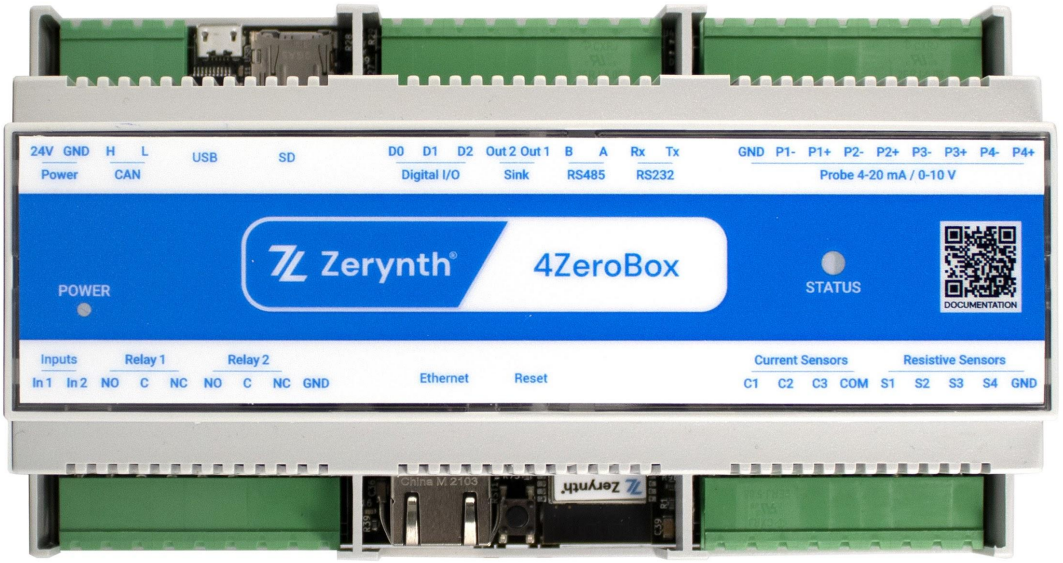
4ZeroBox User Manual

Part Number: IND-4ZB-09-F016



For more details, visit: www.zerynth.com

Contents of the present documentation refers to products and technologies described within. All technical data contained in this document may be modified without prior notice The content of this documentation is subject to periodic revision.

Zerynth®

Table of contents

Overview

4ZeroBox is a modular data aquisition unit that simplifies the development of Industrial IoT applications allowing rapid integration with sensors, actuators, and Cloud services.

4ZeroBox mounts **ZM1 Module** (240MHz, 16Mb Flash, up to 600 MIPS) and provides many onboard features like

- 4 Industrial Analog input channels, 2 Opto-isolated channels and 2 digital outputs.
- 2 On-board Relays, CAN, RS232 and RS485 Interfaces.
- Microchip ATECC608A crypto chip to ensure high-standard security.
- Wi-Fi-and-Bluetooth,Ethernet support.

4ZeroBox lets the user choose the best installation strategy, adapting it to the specific industrial environment. While allowing to acquire data from the PLC via digital ports - filtering the data onboard to avoid bandwidth overload and waste of cloud resources - it also enables the installation and management of external sensors, for a full Industrial IoT experience.

General Characteristics

- ZM1 Module
  - 32-bit dual Core microcontroller based on a customized version of the ESP32 microcontroller.
  - Clock frequency up to 240 Mhz.
  - Embedded 16 MB SPI Flash memory
  - Integrates the ATECC608A crypto element to allow ultra-secure communication.
  - WiFi and Bluetooth® Low-Energy Support
- 4 Analog channels that can measure (dependent on the dip switch configuration):
  - 4-20mA sensors (single ended or differential)
  - 0-10V sensors (single ended or differential)
  - 3 current transformers (non-invasive)
  - 4 resistive sensors (NTC, RTD, contact, proximity, etc.)
- 2 NO/NC Relay (6A @ 250V AC)
- 2 Opto-isolated channels and 2 digital outputs (2A @ 30V).
- RS232 and RS485 Interface.
- Supports CAN Protocol.
- LiPo Battery support
- MicroSD card slot
- RGB status led
- MikroBus Slots
- DIN-rail mountable (9 slots)

Screw Description

Connector J1		
Screw Number	**Symbol**	**Description**
1	24V	External Power Supply 24Vdc pin
2	GND	Ground pin
3	H	High Channel for CAN Bus (Term Resistor can be enabled through SW1)
4	L	Low Channel for CAN Bus (Term Resistor can be enabled through SW1)

Connector J2		
Screw Number	**Symbol**	**Description**
14	GND	Ground pin
15	P1-	Negative terminal of Probe1 for 0-10V or 4-20mA Sensor (according to SW2 position)
16	P1+	Positive terminal of Probe1 for 0-10V or 4-20mA Sensor (according to SW2 position)
17	P2-	Negative terminal of Probe2 for 0-10V or 4-20mA Sensor (according to SW2 position)
18	P2+	Positive terminal of Probe2 for 0-10V or 4-20mA Sensor (according to SW2 position)
19	P3-	Negative terminal of Probe3 for 0-10V or 4-20mA Sensor (according to SW2 position)
20	P3+	Positive terminal of Probe3 for 0-10V or 4-20mA Sensor (according to SW2 position)
21	P4-	Negative terminal of Probe4 for 0-10V or 4-20mA Sensor (according to SW2 position)
22	P4+	Positive terminal of Probe4 for 0-10V or 4-20mA Sensor (according to SW2 position)

