Industrial Edge How Tos Tank Application

Industrial Edge

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Table of contents

1 Introduction

1.1 Overview

Reference application for demonstration use of industrial edge.

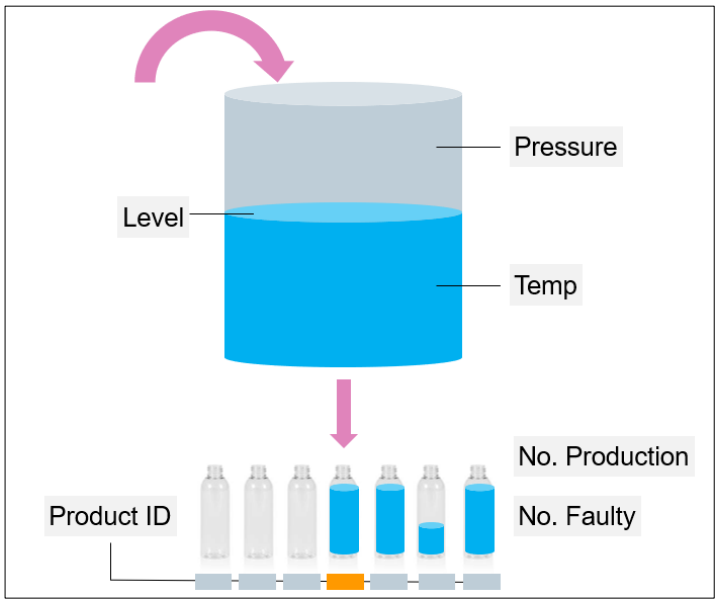
1.2 Mode of operation

This application shall be usable for various use cases to demonstrate the edge functionality and apps. It is based on a STEP 7 TIA project with corresponding HMI. The application simulates the filling process from a tank into bottles. Various simulation models for the tank and the bottles are embedded.

The application can be controlled via the HMI screen.

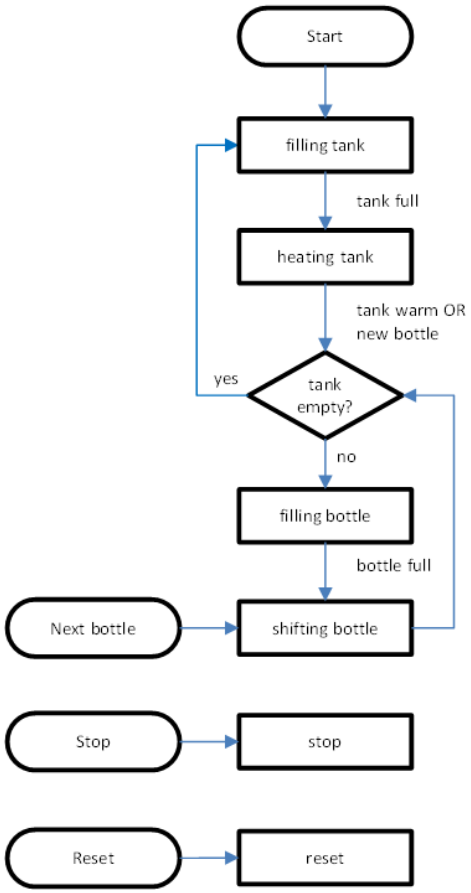
Tank application

Figure 1-1



Operating workflow

Figure 1-2



1.3 Components used

This application example has been created with the following hardware and software components:

Table 1-1

Component	Number	Note
Industrial Edge Management	-	See used version in GitHub how to
Industrial Edge Device	-	See used version in GitHub how to
Industrial Edge Apps	-	See used versions in GitHub how to
SIMATIC TIA Portal	V16	Simulation of HMI included
SIMATIC PLCSIM Advanced	V3.0	Can be used for simulation of PLC

This application example consists of the following components:

Table 1-2

Component	File name	Note
TIA portal project	EdgeHowTos.ap16	

2 Engineering

2.1 Source files

The source files for the TIA project containing this tank application can be found here:

https://github.com/industrial-edge/miscellaneous

2.2 History

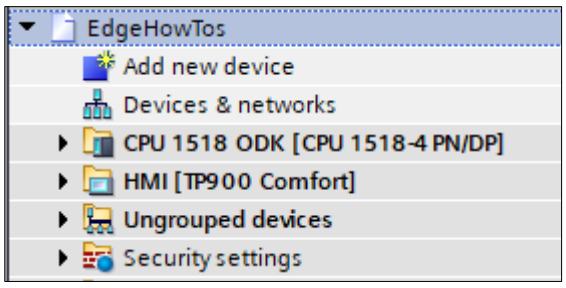
Table 2-1

Version	Date	Modifications
tia-tank-application-20201028.7z	10/2020	First version
tia-tank-application-20210304.7z	03/2021	Version for Industrial Edge V1.1 Parameter for energy data and pressure included
tia-tank-application-20210421.7z	04/2021	Version for Industrial Edge V1.2 Parameter machineState included

