

System Manual
CTR-100

User Manual
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List of Abbreviations

| | |
|------------------|--|
| AI | Analog Input |
| AO | Analog Output |
| CAN | Controller Area Network (according to ISO 11898-1:2003 and ISO 11898-2:2003) |
| CPU | Central Processing Unit |
| ETH | Ethernet |
| FB | Function Block |
| GND | Ground Reference potential |
| GPIO | General Purpose Input Output |
| I/O | Input/Output |
| I ² C | Inter-integrated circuit |
| IoT | Internet of Things |
| M2M | Machine-to-Machine |
| MAC | Media Access Controller (e.g. Ethernet controller) |
| MQTT | Message Queue Telemetry Transport |
| PCB | Printed Circuit Board |
| PDO | Process Data Object |
| PLC | Programmable Logical Controller |
| POT | Potentiometer |
| PWM | Pulse Width Modulation |
| RTC | Real Time Clock |
| RX | Receive |
| SIO | Serial Input Output |
| SDO | Service Data Object |
| SPI | Serial Peripheral Interface |
| tbd | to be defined |
| TX | Transmit |
| UART | Universal Asynchronous Receiver Transmitter |

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1 Introduction

Thank you that you have decided for the SYS TEC IoT-Chip CTR-100. Our IoT-Chip CTR-100 is a plug-in System on Module for cloud connection which is freely programmable by users. Unlike other IoT Chip devices, the SYS TEC electronic IoT-Chip CTR-100 combines sensor2cloud requirements with data preprocessing features ranging from time-critical signals to efficient control tasks. To that end, the IoT-Chip CTR-100 comes with appropriate function libraries pre-installed, making it ready for use straight away. Moreover our IoT-Chip CTR-100 is prepared for the Cloud Services, such as IBM IoT Platform (IBM Watson).

Please take some time to read through this manual carefully. It contains important information about the commissioning, configuration and programming of the IoT-Chip CTR-100. It will assist you in getting familiar with the functional range and usage of the product.

This device contains open source software protected by respective third party proprietary and copy rights. Please refer to Appendix A for details.

For more information, optional products, updates et cetera, we recommend you to visit our website: <http://www.systemec-electronic.com>. The content of this website is updated periodically and provides to you downloads of the latest software releases and manual versions.

Declaration of Electro Magnetic Conformity for the IoT-Chip CTR-100 (EMC law)



The IoT-Chip CTR-100 has been designed to be used as vendor part for the integration into devices (further industrial processing) or as Development Board for laboratory development (hard- and software development).

After the integration into a device or when changes/extensions are made to this product, the conformity to EMC-law again must be assessed and certified. Only thereafter products may be launched onto the market.

The CE-conformity is only valid for the application area described in this document and only under compliance with the following commissioning instructions! The IoT-Chip CTR-100 is ESD-sensitive and may only be unpacked, used and operated by trained personal at ESD-conform work stations.

The IoT-Chip CTR-100 is a module for the application in automation technology. It features IEC 61131-3 programmability, uses standard CAN-bus and Ethernet network interfaces and a standardized network protocol. Consequently, development times are short and hardware costs are reasonable. PLC-functionality is created on-board through a CANopen network layer. Hence, it is not necessary for the user to create firmware.

2 Product Description

2.1 Orderable Parts

Table 1: Orderable parts

| Part number | Product name | Features |
|-------------|-----------------------------|---|
| 3390100 | CTR-100 DIL40 | PLC Program Memory: 128kByte Connector: DIL40 RJ45 for Ethernet |
| 3390101 | CTR-100 LGA | PLC Program Memory: 128kByte Connector: LGA |
| KIT-175 | Development Kit for CTR-100 | IoT-Chip CTR-100 (DIL40 variant) Baseboard for IoT-Chip |

2.2 Technical Data

The IoT-Chip CTR-100 is easy to integrate for use in Internet of Things/ Industry 4.0 applications and the connecting devices/machines to the cloud as these fields require. Like every of our devices the IoT Chip SE is prepared for the direct connection to Cloud. Due to the partnership with IBM we make your devices ready for IoT.

The benefits of the SYS TEC electronic IoT-Chip CTR-100 lie in its use, security and cloud connection. On the chip are libraries and protocols such as CANopen, MQTT or Modbus available, which are ready to use immediately. The templates supplied in the source code are available to users as a starting point for their own customization. I²C and SPI make it possible to directly connect actuators and sensors.

This allows the entire measurement, control and regulation to be handled on the IoT-Chip CTR-100. As a result, the chip works independently of the cloud – whereas with other IoT-chip devices, these processes typically take place in the cloud. There is also no additional gateway required for cloud connection.

Our IoT Chip CTR-100 delivers M2M communication at the highest level, as well as being efficient and available at a moderate cost.



Figure 1: IoT-Chip CTR-100 (DIL40) by SYS TEC electronic GmbH

These are some significant features of the IoT-Chip CTR-100:

- High-performance CPU kernel (ARM® 32-bit Cortex®-M7, 200 MHz CPU Clock, 428 DMIPS)
- PLC Program memory: 128kByte
- DIL-40 socket or LGA
- 1x 10/100 Mbps Ethernet LAN interface (with on-board PHY) and RJ45 connector
- 1x CAN 2.0B interface, usable as CANopen Manager (CiA 302-conform)
- 3x synchronous/asynchronous serial ports (USART)
- Up to 15 digital inputs
- Up to 13 digital outputs
- 4 analog inputs
- 2 analog outputs
- On-board peripherals:
 - RTC
 - Temperature sensor
- Programmable in IEC 61131-3
- Function block libraries for communication (CANopen, Ethernet, I2C, SPI, MQTT, Modbus, UART/USART)
- Function block libraries for hardware components (RTC, Counter, PWM/PTO)
- Support of typical PLC control elements (e.g. Run-LED, Error-LED)
- Small dimension (24mm x 70mm)
- Operating temperature: 0°C...70°C (optional: -40°C...85°C)

Making PLC available as an insert-ready core module with small dimensions reduces effort and costs significantly for the development of user-specific controls. The IoT-Chip CTR-100 is also very well suitable as intelligent network node for decentralized processing of process signals (CANopen and UDP). Additionally, it can be used as basic component for special assemblies or as PLC in hard-to-access areas.

The on-board firmware of the IoT-Chip CTR-100 contains the entire PLC runtime environment including CANopen connection with CANopen master functionality. Thus, the module is able to perform control tasks such as linking in- and outputs or converting rule algorithms. Data and occurrences can be exchanged with other nodes (e.g. superior main controller, I/O slaves and so forth) via CANopen network, Ethernet (UDP protocol) and serial interfaces (UART). Moreover, the number of in- and outputs either is locally extendable or decentralized via CANopen devices. For this purpose, the CANopen-Chip is suitable. It has also been designed as insert-ready core module for the appliance in user-specific applications.

The IoT-Chip CTR-100 provides up to 15 digital inputs (DI0...DI14, 3.3V level), up to 13 digital outputs (DO0...DO12, 3.3V level), 1 high-speed counter input and 2 PWM output (3.3V amplitude). This default I/O configuration can be adapted for specific application requirements by SYS TEC (please contact support@systec-electronic.com if you are interested in this option). Saving the PLC program in the on-board Flash-Disk of the module allows an automatic restart in case of power breakdown.

Programming the IoT-Chip CTR-100 takes place according to IEC 61131-3 using the *OpenPCS* programming system of the company infoteam Software GmbH (<http://www.infoteam.de>). This programming system has been extended and adjusted for the IoT-Chip CTR-100 by the company SYS TEC electronic GmbH. Hence, it is possible to program the IoT-Chip CTR-100 graphically in KOP/FUB, AS and CFC or textually in AWL or ST. Downloading the PLC program onto the module takes place via Ethernet. Addressing in- and outputs and creating a process image follows the SYS TEC scheme for compact control units. Like all other SYS TEC controls, the IoT-Chip CTR-100 supports backward documentation of the PLC program as well as the debug functionality including watching and setting variables, single cycles, breakpoints and single steps.

2.3 Block Diagram

The IoT-Chip CTR-100 signals are combined in signal groups. A signal group is selected using the Configuration filed value in configuration section of PLC Process image. Some signal groups serve multiple functions multiplexed by Configuration field value.

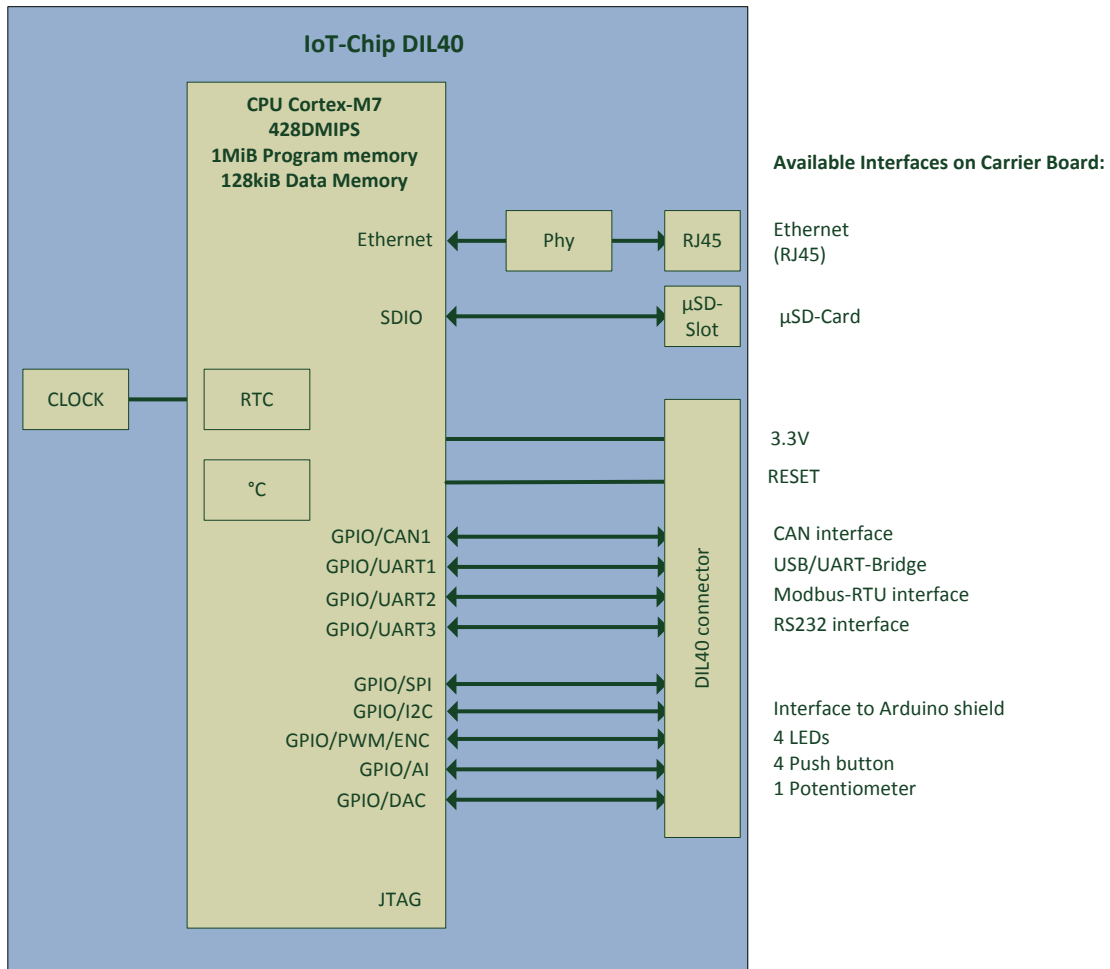


Figure 2: Block diagram IoT-Chip CTR-100 (DIL40 variant)

3 Development Kit IoT-Chip

3.1 Overview

The Development Kit IoT-Chip is a high-capacity, complete package at a particularly favorable price. Based on a compact PLC, it enables the user to perform decentralized, network-compatible automation projects. Additionally, it allows the user to get knowledge about the Internet of Things by offering a big variety of input and output interfaces.



Figure 3: Development Kit IoT-Chip

The Development Kit IoT-Chip ensures quick and problem-free commissioning of the IoT-Chip CTR-100. Therefore, it combines all hard- and software components that are necessary to create own applications: the core module IoT-Chip CTR-100, the corresponding Development Board containing I/O periphery and numerous interfaces, the *OpenPCS* IEC 61131 programming system as well as further accessory. Thus, the Development Kit forms the ideal platform for developing user-specific applications based on the IoT-Chip CTR-100. It allows a cost-efficient introduction into the world of sensor2cloud communication and data preprocessing. All components included in the Kit enable in- and output extensions of IoT-Chip CTR-100 through CANopen-I/O-assemblies. Thus, the Development Kit may also be used for projects that require PLC with network connection.

The Development Kit IoT-Chip CTR-100 contains the following hardware components:

- IoT-Chip CTR-100 (DIL40 connector)
- Development Board for the IoT-Chip CTR-100

The Development Board included in the Kit facilitates quick commissioning of the IoT-Chip and simplifies the design of prototypes for user-specific applications based on this module. Among other equipment, the Development Board comprises different power supply possibilities, one CAN interface, 4 push buttons and 4 LED as control elements for digital in- and outputs and it comprises a potentiometer for the analog input. Signals that are available from pins of the IoT-Chip are linked to the baseboard and enable easy connection of own peripheral circuitry. Hence, the Development Board forms an ideal experimentation and testing platform for the IoT-Chip. The operating temperature should lie between 0°C and 70°C.

The *OpenPCS* IEC 61131 programming system included in the Kit serves as software development platform and as debug environment for the IoT-Chip. Thus, the module can either be programmed graphically in KOP/FUB, AS and CFC or textually in AWL or ST. Downloading the PLC program onto the module takes place via Ethernet. High-capacity debug functionality such as watching and setting variables, single cycles, breakpoints and single steps simplify the development and commissioning of user software for this module.

