grand centrix NB-IoT Module Enables Cloud Connectivity Instruction Manual

Contents

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Modbus Cloud Connect System

System Overview

The Modbus Cloud Connect System is an integrated solution that enables the con-nection of Modbus RTU devices via NB-IoT and LTE-M to the cloud. A compact, CE-certified gateway, the Modbus Cloud Connect Module is installed locally to access one or multiple Modbus server devices on the Modbus RTU bus (RS-485, 2-wire). In addition to periodic read-outs, the system also supports alarm triggering as well as on-demand writing of Modbus registers on the respective Modbus devices.

The gateway includes a factory-installed and tested Vodafone Global MFF2 SIM card (eSIM) to enable data transmission via Narrowband IoT (NB-IoT) and LTE-M in over 25 countries. The necessary data plan for connectivity tariffs is included to directly take advantage of this cellular low power wide area (LPWA) network technologies. For device management, a self-service portal is also part of the system. Here, all relevant device configurations and Modbus RTU bus configurations can be done. The portal also includes an online live data monitor. Finally, the system supports flexible data connection to your backend through cloud adapters (MQTT, HTTP), also configured in the portal. Configuration within the self-service portal supports several layers of templates for Modbus server devices and Modbus systems (each supporting several Modbus server devices). These templates can be used as blueprints for systems that are configured with a Modbus Cloud Connect [MoCC] Module, which allows the creation of complex systems in the field with only a few steps in the self-service portal.

This is ideal for deployments with a larger number of setups with identical or similar installation scenarios.

Technical support is provided for the reliable operation of the solution, including a service desk and initial support for the administration and configuration of the Modbus Cloud Connect Modules as well as the connection of your systems via cloud adapters using the self-service portal. This chapter provides a complete step-by-step journey, from an empty account to a working Modbus solution that delivers data to a cloud backend. The focus is on a

Read the Safety Information chapter of this user guide before using this device. Failure to comply with safety warnings can result in serious injury.

System Walkthrough

quick and easy onboarding experience, without covering all possible corner cases. References are given to the following chapters which explain each step and part of the system in greater detail.

Service Portal Onboarding

With the purchase of your first Modbus Cloud Connect Module, you should have received an email invitation to the self-service portal. Follow the steps described in this email to create a user account in the system. For more details about this procedure, see Initial Access (Onboarding).

Create a Device Type

The next step is to create a device type for the Modbus server device you want to connect. This contains the register definitions and the rules defining how to read and send these registers. For details see the section Device Types.

Create a System Type

A system type defines the blueprint for a Modbus RTU bus configuration. It holds the previously configured device type(s) to describe the Modbus server devices, together with their respective server IDs, and the RS-485 bus configuration (baudrate, parity, stop bits). See Claim a Modbus Cloud Connect Module (Modbus Devices): This step takes ownership of the Modbus Cloud Connect Module, which is the actual hardware that you purchased with the system. By scanning the QR code on the type plate of the product (or from one of the labels on or in the packaging), the Cloud Connect Module becomes visible in your account. For details, refer to Claim a Modbus Cloud Connect Module.

Define a System

By combining a claimed Cloud Connect Module and a system type, you create a system. Read section System for more information.

Install the Hardware

Install and wire the Modbus Cloud Connect Module (see chapter Mod-bus Cloud Connect), including all necessary power and communication connections. Power the device, watch it connect to the cellular network, get its configuration from the cloud, and start reading out Modbus registers by observing the LED (chapter LED Operating States).

Verify Register Readout

Watch data coming in from the device using the live data point monitor in the system view.

Create a Cloud Adapter

Configure a cloud adapter to transmit data to your cloud or backend system, chapter Cloud Adapter, and verify data is coming in on your side of the system. The Modbus Cloud Connect Module is just a single division unit in width.

Modbus Cloud Connect

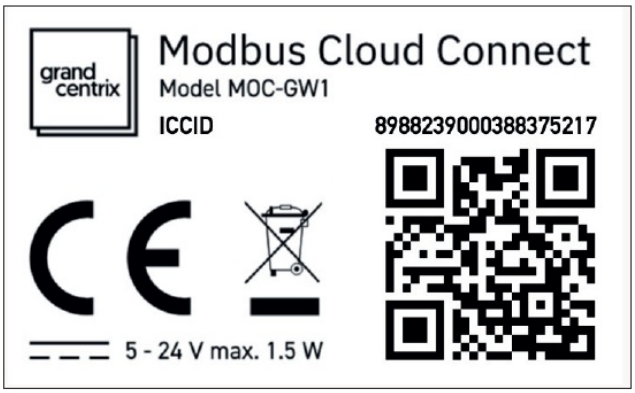
(18mm). All electrical connections are provided by pluggable terminal blocks on the bottom, and the 50Ω SMA antenna port is found on the top side. The form factor of the device supports mounting in typical electri-cal distribution cabinets (with plastic covers that cover the electrical connections).

DIN Rail Mounting

The device is mounted on a 35mm top-hat DIN rail (TH35). It clips onto the DIN rail with two plastic clamps. Make sure the clamps are correctly installed on the housing as shown above, then simply hook the device on the top or bottom edge of the DIN rail and press down on the respective other side. The attachment can be released by grabbing the rectangular opening in one of the DIN rail clamps with a flat-head screwdriver, gently lever-ing away from the DIN rail, and pulling the device off the rail.

Type Plate

The device type plate shows the regulatory required device information and certification marks, as well as the Integrated Circuit Card Identification Number (ICCID) which serves as the unique identifier or serial number for the individual device. The type plate contains a QR code that is used to onboard the device; this includes the ICCID as well as a special authentication code that is unique to the individual device. The type sticker is attached to the side of the module. Once installed, it might become obstructed by other devices on the same DIN rail. To allow for scanning of the QR code after installation, the device package contains an additional, identical type plate sticker. This can be attached to some other part of the installation (where it is permanently visible), or kept as a part of the system documentation.



Type Plate

Type Plate Next Generation

LED

There is a single, full-color (RGB) LED on the top cover of the device. The LED indicates the operating state as well as certain runtime events of the system.

LED Operating States

Continuous light or a regular blinking pattern is used to show the operating state of the device. See the table below for the list of LED operating states.

Color Pattern	Device Operating State
solid yellow	device startup (boot loader)
blinking white	searching for and connecting to the cellular network
solid white	connected to cellular network (normal operating condition)
blinking purple	firmware over-the-air update (FOTA) in progress
LED off	no power (should not happen in normal operation)

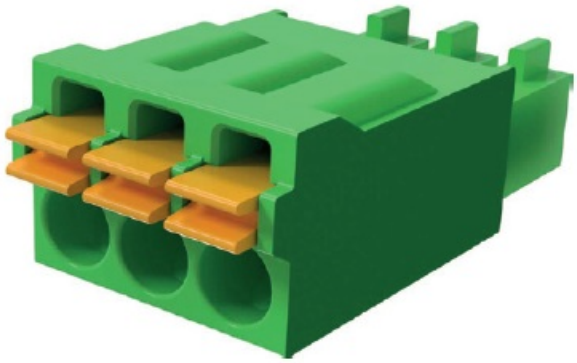
LED Events

The continuous LED pattern will be interrupted to signal individual events, such as activity on the Modbus or reception of certain commands from the cloud. After displaying the event, the LED will revert to displaying the pattern for the operating state.

See the table below for a list of LED events.

Color	Device Event
short green flash	successful Modbus transaction (read or write)
long red flash	failed Modbus transaction (read or write)
short blue flash	system configuration command received from cloud

Electrical Connections



Pluggable Terminal Block

Terminal Block

Both power supply and RS-485 communication interface are connec-ted at the bottom of the device, each via a pluggable terminal block, see figure Pluggable Terminal Block. The terminal blocks are supplied with the device. They use the de-facto industry standard 3.5mm plug-system, so if lost or damaged, they can be replaced with compatible parts such as Phoenix Contact FMC 1,5/3-ST-3,5 or Würth 691304100003. The connectors enable convenient connection with spring clamps without the need for screws. Stripped solid wire can directly be pushed into the connector without a tool. Stripped stranded wire can also directly be used without a ferrule, but the orange lever needs to be operated with a small flat screwdriver to insert the wire. The use of nonsleeved ferrules is possible but unnecessary and not recommended. Refer to the table below for the recommended wiring methods. To remove a wire from the terminal block, press down on the respective orange lever using a small flat screwdriver. This opens the internal cage clamp and the wire can be easily removed while the lever is held down.

Do not use ferrules with plastic sleeves on the wire connections. Sleeves could become stuck in the terminal block openings.

- Wire Type solid or stranded wire
- Wire Cross-Section (metric) 0.2mm² – 1.3mm²
- Wire Cross-Section (AWG) 24 – 16
- Strip Length 9mm

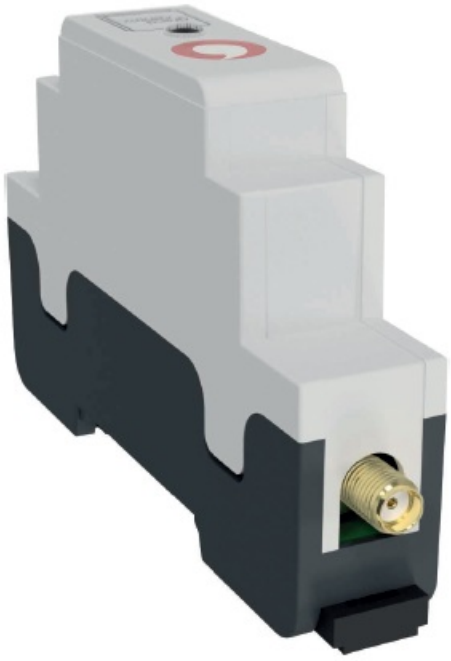
Pin AssignmentThe figure above shows the mapping that signals the ap to which pins on the pluggable terminal by showing the pad print atop the device next to the terminal layout.

Front Terminal Block Pinout

Power Supply

The device requires a 5 . . . 24V DC power supply, connected on the bottom row of the terminal connector (the left pin is the positive supply voltage, and othe ther pins are system ground, see figure Front Terminal Block Pinout). Since the device does not have a dedicated power switch, it is recommended to install a separate switch, circuit breaker, or similar to be able to switch the device on or off independently from the rest of the installation.

- When a 5V DC power source is used, make sure the voltage is stable, as there is little headroom for voltage dips.
- Never connect any of the device inputs to live voltage, any kind of AC voltage, or any nominal DC voltage above the device rating of 24V. Doing so will permanently damage the device and risk electric shock.



RS-485 Bus

The RS-485, two-wire Modbus connection is located on the top row of the terminal connector (see figure Front Terminal Block Pinout for details). Note that A is the positive RS-485 signal (sometimes called A+, D+, or simply + on other devices), while B is the negative RS-485 signal (also called B-, D-, or -). For longer RS-485 bus lengths with high transmission speeds, bus termination at both ends of the bus, typically with 120Ω, is suggested. There is no internal bus termination resistor in the device. The RS-485 pins of the device are protected against overvoltage events up to the maximum operating voltage (24V DC), so an accidental connection of the power supply to the RS-485 bus will not damage the device. However, note that if there are other devices on the RS-485 bus, these might not have an equivalent level of protection.

