SIEMENS

MindSphere

Getting Connected to MindSphere

Getting Started

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER
indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING
indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠ WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Table of contents

This document provides an overview of the MindConnect devices to connect your assets to MindSphere.

Document history

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Version	Date	Changes	Link
V1801.Feb/2019.1	2018-02-11	Added health status to data point section.	Adding data points (Page 63)
		Added SYSTEM protocol section.	Overview of SYSTEM protocol (Page 82)
		Update of S7 protocol section.	Overview of S7 protocol (Page 68)
		Update of OPC UA section.	Overview of OPC UA protocol (Page 72)
V1801.Jan/2019.1	2018-01-14	Update of S7 protocol section.	Overview of S7 protocol (Page 68)
		Update of technical specifications.	Technical specifications of MindConnect Nano (Page 95)
V1801.Dec/2018.1	2018-12-17	Added new topic Regions in MindSphere.	Regions in MindSphere (Page 92)
		Added chapter Firmware update.	Firmware update (Page 85)
		Added chapter Return of defect hardware.	Return of defect hardware (Page 107)
		Update of Notes on usage.	Notes on usage (Page 11)
		Added section Calculation of buffer time.	Read performance MindConnect Elements (Page 101)
		Added chapter USB commandos.	USB commandos (Page 31)
V1801.CW.EU1.K1203	2018-12-03	Updated section configuring protocols.	Configuring protocols (Page 68)
		Added new chapter Read performance of MindConnect Elements.	Read performance MindConnect Elements (Page 101)
V1801.K1113	2018-11-13	Added new protocols Modbus and SIMATEC I/O Shield.	Configuring protocols (Page 68)

Safety Notes 2

2.1 General safety instructions

⚠ WARNING
Life-threatening voltages are present with an open control cabinet
When you install the device in a control cabinet, some areas or components in the open control cabinet may be carrying life-threatening voltages.
If you touch these areas or components, you may be killed by electric shock.
Switch off the power supply to the cabinet before opening it.

System expansions

NOTICE
Damage through system expansions
Device and system expansions may be faulty and can affect the entire machine or plant.
The installation of expansions can damage the device, machine or plant. Device and system expansions may violate safety rules and regulations regarding radio interference suppression. If you install or exchange system expansions and damage your device, the warranty becomes void.

Note the following for system expansions:

Only install system expansion devices designed for this device. Contact your technical support team or the team where you have purchased your PC to find out which system expansion devices may safely be installed.

Observe the information on electromagnetic compatibility (EMC). Refer to the chapter Technical specifications of MindConnect Nano (Page 95)/Technical specifications of MindConnect IoT2040 (Page 98).

NOTICE
"Open Type" UL508
Note that the device is classified as "Open Type" for use in the area of Industrial Control Equipment (UL508).
Installation of the device in an enclosure complying with UL508 is a prerequisite for approval or operation in accordance with UL508.

Battery and rechargeable battery

⚠️ WARNING
Risk of explosion and release of harmful substances
Improper handling of lithium batteries can result in an explosion of the batteries.
Explosion of the batteries and the released pollutants can cause severe physical injury.
Worn batteries jeopardize the function of the device.
Note the following when handling lithium batteries:
• Replace used batteries in good time; see the section "Replacing the backup battery" in the operating instructions.
• Replace the lithium battery only with an identical battery or types recommended by the manufacturer.
• Do not throw lithium batteries into fire, do not solder on the cell body, do not recharge, do not open, do not short-circuit, do not reverse polarity, do not heat above 100°C and protect from direct sunlight, moisture and condensation.

Strong high-frequency radiation

NOTICE
Observe immunity to RF radiation
The device has an increased immunity to RF radiation according to the specifications on electromagnetic compatibility in the technical specifications.
Radiation exposure in excess of the specified immunity limits can impair device functionality resulting in malfunctions and therefore injuries or damages.
Read the information on immunity to RF radiation in the technical specifications.

ESD Guideline

Electrostatic sensitive devices can be labeled with an appropriate symbol.

NOTICE
Electrostatic sensitive devices (ESD)
When you touch electrostatic sensitive components, you can destroy them through voltages that are far below the human perception threshold.
If you work with components that can be destroyed by electrostatic discharge, observe the ESD Guideline. Refer to the chapter ESD guideline (Page 105).

Open Source Software

Siemens will identify the open source software components contained in MindConnect Nano, including the applicable license text and will include such license text(s) in or provide them together with MindConnect Nano. Should the license(s) applicable to any part of the open source software require the distribution of the open source software's source code and build scripts together with MindConnect Nano (or, alternately, an offer to make the source code and build scripts available upon request), then Siemens will provide such source code or such offer to customer together with MindConnect Nano. No license fee is charged to customer for the use of such open source software. Customer acknowledges and agrees that Siemens provides no warranties, express or implied, and no indemnification for the open source software itself. Customer hereby accepts that the open source software is subject to the specific license terms included in or provided together with MindConnect Nano. To the extent there is a conflict between these terms and the open source specific license terms, such terms shall prevail with regard to the open source software.

Industrial Security

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks. In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions only form one element of such a concept. Customer is responsible to prevent unauthorized access to its plants, systems, machines and networks. Systems, machines and components should only be connected to the enterprise network or the internet if and to the extent necessary and with appropriate security measures (e.g. use of firewalls and network segmentation) in place.

Additionally, Siemens' guidance on appropriate security measures should be taken into account. For more information about industrial security, please visit http://www.siemens.com/industrialsecurity.

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends to apply product updates as soon as available and to always use the latest product versions. Use of product versions that are no longer supported, and failure to apply latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under: http://www.siemens.com/industrialsecurity.

2.2 Notes on usage

NOTICE

Possible functional restrictions in case of non-validated plant operation.

The device is tested and certified on the basis of the technical standards. In rare cases, functional restrictions can occur during plant operation.

Validate the correct functioning of the plant to avoid functional restrictions.

Mindsphere provides a highly reliable system, however the MindConnect can be affected by system internal incidents.

Note

Use in an industrial environment without additional protective measures.

This device was designed for use in a normal industrial environment according to IEC 60721-3-3.

Note

Firmware MiniWeb versions

The connection to a SIMOCODE, SIMOTION, SINAMICS OPC UA Server cannot reestablish automatic if the used Firmware has a MiniWeb version is less than V5.1. It's recommended to upgrade to a new Firmware version of the SIMOCODE, SIMOTION, SINAMICS device.

Introduction

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3.1 Getting Started

This manual gives you an overview of MindSphere with MindConnect Nano and MindConnect IoT2040, enabling you to commission these devices and start working with MindSphere.

Basic knowledge requirements

- A solid background in personal computers is required.
- General knowledge in the field automation control engineering is recommended.

Scope of validity of this document

This manual is valid for MindSphere and MindConnect Elements:

- MindConnect Nano
- MindConnect IoT2040

Convention

The term "device" is used to refer to MindConnect Nano and MindConnect IoT2040. The terms for MindSphere can be found in Glossary in the Appendix of this documentation.

The configuration parameters should be extracted out of the text or tables and depend respectively on the needs and constellation of the individual system.

Internet address

Click the following link to find MindSphere documentation: MindSphere Documentation Area (http://documentation.mindsphere.io)

3.2 Purpose of this document

This Getting Started provides you with information to become familiar with commissioning the device MindConnect Nano or IoT2040 (MindConnect Elements) and working with MindSphere.

By using the examples given in this manual, you will be able to develop or change your service. You will know how to access and configure the data from your assets as well as create and answer requests.
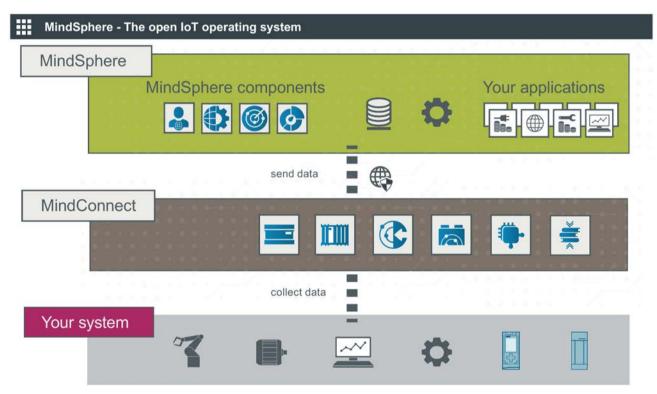
You will work through typical steps involved in configuring MindConnect Elements and your asset data. You will become familiar with the tools that MindSphere provides for configuration and visualization of assets and aspects.

3.3 Functional overview of MindSphere

This part of Getting Started outlines the functional overview of MindSphere.

MindSphere offers the means to monitor asset status as well as support maintenance and services. This requires sensor data, the tools to collect and transfer data as well as intelligent software that offers the monitoring and support functions.

MindConnect Elements provide the hardware for collecting data from assets and transferring it into MindSphere, which includes hosting via a web user interface.

With MindSphere and MindConnect Elements you can:

- Create and manage users and customers

- Create, manage and change assets in MindSphere

- Onboard MindConnect Elements to MindSphere in order to collect data from your assets and transfer it to MindSphere

- Collect data from data sources (S7, OPC UA) via MindConnect Elements

- Visualize the uploaded data (timeseries)

- Display datapoints and open events of an asset

- Manage the connected assets and automate rules

3.4 Working with MindSphere

This part of the Getting Started provides you with a brief summary of instructions described in detail in this manual.

Requirements

- Internet connection and newest version of your internet browser(e. g. Google chrome or Firefox) for online user interface
- Internet connection for MindConnect Nano/IoT2040 device
- Provide standard HTTPS capabilities for MindConnect Nano/IoT2040 - outbound HTTPs connection(s) on port 443
- Link to the online Launchpad with user and password data as supplied by Siemens
- Device (PC, tablet etc.) with minimum screen resolution of 1024x768

Configuring steps

Prepare MindConnect Elements for MindSphere

1. Mount MindConnect Nano/IoT2040 on your physical asset.
2. Connect MindConnect Elements to power supply and the Internet.

Onboard MindConnect Elements

1. Log in to your MindSphere account.
2. Configure your asset and MindConnect Element which is mounted to your physical asset.
3. Configure network settings of MindConnect Elements and proxy as needed to establish Internet connection to MindSphere.
4. Upgrade to the newest firmware version.
5. Establish the initial connection (onboarding) by transferring the configuration manually by USB stick.

Configure data collection with Asset Manager

1. Log in to MindSphere with your account.
2. Create an asset in Asset Manager.
3. Configure the data points you want to use.
4. MindConnect Nano/IoT2040 receives the configuration from MindSphere via an existing Internet connection.
5. MindConnect Nano/IoT2040 starts the data acquisition.
6. The timeseries can be displayed in Fleet Manager.

Visual analysis of assets with Fleet Manager

1. Monitor assets in different views.

2. Monitor aspects and events.

3.5   Data model in "Asset Manager"

This chapter describes the data model of Asset Manager within MindSphere. The data model will show you what processes are necessary to connect and use your asset data in MindSphere.

Definition asset

An asset is a digital representation of a machine or an automation system with one or multiple automation units (e.g. PLC) connected to MindSphere.

MindSphere data collection and data provisioning is based on so called (virtual) assets. This can be anything like a pump, motor, PLC, an entire tool machine, a production line, a robot, a crane, a car, a wind turbine and so on. The data of an asset is collected and sent to MindSphere to make that data available for further processing and analytics.
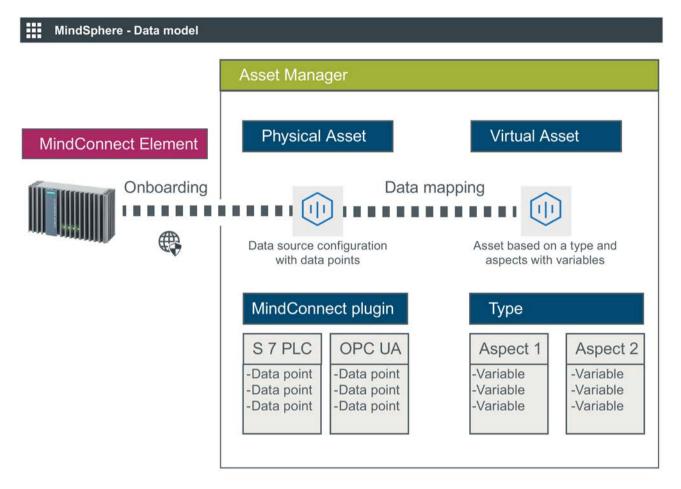
Definition aspect

Aspects are a data modeling mechanisms for assets. Aspects group related data points based on their logical association. For example: The pump skid has an aspect e.g. "Energy_consumption" that contains the data points: "power", "current", "voltage" etc. Aspect is specified in Asset Manager and its name can be freely chosen, but should have conjunction to datapoints and a physical asset. An aspect can consist of several variables.

Data model

The following graphic shows the data model in Asset Manager:

In Asset Manager devices like MindConnect Nano are defined as the data source. The device sends data points to MindSphere. These data points must be connected to the aspects and variables. Asset Manager uses aspects and variables as data containers.

Within MindSphere you add data points to a data source to collect the data, for example from a control unit. In the next step you have to link the data points to the respective variables of an aspect.

To enable data connecting and in order to use your data in MindSphere you have to fulfill the following processes:

- **Onboarding** (Page 45): Onboarding is the process of attaching a MindConnect Element to MindSphere.

- **Data mapping** (Page 65): Data mapping matches variables of an aspect with the respective data points of a data source.

Overview of MindConnect Elements

<div style="text-align:right">**4**</div>

MindConnect Elements, MindConnect Nano and MindConnect IoT2040, are embedded industrial PCs. They are able to connect to MindSphere, collect data from the field and transfer it encrypted to MindSphere.

MindConnect Nano

MindConnect Nano is a preconfigured Industrial PC that allows connectivity to MindSphere. The device supports the transmission of data encrypted through a secured Internet connection to MindSphere. MindConnect Nano allows fast and easy IoT connectivity of machines and systems. For more information refer to chapter Technical specifications of MindConnect Nano (Page 95). The following graphic shows the MindConnect Nano:

MindConnect IoT2040

MindConnect IoT2040 has compact a design and can also be used for collecting and transferring data to MindSphere in smaller production environments. The device supports the transmission of encrypted data over a secured Internet connection to enable cloud-based applications and services. For more information refer to chapter Technical specifications of MindConnect IoT2040 (Page 98). The following graphic shows the MindConnect IoT2040:

Mounting and installing MindConnect Elements

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5.1 Checking package upon delivery

1. When accepting a delivery, please check the package for visible transport damage.

2. If any transport damage is present at the time of delivery, submit a complaint at the shipping company in charge. Have the shipper confirm the transport damage immediately.

3. Unpack the device at its installation location.

4. Keep the original packaging in case you have to transport the unit again.

Note

Damage to the device during transport and storage

If a device is transported or stored without packaging, shocks, vibrations, pressure and moisture may impact the unprotected unit. Damaged packaging indicates that ambient conditions may have already had a massive impact on the device.

The device may be damaged.

Do not dispose of the original packaging. Pack the device during transportation and storage.

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5. Check the content of the packaging and any accessories you may have ordered for completeness and damage.

6. If the content of the package is incomplete, damaged or does not match your order, inform the responsible delivery service immediately.

⚠ WARNING
Electric shock and fire hazard due to damaged device
A damaged device can be under hazardous voltage and trigger a fire in the machine or plant. A damaged device has unpredictable properties and states.
Death or serious injury could occur.
Make sure that the damaged device is not inadvertently installed and put into operation. Label the damaged device and keep it locked away. Return the device for immediate repair.