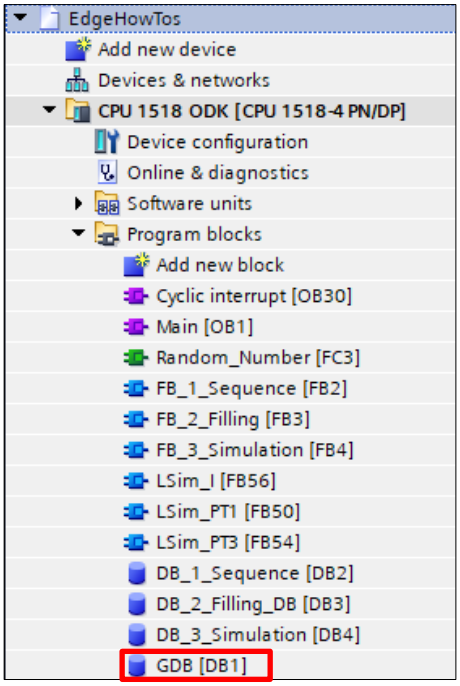
2.3 Description of interface DB “GDB”

The TIA portal project consists of a CPU 1518 ODK and a corresponding HMI. The application also runs on every other PLC, e.g. CPU 1511.

The CPU contains the engineering program for the whole tank application, that can be controlled via the HMI. Alternatively, the tank application can be controlled via the Industrial Edge apps by triggering the corresponding parameters.



The data exchange between the TIA portal project and the Industrial Edge apps is done via the global DB “***GDB”***. This DB is set to ‘not optimized’, to be able to work with the offsets.



Overview of DB

GDB

		Name	Data type	Offset	Comment
1		Static			
2		operate	"typeOperate"	0.0	application operation
3		model	"typeModel"	6.0	model parameter
4		externalSignals	"typeSignals"	46.0	signals from external model
5		signals	"typeSignals"	90.0	current signals from tank and bottle
6		process	"typeProcess"	134.0	current process information
7		hmiSignals	"typeHmi"	140.0	signals from hmi
8		appSignals	"typeApp"	142.0	signals from edge app

Parameters of DB

Parameter „operate“

operate	"typeOperate"	0.0		☐	☑	☑	☑	☐		application operation
extModeActive	Bool	0.0	false	☐	☑	☑	☑	☐		true = activate external model / simulation
state	"typeState"	2.0		☐	☑	☑	☑	☐		operating state
FillingTank	Bool	2.0	false	☐	☑	☑	☑	☐		filling tank
HeatingTank	Bool	2.1	false	☐	☑	☑	☑	☐		heating tank
FillingBottle	Bool	2.2	false	☐	☑	☑	☑	☐		filling bottle
ShiftingBottle	Bool	2.3	false	☐	☑	☑	☑	☐		shifting bottle
Stop	Bool	2.4	false	☐	☑	☑	☑	☐		stop filling
Reset	Bool	2.5	false	☐	☑	☑	☑	☐		reset application
machineState	Int	4.0	0	☐	☑	☑	☑	☐		see user constants (1 = filling tank, 2 = heating

Parameter „model“

model	"typeModel"	6.0		☐	☑	☑	☑	☑		model parameter
cycleTime	Real	6.0	0.01	☐	☑	☑	☑	☐		cycle time[s]
tank	Struct	10.0		☐	☑	☑	☑	☐		model struct of tank
AT	Real	10.0	0.8	☐	☑	☑	☑	☐		surface area of tank [m²]
H	Real	14.0	2.0	☐	☑	☑	☑	☐		high of tank [m]
Vin	Real	18.0	500.0	☐	☑	☑	☑	☐		incoming volume flow [l/min]
maxLevel	Real	22.0	1.6	☐	☑	☑	☑	☐		max level of tank [m³]
roomTemperat...	Real	26.0	20.0	☐	☑	☑	☑	☐		room temperature of tank [°C]
maxTemperature	Real	30.0	80.0	☐	☑	☑	☑	☐		max temperature of tank [°C]
density	Real	34.0	997.0	☐	☑	☑	☑	☐		liquid density [kg/m³]
bottle	Struct	38.0		☐	☑	☑	☑	☐		model struct of bottle
maxLevel	Real	38.0	0.1	☐	☑	☑	☑	☐		max level of bottle [m³]
AB	Real	42.0	0.001	☐	☑	☑	☑	☐		surface area of filling hole to fill bottle [m²]