- The RS-485 bus is referenced to system ground. If other bus participants are supplied from the same power supply, make sure these use the same ground potential

Antenna Connection

The device has an industry-standard, female SMA antenna port above the housing, see the figure above. One of two possible antenna options is supplied with the device. Connect the male SMA connector of the antenna cable to the SMA port of the device and screw the hand tight (do not use excessive force).

- Antenna cables are coax cables and are especially susceptible to damage from bending or squeezing. Make sure the antenna cable does not get kinked when installed in tight areas.

Antenna

The Modbus Cloud Connect Device is delivered with one of two possible antenna options. Choice of the appropriate antenna needs to be made before ordering the device depending on the installation environment.

Magnetic Antenna

The magnetic antenna is primarily designed to hold onto metallic/conductive surfaces, e.g. metal housings, shelves, holding brackets, etc. In addition to the magnet that is integrated into the antenna foot, it also has double-side side adhesive tape that can be used to permanently fix the antenna to the mounting surface. To achieve an optimal radiation pattern, always install this antenna in an upright position.

Magnetic Antenna

Adhesive Antenna

The adhesive antenna is meant for mounting on non-metal surfaces, like plastic distribution boxes, plastic face plates of machines, cardboard, wooden frames, etc. It is equipped with double-sided adhesive tape on the underside of the antenna body. One typical application is mounting the antenna on the inside of a plastic enclosure of a larger device. This is especially useful if the antenna solution should not be visible to the end user or the enclosure needs to have properties that prohibit the use of an external antenna (like water- or dust-proof enclosure).

Adhesive Antenna

Do not attach the adhesive antenna directly to a metal surface. This will prevent the antenna from effectively radiating power.

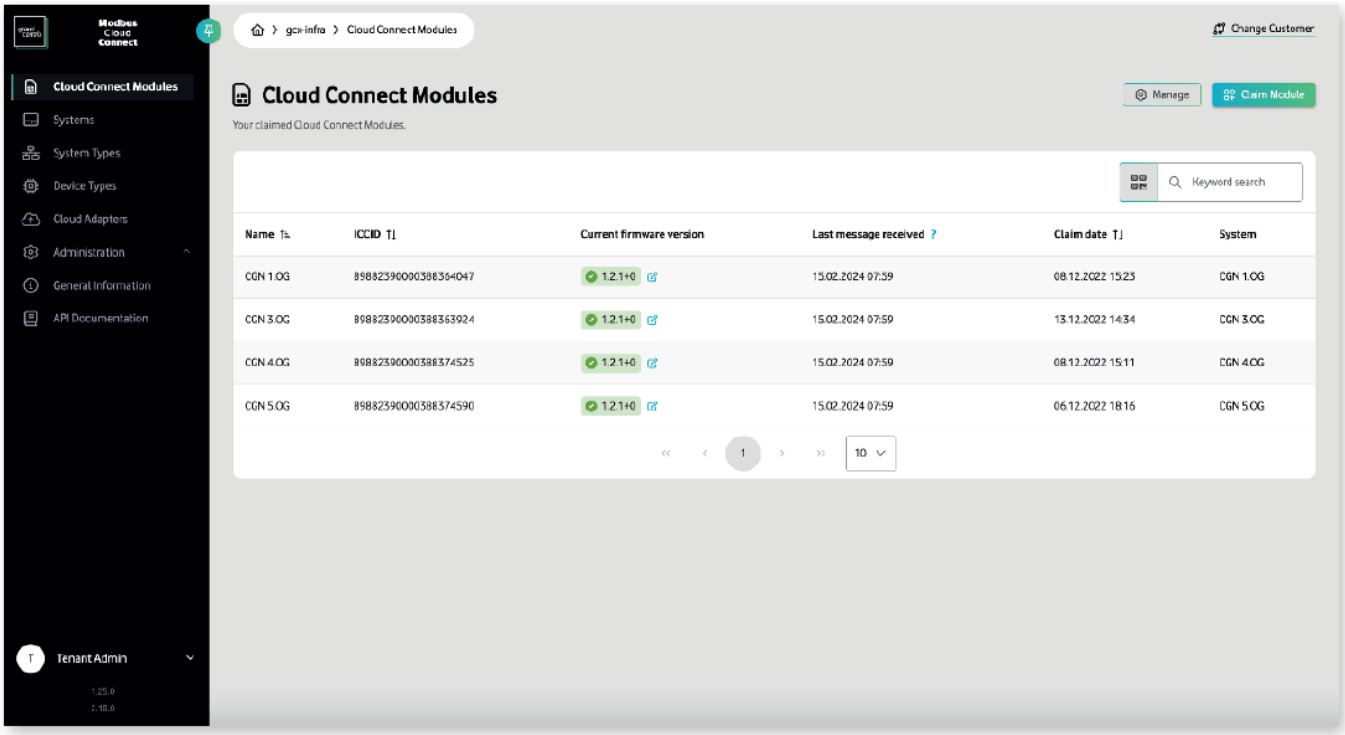
Non-Standard Antennas

In principle, it is possible to use a custom, nonstandard antenna with the device. Please note that this option should only be used by experienced users familiar with radio and antenna technology, as the end user takes full responsibility for compliance with regulatory requirements. The respective antenna must have an SMA (male) connector, 50Ω input impedance, and a maximum antenna gain of 5 dBi. Generally, an antenna with omnidirectional radiation characteristics and an efficiency of ≥ 80% in the cellular LPWA (NB-IoT, LTE-M) network bands are suggested. These frequencies include LTE bands 3, 8, 20, and 28.

- As with any antenna solution, keep the antenna body away from metal parts (an exception is the metal mounting surface for the magnetic antenna).
- Never install an antenna within a metal box, as this will prohibit any reasonable radio performance (Faraday cage). If the device itself is within a metal enclosure, use the antenna cable to place the antenna outside of the enclosure.

Self-Service Portal

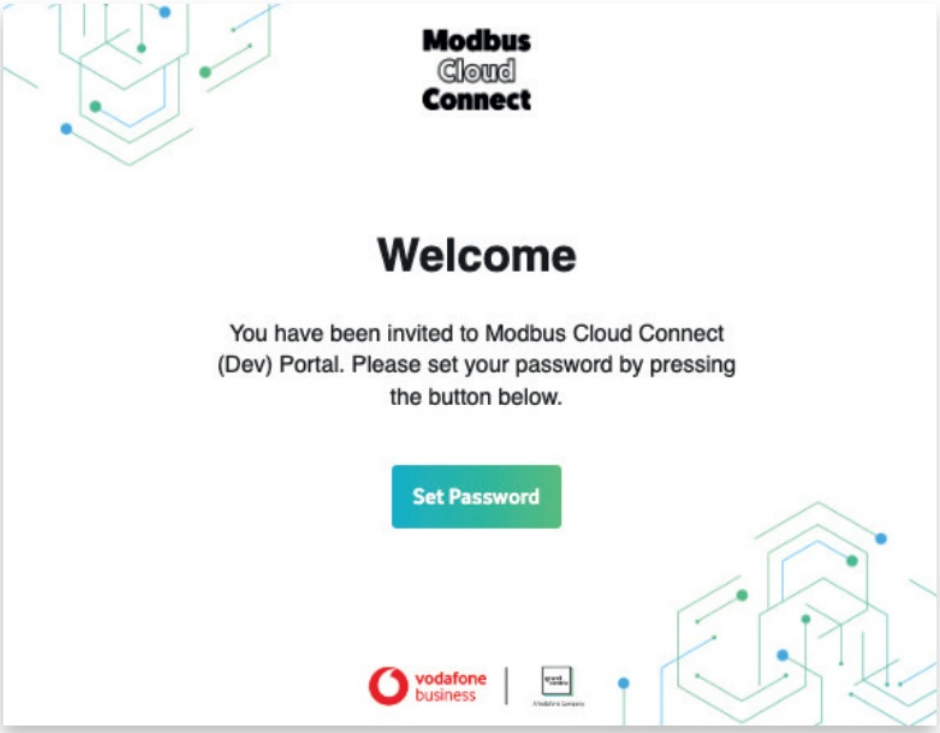
All parts of the Modbus Cloud Connect System are configured and managed through the self-service portal at https://modbuscloudconnect.net. This includes the provisioning of the gateway devices, which receive their configuration from the self-service portal via the cellular network connection, as well as the cloud adapters which define how data is forwarded to your backend system. See the figure below for a screenshot of the self-service portal with Cloud Connect Modules already in service. Note that the Modbus Cloud Connect self-service portal does not store any actual Modbus payload data. Payload data is forwarded “on the fly” from the local gateway(s) through the configured cloud adapter(s) towards your backend infrastructure.



Modbus Cloud Connect Self-Service Portal

Initial Access (Onboarding)

As a part of the overall customer onboarding process, you should have received an email with an invitation link for the Modbus Cloud Connect self-service portal (see figure New User E-Mail). By clicking the button, you can set a password which creates the first user (administrator) within the portal. If you did not receive this initial invitation mail, please go to the service portal at https://service.grandcentrix.net and let us know so we can restart the initial onboarding. Procedure.



New User E-Mail

Users

With the initial onboarding, only a single user is created within your account, who will automatically have administrator access. More user accounts can be created as needed, by selecting “Administration / Users” from the left-side menu.
It is not strictly necessary to have multiple users with separate roles in the system because in principle a single user can manage all system properties with a single account. Separate roles typically make sense if different people act in different roles, for example in larger corporate structures or when working together with subcontractors. When a new user account is created, the system will send an e-mail to the specified e-mail address, allowing the user herself to enter the password for the new account (see figure above). The administrator creating the user can define a role for the new user. The following roles are available:

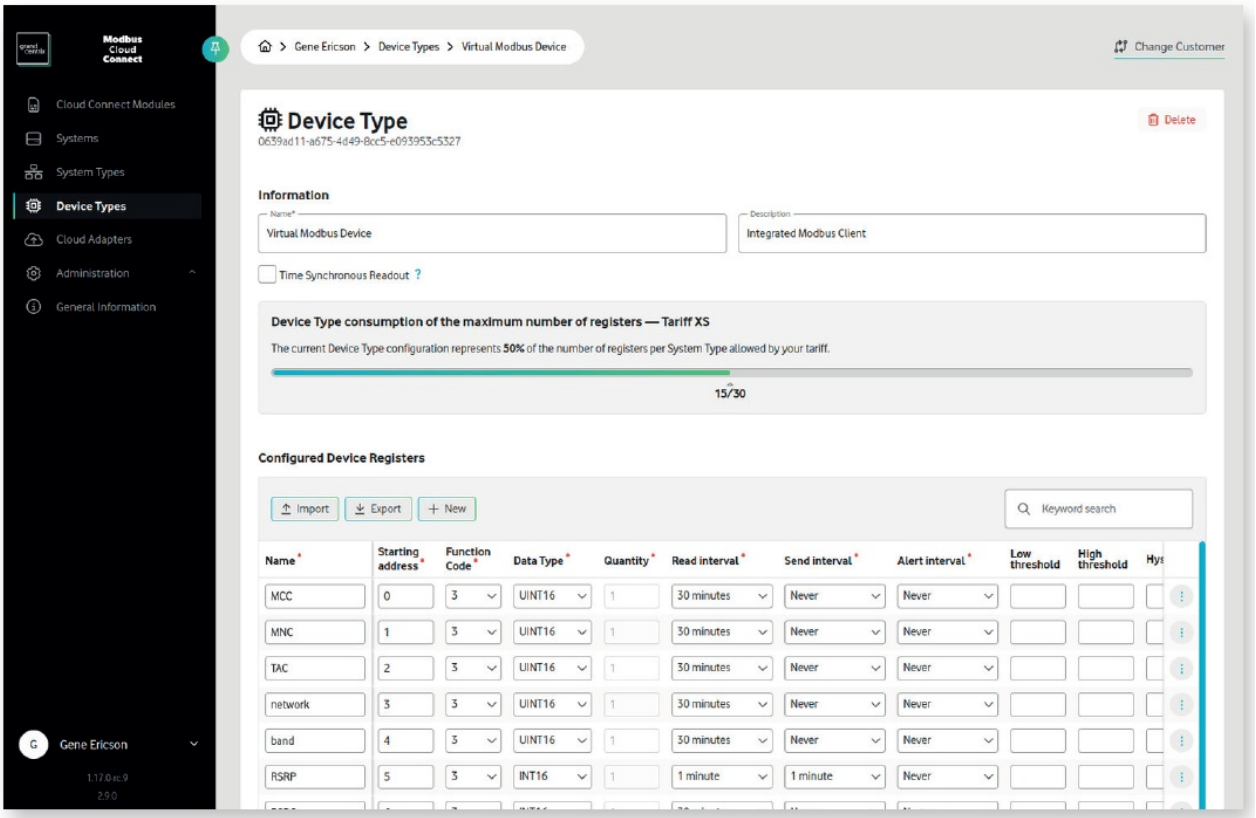
- Admin.
- Specialist.
- Installer.

Device Types

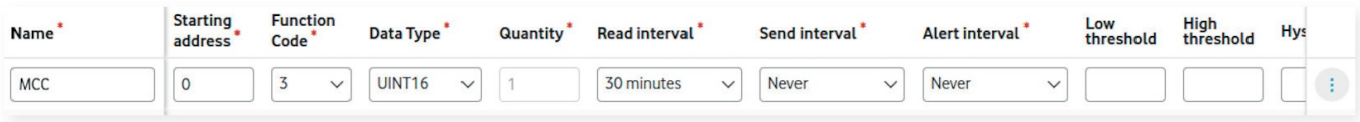
Device types describe Modbus server devices in terms of their register configuration for readout. A device type is defined once for a particular type of Modbus server device and later used as a template for an actual instance of this Modbus server device within an installation. As an example, if you have a Modbus-enabled electrical energy meter, you can define a device type for it, which will contain all the registers to be read from this specific type of energy meter. The device type does not yet refer to an actual meter in an actual installation, and it does not yet have a Modbus device address. It will later be used as a part of a system type. Usually, a specific type of Modbus server will only need one device type in the system, which will then be reused for all occurrences of this type of Modbus server in all installations. In special cases, it might however be necessary to define more than one device type for the same type of Modbus server, if you want to read certain registers only in some installations or if you want to read registers at a different time interval in different installations.

Time Synchronous Readout

By default, the configured intervals are calculated according to the last restart of the module (e.g. if the last restart was on 01.08.2023 at 14:30:35 and the read interval is set to 5 minutes, the first read after the restart was performed on 01.08.2023 at 14:35:35). There are some special cases where the reading must be performed time-syn-synchronously to the absolute device time. For these kinds of use cases, we have a time-synchronous readout feature, which can be enabled by our customer service upon request. After enabling it, you can activate this option by selecting the checkbox „Time Synchronous Readout. If a system contains at least one device that has time-synchronous readouts enabled, the entire Cloud Connect module operates in time-synchronous readout mode.



Device Type Configuration



Device Register

Register Definition

The main function of a device type is that it acts as a container for Modbus register definitions, along with defining how and at which time intervals to read and transmit them to the network.
Create a new register. For the following register configuration, you need to know the Modbus register layout of the Modbus server device you are going to read. If in doubt, consult the reference documentation of the respective device, which should have a table or list of register definitions. Each register has a name that can later be used to identify the data when it is delivered through a cloud adapter (through the modbusRe-gisterName template field, (see section Template Fields). The starting address is the Modbus register address, as a decimal number,

without any kind of offset. Note that some Modbus devices might define this differently: there are devices on the market that label the register on address 0 as 1, or label the register on address 0 as 300000 because it is used with function code 3, or generally expect register addresses in hex (without explicitly stating this anywhere). In Modbus Cloud Connect, the configured register address is exactly the one used in the protocol, in decimal notation.

Function code is the Modbus function code used to periodically read the register. Since the Modbus protocol defines function codes 1 – 4 as those used for read access, these are exactly the values that can be chosen here.

Data type controls how the data read over the Modbus protocol will be treated when transferred over the network.

Refer to the table for the list of data types to choose from. The INT and UINT data types are per Modbus specification in MSB first (big-endian) byte order. For compatibility with “peculiar” devices, variants with LSB first (little endian) byte order (XXX_LE) and mixed-endian byte order (for 32 and 64-bit types, XXX_ME) are also provided.

Data type	Description
INT16	Modbus signed integer (single register, 16-bit)
UINT16	Modbus unsigned integer (single register, 16-bit)
INT32	Modbus signed integer (two registers, 32-bit)
UINT32	Modbus unsigned integer (two registers, 32-bit)
INT64	Modbus signed integer (four registers, 64-bit)
UINT64	Modbus unsigned integer (four registers, 64-bit)
FLOAT32	IEEE 754 floating point number (two registers, 32-bit)
FLOAT64	IEEE 754 floating point number (four registers, 64-bit)
RAW	Raw data, serialized as a hex string (e.g. „00f0“)
UINT8	Integer with values 0 or 1, only for single-bit reads with Modbus function codes 1 or 2

Little- and mixed-endian integer representations are highly unusual in Modbus. Use them only if you are certain you have a nonstandard Modbus server that requires them.

Quantity is the number of Modbus coils (single-bit, for function codes 1 and 2) or registers (each 16-bit, for function codes 3 and 4) that are read for the respective data types. When choosing one of the numeric data types, this value is displayed for information only as it can be derived from the length of the data type. For the RAW data type, you need to explicitly set this field.

- **Low threshold and High threshold** are optional parameters for numeric data types (INT, FLOAT). If set, each time a register is read from the Modbus server device, it is compared against these thresholds. If the value read is smaller than the low threshold or bigger than the high threshold, an alert state is set on the register. The alert state governs whether the send interval or the alert interval defines the transmission frequency of the register, see below.
- **Read interval** is the frequency of how often the register is read over the local Modbus from the Modbus server device. It does not specify how often the value of the register is sent to the cloud. It might make sense to read a value locally on the Modbus more often than the regular send interval because an alert interval is configured for the device or the send-on change feature is selected, see below.
- **Send interval** specifies the frequency of how often a value is sent to the cloud if the register is not in the alert

state (or no thresholds are configured). This must be longer or equal to the read interval.

- **Alert interval** sets the frequency of how often a value is sent to the cloud in an alert state. Thus, it can only be set if at least one threshold is configured. The size of the available read, send, and alert intervals as well as the number of registers per module depend on your chosen tariff (you can also see which tariff you have in the Self-Service Portal / My Profile). If the available intervals do not meet your needs, please contact our sales department to adjust your tariff.
- **Hysteresis.** If this optional parameter is set to value H, the value comparisons against the low and high thresholds are made with a hysteresis bracket of ± around the threshold. This also applies to the evaluation of the send-on change flag, where the hysteresis bracket is around the old value. For example, if you set the hysteresis to 10 and have a low threshold L, the value needs to go smaller than L – 5 to set the alert state and subsequently needs to get larger than L+5 to clear the alert state again.
  Send on change. If set, the value is sent to the cloud each time it changes. If a hysteresis is also set, the value needs to change more than ± (compared to the last sent value) to trigger the send. Regular sends via the send interval or the alert interval will still happen as they are not deactivated by this setting.

Virtual Modbus Device

- In addition to sending data from configured Modbus server devices, the Modbus Cloud Connect Module also supports sending internal data from the module itself to your cloud. In this case, the module acts as an additional “virtual” Modbus device that can supply various data. For example:

Optimize network connection and find out the locations of devices

- The Virtual Modbus Device feature provides information about the MCC (Mobile Country Code) and MNC (Mobile Network Code). These codes identify the country and mobile carrier to which the device is connected. You can use this information to ensure you are using the best connectivity for your geographic location, resulting in optimized connectivity and improved communications.

Monitoring the network technology

- The Virtual Modbus Device feature also includes information about the current network technology, whether it is LTE-M or NB-IoT. This information allows you to understand the technology your device is currently using and ensure you are using the best possible technology for your needs.

Real-time monitoring of signal strength

- By providing values such as RSRP (Reference Signal Received Power) and RSRQ (Reference Signal Received Quality), the Virtual Modbus Device feature can inform you of current signal strength and quality. This allows you to identify locations with better coverage and improve the quality of your connection.

Internal status / Info parameters

- Information such as the firmware version of the modem and the device, as well as the operating time of the device in seconds, allows you to monitor the performance and condition of your device. This is particularly

useful for detecting problems early and taking maintenance action, it also helps our service team improve response times to incidents reported by customers.

Adjustment of the LED brightness

The Virtual Modbus Device feature offers the possibility to adjust the LED brightness. You can adjust the LED brightness according to your individual preferences to optimize the user experience.

Functional Description

The Virtual Modbus Device feature allows:

- reading out diagnostic data from a Modbus Cloud Connect Module, and
- configuring an MOCC device's component.