NOTICE
Damage from condensation
If the device is subjected to low temperatures or extreme fluctuations in temperature during transportation, for example in cold weather, moisture could build up on or inside the HMI device.
Moisture causes a short circuit in electrical circuits and damages the device. In order to prevent damage to the device, proceed as follows: • Store the device in a dry place. • Bring the device to room temperature before starting it up. • Do not expose the device to direct heat radiation from a heating device. • If condensation develops, wait approximately 12 hours or until the device is completely dry before switching it on.

7. Please keep the enclosed documentation in a safe place. It belongs to the device. You will need the documentation when you commission the device for the first time.

8. Write down the identification data of the device.

5.2 Mounting MindConnect Nano

Note

Security of MindConnect Elements

In order to ensure the security of your MindConnect Element, you should mount it in a restricted access location e. g. lockable cabinet.

This reduces the possibility of manipulations on the device/customer data.

5.2.1   Permitted mounting positions and surrounding temperature

The following mounting positions and surrounding conditional temperature are permitted:

- **Horizontal mounting position**: The horizontal mounting position is the preferred position. Maximum surrounding temperature is 60°C.

- **Vertical mounting position:** Maximum surrounding temperature is 50°C.

Note

> 50 °C: Install in RAL

RAL = Restricted Access Location - e.g. a lockable cabinet

Free space around the device

Please make sure there's enough empty space around the device

- Above the device: ≥ 50 mm

- Below the device: ≥ 100 mm

Note
Maximum height

The maximum altitude to install MindConnect Nano is 4000 m.

5.2.2 Connecting the protective earth
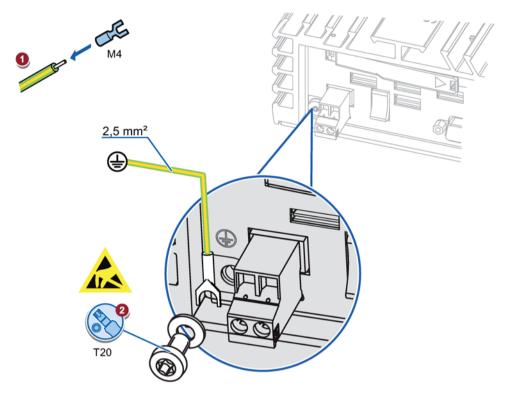
Figure 5-1   Connecting protective earth

5.3 Mounting MindConnect IoT2040

5.3.1 Permitted mounting positions and surrounding temperature

The following mounting positions and surrounding conditional temperature are permitted:

- **Horizontal mounting position**: The horizontal mounting position is the preferred position. Maximum surrounding temperature is 50°C.

- **Vertical mounting position:** Maximum surrounding temperature is 50°C.

Note

> 50 °C: Install in RAL

RAL = Restricted Access Location - e.g. a lockable cabinet

Free space around the device

Please make sure there's enough space around the device

- Above the device: ≥ 50 mm
- Below the device: ≥ 50 mm

5.3.2 Mounting types

Note

Ensure that the mounting surface on the wall can bear four times the total weight of the device, including attached elements.

Use only the anchors and screws specified in the operating instructions.

The following mounting types of the device are possible:

Mounting on rails
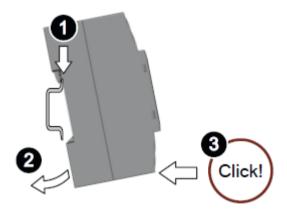
Figure 5-2   Mounting on rails

Wall mounting

Figure 5-3   Wall mounting

5.4   LED lights of MindConnect Elements

5.4.1   LED lights of MindConnect Nano

LED lights

The LED lights status provide information on efficient self-diagnostics. The following graphics show the LED lights of the MindConnect Nano:

Figure 5-4   LED lights - bottom view 1

Figure 5-5   LED lights - bottom view 2

The following table shows the meanings of the LED lights:

LED-Name	Status	Description
PC ON/WD	GREEN	Power on
	ORANGE	System restart
L1-RUN/STOP	ORANGE	• No connection to proxy· • No connection to MindSphere For explanation of possible problems and respective solution, please refer to the chapter "Troubleshooting".
	Blinking ORANGE	Connection to MindSphere is being established.
	Blinking GREEN	Onboarding is in progress.
	GREEN	MindConnect Nano is onboarded to MindSphere.
L2 - ERROR	Blinking ORANGE	Firmware update active.
	ORANGE	• No connection to the data sources For explanation of possible problems and respective solution, please refer to the chapter "Troubleshooting".
	Blinking RED	• Data loss For explanation of possible problems and respective solution, please refer to the chapter "Troubleshooting".
	RED	Firmware update error
L3 - MAINT	Blinking ORANGE	USB stick is active: • Installing USB configuration
	ORANGE	Onboarding failed: • Configuration file on the USB stick is not valid
	Blinking RED	• USB stick Error For explanation of possible problems and respective solution, please refer to the chapter "Troubleshooting".

You can find more information about LED error codes in section Troubleshooting (Page 28).

5.4.2   LED lights of MindConnect IoT2040

LED lights

The LED lights provide information on the status of the device for efficient self-diagnostics.

MindConnect IoT2040 features the following LED lights:

LED-Name	Status	Description
PWR	GREEN	Power on
SD	GREEN	Micro SD card active
USB	GREEN	USB Power (5V) is available
OC	RED	Overcurrent
USER	GREEN/RED/ORANGE	Programmed for MindSphere, see details below

The USER LED light is only programmed for MindSphere.

Figure 5-6   USER LED light

The following table describes the device behavior associated when a different USER LED status is displayed

Name	Status	Description
USER LED	Fast ORANGE Blinking	USB STICK ACTIVE • Network diagnostics are running • Configuration file is being read
USER LED	RED Blinking	USB STICK ERROR • Read error, USB flash drive is damaged • Configuration file is invalid (damaged, illegible or configured for a different asset) • Write error, USB flash drive is write-protected or its memory is full. For explanation of possible problems and respective solution, please refer to the chapter "Troubleshooting".
	ORANGE Blinking	FIRMWARE UPDATE ACTIVE
	RED	FIRMWARE UPDATE ERROR For explanation of possible problems and respective solution, please refer to the chapter "Troubleshooting"
	ORANGE	NO CONNECTION TO PROXY • Network cable is missing or damaged • Ethernet port on MindConnect IoT2040 is damaged • "ipconfig" of MindConnect IoT2040 is incorrect • Firewall of MindConnect IoT2040 blocks • Your company's router is damaged • Proxy is offline • No authentication on Proxy • Proxy configuration is invalid

Name	Status	Description
	ORANGE	NO CONNECTION TO CLOUD • Proxy is invalid • Server is offline • An addressed server cannot be accessed • Network problems of a provider • No authorization
	ORANGE Blinking	CONNECTION TO CLOUD ESTABLISHED LED light flashes green for a short time to indicate the onboarding process - otherwise is orange
	GREEN Blinking	ONBOARDING IN PROGRESS
USER LED	ORANGE Flashing	ONBOARDING FAILED LED flashes red for a short time to indicate onboarding is falling Possible reason: • Server error • OBT is no longer valid For explanation of possible problems and respective solution, please refer to the chapter "Troubleshooting".
	GREEN	ONBOARDED
	ORANGE	NO CONNECTION TO DATA SOURCE • Problem with network connection of your machine • Network cable is not plugged in or is damaged • Machine is offline
	RED Blinking	MindConnect IoT2040 IS LOSING DATA • MindConnect IoT2040 is offline and the data buffer is full • Slow data transfer For explanation of possible problems and respective solution, please refer to the chapter "Troubleshooting".

You can find more information about LED error codes in section Troubleshooting (Page 28).

5.4.3   Troubleshooting

Error	Problem	Possible cause	Possible remedy
MCN L1-RUN/STOP IoT2040 USER LED ORANGE	MindConnect Element can-not onboard to MindSphere	Network connection problem: • Either IP address is not valid or configured IP ad-dress already exists in the network of MindCon-nect Nano • Either disabled or invalid configured Proxy • Proxy is offline • Interrupted connection • IP address is configured via DHCP, but there is no internet connection. • Firewall blocks MindCon-nect Elements • Your company's router is damaged	• Check your configuration connection: If configured IP and Proxy are valid • Check physical connec-tion: your company's router, Ethernet cables etc.
	No Internet connection		
MCN L2 - ERROR LED IoT2040 USER LED ORANGE	Although an asset is onboarded, no time series are uploaded to Fleet Man-ager and Visual Analyzer.	No connection to data source	Check the connection be-tween MindConnect Nano and data sources (Plant Network ports and cables - S7/OPC UA Server)
		The address of the data point configuration can be incorrect	• Check the connection between MindConnect Nano and data sources (Plant Network ports and cables - S7/OPC UA server) • Check data sources configuration. • Check configuration of each data point.
	MindConnect Nano/IoT2040 cannot onboard to Mind-Sphere	• Incorrect asset configura-tion • Not accomplished asset configuration (Network Connection)	Check configuration of your asset (Network Configura-tion).
		Invalid ID of MindConnect Nano	Check if MindConnect Nano ID is correct.

Error	Problem	Possible cause	Possible remedy
MCN L2- ERROR LED blinking RED IoT2040 USER LED blinking RED	Data loss	MindConnect Nano/IoT2040 was too long offline, so it could not send data to Mind-Sphere and the storage is full.	• Check outbound connection • Check Ethernet cables • Check Proxy (IP address, User Authentication can be required)
MCN L2- ERROR LED RED IoT2040 USER LED	Firmware update error	• Technical problems with a new version of firmware • Incorrect firmware type • Certificate problems, Authentication problems etc.	• Make sure that you are using the correct firmware type (MindConnect Nano/IoT2040). • MindConnect Nano/IoT2040 will automatically restart and then firmware update will be carried out after a while. • If MindConnect Nano/IoT2040 does not restart automatically, then restart it manually: by switching on and off the "power button" on MindConnect Nano and by switching off/on the power supply for Mind-Connect IoT2040.

Error	Problem	Possible cause	Possible remedy
MCN L3- MAINT LED ORANGE IoT2040 USER LED blinking	Onboarding failed	• Configuration file on the USB stick is invalid • Internal error	• Make sure that the data on the USB stick still is valid. (The data, which you exported to the USB stick, is still valid only for 7 days.). If it is expired, use the asset configuration to export a new valid configuration to your USB stick. • Check asset configuration and reconfigure, if it is required and export a new configuration to USB stick
MCN L3-MAINT LED blinking RED IoT2040 USER LED blinking	Problems with USB stick	• Incorrect formatting of USB stick (no FAT or FAT32) • USB stick is damaged • Write error, USB stick is write-protected or its memory is full. • Configuration file is invalid (damaged, illegible) • See also below	• Check format and partition of the USB stick. It must be FAT or FAT32 formatted and may only contain a single partition. • Try a new USB stick

Error	Problem	Possible cause	Possible remedy
	Although no LED lights are shown (except PC ON/WD with constant GREEN) and internet connection is OK, MindConnect Nano still cannot be onboarded to MindSphere	Problems with USB stick: • Configuration file in USB stick cannot be read or accepted by MindConnect Nano: • Problems with configuration file • Configuration file is located in an incorrect directory. • Expired configuration file on the USB stick • The configuration file is invalid or not copied to the USB stick	• Remove and plug an USB stick into MindConnect Nano • Check the diagnosis file on the USB stick. • Check the name of the configuration file. It must have MindConnect Nano ID. Do not change the name of the downloaded file. • Check whether the directory is valid. (Configuration file must be in the root directory of the USB stick.) • Make sure that the data on the USB stick is still valid. (The data, which you exported to the USB stick, is still valid only for 7 days.) If it is expired, use the asset configuration to export a new valid configuration to your USB stick.
	System Error	Unknown	• Switch MindConnect Nano off and on again. • If the problem persists, contact your Siemens Support/„Expert Center".

5.5 USB commandos

You can run diagnostic and maintenance USB commands on your MindConnect Element.

The following lists various USB commands and the respective JSON format:

Copy agent logs to USB stick

You can create agent runtime log files and provide them by using the USB stick.

The following command will collect all log files, put them into a .tar.gz file and copy this file to the USB stick.

JSON format：

{

```
    "Commands": [

     {

      "Cmd":"CopyAgentLogsToUsbStick"

     }

    ]

   }
```

Copy archived logs to USB stick

You can retrieve archived log files from MindConnect Nano/IoT2040 by using the USB stick. The following command will copy all archived log files to a sub directory on the USB stick and delete the copied log files from the archive folder optionally.
Sub directories on the USB stick will have following structure: ConBox_<BOX ID>/<CurrentTime>Sample:ConBox_J47110815/20180318T191647

JSON format:

```
{

   "Commands": [

    {

     "Cmd":"CopyArchivedLogsToUsbStick",

     "DeleteAfterCopy":"false"

    }

   ]

  }
```

Copy system files to USB stick

For analysis purpose you can copy system files to a USB stick by providing a ConBox_Commands.json file on the USB stick that contains the CopySystemFilesToUsbStick command.

The following command will collect the requested system files and provide them as a ConBox_<deviceID>_SystemFiles.tar.gz file on the USB stick.

JSON format:

```
{

   "Commands": [

    {

     "Cmd": "CopySystemFilesToUsbStick",

     "TypeOfFiles": "LinuxSystemFiles"

    }

   ]
```

```
}
```

System files:

Depending on the value of TypeOfFiles the .tar.gz file will contain different system files.

TypeofFiles	Collected system files
LinuxSystemFiles	/persistent/config/hosts
	/persistent/config/interfaces
	/persistent_massdata/sysmsg.log
	/persistent_massdata/sysmsg.log.0
	/tmp/resolv.conf
	/tmp/sysinfos.info
	/var/log/boot
	/var/log/dmesg
	/var/log/fsck.log
AgentSystemFiles	/persistent_appconfig/dns.static
	/persistent_appconfig/loggingconfig.ini
AllSystemFiles	All Linux and Agent system files listed above.

Change system time

For the case that the system time should have been changed so that agent runtime is no longer able to connect to MindSphere, you can retrieve the backend time to correct the system time. The following command provides the possibility to change the system time manually via ConBox_Commands.json file on the USB stick.

JSON format:

```
{

 "Commands": [

  {

    "Cmd": "SetSystemTime",

    "NewTime": "2017-09-19T12:34:56"

  }

 ]

}
```

Perform factory reset

For factory reset a ConBox_Commands.json file can be provided by using the USB stick.

The network settings will be reset to their initial state on MindConnect Nano/IoT2040. All temporary files will be then deleted. At the end the MindConnect device will be restarted automatically.

The factory reset command is available on MindConnect Nano/IoT2040 version 03.01.00.00 b00x or later.

JSON format:

```
{
  "Commands": [
    {
     "Cmd": "DoFactoryReset",
     "DeviceID": "_MindConnect_ID_"
    }
  ]
}
```

You can find more information on how to set a MindConnect Element to factory settings in chapter Manual firmware update of MindConnect Element (Page 85)

Connecting MindConnect Elements

<div style="text-align: right; font-size: 2em;">6</div>

This chapter shows you how to connect MindConnect Elements to the power supply and to the Internet (for MindSphere).

6.1 Commissioning MindConnect Element

Objective

The MindConnect Elements should be connected to the power supply and commissioned.

Requirements

- The protective conductor is connected (valid only for MindConnect Nano). Refer to the chapter Connecting the protective earth (Page 22).
- A two-core cable with a cable cross-section of 0.75 mm² to 2.5 mm².
- A slotted screwdriver with a 3 mm blade.