3.2 Electric commissioning of the Development Kit IoT-Chip

The Development Kit IoT-Chip can be simply powered via USB. An external power adapter is only required for running the Development Kit stand alone, without connection to a Host PC. An USB cable is already included in the Kit delivery. For commissioning the Kit, it is essential to use at least USB (for power supply and configuration via virtual serial interface, see section 10) and ETH. Table 2 provides an overview over the connections of the Development Kit IoT-Chip.

Table 2: Connections of the Development Kit IoT-Chip

| Connection | Remark |
|-----------------------------------|---|
| USB (Power supply and COM0/RS232) | USB is used for: <ul style="list-style-type: none"> - Power supply and - Serial connection to run configuration shell (e.g. setting CAN and IP configuration, see section 10) |
| Alternative Power Supply | An external power supply (5...14V) can be used optionally for running the Development Kit stand alone, without connection to a Host PC. |
| ETH0 (Ethernet) | This interface serves as communication interface with the Programming PC and is necessary for the program, besides can be used freely for the user program. |
| CAN0 | This interface can be used freely for the user program. |
| COM1 (Modbus) | This interface can be used freely for general operation of the user program. |
| COM2 (RS232) | This interface can be used freely for general operation of the user program. |

Figure 4 shows the positioning of the most important connections of the Development Board for the IoT-Chip besides the Ethernet interface (ETH0). While the ETH0-interface of the Development Kit IoT-Chip DIL40 is placed on the IoT-Chip, in LGA-version it could be located on the baseboard next to the IoT-Chip.

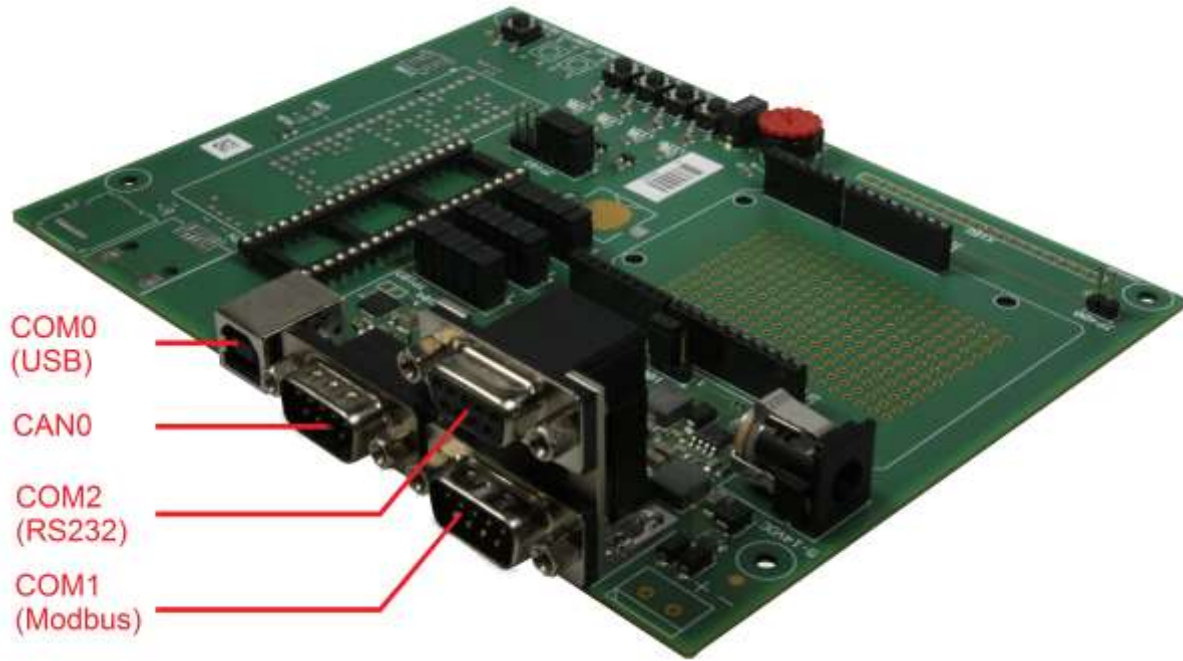


Figure 4: Most important connections on the Development Board of the IoT-Chip

3.3 Control elements of the Development Kit IoT-Chip

The Development Board allows the easy commissioning of the IoT-Chip. It has various control elements available to configure the module and to simulate inputs and outputs to the IoT-Chip. In Table 3 control elements of the Development Board are listed and their meaning is described.

Table 3: Control elements of the Development Board for the IoT-Chip

| Control element | Name | Meaning |
|-----------------|-------|--|
| Pushbutton 0 | SW0 | Digital Input DI0 (Process Image: %IX0.0) |
| Pushbutton 1 | SW1 | Digital Input DI1 (Process Image: %IX0.1) |
| Pushbutton 2 | SW2 | Digital Input DI2 (Process Image: %IX0.2) |
| Pushbutton 3 | SW3 | Digital Input DI3 (Process Image: %IX0.3) |
| LED 0 | LED0 | Digital Output DO0 (Process Image: %QX0.0) |
| LED 1 | LED1 | Digital Output DO1 (Process Image: %QX0.1) |
| LED 2 | LED2 | Digital Output DO2 (Process Image: %QX0.2) |
| LED 3 | LED3 | Digital Output DO3 (Process Image: %QX0.3) |
| Pot (ADC) | R105 | Analog Input AI0 (Process Image: %IW8.0) |
| Run-LED | RUN | Display of activity state of the PLC (see section 6.6.1) |
| Error-LED | ERROR | Display of error state of the PLC (see section 6.6.2) |

3.4 Optional accessory

3.4.1 USB-RS232 Adapter Cable

The SYS TEC USB-RS232 Adapter Cable (order number 3234000) provides a RS232 interface via an USB-Port of the PC. Together with a terminal program, it enables the configuration of the IoT-Chip from PCs, e.g. laptop computers which do not have RS232 interfaces any more.



Figure 5: SYS TEC USB-RS232 Adapter Cable

3.4.2 CAN-Cable

The Development Board of the IoT-Chip features one CAN-interface. To connect the board to an existing CAN-network, a CAN-cable is needed. This cable is not part of the order. Of course SYS TEC electronic offers the production of customized cables on inquiry.

3.4.3 RS485-Cable

To establish a connection via Modbus, the Development Board of the IoT-Chip uses the COM1-interface. The cable should be attached to the female SUB-D9 connector on the baseboard. As this cable is not part of the order, contact SYS TEC electronic in case of need.

4 Electrical characteristic of the IoT-Chip CTR-100

4.1 General operating conditions

The following table shows the general operating conditions together with their respective operating range of the IoT-Chip CTR-100.

Table 4: General operating conditions

| Symbol | Parameter | Min | Typ | Max | Unit |
|----------------|---|-------|-----|-------|------|
| 3V3 | Standard operating voltage 3V3 (VCC, VDDA) | 3.135 | 3.3 | 3.465 | V |
| I3V3 | Total current consumption 3V3-Domain | - | 250 | 450 | mA |
| VREF | Reference voltage (3V3-VREF < 1.2V!) | 2.3 | - | 3V3 | V |
| IVREF | VREF DC current consumption | - | 300 | 500 | µA |
| VBAT | Backup operating voltage (internal, external RTC) | 1.8 | - | 3.6 | V |
| IVBAT | Backup domain supply current | - | - | TBD | µA |
| T _A | Operating Temperature Range (Standard) | 0 | - | 70 | °C |
| T _A | Operating Temperature Range (Optional) | -40 | - | 85 | °C |

4.2 I/O characteristic

The tables below show the most important characteristics of analog and digital in- and outputs.

Table 5: Analog input characteristic

| Symbol | Parameter | Min | Typ | Max | Unit |
|--------------------|---|-----|------|------|------|
| V _{AI} | Conversion voltage range | 0 | - | VREF | V |
| Resolution | | | 12 | | bit |
| R _{ADC} | Sampling switch resistance | 1.5 | | 6 | kΩ |
| R _{AI} | External input impedance | - | - | 50 | kΩ |
| C _{ADC} | Internal sample and hold capacitor | - | 4 | 7 | pF |
| t _s | Sampling time | | 4.48 | | µs |
| t _{cycle} | Cycle time to convert the 4 AI channels | | 32 | | µs |
| ET | Total unadjusted error | | ±3 | ±4 | LSB |
| EO | Offset error | | ±2 | ±3 | LSB |
| I _{INJ+} | Positive injection current ⁽¹⁾ | | | 5 | mA |
| I _{INJ-} | Negative injection current ⁽¹⁾ | | | 0 | mA |

(1) ADC accuracy versus negative injection current:

Injecting a negative current on any analog input pins should be avoided as this significantly reduces the accuracy of the conversion being performed on another analog input. It is recommended to add a Schottky diode (pin to ground) to analog pins which may potentially inject negative currents.

Table 6: Analog output characteristic

| Symbol | Parameter | Min | Typ | Max | Unit |
|-------------------|---|-----|-----|----------|------|
| AO min | Lower AO voltage with buffer ON ⁽¹⁾ | 0.2 | | - | V |
| AO max | Higher AO voltage with buffer ON ⁽¹⁾ | - | - | VDDA-0.2 | V |
| R _{LOAD} | Impedance output with buffer ON ⁽¹⁾ | 5 | - | | kΩ |
| C _{LOAD} | Capacitive load with buffer ON ⁽¹⁾ | - | - | 50 | pF |

(1) The pin AOx integrates an output buffer that can be used to reduce the output impedance and to drive external loads directly without the use of an external operational amplifier. This buffer is used. The AOx output buffer is power supplied by VDDA.

Table 7: Digital input characteristic

| Symbol | Parameter | Min | Typ | Max | Unit |
|-----------------------|---|------------|-----|-----------|------|
| V _{IL} | Input low level voltage | GND-0.3 | 0 | 0.3 x 3V3 | V |
| V _{IH} | FT I/O input high level voltage | 0.7 x 3V3 | 3.3 | 5.2 | V |
| V _{IH} | TC I/O input high level voltage | 0.7 x 3V3 | 3.3 | 3.6 | V |
| V _{hys} | IO FT Schmitt trigger voltage mV hysteresis | 0.05 x 3V3 | | | V |
| I _{lkg} | I/O FT input leakage current | - | - | 3 | μA |
| C _{IO} | I/O pin capacitance | - | | 5 | pF |
| t _{f(IO)out} | Output high to low level fall time and output low to high level rise time for C _L =10 pF | | | 2.5 | ns |

Table 8: Digital output characteristic

| Symbol | Parameter | Min | Typ | Max | Unit |
|--------------------------|--|-----|-----|-----|------|
| V _{OL} | Output low level voltage for an I/O pin when 8 pins are sunk at same time (I _{IO} =8mA) | - | - | 0.4 | V |
| V _{OH} | Output high level voltage for an I/O pin when 8 pins are sourced at same time | 2.4 | - | - | V |
| I _{IO} | Output current sunk/source by any I/O pin | - | - | 25 | mA |
| I _{IOmaxsource} | The maximum sum of I _{IO} sourced by the device | - | - | 150 | mA |
| I _{IOmaxsink} | The maximum sum of I _{IO} sunk by the device | - | - | 150 | mA |

4.3 Ethernet characteristics

In the table below you will find important information about the Ethernet characteristics of the IoT-Chip CTR-100.

Table 9: Ethernet receive or transmit signal characteristic

| Symbol | Parameter | Min | Typ | Max | Unit |
|-----------------|---------------------------|-----|-----|-----|------|
| VIHETH | Input high level voltage | 2 | - | - | V |
| VILETH | Input low level voltage | - | - | 0.8 | V |
| VOHETH | Output high level voltage | 2.4 | - | | V |
| VOLETH | Output low level voltage | - | - | 0.4 | V |
| IINETH | Input Current | - | -10 | 10 | μA |
| I _{oz} | Output Tri-State Leakage | - | - | 10 | μA |

Table 10: Ethernet LED output characteristic

| Symbol | Parameter | Min | Typ | Max | Unit |
|------------------|--------------------------|-----|-----|-----|------|
| I _{LED} | LED output drive current | - | 8 | - | mA |

5 Pinout of the IoT-Chip CTR-100

The IoT-Chip CTR-100 provides board I/O functionalities through simple connector footprint. Figure 6 shows the footprints of the Development Board and the IoT-Chip CTR-100 including the pin numbers.