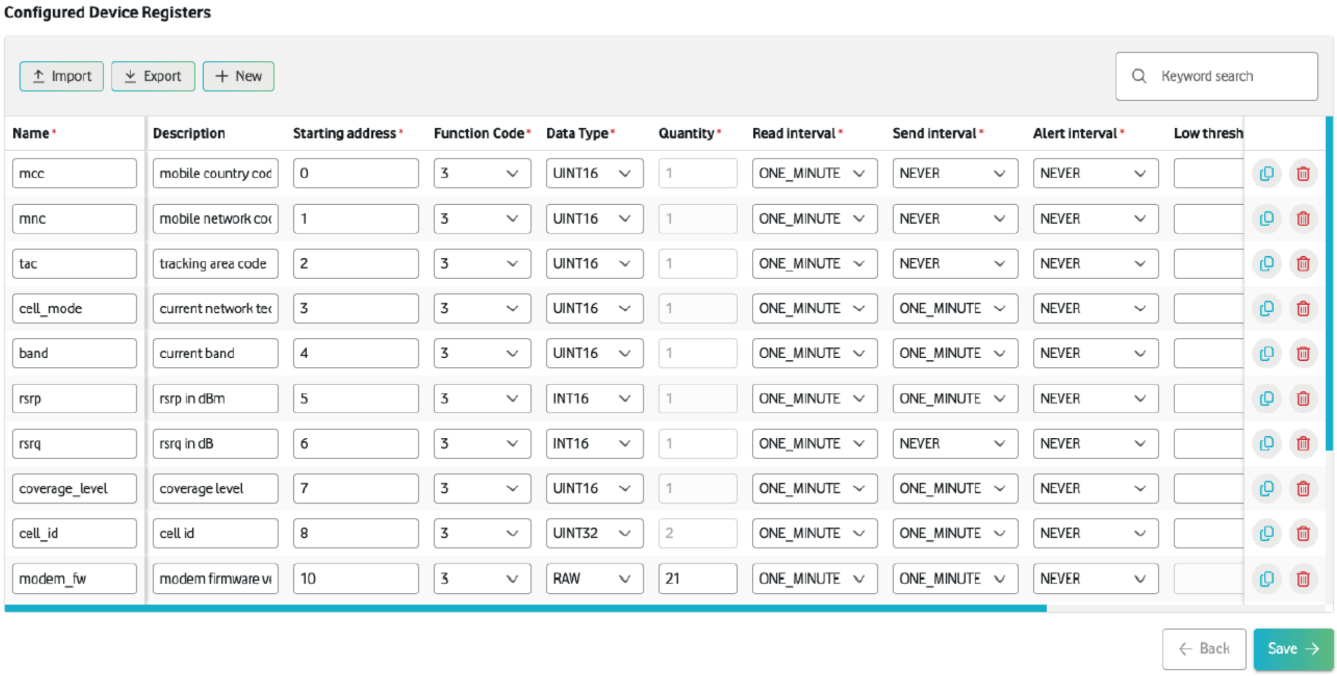
The Virtual Modbus Device contains multiple virtual 16-bit Modbus registers that can be queried as if they were registers of a real Modbus server (server) device. This means that you can make use of the Instant Read/Write feature for the Virtual Modbus Device, as well as set up a Device Type with registers from the Virtual Modbus device and assign this Device Type to a System for periodic readout and monitoring of desired diagnostic data.

The Virtual Modbus Device has the following constraints:

- Only FC03 (Read Holding Registers) and FC16 (Write Multiple Registers) are allowed.
- Contiguous reads/writes across multiple different data values are NOT allowed, that is, only one value can be queried at one time.
- The Virtual Modbus Device is designed to behave like a normal, real Modbus RTU server device, that is, it does not know the "value type". Therefore, users will need to make sure that they input the correct value type as specified in the below table (which is the same for setting up any off-the-shelf Modbus RTU server device using the Modbus-Cloud-Connect platform).

Register Description

The bus address for the Virtual Modbus Device is 255.



Example of a Virtual Modbus Device type configuration

Virtual Modbus Device Registers Configuration

Starting Address	Quantity (NO. of 16-bit regs)	Value type	Description	Example value	Value range	Writeable? (FC16)
0	1	UINT16	MCC (Mobile Country Code)	262	[1, 999] (262=Germany)	
1	1	UINT16	MNC (Mobile Network Code)	2	[1, 999] (2 = Vodafone)	
2	1	UINT16	TAC (0xAF65)	44901 (0xAF65)	[0x0000, 0xFFFF]	
3	1	UINT16	Current Network Technology	7 (LTE-M) or 9 (NB-IoT)	either 7 or 9	
4	1	UINT16	Current Band	8 or 20	either 8 or 20	
5	1	INT16	RSRP in dBm	-91	[-157, -43]	
6	1	INT16	RSRQ in dB	-4	[-34.5, 3.5]	
7	1	UINT16	Coverage Level	0 - No repetitions or small number of repetitions 1 - Medium number of repetitions 2 - Large number of repetitions	either 0 or 1 or 2	
8	2	UINT32	Cell ID	10311014 (0x009d5566)	[0x00000000, 0xFFFFFFFF]	
10	21	RAW	Modem Firmware Version	b'nrf9160_1.3.2\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\ x00\x00\x00\x00\x00\x00', which can be converted to a string with (in Python): value.decode(,utf-8').rstrip(,\0')		
31	1	INT16	NTC Temperature in 1/10 degree Celsius	275 (27.5 degree Celsius)	[-400, 1250]	
32	2	UINT32	Device Uptime in seconds	630	[0, 4294967295]	
34	2	UINT32	Random Number	2402939149		
36	13	RAW	Device Firmware Version	b'1.1.1+5\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00', which can be converted to a string with (in Python): value.decode(,utf-8').rstrip(,\0')		
49	1	UINT16	LED brightness	0 to 100	[0, 100]	Yes

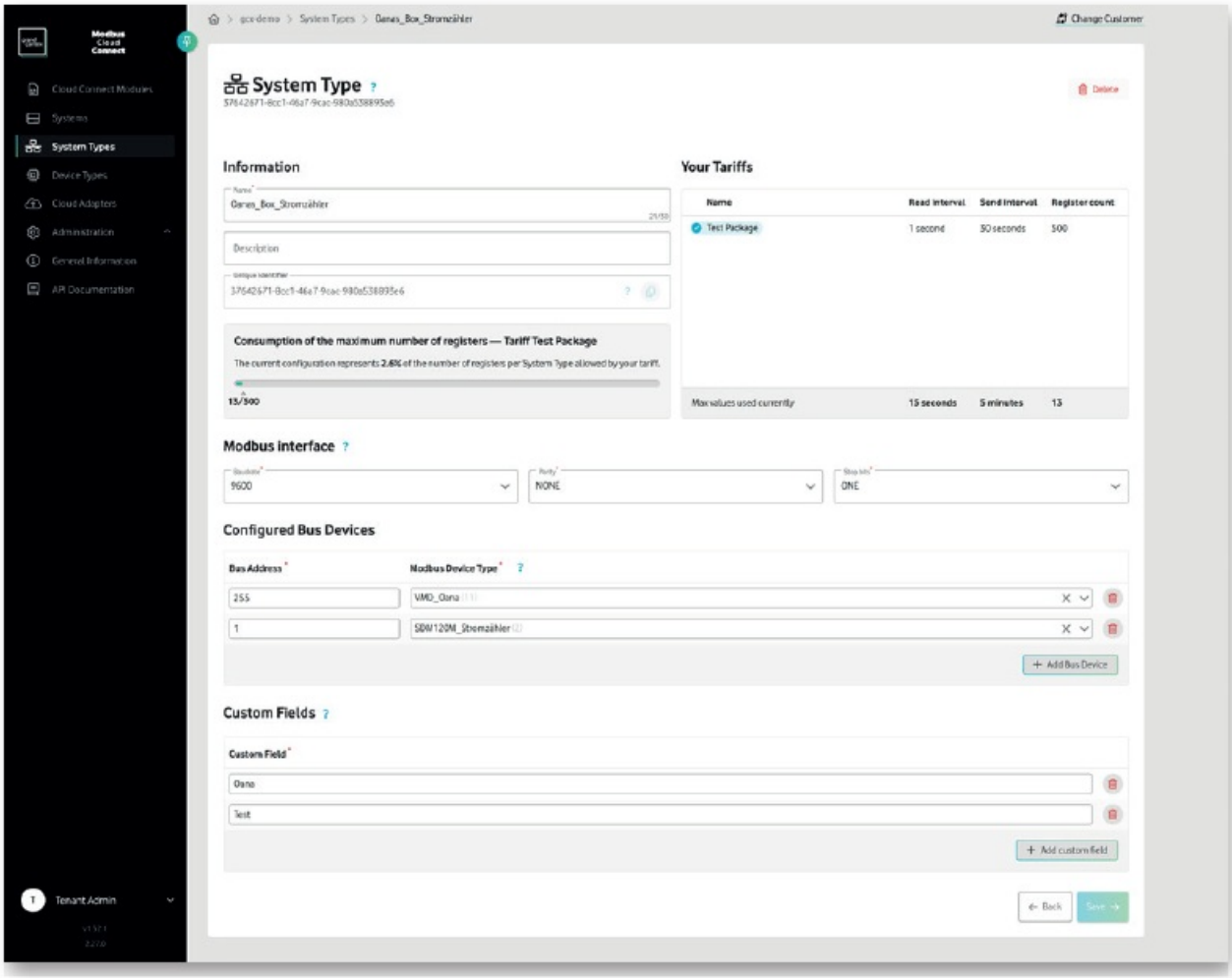
System Types

System types describe a complete Modbus system setup, including the RS-485 bus communication settings (baudrate, parity, stop bits) and all Modbus server devices with their respective Modbus server addresses (server IDs). A system type can later be used as a template for an actual installation. As an example, if you have a configuration where there is a Modbus-enabled electrical energy meter and a Modbus temperature sensor, both connected to the same RS-485 bus, you would first configure two device types for these two Modbus server devices. Then, create a system type for the configuration, which combines both device types, their respective server addresses on the bus, and the bus parameters to form the blueprint of an actual installation. The system type will later be used as a part of a system (see Chapter System). Refer to figure System Type Configuration for a view of the system type screen. You can set a name that is used to reference the system type when it is used in other places on the self-service portal, as well as a purely informational description.

In a single Modbus installation, all devices connected to the same RS-485 bus must use the same settings.

Custom Fields

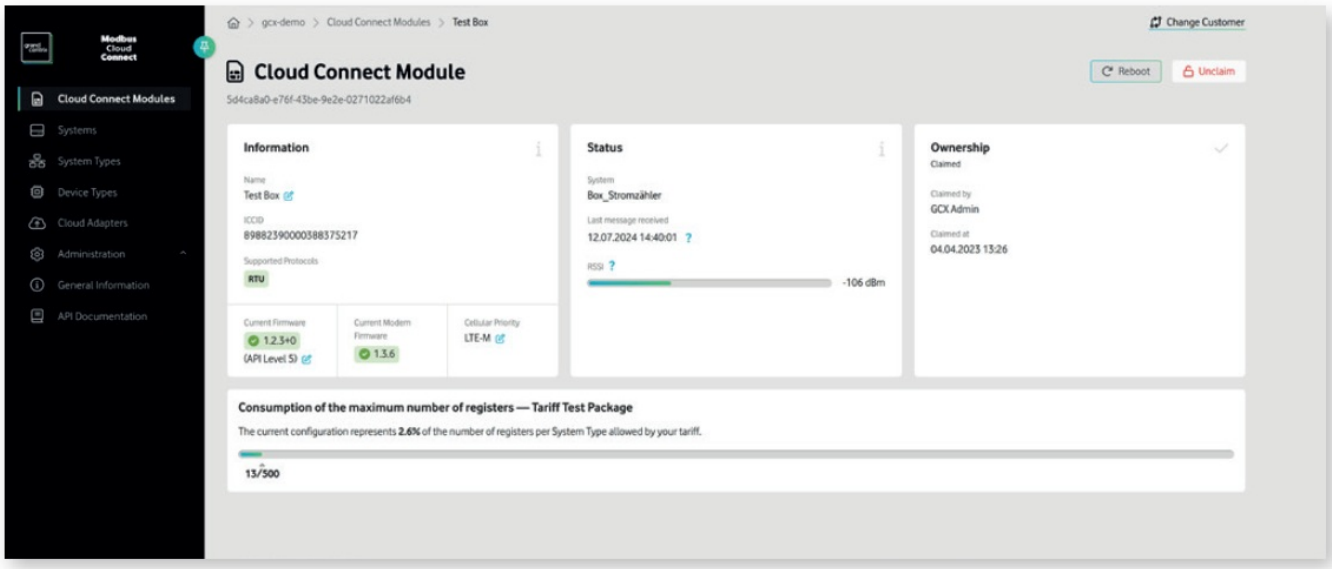
Systems can have custom fields, which are essentially parameters or variables that can later be referenced in cloud adapter data messages. This concept is typically only used if the cloud system requires certain variables or fields to be set in the incoming data. In the system type, you can create a custom field name, which enforces all systems of this type to later have a custom field of this name. The actual value of the custom field is defined within the system. This feature is optional, and in many cases not needed because there are other unique identifiers (like the ICCID) for a system. It is recom-mended to only use custom fields if the backend integration (via cloud adapter) needs them.