Connector J3		
Screw Number	**Symbol**	**Description**
23	GND	Ground pin
24	NC2	Normal Closed Terminal of Relay 2
25	COM2	Common Terminal of Relay 2
26	NO2	Normal Open Terminal of Relay 2
27	NC1	Normal Closed Terminal of Relay 1
28	COM1	Common Terminal of Relay 1
29	NO1	Normal Open Terminal of Relay 1
30	Opto-In2	Opto-Isolator Input 2 - input terminal with isolated positive terminal - from 5Vdc to 24Vdc (according to SW2 position)
31	Opto-In1	Opto-Isolator Input 1 - input terminal with isolated positive terminal - from 5Vdc to 24Vdc (according to SW2 position)

Connector J4		
Screw Number	**Symbol**	**Description**
5	D0	Digital Input directly connected to the microcontroller with integrated ADC functionalities (Max 3.3V input)
6	D1	Digital Input directly connected to the microcontroller with integrated ADC functionalities (Max 3.3V input)
7	D2	Digital Input/Output directly connected to the microcontroller (Max 3.3V input)
8	Out2 Sink2	Sink2 Output to enable external circuits (2A @ 30V)
9	Out1 Sink1	Sink1 Output to enable external circuits (2A @ 30V)
10	B/RS485	B Channel of RS485 Bus (Pull-Down and/or Term Resistor can be enabled through SW1)
11	A/RS485	A Channel of RS485 Bus (Pull-Up and/or Term Resistor can be enabled through SW1)
12	RX/RS232	RX Channel of RS232 Bus
13	TX/RS232	TX Channel of RS232 Bus

Connector J5		
Screw Number	**Symbol**	**Description**
32	GND	Ground pin
33	S4	Input for Resistive Sensor 4
34	S3	Input for Resistive Sensor 3
35	S2	Input for Resistive Sensor 2
36	S1	Input for Resistive Sensor 1
37	COM	COM pin for Current Transformers (to close current loop)
38	C3	Input pin for Current Transformer 3 (Max ±50 mA)
39	C2	Input pin for Current Transformer 2 (Max ±50 mA)
40	C1	Input pin for Current Transformer 2 (Max ±50 mA)

IMPORTANT : Current Transformers (CTs) are sensors that measure alternating current (AC). They are particularly useful for measuring whole building electricity consumption or generation.

Technical Specifications

Power Supply	
Voltage	8 to 36 Vdc
Power Consumption	Typical: 1 W; Maximum: 5 W.

Inputs / Outputs	
ADC Inputs Resolution	11 bit + sign.
4-20mA Channels - x4 (according to switches position)	Min supported input current 4 mA Max supported input current 20 mA
0-10V Channels - x4 (according to switches position)	Min supported input voltage 0 V Max supported input voltage 10 V
Resistive Channels (x4)	Min supported Resistor value 0 Ohm Max supported Resistor value 70 KOhm
Current Channels (x3)	Min supported input current -50 mA Max supported input current 50 mA

Opto-Isolator Inputs	Input Voltage 5 to 24V
Relays	6 A - 250 VAC (general use) at 40°C 8 A - 30 VDC (resistive load) at 40°C
Sinks	20A - 30V (general use) at 40°C
Digital I/O	Max supported voltage 3.3 V

IMPORTANT : Values in table are referred to related standards; 4-20mA channels are compatible also with 0-20mA industrial standard (software settings).

Environmental Conditions	
Recommended operating temperature	-20 to +60 °C
Humidity	Max 80% (not condensing)
Storage Temperature	-40 to +85 °C
Degree Protection	< IP40

IMPORTANT : operating the device at high temperature for a short period of time is allowed however we strongly recommend operating the device at the ***recommended operating temperature.***

Connectors	
Ethernet	RJ45 Connector
Programming	Micro USB Connector
Micro SD	Micro SD Slot
Power Supply, Sensors, RS485, RS232, CAN, Relays, Opto-Isolators, Sinks	Pluggable Screw Connectors 5.08 pitch
Li-Po Battery	JST Connector
MikroBus Click Add-on	MikroBus Slots

IMPORTANT : continuous attachment and detachment of the cable on the ethernet connector might damage the device.

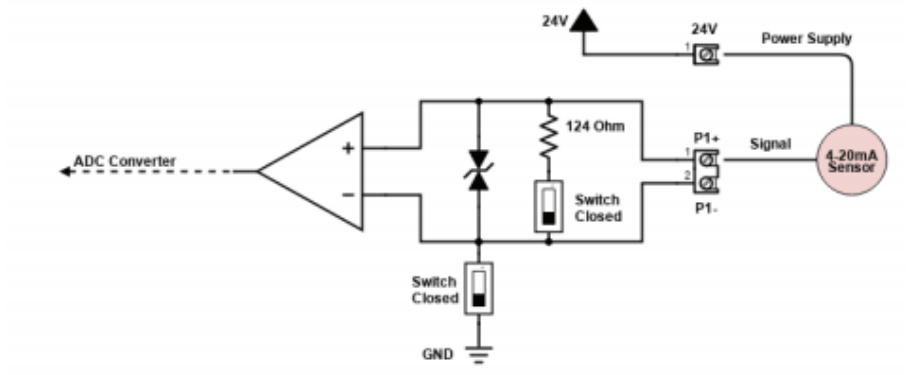
Enclosure	
Dimensions	L: 160 mm; H: 90 mm; W: 58 mm
Material	PC (UL 94 V-0), Light Grey