Parameter „externalSignals“

externalSignals	"typeSignals"	46.0		☐	☑	☑	☑	☑	signals from external model
tankSignals	Struct	46.0		☐	☑	☑	☑	☐	
actLevel	Real	46.0	0.0	☐	☑	☑	☑	☐	actual level of tank [l]
maxLevel	Bool	50.0	false	☐	☑	☑	☑	☐	max level of tank reached
actPressure	Real	52.0	0.0	☐	☑	☑	☑	☐	actual pressure of tank [hPa]
actTemperature	Real	56.0	0.0	☐	☑	☑	☑	☐	actual temperature of tank [°C]
maxTemperature	Bool	60.0	false	☐	☑	☑	☑	☐	max level of temperature reached
bottleSignals	Struct	62.0		☐	☑	☑	☑	☐	
actLevel	Real	62.0	0.0	☐	☑	☑	☑	☐	actual level of current bottle [l]
maxLevel	Bool	66.0	false	☐	☑	☑	☑	☐	max level of bottle reached
outputTank	Real	68.0	0.0	☐	☑	☑	☑	☐	Vout of Tank / Vin of bottle [m³/s]
energySignals	Struct	72.0		☐	☑	☑	☑	☐	
energyConsumptionFillingTank	Real	72.0	0.0	☐	☑	☑	☑	☐	energy consumption during filling tank [kWh]
waterConsumptionFillingTank	Real	76.0	0.0	☐	☑	☑	☑	☐	water consumption during filling tank [l]
energyConsumptionHeatingTank	Real	80.0	0.0	☐	☑	☑	☑	☐	energy consumption during heating tank [kW
energyConsumptionFillingBottles	Real	84.0	0.0	☐	☑	☑	☑	☐	energy consumption during filling bottles [kW
alarm	Word	88.0	16#0	☐	☑	☑	☑	☐	alarm bit

Parameter „signals“

signals	"typeSignals"	90.0		☐	☑	☑	☑	☑	current signals from tank and bottle
tankSignals	Struct	90.0		☐	☑	☑	☑	☐	
actLevel	Real	90.0	0.0	☐	☑	☑	☑	☐	actual level of tank [l]
maxLevel	Bool	94.0	false	☐	☑	☑	☑	☐	max level of tank reached
actPressure	Real	96.0	0.0	☐	☑	☑	☑	☐	actual pressure of tank [hPa]
actTemperature	Real	100.0	0.0	☐	☑	☑	☑	☐	actual temperature of tank [°C]
maxTemperature	Bool	104.0	false	☐	☑	☑	☑	☐	max level of temperature reached
bottleSignals	Struct	106.0		☐	☑	☑	☑	☐	
actLevel	Real	106.0	0.0	☐	☑	☑	☑	☐	actual level of current bottle [l]
maxLevel	Bool	110.0	false	☐	☑	☑	☑	☐	max level of bottle reached
outputTank	Real	112.0	0.0	☐	☑	☑	☑	☐	Vout of Tank / Vin of bottle [m³/s]
energySignals	Struct	116.0		☐	☑	☑	☑	☐	
energyConsumptionFillingTank	Real	116.0	0.0	☐	☑	☑	☑	☐	energy consumption during filling tank [kWh]
waterConsumptionFillingTank	Real	120.0	0.0	☐	☑	☑	☑	☐	water consumption during filling tank [l]
energyConsumptionHeatingTank	Real	124.0	0.0	☐	☑	☑	☑	☐	energy consumption during heating tank [kWh
energyConsumptionFillingBottles	Real	128.0	0.0	☐	☑	☑	☑	☐	energy consumption during filling bottles [kWh
alarm	Word	132.0	16#0	☐	☑	☑	☑	☐	alarm bit