System Type Configuration

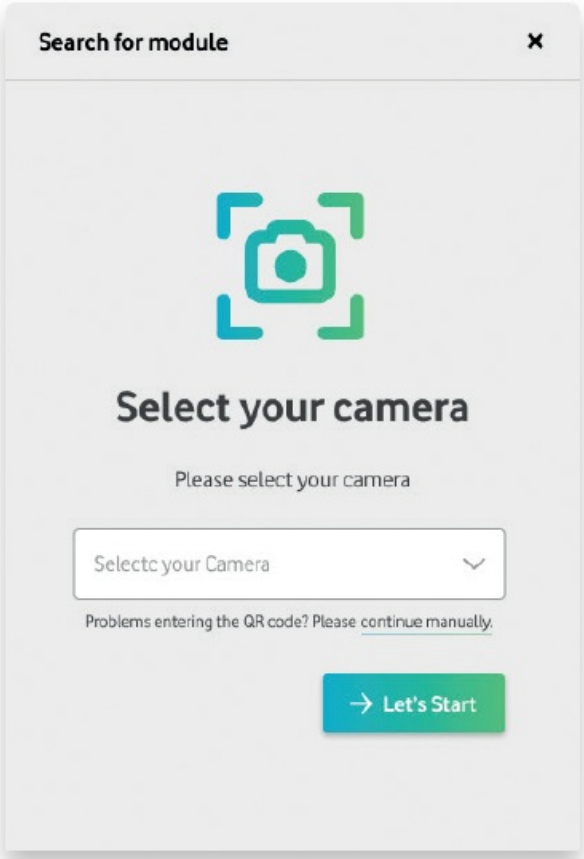
Cloud Connect Modules

This section of the self-service portal is used to manage the Modbus Cloud Connect Modules (see chapter Modbus Cloud Connect). There is little to configure here, because cloud connect modules connect over the cellular network to the self-service portal without any need for configuration or provisioning. Only the process of “claiming” a module is necessary to take ownership of the module. Each module has an ICCID (Integrated Circuit Card Identifier), and a unique ID to identify the module.



Cloud Connect-Module

Claiming a Cloud Connect Module



Inital Sceen

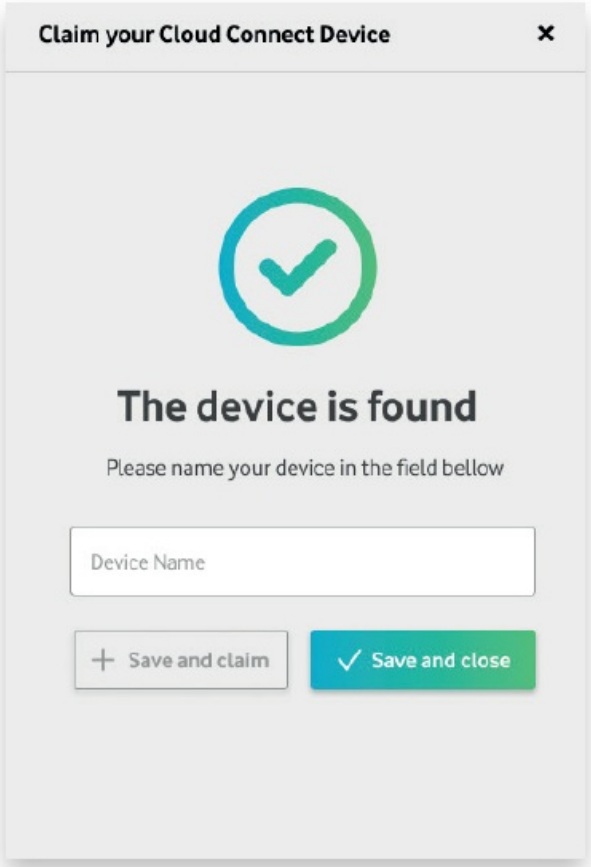
QR code scanner

Initial Screen

When the claiming dialog opens for the first time, the browser displays a permission request to access the camera. The permission is required to allow the claiming through the QR code. If the permission is not granted, a message will be shown in the drop-down. After allowing access to the camera, all connected cameras are listed in the dropdown and can be chosen to be used for the QR code claiming. If a camera is selected, the button will be enabled to continue the claiming process. The second way of claiming is manual claiming This will be explained in the section Manual Claiming.

QR Code Scanner

On this page, the selected camera will be activated, and the video stream will be visible inside the gray rectangle. From the moment the camera is started up, the QR code of the Module only has to be held in front of the camera. When the front end has recognized the QR code, a quick check of the validity of the code will be made. If the check fails, an error message will appear below the scanner else, the dialog will jump to the next claiming step. If the QR code is not recognized after some time, it is possible to claim the Module manually by returning to the previous screen and clicking on continue manually. This will be explained in the section Manual Claiming.



Claim the device

Manual Claiming

Claim the Device

This is the last step of the claiming process, where just the name of the device needs to be entered. After entering the name, you can either finish the claiming process and close the dialog with the highlighted button (“Claim and close”) or claim the device and start a new claiming process by pressing the gray button (“Claim and start over”).

Manual Claiming

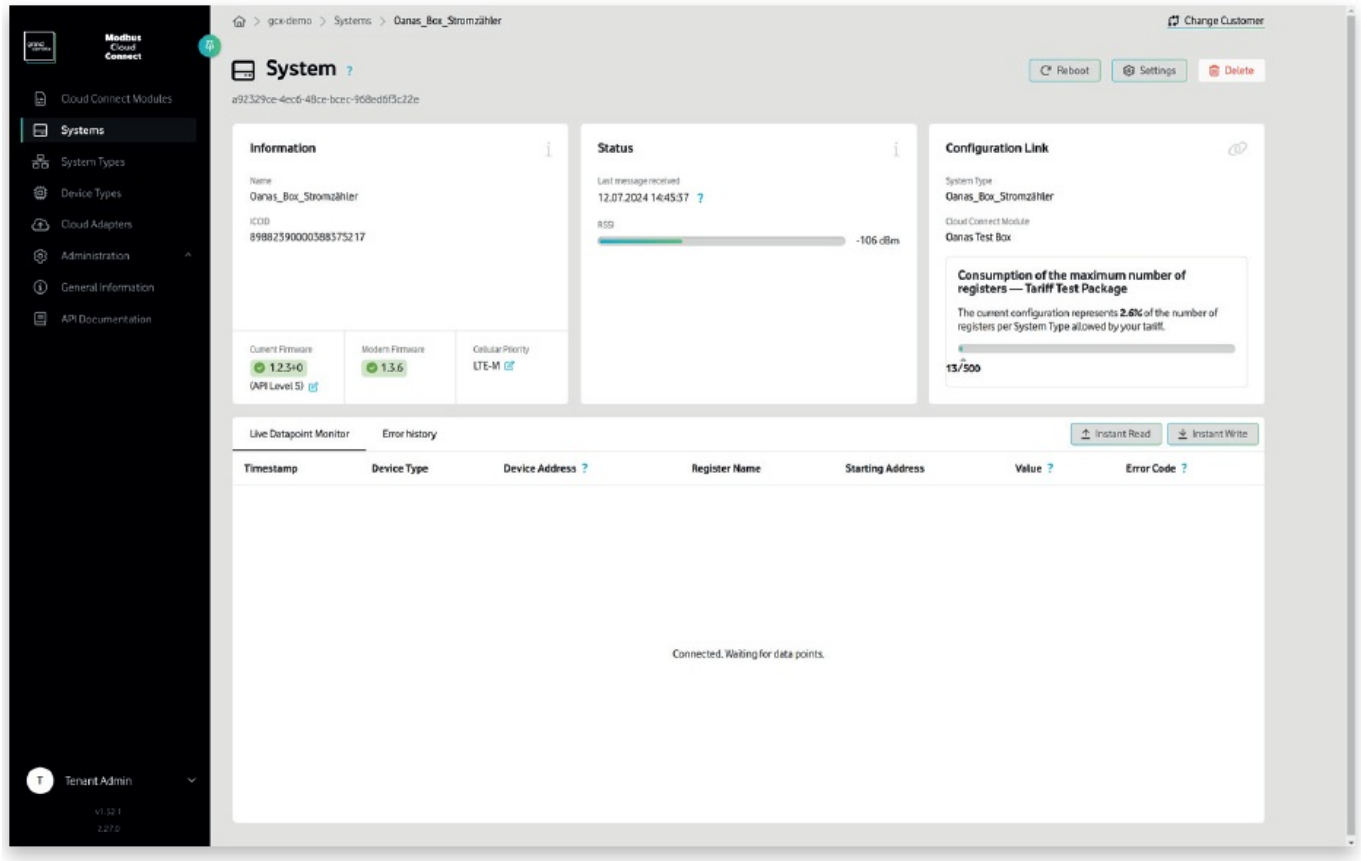
For manual claiming, you need the ICCID and secret tag of the Module. You can find the two values printed on the label beside the QR code. After entering the values and clicking the highlighted button, a quick check of the validity of the data will be made. If the check fails, an error message will appear below the button else, the dialog will jump to the next claiming step. If your device label doesn’t contain the secret tag, it is also possible to extract the value from the link stored inside the QR code. Therefore, you require a tool to read out the QR code. After that, you can find the secret tag at the end of the link right after the (#).

System

A system is formed by configuring a Modbus Cloud Connect Module with a system type. The system type contains all necessary RS-485 bus communication parameters, as well as a list of Modbus server devices and their respective registers (through the contained device types). Custom fields can be set for the system to later be used

in cloud adapter data messages, usually to match data within a backend system. If the selected system type includes a template for custom fields (see section Custom fields), press the button to pre-populate the list of fields. This feature is optional, and in many cases not needed because there are other unique identifiers (like the ICCID) for a system. So it is recommended to only use custom fields if the backend integration (via cloud adapter) needs them. When all necessary information is given, click the green checkmark button to create the system.