Standards	RoHS compliant DIN EN 60715 TH35 REACH compliant

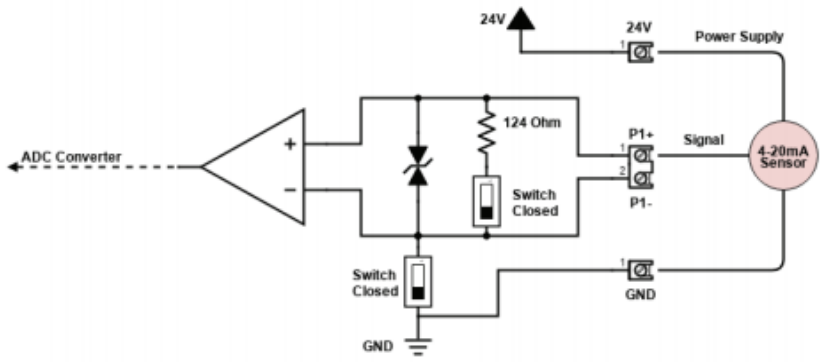
4-20mA Channels

The 4ZeroBox has 4 analog channels for 4-20mA probes. These channels can be used for reading 2, 3 and 4 wires 4-20mA sensors; through switches positions, standard mode or differential mode can be chosen.

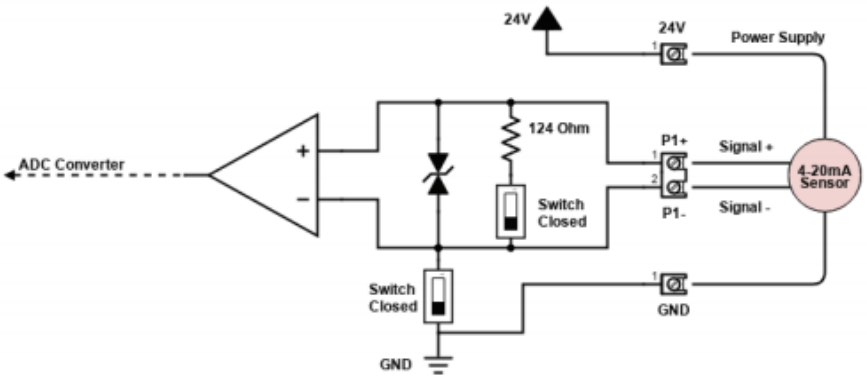
The following diagrams report various wiring configuration



2 wire 4-20mA Sensor Reading Circuit

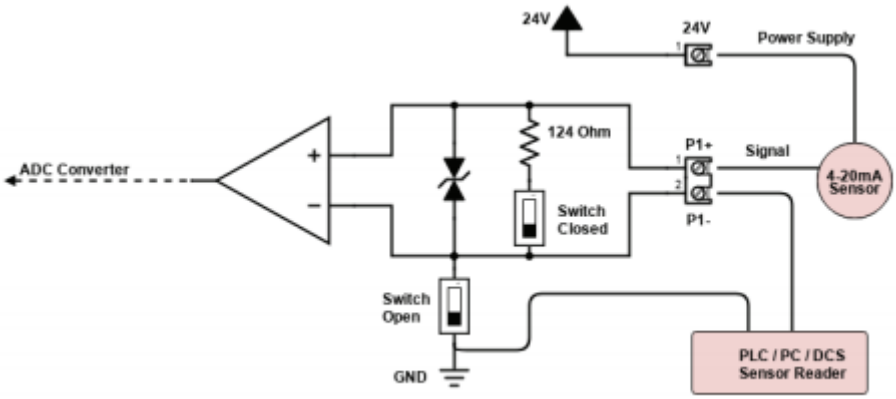


3 wires 4-20mA Sensor Reading Circuit



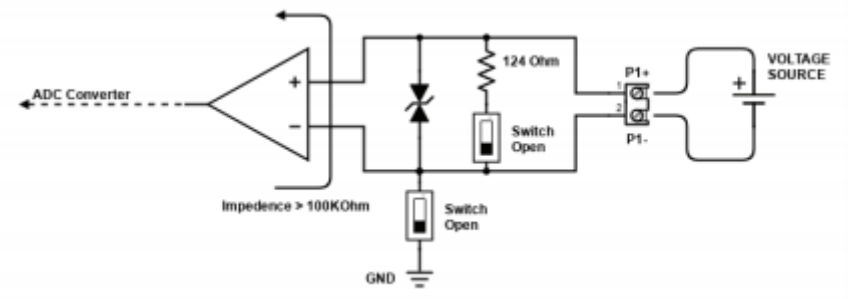
4 wires 4-20mA Sensor Reading Circuit

The 4-20mA channels can be also used for reading current signals with other readers or PLC (Differential mode) . The following diagrams report various wiring configurations for the serial reading of 4-20mA signals.