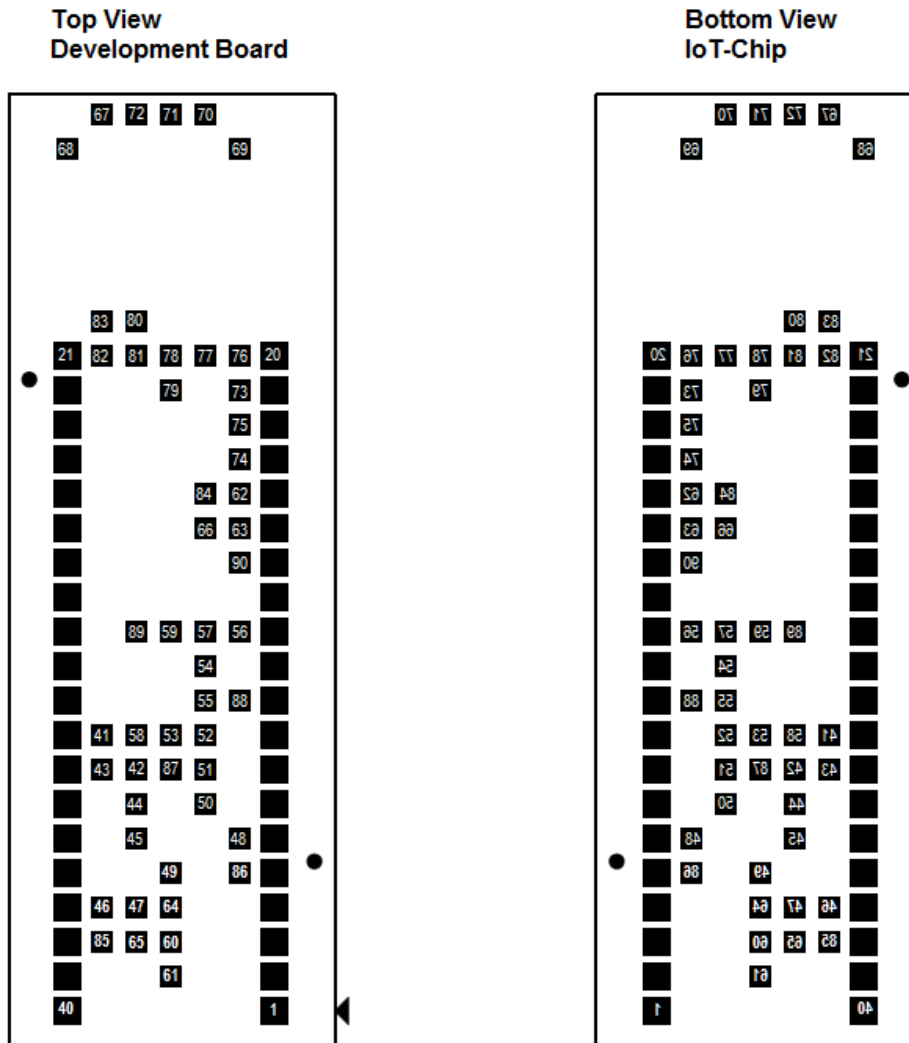


Figure 6: Footprints Development Board and IoT-Chip CTR-100

Figure 7 exemplifies the dimensions of the Development Board and the IoT-Chip CTR-100. With the help of Figure 6 and Figure 7 customers are able to develop own PCB's in which the IoT-Chip CTR-100 could be integrated easily.

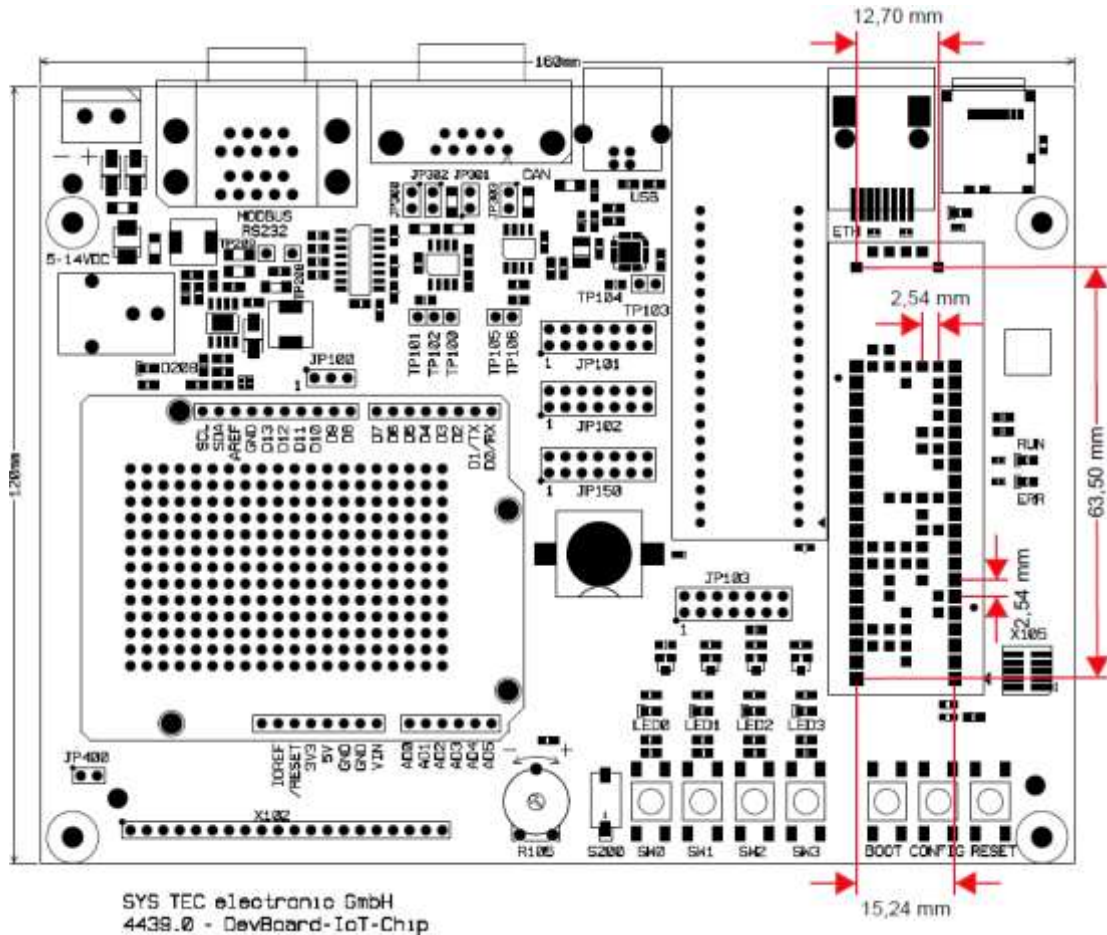


Figure 7: Dimensions of Development Board and IoT-Chip CTR-100 - top view

Table 11 lists all pins which are accessible by the customer and could be used by user-written PLC software.

Table 11: Pin Assignment

| Pin # | Pin Label | PLC Function 1 | PLC Function 2 | Remark |
|-------|-----------|-----------------------|----------------|---|
| 1 | 3V3 | | | |
| 2 | GND | | | |
| 3 | GPIO1 | UART0_RXD | | |
| 4 | GPIO2 | UART0_TXD | | |
| 5 | GPIO3 | DO0 [User-LED0] | PWM0 | |
| 6 | /RESET | | | |
| 7 | GPIO4 | CAN0_TXD | | |
| 8 | GPIO5 | CAN0_RXD | | |
| 9 | GPIO6 | UART1_RXD | | |
| 10 | GPIO7 | UART1_TXD | | |
| 11 | GPIO8 | UART1_DE | | |
| 12 | GPIO9 | DO4 | SPI0_/CS | To enable SPI, use command described in section 10.2.8. |
| 13 | GPIO10 | DI5 | SPI0_MISO | |
| 14 | GPIO11 | DI6 | SPI0_MOSI | |
| 15 | GPIO12 | DI7 | SPI0_CLK | |
| 16 | GPIO13 | DI8 | I2C0_SDA | To enable I2C, use command described in section 10.2.7. |
| 17 | GPIO14 | DI9 | I2C0_SCL | |
| 18 | GND | | | |
| 19 | GPIO15 | DI0 [Push-button SW0] | | |

| Pin # | Pin Label | PLC Function 1 | PLC Function 2 | Remark |
|-------|-----------|-----------------------|----------------|--|
| 20 | GPIO16 | DI1 [Push-button SW1] | | |
| 21 | GND | | | |
| 22 | GPIO17 | DI2 [Push-button SW2] | | |
| 23 | GPIO18 | DI4 | ENC0 (CH1) | |
| 24 | GPIO19 | DI5 | ENC0 (CH2) | |
| 25 | GPIO20 | DO1 [User-LED1] | PWM1 | |
| 26 | GPIO21 | DO2 [User-LED2] | | |
| 27 | VREF | | | |
| 28 | GND | | | |
| 29 | GPIO22 | AI0 [Poti] | | |
| 30 | GPIO23 | AI1 | | |
| 31 | GPIO24 | AO0 | | |
| 32 | GPIO25 | AO1 | | |
| 33 | GPIO26 | AI2 | | |
| 34 | GPIO27 | AI3 | | |
| 35 | GPIO28 | DO3 [User-LED3] | | |
| 36 | GPIO29 | DI3 [Push-button SW3] | | |
| 37 | GPIO30 | UART2_CTS | | |
| 38 | GPIO31 | UART2_RTS | | |
| 39 | GPIO32 | UART2_TXD | | |
| 40 | GPIO33 | UART2_RXD | | |
| 41 | GPIO34 | | | Accessible via pins 2-20 on patch field X102 (only LGA-Version). |
| 42 | GPIO35 | | | |
| 43 | GPIO36 | | | |
| 44 | GPIO37 | | | |
| 45 | GPIO38 | | | |
| 46 | GPIO39 | | | |
| 47 | GPIO40 | | | |
| 48 | GPIO41 | | | |
| 49 | GPIO42 | | | |
| 50 | GPIO43 | | | |
| 51 | GPIO44 | | | |
| 52 | GPIO45 | | | |
| 53 | GPIO46 | | | |
| 54 | GPIO47 | | | |
| 55 | GPIO48 | | | |
| 56 | GPIO49 | | | |
| 57 | GPIO50 | | | |
| 58 | GPIO51 | | | |
| 59 | GPIO52 | | | |

Pins 41-59 are accessible via patch field X102 (pins 2-20) only when using the LGA-version of the Development Kit. This feature is not integrated now and will be available in future.

To switch between PLC Functions use the Configuration Command Shell described in section 10. If the PLC Function 2 is enabled, corresponding pins are used for the new function and are no longer available as digital inputs or outputs.

Commands for enabling PLC Function 2 are listed in section 10.2.

Table 12 is a subset of Table 11 and only includes all in- and outputs of the IoT-Chip CTR-100 sorted by their function.

Table 12: Connections of the IoT-Chip CTR-100, only I/O, sorted by function

| Pin # | I/O structure | PLC Function 1 | PLC Function 2 A=alternative, S=simultaneous | Resistor Type internal | Resistor Type external |
|-------|---------------|-----------------------|--|------------------------|------------------------|
| 19 | DI | DI0 [Push-button SW0] | | Pull Down | |
| 20 | DI | DI1 [Push-button SW1] | | Pull Down | |
| 22 | DI | DI2 [Push-button SW2] | | Pull Down | |
| 36 | DI | DI3 [Push-button SW3] | | Pull Down | |
| 23 | DI | DI4 | A: ENC0 (CH1) | Pull Down | |
| 24 | DI | DI5 | A: ENC0 (CH2) | Pull Down | |
| 14 | DI | DI6 | A: SPI0_MISO | Pull Down | |
| 15 | DI | DI7 | A: SPI0_CLK | Pull Down | |
| 16 | DI | DI8 | A: I2C0_SDA | No Pull | Pull Up (1k Ω) |
| 17 | DI | DI9 | A: I2C0_SCL | No Pull | Pull Up (1k Ω) |
| 5 | DO | DO0 [User-LED0] | A: PWM | No Pull | |
| 25 | DO | DO1 [User-LED1] | A: PWM | No Pull | |
| 26 | DO | DO2 [User-LED2] | | No Pull | |
| 35 | DO | DO3 [User-LED3] | | No Pull | |
| 12 | DO | DO4 | A: SPI0_/CS | No Pull | |
| 13 | DO | DO5 | A: SPI0_MOSI | Pull Down | |
| 29 | AI | AI0 [POT] | | No Pull | |
| 30 | AI | AI1 | | No Pull | |
| 33 | AI | AI2 | | No Pull | |
| 34 | AI | AI3 | | No Pull | |
| 32 | AO | AO0 | | No Pull | |
| 32 | AO | AO1 | | No Pull | |

6 PLC Functionality of the IoT-Chip CTR-100

6.1 System start of the IoT-Chip CTR-100

By default, the IoT-Chip CTR-100 loads all necessary firmware components upon Power-on or Reset and starts running the PLC program afterwards. Hence, the IoT-Chip CTR-100 is suitable for the usage in autarchic control systems. In case of power breakdown, such systems resume the execution of the PLC program independently and without user intervention. Figure 8 illustrates the system start in detail:

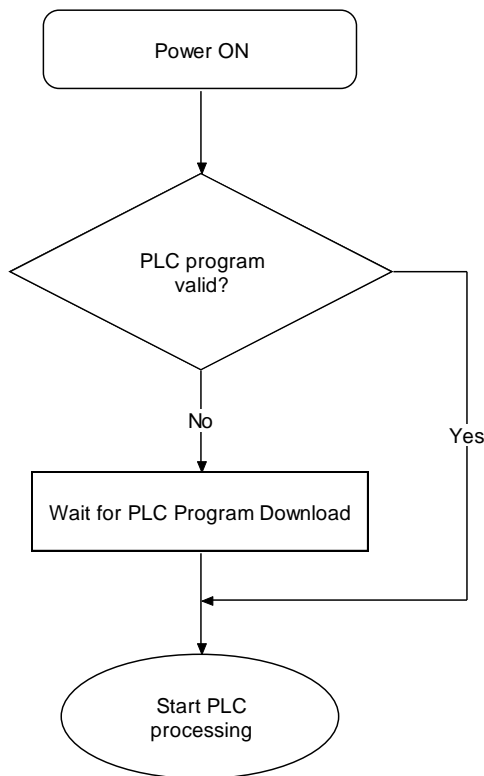


Figure 8: System start of the IoT-Chip CTR-100

If the firmware has found a valid control program in the non-volatile memory, this program is restarted and processed. Otherwise the reactivated program is ready for execution and the IoT-Chip CTR-100 is in stop mode.

6.2 Programming the IoT-Chip CTR-100

The IoT-Chip CTR-100 is programmed with IEC 61131-3-conform *OpenPCS* programming environment. There exist additional manuals about *OpenPCS* that describe the handling of this programming tool. Those are part of the software package "*OpenPCS*".

The IoT-Chip CTR-100 firmware is based on standard firmware for SYS TEC's compact control units. Consequently, it shows identical properties like other SYS TEC control systems. This affects especially the process image setup (see section 6.3) as well as the functionality of control elements (Run-LED, Error-LED).