NOTICE

Power supply requirements

MindConnect Nano should only be connected to a 24 V DC to power supply which satisfies the requirements of safety extra low voltage (SELV) according to IEC/EN/DIN EN/UL 60950-1.

MindConnect IoT2040 should only be connected to a 9...36 V DC power supply which meets the requirements of safe extra low voltage (SELV) according to IEC/EN/DIN EN/UL 60950-1.

The power supply must meet the NEC class 2 or LPS requirement in accordance with IEC/EN/DIN EN/UL 60950-1.

Note

The MindConnect Nano/IoT2040 package does not include power supply. The appropriate power supply product from Siemens with the name SITOP can be used.

Procedure

⚠ CAUTION
Danger of burns
The surface of the device can reach temperatures of over 70 °C. Any unprotected contact may cause burns. Avoid direct contact during operation of the device. Touch the device only with appropriate protective gloves.

1. Switch off the power supply on the device.
2. Connect the cores of the power supply.

3. Insert the terminal at the indicated position.

    – The graphic shows how to connect the power supply for MindConnect Nano:
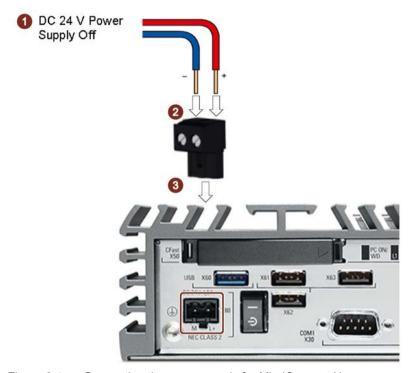
Figure 6-1   Connecting the power supply for MindConnect Nano

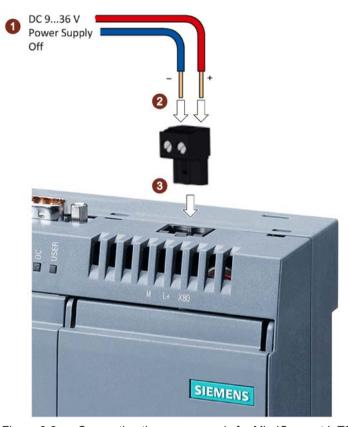   – The graphic demonstrates the steps how to connect the power supply for MindConnect IoT2040:

Figure 6-2   Connecting the power supply for MindConnect IoT2040

4. Power on the power supply.

   – For MindConnect Nano, set the on/off switch to position "I" (ON). The "PC ON/WD"
     LED lights up green.

   – For MindConnect IoT2040, switch on the power supply. The graphic shows the "PWR"
     LED lights up green.
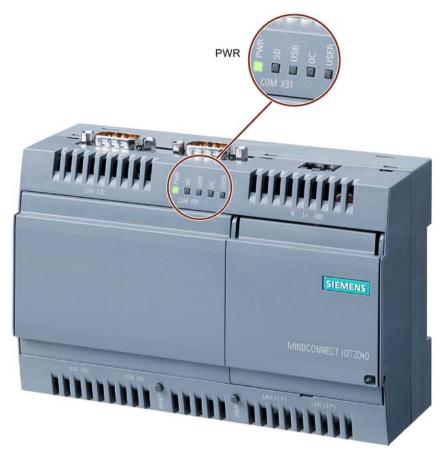
Figure 6-3   Power on a power supply for MindConnect IoT2040

Result

MindConnect Nano/IoT2040 is now prepared and you can onboard it to MindSphere.

If the green light does not appear, refer to section Troubleshooting (Page 28) for more information about LED messages.

6.2   Firewall/Proxy rules for MindSphere

MindConnect Element require open HTTPS and DNS ports for communication with MindSphere. You can open port 443 to enable this.

MindConnect Element will connect to the following DNS names:
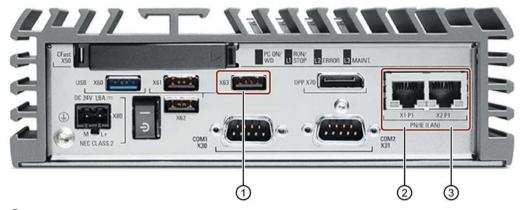
<region>.mindsphere.io

For <region> enter the area that was defined in your contract, e. g. eu1.

Mindsphere uses modern cloud principles (such as content delivery networks) to achieve high availability/scalability. The above mentioned DNS names can be resolved to a large range of IP addresses based on the context of the caller and the state of the backend.

6.3 Connecting MindConnect Nano to MindSphere network

The following options are available for integrating the device in existing or planned system environments and networks.

① X63 port
② PN/IE LAN X1 P1 port
③ PN/IE LAN X2 P1 port

Figure 6-4   Connections of MindConnect Nano

The following table explains each connection port in detail:

Port	Description
X63	USB 2.0 port, high current. Configuration file on USB stick. **Required during onboarding process.**
PN/IE LAN X1 P1	RJ45 Ethernet connection 1 for 10/100/1000 Mbps. Access to the Internet (to MindSphere). **Required to start onboarding process.**
PN/IE LAN X2 P1	RJ45 Ethernet connection 2 for 10/100/1000 Mbps. Access to the plant network or asset (e.g. S7, OPC UA). **Required to complete onboarding process.**

Procedure

Before you start onboarding, connect MindConnect Nano to MindSphere, as follows:

Insert Ethernet cable into the port labeled with **X1 P1** to connect MindConnect Nano to MindSphere.

Note

MindConnect Nano MAC address

The type plate on of the MindConnect Nano shows 2 MAC addresses. The first MAC address belongs to port X1 P1.

Figure 6-5   Connecting the port X1 P1 for Internet (MindSphere)

6.4 Connecting MindConnect IoT2040 to MindSphere network

The following options are available for integrating the device in existing or planned system environments and networks.

① X60 port
② PN/IE LAN X1 P1 port
③ PN/IE LAN X2 P1 port

Figure 6-6   Interfaces of MindConnect IoT2040

The following table explains each connection port in detail:

Port	Description
X60	USB 2.0 port, high current. Configuration file on USB stick. **Required during onboarding process.**
PN/IE LAN X1 P1	RJ45 Ethernet connection 1 for 10/100/1000 Mbps. Access to the Internet (to MindSphere). **Required to start onboarding process**
PN/IE LAN X2 P1	RJ45 Ethernet connection 2 for 10/100/1000 Mbps. Access to the plant network (e.g. S7, OPC UA). **Required to complete onboarding process.**

Procedure

Before you start onboarding, connect MindConnect IoT2040 to MindSphere, as follows:

Insert Ethernet cable for Internet into the port labeled with **X1 P1.**

Figure 6-7   Connecting the port X1P1 for internet (MindSphere)

Note

During the onboarding process, only one USB stick is supported. Do not plug in more than one USB stick. The recommended USB port is the USB port with label X60.

6.5   Connecting Port X2 P1 for MindConnect Element

Objective

The MindConnect Element can now be connected to the plant network or asset.

Requirements

- An asset has been created in Asset Manager.
- The configuration has been transferred via USB stick to the MindConnect Element.

Procedure

To connect the MindConnect Element to your plant network or asset, insert the Ethernet cable into the port labeled with **X2 P1**.

The following graphic shows the connecting port of the MindConnect Nano:

Figure 6-8   Connecting Ethernet Port X2 P1 MindConnect Nano

The following graphic shows the connecting port of the MindConnect IoT2040:

Figure 6-9   Connecting Ethernet Port X2 P1 MindConnect IoT2040

Onboarding MindConnect Elements

7

7.1 Overview of onboarding MindConnect Element

This chapter describes the initial configuration of an asset and MindConnect Nano/IoT2040 in order to onboard MindConnect Nano/IoT2040 to MindSphere. Onboarding is the process of attaching a MindConnect Element to MindSphere.

To establish the initial connection between MindConnect Nano/IoT2040 and MindSphere (onboarding), you have to configure the essential asset and MindConnect Nano/IoT2040 data. For onboarding the full configuration is not required, although you can accomplish all steps using Asset Manager.

The respective data to be configured for onboarding is described in the following procedure.

Requirements

- MindConnect Nano/IoT2040 is connected to the Internet and powered on.
- The connection cable for the Internet is correctly plugged into the Ethernet port for the Internet (MindSphere).
- MindConnect Nano/IoT2040 is connected to asset or plant network.
- You have received the link to the MindSphere UI with credentials (user and password data).
- A customer account is created.
- A standard USB device with a single partition in FAT or FAT32 is formatted.
- You have the role "mdsp:core:TenantAdmin". The user roles are set in Settings.

Note

Prepare MindConnect Elements

To prepare your MindConnect Element for MindSphere V3, you have to update the firmware for boxes that were already connected to MindSphere V2 (SAP).

You can find more information in chapter Manual firmware update of MindConnect Element (Page 85).

Onboarding Procedure

In order to onboard MindConnect Nano/IoT2040, you must perform the following steps:

1. Login to MindSphere. (Page 46)
2. Create an asset in Asset Manager. (Page 46)
3. Enable connection to MindConnect Element in Asset Manager. (Page 48)

    4. Configuring network settings (Page 50)

    5. Transfer configuration to MindConnect Element (Page 52).
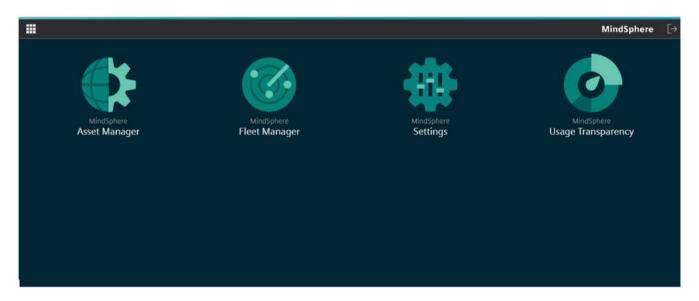
7.2   Logging in to MindSphere

To log in to MindSphere, proceed as follows:

1. Click the link provided via mail by the Siemens AG.

    – The MindSphere landing page for login will appear.

2. Log in to MindSphere with your Webkey login credentials.

    – You will be redirected to your personal MindSphere Launchpad.

    – Depending on your offering the Launchpad Icons will be displayed.

Note

MindSphere supports English and German languages. Therefore it is recommended to set the browser default to English, if you use a different language.

7.3   Creating an asset
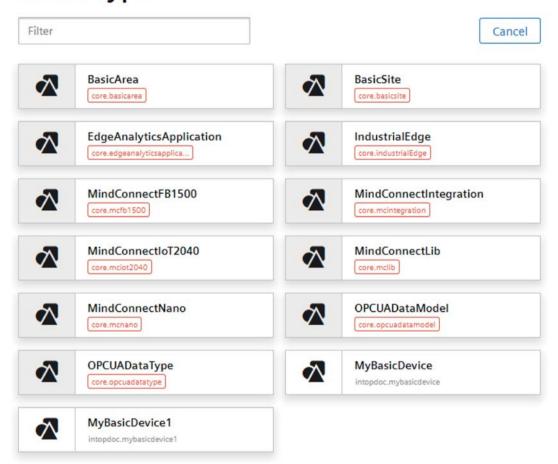
To connect your MindConnect Element in Asset Manager you need to create an asset.

Procedure

To create an asset proceed as follows:

1. Select Asset Manager from the Launchpad.

2. Click "Assets" in the navigation area.

3. To create a new asset click ⊕ .

   The asset type overview window is opened.

Select type

| Filter | Cancel |

BasicArea `core.basicarea`	**BasicSite** `core.basicsite`
EdgeAnalyticsApplication `core.edgeanalyticsapplica...`	**IndustrialEdge** `core.industrialEdge`
MindConnectFB1500 `core.mcfb1500`	**MindConnectIntegration** `core.mcintegration`
MindConnectIoT2040 `core.mciot2040`	**MindConnectLib** `core.mclib`
MindConnectNano `core.mcnano`	**OPCUADataModel** `core.opcuadatamodel`
OPCUADataType `core.opcuadatatype`	**MyBasicDevice** intopdoc.mybasicdevice
MyBasicDevice1 intopdoc.mybasicdevice1	

4. Select the respective asset type for your MindConnect Element, e. g. MindConnect Nano.

5. Enter a name and the data for the asset, e. g. "Wind turbine"

6. Confirm the entries with "Save".

Result

The new asset is available at the asset list.

The following graphic shows the created asset:

7.4 Enable connection to MindConnect Element
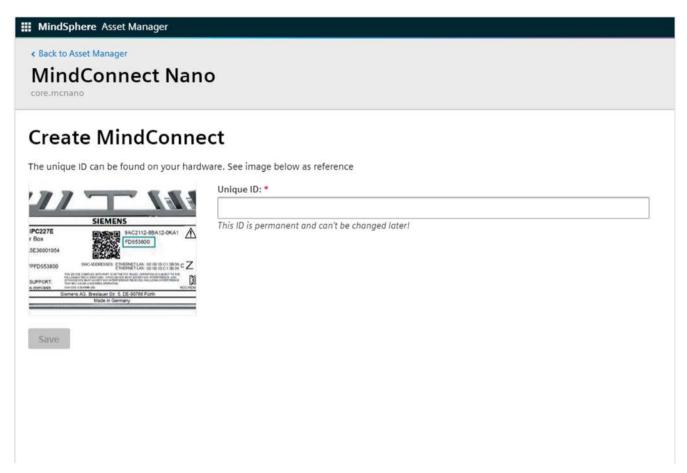
To use a MindConnect Element with MindSphere you have to enable the connection. Within enabling the connection you can assign a MindConnect Element to an asset.

Procedure

To enable the connection to the MindConnect Element proceed as follows:

1. Select the asset in the "Asset" tab.

2. Click on the asset icon, e. g. "MindConnect Nano".

   The "Create MindConnect" screen appears.

3. Enter the unique ID from your hardware.

Result

You have enabled the connection to the MindConnect Element.

See also

Adding a data source and data points (Page 61)

7.5 Configuring network settings

Network configuration of MindConnect Nano/IoT2040 requires information on the ethernet interfaces for data acquisition (ethernet labeled with X2P1) and MindSphere (ethernet labeled with X1P1). If your company uses a proxy server, it must also be configured to connect MindConnect Nano/IoT2040 to MindSphere. Contact your IT administrator for details on your local network settings.
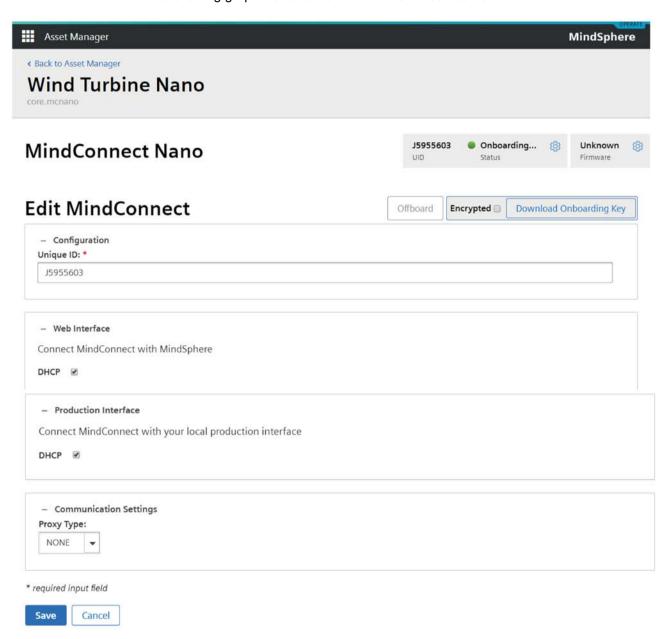
After enabling the connection to the MindConnect Element you can edit the network configuration. You can enter either a static IP address or use DHCP. The last option is possible, if there is a DHCP server available in your company network.

