sysWORXX CTR-800/CTR-810

Technical Specifications

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SYS TEC electronic AG Am Windrad 2 D-08468 Heinsdorfergrund
Phone: +49 (3765) 38600-0 Fax: +49 (3765) 38600-4100
Web: https://www.systec-electronic.com Mail: info@systec-electronic.com

Changes

Version	Section	Changes
01	-	Initial document

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Contact	**Direct**	**Your Local Distributor**
Address:	SYS TEC electronic AG Am Windrad 2 D-08468 Heinsdorfergrund GERMANY	Please contact us for information about your local distributor. info@systec-electronic.com
Ordering Information:	+49 (0) 37 65 / 38 600-0 info@systec-electronic.com	
Technical Support:	+49 (0) 37 65 / 38 600-0 support@systec-electronic.com	
Fax:	+49 (0) 37 65 / 38 600 4100	
Web Site:	https://www.systec-electronic.com	

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1 Introduction

This document includes all device specific information for the sysWORXX CTR-800 and CTR-810. The devices is identical, except the build-in interface connections.

To get more general information on how to operate the device, please refer to the System Manual of our sysWORXX device series L-2932 (see Table 1).

2 Overview

Table 1 lists up all relevant manuals for the device.

Table 1: Overview of relevant manuals

Information about…	In which manual?
Specific technical information about the device	In this manual
First steps to configure the device and host tools, a first software example	Quick start guide sysWORXX series – L2935
Basic information about the device (configuration, administration, process image, connection assignment, firmware update, reference designs et cetera)	System Manual sysWORXX series – L-2932

3 Product Description

The sysWORXX CTR-800 and 810 extends the SYS TEC electronic AG product range within the field of IoT and control applications. It is an innovative, Linux-based compact controller for universal processing purposes of standard industrial signals. The controller module provides to the user numerous local in- and outputs as well as versatile communication interfaces. Due to CAN and Ethernet interfaces, it is suited for realizing decentral control tasks in distributed fieldbus systems of automation technology. With all these tools and interfaces, one can write their own applications for their specific needs and purposes.

Figure 1: Top view of the sysWORXX CTR-800

The most significant features of the device are listed below:

- Linux-based edge device with industrial controls
- Ti Sitara AM62x - Up to Quad 64-bit Arm Cortex-A53 microprocessor subsystem at up to 1.4 GHz
    - Quad-core Cortex-A53 cluster with 512KB L2 shared cache with SECDED ECC
    - Each A53 Core has 32KB L1 DCache with SECDED ECC and 32KB L1 ICache with Parity protection
    - Single-core Arm® Cortex®-M4F MCU at up to 400 MHz
    - 256KB SRAM with SECDED ECC
    - Dedicated Device/Power Manager
- 1 GiB DDR-RAM (optional up to 2 GiB)
- 8 GiB eMMC FLASH Memory (optional 16GiB, 32GiB)
- 1x USB 2.0 Host interface
- 2x 10/100/1000 Mbps Ethernet LAN interface
- 2x CAN 2.0B interface, usable as CANopen Manager (CiA 302-conform)
- 3x asynchronous serial ports (UART), usable as RS-232 or RS-485
- 16 digital inputs 24VDC, galvanic isolated
    - Alternate function: 1 high-speed counter input, galvanic isolated
    - Alternate function: 1 A/B-Encoder
- 16 digital outputs 24VDC/500mA, galvanic isolated, short-circuit-proof

  - Alternate function: 2 PWM outputs 24VDC/500mA 1KHz
- 2 Relay outputs (2x change-over relay)
- 4 analog inputs 0-10VDC or 0-20mA with 12-Bit resolution
- RTC (with buffer capacitor)
- 2 temperature sensors, CPU and System temperature
- On-board software: Yocto Linux, Docker run time, Python, Node-RED, .NET Core
- Programmable according to IEC 61131-3 (Codesys), C/C++, C#, Java, and Python
- Function block libraries for communication (CANopen, Ethernet and UART)
- Function block libraries for hardware components (RTC, Counter, PWM)
- Linux-based (other user programs are executable in parallel)
- Remote login via SSH
- Dimensions: 162 x 91 x 60mm
- Temperature 0° … 55°C
- Suitable for DIN top hat rail mounting