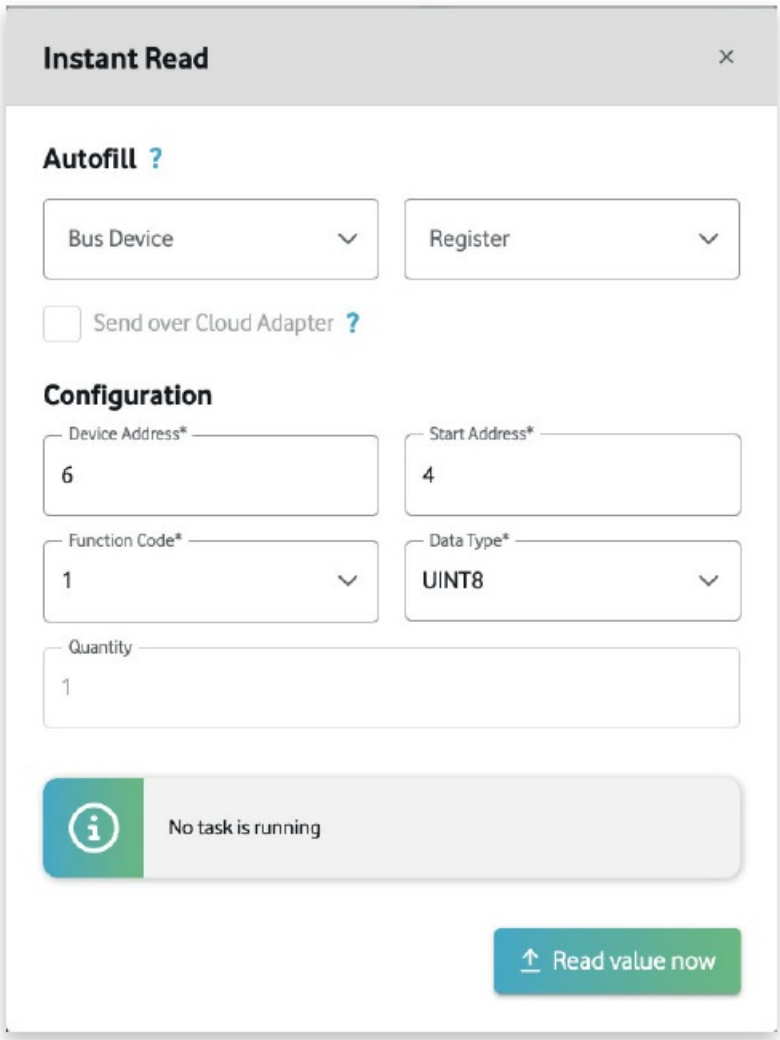
After a system is created, the linked Cloud Connect Module will reboot to receive the new configuration.



System Detail View

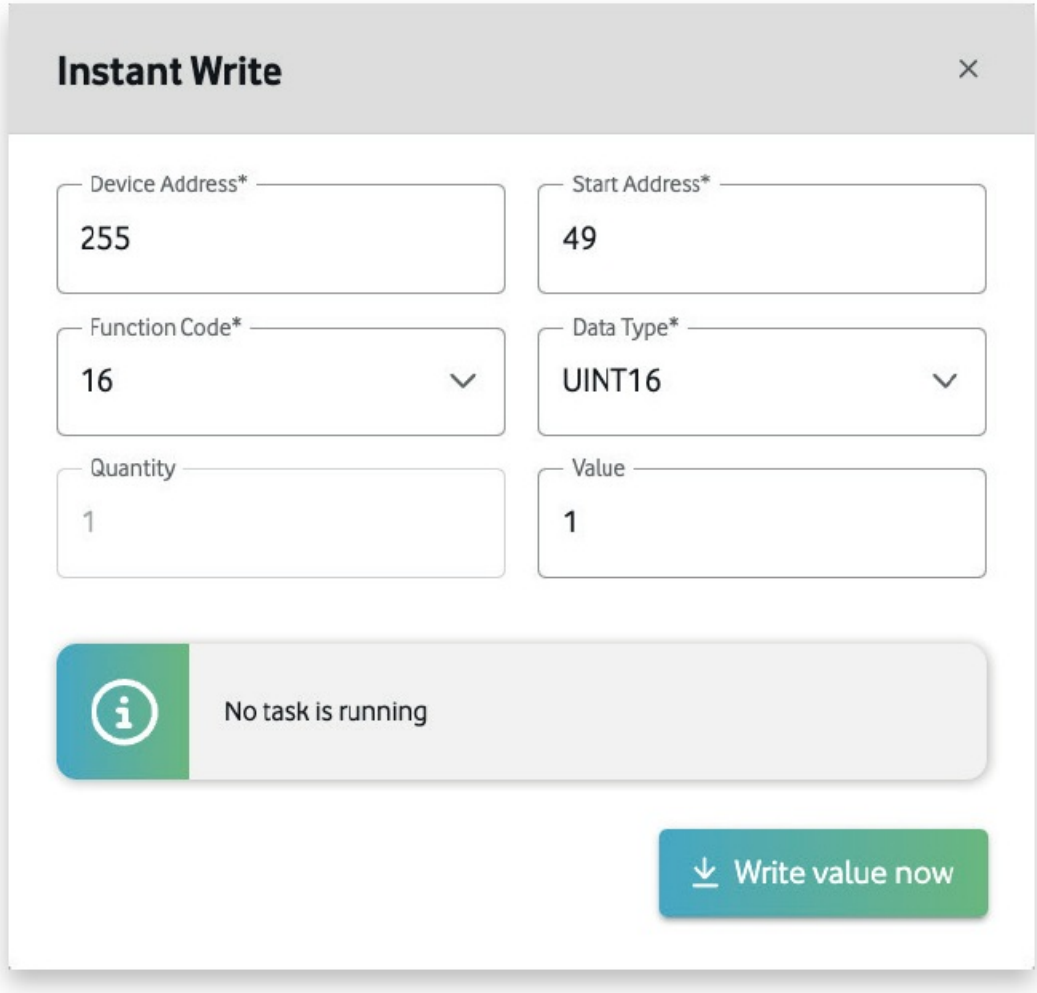
- **Reboot**
  - The Cloud Connect Module can be restarted (rebooted). This initiates a device software restart (all system and device configuration data is retained).
- **Settings**
  - This button enables editing of the system configuration. The dialog is the same as the one used to create a new system.
- **Live Datapoint Monitor**
  - This table is a real-time, live update monitor of the datapoint messages delivered by the system. This is a very helpful tool to verify that the module is reading data successfully on the local Modbus, transferring this data to the cloud. For most data points, a quick look at the value should also confirm if the correct parameter is being read out. Errors & Events is being read out. The Live Datapoint Monitor also contains the errors reported by the Modbus Cloud Connect Module (see figure System Detail View), e.g. if there are communication problems on the local RS-485 interface (Modbus RTU).
- **Instant Read**
  - “Instant Read“can initiate a one-time, manual Modbus read request on the bus. This request is transferred in real-time from the self-service portal to the Modbus Cloud Connect Module. It is executed locally on the RS-485 Modbus, and the result is delivered back and shown in the web dialog. Manual read requests are not restricted to Modbus server device registers previously configured within a device type,

but can rather address any server and register address on the Modbus By selecting the “Send over Cloud Adapter” checkbox, the read value will be additionally transmitted to all of your configured cloud adapters to your cloud.



Instant Read Dialog

- **Instant Write**
  - In the same fashion as the instant read feature, “Instant Write” lets you initiate a one-time, manual Modbus write request on the bus. This request is transferred in real-time from the self-service portal towards the Modbus Cloud Connect Module, executed locally on the RS-485 Modbus and the result is delivered back and shown in the web dialog. Manual write requests are not restricted to Modbus server device registers previously configured within a device type, but can rather address any server and register address on the Modbus.



Instant Write Dialog

Error Events

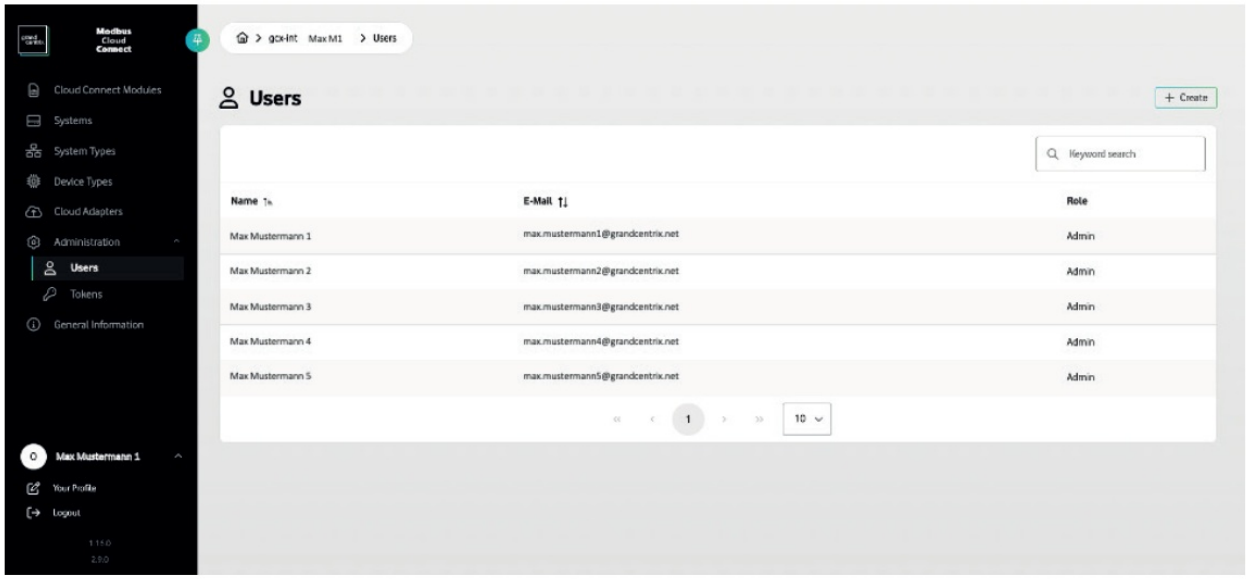
In the table below you can find the commcommonsible errors that can be reported by a MoCC Module, possible causes for such errors, and how to resolve them. For any other errors that you encounter that are not in the table below, please contact our Customer Service.

Message Type	Error	Possible causes	Resolutions
[Channel 2 - Data] **3 - Error Message** (during periodic readout)	20 Low-level error 21 Timeout	This means there is no response from the server device, which can be caused by: • a wrong server address (a.k.a bus address, device address) • mismatched baudrate/parity/stopbits between the server and the client (MoCC Module) • bad wirings (A/B mixed up, disconnected wires)	Check if: • The server address is correctly set on both the server device and the Frontend • baudrate/parity/stopbits match • Wires are OK (make sure A/B are not mixed up, contacts are secured).
	22 IO Error (wrong CRC or Request Response mismatch) 23 Message Size Error	This means there is a response from the server device, but the response is malformed, which can be caused by: • mismatched baudrate/parity/stopbits between the server and the client (MoCC Module) • noise on the wires	Check if: • baudrate/parity/stopbits match • Wires are OK (make sure the contacts are secured).
[Channel 3 - Response] **6 - InstantRead Response**	2 Invalid device address 3 Invalid start address 4 Invalid quantity 5 Invalid value type 6 Invalid value 7 Mismatched quantity and value type	This occurs during checks of the arguments in the command, and before the read-out is carried out on the RS-485 lines.	These errors should be caught by the Frontend prior to the InstantRead command being sent to the device. Nonetheless, if the device respond with one of these errors, the parameters entered by the user on the Frontend need to be double checked: • Device (a.k.a server/bus) address must be within [0, 255], with 255 being the special case for accessing the Virtual Modbus Device • Start address must be within [0, 65535] • Quantity, value type and value must not contradict one another.
	20 Low-level error 21 Timeout 22 IO Error (wrong CRC or Request Response mismatch) 23 Message Size Error	Same as those in "3 - Error Message"	Same as those in "3 - Error Message"
[Channel 3 - Response] **7 - InstantWrite Response**	2 Invalid device address 3 Invalid start address 4 Invalid quantity 5 Invalid value type 6 Invalid value 7 Mismatched quantity and value type 20 Low-level error	Same as those in "6 - InstantRead Response"	Same as those in "6 - InstantRead Response"

Administration / Users

In this section, you will find a list of all users related to your customer account. On the detail page of each user, you can set the permissions, the desired portal language, the date format, and disable/enable the user.
Note: By deactivating the account, the user can no longer log into the portal, but the account is not deleted and will still be listed in the user overview. Only users who have not claimed a device can be deleted.