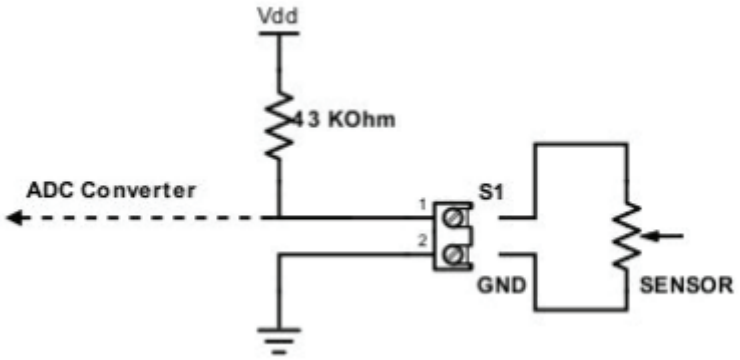
0-10V Channels

Same screws used for 4-20mA sensor reading of The 4ZeroBox can be set by dip-switches to read industrial standard 0-10V sensors. Through switches positions, standard mode or differential mode can be chosen; the following diagram reports 0-10V Sensor reading circuit.



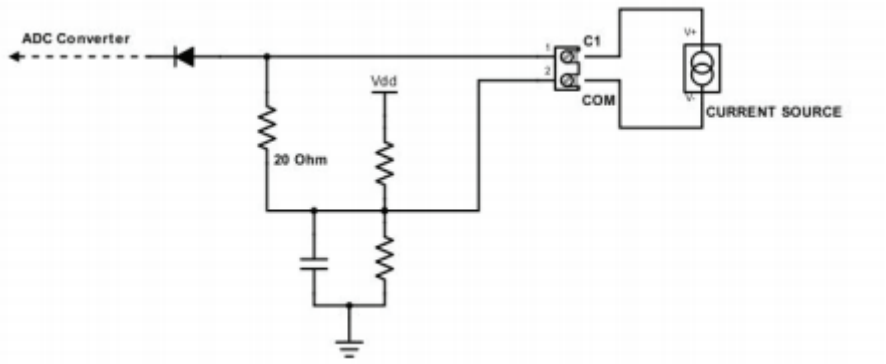
Resistive Channels

S1, S2, S3, S4 represent 4 inputs for resistive channels; resistive probes are sensors that change their resistive value in function of their related measured physical quantity. Examples of these probes are RTD Sensors (Resistance Temperature Detector), NTC Sensors (Negative Temperature Coefficient), Contact Sensors, Proximity Sensors etc. The following diagram reports Resistive Sensor reading wiring configuration.

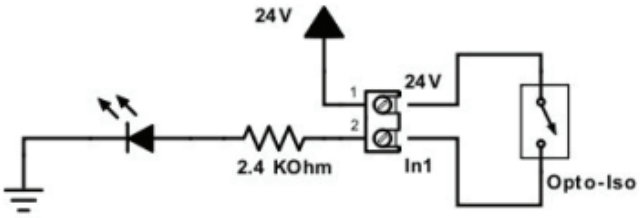


Current Transformers Channels

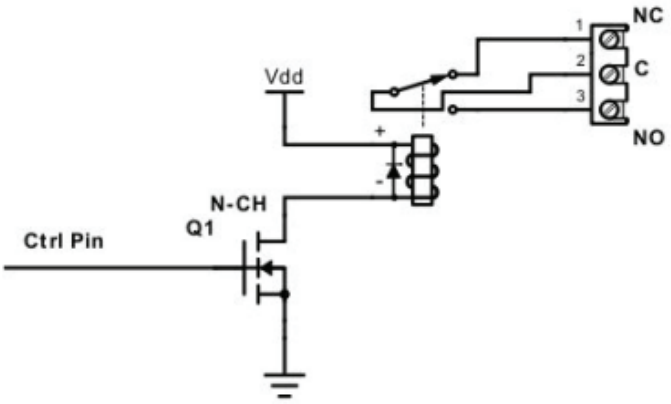
C1, C2, C3, in combination with COM to close the current measurement loop, are the input screws for connecting 3 different current transformers; these sensors measure alternating current (AC) and they are particularly useful for measuring whole building electricity consumption or generation.