The IoT-Chip CTR-100 firmware provides numerous function blocks to the user to access communication interfaces. Table 13 specifies the availability of FB communication classes (SIO, CAN, UDP).

Table 13: Support of FB communication classes for the IoT-Chip CTR-100

| Type of Interface | IoT-Chip CTR-100 Art. no: 3390100/3390101 | Remark |
|-------------------|--|----------------------------------|
| CAN | X | FB description see manual L-1008 |
| UDP | X | FB description see manual L-1054 |
| SIO | X | FB description see manual L-1054 |

Table 35 in Appendix B contains a complete listing of firmware functions and function blocks that are supported by the IoT-Chip CTR-100.

Detailed information about using the CAN interfaces in connection with CANopen is provided in section 6.7.

6.3 Process image of the IoT-Chip CTR-100

6.3.1 Local In- and Outputs

Compared to other SYS TEC compact control systems, the IoT-Chip CTR-100 obtains a process image with identical addresses. All in- and outputs listed in Table 14 are supported by the IoT-Chip CTR-100.

Table 14: Assignment of in- and outputs to the process image of the IoT-Chip CTR-100

| I/O of the IoT-Chip CTR-100 | Address and Data type in the Process Image |
|-----------------------------|---|
| DI0 ... DI5 | %IB0.0 as Byte with DI0 ... DI5 %IX0.0 ... %IX0.5 as single Bit for each input |
| AI0 | %IW8.0 15Bit + sign (0 ... +32767) |
| AI1 | %IW10.0 15Bit + sign (0 ... +32767) |
| AI2 | %IW12.0 15Bit + sign (0 ... +32767) |
| AI3 | %IW14.0 15Bit + sign (0 ... +32767) |
| C0 | %ID40.0 31Bit + sign ($-2^{31} - 2^{31} - 1$) Counter: counter input: DI2.4, direction: DI2.5, see section 6.5.1 AB Encoder: channel A: DI2.4, channel B: DI0.4, see section 6.5.1 |
| On-board Temperature Sensor | %ID72.0 31Bit + sign as 1/10000 °C |
| DO0 ... DO4 | %QB0.0 as Byte with DO0 ... DO4 %QX0.0 ... %QX0.4 as single Bit for each output |
| AO0 | %QW8.0 15Bit + sign (0 ... +32767) |
| AO1 | %QW10.0 15Bit + sign (0 ... +32767) |

| I/O of the IoT-Chip CTR-100 | Address and Data type in the Process Image |
|-----------------------------|--|
| P0 | %QX0.0 (default value for inactive generator) Impulse output: DO0, see section 6.5.2 |
| P1 | %QX0.1 (default value for inactive generator) Impulse output: DO1, see section 6.5.2 |

In- and outputs of the IoT-Chip CTR-100 are not negated in the process image. Hence, the H-level at one input leads to value "1" at the corresponding address in the process image. Contrariwise, value "1" in the process image leads to an H-level at the appropriate output.

6.3.2 In- and outputs of user-specific baseboards

The connection lines leading towards the outside provides to the user most effective degrees of freedom for designing the in-/output circuit of the IoT-Chip CTR-100. Therewith, all in- and outputs of the IoT-Chip CTR-100 can be flexibly adjusted to respective requirements. This implicates that the process image of the IoT-Chip CTR-100 is significantly conditioned by the particular, user-specific in-/output circuit. Please contact our support employee if you are interested in this option:

support@sys-tec-electronic.com

6.4 Communication interfaces

6.4.1 Serial interfaces

The IoT-Chip CTR-100 features 3 serial interfaces (COM0 ... COM2).

COM0: This interface is used for communication between PC and PLC to allow for:

- Configuration of module settings (see section 10)
- Firmware updates (see section 7)
- PLC program download and debugging

On the Development Kit IoT-Chip the interface SIO0 is tunneled via USB on connector USB.

COM1: This interface can be used freely for general operation of the user program.

COM2: This interface can be used freely for general operation of the user program.

6.4.2 CAN interfaces

The IoT-Chip CTR-100 features one CAN interface (CAN0). The CAN interface allows data exchange with other devices via network variables and it is accessible from a PLC program via function blocks of type "CAN_Xxx" (see section 6.7 and "User Manual CANopen Extension for IEC 61131-3", Manual no.: L-1008).

Section 6.7 provides detailed information about the usage of the CAN interface in connection with CANopen.

6.4.3 Ethernet interfaces

The IoT-Chip CTR-100 features one Ethernet interface (ETH0). It serves as service interface to administer the IoT-Chip CTR-100 and enables data exchange with other devices. The interface is accessible from a PLC program via function blocks of type "LAN_Xxx" (see manual "SYS TEC-specific Extensions for OpenPCS / IEC 61131-3", Manual no.: L-1054).

6.5 Specific peripheral interfaces

6.5.1 Counter inputs

The IoT-Chip CTR-100 features one fast counter input (C0). Prior to its usage, the counter input must be parameterized via function block "CNT_FUD" (see manual "SYS TEC-specific Extensions for OpenPCS / IEC 61131 3", Manual no.: L 1054). Afterwards, in a PLC program the current counter value is accessible via process image (see Table 14 in section 6.3.1) or via function block "CNT_FUD". Table 15 lists the allocation between counter channel and inputs.

Please note that the counting direction is determined once during initialization. So, if hardware direction control is used, the corresponding pin is checked only during initialization. The direction cannot be changed during runtime, except by calling "CNT_FUD" again with the desired direction or hardware detection.

Table 15: Allocation between counter channels and inputs

| Counter channel | Counter input | Optional direction input | Counter value in process image |
|-----------------|------------------|--------------------------|--------------------------------|
| C0 | C0 (DI20) %IX2.4 | DI21 %IX2.5 | %ID40.0 |

The theoretical maximum frequency for counter inputs is 24MHz. Practically the frequency depends on the number of interrupts done before the counter interrupt is invoked.

Counter C0 also supports AB encoding in X4 mode. For using the AB encoding mode, it is necessary to use the counter input for channel A and DI4 for channel B. Please see Table 16 for more information regarding the channel mapping. Using AB encoding will automatically disable the corresponding digital input. Reading them will return 0 for the corresponding digital input.

Table 16: Allocation between counter channels and AB inputs

| AB Encoder | Channel A | Channel B | Counter value in process image |
|------------|------------------|------------|--------------------------------|
| C0 | C0 (DI20) %IX2.4 | DI4 %IX0.4 | %ID40.0 |

6.5.2 Pulse outputs

To release PWM signal sequences, the IoT-Chip CTR-100 features 2 pulse outputs (P0 and P1). Prior to its usage, all pulse outputs must be parameterized using function block "PTO_PWM" (see manual "SYS TEC-specific Extensions for OpenPCS / IEC 61131 3", Manual no.: L 1054).

After the impulse generator is started, it takes over the control of respective outputs. If the impulse generator is deactivated, the respective output adopts the corresponding value that is filed in the process image for this output (see Table 14 in section 6.3.1). Table 17 lists the allocations between impulse channels and outputs.

Table 17: Allocation between impulse channels and outputs

| Impulse channel | Impulse output |
|-----------------|------------------|
| P0 | P0 (DO20) %QX2.4 |
| P1 | P1 (DO21) %QX2.5 |

Table 18 shows the characteristics of the pulse width modulation outputs.

Table 18: Characteristics of PWM/PTO output

| Function | Resolution | Max. Cycle Time | Min. Cycle Time |
|------------------------------|------------|------------------|-----------------|
| Pulse Width Modulation (PWM) | 16 Bit | 65535 ms (15mHz) | 2 µs (500 kHz) |

6.6 Control and display elements

There are three different LED mounted on the IoT-Chip CTR-100 (DIL40 variant) or on the Development Board (LGA-version): Run-LED, Error-LED and the Link-LED of the Ethernet connection. The different states of the Run-LED and the Error-LED are explained in the following section.

6.6.1 Run-LED (green)

The Run-LED provides information about the activity state of the control system. The activity state is shown through different modes:

Table 19: Display status of the Run-LED

| LED Mode | PLC Activity State |
|---|---|
| Off | The PLC is in state "Stop": <ul style="list-style-type: none"> the PLC does not have a valid program, the PLC has received a stop command from the <i>OpenPCS</i> programming environment or the execution of the program has been canceled due to an internal error |
| Quick flashing in relation 1:8 to pulse | The PLC is on standby but is not yet executing: <ul style="list-style-type: none"> The PLC has received a start command from the <i>OpenPCS</i> programming environment but the local Run/Stop switch is still positioned to "Stop" |
| Slow flashing in relation 1:1 to pulse | The PLC is in state "Run" and executes the PLC program. |
| Quick flashing in relation 1:1 to pulse | The PLC is in mode "Reset". |

6.6.2 Error-LED (red)

The Error-LED provides information about the error state of the control system. The error state is represented through different modes:

Table 20: Display status of the Error-LED

| LED Mode | PLC Error State |
|---|--|
| Off | No error has occurred; the PLC is in normal state. |
| Permanent light | A severe error has occurred: <ul style="list-style-type: none"> The PLC was started using an invalid configuration (e.g. CAN node address 0x00) and had to be stopped or A severe error occurred during the execution of the program and caused the PLC to independently stop its state "Run" (division by zero, invalid Array access, ...), see below |
| Slow flashing in relation 1:1 to pulse | A network error occurred during communication to the programming system; the execution of a running program is continued. This error state will be reset independently by the PLC as soon as further communication to the programming system is successful. |
| Quick flashing in relation 1:1 to pulse | The PLC is in mode "Reset". |
| Quick flashing in relation 1:8 to pulse | The PLC is on standby, but is not yet running: <ul style="list-style-type: none"> The PLC has received a start command from the <i>OpenPCS</i> programming environment but the local Run/Stop switch is positioned to "Stop" |

In case of severe system errors such as division by zero or invalid Array access, the control system passes itself from state "Run" into state "Stop". This is recognizable by the permanent light of the Error-LED (red). In this case, the error cause is saved by the PLC and is transferred to the computer and shown upon next power-on.

6.7 Using CANopen for CAN interfaces

The IoT-Chip CTR-100 features one CAN interface (CAN0), usable as CANopen Manager (conform to CiA Draft Standard 302).

The CAN interface allow for data exchange with other devices via network variables and is usable from a PLC program via function blocks of type "CAN_Xxx". More details are included in "User Manual CANopen Extension for IEC 61131-3", Manual no.: L-1008.

The CANopen services **PDO** (**P**rocess **D**ata **O**bjects) and **SDO** (**S**ervice **D**ata **O**bjects) are two separate mechanisms for data exchange between single field bus devices. Process data sent from a node (**PDO**) are available as broadcast to interested receivers. PDOs are limited to 1 CAN telegram and therewith to 8 Byte user data maximum because PDOs are executed as non-receipt broadcast messages. On the contrary, **SDO** transfers are based on logical point-to-point connections ("Peer to Peer") between two nodes and allow the receipted exchange of data packages that may be larger than 8 Bytes. Those data packages are transferred internally via an appropriate amount of CAN telegrams. Both services are applicable for interface CAN0 of the IoT-Chip CTR-100.

SDO communication basically takes place via function blocks of type "CAN_SDO_Xxx" (see "User Manual CANopen Extension for IEC 61131-3", Manual no.: L-1008). Function blocks are also available for PDOs ("CAN_PDO_Xxx"). Those should only be used for particular cases in order to also activate non-CANopen-conform devices. For the application of PDO function blocks, the CANopen configuration must be known in detail. The reason for this is that the PDO function blocks only use 8 Bytes as input/output parameter, but the assignment of those Bytes to process data is subject to the user.

Instead of PDO function blocks, network variables should mainly be used for PDO-based data exchange. Network variables represent the easiest way of data exchange with other CANopen nodes. Accessing network variables within a PLC program takes place in the same way as accessing internal, local variables of the PLC. Hence, for PLC programmers it is not of importance if e.g. an input variable is allocated to a local input of the control or if it represents the input of a decentralized extension module. The application of network variables is based on the integration of DCF files that are generated by an appropriate CANopen configurator. On the one hand, DCF files describe communication parameters of any device (CAN Identifier, etc.) and on the other hand, they allocate network variables to the Bytes of a CAN telegram (mapping). The application of network variables only requires basic knowledge about CANopen.

In a CANopen network, exchanging PDOs only takes place in status "*OPERATIONAL*". If the IoT-Chip CTR-100 is not in this status, it does not process PDOs (neither for send-site nor for receive-site) and consequently, it does not update the content of network variables. The CANopen Manager is in charge of setting the operational status "*OPERATIONAL*", "*PRE-OPERATIONAL*" etc. (mostly also called "CANopen Master"). In typical CANopen networks, a programmable node in the form of a PLC is used as CANopen-Manager. The IoT-Chip CTR-100 is optionally able to take over tasks of the CANopen Manager.

As CANopen Manager, the IoT-Chip CTR-100 is able to parameterize the CANopen I/O devices ("CANopen-Slaves") that are connected to the CAN bus. Therefore, upon system start via SDO it transfers DCF files generated by the CANopen configurator to the respective nodes.

6.7.1 CAN interface CAN0

Interface CAN0 features a dynamic object dictionary. This implicates that after activating the PLC, the interface does not provide communication objects for data exchange with other devices. After downloading a PLC program (or its reload from the non-volatile storage after power-on), the required communication objects are dynamically generated according to the DCF file which is integrated in the PLC project. Thus, CAN interface CAN0 is extremely flexible and also applicable for larger amount of data.

For the PLC program, all network variables are declared as "*VAR_EXTERNAL*" according to IEC61131-3. Hence, they are marked as „outside of the control“, e.g.:

```
VAR_EXTERNAL
  NetVar1 : BYTE ;
  NetVar2 : UINT ;
END_VAR
```

A detailed procedure about the integration of DCF files into the PLC project and about the declaration of network variables is provided in manual "*User Manual CANopen Extension for IEC 61131-3*" (Manual no.: L-1008).