Procedure

To configure the network setting, follow these steps:

1. Select the asset in the "Asset" tab.
2. Click on the asset icon, e. g. "MindConnect Nano".
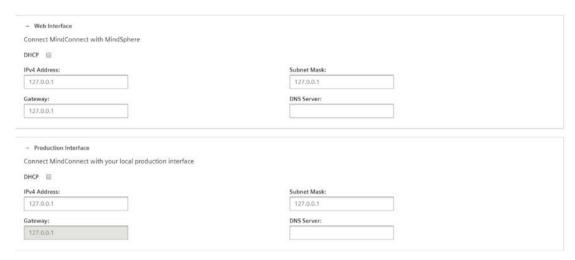
3. Click next to "Status" on the button ⚙.

The following graphic shows the "Edit MindConnect" screen:

4. Activate DHCP if a DHCP server is available in your company network or enter the respective information for static IP address.
The following graphic shows the IP address input fields:

5. Enter the proxy data area "Communication Settings" if necessary and click "Save".

   – In this case, contact your network administrator to get the proxy data.

   Note

   If nothing else is configured manually, MindConnect Nano/IoT2040 will try to obtain IP addresses for both adapters via DHCP.

   ---

6. Click on "Save", to complete the configuration.

7.6 Transferring configuration to MindConnect Element

Requirement

- A standard USB device with a single partition in FAT or FAT32 is formatted.
- You have enabled the connection to the MindConnect Element.
- You have configured the network settings.

Procedure
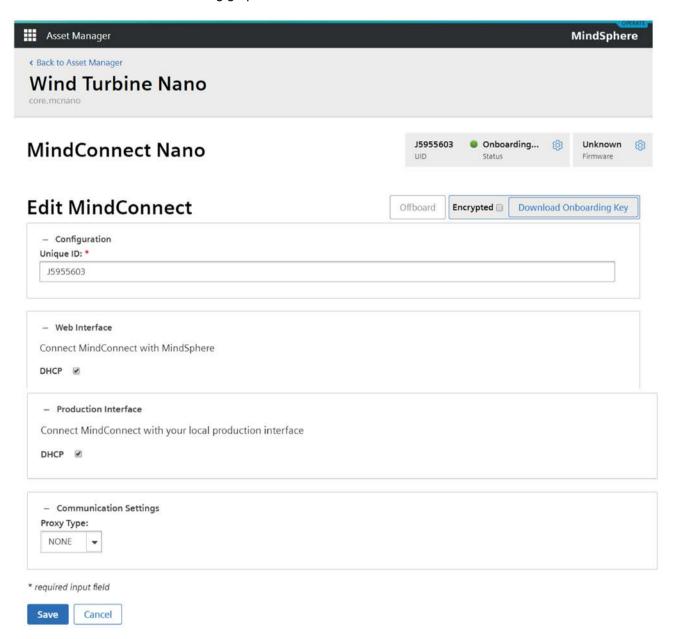
⚠WARNING
USB stick information
The configuration created in this step includes security relevant information. You can encrypt and sign the information. Take care of the USB stick and the information flow from MindSphere to USB stick and from USB stick to the MindConnect Element. Delete the USB stick after use.

To export the configuration, follow these steps:

1. In the MindConnect settings click ⚙.

   The following graphic shows the "Edit MindConnect" screen:

2. In order to encrypt the onboarding key data, activate the "Encrypted" checkbox.

3. Click on "Download Onboarding Key".

4. Save the downloaded file to the root directory of your USB stick.

5. Insert the USB stick into the USB port of the MindConnect Element, e. g. "MindConnect Nano"

Note

During the import of the configuration, the following LED-states are to be expected:
1. MAINT LED flashes orange
2. RUN LED blinks green
3. On-boarding result
   – RUN LED green: MindConnect onboarded successfully
   – MAINT LED orange: onboarding failed

The process can take up to 30 minutes. Please do not remove the USB stick during this time.

---

6. After successfully importing the configuration, remove the USB stick from the MindConnect Element.

7. Check the status of the MindConnect Element at the Overview.

Result

The connection status in Asset Manager at the overview has changed to "Onboarded". The configuration of the asset has been transferred to the MindConnect Element. The connection between the MindConnect Element and MindSphere is established.

Once MindConnect Nano/IoT2040 is onboarded, the connection to your asset is permanent and your asset for data collection can be configured. This requires configuration of machine data to be monitored. Any additional configuration (except network configuration) of the connected asset will automatically be synchronized with your onboarded MindConnect Nano/IoT2040.

The connection to the asset is permanent and can only be cancelled by offboarding. For this purpose, refer to the Asset Manager documentation.

Configuring data in Asset Manager

8

After onboarding a MindConnect Element, you need to configure the data in Asset Manager. You have to set up a data connection to receive data from your MindConnect Element.

In order to use the data from your MindConnect Element in MindSphere you need to a map the received data to the Asset Manager data model.

Asset Manager uses the following areas:

- Assets
- Types
- Aspects

In order to configure data in Asset Manager you need to fulfill the following steps:

- Creating an aspect and variables (Page 56)

  In this step you create aspects and variables you want to use in MindSphere.

- Creating a type in Asset Manager (Page 58)

  In this step you create an asset type to enable data mapping.

- Adding a data source (Page 61)

  The data source defines the reading of the data from the MindConnect Element.

- Mapping an aspect to a data source (Page 65)

  In this final step you map the data of the MindConnect Element to the aspects and variables in MindSphere.

8.1   Creating an aspect and variables

To use the data of your MindConnect Element in MindSphere you need to create aspects and variables in Asset Manager.

Aspects are combined, pre-configured data and form the context for the evaluation of industrial processes. An aspect can consist of several variables. Within the industry process, assets transfer the aspects as time series data in MindSphere.

In Asset Manager you can create aspect types. Aspect types are pre-configured templates for aspects. The advantage of aspects types is to use one type for several assets. For example, you can create one aspect type for all generators of a wind farm with the variable rotation speed.

Procedure

To add an aspect type in Asset Manager, e. g. "Generator", follow these steps:

1. On the start screen click "Aspects".

2. To create a new aspect click ⊕.

3. Enter your Tenant ID for the aspect, e. g. "idevdoc.generator".

> **Note**
>
> All custom aspects and types must be named as "<TenantID>.xxx"

4. Enter a name and description for the aspect e. g. "Generator".

5. Follow these steps for each variable, e. g. "RotationSpeed":

   – Enter variable data.

   > **Note**
   > • The units and data types specified here will need to match exactly(also case sensitive) with the physical data source.
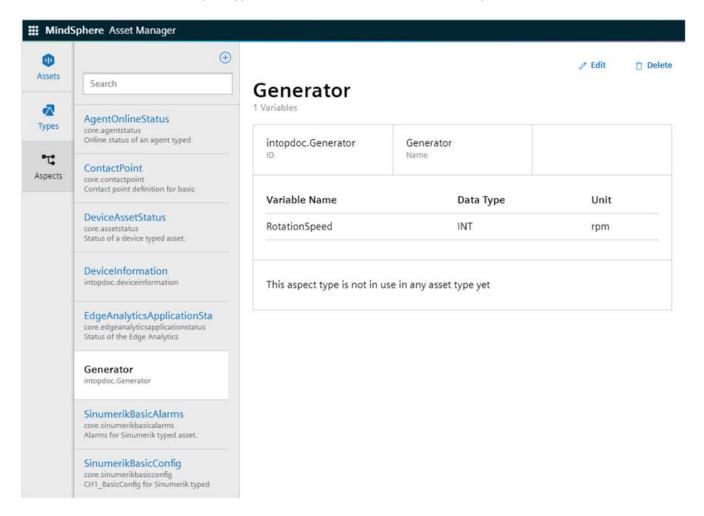
Figure 8-1   Variable data

   – Click "Add variable".

6. Confirm with "Save".

Result

The new aspect type with its variables is available in the aspect list.

8.2 Creating a type in Asset Manager

To enable data mapping you first have to create an asset type. An asset type is a pre-configured template for an asset. The asset type predefines which aspects are integrated into the template. You have to link aspects to an asset type to enable the connection to a data point.

Requirement

- You have created an aspect.

Procedure
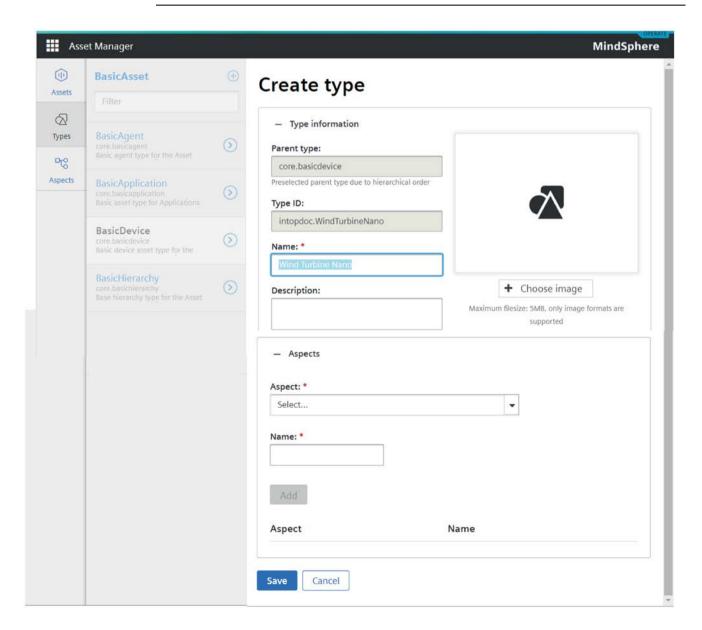
To create an asset type proceed as follows:

1. Click on the "Types" tab in Asset Manager.

2. Click on "BasicDevice".

3. To create a new asset type click ⊕ .

4. Enter ID and name for asset type, e. g. "Wind turbine".

Note

The ID must be named as "TenantID.xxx".

---
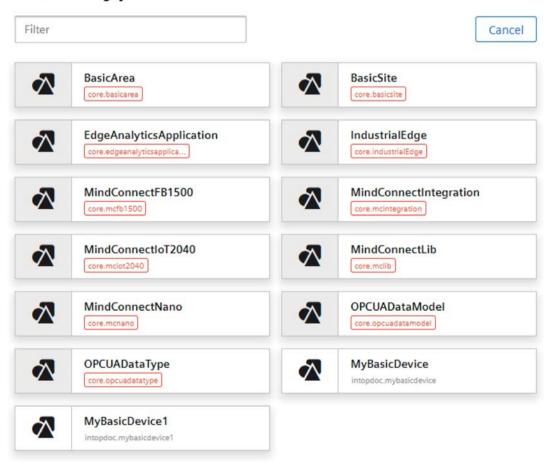
5. Select an aspect type from the dropdown menu, e. g. "Generator". You can find additional information on aspects in the chapter Creating an aspect and variables (Page 56)

6. Enter an aspect name and click "Add".

7. To save the asset type click "Save".

Result

You created a new asset type. The new asset type is now available in the presets. The following graphic shows the new available asset type "Wind turbine" in assets.

8.3 Adding a data source and data points

8.3.1 Adding a data source

To receive the data of your MindConnect Element you need to add a data source. The data source specifies the protocol and reading cycle that is used to transfer the data from your asset to the MindConnect Element. Within the data source, you enter the IP address of the asset inside of your network.

Requirement

- You have created an asset and an aspect.
- You have enabled the connection to the MindConnect Element.
- You have the IP address of the asset inside of your network.
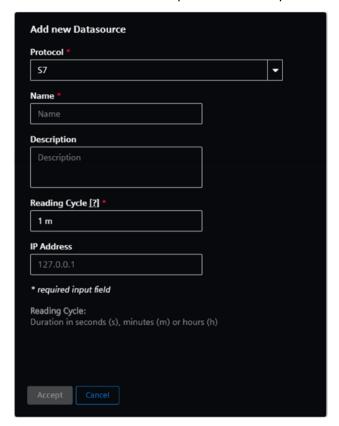
Procedure

To add a data source to an asset of type MindConnect, e. g. "Generator", follow these steps:

1. Click on the asset in the "Assets" tab, e. g. "Wind turbine".
2. Click on the asset icon, e. g. "MindConnect Nano".

3. Click "Add new data sources".

   – The window to enter the protocol data is opened
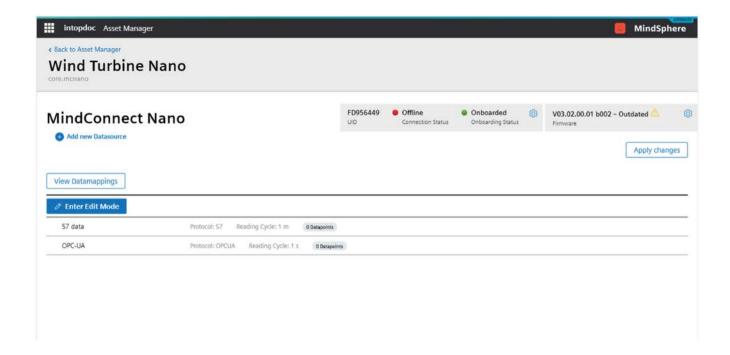
Note

- The default reading cycle is 86400 seconds, which is one day.
- You can find additional information on supported protocols in the chapter Configuring protocols (Page 68).

4. Enter data source data and confirm with "Accept".

5. To save the data source click "Save".

Result

You have now created a new data source. The new data source is available at the asset details of your MindConnect Element.

The following graphic shows the added data source:

8.3.2 Adding data points

A data point is a measurable value of an asset that can be represented numerically and graphically. Examples of a data point are temperature or pressure. Within MindSphere you add data points to a data source to collect the data for example from a control unit. In the next step you have to link the data points of a data source with the respective variables of an aspect.

Note

Health status

The health status shows the quality of the connection of the data point. You can click on the status to get further information. You can find additional information about quality code in chapter Quality code settings (Page 92).

Requirement

- You have created a data source.
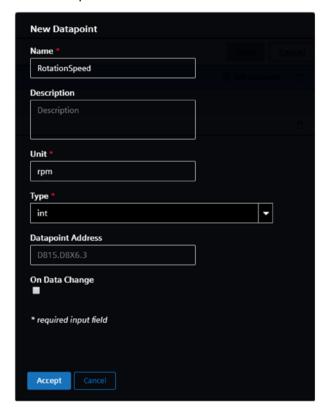
Procedure

To add a data point to a data source, e. g. "RotationSpeed", follow these steps:

1. Click on the asset in the "Assets" tab, e. g. "Wind turbine".

2. Click on the asset icon, e. g. "MindConnect Nano".

3. To edit the data source you have to click on "Enter Edit Mode".

   – Edit functions appear next to the data source.

4. Click on "Add Datapoint".

5. Enter data point data.

Note
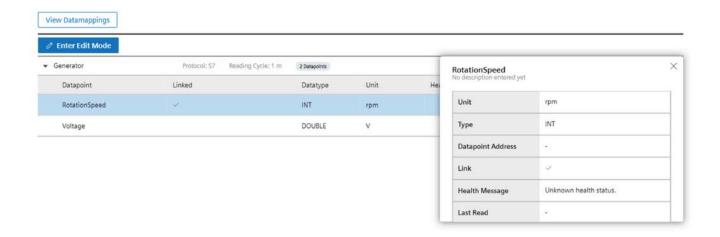
- The units and data types specified here will need to match exactly with the aspects and variables. If they are different, the aspect cannot be connected to the data point.