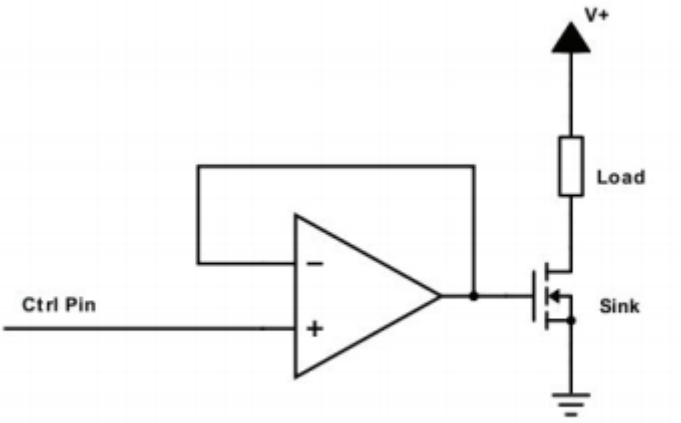


Opto-Isolators, Relay, Sinks



Opto-Isolator Reading Circuit

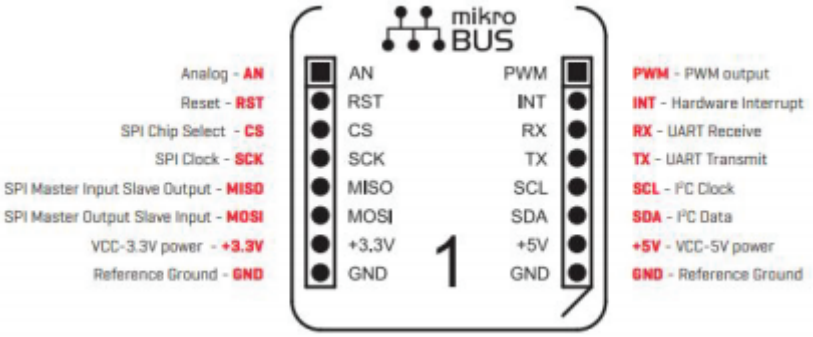




Sink Circuit

MikroBus Slots

The MikroBus slot comprises a pair of 1x8 female headers with a specific proprietary pin configuration. The pinout (always laid out in the same order) consists of three groups of communications pins (SPI, UART and I2C).



To complete the MicroBus standard there are six additional pins (PWM, Interrupt, Analog input, Reset and Chip select), and two power groups (+3.3V and GND on the left, and 5V and GND on the right 1x8 header).
The spacing of pins is compatible with standard (2.54 mm pitch) breadboards.

With these 2 slots, the user can extend the 4ZeroBox with hundreds of MikroElektronika click boards (available on www.mikroe.com/click) to add extra-features to the 4ZeroBox (for example GPS module, LoRa module, GPRS Module, etc.).

IMPORTANT : Each hardware component and major feature can be handled via software through high-level functions in a dedicated library (more info in “4ZeroBox Board Support Package”); each expansion click mountable on the MikroBus slot, instead, needs a specific extra library.
IMPORTANT : During the programming phase, jumper JP1 must be in U5V position and the external power supply must be detached; once programmed and installed on DIN rail, jumper JP1 of the 4ZeroBox must be placed in E5V position.

Dip-Switches

Switch SW1 (the lower one) handles functionalities related to MikroBus Slots, RS485 peripheral, and CAN peripheral; more details in the following table.

Switch SW1

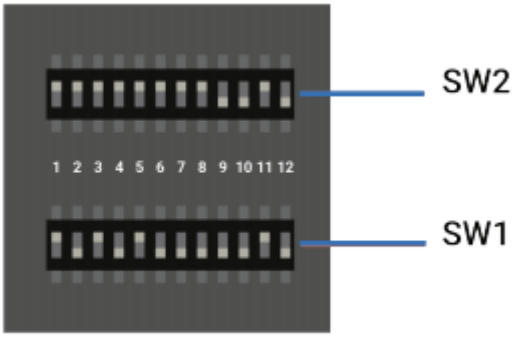
Pin	OFF Position	ON Position
1	CS pin on MikroBus Slot 1 disabled	CS pin on MikroBus Slot 1 enabled
2	CS pin on MikroBus Slot 2 disabled	CS pin on MikroBus Slot 2 enabled
3	RX pin on MikroBus Slot 1 disabled	RX pin on MikroBus Slot 1 enabled
4	RX pin on MikroBus Slot 2 disabled	RX pin on MikroBus Slot 2 enabled
5	TX pin on MikroBus Slot 1 disabled	TX pin on MikroBus Slot 1 enabled
6	TX pin on MikroBus Slot 2 disabled	TX pin on MikroBus Slot 2 enabled
7	Pull-up on RS485 Ch A disabled	Pull-up on RS485 Ch A enabled
8	Pull-down on RS485 Ch B disabled	Pull-down on RS485 Ch B enabled
9	Term resistor on RS485 Bus disabled	Term resistor on RS485 Bus enabled
10	Term resistor on CAN Bus disabled	Term resistor on CAN Bus enabled
11	RST pin on MikroBus Slot 1 disabled	RST pin on MikroBus Slot 1 enabled
12	RST pin on MikroBus Slot 2 disabled	RST pin on MikroBus Slot 2 enabled

Switch SW2 (the upper one) handles functionalities related to 4-20mA and 0-10V Sensors, RS232 and USB peripheral, and Opto-Isolator Inputs; more details in the following table.

Switch SW2

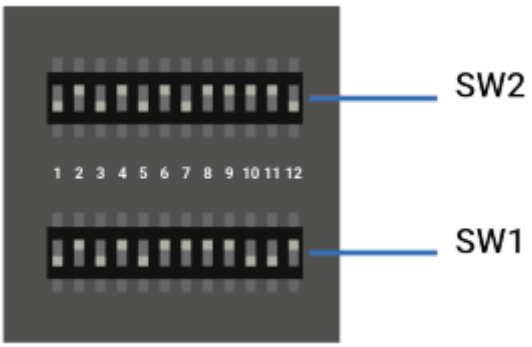
Pin	OFF Position	ON Position
1	0-10V range reading sensor enabled for Probe1	4-20mA range reading sensor enabled for Probe1
2	Probe1 differential measurement enabled	Probe1 measurement referred to onboard GND
3	0-10V range reading sensor enabled for Probe2	4-20mA range reading sensor enabled for Probe2
4	Probe2 differential measurement enabled	Probe2 measurement referred to onboard GND
5	0-10V range reading sensor enabled for Probe3	4-20mA range reading sensor enabled for Probe3
6	Probe3 differential measurement enabled	Probe3 measurement referred to onboard GND
7	0-10V range reading sensor enabled for Probe4	4-20mA range reading sensor enabled for Probe4
8	Probe4 differential measurement enabled	Probe4 measurement referred to onboard GND
9	Opto-Isolator input Ch 1 enabled to 24 V	Opto-Isolator input Ch 1 enabled to 5 V
10	Opto-Isolator input Ch 2 enabled to 24 V	Opto-Isolator input Ch 2 enabled to 5 V
11	USB RX channel disabled	USB RX channel enabled
12	RS232 RX channel disabled	RS232 RX channel enabled