When using CAN interface CAN0 it must be paid attention that the generation of required objects takes place upon each system start. This is due to the dynamic object directory. "Design instructions" are included in the DCF file that is integrated in the PLC project. **Hence, changes to the configuration can only be made by modifying the DCF file.** This implies that after the network configuration is changed (modification of DCF file), the PLC project must again be translated and loaded onto the IoT-Chip CTR-100.

6.8 Controller specific PLC Function Blocks

6.8.1 The Function Blocks SIO_*

This group of function blocks controls the serial interfaces *SIO0*, *SIO1* and *SIO2*. The function blocks are described in the manual “L-1054 SYS TEC-specific Extensions for OpenPCS / IEC61131-3”.

This section gives additional information about the function block operands PORT and PROTOCOL depending on the interface.

Definition of the Operands:

| | |
|-----------|---|
| PORT: | Number of serial interface to be used 0 = SIO0 (COM0, RS232 via USB) 1 = SIO1 (COM1, RS485) 2 = SIO2 (COM2, RS232) |
| PROTOCOL: | The PROTOCOL operand defines whether RS232, XON/XOFF, RS422, RS485, RTS/CTS is used. 0 = Basic RS232 (available for SIO0, SIO2) 1 = XON/XOFF (available for SIO0, SIO2) 2 = Hardware Handshake via RTS/CTS (available for SIO2) 3 = RS485 (available for SIO1) 4 = RS422 (N/A) |

7 Updating the IoT-Chip CTR-100 Firmware

Updating the firmware of the IoT-Chip CTR-100 is not possible at the moment.
For further information please contact the technical support of SYS TEC electronic:

Telephone: +49 (0) 3765 / 38 600-0
E-Mail: support@sys-tec-electronic.com

8 Baseboard Configuration

The following chapter describes possible jumper configurations. These configurations are referring to the supplied baseboard of the IoT-Chip CTR-100.

8.1 Voltage Reference

Connector JP 100 defines the value of the voltage reference. If pin 2 is connected to pin 1, the board uses the voltage which is connected to the pin labelled "AREF". If pin 2 is connected to pin 3, the voltage reference is set to +3.3V.

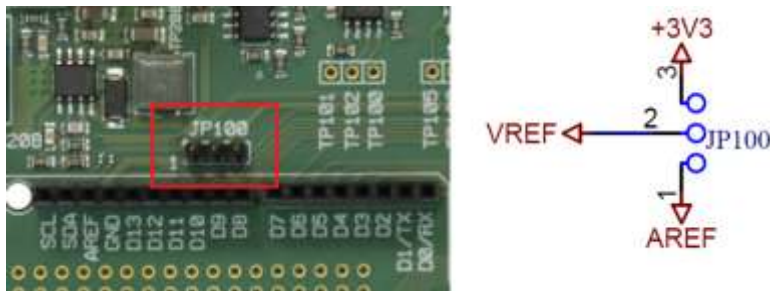


Figure 9: Position and Function of Connector JP100

8.2 GPIO on Connectors JP101 and JP102

These two connectors are responsible for connecting several GPIO pins of the IoT-Chip CTR-100 to the labelled pin header on the baseboard (see Table 22). See section 5 for further information of alternative functions of GPIO pins.

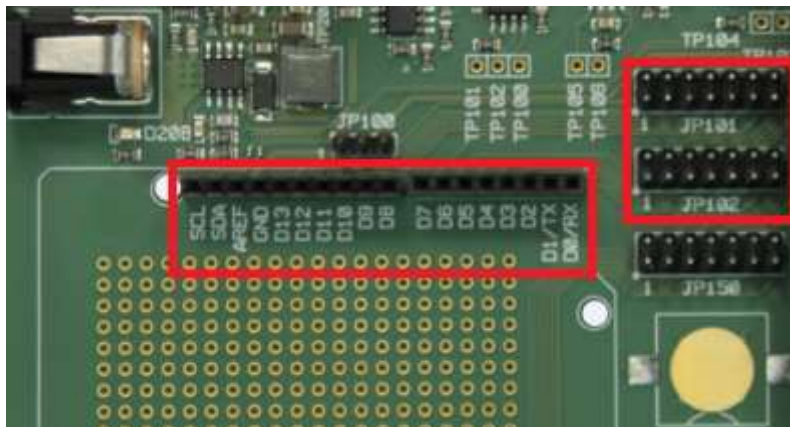


Figure 10: Connectors JP101 and JP102 and corresponding pin header

Table 22: Mapping of Connectors JP101 and JP102

| Jumper on baseboard | Function on IoT-Chip CTR-100 | Label on Baseboard |
|---------------------|------------------------------|--------------------|
| JP101(1) | DI7/SPI0_CLK | D13 |
| JP101(2) | DI6/SPI0_MISO | D12 |
| JP101(3) | DO5/SPI0_MOSI | D11 |
| JP101(4) | DO4/SPI0_CS | D10 |
| JP101(5) | DO0/PWM | D9 |
| JP101(6) | UART2_RTS | D8 |
| JP101(7) | UART2_CTS | D7 |
| JP102(1) | DO3 | D6 |
| JP102(2) | DO1/PWM | D5 |
| JP102(3) | DI5/ENC0(CH1) | D4 |
| JP102(4) | DI4/ENC0(CH2) | D3 |
| JP102(5) | DI2 | D2 |
| JP102(6) | UART2_TXD | D1/TX |
| JP102(7) | UART2_RX | D0/RX |

8.3 GPIO and electric potential on connector JP103

The first four jumpers on connector JP103 are used to enable or disable the four push buttons. While pins 9 and 10 offer access to GND, pins 11 and 12 are on an electrical potential of +3.3V.

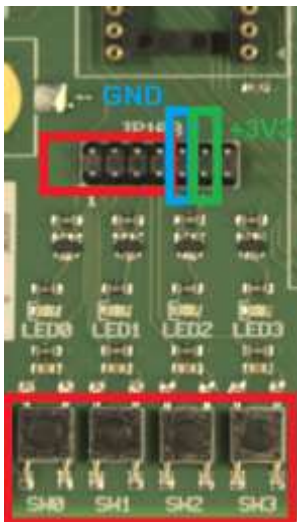


Figure 11: Function of connector JP103

8.4 GPIO on Connector JP150

The mapping of the analog inputs and outputs are defined by the jumpers on connector JP150. Further information are listed in Table 23.

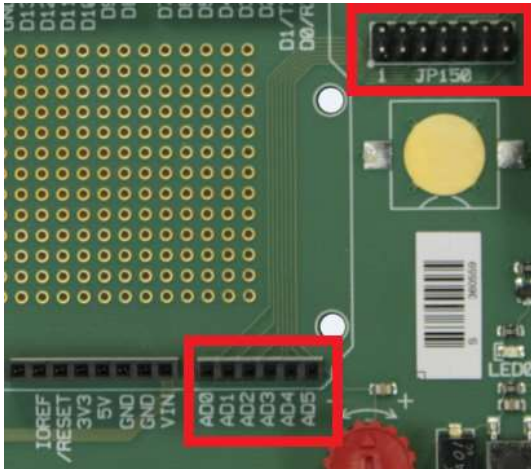


Figure 12: Connector JP150 and corresponding pin header

Table 23: Mapping of Connector JP150

| Jumper on baseboard | Function on IoT-Chip CTR-100 | Label on Baseboard |
|---------------------|-------------------------------|--------------------|
| JP150(1) | AI0 | AD0 |
| JP150(2) | AI1 | AD1 |
| JP150(3) | AI2 | AD2 |
| JP150(4) | AI3 | AD3 |
| JP150(5) | AO0 | AD4 |
| JP150(6) | AO1 | AD5 |
| JP150(7) | Connects potentiometer to AI0 | |

8.5 Serial Output

The IoT-Chip CTR-100 offers three different serial outputs. SIO0 refers to the UART/USB-Bridge (COM0) which is the default interface for the configuration shell and can be used for user output during runtime. On the Development Board it is tunneled via USB (see Figure 13).

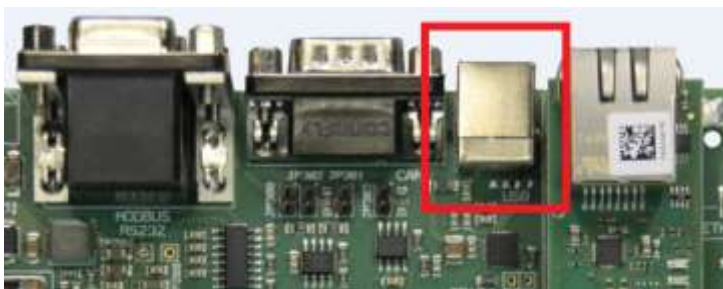


Figure 13: Position of the USB-Interface

SIO1(COM1) refers to the Modbus-RTU (RS485) and uses the male SUB-D 9 connector. Jumpers 300-302 are responsible for terminating the Modbus. For a successful termination all three jumpers must be set. The positions of the jumpers are marked in Figure 14.

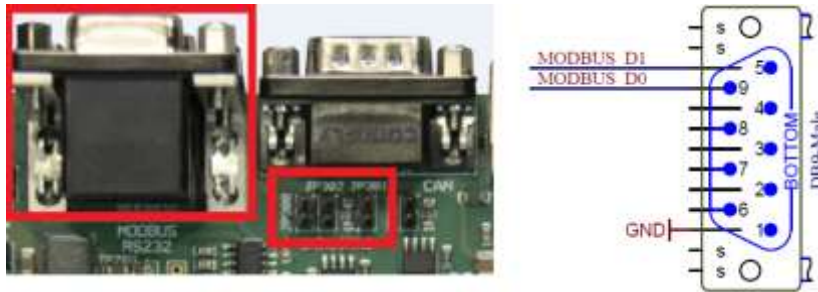


Figure 14: Interface, jumper and pin configuration for Modbus

The serial interface SIO2(COM2) uses the female SUB-D 9 connector positioned over the Modbus-Interface by RS232. The pin configuration for RS232 is shown in Figure 15.

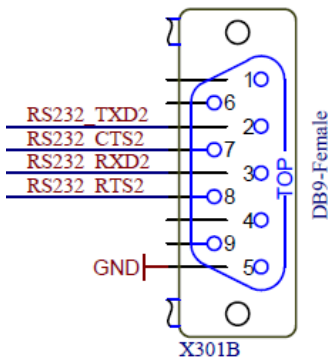


Figure 15: Pin configuration for RS232

8.6 Controller Area Network

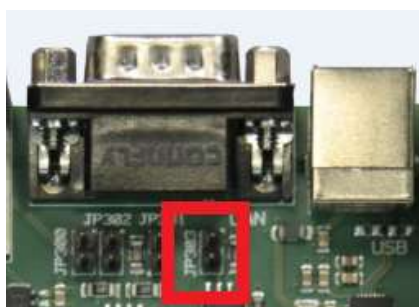


Figure 16: Position of JP303

The jumper JP303 is the termination jumper of the CAN interface and is only necessary if the CAN bus is not terminated by another device or resistor. If the jumper is set, the CAN bus is terminated by a resistor of 120 Ω.

9 OpenPCS Programming System

9.1 Installation OpenPCS Programming System

Step 1:

- Start the OpenPCS setup program (e.g. "PS665e.exe") and follow the self-explanatory instructions until the following dialog window appears.

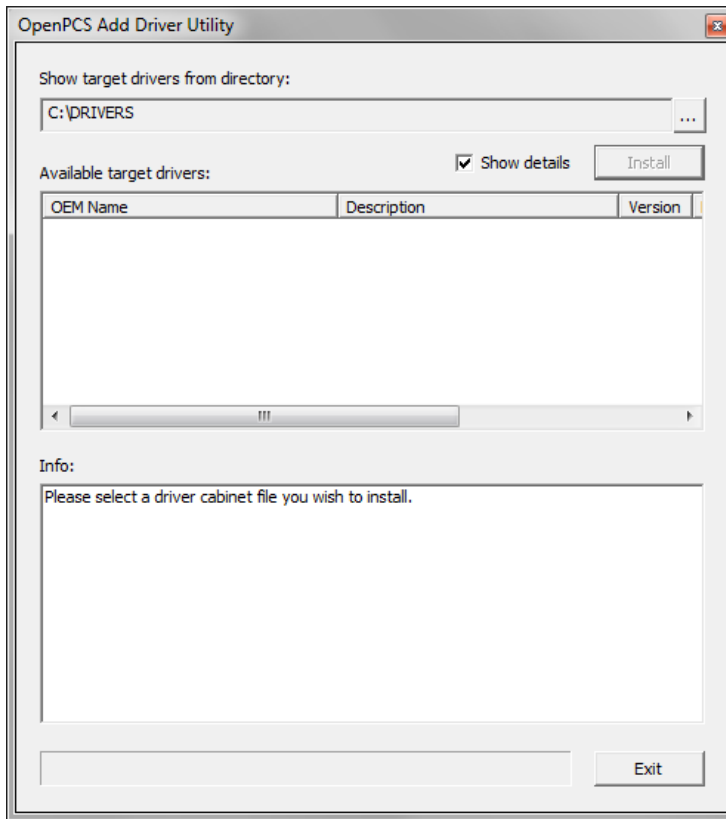


Figure 17: OpenPCS Installation Setup

Close the dialog in shown in Figure 17 by clicking on button "Exit" (driver installation will be done with the "SYSTEC OpenPCS Extension", see Step 2).

Step 2:

- Start the "SYSTEC OpenPCS Extension" setup program (e.g. "SYSTEC-OpenPCS-Extension_702e_100.exe". Follow the instructions of the install program.

- In the “Select Components” dialog select “Standard Installation for SYS TEC Control Units” and then click on button “Next”.

