect to this port for MODBUS RTU serial communication. Note that in-out daisy chain is possible.



DIGITAL INTERFACES

All the parameters described in the next sections can be accessed either through the dedicated software SWCX1 running on a PC/IPC (recommended) or through a MODBUS client connected to Ethernet TCP/IP or RS485 port. Registers, which can be readable and/or writable according to the specific user role, are subdivided in partitions with different usage and role access:

- (1) Identification
- (2) Internal Diagnostics
- (3) Configuration
- (4) Communication
- (5) Cyber-Security
- (6) Command
- (7) User
- (8) Monitoring
- (9) Termination Board & Module Information
- (10) Module Scan Data.

(1) Identification

The following parameters allow the unique identification of the Gateway:

GMI Code: 18253 (decimal).

Series Code: X1 = 22577 (decimal).

SW Revision: A progressive positive number indicating the software revision.

Product Code: X1-GW-01 = 16385 (decimal).

Model Family: X1-GW = 16 (decimal).

HW Revision: A progressive positive number indicating the hardware revision.

Device Id: Module Serial Number.

MAC Address 0-1: MAC Address Bytes 0 & 1

MAC Address 2-3: MAC Address Bytes 2 & 3

MAC Address 4-5: MAC Address Bytes 4 & 5

(2) Internal Diagnostics

The following parameters indicate the module internal status:

Module Status:

bit0: Device Malfunction (0: device ok, 1: device fault)

bit1: Configuration Changed Flag (0: no change, 1: configuration changed)

bit2: Busy Flag (0: device ready, 1: device busy)

Mission Time: Mission time (days) since the first installation.

(3) Configuration

The module allows the configuration of the following parameters:

Scan Enable: Scan operation enable switch.

(4) Communication

The following parameters allow MODBUS RTU RS485 and TCP/IP communication settings, the Gateway appearing as a Server in the network.

MODBUS RS485 Server Address: Address used to access the Gateway through MODBUS RS485. Allowed values range between 1 and 247.

MODBUS RS485 Server Baudrate: Baudrate selection for MODBUS RTU RS485 communication. Supported values are: 0=19.2 kbps, 1=38.4 kbps, 2=57.6 kbps, 3=115.2 kbps.

MODBUS RS485 Server Parity: Parity selection for MODBUS RTU RS485 communication. Supported values are: 0=no parity, 1=even parity, 2=odd parity.

MODBUS RS485 Server 32-BIT ENDIANNESS: Endianness for 32-bit parameters in MODBUS RTU RS485 communication. Supported value is: 0=little endian.

MODBUS RS485 Server TERMINATION RESISTANCE: Termination resistance switch for MODBUS RTU RS485 communication. Supported values are: 0=OFF, 1=ON.



IP Address: IP IPv4 Address

Net Mask: Net Mask IPv4 Address

Gateway Address: Gateway IPv4 Address

DNS Server Address: DNS Server IPv4 Address

Max wrong login attempts: Maximum number of wrong login attempts before starting a 1-minute retry counter

(5) Cyber-Security

The following parameters are related to the role passwords.

Maintenance Password Enable: Maintenance password switch: 0=OFF, 1=ON

Maintenance Password: Maintenance role password is 8 word (16 byte) wide, for up to 16 ASCII characters.

Administrator Password Enable: Administrator password switch: 0=OFF, 1=ON

Administrator Password: Administrator role password is 8 word (16 byte) wide, for up to 16 ASCII characters.

(6) Command

The following parameters are related to Gateway command execution.

Gateway Command: Command execution register. Acceptable values are:

0 = No command

2 = Write Configuration Parameters to Non-Volatile Memory

3 = Write Communication Parameters to Non-Volatile Memory

4 = Write Cyber-Security Parameters to Non-Volatile Memory

5 = Write Tags to Non-Volatile Memory

8 = Reset Changed Configuration Flag

10 = End/Close Session

11 = Login Check

12 = Realtime Internal Clock Synchronization

17 = Full Build (Building on all channels)

18 = Single Build (Building on single channel)

Wrong values or operations requested from unauthorized roles will be replied with "Illegal Data Value".