Typical configurations of Switches



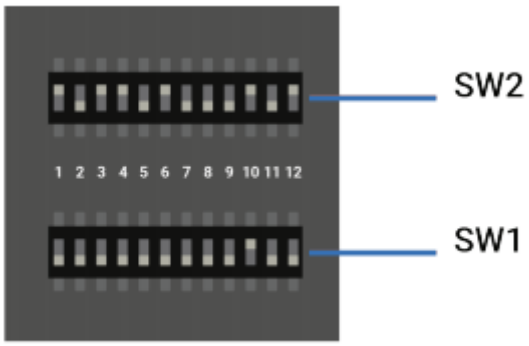
Configuration 1:

- 4ZeroBox in Programming/Debug mode:
  SW2 pin11 enabled and SW2 pin12 disabled;
- Analog Interface set to read 4 channels 4-20mA referred to 4ZeroBox GND:
  SW2 pin1 to pin8 enabled;
- Opto-Isolators 1 and 2 optimized to read input voltage up to 24V:
  SW2 pin9 and pin10 disabled;
- MikroBus Slot 1 full connected:
  SW1 pin1, pin3, pin5, pin11 enabled;
- MikroBus Slot 2 disconnected:
  SW1 pin2, pin4, pin6, pin 12 disabled;
- Pull-Up on channel A, Pull-Down on channel B and Term Resistor of RS485 disabled:
  SW1 pin7, pin8, pin9 disabled;
- Term Resistor of CAN Bus disabled:
  SW1 pin10 disabled.



Configuration 2:

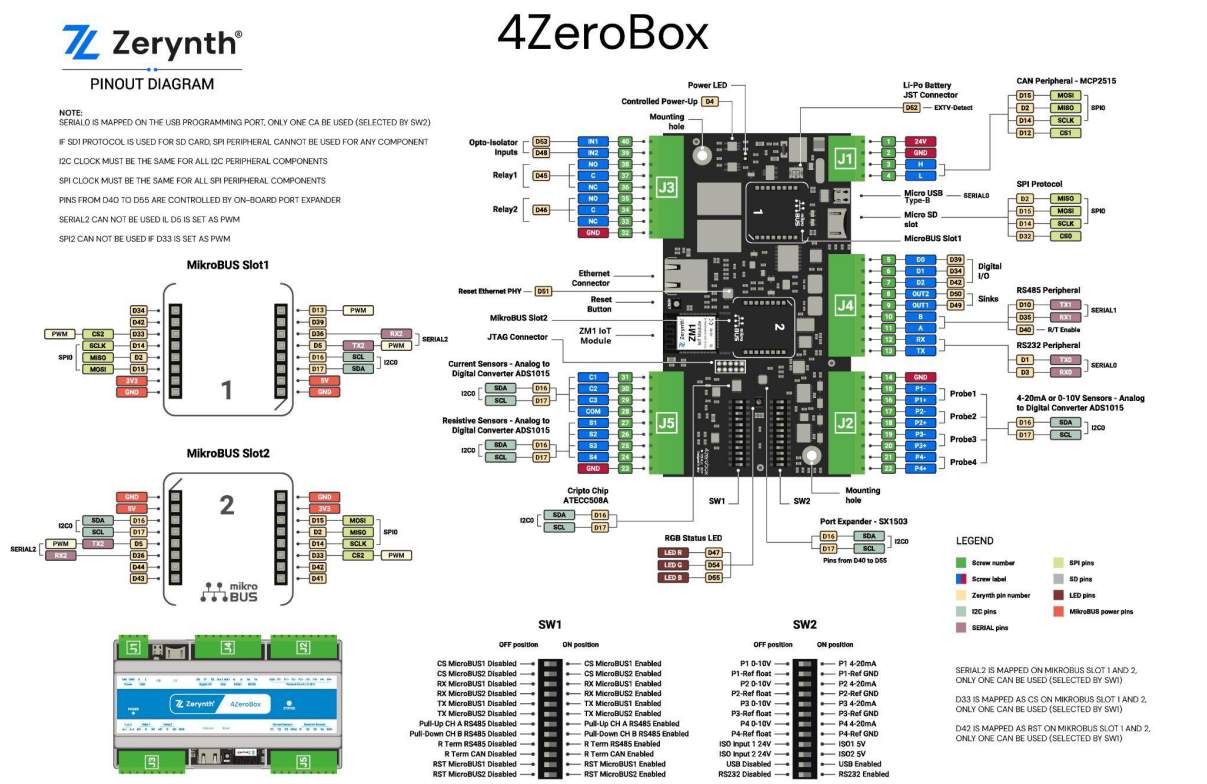
- 4ZeroBox in Programming/Debug mode:
  SW2 pin11 enabled and SW2 pin12 disabled;
- Analog Interface set to read 4 channels 0-10V referred to 4ZeroBox GND:
  SW2 pin1, pin3, pin5, pin7 disabled;
  SW2 pin2, pin4, pin6, pin8 enabled;
- Opto-Isolators 1 and 2 optimized to read input voltage up to 5V:
  SW2 pin9 and pin10 enabled;
- MikroBus Slot 1 disconnected:
  SW1 pin1, pin3, pin5, pin11 disabled;
- MikroBus Slot 2 fully connected:
  SW1 pin2, pin4, pin6, pin12 enabled;
- Pull-Up on channel A, Pull-Down on channel B and Term Resistor of RS485 enabled:
  SW1 pin7, pin8, pin9 enabled;
- Term Resistor of CAN Bus disabled:
  SW1 pin10 disabled.