- The protocol datatypes specify the Datapoint Address. You can find additional information on protocol datatypes in the chapter Configuring protocols (Page 68).

6. Confirm with "Accept".

7. To save the added data point in "Edit Mode" click "Save".

Result

The new data point is available at the data source.

In order to send the changes to the device, you have to click "Apply Changes" in the MindConnect plugin.

The following graphic shows the health status of the new data point:

8.4 Mapping an aspect to a data source

Data mapping means matching variables of an aspect with the respective data points of a data source.

- Variables of an aspect represent the MindSphere data.
- Data points of a data source represent the data of the MindConnect Element.

To use the data of your MindConnect Element you have to map them to the respective variables of an aspect.

Requirement

You have now created an asset based on your desired aspect and asset type.
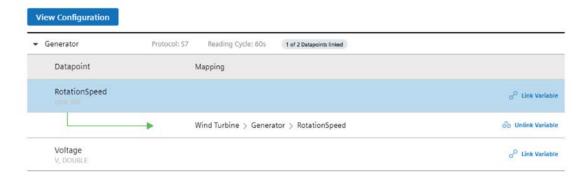
Procedure

To map a variable to a data point, e. g. "RotationSpeed", follow these steps:

1. Click on the asset in the "Assets" tab, e. g. "Wind turbine1".
2. Click on the MindConnect Element Plugin icon, e. g. "MindConnect Nano".
3. Click "View data mapping".
4. Select the aspect, e. g. "Generator".
5. Select the variable you want to map to the data point, e. g. "RotationSpeed".
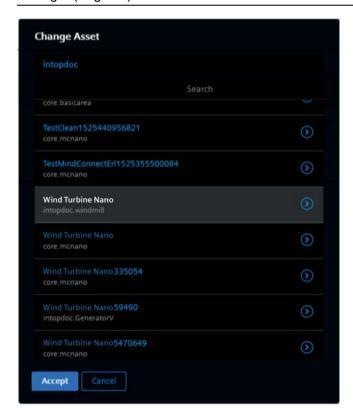
6. Select the data point you want to map and click "Link Variable".
   The following graphic shows the "Link Variable" option:
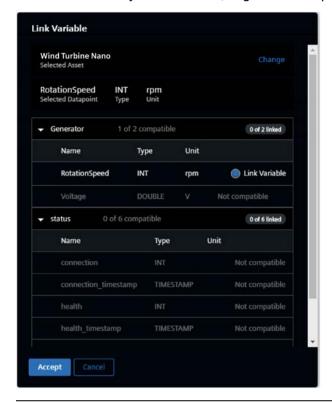
7. Select the previously created asset type and click "Accept", e. g. "Wind turbine".

Note

You can find additional information on asset types in the chapter Creating a type in Asset Manager (Page 58).

8. Select the variable you want to link, e. g. "RotationSpeed".

Note

Only units and data types that match exactly with the aspects and variables are available. If they are different, the aspect can't be connected to the data point (also case sensitive).

9. To link the variable click "Accept".

Result

The data point is now mapped to the variable.
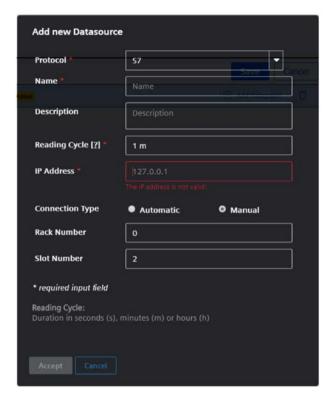
The following graphic shows a mapped variable:

Configuring protocols

<div style="text-align: right; font-size: large;">9</div>

9.1 Overview of S7 protocol

The following image shows the data source input window for the S7 protocol:

You can choose between automatic and manual connection type.

- Automatic: This mode tries to find slot and rack number automatically.

- Manual: In this mode you can enter the rack and slot number manually.

You can read data out of SIMATIC S7 devices via PUT/GET communication. Therefore the PUT/GET communication has to be activated inside of your S7 device.

Note

Symbolic access

This solution does not allow full symbolic access.

Address format examples

In order to read the data out of data block you have to deactivate the "Optimized block access" in TIA Portal.

Data block	MindSphere type	Description	Signed / Unsigned data
DB15.DBX6.3	Integer	Reads 3rd bit of byte 6 of datablock 15	Unsigned
DB15.DBB4	Integer	Reads a byte starting from offset 4 of datablock 15	Unsigned
DB15.DBBYTE4	Integer	Reads a byte starting from offset 4 of datablock 15	Unsigned
DB15.DBCHAR6	Integer	Reads a char starting from offset 6 of datablock 15	Signed
DB15.DBW10	Double	Reads a word starting from offset 10 of datablock 15	Unsigned
DB15.DBWORD10	Double	Reads a word starting from offset 10 of datablock 15	Unsigned
DB15.DBINT12	Integer	Reads an integer starting from offset 12 of datablock 15	Signed
DB15.DBDW24	Double	Reads a double word starting from offset 24 of datablock 15	Unsigned
DB15.DBDWORD24	Double	Reads a double word starting from offset 24 of datablock 15	Unsigned
DB15.DBDINT28	Integer	Reads a double integer starting from offset 28 of datablock 15	Signed
DB15.DBREAL32	Double	Reads a floating point number starting from offset 32 of datablock 15	Signed
DB15.DBSTRING10	String	Reads a string starting from offset 12.10th byte is maximum string length (254) and 11th byte is actual string length. If 11th byte is AA, 170 bytes read starting from 12th byte. [1]	-
DB15.DBSTRING10,100	String	Reads a string starting from offset 10. Length of the string is 100 bytes. (Maximum string length is 254) [1]	-
T4	-	Reads 4th timer [1]	-
C5	-	Reads 5th counter [1]	-
QX35.1	-	Reads 1st bit of 35th byte of output [1]	-
MD16	-	Reads a double word of memory starting from offset 16 [1]	-
IB40	-	Reads a byte of input starting from offset 40 [1]	-

[1] *Only timer and counters don't need variables.*

Note

Signed values

If you want to read a signed value, you have to use the respective signed datablock.

Example:

DB1831.DBW508 is unsigned. You can use DB1831.DBINT508 instead.

Area Types

S7 datapoint addresses must contain an area type.

Area type	Description
I: Process Input	Reads Input value of Process image.
PI: Peripheral Input	Reads Input value directly from hardware.
Q: Process Output	Reads Input value of Process image.
PQ: Peripheral Output	Reads Output value directly from hardware.
M: Memory	Reads Memory value of hardware.
T: Timer	Reads Timer value of hardware.
C: Counter	Reads Counter value of hardware.
DB: Datablock	Reads datablock value from hardware.
DI: Instance Data	Reads data directly from hardware.

Area Number

S7 datapoint addresses must contain area number.

e.g.: DB10 (10. datablock)

Variable Types

Area types other than timer and counter must contain a variable type.

S7 data type	Length	Asset data point type	Asset data point address
Byte (unsigned)	1 byte	Integer	DB1.DBX0.0
Char (signed)	1 byte	Integer	DB1.DBB1, DB1.DBCHAR8
DINT (signed)	4 bytes	Long	DB1.DBDINT4
DWord (unsigned)	4 bytes	Long	DB1.DBDWORD10
Int (signed)	2 bytes	Integer	DB1.DBINT2
Real	4 bytes	Double	DB1.DBREAL16, DB1.DBD16
String	254 bytes	String	DB1.DBSTRING16,254
Word (unsigned)	2 bytes	Integer	DB1.DBW8

Offset

Variable types must have an offset. Offset is the starting byte number.

e. g. DW4 (a double word starting from byte 4)

String
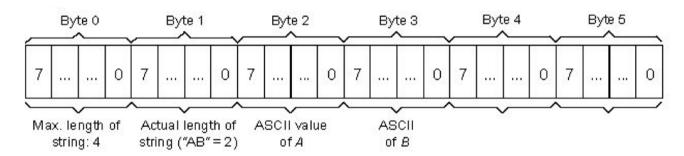
Data type	Length in bytes	Format
STRING[n] or STRING	n+2	ASCII character of any length. n specifies the length of the character string. A maximum length of 254characters is permitted. If no length is specified, the default setting is 254 characters.

Data type	Examples of format used
STRING[2]	'AB'
STRING[55]	'The character string can consist of up to 55 characters'

Note

You must enclose your character string in single quotation marks.

The following example shows the byte order when specifying the datatype STRING[4] with the output value 'AB'.

* Tod

TIME_OF_DAY (Time)	32	Time is in steps of 1 ms	TOD#0.0.0.0 to TOD#23:59:59.999	L TOD#1:10:3.3 L TIME_OF_DAY#1:10:3.3

* Time

Returns milliseconds.

Format

The DT (DATE_AND_TIME) datatype saves the information on date and time of day in BCD format.

The following table shows the properties of datatype DT:

Length (bytes)	Format	Range of values	Example of value input
8	Date and time (year-month-day		

9.2 Overview of OPC UA protocol

OPC UA data parameter

The following image shows the data source input window for the OPC UA protocol:

For the OPCUA protocol, the data source input supports the following parameters:

Parameter	Description
Protocol	Shows the selected protocol type.
Name	Name of the data source.
Description	Add a description for data source.
Reading Cycle	Enter a reading cycle for the data source.
OPC UA Server Name	Enter the name of the OPC UA Server Name.
OPC UA Server IP Address	Enter the OPC UA Server IP Address.

Parameter	Description
OPC UA Authentica-tion Type	You can choose between the following types: • NONE: No authentication enabled. • BASIC: Enables the OPC UA BASIC authentication.
OPC UA Security Mode	You can choose between the following modes: • NONE: No security mode • CERTIFICATE: Enables to upload a certificate in the following formats: *.pfx, *.pf12, *.cer, *.crt, *.der, *.p7b, *.p7r, *.spc

OPC UA Data Access Specification

OPC UA Data Access Specification does not specify a certain representation for OPC UA Addresses (NodeId). A NodeId is represented by a combination of:

- NamespaceIndex
- IdentifierType
- Identifier

OPC UA Client Driver addresses have the following syntax: ns=;=.

Note

OPC browsing is not supported.

For more information refer to the table below:

Field	Description	
NamespaceIndex	The index of the OPC UA Server namespace in which the address resides. If the index is 0, the entire ns=;= clause is omitted.	
IdentifierType	The type of address. OPC UA supports the following four address types:	
	i	A numeric address represented with 32-bit unsigned integer
	s	A string address containing characters that can be encoded using UTF-8
	g	A GUID address in the format of XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX
	b	An opaque address (such as a byte string)
Identifier	The address that is formatted as a string. This address may be numeric, string, GUID, or opaque.	

Examples NodeId

Below you can see examples of an OPC UA Addresses (NodeId) representation:

String

String IdentifierType	Example
ns=[id];s=[string]	ns=5;s=Counter1

Attribute NodeId	Value NodeId
NamespaceIndex	5
IdentifierType	String
Identifier	Counter1

Note

String for Identifier

The string you enter at the four Identifier will be case sensitive.

Numeric

Numeric IdentifierType	Example
ns=[id];i=[number]	ns=0;i=3190 OR

Attribute NodeId	Value NodeId
NamespaceIndex	0
IdentifierType	Numeric
Identifier	3190 [BaseEventType_LocalTime]

Guid

Guid IdentifierType	Example
ns=[id];g=[guid]	ns=1;g=0d4e10fa-b9e1-4842-bca6-887c7d8c31f0

Base64(Opaque)

Base64(Opaque) Iden- tifierType	Example
ns=[id];b=[base64]	ns=2;b=M/RbKBsRVkePCePcx24oRA==

Datatypes Conversion

The following table shows the Datatype Conversion:

IEC61131 elementary datatypes	OPC UA built-in datatypes	MindSphere Type
BOOL	Boolean	boolean
SINT	SByte	int
USINT	Byte	int
INT	Int16	int
UINT	UInt16	int
DINT	Int32	int

IEC61131 elementary datatypes	OPC UA built-in datatypes	MindSphere Type
UDINT	UInt32	int
LINT	Int64	long
ULINT	UInt64	long
BYTE	Byte	int
WORD	UInt16	int
DWORD	UInt32	int
LWORD	UInt64	long
REAL	Float	double
LREAL	Double	double
STRING	String	string
CHAR	Byte	int
WSTRING	String	string
WCHAR	UInt16	int
DT DATE_AND_TIME	DateTime	n/a
DATE	DateTime	n/a
TOD TIME_OF_DAY	DateTime	n/a
TIME	Double	double

Note
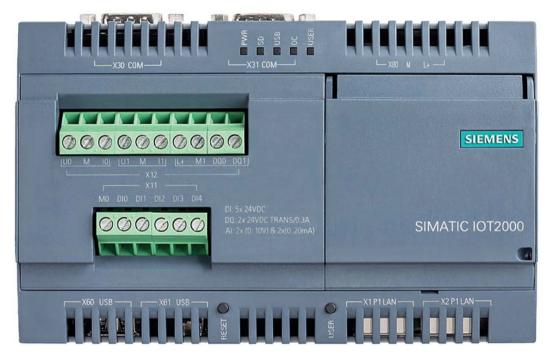
"NodeID" is not a valid part of the OPC string anymore.

9.3　　Overview of SIMATIC I/O Shield

SIMATIC I/O Shield device has been plugged-in to MindConnect IoT2040 and set up according to I/O Shield operating instructions. Analog and digital input signals are connected to SIMATIC I/O Shield connectors.
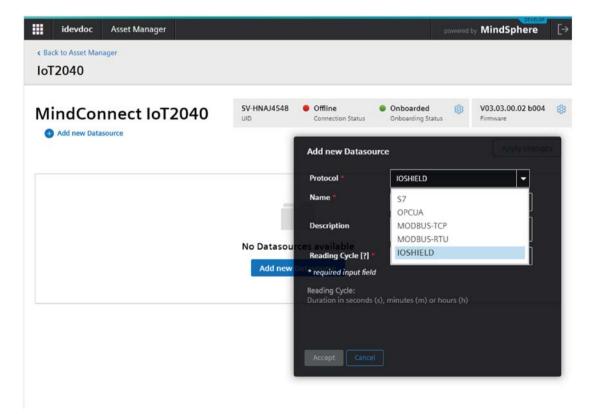
You can find more information about the SIMATIC I/O Shield Modul in the SIMATIC IOT IOT2000 Extension Modules manual (https://support.industry.siemens.com/cs/document/109745681/iot2000-extension-modules?dti=0&lc=en-WW). The following picture shows the SIMATIC IOT2000 Input/output Modul:

You can select the protocol type SIMATIC I/O Shield while adding a new data source in Asset Manager.

The following picture shows the protocol selection in Asset Manager:

After selecting the protocol you can enter the parameter Name, Description and Reading Cycle.

SIMATIC I/O Shield data point parameter

In order to collect the data of your SIMATIC I/O Shield device, you must add new data points.

The signal that has to be recorded can be configured by specifying pin type (analog/digital) and the pin number as it is printed on SIMATIC I/O shield device. For the analog inputs, the read value corresponds to a percentage value between 0 and 1. The percentage value refers to the permissible voltage range between 0-10 V. The read value must be converted accordingly for the connected sensor.