Single Build - Channel Id: Target channel (1-256) for Single Build operation.

Internal Time Synchro - Year: Year (2000-2100) for internal time synchronization operation.

Internal Time Synchro - Month: Month (1-12) for internal time synchronization operation.

Internal Time Synchro - Day: Day (1-31) for internal time synchronization operation.

Internal Time Synchro - Hour: Hour (0-23) for internal time synchronization operation.

Internal Time Synchro - Minute: Minute (0-59) for internal time synchronization operation.

Internal Time Synchro - Second: Second (0-59) for internal time synchronization operation.

Module Command - Module channel: Target channel (0-255) for module command execution.

Module Command - Command Id: Specific module command id. Acceptable values are:

0 = No command

3 = Write Configuration Parameters to Non-Volatile Memory

8 = Reset Changed Configuration Flag

(7) User

User registers are accessible to all and enable role switching.

Login Role: Write the role to switch to: 0=Observer, 1=Maintenance, 2=Administrator.

Password: Role password is 8 word (16 byte) wide, for up to 16 ASCII characters.

(8) Monitoring

Monitoring parameters register the current Gateway conditions.

Current Session Role: Currently open session role: 0=Observer, 1=Maintenance, 2=Administrator.

Current Session Status: Currently open session status: 0=Close, 1=Open.

Current Session Port: Currently open session port: 0=RS485, 1=USB, 2=Ethernet TCP/IP.

Wrong Login Attempts: Current number of wrong login attempts.

Internal Clock - Year: Current year of the internal clock.

Internal Clock - Month: Current month of the internal clock.

Internal Clock - Day: Current day of the internal clock.

Internal Clock - Hour: Current hour of the internal clock.

Internal Clock - Minute: Current minute of the internal clock.

Internal Clock - Second: Current second of the internal clock.

(9) Termination Board & Module Information

Data related to X1 Termination Board and Modules can be found in this section.

Channel Tags: This partition collects the tags of all the addressable channels (up to 16). Each tag is 8 word (16 byte) wide, for up to 16 ASCII characters each.

Termination Board Information: This partition shows the X1 board information, including type and number of channels. Termination board type can be found on the corresponding model instruction manual

Module Information: A single head Gateway can manage up to 16 channels, installed on a single board. All information regarding the modules are assigned 200 words (2 byte each), starting from address 10000. Within the 200 assigned registers, module information is organized as indicated in the corresponding model instruction manual. For example, to monitor the current through an X1-IS-AI-01-S analog input barrier placed on the 10th position, the correct address to be interrogated is $10000 + 200 \times (\#CH - 1) + ParamAdr = 11800 + 63 = 11863$.

(10) Module Scan Data

This section contains field data continuously retrieved by all built modules during Scan. Each module is reserved 4 words (2 bytes each):

- (1) Primary Variable
- (2) Secondary Variable
- (3) Tertiary Variable
- (4) Field Fault Status (0 = No Fault, 1 = Fault)

Scan operation can be used with the following models:

- (1) X1-IS-AI-01-S
- (2) X1-IS-AI-02-S
- (3) X1-IS-AO-01-S
- (4) X1-IS-AO-02-S
- (5) X1-IS-DI-02-S
- (6) X1-IS-DO-01-S
- (7) X1-IS-DO-02-S
- (8) X1-IS-TMP-01-S
- (9) X1-IS-UNI-01-S
- (10) X1-NIS-AI-01-S
- (11) X1-NIS-AI-02-S
- (12) X1-NIS-AO-01-S
- (13) X1-NIS-AO-02-S
- (14) X1-NIS-DI-02-S
- (15) X1-NIS-DO-01-S
- (16) X1-NIS-DO-02-S
- (17) X1-NIS-TMP-01-S
- (18) X1-NIS-UNI-01-S
- (19) X1-NIS-RLO/SS-04-S
- (20) X1-NIS-RLO/SS-05-S

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(21) X1-NIS-RLO/EM-04-S

(22) X1-NIS-RLO/EM-05-S

The content of the first three variables is model dependent and it is indicated in the corresponding instruction manual.