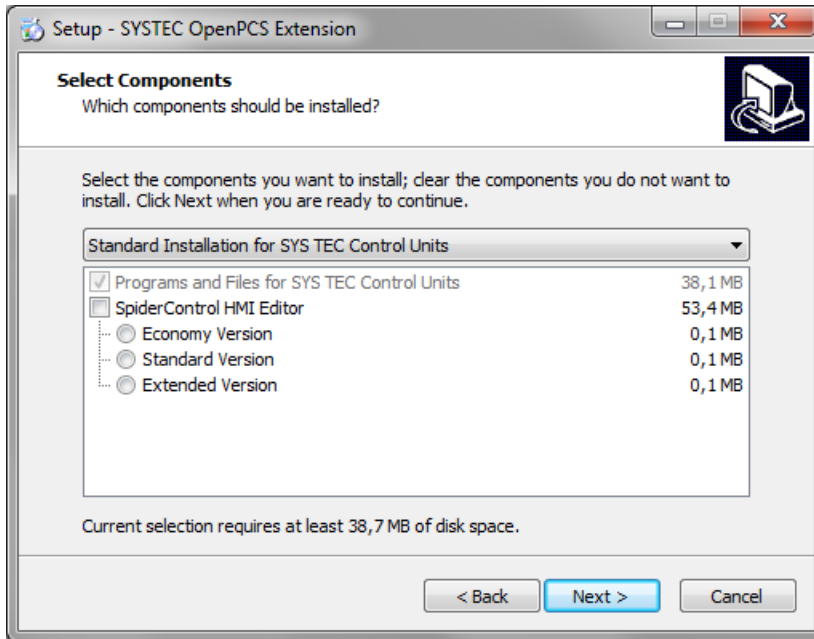


Figure 18: SYS TEC OpenPCS Extension select components dialog

- Insert your name and company into the “infoteam OpenPCS Licences” window and click “OK”.

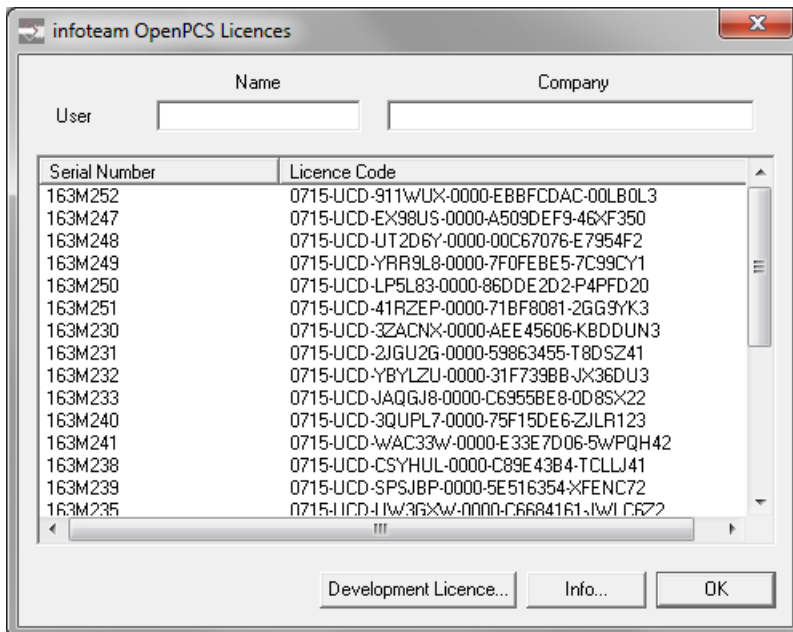


Figure 19: SYS TEC OpenPCS Extension Setup

- Finish the installation.



Figure 20: SYS TEC OpenPCS Extension Setup

9.2 Define Network Connection

Step 1:

- Select "PLC" > "Connections..." from the OpenPCS menu.
- In the dialog window "Connection Setup", click at the button "New". This will in turn open the following window.

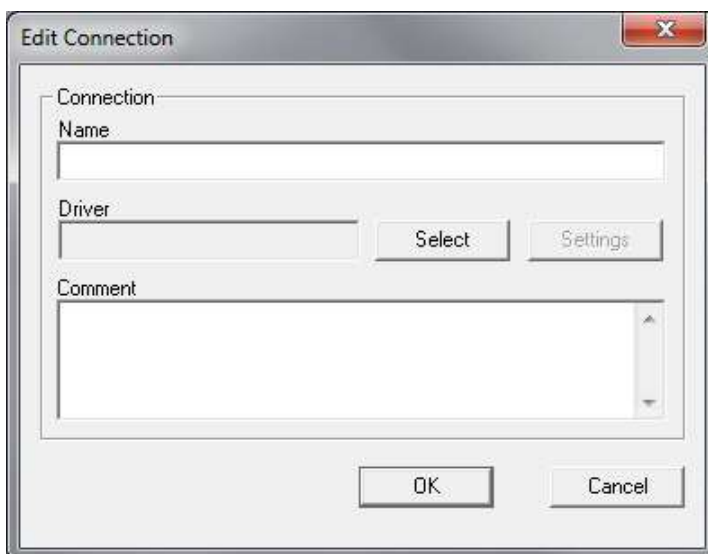


Figure 21: Target Connection – Edit Connection

Step 2:

- Choose the button “Select”.
- Select the driver “*SYSTEC Standard Driver*”. This is the first choice for many kinds of connections.

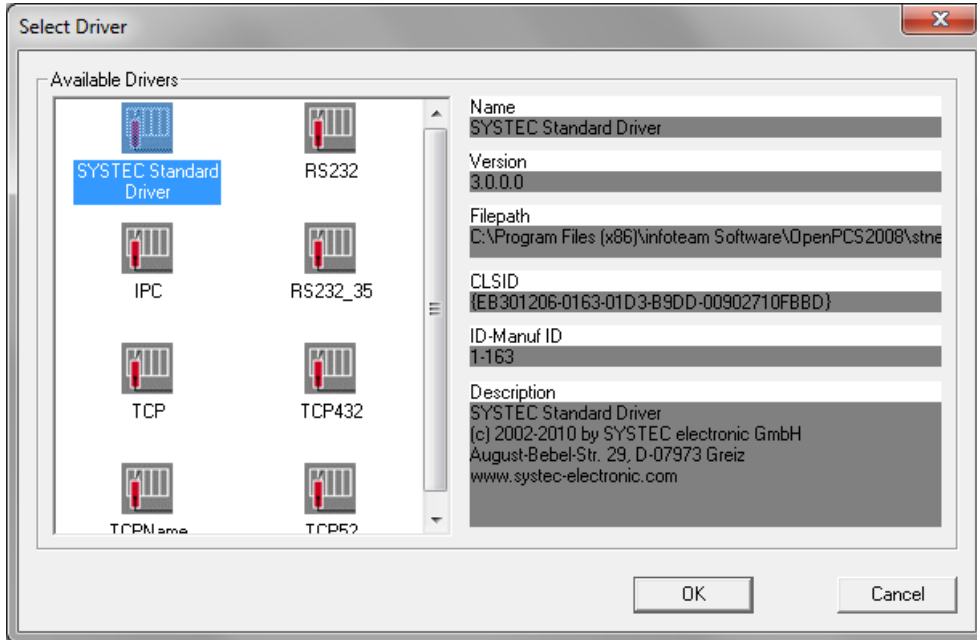


Figure 22: Target Connection – Select Driver

- Confirm the selection by clicking “OK”.

Step 3:

- Enter a meaningful name for the connection settings, e.g. “*UDP_192_168_10_180*”.
- Now, the “*Edit Connection*” dialog looks like this:

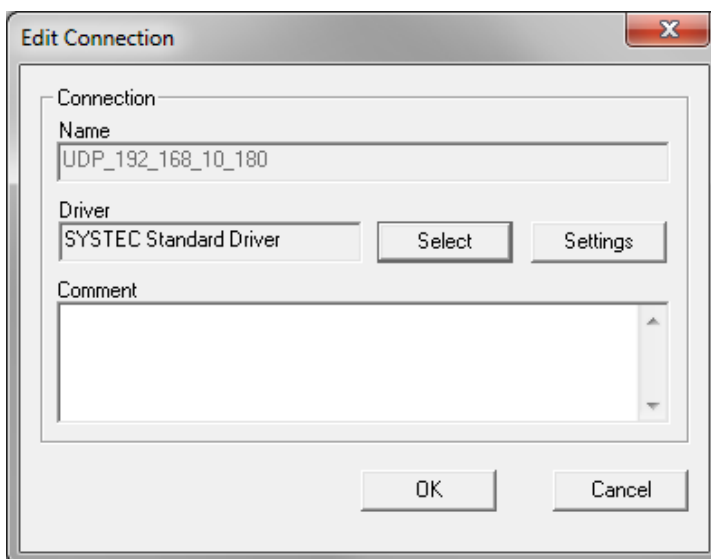


Figure 23: Target Connection – Edit Connection (filled)

- Finish the configuration of the target connection by clicking “OK” in the “Edit Connection” dialog and “Close” in the “Connection Setup” window

9.3 Assign Network Connection to Resource

Step1:

- Select “PLC” > “Resource Properties...” from the OpenPCS main menu.
- Choose “SYSTEC – lotChip-F767/Z5 (3390100/Z5)” for the Hardware Module setting and the Network Connection “UDP_192_168_10_180”, which has been created in the previous section.

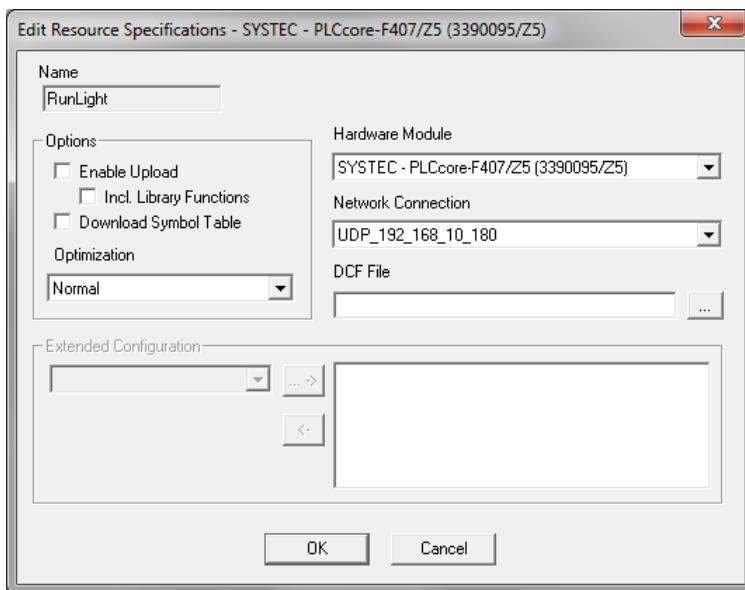


Figure 24: Resource Properties

- Confirm the settings by clicking “OK”.

Step2:

- Use either the entry “PLC” > “Rebuild Active Resource” from the main menu or click at the appropriate icon as shown in the screen snapshot.

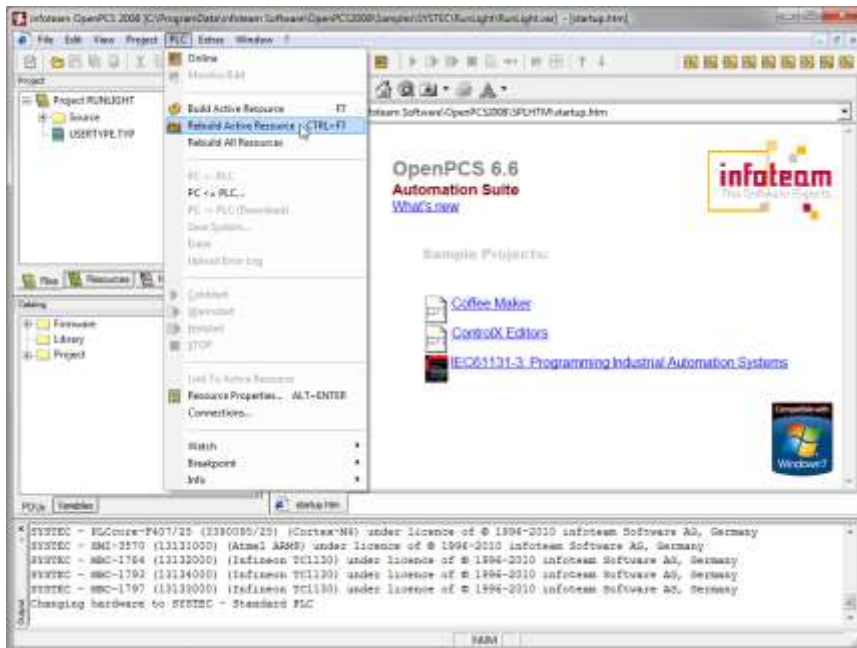


Figure 25: OpenPCS - Rebuild Active Resource

10 Configuration Command Shell

10.1 Entering the Configuration Command Shell

The Configuration Command Shell (herein after called Configuration Shell) of the *Controller* provides a set of commands to read and write device configurations such as TCP/IP address settings and CAN interface configurations.

```

----- Configuration Command Shell -----

type 'help' to get a overview of all available commands
type '<command> ?' to get a more detailed help for a command
Ctrl+E = (E)dit last command
Ctrl+R = (R)epet last command

Configuration State: The configuration loaded from FLASH is valid

> help
GET_DEV_CONFIG : Display current Device Configuration
SET_LIC_KEY    : Set License Key
SET_IP_CONFIG  : Set IP Configuration
SET_CAN_CONFIG : Set CAN Configuration
SET_CAN_ERRLEV : Set CAN Error Level
SET_EXT_IO_MODE : Set Extended IO Mode
SET_HDG_MODE   : Set Watchdog Mode
SET_SS0A_MODE  : Set Download Mode (single/multi segments)
SET_I2C_MODE   : Set I2C Mode
SET_SPI_MODE   : Set SPI Mode
SET_CRC_MODE   : Set CRC Mode for Saving/Loading PLC Resource
GET_RTC        : Get System Time and Date from on-board RTC
SET_RTC        : Set System Time and Date for on-board RTC
GET_LAST_ERROR : Display Information about the last System Error
PRINT_CFG_FILE : Print Configuration File
DEL_CFG_FILE   : Delete Configuration File
DEL_PLG_PROG   : Delete PLC Program File
DEL_MVDATA     : Delete MVDATA File
DIR            : Show available Files and Directories
DUMP_FILE      : Dump File Content
DEL_FILE       : Delete File
FORMAT_FS      : Format Flash File System
EXIT           : Exit this Shell and Save Configuration
HELP          : Display this Help Screen
<command> ?   : Display a more detailed Help for a Command
Ctrl+E        : Edit last Command
Ctrl+R        : Repeat last Command

> █

```

Figure 26: Built-in Configuration Command Shell

The Configuration Shell uses the serial interface SIO0 of the IoT-Chip CTR-100. On the Development Kit the interface SIO0 is tunneled via USB on connector USB. To access the Configuration Shell, connect the Development Kit to the PC using the USB cable delivered with the Kit.