Configuration 3:

- 4ZeroBox with RS232 enabled:
  SW2 pin11 disabled and SW2 pin12 enabled;
- Analog Interface set to read:
  SW2 pin1 enabled, pin2 disabled (channel 4-20mA differential);
  SW2 pin3, pin4 enabled (channel 4-20mA referred to 4ZeroBox GND);
  SW2 pin5 disabled, pin6 enabled (channel 0-10V referred to 4ZeroBox GND);
  SW2 pin7, pin8 disabled (channel 0-10V differential);
- Opto-Isolators 1 optimized to read input voltage up to 24V:
  SW2 pin9 disabled;
- Opto-Isolators 2 optimized to read input voltage up to 5V:
  SW2 pin10 enabled;
- MikroBus Slot 1 and 2 disconnected:
  SW1 pin1, pin2, pin3, pin4, pin5, pin6, pin11, pin12 disabled;
- Pull-Up on channel A, Pull-Down on channel B and Term Resistor of RS485 disabled:
  SW1 pin7, pin8, pin9 disabled;
- Term Resistor of CAN Bus enabled:
  SW1 pin10 enabled.

Pinmap



According to the Zerynth standards and terminology, below you'll find the map of the 4ZeroBox pins with related connections and functionalities.

Pin Name	Direction	Functions	Connected to
D0	IN	Reserved	Auto-Programming Circuit Ethernet Oscillator (XTAL1)
D1	OUT	SERIAL0 - TX pin	USB Serial Port RS232 Peripheral
D2	IN	SPI0 - MISO pin	SD Card Slot CAN Peripheral (MCP2515) MISO pin on MikroBus Slot 1 MISO pin on MikroBus Slot 2
D3	IN	SERIAL0 - RX pin	USB Serial Port RS232 Peripheral
D4	IN	Digital Pin to Power On/Off all components except ZM1 and Ethernet block	Controlled Power Supply block
D5	OUT	SERIAL2 - TX pin	RS485 Periphera
D10	OUT	SERIAL1 - TX pin	TX pin on MikroBus Slot 1 TX pin on MikroBus Slot 2

D12	OUT	SPI0 - CS1 pin (Chip Select)	CAN Peripheral (MCP2515)
D13	IN/OUT	Digital I/O or PWM	PWM pin on MikroBus Slot 1
D14	OUT	SPI0 - SCLK pin	SD Card Slot CAN Peripheral (MCP2515) SCK pin on MikroBus Slot 1 SCK pin on MikroBus Slot 2
D15	OUT	SPI0 - MOSI pin	SD Card Slot CAN Peripheral (MCP2515) MOSI pin on MikroBus Slot 1 MOSI pin on MikroBus Slot 2
D16		I2C0 - SDA pin	Crypto Chip (ATECC608A) Port Expander (SX1503) A/D Converters (ADS1015) SDA pin on MikroBus Slot 1 SDA pin on MikroBus Slot 2
D17	OUT	I2C0 - SCL pin	Crypto Chip (ATECC608A) Port Expander (SX1503) A/D Converters (ADS1015) SCL pin on MikroBus Slot 1 SCL pin on MikroBus Slot 2
D18	IN/OUT	Reserved	MDIO pin on Ethernet
D19	OUT	Reserved	EMAC_TXD0 pin on Ethernet
D21	OUT	Reserved	EMAC_TX_EN pin on Ethernet
D22	OUT	Reserved	EMAC_TXD1 pin on Ethernet
D23	OUT	Reserved	MDC pin on Ethernet
D25	IN	Reserved	EMAC_RXD0 pin on Ethernet
D26	IN	Reserved	EMAC_RXD1 pin on Ethernet
D27	IN	Reserved	EMAC__RX_CRS_DV pin on Ethernet
D32	OUT	SPI0 - CS0 pin (Chip Select)	SD Card Slot