- **Admin:**
  - Has unlimited access to all configuration options. The only role that can create, manage, and delete other users.
- **Specialist:**
  - Has all rights like the administrator, except for the ability to create new users.
- **Installer:**
  - Can view the configuration of device and system types but cannot create or modify them. They have unrestricted access to the systems. Additionally, the installer can register modules and execute instant-read, instant-write, and reboot commands.



User Overview

Cloud Adapters

Cloud adapters are the interface of the system to your cloud/backend. A Modbus Cloud Connect Module regularly reads data on the Modbus out of Modbus server devices according to the system and device type configuration. This register data is transferred to the Modbus Cloud Connect system, and forwarded via a cloud adapter to your cloud. An account can have multiple cloud adapters, each of which will forward all data towards its respective endpoint (no load sharing or multiplexing takes place). Two types of cloud adapters are supported: HTTP and MQTT. The payload data formatting is the same for both protocol variants.

Message Payload

Message payload formatting is done according to a payload template that is configured with the cloud adapter. An example of such a payload template might look like this:

```
{
  "iccid": "{{iccid}}",
  "modbusDeviceAddress": {{modbusDeviceAddress}},
  "modbusRegisterStartingAddress":
    {{modbusRegisterStartingAddress}},
  "recordedTimestamp":"{{recordedTimestamp}}"
  "value": {{value}}
}
```

This defines the structure of a JSON object, whose fields are populated with variables called template fields. The value of these variables depends on the actual Modbus register data that is transported over the cloud adapter.

Send Batched

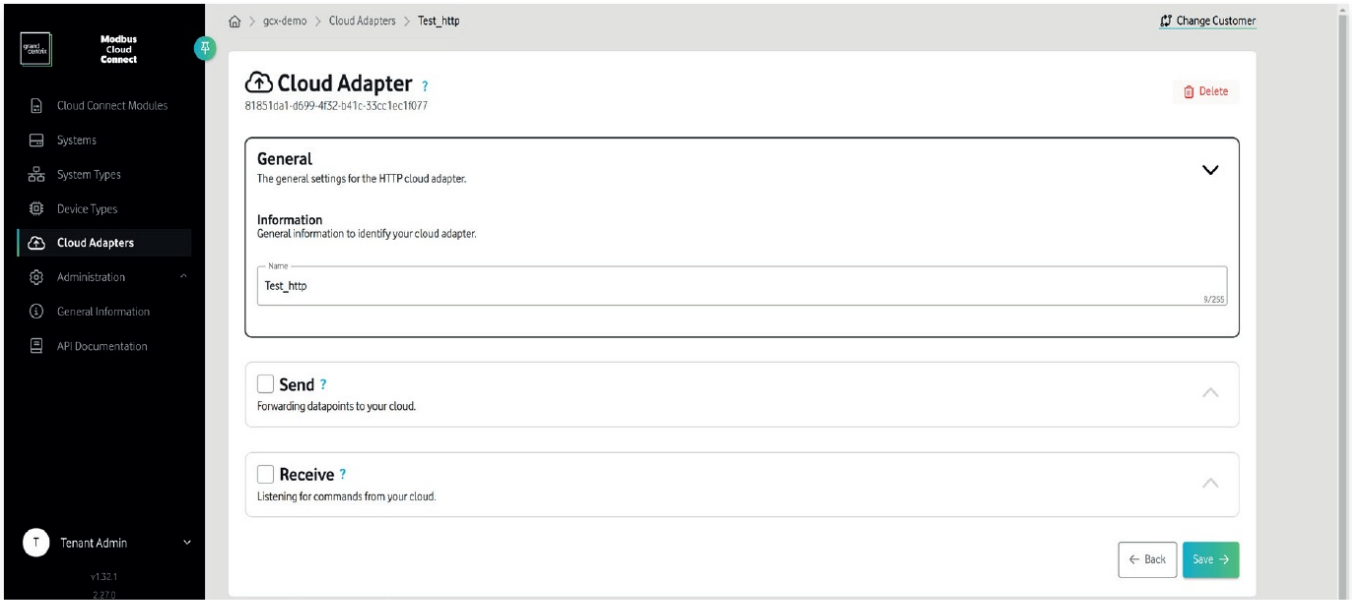
Readouts from devices with overlapping send intervals are systematically grouped into a single consolidated message and forwarded to your cloud adapter. By default, this message adopts the format of a JSON array based on your pre-defined template. This feature is applicable and activated for both MQTT and HTTP cloud adapters. It‘s important to note that enabling this option restricts the utilization of register-specific template fields within the topic (for MQTT) or the URL (for HTTP) of your cloudadaptee because their values might differ among register readouts. Please note that the send batched option is enabled by default.

Template Fields

Template fields referenced in the message payload with double curly braces like {{templateField}} are replaced with the actual value before the message is sent via the cloud adapter. In addition, custom fields defined with the system type and system can also be used as template field variables.

HTTP Cloud Adapter

This section describes the properties of the HTTP cloud adapter. It applies to the dialog when creating a new cloud adapter as well as modifying an existing one.



HTTP Cloud Adapter

General Setup

By selecting “Send” and “Receive” you define the data flow through this cloud adapter.\ Configure “Send” to only send messages from the Modbus Cloud Con-nect System to the HTTP endpoint, or “Receive” to only send instant read / write commands. Both “send” and “receive” could be selected as well. If none of the “Send” or “Receive” are selected, the cloud adapter will not be served (no HTTP connection will be established).

- The HTTP cloud adapter always requires an encrypted connection using TLS (HTTPS).

Send

This section primarily describes the data flow from regular register read-outs on the local Modbus towards the self-service portal, and using message payload transformation with template fields onto your cloud backend (via HTTP).

Request Body

The template for the message payload includes variable references to template fields. For details, see section Message Payload. The message payload will always be sent with HTTP content-type application/json.

Receive

The Modbus Cloud Connect system exposes a RESTful API that ena-bles customers to control some aspects of the system. These include instant data requests (read or write), which correspond to the “Instant Read” and “Instant Write” functionalities in the self-service portal (see sections Instant Read and Instant Write in System), as well as the possibility to request a reboot of the Cloud Connect Module. Additionally, the API allows you to claim Cloud Connect Modules and configure Systems. Instant Reads and Writes can be used to query data in registers that are only used very specifically for one-time or set registers on Modbus server devices (e.g., to change the state of actors, or to change parameters for sensor devices). To use the HTTP REST API for the backchannel, you must first create an API token, which is then used to authenticate the HTTP request. To create a token, please enter a name (for documentation purposes only) and select one or more scopes from the drop-down list. Please note that certain scopes may not be enabled for all the customer accounts. For more information please contact our Customer Service.

- Do not create manual HTTP header fields for HTTP headers that are set by default, such as Date or Content-

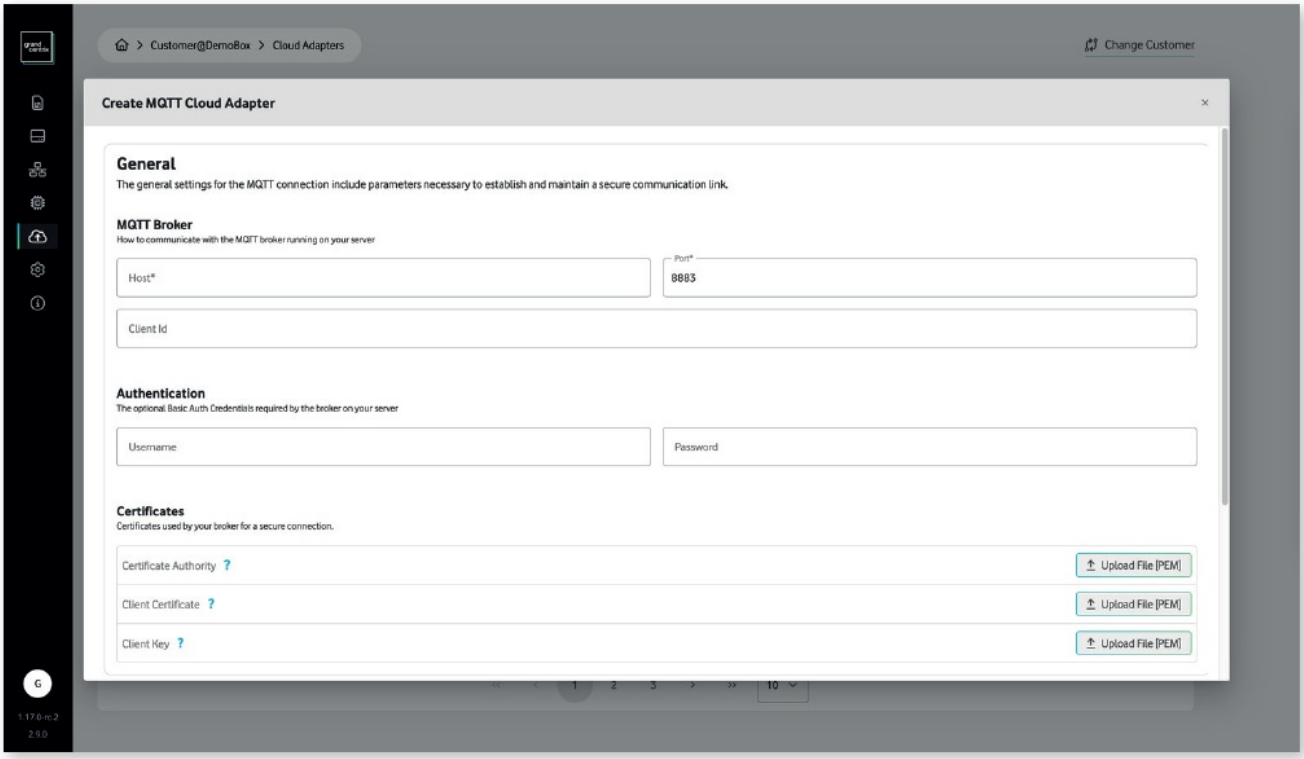
Length. Unspecified behavior might result.

- The detailed HTTP REST API documentation can be found in the self-service portal under the menu item „API documentation“.