On the PC side the virtual COM port driver delivered with the Kit ("*CP210xVCPInstaller.exe*") has to be installed. This will add an additional virtual serial interface to the Host PC. This allows for access to the Command Shell using a Terminal program. Suitable as Terminal program would be "*HyperTerminal*" which is included in the Windows delivery or "*Tera Term*" which is available as Open Source and meets higher demands (downloadable from: <http://tssh2.sourceforge.jp>).

The Terminal program must be configured as follows (see Figure 27):

- 115200 Baud
- 8 Data bit
- 1 Stop bit
- no parity
- no flow control

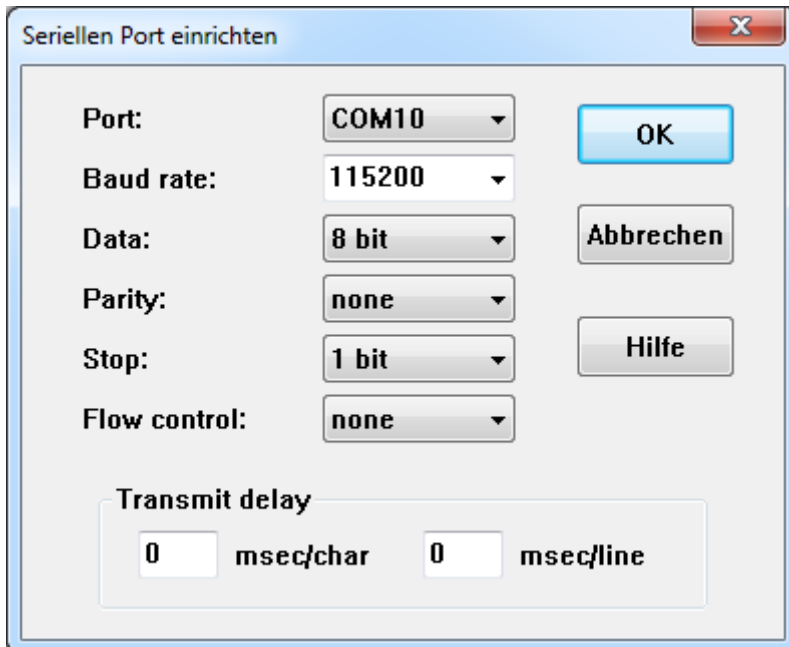


Figure 27: Terminal configuration using the example of "TeraTerm"

To start the Configuration Shell of the IoT-Chip CTR-100 move the dip switch 2 in the upper position and reboot the chip.

After entering the Command Shell, the status message should come up on the terminal window as shown in Figure 26. All inputs are case insensitive. The *HELP* command gives you an overview about all commands available. To get help for a specific command just enter *HELP* followed by the command name or type the command followed by an "?". Press *CTRL+R* to repeat the last command. The command *EXIT* terminates the Configuration Shell. The configuration is stored in non-volatile memory and the PLC starts with current settings.

Warning

Please note that the following commands cannot be undone:

- *DEL_CFG_FILE*
- *DEL_PLC_PROG*
- *DEL_NVDATA*
- *DEL_FILE*
- *FORMAT_FS*

Please take care about respective commands!

10.2 Command Description

The following section describes the commands available for the Command Configuration Shell on the IoT-Chip CTR-100.

10.2.1 GET_DEV_CONFIG

The command `GET_DEV_CONFIG` shows the current device configuration. This command has no parameters.

Example

```
> GET_DEV_CONFIG
```

Device Information:

```
Type: SYSTEC IotChip-F767/Z5 (3390100/Z5)
DeviceID: 1013005
Serial Number: 17070007
License Key: RIKE-AJC8-05V3-62B0-JXJB-82EK-JLDT-8KEK
Product Code: 3390100
Hardware:
  CPU Board: 4436.00
  IO Board: 4439.00
  I/O Driver: 1.00
Firmware: 5.10.01.00
Build Date/Time: May 12 2017 / 11:32:43
Virtual Machine: 7.03 - 2 (#42)
OEM-ID: 163
```

Device Configuration:

```
Config File: 0:/IOTC-F767.cfg
PLC Backup Dir: plcdata
Memory available: 128 kByte
ProcessImage:
  Extended I/Os: disabled
RuntimeSettings:
  Watchdog: Off
  I2C: enabled
  SPI: enabled
  SnglSegDwl Mode: enabled
  CRC Mode: enabled
```

```
ETH0 MAC Addr: 70-B3-D5-AB-47-AF
ETH0 IpAddr: 192.168.10.222
ETH0 SubnetMask: 255.255.255.0
ETH0 Gateway: 192.168.10.1
ETH0 PortNum: 8888
```

```
CAN0 Enable: on
CAN0 NodeID: 32 (0x20)
CAN0 Baudrate: 1000
CAN0 MasterMode: off
CAN0 ErrorLevel: AllNetErrors
```

Ok
>

10.2.2 SET_IP_CONFIG

The command `SET_IP_CONFIG` is used to set the communication parameters for Ethernet interface.

Command

```
SET_IP_CONFIG <IfNum IpAddr [NetMask [Gateway [PortNum]]]>
```

Table 24: Parameter for command `SET_IP_CONFIG`

| Parameters | Attribute | Values | Description |
|------------|-----------|---------------------|---|
| IfNum | Mandatory | 0 -> ETH0 | Interface number for Ethernet interface |
| IpAddr | Mandatory | i.e. 192.168.10.130 | IP address |
| NetMask | Optional | i.e. 255.255.255.0 | Network mask |
| Gateway | Optional | i.e. 192.168.10.200 | IP address of default gateway |
| PortNum | Optional | i.e. 8888 | Port number |

Example

```
SET_IP_CONFIG 0 192.168.10.130 255.255.255.0
OK
>
```

10.2.3 SET_CAN_CONFIG

The command `SET_CAN_CONFIG` is used to set the communication parameters of the CAN communication interface CAN0.

Command

```
SET_CAN_CONFIG <IfNum Enable [NodeID [Bitrate [MstMode ]]]>
```

Table 25: Parameter for command `SET_CAN_CONFIG`

| Parameters | Attribute | Values | Description |
|------------|-----------|---------------------------------------|---------------------------------------|
| IfNum | Mandatory | 0 -> CAN0 | Interface number for CAN interface |
| Enable | Mandatory | on/off | Enables or disables the CAN interface |
| NodeID | Optional | 1...0x7F | Node-ID (i.e. 0x21) |
| Bitrate | Optional | 20, 50, 100, 125,250, 500, 1000 | CAN-bus baud rate (i.e. 500) |
| MstMode | Optional | on/off | Master mode (on/off) |

Example

```
SET_CAN_CONFIG 0 on 32 1000 off
OK
>
```

10.2.4 SET_CAN_ERRLEV

The command `SET_CAN_ERRLEV` sets the error level for saving CAN errors in the Error Log of the PLC. This Error Log can be uploaded if the IoT-Chip CTR-100 is online connected to the OpenPCS Programming System.

Command

```
SET_CAN_ERRLEV <IfNum ErrorLevel>
```

Table 26: Parameter for command `SET_CAN_ERRLEV`

| Parameters | Attribute | Values | Description |
|------------|-----------|-----------|---|
| IfNum | Mandatory | 0 -> CAN0 | Interface number for CAN interface |
| ErrorLevel | Mandatory | no | No CAN errors are logged in the Error Log |
| | | heavy | Only heavy occurring errors (i.e. BusOff) are logged in the Error Log |
| | | all | All occurring CAN errors are logged in the Error Log |

Example

```
> SET_CAN_ERRLEV 0 all
Ok
>
```

10.2.5 SET_WDG_MODE

The command `SET_WDG_MODE` is used to define the behavior of the on-board watchdog of the IoT-Chip CTR-100.

Command

```
SET_WDG_MODE <WdgMode>
```

Table 27: Parameter for watchdog configuration

| Parameter | Attribute | Values | Description |
|-----------|-----------|---------|--|
| WdgMode | Mandatory | on | Default-setting, Watchdog guarding is activated. The device is reset on Watchdog-event. |
| | | monitor | Watchdog-events are recognized by the firmware without resetting the device. However, an error message (message box) is sent to the programming system when a Watchdog-event has occurred. |
| | | off | Watchdog-guarding is inactive; the device does not react to any Watchdog-events. |

Example

```
> SET_WDG_MODE off
Ok
>
```

10.2.6 SET_SSDWL_MODE

The command `SET_SSDWL_MODE` sets the mode for the transfer of a PLC program archive from the OpenPCS Programming System to the IoT-Chip CTR-100. The command is described only for completeness. The use of the command is very rarely needed.

Background:

A PLC program archive contains several segments of data. To reduce the transfer time the segments are packed together to a container and the device sends only one ACK/NAK for one container. If the PC will not receive the ACK/NAK within a defined timeout, the connection will break with an error message. The time between the transferred container and sending of the ACK/NAK depends on the machine speed of the device. In rare cases it can happen that is needed too long time for the processing of a container. In this case, the command `SET_SSDWL_MODE` can be used to switch from container to a single segmented transfer mode.

Command

```
SET_SSDWL_MODE <SSDwlMode>
```

Table 28: Parameter for command SET_SSDWL_MODE

| Parameter | Attribute | Values | Description |
|-----------|-----------|--------|--|
| SSDwlMode | Mandatory | on | A PLC program archive will be transferred with single segments (single segment download). |
| | | off | A PLC program archive will be transferred in a container. This needs the shortest transfer time (Default setting). |

Example

```
> SET_SSDWL_MODE off
OK
```


10.2.7 SET_I2C_MODE

The command SET_I2C_MODE is used to enable or disable the I²C communication of the IoT-Chip CTR-100.

Command

```
SET_I2C_MODE <I2cMode>
```

Table 29: Parameter for command SET_SDCARD_MODE

| Parameter | Attribute | Values | Description |
|-----------|-----------|--------|--------------------------|
| I2cMode | Mandatory | on | Enable I ² C |
| | | off | Disable I ² C |

Example

```
> SET_I2C_MODE on
OK
>
```

10.2.8 SET_SPI_MODE

The command SET_SPI_MODE is used to enable or disable the SPI communication of the IoT-Chip CTR-100.

Command

```
SET_SPI_MODE <SpiMode>
```

Table 30: Parameter for command SET_SDCARD_MODE

| Parameter | Attribute | Values | Description |
|-----------|-----------|--------|-------------|
| SpiMode | Mandatory | on | Enable SPI |
| | | off | Disable SPI |

Example

```
> SET_SPI_MODE on
OK
>
```

10.2.9 GET_RTC

This command shows the system time and date from the on-board RTC unit. This command has no parameters.

Example:

```
> GET_RTC
Valid: yes
Time 12:30:15
Date: 2017/05/05
```

10.2.10 SET_RTC

Command

```
SET_RTC <hh:mm:ss [yyyy/mm/dd]>
```

SET_RTC enables you to set the system time and date for the on-board RTC. The RTC on the IoT-Chip CTR-100 is battery backed. The time format is based on 24h. Please refer to the SYS TEC PLC extension Manual (L-1054) for more information on how accessing the RTC from within the PLC program.

Table 31: Parameter for command SET_RTC

| Parameter | Attribute | Description | |
|------------|-----------|-------------|------------------|
| hh:mm:ss | Mandatory | hh: | hour (0...24) |
| | | mm: | minutes (0...59) |
| | | ss: | seconds (0...59) |
| yyyy/mm/dd | Optional | yyyy: | year |
| | | mm: | month |
| | | dd: | day |

Example

```
> SET_RTC 12:30:59 2017/05/05
OK
```

10.2.11 SET_CRC_MODE

The command SET_CRC_MODE enables or disables the CRC check for saving/loading the PLC resource.

Command

```
SET_CRC_MODE <CrcMode>
```

Table 32: Parameter for command SET_CRC_MODE

| Parameter | Attribute | Values | Description |
|-----------|-----------|--------|-----------------------|
| CrcMode | Mandatory | on | Enables the CRC mode |
| | | off | Disables the CRC mode |

Example

```
> SET_CRC_MODE off
OK
>
```

10.2.12 GET_LAST_ERROR

The command GET_LAST_ERROR prints detailed information about the last system error occurred. This command has no parameters.

Example

```
> GET_LAST_ERROR
ErrorCode = 0
ErrorText = Controller working normal
Ok
>
```

10.2.13 PRINT_CFG_FILE

The command `PRINT_CFG_FILE` shows the content of the configuration file if the file exists.

Example

```
> PRINT_CFG_FILE

[ETH0]
IpAddr=192.168.10.222
SubnetMask=255.255.255.0
Gateway=192.168.10.1
PortNum=8888

[CAN0]
Enable=1
NodeID=0x20
Baudrate=1000
MasterMode=0
ErrLevel=2

[PlcSettings]
EnableExtIo=0
WatchdogMode=2
EnableI2c=1
EnableSpi=1
SnglSegDwlMode=1
CrcCheckMode=1

Ok
>
```

10.2.14 DEL_CFG_FILE

The command `DEL_CFG_FILE` deletes the configuration file. Once done, this cannot be undone. This command has no parameters.