D33	OUT	SPI0 - CS2 pin (Chip Select)	CS pin on MikroBus Slot 1 CS pin on MikroBus Slot 2
D34	IN	Digital Input or ADC input	AN pin on MikroBus Slot 1 Pin 1 on Digital I/O Screw
D35	IN	SERIAL1 - RX pin	RX pin on MikroBus Slot 1 RX pin on MikroBus Slot 2
D36	IN	SERIAL2 - RX pin	RS485 Peripheral
D39	IN	Digital Input	INT pin on MikroBus Slot 1 Pin 0 on Digital I/O Screw
D40	OUT	Receive/Transmit enable pin	RS485 Peripheral
D41	IN/OUT	Digital I/O	AN pin on MikroBus Slot 2
D42	IN/OUT	Digital I/O	RST pin on MikroBus Slot 1 or Slot 2 Pin 2 on Digital I/O Screw
D43	IN/OUT	Digital I/O	PWM pin on MikroBus Slot 2
D44	IN/OUT	Digital I/O	INT pin on MikroBus Slot 2
D45	OUT	Digital Output	Relay 1
D46	OUT	Digital Output	Relay 2
D47	OUT	Digital Output	Led Red
D48	IN	Digital Input	Opto-Isolator Input 2
D49	OUT	Digital Output	Sink 1
D50	OUT	Digital Output	Sink 2
D51	OUT	Digital Output	Ethernet Reset pin
D52	IN	Digital Input	External Voltage Detect pin

D53	IN	Digital Input	Opto-Isolator Input 1
D54	OUT	Digital Output	Led Green
D55	OUT	Digital Output	Led Blue

IMPORTANT : SERIAL0 is mapped on the USB programming/debugging port and on the RS232 peripheral can be used only one (selected by SW2 - see Dip-Switches and Jumper Settings)
IMPORTANT : SERIAL1 is mapped on the MikroBus Slot 1 and MikroBus Slot 2; can be used only one at a time (selected by SW1 - see Dip-Switches and Jumper Settings).
IMPORTANT : CS and RST pins of MikroBus Slot 1 and 2 are connected on microcontroller side respectively
to D33 and D42 so they cannot be enabled to both MikroBus Slots.
IMPORTANT : I2C0 clock frequency must be the same respectively for all I2C Components.
IMPORTANT : SPI0 clock frequency must be the same respectively for all SPI Components.
IMPORTANT : I2C address already used by internal components of the 4ZeroBox are:
- 0x35 (hex) Crypto Chip
- 0x20 (hex) Port Expander;
- 0x48 (hex) A/D Converter for Resistive sensors;
- 0x49 (hex) A/D Converter for 4-20mA and/or 0-10V Sensors;
- 0x4B (hex) A/D Converter for current sensors.

Getting Started

- Download the Zerynth SDK from our website: https://www.zerynth.com/zsdk/
- Install the Zerynth SDK and open the VSCode application
- Register a Zerynth account and log-in
- Connect the Development Board to the PC using the USB Type-C Cable
- Clone the “Hello Zerynth” example
- Uplink the project
- For more details about the installation and demos, please visit: https://docs.zerynth.com.

Declaration of Conformity

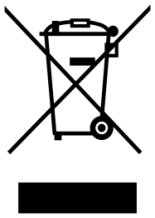
IMPORTANT: KEEP THESE INFORMATION FOR FUTURE REFERENCE FOR FULL SET UP AND INSTALLATION INSTRUCTIONS PLEASE VISIT docs.zerynth.com

Warnings

- All external power supplies used with Zerynth boards must comply with the relevant regulations and standards applicable in the country of use and must provide a voltage between 9 and 36 VDC.
- Hereby, ZERYNTH srl declares that the radio equipment type Zerynth Development boards are in compliance with Directive 2014/53/EU (RED). The full text of the EU declaration of conformity is available at the following internet address: https://www.zerynth.com/download/20246/
- The manufacturer cannot guarantee compliance with the RED directive if the end user uses custom circuits other than those supplied by Zerynth (used in conformity tests).
- All expansion boards that require CE marking have been tested and meet the essential requirements set by the Directives: 2014/30/EU (EMC), 2014/35/EU (LVD), 2011/65/EU (RoHS). The declaration of conformity (DoC) can be downloaded from the website https://www.zerynth.com/download/20246/
- All Zerynth boards have undergone compliance testing for conducted and radiated emissions meeting the requirements of the following standards: FCC Part 15 B and IC ICES-003.
- Any device or component connected to one of the expansion connectors must comply with the electrical characteristics defined in the specifications described in the complete manual to ensure that the performance and safety requirements are met.
- Each cable used to connect other devices or components to the Zerynth boards must be less than 300 cm long and must offer adequate insulation and operation so that the appropriate performance and safety requirements are met.

Instructions for safe use

- Do not expose this product to water or moisture and do not place it on a conductive surface while it is operating.
- Do not expose this product to excessive heat sources which could cause it to operate outside the permitted temperature range defined in the specifications (-40, +85 ° C).
- Be careful when handling the product to avoid mechanical or electrical damage to the printed circuit board and connectors.
- If a board looks damaged, do not use it.
- Do not touch the printed circuit board when it is powered and never operate on live electrical parts.
- The printed circuit board must not come into contact with conductive objects when it is powered.
- Discharge static electricity from your body and touch only the edges of the board to minimize the risk of damage from electrostatic discharge.



EN - Waste Electrical and Electronic Equipment (WEEE) Symbol

The use of the WEEE symbol indicates that this product/board may not be treated as household waste. By ensuring this product/board is disposed of correctly, you will help protect the environment. For more detailed information about recycling of this product/board, please contact your local authority, your household waste disposal service provider or the shop where you purchased it.