Gateway MODBUS Addresses

X1 Series Gateway family X1-GW allows the communication to the module through MODBUS protocol. Address, type, factory values and access rights (subject to user role) of the available parameters are reported in the following table:

MODBUS	Parameter	Type	Factory Value	Access
0	GMI Code	Uint16	18253	R
1	Series Code	Uint16	22577 (X1)	R
2	SW Revision	Uint16	Gateway SW rev.	R
3	Product Code	Uint16	16385 (X1-GW-01)	R
4	Model Family	Uint16	16 (X1-GW)	R
5	HW Revision	Uint16	Gateway HW rev.	R
6	Device ID	Uint32	Gateway S/N	R
8	MAC Address 0-1	Uint16	-	R
9	MAC Address 2-3	Uint16	-	R
10	MAC Address 4-5	Uint16	-	R
11	Module Status	Uint16	-	R
12	Mission Time	Uint16	-	R
16	Scan Enable	Uint16	0 (No Scan)	R(O), RW(M/ A)
100	MODBUS RS485 Server Address	Uint16	1	R(O/M), RW(A)
101	MODBUS RS485 Server Baudrate	Uint16	1 (38.4 kbps)	R(O/M), RW(A)
102	MODBUS RS485 Server Parity	Uint16	1 (Even parity)	R(O/M), RW(A)
103	MODBUS RS485 Server 32-BIT Endianness	Uint16	0 (Little endian)	R
104	MODBUS RS485 Server Termination Resistance	Uint16	0 (OFF)	R(O/M), RW(A)
106	IP Address (High Part)	Uint16	49320 (192.168)	R(O/M), RW(A)
107	IP Address (Low Part)	Uint16	10 (0.10)	R(O/M), RW(A)
108	Net Mask (High Part)	Uint16	65535 (255.255)	R(O/M), RW(A)

MODBUS	Parameter	Type	Factory Value	Access
109	Net Mask (Low Part)	Uint16	65280 (255.0)	R(O/M), RW(A)
110	Gateway Address (High Part)	Uint16	49320 (192.168)	R(O/M), RW(A)
111	Gateway Address (Low Part)	Uint16	100 (0.100)	R(O/M), RW(A)
112	DNS Server Address (High Part)	Uint16	2560 (10.0)	R(O/M), RW(A)
113	DNS Server Address (Low Part)	Uint16	5 (0.5)	R(O/M), RW(A)
114	Max wrong login attempts	Uint16	5	R(O/M), RW(A)
200	Maintenance Password Enable	Uint16	0 (OFF)	RW(A)
201-208	Maintenance Password	Uint16	"0000000000000000"	RW(A)
209	Administrator Password Enable	Uint16	0 (OFF)	RW(A)
210-217	Administrator Password	Uint16	"0000000000000000"	RW(A)
300	Gateway Command	Uint16	-	W*2
301	Channel for Single Build (Shared with next)	Uint16	-	W(A)
301	Internal Time Synchro - Year (Shared with previous)	Uint16	-	W(A)
302	Internal Time Synchro - Month	Uint16	-	W(A)
303	Internal Time Synchro - Day	Uint16	-	W(A)
304	Internal Time Synchro - Hour	Uint16	-	W(A)
305	Internal Time Synchro - Minute	Uint16	-	W(A)
306	Internal Time Synchro - Second	Uint16	-	W(A)
307	Module Command: Module Channel (0-15)	Uint16	-	W(A)*1
308	Module Command: Command Id	Uint16	-	W(A)*1
309	Module Command: Command Parameters	Uint16	-	W(A)*1
400	Login Role	Uint16	-	W
401-408	Password	Uint16	-	W
500	Current Session Role	Uint16	-	R
501	Current Session Status	Uint16	-	R
502	Current Session Port	Uint16	-	R
503	Wrong Login Attempt Counter	Uint16	-	R
504	Internal Clock: Year	Uint16	-	R
505	Internal Clock: Month	Uint16	-	R
506	Internal Clock: Day	Uint16	-	R
507	Internal Clock: Hour(0-23)	Uint16	-	R