The default hardware comes with a Yocto Linux operating system. This base system can be used to program in different programming languages and provides the Node-RED programming environment. To identify each individual device, the manufacturer, revision, serial, and order number are be printed on a label on the right side of the device. Some additional hardware and software components are also available:

Order no.: **16066000**:	sysWORXX CTR-800 with Yocto Linux installation, Spring type PCB terminals
Order no.: **19374003**:	sysWORXX CTR-810 with Yocto Linux installation, Molex Micro Clasp connectors

To develop software with our device, one can find sources on our GitHub (https://github.com/systec-electronic) and our website (https://www.systec-electronic.com/).

4 Interface of the Device

4.1 Pin Assignment

Figure 2 shows the positioning of connectors on the device as an overview. Table 2 lists all connectors in detail.

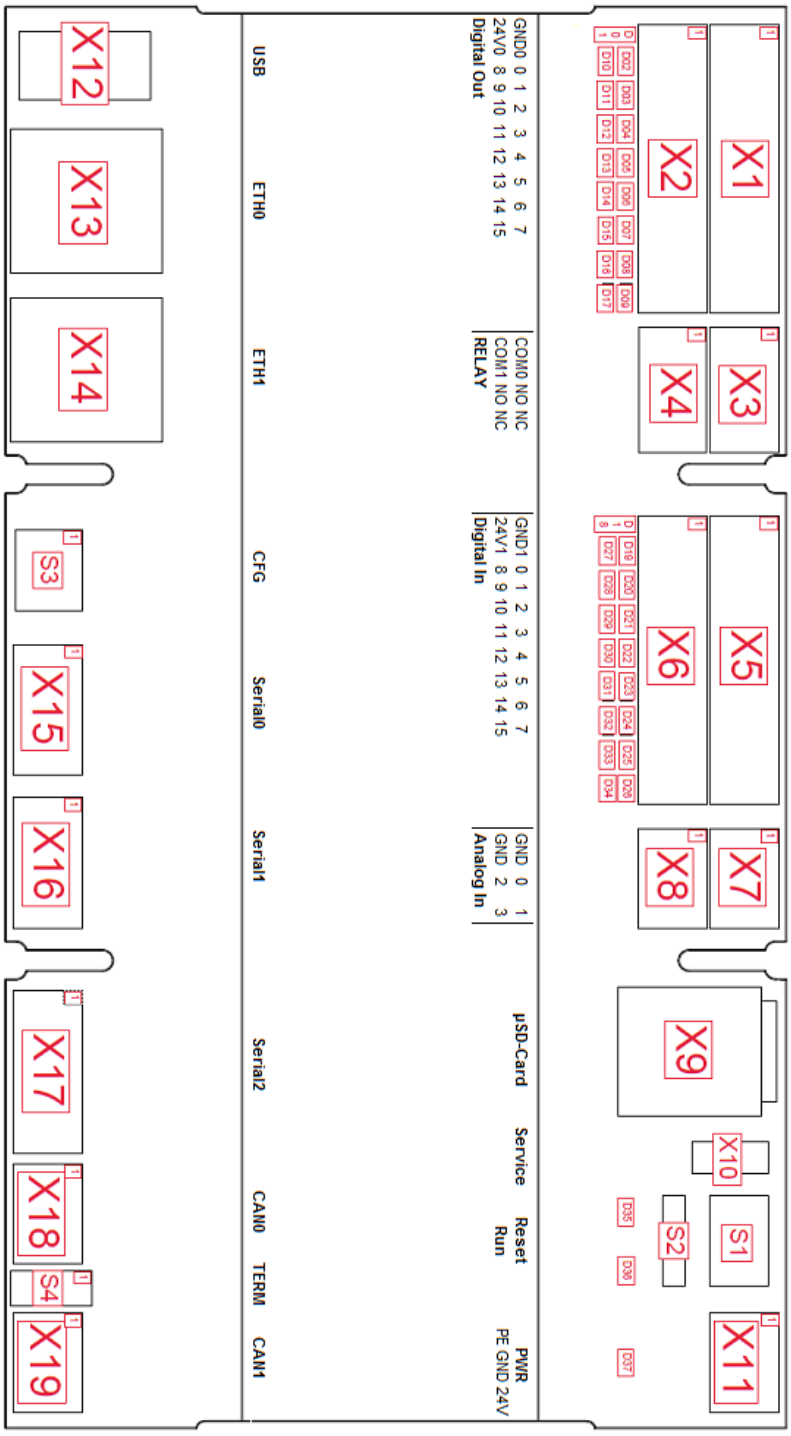

Figure 2: Interface and connector assignment

Table 2: Pin assignment

Terminal	Pin	Signal name	Remark
Digital Outputs X1	1	GND0	24Vdc
	2 … 9	DO0 … DO7	
Digital Outputs X2	1	24V0	
	2 … 9	DO8 … DO15	
Relay 0 X3	1	COM0	230Vac
	2	NO	
	3	NC	
Relay 1 X4	1	COM1	230Vac
	2	NO	
	3	NC	