Following inputs can be chosen:

Input	Pin type	Pin number	Recommended data type
AI0	Analog	0	DOUBLE
AI1	Analog	1	DOUBLE
AI2	Analog	2	DOUBLE
AI3	Analog	3	DOUBLE
DI0	Digital	0	BOOLEAN
DI1	Digital	1	BOOLEAN
DI2	Digital	2	BOOLEAN
DI3	Digital	3	BOOLEAN
DI4	Digital	4	BOOLEAN

9.4 Overview of Modbus protocol

MindSphere supports the Modbus protocol for the MindConnect IoT2040 and MindConnect Nano plugin. You can select the protocol type Modbus TCP and Modbus RTU while adding a new data source in Asset Manager.

Note

Modbus configuration

The Modbus configuration view is only visible after a successful onboarding of the MindConnect IoT2040/Nano. The MindConnect Nano Version must be higher than V3.3.0.2.

For the connection Modbus supports cables with 3 wires.

The following picture shows the protocol selection in Asset Manager:

Figure 9-1   Modbus

For more information about how to create a new data source see chapter AUTOHOTSPOT.

Modbus TCP data source parameter

In order to connect a Modbus TCP device, you need to select the Modbus TCP protocol and enter the following data source parameters:

Parameter	Description
IP Address	IP address of the Modbus device
Port	Port number of the Modbus device (default: 502)

Modbus RTU data source parameter

In order to connect a Modbus RTU device, you need to select the Modbus RTU protocol and enter the following data source parameters:

Parameter	Description
Serial Port	Available serial ports: • COM1 • COM2
Serial Type	Supported serial communication standards: • RS232 • RS422 • RS485
Baud rate	Baud rate for serial communication: • 9600 • 2400 • 4800 • 19200 • 38400 • 57600 • 115200
Data bits	Data bits for serial communication: • 5 • 6 • 7 • 8
Stop bits	You can select the number of stop bits for serial communication: • 1 • 2
Parity	Parity for serial communication: • Odd • None • Even
Termination	Onboard termination: • On • Off

Pin assignment of Modbus protocols
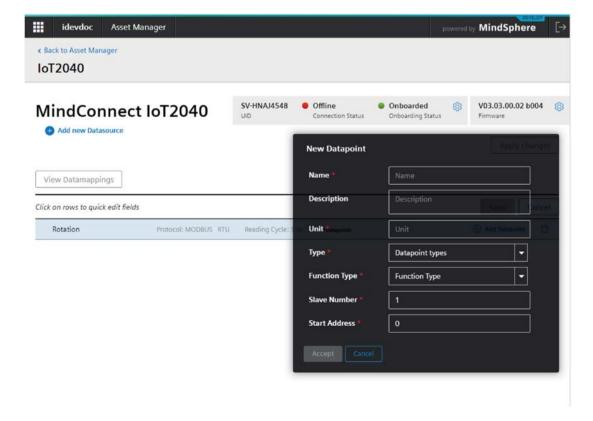
The following table shows the pin assignment for each Modbus protocol:

Pin	RS 485	RS 422	RS 232
1	Data- Transmit / receive data - (I/O) for half-duplex mode	TX- Transmitted data - (O) for full-duplex mode	DCD Data carrier detect (I)
2	Data+ Transmit / receive data+ (I/O) for half-duplex mode	TX+ Transmitted data + (O) for full-duplex mode	RxD Received data (I)
3	-	RX+ Receive data + (I) for full-duplex mode	TxD Transmitted data (O)
4	-	RX- Receive data - (I) for full-duplex mode	DTR Data terminal ready (O)
5	M Signal ground	M Signal ground	M Ground
6	-	-	DSR Data set ready (I)
7	-	-	RTS Request to send (O)
8	-	-	CTS Clear to send (I)
9	-	-	RI Incoming call (I)

Modbus RTU data point parameter

In order to collect the data of your Modbus RTU device, you must add new data points.

The following picture shows the data point parameter window:

The following table shows the parameter of the Modbus RTU data point window:

Parameter	Description
Data Type	Data type supported by backend (e.g. INT).
Function Type	Function type - depends on the type of the data (see manual of the Modbus device). 1: Read Coils 2: Read Inputs 3: Read Holding Registers 4: Read Input Registers Currently function codes 1..4 are supported.
Slave Number	Address/Slave number of the Modbus device.
Start Address	Start address (offset) of the data.
Quantity	Quantity of data to be read.
VariableType	You can choose the following variable types of the Modbus data to be read: 1: char 2: unsigned char 3: short 4: unsigned short 5: long 6: unsigned long 7: float 8: double 9: ASCII-Text
Real Type	Real type - determines, if the registers of real values have to be processed in reversed order 0: Normal order 1: Reversed order
Response Address Offset	Offset of the data to return in register units.
Response Quantity	Quantity of the returned data. Only for string data a value greater than 1 is supported.

Technical specification

Protocol	Description	Value	Data rate
Modbus RTU - RS485	Data provider	32	
	Max cable length	1200 m	max. 115,2 kBd
Modbus RTU - RS422	Data provider	10	
	Max cable length	1200 m	max. 115,2 kBd
Modbus RTU - RS232	Data provider	1	
	Maximum cable length	900 m	2,4 kBd
		300 m	4,8 kBd
		152 m	9,6 kBd
		15 m	19,2 kBd
		5 m	57,6 kBd
		< 2 m	115,2 kBd

9.5 Overview of SYSTEM protocol

You can use the protocol SYSTEM to implement a system information adapter for analysis purposes. The SYSTEM protocol can collect the following information from MindConnect devices:
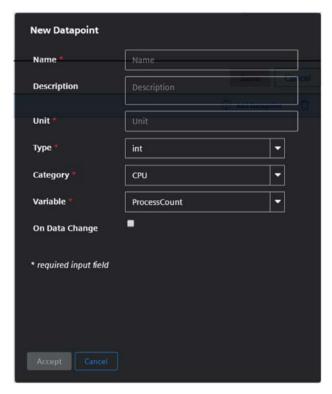
- Overall CPU load

- Overall memory consumption

- Network traffic

- Application specific data

  – CPU load memory consumption

- Disk usage

You can choose the SYSTEM protocol as a data source without configuring specific system parameters, except the reading cycle.

After creating the data source you can configure the following categories in a new data point:

- CPU

- Memory

- Network

- Disk

The following image shows the data point input window for the SYSTEM protocol:

Each category has its own set of variables which will be described in the following.

CPU information

The following table shows the available variables for the category CPU information:

Variable	Data type	Description
LoadAvg1	Float	Average of all values for the last 1 minute.
LoadAvg5	Float	Average of all values for the last 5 minutes.
LoadAvg10	Float	Average of all values for the last 10 minutes.
ProcessCount	String	Count of actual processes in the system.
LastPidUsed	Unsigned integer	Last used process ID.

Memory information

The following table shows the available variables for the category Memory information:

Variable	Data type	Description
MemTotal	Unsigned long	Total usable memory of the system in bytes.
MemFree	Unsigned long	Total free memory of the system in bytes.
MemAvailable	Unsigned long	Total available memory of the system in bytes.
KernelStack	Unsigned long	Stacksize.

Network information

The following table shows the available variables for the category Network information:

Variable	Data type	Description
Innoectpkts	Unsigned long	In and Out IP traffic in bytes.
Inbcastpkts	Unsigned long	Number of received broadcast packets.
TCPHPAcks	Unsigned long	ACK received in TCP fast path.
DelayedACKs	Unsigned integer	TCP delayed acknowledgment (Network performance).
BytesReceived	Unsigned long	Number of bytes received by the network.
BytesSend	Unsigned long	Number of bytes which where send to the network.

Disk information

Disk collects information about disk usage and provides the following subcategories:

- root

- persistent

- persistent_appconfig

- persistent_massdata

The following table shows the available variables for the category Disk information:

Variable	Data type	Description
Size	Unsigned long	Partition size in bytes.
Used	Unsigned long	Used space in bytes.
Available	Unsigned long	Available space in bytes.

Firmware update

<div style="text-align: right; font-size: 2em;">10</div>

10.1 Manual firmware update of MindConnect Element

To prepare your MindConnect Element for MindSphere V3 please follow the next two steps:

- Set MindConnect to factory settings
- Load new firmware on your MindConnect Element

Set MindConnect to factory settings

> **Note**
>
> This procedure is only necessary for boxes that were already connected to MindSphere V2 (SAP). V1 cannot be upgraded.

1. Set the MindConnect back to factory settings.
2. Create a "ConBox_Commands.json" file with your favorite code editor.

   Content of "ConBox_Commands.json":

   ```
   {
     "Commands": [
      {
       "Cmd": "DoFactoryReset",
       "DeviceID": "MindConnectID"
      }
     ]
   }
   ```

   > **Note**
   >
   > `MindConnectID` has to be replaced with the serial number of the device.

3. Copy the extracted/unzipped fw.tar file to a USB stick (fat32 formatted).
4. Plug the USB stick in the MindConnect hardware.
   - The MindConnect will be restarted automatically.
   - The network and SAL settings will be reset to their initial state on MindConnect Element.
   - All SAL and script logging files will be deleted.

Load new firmware on your MindConnect Element

1. Download the firmware ZIP file from Siemens Industry Online Support Page.

    –   Firmware download MindConnect Nano
        (https://support.industry.siemens.com/cs/ww/en/view/109745561)

    –   Firmware download MindConnect IoT2040
        (https://support.industry.siemens.com/cs/ww/en/view/109745562)

2. Unzip the firmware on your local machine.

3. Copy the unzipped files to a USB stick.

4. Insert the USB stick into the MindConnect Element and wait until the firmware update is complete.

    –   Update carried out: ERROR LED flashes orange

    –   MindConnect Element reboots

    –   MAINT LED flashes orange for a few seconds

    –   RUN LED orange (not connected to MindSphere)

5. Disconnect the USB stick.

10.2   Firmware update in Asset Manager

In Asset Manager you can update the firmware of your MindConnect Element.

NOTICE
Outdated version
Please keep your firmware always updated.

To perform a firmware update proceed as follows:

1. Select the asset in the "Asset" tab.

2. Open the MindConnect plugin.

3. Click next to "Firmware" on the button ⚙ .

4. Accept the terms and conditions.

5. To select a firmware release click "Choose another firmware release".

    –   The "select firmware" dialog appears.

6. Select product and available version and click "Accept".

7. To update your firmware click "Update your firmware".

Visual analysis of assets in Fleet Manager

11

11.1 Overview visual analysis

This chapter provides a brief overview of the visual analysis of your asset, which was configured in Asset Manager. It gives you a brief overview of how to monitor the data of a selected asset in Fleet Manager. For more information refer to the MindSphere documentation.

Requirements

- MindConnect Nano/IoT2040 is connected to the internet and onboarded.
- Aspects and variables are configured in Asset Manager.

Procedure

To see the visualized data in Fleet Manager, you can proceed as follows:

1. Select a required asset to view its data. (Page 87)
2. View aspects of a selected asset. (Page 89)
3. View events of a selected asset. (Page 91)

11.2 Selecting assets

Fleet Manager offers the means for viewing and simple searching/sorting/filtering of assets. You access Fleet Manager via the MindSphere Launchpad.

Requirement

You have created assets in Asset Manager.

Procedure

To select an asset in Fleet Manager, proceed as follows:

1. In the MindSphere Launchpad, click "Fleet Manager".

   The overview page of Fleet Manager appears and you can see the list with assets on the left-hand side.

2. To view an asset, select between "Fleet" or "Hierarchy" views.

3. To see the map view, click [📍] .

4. To quickly find the created asset e.g. "Wind turbine", choose one of the following features:

   – Select the asset that is linked to your aspect and asset type.

   – Enter a required text in the searching box.
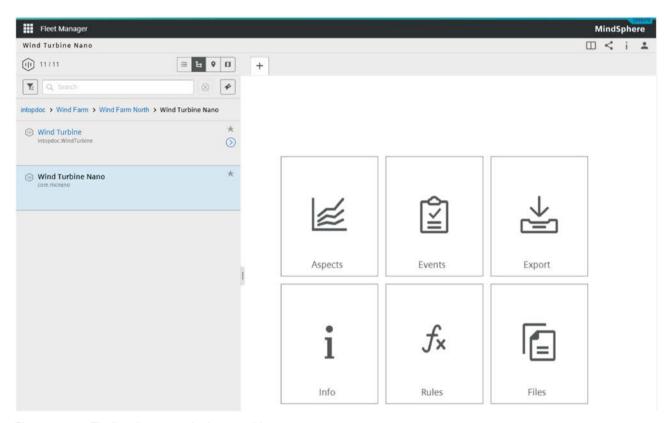
Figure 11-1   Finding the asset via the searching text

   – Or click the "Filter & sort" button to restrict the asset list.
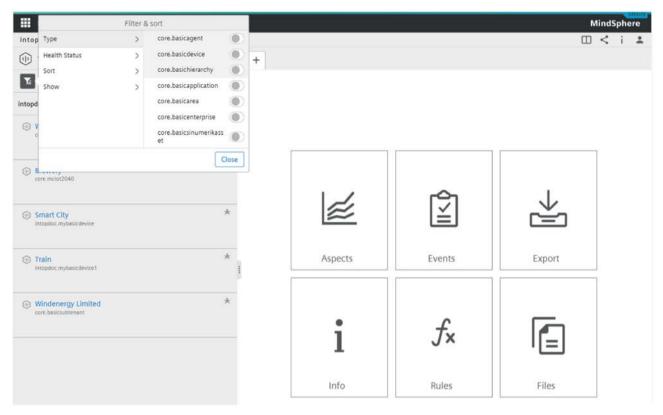
Figure 11-2   Finding the asset "Filter & sort"

Result

The navigation displays the selected asset that corresponds to the search or filter parameters.

11.3   Viewing aspects

After you have selected an asset to be monitored, you can open an extension to see the status of its single aspects or events in detail in the right column. To view variables of aspects Fleet Manager offers you the "Aspects" extension.

Requirement

You have created aspects in Asset Manager.
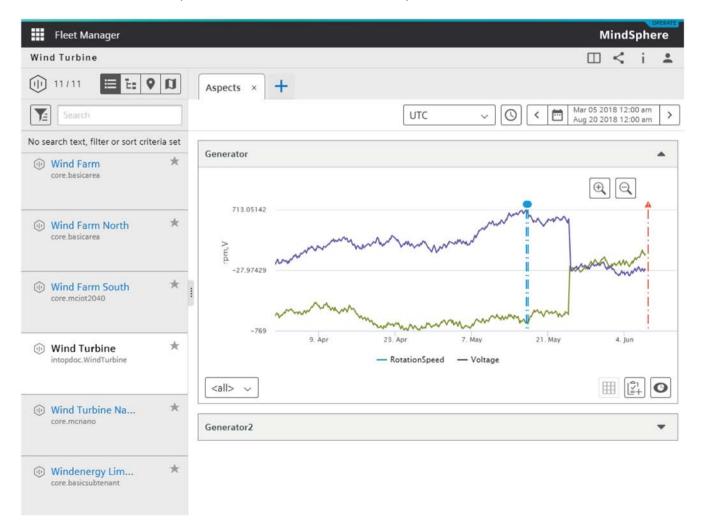
Procedure

To view variables of aspects in the "Aspect" extension, proceed as follows:

1. In the right-hand side of Fleet Manager, click the "Aspects" extension icon.

   – The "Aspects" extension opens on the right-hand side.

2. Select and expand an aspect e.g. "Generator":

   – Aspect "Generator" is opened.

   – You can set a time frame (Time picker: day, week, and month) and see the variables, which you want to monitor.