MODBUS	Parameter	Type	Factory Value	Access
508	Internal Clock: Minute	Uint16	-	R
509	Internal Clock: Second	Uint16	-	R
1000-1007	X1 Channel 1 Tag	8 x Uint16	-	R, W(M/A)
1008-1015	X1 Channel 2 Tag	8 x Uint16	-	R, W(M/A)
...	X1 Channel j Tag	8 x Uint16	-	R, W(M/A)
4000	X1-TB 1 Type	Uint16	-	R
4001	X1-TB 1 Number of Channels	Uint16	-	R
10000-10199	X1 Module 1 Information	200 x	-	R, W(M/A)
10200-10399	X1 Module 2 Information	200 x	-	R, W(M/A)
...	X1 Module j Information	200 x	-	R, W(M/A)
62000-62003	X1 Module 1 Scan Registers	4 x Uint16	-	R
62004-62007	X1 Module 2 Scan Registers	4 x Uint16	-	R
...	X1 Module j Scan Registers	4 x Uint16	-	R

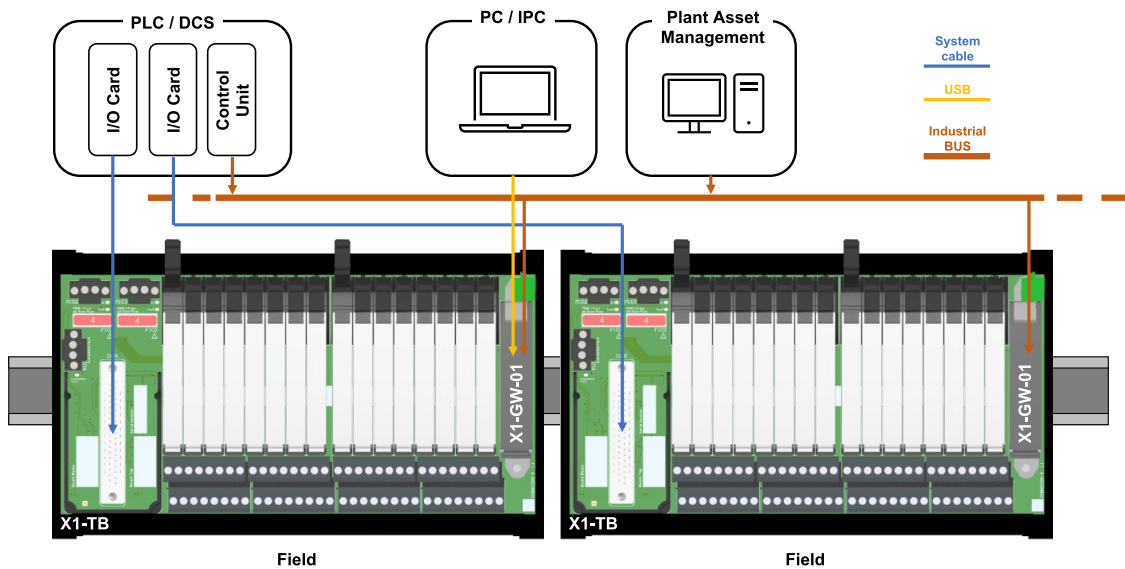
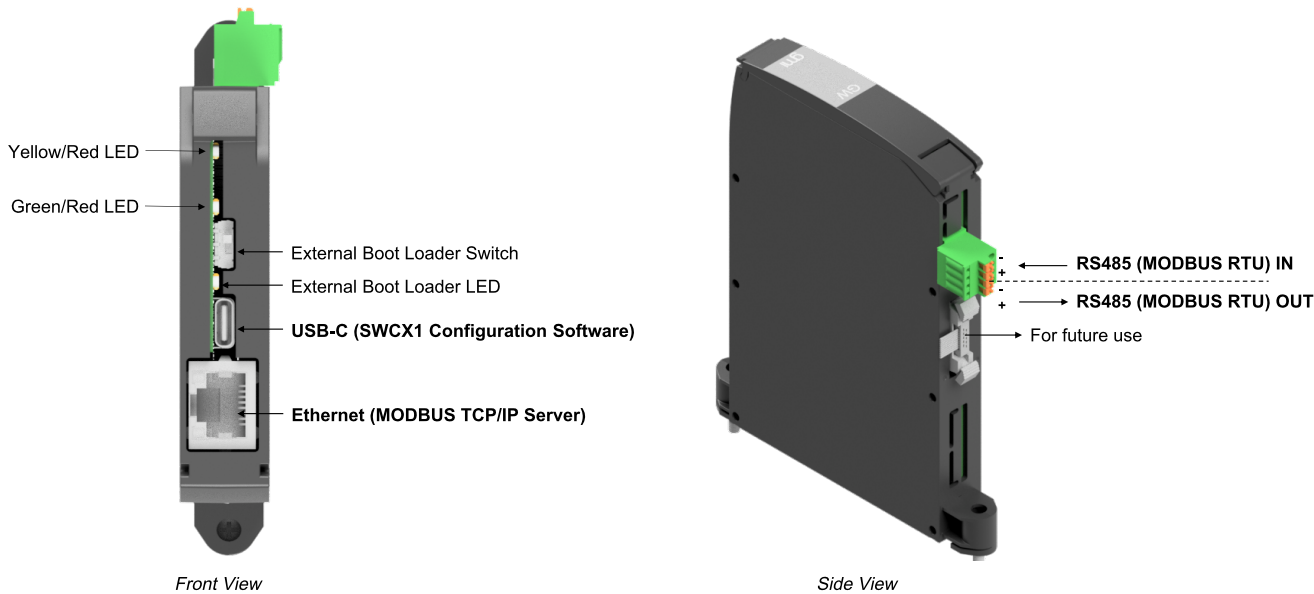
Notes:

- In the access right column: O=Observer, M=Maintenance, A=Administrator. When not specified, operation refers to any role.
- (*1) Module commands registers (addresses 307 to 309) must be written within the same MODBUS write command. Accessibility is specified in the dedicated table.

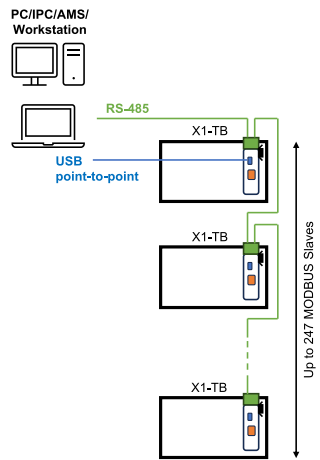
Command	Description	Access Rights		
		Observer	Maintenance	Administrator
3	Write Configuration parameters to EEPROM	N	Y	Y
8	Reset Configuration Flag	N	Y	Y

Note:
 (*2) Gateway commands are not accessible to all roles. The following table specifies who can do what.

Command	Description	Access Rights		
		Observer	Maintenance	Administrator
2	Write only Configuration registers to EEPROM	N	Y	Y
3	Write only Communication registers to EEPROM	N	N	Y
4	Write only Cyber Security registers to EEPROM	N	N	Y
5	Write only Tag registers to EEPROM	N	Y	Y
8	Reset Changed Configuration Flag	N	Y	Y
10	Close/End Session	N	Y	Y
11	Check login and password	Y	Y	Y
12	Internal Realtime Watch Synchronization	N	N	Y
17	Full Build	N	N	Y
18	Single Build	N	N	Y



MODBUS RTU RS-485 NETWORK



MODBUS TCP/IP NETWORK