Digital Inputs X5	1	GND1	24Vdc
	2 … 9	DI0 … DI7	
Digital Inputs X6	1	24V1	
	2 … 9	DI8 … DI15	
Analog Inputs X7	1	GND	0 … 10V/0 … 20mA
	2, 3	AI0, AI1	
Analog Inputs X8	1	GND	
	2, 3	AI2, AI3	
µSD-Card-Holder X9	-	-	-
µUSB (console) X10	-	-	-
Power X11	1	PE	24Vdc
	2	GND	
	3	24VDC	
USB-Host X12	-	-	-
Ethernet 0 X13	-	-	-
Ethernet 1 X14	-	-	-

Terminal	Pin	Signal name	Remark
Serial Interface 0 X15	1	RX	Mode: RS-232
	2	-	
	3	TX	
	4	GND	
	1	A/D0	Mode: RS-485/Modbus RTU
	2	B/D1	
	3	-	
	4	GND	
Serial Interface 1 X16	1	RX	Mode: RS-232
	2	-	
	3	TX	
	4	GND	
	1	A/D0	Mode: RS-485/Modbus RTU
	2	B/D1	
	3	-	
	4	GND	
Serial Interface 2 X17	1	RX	Mode: RS-232
	2	CTS	
	3	TX	
	4	RTS	
	5	GND	
	1	A/D0	Mode: RS-485/Modbus RTU
	2	B/D1	
	3	-	
	4	-	
	5	GND	
CAN 0 X18	1	HIGH	-
	2	LOW	
	3	GND_CAN0	
CAN 1 X19	1	HIGH	-
	2	LOW	
	3	GND_CAN1	

4.2 Galvanic Isolation

Figure 3 shows the galvanic isolation of the different interfaces and system components.

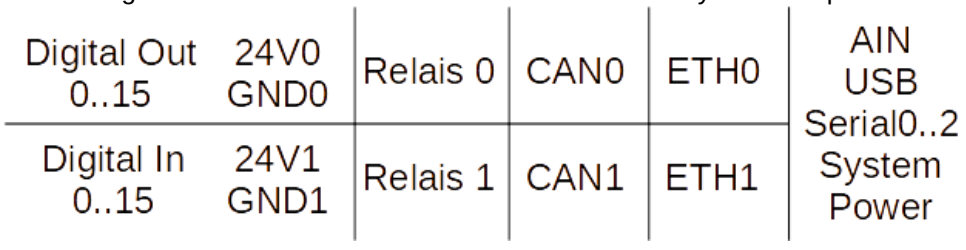

Figure 3: Galvanic isolation

- Analog Inputs, USB and Serial interfaces have same reference potential.
- Digital Out, Digital In and CAN have a **functional isolation** of 50 VDC.
- Interfaces ETH0 and ETH1 have a **basic isolation** of 230 VAC.
- Relays 0 and 1 have **reinforced isolation** of 230 VAC.