3. Select the dates from the last week in the calendar.

4. To show the exact measured values, move the mouse over the graph.

Result

The "Aspects" extension shows the chosen aspect of an asset.

11.4   Viewing events

All events are displayed in an overview of the "Events" extension and you can influence the view through different filter criteria. You can also assign a specific status to events. You can find additional information on creating events in the Fleet Manager documentation.

Requirements
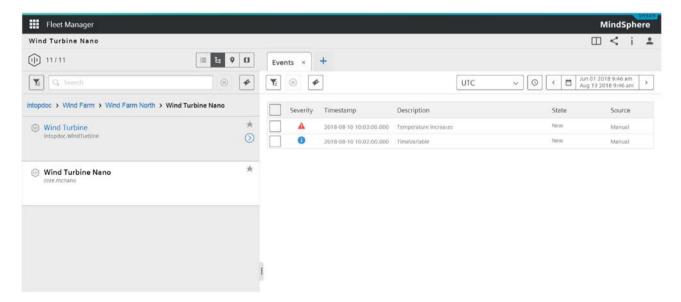
- You have created assets in Asset Manager.
- Events have been created and are already available.

Procedure

1. Select the required asset e.g. "Wind turbine", in the left-hand side of the window.
2. In the right-hand side, click the "Events" extension icon.
3. Click the tab "Events".

Result

The events data of asset "Wind turbine" is displayed.

Appendix A

A.1 Regions in MindSphere

You can purchase MindSphere on different regions in various data center.

The following table shows the regions and the location:

Region	Data center location	MindSphere infrastructure provider
Europe 1	Frankfurt, Germany (eu 1)	Amazon Web Services
Europe 2	Amsterdam, Netherlands (eu 2)	Microsoft Azure

A.2 Quality code settings

### A.2.1 Using quality code

The quality code measures the quality of the connection from a data provider to the MindConnect Element. In MindSphere you can enable or disable the transmission of the quality code.

You can switch the quality code on or off:
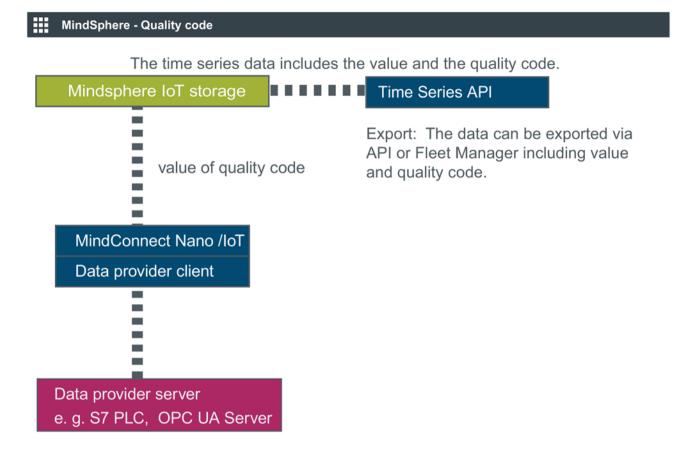
- **TRUE:** The quality code is transferred with the data to MindSphere.

- **FALSE:** The quality code is not transferred with the data to MindSphere. Erroneous or bad transmissions and signal losses can not be detected by MindSphere. Instead the value 0 will be stored for the missing data.

You can find more information about the corresponding values in chapter Overview of quality codes (Page 93).

Within a MindConnect Element the quality code is set by default to on. You can activate or deactivate the quality code using the Time Series Service API (https://developer.mindsphere.io/apis/iot-iottimeseries/api-iottimeseries-overview.html).

If you export the time series value (e.g. with Fleet Manager) you can see the data points with its connected quality code. This helps you to analyze time ranges where no data is available. This will avoid drawing false conclusions from a null value.

The following graphic shows a dataflow overview of the quality code:

If the data provider (e.g. S7 PLC, OPC UA Server) is not available, the MindConnect Element or the data provider client will send up a "0" with a quality code. The value of the quality code shows that this is not a valid data.

- If the function "Quality code" is enabled for this data point all the information can be stored in the database. The database creates a request to Fleet Manager to show the bad quality code information in a chart.

- If the function "Quality code" is disabled, the value 0 will be saved anyway. But you cannot figure out if this data is valid.

A.2.2 Overview of quality codes

The following table is based on the OPC UA standard and shows the possible quality codes:

Code	Hexadecimal Code	Signed Integer Code	Description
* GOOD	0x00000000	0	Good, all items could be read.
* GOOD_INCOMPLETE	0x00BA0000	12189696	Good results may be incomplete - at least one item could be read.

Code	Hexadec-imal Code	Signed Integer Code	Description
* UNCERTAIN_INITIAL_VALUE	0x40920000	1083310080	Uncertain Initial Value - initial value.
* BAD	0x80000000	-2147483648	Bad - generic error.
* BAD_SERVICE_UNSUPPORTED	0x800B0000	-2146762752	Bad Service Unsupported - service unsupported.
* BAD_TIMEOUT	0x800A0000	-2146828288	Bad Timeout - Timeout occurred.
* BAD_TOO_MANY_OPERATIONS	0x80100000	-2146435072	Bad Too Many Operations - The request could not be processed because it specified too many operations.
* BAD_ACCESS_DENIED	0x801F0000	-2145452032	Bad Access Denied - Access denied.
* BAD_IDENTITY_TOKEN_REJECTED	0x80210000	-2145320960	Bad Identity Token Rejected.
* BAD_TCP_INTERNAL_ERROR	0x80820000	-2138963968	TCP internal error occurred.
* INVALID_ARGUMENT	0x80AB0000	-2136276992	Bad Invalid Argument - all items could not be read.
* BAD_CONFIGURATION_ERROR	0x80890000	-2138505216	Lack of configuration info.
* BAD_NODE_ID_UNKNOWN	0x80340000	-2144075776	Bad item address.
* BAD_CONNECTION_REJECTED	0x80AC0000	-2136211456	Connection problem.
* BAD_TYPE_MISMATCH	0x80740000	-2139881472	Type conversion has problem.
* BAD_NOT_READABLE	0x803A0000	-2143682560	Read operation(s) has problem.
* BAD_NOT_WRITABLE	0x803B0000	-2143617024	Write operation(s) has problem.
* BAD_NOT_SUPPORTED	0x803D0000	-2143485952	Operation is not supported.

Code	Hexadecimal Code	Signed Integer Code	Description
* BAD_SECURITY_CHECKS_FAILED	0x80130000	-2146238464	Indicates security problems.
* BAD_OUT_OF_SERVICE	0x808D0000	-2138243072	OPC service has problems.
* BAD_REQUEST_TOO_LARGE	0x80B80000	-2135425024	Request too large.
* BAD_BOUND_NOT_FOUND	0x80D70000	-2133393408	No data found to provide upper or lower bound value.
* BAD_UNKNOWN_RESPONSE	0x80090000	-2146893824	An unrecognized response was received from the server.
* BAD_DISCONNECT	0x80AD0000	-2136145920	The server has disconnected from the client.
* BAD_INDEX_RANGE_INVALID	0x80360000	-2143944704	The syntax of the index range parameter is invalid.
* BAD_INVALID_STATE	0x80AF0000	-2136014848	The operation cannot be completed because the object public String getValue() { return value; }is closed.
* BAD_INTERNAL_ERROR	0x80020000	-2147352576	An internal error occurred as a result of a programming or configuration error.
* BAD_SERVER_URI_INVALID	0x804F0000	-2142306304	The ServerUri is not a valid URI.
* BAD_NOT_FOUND	0x803E0000	-2143420416	A requested item was not found or a search operation ended without success.
* BAD_NO_DATA	0x809B0000	-2137325568	No data exists for the requested time range or event filter.
* BAD_DATA_LOST	0x809D0000	-2137194496	Data is missing due to collection started/stopped/lost.

A.3 Technical specifications of MindConnect Nano

Functions	
Field protocol – S7	Siemens S7 (for S7-3xx / S7-4xx/ S7-12xx/ S7-15xx / ET-200s PLCs)
Field protocol – OPC UA	Part 8 of the OPC UA specification (Data Access)

Functions	
Configuration of data collection	With Asset Manager in MindSphere
Data buffering	Up to 500 MB buffering space for collected data
Proxy support	Yes
DHCP support	Yes
Security	Connection outbound via HTTPS on port 443 to MindSphere only; no incoming connection accepted SSL/TLS encryption of data in transit to MindSphere

Supply voltage	
Type of supply voltage	24 V
Current consumption	max. 1.8 A at 24 V
Mains buffering	
Mains/voltage failure stored energy time	20 ms

Interfaces	
USB port	1x USB 3.0 / 3x USB 2.0
PCIe slot	1x PCIe x1 (Disabled)
serial interface	1x COM (Disabled)
Video interfaces	
Graphics interface	1x DisplayPort (Disabled)
Industrial Ethernet	
Industrial Ethernet interface	2x 1000 Mbit RJ45

Monitoring functions	
Status LEDs	Yes
Fan	No

EMC	
Interference immunity against discharge of static electricity	
Interference immunity against discharge of static electricity	±6 kV contact discharge acc. to IEC 61000-4-2; ±8 kV air discharge acc. to IEC 61000-4-2
Interference immunity to cable-borne interference	
Interference immunity on supply cables	• ±2 kV acc. to IEC 61000-4-4, burst; ±1 kV acc. to IEC 61000-4-5, surge symmetric; • ±2 kV acc. to IEC 61000-4-5, surge asymmetric;
Interference immunity on signal cables >30m	• ±2 kV acc. to IEC 61000-4-5, surge, length > 30 m;
Interference immunity on signal cables < 30m	• ±1 kV acc. to IEC 61000-4-4; burst; length < 3 m; • ±2 kV acc. to IEC 61000-4-4; burst; length > 3 m;

EMC	
Interference immunity against voltage surge	
asymmetric interference	±2 kV acc. to IEC 61000-4-5, surge asymmetric
symmetric interference	±1 kV acc. to IEC 61000-4-5, surge symmetric
Interference immunity against high-frequency electromagnetic fields	
Interference immunity against high frequency radiation	• 10 V/m for 80 - 1000 MHz and 1.4 - 2 GHz, 80% AM acc. to IEC 61000-4-3; • 3 V/m for 2 - 2.7 GHz, 80% AM acc. to IEC 61000-4-3; • 10 V/m for 10 kHz - 80 MHz, 80% AM acc. to IEC 61000-4-6
Interference immunity to magnetic fields	
Interference immunity to magnetic fields at 50 Hz	100 A/m; to IEC 61000-4-8
Emission of conducted and non-conducted interference	
Interference emission via line/AC current cables	EN 61000-6-3, EN 61000-6-4, CISPR 22 Class B, FCC Class A

Degree and class of protection	
IP (at the front)	IP20
IP (rear)	IP40
Standards, approvals, certificates	
CE mark	Yes
UL approval	Yes
UL 508	Yes
cULus	Yes
RCM (formerly C-TICK)	Yes
KC approval	Yes
EMC	CE, EN 61000-6-4:2007, EN 61000-6-2:2005
EN 61000-6-2	Yes
Dust protection	Protection against foreign bodies > 1 mm
FCC	Yes
Marine approval	
Germanischer Lloyd (GL)	Yes
American Bureau of Shipping (ABS)	Yes
Bureau Veritas (BV)	Yes

Ambient conditions	
Ambient temperature during operation	
Ambient temperature during operation	0 °C up to 60 °C
min.	0 °C
max.	60 °C
Ambient temperature during storage/transportation	

Ambient conditions	
min.	-20 °C
max.	60 °C
Relative humidity	
Relative humidity	Tested according to IEC 60068-2-78, IEC 60068-2-30: Operation: 5% to 80% at 25 °C (no condensation), Storage: 5% to 95% at 25 °C (no condensation)
Vibrations	
Vibration load in operation	Tested to DIN IEC 60068-2-6: 10 Hz to 58 Hz: 0.075 mm, 58 Hz to 200 Hz: 9.8 m/s² (1 g)
Shock testing	
Shock load during operation	Tested according to IEC 60068-2-27: 150 m/s², 11 ms

Software	
MindConnect Software	Pre-installed MindConnect Software

Dimensions	
Width	191 mm
Height	100 mm
Depth	60 mm

A.4 Technical specifications of MindConnect IoT2040

Functions	
Field protocol – S7	Siemens S7 (for S7-3xx / S7-4xx / S7-12xx/ S7-15xx/ ET-200s PLCs)
Field protocol – OPC UA	Part 8 of the OPC UA specification (Data Access)
Configuration of data collection	With Asset Configuration tool in MindSphere
Data buffering	Up to 500 MB buffering space for collected data
Proxy support	Yes
DHCP support	Yes
Security	Connection outbound via HTTPS on port 443 to MindSphere only; no incoming connection accepted SSL/TLS encryption of data in transit to MindSphere

Installation type/mounting	
Design	IoT Gateway, built-in unit
Mounting	DIN rail, wall mounting

Supply voltage	
Type of supply voltage	DC 9…36 V, no galvanic isolation
Mains buffering	
Mains/voltage failure stored energy time	5 ms

Interfaces	
USB port	1x USB 2.0, 1x USB client
Connection for keyboard/mouse	USB / USB
serial interface	2x COM ports (RS 232, RS 485)
Industrial Ethernet	
Industrial Ethernet interface	2 x Ethernet (RJ45)
100 Mbps	Yes
1000 Mbps	No

Monitoring functions	
Watchdog	Yes
Status LEDs	Yes

EMC	
Interference immunity against discharge of static electricity	
Interference immunity against discharge of static electricity	±4 kV contact discharge acc. to IEC 61000-4-2; ±8 kV air discharge acc. to IEC 61000-4-2
Interference immunity against high-frequency electromagnetic fields	
Interference immunity against high frequency radiation	• 10 V/m for 80 - 1000 MHz, 80% AM acc. to IEC 61000-4-3; • 3 V/m for 1.4 - 2 GHz, 80% AM acc. to IEC 61000-4-3; • 1 V/m for 2 - 2.7 GHz, 80% AM acc. to IEC 61000-4-3; • 10 V for 150 kHz - 80 MHz, 80% AM acc. to IEC 61000-4-6;
Interference immunity to cable-borne interference	
Interference immunity on supply cables	• ±2 kV acc. to IEC 61000-4-4, burst; • ±1 kV acc. to IEC 61000-4-5, surge symmetric; • ±2 kV acc. to IEC 61000-4-5, surge asymmetric;
Interference immunity on signal cables >30m	±2 kV acc. to IEC 61000-4-5, surge, length > 30 m
Interference immunity on signal cables < 30m	±2 kV in accordance with IEC 61000-4-4, burst, length > 30 m
Interference immunity against voltage surge	
Asymmetric interference	±2 kV acc. to IEC 61000-4-5, surge asymmetric
Symmetric interference	±1 kV acc. to IEC 61000-4-5, surge symmetric
Interference immunity to magnetic fields	

EMC	
Interference immunity to magnetic fields at 50 Hz	100 A/m; to IEC 61000-4-8
Emission of conducted and non-conducted interference	
Emission of conducted and non-conducted interference	EN 61000-6-4:2007 +A1:2011

Degree and class of protection	
IP (at the front)	IP20
Standards, approvals, certificates	
Approval	CE (industry), UL, cULus
CE mark	Yes
UL approval	Yes
cULus	Yes
KC approval	Yes
EMC	• CE • EN 61000-6-4:2007 +A1:2011 • EN 61000-6-2:2005 • EN 61000-6-3:2007 +A1:2011 • EN 61000-6-1:2007

Ambient conditions	
Ambient temperature during operation	
Ambient temperature during operation	0 °C to 50 °C
min.	0 °C
max.	50 °C
Relative humidity	
Relative humidity	• Tested according to IEC 60068-2-78 • IEC 60068-2-30: Operation: 5 % to 85 % at 30 °C (no condensation) • storage / transport: 5 % to 95 % at 25 / 55 °C (no condensation)
Vibrations	
Vibration load in operation	Tested according to IEC 60068-2-6: 5 Hz to 9 Hz: 3.5 mm; 9 Hz to 200 Hz: 9.8 m/s²
Shock testing	
Shock load during operation	Tested according to IEC 60068-2-27: 150 m/s², 11 ms

Software	
MindConnect Software	Pre-installed MindConnect Software

Dimensions	
Width	144 mm
Height	90 mm
Depth	53 mm

A.5 Calculation of buffer time

In order to calculate the buffer time for MindConnect Nano or MindConnect IoT2040 you can use the following formula:

$$\text{Buffer time} = \frac{\text{Buffer size}}{\text{Number of data points (Read cycle)} * \text{Bytes per data point}}$$

The following example shows the buffer time for a MindConnect Nano with 500 MB data buffer:

In this case, 120 bytes is the memory needed for one data point.

$$\text{Buffer time} = \frac{500{,}000{,}000 \text{ byte}}{250 \text{ 1/s} * 120 \text{ byte}} = 16{,}666.6 \text{ s} \triangleq 4.6 \text{ hrs}$$

A.6 Read performance MindConnect Elements

All MindConnect Elements have a clear limitation on soft limits(unmonitored number of data points and data connections). The only fixed limit is 1050 data points. Within the soft limits, you can configure data connections and data points without reaching the limits.