Example

```
> DEL_CFG_FILE
Do you really want to delete the device configuration file (y/n)? y
Ok
>
```

10.2.15 DEL_PLC_PROG

The command `DEL_PLC_PROG` deletes the saved PLC program in the PLC program backup archive. Once done, this cannot be undone. This command has no parameters.

Example

```
> DEL_PLC_PROG
Do you really want to delete the PLC program archive (y/n)? y
Ok
>
```

10.2.16 DEL_NVDATA

The command *DEL_NVDATA* deletes all data (variables) stored in non-volatile memory area. Once done, this cannot be undone. This command has no parameters.

Example

```
> DEL_NVDATA
Do you really want to delete the NVDATA archive (y/n)? y
Ok
>
```

10.2.17 DIR

The command *DIR* allows you to see all available files saved in the Flash Files System. This command has no parameters.

Example

```
> DIR

Files and Directories of Flash File System:

+ 0:/
|
+ -- plcdata
|   |
|   + -- PLCARCHV.BIN      13699 Bytes
+
|
+ -- IOTC-F~1.CFG          271 Bytes

Ok

>
```

10.2.18 DUMP_FILE

The command *DUMP_FILE* prints out the contents of the given file in hexadecimal or in ASCII text form.

Command

DUMP_FILE <FileName [-a]>

Table 33: Parameter for command *DUMP_FILE*

| Parameter | Attribute | Description |
|-----------|-----------|--|
| FileName | Mandatory | Path to the file that should be dumped. |
| -a | Optional | Print file as ASCII output instead of hex dump |

Example

```
> DUMP_FILE IOTC-F~1.CFG
00000000: 0A 5B 45 54 48 30 5D 0A 49 70 41 64 64 72 3D 31 .[ETH0].IpAddr=1
00000010: 39 32 2E 31 36 38 2E 31 30 2E 32 32 32 0D 0A 53 92.168.10.222..S
00000020: 75 62 6E 65 74 4D 61 73 6B 3D 32 35 35 2E 32 35 ubnetMask=255.25
00000030: 35 2E 32 35 35 2E 30 0D 0A 47 61 74 65 77 61 79 5.255.0..Gateway
00000040: 3D 31 39 32 2E 31 36 38 2E 31 30 2E 31 0D 0A 50 =192.168.10.1..P
00000050: 6F 72 74 4E 75 6D 3D 38 38 38 38 0D 0A 0A 5B 43 ortNum=8888...[C
00000060: 41 4E 30 5D 0A 45 6E 61 62 6C 65 3D 31 0D 0A 4E AN0].Enable=1..N
00000070: 6F 64 65 49 44 3D 30 78 32 30 0D 0A 42 61 75 64 odeID=0x20..Baud
00000080: 72 61 74 65 3D 31 30 30 30 0D 0A 4D 61 73 74 65 rate=1000..Maste
00000090: 72 4D 6F 64 65 3D 30 0D 0A 45 72 72 4C 65 76 65 rMode=0..ErrLeve
000000A0: 6C 3D 32 0D 0A 0A 5B 50 6C 63 53 65 74 74 69 6E l=2...[PlcSettin
000000B0: 67 73 5D 0A 45 6E 61 62 6C 65 45 78 74 49 6F 3D gs].EnableExtIo=
000000C0: 30 0D 0A 57 61 74 63 68 64 6F 67 4D 6F 64 65 3D 0..WatchdogMode=
000000D0: 32 0D 0A 45 6E 61 62 6C 65 49 32 63 3D 31 0D 0A 2..EnableI2c=1..
000000E0: 45 6E 61 62 6C 65 53 70 69 3D 31 0D 0A 53 6E 67 EnableSpi=1..Sng
000000F0: 6C 53 65 67 44 77 6C 4D 6F 64 65 3D 31 0D 0A 43 lSegDwlMode=1..C
00000100: 72 63 43 68 65 63 6B 4D 6F 64 65 3D 31 0D 0A rcCheckMode=1..

Ok
>
```

10.2.19 DEL_FILE

The command *DEL_FILE* deletes a specific file from the Flash File System. Once done, this cannot be undone.

Command

```
DEL_FILE <FileName>
```

Table 34: Parameter for command *DEL_FILE*

| Parameter | Attribute | Description |
|-----------|-----------|--|
| FileName | Mandatory | Path to the file that should be deleted. |

Example

```
> DEL_FILE IOTC-F~1.CFG
Ok
>
```

10.2.20 FORMAT_FS

The command *FORMAT_FS* formats the Flash File System located in the external Flash memory. Once done, this cannot be undone. This command has no parameters.

Note
 During this operation all data in the Flash File System will be deleted. There is no way to backup or restore this data, so please be **carefully!**

Example

```
> FORMAT_FS
```

```
CAUTION: This will delete all data stored in the FLASH File System!  
Do you really want to continue (y/n)? y
```

```
Formatting the FLASH File System need some seconds, please wait..
```

```
OK
```

```
>
```

10.2.21 EXIT

The command *EXIT* terminates and leaves the Configuration Shell, save the configuration and restart the PLC.

10.2.22 HELP

The command *HELP* shows all available commands as well as a short command description (see Figure 26).

Appendix A: Third Party Software Components

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[1] lwIP

lwIP (lightweight IP) is an lightweight open source TCP/IP stack designed for embedded systems.

Project URL: <http://savannah.nongnu.org/projects/lwip/>

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 *
 * This file is part of the lwIP TCP/IP stack.
 *
 * Author: Adam Dunkels <adam@sics.se>
 */
```

[2] Paho MQTT Embedded/C

The Eclipse Paho MQTT package is a client library for MQTT embedded devices.

Project URL: <https://github.com/eclipse/paho.mqtt.embedded-c>

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Appendix B: Firmware function scope of IoT-Chip CTR-100

Table 35 lists all firmware functions and function blocks available on IoT-Chip CTR-100.

Sign explanation:

| | |
|----------------|---|
| FB | Function block |
| FUN | Function |
| Online Help | OpenPCS online help |
| L-1054 | Manual "SYS TEC-specific extensions for OpenPCS / IEC 61131-3", Manual no.: L-1054) |
| PARAM:={0,1,2} | values 0, 1 and 2 are valid for the given parameter |

Table 35: Firmware functions and function blocks of IoT-Chip CTR-100

| Name | Type | Reference | Remark |
|--|------|-------------|--------|
| PLC standard Functions and Function Blocks | | | |
| SR | FB | Online Help | |
| RS | FB | Online Help | |
| R_TRIG | FB | Online Help | |
| F_TRIG | FB | Online Help | |
| CTU | FB | Online Help | |
| CTD | FB | Online Help | |
| CTUD | FB | Online Help | |
| TP | FB | Online Help | |
| TON | FB | Online Help | |
| TOF | FB | Online Help | |
| Functions and Function Blocks for string manipulation | | | |
| LEN | FUN | L-1054 | |
| LEFT | FUN | L-1054 | |
| RIGHT | FUN | L-1054 | |
| MID | FUN | L-1054 | |
| CONCAT | FUN | L-1054 | |
| INSERT | FUN | L-1054 | |
| DELETE | FUN | L-1054 | |
| REPLACE | FUN | L-1054 | |
| FIND | FUN | L-1054 | |
| GETSTRINFO | FB | L-1054 | |
| CHR | FUN | L-1054 | |
| ASC | FUN | L-1054 | |
| STR | FUN | L-1054 | |
| VAL | FUN | L-1054 | |
| Functions and Function Blocks for OpenPCS specific task controlling | | | |
| ETRC | FB | L-1054 | |
| PTRC | FB | L-1054 | |
| GETVARDATA | FB | Online Help | |
| GETVARFLATADDRESS | FB | Online Help | |
| GETTASKINFO | FB | Online Help | |

| Name | Type | Reference | Remark |
|---|------|-------------|---|
| Functions and Function Blocks for handling of non-volatile data | | | |
| NVDATA_BIT | FB | L-1054 | DEVICE:={0} (Default), see ⁽¹⁾ |
| NVDATA_INT | FB | L-1054 | DEVICE:={0} (Default), see ⁽¹⁾ |
| NVDATA_STR | FB | L-1054 | DEVICE:={0} (Default), see ⁽¹⁾ |
| NVDATA_BIN | FB | L-1054 | DEVICE:={0} (Default), see ⁽¹⁾ |
| Functions and Function Blocks for handling of time | | | |
| GetTime | FUN | Online Help | |
| GetTimeCS | FUN | Online Help | |
| DT_CLOCK | FB | L-1054 | |
| DT_ABS_TO_REL | FB | L-1054 | |
| DT_REL_TO_ABS | FB | L-1054 | |
| Functions and Function Blocks for counter inputs and pulse outputs | | | |
| CNT_FUD | FB | L-1054 | CHANNEL:={0,1} |
| PTO_PWM | FB | L-1054 | CHANNEL:={0,1} |
| PTO_TAB | FB | L-1054 | CHANNEL:={0,1} |
| Functions and Function Blocks for Serial interfaces | | | |
| SIO_INIT | FB | L-1054 | PORT:={0,1,2} ⁽²⁾ |
| SIO_STATE | FB | L-1054 | PORT:={0,1,2} ⁽²⁾ |
| SIO_READ_CHR | FB | L-1054 | PORT:={0,1,2} ⁽²⁾ |
| SIO_WRITE_CHR | FB | L-1054 | PORT:={0,1,2} ⁽²⁾ |
| SIO_READ_STR | FB | L-1054 | PORT:={0,1,2} ⁽²⁾ |
| SIO_WRITE_STR | FB | L-1054 | PORT:={0,1,2} ⁽²⁾ |
| SIO_READ_BIN | FB | L-1054 | PORT:={0,1,2} ⁽²⁾ |
| SIO_WRITE_BIN | FB | L-1054 | PORT:={0,1,2} ⁽²⁾ |
| Functions and Function Blocks for CAN interfaces / CANopen | | | |
| CAN_GET_LOCALNODE_ID | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_CANOPEN_KERNEL_STATE | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_REGISTER_COBID | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_PDO_READ8 | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_PDO_WRITE8 | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_SDO_READ8 | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_SDO_WRITE8 | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_SDO_READ_STR | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_SDO_WRITE_STR | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_SDO_READ_BIN | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_SDO_WRITE_BIN | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_GET_STATE | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_NMT | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_RECV_EMCY_DEV | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_RECV_EMCY | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_WRITE_EMCY | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_RECV_BOOTUP_DEV | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_RECV_BOOTUP | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_ENABLE_CYCLIC_SYNC | FB | L-1008 | NETNUMBER:={0} (Default) |
| CAN_SEND_SYNC | FB | L-1008 | NETNUMBER:={0} (Default) |

| Name | Type | Reference | Remark |
|--|------|-----------|--------------------------|
| CANL2_INIT | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_SHUTDOWN | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_RESET | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_GET_STATUS | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_DEFINE_CANID | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_DEFINE_CANID_RANGE | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_UNDEFINE_CANID | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_UNDEFINE_CANID_RANGE | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_MESSAGE_READ8 | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_MESSAGE_READ_BIN | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_MESSAGE_WRITE8 | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_MESSAGE_WRITE_BIN | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_MESSAGE_UPDATE8 | FB | L-1008 | NETNUMBER:={0} (Default) |
| CANL2_MESSAGE_UPDATE_BIN | FB | L-1008 | NETNUMBER:={0} (Default) |
| Functions and Function Blocks for Ethernet interfaces / UDP | | | |
| LAN_GET_HOST_CONFIG | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_ASCII_TO_INET | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_INET_TO_ASCII | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_GET_HOST_BY_NAME | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_GET_HOST_BY_ADDR | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_UDP_CREATE_SOCKET | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_UDP_CLOSE_SOCKET | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_UDP_RECVFROM_STR | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_UDP_SENDTO_STR | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_UDP_RECVFROM_BIN | FB | L-1054 | NETNUMBER:={0} (Default) |
| LAN_UDP_SENDTO_BIN | FB | L-1054 | NETNUMBER:={0} (Default) |
| Functions and Function Blocks for Modbus | | | |
| MODBUS_OPEN_INSTANCE | FB | L-1829 | |
| MODBUS_CLOSE_INSTANCE | FB | L-1829 | |
| MODBUS_REGISTER_VAR_LIST | FB | L-1829 | |
| MODBUS_READ_REGS | FB | L-1829 | |
| MODBUS_WRITE_SINGLE_REG | FB | L-1829 | |
| MODBUS_WRITE_MULTI_REGS | FB | L-1829 | |
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| MODBUS_READ_COILS | FB | L-1829 | |
| MODBUS_WRITE_SINGLE_COIL | FB | L-1829 | |
| MODBUS_RAW_PDU_REQUEST | FB | L-1829 | |
| Functions and Function Blocks for I2C | | | |
| tbd | | | |
| Functions and Function Blocks for SPI | | | |
| tbd | | | |
| Functions and Function Blocks for MQTT | | | |
| tbd | | | |

- (1) These information are stored outside the file system to protect them against power outages which may cause a corrupted file system. In such case however the data are still getting corrupted if the power loss occurred while erasing one page or writing data to the flash. Writing to NVData requires at least one erase and write operation per 4k flash page which usually requires about 90 ms (max. 350 ms). Writing to multiple pages requires correspondingly more time. It is recommended to use 4k aligned data blocks to prevent writing multiple pages.
- (2) As chapter 6.4.1 states, the IoT-Chip CTR-100 supports 3 different serial interfaces. Each of them can be used by passing the corresponding interface number to the function block as *PORT* parameter. The following list shows relation between the interface and the *PORT* parameter.

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