4.3 Cable types and maximum cable lengths

The following table shows, which cable types are recommended for the different interfaces:

Table 3: Recommended cable lengths, types and wire cross section

Interface	Cable length	Recommended cable types	Wire cross section
Digital outputs	<30m	Any cable suitable to the specific usage.	0,2 - 1,5mm² or AWG24 – 16
Digital inputs			
Analog inputs			
Analog outputs			
Relay Output			
CAN	<30m	Shielded twisted pair	
SERIAL	RS232: <15m Modbus RTU: <30m	Shielded twisted pair	
Ethernet	<30m	S/FTP Cat 6	-
USB, Service	<3m	USB standard cable	-
POWER	<30m	Any cable suitable to the specific usage.	1mm² - 1,5mm² or AWG17 - 16

4.4 User Interface

Table 4: Description Switches

Switch	Port	OFF	ON
S1	-	-	RESET
S2	-	Position = left (see Figure 2) PLC stop (outputs deactivated)	Position = right (see Figure 2) PLC run (program re-starts)
S3[1]	1	**SERIAL0:** RS-485: Bus termination off RS-232: Must be set!	**SERIAL0:** RS-485: Bus termination on RS-232: Do not set!
	2	**SERIAL1:** RS-485: Bus termination off RS-232: Must be set!	**SERIAL1:** RS-485: Bus termination on RS-232: Do not set!
	3	**SERIAL2**: RS-485: Bus termination off RS-232: Must be set!	**SERIAL2:** RS-485: Bus termination on RS-232: Do not set!
	4	Configuration: **ON**	Configuration: **OFF**
	5	Normal Booting	Boot in U-Boot Bootloader CLI
	6	Boot mode: SD-Card	Boot mode: eMMC
S4	1	CAN0: Bus termination off	CAN0: Bus termination on
	2	CAN1: Bus termination off	CAN1: Bus termination on

Note S3: The configuration described depends on the operating mode (RS-232, RS-485) selected in the software.

Table 5: Description LEDs

LED	Color	Feature
D01	Green	Status of the power supply for the DO's
D02 … D17	Yellow	Signal status of the DO's (on = high; D02 = DO0, D03 = DO1, …)
D18	Green	Status of the power supply for the DI's
D19 … D34	Yellow	Signal status of the DI's (on = high; D19 = DI0, D20 = DI1, …)
D35	Green	Status of the PLC: **RUN** f=1 Hz; **STOP** f=0.5 Hz
D36	Red	ERROR-LED, signals an occurring (PLC or IO-driver) error
D37	Green	Status of the power supply for the device

[1] The switches for the serial interfaces are in reversed order (2, 1, 0) on all devices labeled as prototype.

4.5 Power Supply

The devices feature power supply inputs (24VDC ±20%) for CPU unit and two peripheries. The connector supplies the CPU unit, the digital in- and outputs. This input has reverse polarity protection. If the device experiences a power fail, there is a short time window to act accordingly, for example to safe your data. During this time frame, the device will work normally then shuts down. To access the power fail signal, one must use the driver library in a separate program (see L-2782, Section 6). The exact values for power fail and the delay time are documented in section 7.

4.6 Analog Inputs

To get the real value for the voltage or current measurement, the LSB must be multiplied by the measured counts. The specific values and calculation are as follows:

Example for voltage measurement:

U = 1 LSB *COUNTS
U = 808.2165µV * 6400 = 5.1725V

Example for current measurement:

I = 1 LSB *COUNTS
I = 1.86625µA * 6387 = 11.9197mA

4.7 Serial Interfaces

The following table shows the list of serial interfaces and the corresponding Linux-Devices:

Table 6: Serial interface to Linux device node path

Interface	Linux-Device (*INTERFACE*)
SERIAL0	/dev/ttyS4
SERIAL1	/dev/ttyS5
SERIAL2	/dev/ttyS6
SERVICE [2]	/dev/ttyS2

[2] The **SERVICE** interface is used as the default Linux console for serial access to the device. Do not use this for custom applications unless you really know how to handle this without any conflicts.

5 Library sysWORXX IO

The **libsysworxx-io** library enables access to the different inputs and outputs of the device as well as additional device information. The header file with the public interface is located at "**/usr/include/sysworxx_io.h**".