MQTT Cloud Adapter

This section describes the properties of the MQTT cloud adapter. It applies to the dialog when creating a new cloud adapter as well as modifying an existing one. The MQTT cloud adapter is technically an MQTT client that connects to an MQTT broker provided by you. Select “Send” to only send messages from the Modbus Cloud Connect System to the MQTT broker, or “Receive” to only subscribe for instant read / write command topics.

- Select “Send“ and „Receive” to enable both features over the same MQTT connection. If none of the “Send” or “Receive” are selected, the cloud adapter will not be served (no MQTT connection will be established).



MQTT Cloud Adatper

- The MQTT cloud adapter always requires an encrypted connection using TLS (MQTTS).

Send

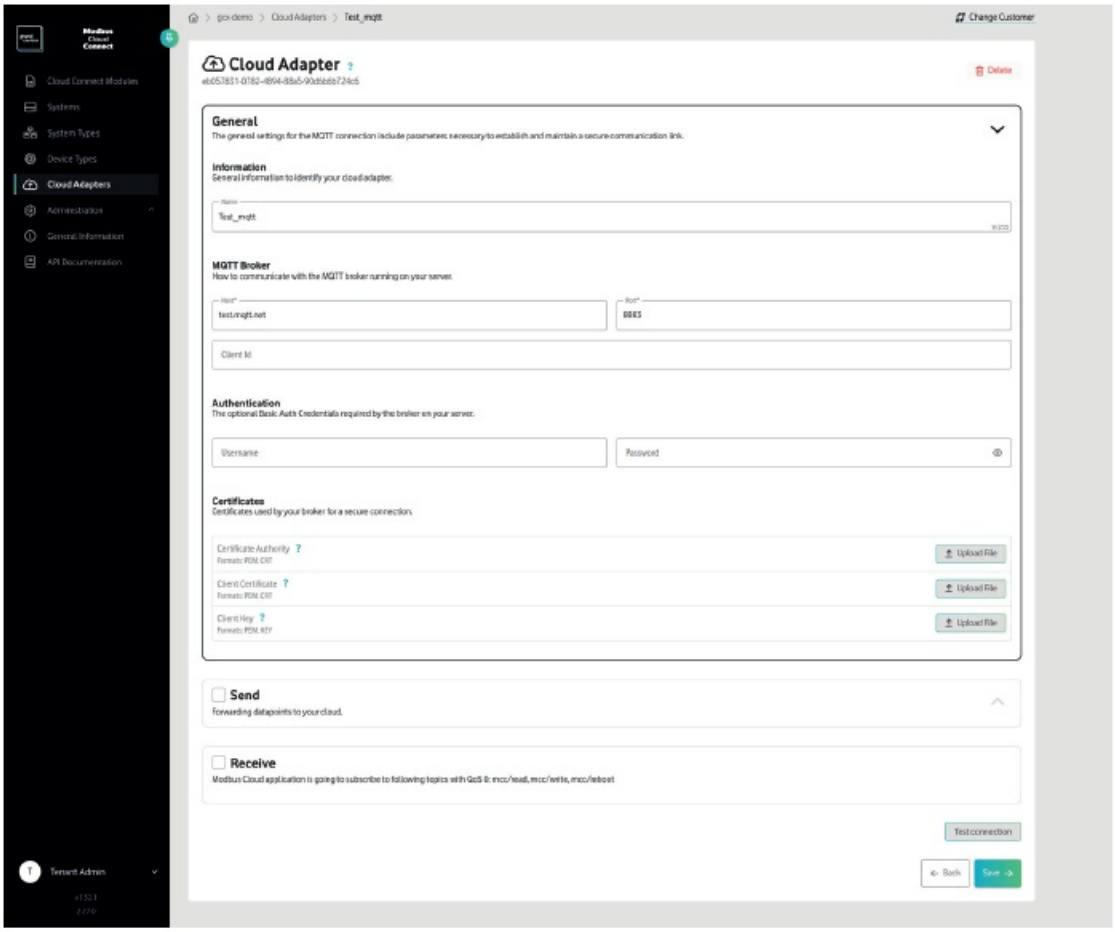
This section primarily describes the data flow from regular register read-outs on the local Modbus towards the self-service portal, and using message payload transformation with template fields onto your cloud backend (via MQTT).

Receive

Modbus Cloud Connect also supports a backchannel for the MQTT Cloud Adapter. The MQTT cloud adapter implements the backchannel by subscribing to several topics through which the respective commands need to be delivered. If the „Receive“ box of the Cloud Adapters is checked, the following command topics will be subscribed.

- MCC/read
- MCC/write
- MCC/reboot

Make sure in the configuration of the MQTT brbrokerhat the cloud adapter MQTT client connection is authorized to subscribe to these topics if you want to use the backchannel feature.



MQTT Cloud Adapter Send

General Safety

Keep away from pacemakers and other personal medical devices.

Do not use in explosive environments.

Avoid contact with liquids, keep dry.

Do not try to disassemble.

Avoid extreme temperatures.

Use only approved accessories.

Safety during Installation

The module itself only operates on Safety Extra Low Voltage (SELV). However, it is often used in environments where other, higher voltages might be present, such as in electrical distribution cabinets. Working near live electrical components always carries the risk of electric shock.

All work on electrical installations must only be carried out by sufficiently qualified personnel.

Damaged Modules

If the module seems damaged, gets hot, generates smoke or otherwise obviously malfunctions, cut off power immediately and remove it from the installation.

Pin Protection

The RS-485 pins of the device are protected against overvoltage events up to the maximum operating voltage (24V DC), so an accidental connection of the power supply to the RS-485 bus will not damage the module. However, note that if there are other devices on the RS-485 bus, these might not have an equivalent level of protection. The power supply pins are protected against reverse polarity. Since device ground is connected to RS-485 ground, a reverse polarity event, especially with a voltage exceeding the RS-485 common mode range (–7V . . . 12V) might again damage other devices on the RS-485 bus if these lack an equivalent level of protection.

Never connect any of the module inputs to live voltage, any kind of AC voltage, or any DC voltage above the module rating of 24V. Doing so will permanently damage the module and create the risk of electric shock.

Antenna Port

The antenna port (SMA connector) is referenced to system ground.

- Do not connect the outer coax shield to any external potential (risk of short-circuit).
- Do not short circuit the antenna port. This will permanently damage the module.
- Do not operate the module without a connected antenna (50Ω impedance). This could permanently damage the module.

Safety-Critical Environments

This system is not designed for use in any form of safety-critical environment. While it can be used to monitor industrial machinery, the product itself does not conform to the EU Machinery Directive (2006/42/EC) and has no SIL or PL classification. If used as a part of a machine, this has to be taken into account as a part of the machine's risk analysis.

Do not use the system in a setting where reading or writing Modbus registers could create any type of safety risk for persons or property.

RF Exposure

The module complies with the standard EN IEC 62311:2020 as defined in the „1999/519/EC Council Recommendation on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)." If the module is active, please maintain a minimum distance of at least 20cm away from the antenna.

grand centrix
A Vodafone Company

EU-Konformitätserklärung / EU Declaration of Conformity

CE

Wir, der Hersteller

grandcentrix GmbH
Holzmarkt 1
50676 Köln

erklären in alleiniger Verantwortung, dass die Produkte / Modelle

Modbus Cloud Connect Device, Modell gcx-mcs-1 / MOC-GW1

auf die sich diese Erklärung bezieht, den relevanten Richtlinien und Verordnungen entsprechen. Die Konformität bezüglich der notwendigen Eigenschaften wurde anhand der folgenden Normen und normativen Dokumenten überprüft:

Norm	Richtlinie / Anforderungen
EN 62368-1:2014 EN 62311:2008	**2014/53/EU Funkanlagenrichtlinie** Artikel 3 (1) a) Gesundheit und Sicherheit
EN 301 489-1 V1.9.2 EN 301 489-52 V1.2.1 EN 61000-6-2:2005 EN 301 908-1 V15.1.1 EN 301 908-13 V13.2.1	**2014/53/EU Funkanlagenrichtlinie** Artikel 3 (1) b) Elektromagnetische Verträglichkeit Artikel 3 (2) Effektive und effiziente Nutzung des Funkspektrums
EN IEC 63000:2018	**2011/65/EU RoHS + 2015/863**

Köln, 25.01.2023

Roland Hänel (CTO)

We, the manufacturer

grandcentrix GmbH
Holzmarkt 1
50676 Köln

declare under our sole responsibility that the products / type models

Modbus Cloud Connect Device, model gcx-mcs-1 / MOC-GW1

to which this declaration relates conform to the relevant directives and regulations. The conformity with the essential requirements has been demonstrated against the following standards:

Standard	Directive / Requirement
EN 62368-1:2014 EN 62311:2008	**2014/53/EU Radio Equipment Directive** Article 3 (1) a) Health and Safety
EN 301 489-1 V1.9.2 EN 301 489-52 V1.2.1 EN 61000-6-2:2005 EN 301 908-1 V15.1.1 EN 301 908-13 V13.2.1	**2014/53/EU Radio Equipment Directive** Article 3 (1) b) Electromagnetic Compatibility Article 3 (2) Effective and Efficient Use of Radio Spectrum
EN IEC 63000:2018	**2011/65/EU RoHS + 2015/863**

Cologne, 25.01.2023

Roland Hänel (CTO)

Service and Maintenance

- **Manufacturer Information**
  - The module is designed, produced and placed on the market by:
  - **grandcentrix GmbH**
    - Holzmarkt 1
    - 50676 Cologne
    - Germany
- **Service**
  - To receive support, please go to the ticket system at **https://service.grandcentrix.net** and log in with the credentials that were provided during the onboarding process.
- **Cleaning**
  - If cleaning is needed, use a soft, lightly damp cloth to clean the module. Standard household cleaning agents can be used. Do not use alcohol acids or products containing these substances for cleaning. Do not clean the module while it is powered.
- **Maintenance**
  - The module does not need any scheduled maintenance or service work.
- **Repairs**
  - There are no serviceable parts inside the module and it is not designed to be opened. In case of defects, the device needs to be replaced with a new one. Repair work can only be carried out by the device manufacturer.
- **Disposal**

  - This module is marked with the Waste from Electrical and Electronic Equipment (WEEE) symbol (see figure above), which means it must not be disposed of as household waste. Hand over the module to a local electronic recycling facility or electronic waste collection system or send it back to the manufacturer for recycling. The device does not contain any batteries.

Onboarding/Configuration

- The self-service portal for all onboarding and configuration options can be reached at **www.modbuscloudconnect.net**.
- If you have any questions or problems, you can reach our service desk at
- **https://service.grandcentrix.net**.
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Responsible for the content: grandcentrix GmbH, Holzmarkt 1 D-50676 Cologne Germany,
www.grandcentrix.net

Documents / Resources

	grand centrix NB-IoT Module Enables Cloud Connectivity [pdf] Instruction Manual NB-IoT Module Enables Cloud Connectivity, NB-IoT, Module Enables Cloud Connectivity, Enables Cloud Connectivity, Cloud Connectivity, Connectivity

References

- Modbus Cloud Connect | Self-Service-Portal | grandcentrix
- Modbus Cloud Connect | Self-Service-Portal | grandcentrix
- Jira Service Management
- User Manual