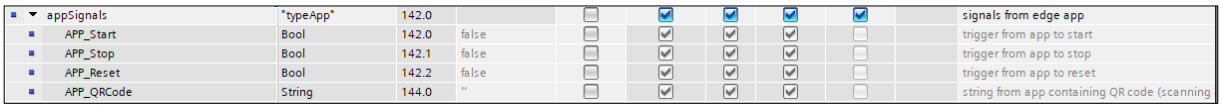
Parameter „process“

process	"typeProcess"	134.0		☐	☑	☑	☑	☑	current process information
productId	Int	134.0	0	☐	☑	☑	☑	☐	product id of current bottle
numberProduced	Int	136.0	0	☐	☑	☑	☑	☐	number of filled bottles
numberFaulty	Int	138.0	0	☐	☑	☑	☑	☐	number of faulty bottles

Parameter „hmiSignals“

hmiSignals	"typeHmi"	140.0		☐	☑	☑	☑	☑	signals from hmi
HMI_Start	Bool	140.0	false	☐	☑	☑	☑	☐	trigger from hmi to start
HMI_Stop	Bool	140.1	false	☐	☑	☑	☑	☐	trigger from hmi to stop
HMI_Reset	Bool	140.2	false	☐	☑	☑	☑	☐	trigger from hmi to reset
HMI_NextBottle	Bool	140.3	false	☐	☑	☑	☑	☐	trigger from hmi to shift bottle

Parameter „appSignals“

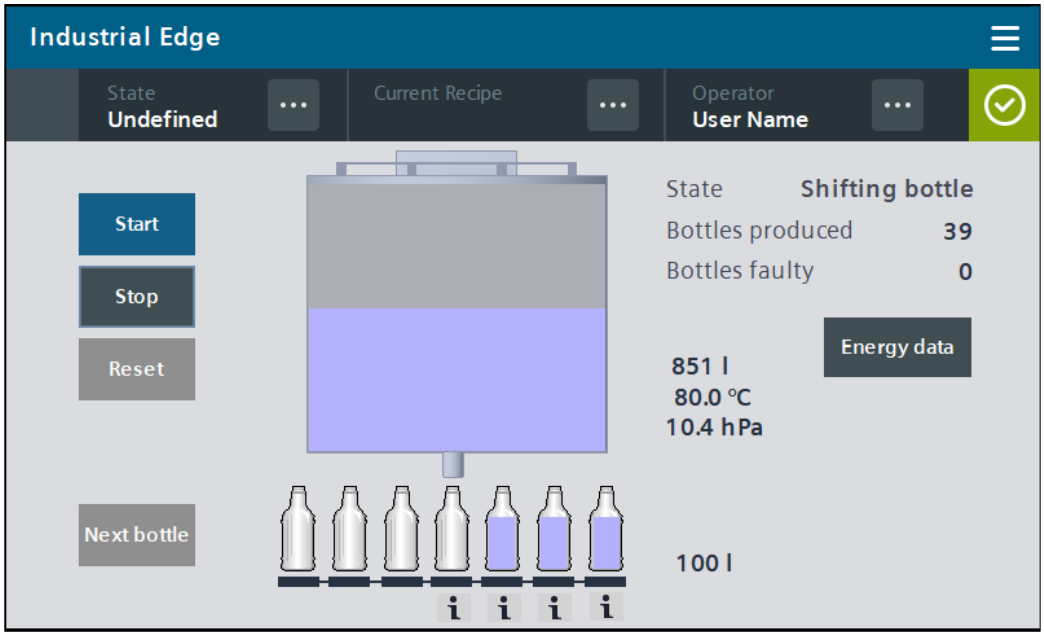


appSignals	"typeApp"	142.0		☐	☑	☑	☑	☑	signals from edge app
APP_Start	Bool	142.0	false	☐	☑	☑	☑	☐	trigger from app to start
APP_Stop	Bool	142.1	false	☐	☑	☑	☑	☐	trigger from app to stop
APP_Reset	Bool	142.2	false	☐	☑	☑	☑	☐	trigger from app to reset
APP_QRCode	String	144.0	''	☐	☑	☑	☑	☐	string from app containing QR code (scanning

3 HMI

3.1 Overview

Via the HMI the tank application can be started, stopped, and reset. The application runs through the different operating states and shows important process values. The filling process can be interrupted by clicking “next bottle”, to simulate a faulty product.