The concept of the libsysworxx-io library that encapsulates specific hardware and provides a uniform interface for different devices is based on the principles of abstraction and modularity. Essentially, this library is intended to hide the various hardware components behind a common interface, so that developers only need to work with this uniform API, regardless of the specific device (sysWORXX Pi-AM62x, CTR-6xx, CTR-8xx) they use. This significantly simplifies software development, maintenance, and extension.

There are different functions for data exchange depending on the IO type. For details about the parameter types of the functions please refer the header file "**sysworxx_io.h**". To read or write the value of a specific channel, a channel number must be specified. The channel number is mapped by libsysworxx-io and depends on the device tree and device tree overlay used. Digital outputs are written immediately upon request, and changes to digital inputs are reported as events. Analog values are read cyclically, with the cycle time depending on the IO type and the specific device.

Table 7 shows the channel mapping for the IO-Header when the generic Device Tree Overlay is used.

Table 7: Channel Mapping of CTR-800/CTR-810

IO-Type	libsysworxx-io function	Channel	IO-Label	Data exchange
Digital Inputs	IoGetInput IoRegisterInputCallback IoUnregisterInputCallback	0	DI_0	By event
		…		
		15	DI_15	
Digital Outputs	IoSetOutput	0	DO_0	By request
		…	…	
		15	DO_15	
Relay Outputs	IoSetOutput	16	RELAY0_EN	By request
		17	RELAY1_EN	
Analog Inputs	IoAdcGetValue IoAdcSetMode	0	AI_0	Cyclic (t_{AI_sample})
		…	…	
		3	AI_3	
Temperature Sensors	IoTmpGetValue	0	CPU-Temperature	Cyclic (t_{Temp_sample})
		1	System Temperature Sensor	
Counter Inputs	IoCntGetValue IoCntEnable IoCntSetPreload IoCntSetup	0	Counter 0	By request
LEDs	IoSetRunLed	-	PLC Run Led	By request
	IoSetErrorLed	-	PLC Error Led	
Status/Control Signals	IoGetInput IoRegisterInputCallback IoUnregisterInputCallback	32	PowerFail24VDC (/PF)	By event
		33	DiEr (DI_/ERR)	
		34	UsbOc (USB_/OC)	
		35	DoPf/DO_PF)	
		36	DoDiag	
PWM Outputs	IoPwmEnable IoPwmSetup IoPwmSetTimebase	14	PWM0	By request
		15	PWM1	By request

6 Device files /dev and interfaces

Table 8: Overview Device files and interfaces

Interface	/dev/…	Aliases	CPU interface
SERVICE (Linux Console)	ttyS2	serial2	&main_uart0
SERIAL0	ttyS4	serial4	&main_uart4
SERIAL1	ttyS5	serial5	&main_uart5
SERIAL2	ttyS6	serial6	&main_uart6
eMMC interface	mmcblk0	mmc0	&sdhci0
SD-Card interface	mmcblk1	mmc1	&sdhci1
ETH0	-	ethernet0	&cpsw_port1
ETH1	-	ethernet1	&cpsw_port2

7 Technical Specification

Environmental Parameters		Typical	Minimum Maximum
Power Supply	V_{CPU}	24VDC	19.2…30VDC
	V_{IO}	24VDC	19.2…30VDC
	power fail level	18,2V	
	power fail delay time	10ms	
Current Consumption (Inactive IOs)	I_{CPU}	100mA	
	I_{IO}	30mA	
Temperature Range	Storage temperature		-20..+70°C
	Operating temperature		0…55°C
MTTF	According to SN29500 at 40°C		> 373134 h
Protection class	Housing	IP20	
Weight	without any cable and packing	295g	
Dimensions	Width Height Depth		162mm 61mm 91mm
Connector type	Spring type connector		