The following describes how to proceed if you want to exceed these limits.

Tested MindConnect limits

	MindConnect Nano	MindConnect IOT2040
Max mount of data points can be configured (Fix)	1050	1050
Data points OPC UA / S7 / Modbus TCP (read per second)	250	30
Connections to data providers	30	5
String data points	10	3
Data points - Modbus RTU RS485 / RS422 - 9,6 kBd	20	15

	MindConnect Nano	MindConnect IOT2040
Data points - Modbus RTU RS485 / RS422 - 19,2 kBd	35	20
Data points - Modbus RTU RS485 / RS422 - >= 38,4 kBd	80	30
Data points - Modbus RTU RS232 - 57,6 kBd	40	30

Adaptions of the limits

Subsequently listed are the parameters the influence the read performance of a MindConnect Element. By varying one of these parameters all others will be affected as well. These are the variables:

- Performance of MindConnect hardware

- Number of connections to data providers

- Type of connection to providers (S7 / OPC UA / Modbus / ...)

- Amount of data points per second

- Type of data points (String or no string)

- Performance of data provider (PLC, OPC Server)

Note

Reading data from a data provider will always cause an effect on it. The performance of the data provider (PLC / OPC Server / Modbus) is one of the most important limiting factors. If more devices (e.g. OPC server, HMIs, SCADA systems,...) are connected to this data provider (e.g. PLC) the reading cycle can rise.

Example calculations (MindConnect Nano)

- It can be possible to read 300 data points per second out of a PLC. This is possible if the PLC is powerful and just one data provider is used.

- It can be possible to read 1000 data points out of 30 data providers if the reading cycle will be switched to 4sec.

- It can be possible to read out of 35 data providers if you just read 200 data points per second.

Note

To make sure a configuration works for your setup it needs to be monitored over a longer period of time.

System Test results

The following tables show how long it takes to read a data item from one of the devices. These are not fixed values but an indication of how the devices would react.

MindConnect NANO

Type	MS per data point read		
	Min	Mid	Max
S7 300	1,13	1,74	3,08
S7 1500	0,37	1,60	3,89
S7 1200	3,50	5,18	7,50
S7 ET200S CPU	0,89	2,09	3,71
OPC UA @ PC[1]	2,38	6,64	8,53
OPC UA@ PLC	2,66	3,27	4,69

[1] OPC UA @ PC always depends on the hardware.

- Read of a string data point you have to multiply the time with 2,5 per data point

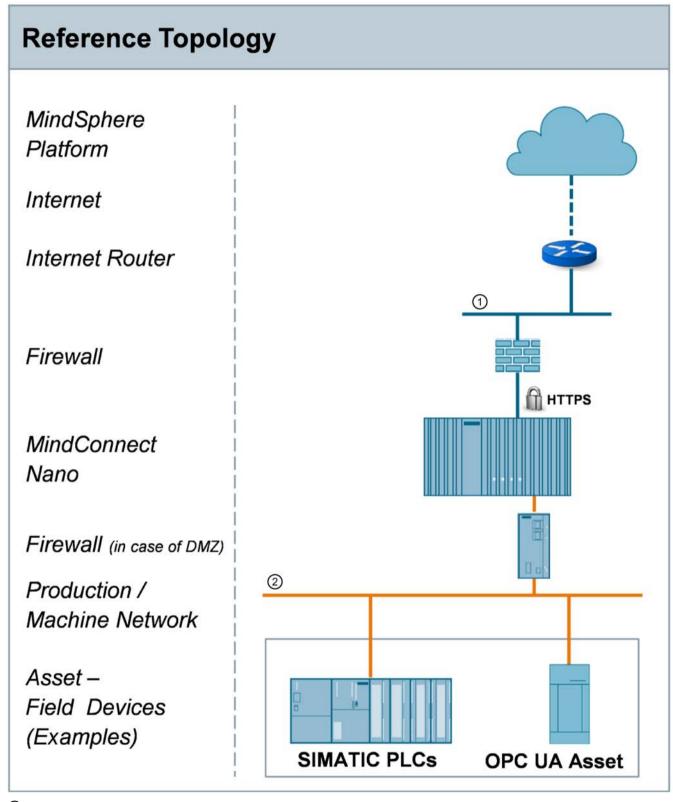- All devices are around 75% full

MindConnect IOT2040

Type	MS per data point read		
	Min	Mid	Max
S7 300	2,10	4,28	6,61
S7 1500	3,73	4,54	5,22
S7 1200	6,29	6,72	7,11
S7 ET200S CPU	1,92	5,01	8,33
OPC UA @ PC			
OPC UA@ PLC	4,42	5,50	7,66

- Read of a string data point you have to multiply the time with 2,5 per data point

- All devices are around 75% full

A.7 Firewall Settings

It is recommended to use a firewall between the Internet and the MindConnect Elements, this is also recommended for communication to the automation network.

In the direction to Automation Network a firewall supporting NAPT (in case of DMZ, see section "List of abbreviations") or supporting the "Ghost-Mode" is required. Siemens offers many types of Firewalls for fulfilling these requirements.

①   Corporate / Office Network with route to the internet or direct internet access, e.g. via a DSL modem

②   Production / Machine Network

"Ghost-Mode", also known as "Transparent Mode", is used to protect individual, event alternating, devices by dynamically taking over the IP address.

A.8　ESD guideline

What does ESD mean?

An electronic module is equipped with highly integrated components. Due to their design, electronic components are highly sensitive to overvoltage and thus to the discharge of static electricity. Such electronic components or modules are labeled as electrostatic sensitive devices.

The following abbreviations are commonly used for electrostatic sensitive devices:

- ESD – Electrostatic sensitive device,

- ESD – Electrostatic Sensitive Device as a common international designation.

Electrostatic sensitive devices can be labeled with an appropriate symbol.

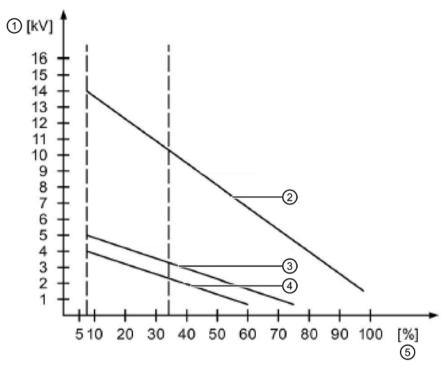| NOTICE |
| --- |
| **Damage to ESD from touch** |
| Electrostatic sensitive devices, ESD, can be destroyed by voltages which are far below the human perception limit. If you touch a component or electrical connections of a module without discharging any electrostatic energy, these voltages may arise. |
| The damage to a module by an overvoltage can often not be immediately detected and only becomes evident after an extended period of operation. The consequences are incalculable and range from unforeseeable malfunctions to a total failure of the machine or system. |
| Avoid touching components directly. Make sure that persons, the workstation and the packaging are properly grounded. |

Charge

Every person without a conductive connection to the electrical potential of his/her surroundings can be electrostatically charged.

The material with which this person comes into contact is of particular significance. The figure shows the maximum electrostatic voltages with which a person is charged, depending on humidity and material. These values conform to the specifications of IEC 61000-4-2.

① Voltage
② Synthetic materials
③ Wool
④ Antistatic materials such as wood or concrete
⑤ Relative humidity

NOTICE

Grounding measures

There is no equipotential bonding without grounding. An electrostatic charge is not discharged and may damage the ESD.

Protect yourself against discharge of static electricity. When working with electrostatic sensitive devices, make sure that the person and the workplace are properly grounded.

Protective measures against discharge of static electricity

- Disconnect the power supply before you install or remove modules which are sensitive to ESD.

- Pay attention to good grounding:

  - When handling electrostatic sensitive devices, make sure that persons, the workstation and devices, tools and packaging used are properly grounded. This way you avoid static discharge.

- Avoid direct contact:

  - As a general rule, do not touch electrostatic sensitive devices, except in the case of unavoidable maintenance work.

  - Hold the modules at their edge so that you do not touch the connector pins or conductor paths. This way, the discharge energy does not reach and damage the sensitive components.

  - Discharge your body electrostatically before you take a measurement at a module. Do so by touching grounded metallic parts. Always use grounded measuring instruments.

A.9 Return of defect hardware

In case of a defect or corrupted hardware you can find contacts and information under the following links:

Spare part services

In case of a defect or corrupted hardware you can find detail information in the SIOS Article - Spare Parts Services (https://support.industry.siemens.com/cs/sc/2110/spare-parts-services?lc=en-WW).

Delivery of spare parts

For ordering, provision and delivery of spare parts you can find more information in the SIOS Article - Delivery of Spare Parts. (https://support.industry.siemens.com/cs/sc/2112/ordering-provision-and-delivery-of-spare-parts?lc=en-WW)

Siemens Contact Database

You can find your personal contact for spare parts in the Siemens Contact Database (https://www.automation.siemens.com/aspa_app/?cntryid=DE&comptcid=e&lang=en).

A.10 List of abbreviations

Abbreviation	Description
DMZ	Demilitarized Zone (referred to a perimeter network)
GUI	Graphical User Interface
HTTPS	Hyper Text Transfer Protocol Secure
IoT	Internet of things
IoT2040	MindConnect IoT2040
IP	Internet Protocol
LAN	Local Area Network
MCN	MindConnect Nano
MSU	MindSphere Unit
NAPT	Network Address and Port Translation
OEM	Original Equipment Manufacturer
OPC UA	Open Platform Communications Unified Architecture
PC	Personal Computer
S7	STEP 7
UI	User Interface

Glossary

Aspect

Aspects are a data modeling mechanisms for assets. Aspects group the data points based on logical sense. For example: The pump skid has an aspect e.g. "Energy_consumption" that contains the data points: "power", "current", "voltage" etc.

Aspect is specified in Asset Manager and its name can be freely chosen, but should bring together a logical grouping of data points and a physical asset.

Asset

An asset is a digital representation of a machine or an automation system with one or multiple automation units (e.g. PLC) connected to MindSphere.

MindSphere data collection and data provisioning is based on so called (virtual) assets. This can be anything such as a pump, motor, PLC, an entire tool machine, a production line, a robot, a crane, a car, a wind turbine and so on. The data of an asset is collected and sent to MindSphere to make that data available for further processing and analytics.

Asset Identifier

Asset Identifier is an identifier assigned by the manufacturer of the device, to which MindConnect Nano will be connected. After the onboarding process, MindConnect Nano is connected to this device. The serial number identifies the asset to which the data belongs.

Asset Manager

Asset Manager is a Web Graphical User Interface for asset configuration. According to these configurations, the following functions are available:

Asset Configuration: assets can be created, onboarded, modified, cloned, moved, deleted or offboarded.

Asset type

Asset type is a sort or kind of a product line made by one manufacturer.

Components

Components represent built-in functionality in MindSphere. Components are:

- Asset Manager
- Fleet Manager
- Settings
- UTC Reporting

For the complete list and description of Components, refer to the "MindSphere" documentation.

Data point

Data points refer to elements (variables), which allow values to be obtained from data sources (OPC UA or S7 etc.). They are combined into a relevant aspect. For example, "temperature" and "torque" are data points of an aspect "Energy_consumption".

Data points are configured in "Asset Manager". In "Fleet Manager", their values are visualized as time series.

Data source

A data source is a physical element of a device, which can be monitored by MindSphere.

For example: OPC UA Server, S7.

Event

In "Fleet Manager", an event is a change of a datapoint state. Events are used for the requests. With a rule it is possible to define the request, which will be created in MindSphere when the event is triggered.

Besides the monitoring rule, a description of event (e.g. "The limit is exceeded, this may indicate damage in the pump"), the resulting action (e.g. "Please contact your hotline") and priority (urgent, important or info) can be lodged.

See also "request", "rule".

Fleet Manager

Fleet Manager is a visualization tool which provides an overview of existing assets and their information (asset name, customer name, location). Fleet Manager displays your configured asset, aspects with datapoints in charts and list of all requests etc.

Last Connection

"Last Connection" status in "Asset Manager" gives the information, when a MindConnect Element was online for the last time.

MindConnect Element

MindConnect Elements are devices for transferring data and allow connectivity to MindSphere such as MindConnect Nano, MindConnect IoT2040 or MindConnect FB.

MindSphere

MindSphere is the Siemens Industrial IoT operation system comprising the core cloud services and applications, whereas the MindConnect Element provides secure and easy connectivity from the field or machine to MindSphere. In MindSphere, submitted data by a

MindConnect Element is processed and stored for analysis and further management purposes.

For more information, refer to the "MindSphere" documentation.

MindSphere Launchpad

MindSphere Launchpad is the entry point for components as well as for available applications.

Online/Offline Mode in Asset Manager

Online indicates internet connection, when the MindConnect Nano/IoT2040 sends the data to the server. Offline mode means the absence of the internet connection and the MindConnect Nano/IoT2040 is no longer able to send data to the server.

Organization

Organization is the part of hierarchical asset configuration in Asset Manager. Within organization, areas/assets are specified.

As the administrator (OEM), you manage organizations, their customers and assets. As the user of an organization, you can access the assets assigned only to this organization.

In the context of MindSphere, an organization can be anything and is defined by the administrator depending on their requirements: customer, cost center, branch etc.

Request

Requests are the messages which log asset incidents based on predefined rules.

You can create manual requests as well as requests for the regular acquisition of measured quantities with measuring series.

See also "event", "rule".

Rule

With rules you can configure an automatic monitoring of datapoints on events. For example, a request will be created automatically by the system, if a value exceeds or falls below a threshold (edge trigger).

See also "event", "request".

Settings

Settings is a Web Graphical User Interface for user, organization and role configuration.

Time series

Time series is a sequence of measurements which are produced by data sources over time. Analysis and visualization tools (e.g. Fleet Manager) can retrieve collected time series and

present it to the user after processing. In Asset Manager, the measurements, that have to be collected, can be specified.