4 Edge Use Cases

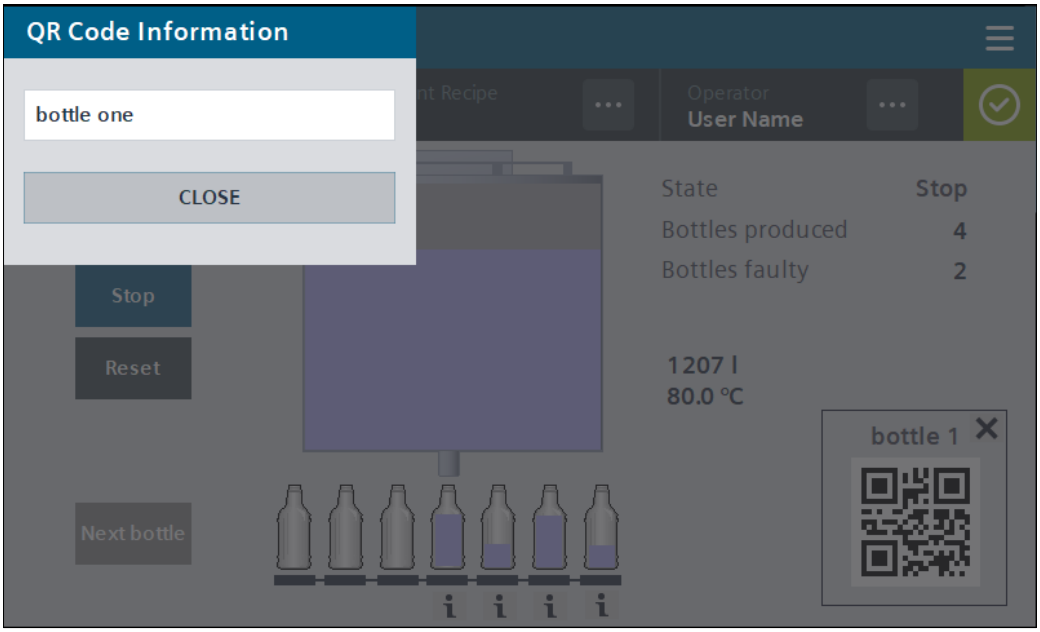
4.1 QR-Code Scanner

https://github.com/industrial-edge/qr-code-scanner

The application reads the QR Code provided by the scanner and publishes it on the IE Databus to the topic corresponding to the S7 Connector, which sends the data to the PLC (parameter *APP_QRCode*). If the PLC receives a new QR Code String, the information is displayed in the HMI Panel.

Interface parameter: *GDB.appSignals.**APP_QRCode***

Example of scanned QR code in HMI:



4.2 Data Service – Getting Started

https://github.com/industrial-edge/data-service-getting-started

This example shows how to use the Industrial Edge App "Data Service" to model data structure and store data.

Interface parameter:
*GDB.process.**numberProduced***
*GDB.process.**numberFaulty***
*GDB.signals.tankSignals.**actLevel***
*GDB.signals.tankSignals.**actTemperature***

4.3 Notifier – Getting Started

https://github.com/industrial-edge/notifier-getting-started

Example showing how to use the Industrial Edge App "Notifier" to create notifications in case of an event.

Interface parameter:
*GDB.process.**numberProduced***
*GDB.process.**numberFaulty***
*GDB.signals.tankSignals.**actLevel***
*GDB.signals.tankSignals.**actTemperature***

4.4 Archiving and Visualization

https://github.com/industrial-edge/archiving-and-visualization

The Industrial Edge Application "Archiving & Visualization" collects data values, stores them in an Influxdb database and visualize them with a Grafana dashboard.

Interface parameter:
*GDB.signals.tankSignals.**actLevel***
*GDB.signals.tankSignals.**actTemperature***
*GDB.process.**numberProduced***
*GDB.process.**numberFaulty***
*GDB.hmiSignals.**HMI_NextBottle***