I/O-configuration (digital)		Typical	Maximum
Digital Outputs DO0 ... 15			
24VDC-Output (High Side Switch)	U_{OH} at I_{OH} = 500 mA	V_{IO}-0.12V < U_{OH} <V_{IO}	
	U_{OL} at I_{OL} = 0 mA		0.5V
	Current limitation I_{OH_max}		700mA
	Max. current		16x0,5A
	Impedance		0.11Ohm
	$I_{OL(off)}$		10µA
	t_{off} at I_{OH} = 500 mA	22 µs	27µs
	t_{on} at I_{OH} = 500 mA	27 µs	45µs
	Frequency	ca. 200 Hz	1KHz[3]
PWM Output (DO14 + DO15)			
24VDC-Output (High Side Switch)	T_{jitter}		25µs
	T_{on_min} and min. pulse width		800ns
	Frequency		1kHz
Digital Outputs RELAY0/RELAY1			
Relay output (N.O.)	Switching Voltage		220VDC 250VAC
	Switching Current		110VDC / 0.3A 30VDC / 2.0A 120VAC / 0.5A 240VAC / 0.25
	Contact rating		60W/62.5VA
	On-board fuse	no[4]	
	Durability (mechanical.)	$100x10^6$	
	Durability (electrical.) @12V/10mA @60V/500mA @30V/1000mA @30V/2000mA	 $5x10^7$ $5x10^5$ $1x10^6$ $2x10^5$	
	t_{on}	4ms	
	t_{off}	4ms	

[3] Frequency limit of hardware interface circuit. The frequency may vary due to software limitations.
[4] Add external fuse according to maximum current

	Isolation	1000Vrms	
Digital Inputs DI0 … 15			
24VDC- Inputs, plus switching	U_{IH}	13V	30V
	U_{IL}	-3V	12.3V
	I_{IH} (V_{IN}=6.7V)	1.3mA	
	I_{IH} (V_{IN}=30V)		3.5mA
	Input type according to IEC61131-2	Type 1	
	T_{DLY}		100ns
Counter Input and Step Direction (DI14 + DI15)			
24VDC- Inputs, plus switching	Min. pulse width		25µs
	Frequency		10kHz
A/B-Encoder (DI14 + DI15)			
24VDC- Inputs, plus switching	Frequency		10kHz
	Phase Margin (A/B-Encoder)		±45°

I/O-configuration (analog)		Typical	Maximum
Analog Inputs AI0 ... 3			
0 ... 10V	Measurement range U_I	0…11.64V	
	Measurement error	0.23%	0.5%[5]
	Destructive voltage U_{I_max}	-	30V
	Input resistance R_I	97kΩ ±0.1%	
	Physical Resolution	-	12Bit
	LSB	808,2165 µV	
	Cut off frequency	70Hz	
0 ... 20mA	Measurement range I_I	0…26.865mA[6]	
	Measurement error	0.23%	0.5%[5]
	Input resistance R_I	67Ω ±0.1%	
	Physical Resolution	-	12Bit
	LSB	1,86625 µA	
	Cut off frequency	160Hz	

Communication Interfaces		Minimum	Maximum
CAN-Bus			
CAN0, CAN1	Baudrate	5kBaud	1Mbaud
	Max. number of nodes		64
	CAN-H, CAN-L short-circuit-proof towards 24V		
RS-232/RS-485			
SERIAL0	Baudrate	1200Baud	115200Baud
SERIAL1	Baudrate	1200Baud	115200Baud
SERIAL2	Baudrate	1200Baud	115200Baud
SERVICE	Baudrate	1200Baud	115200Baud
Ethernet			
ETH0	Bandwith	10Mbit/s	1000Mbit/s
ETH1	Bandwith	10Mbit/s	1000Mbit/s
Backplane Bus			
SERIAL1	Baudrate	1200Baud	115200Baud
SPI	Frequency		5MHz

libsysworxx-io		Minimum	Maximum
IODAEMON			
t_{AI_sample}	Cycle time		100ms
t_{TEMP_sample}	Cycle time		2000ms

[5] Value is defined over temperature range.
[6] Input is protected against overcurrent; max. voltage should not exceed 30V

Standards and approvals		
See the appendix or product folder on the website for the currently valid declaration of conformity		

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SYS TEC electronic AG
Am Windrad 2
D - 08468 Heinsdorfergrund
GERMANY
Fax: +49 (0) 37 65 / 38600-4100
Email: info@systec-electronic.com