4.5 Archiving and Operation

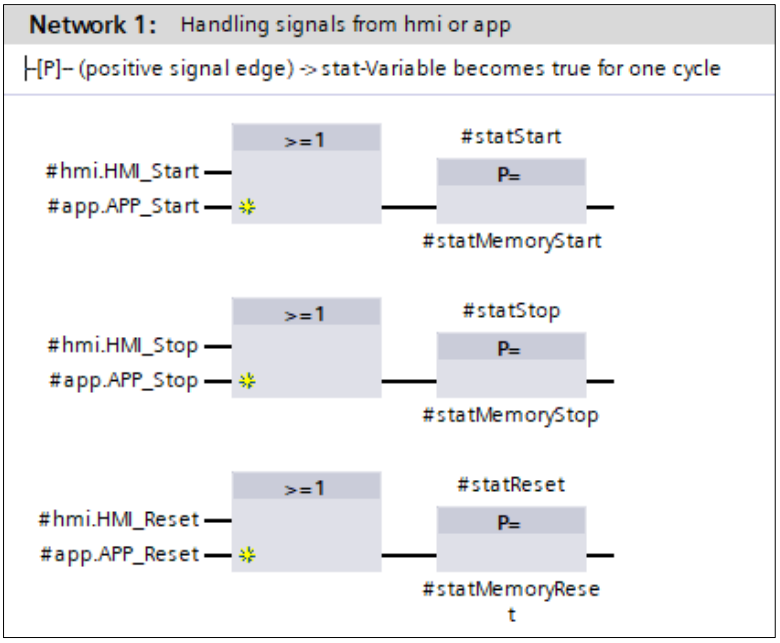
https://github.com/industrial-edge/archiving-and-operation

The Industrial Edge Application "Archiving & Operation" provides a web UI for operating the tank application with push buttons to start, stop and reset the filling process. By pushing the buttons, a http request is sended to the MQTT client of the app and forwarded to the IE Databus. The S7 Connector receives the message and writes the control command to the PLC, that is controlling the tank application.

Interface parameter:
*GDB.appSignals.**APP_Start***
*GDB.appSignals.**APP_Stop***
*GDB.appSignals.**APP_Reset***

TIA project code, where the operating commands are handled:

FB_1_Sequence



4.6 IoT Gateway

https://github.com/industrial-edge/iot-gateway

Using the IE system apps to preprocess PLC data and push it to the cloud.

Interface parameter: *GDB.signals.tankSignals.**actLevel***

4.7 Performance Insight – Getting Started

https://github.com/industrial-edge/performance-insight-getting-started

This document describes how to get the data from a PLC into the Performance Insight app to visualize modeled data.

Interface parameter:
*GDB.signals.tankSignals.**actLevel***
*GDB.signals.tankSignals.**actTemperature***
*GDB.process.**numberProduced***
*GDB.process.**numberFaulty***
*GDB.operate.**machineState***

4.8 Energy Manager – Getting Started

https://github.com/industrial-edge/energy-manager-getting-started

This example shows how to use the Industrial Edge App “Energy Manager”. The Energy Manager will help you make the transition from energy transparency to energy efficiency.

Interface parameter: *GDB.signals.energySignals.**energyConsumptionFillingTank***
*GDB.signals.energySignals.**waterConsumptionFillingTank***
*GDB.signals.energySignals.**energyConsumptionHeatingTank***
*GDB.signals.energySignals.**energyConsumptionFillingBottle***

4.9 Machine Insight – Getting Started

https://github.com/industrial-edge/machine-insight-getting-started

This example shows how to use the Industrial Edge App “Machine Insight”. Machine Insight enables the collection of data from different sources. The data can be of different types: Device and machine status data, messages, diagnostic buffer data and program changes or firmware updates in the PLC.

4.10 Inventory – Getting Started

https://github.com/industrial-edge/inventory-getting-started

This example shows how to use the Industrial Edge App “Inventory”. Inventory application is a web browser-based application that gives you an overall asset view of the factory.

4.11 Profinet IO Connector – Getting Started

https://github.com/industrial-edge/profinet-io-connector-getting-started

This example shows how to use the Industrial Edge App “PROFINET IO Connector”. This app implements a PROFINET Controller which cyclically reads the PN IO data of the configured PROFINET network.

4.12 Ethernet IP – Getting Started

https://github.com/industrial-edge/ethernet-ip-getting-started

5 Appendix

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5.2 Application support

Siemens AG
Digital Industries
Factory Automation
Simatic System Support
DI FA S SUP
Gleiwitzer Str. 555
90475 Nuernberg, Germany

5.3 Links and literature

Table 5-1

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the industrial edge forum http://siemens.com/industrial-edge-forum
\3\	Link to the industrial edge How Tos in GitHub https://github.com/industrial-edge
\4\	Link to the LSim library for simulated controlled systems https://support.industry.siemens.com/cs/document/79047707/regeln-von-simulierten-regelstrecken-in-der-s7-1500-mit-pid_compact-v2?dti=0&lc=de-WW

5.4 Change documentation

Table 5-2

Version	Date	Modifications
V1.0	03/2021	First version
V1.2	04/2021	Release for Industrial Edge V1.2