m.Smart Universal IO Module

Design Specification

Created By: Steve Montgomery

Date: 02/02/2026

Revision: 1.1

1 Introduction:

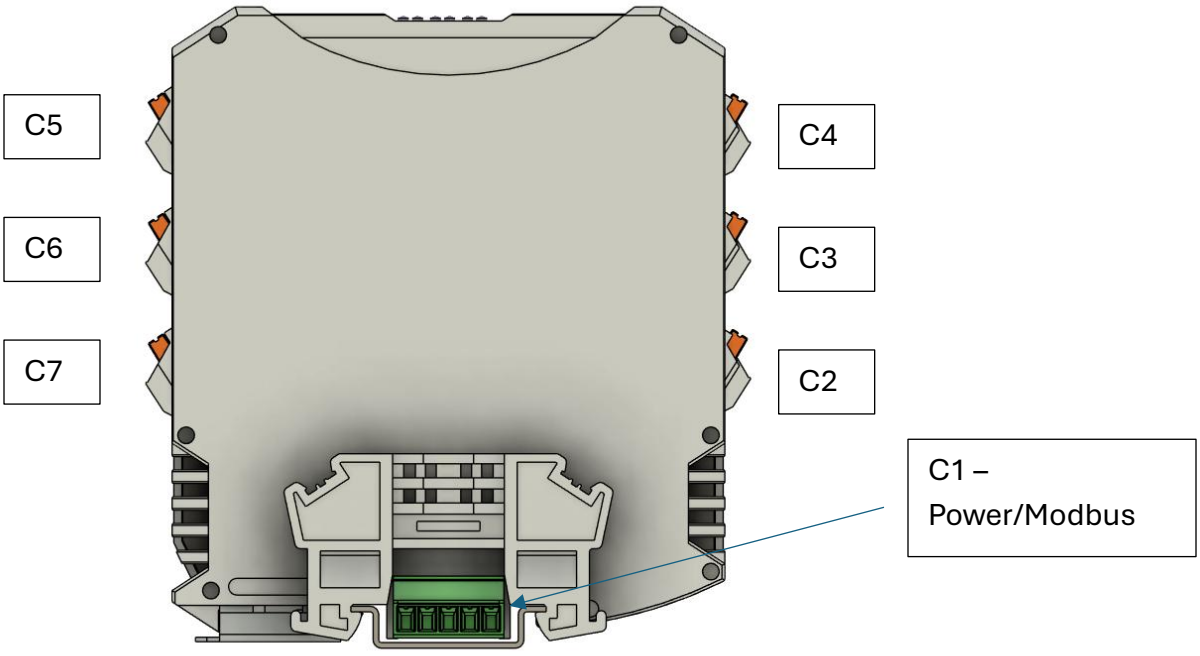
The purpose of this project is create a universal I/O module for water projects that can be used in a variety of applications:

1. Solar powered tower monitoring
    a. Tower level monitored via pressure sensor (4-20mA)
    b. Solar and battery voltage level monitoring (0-30V)
2. Solar powered flow meter monitoring
    a. Flow meter monitoring via pulse output
        i. Pulses are 0V to V+
    b. Solar and battery voltage level monitoring (AI 0-30V)
3. Line powered tower monitoring
    a. Tower level monitoring via pressure sensor
    b. Power loss and bad battery digital inputs (0-24V)
4. VFD Well/Booster Pump Station
    a. Power loss and bad battery digital inputs (0-24V)
    b. Optional flow meter input
    c. Run output - DO
    d. Run Input – DI
    e. Speed Output – AO 0-10V
    f. VFD Fault Input – DI (can be the same DI as Overload DI for contactor booster pump)
    g. Optional suction pressure (AI 4-20mA)
    h. Optional discharge pressure (AI 4-20mA)
    i. If two VFD are required, two modules will need to be used. Each module can handle 1 pump.

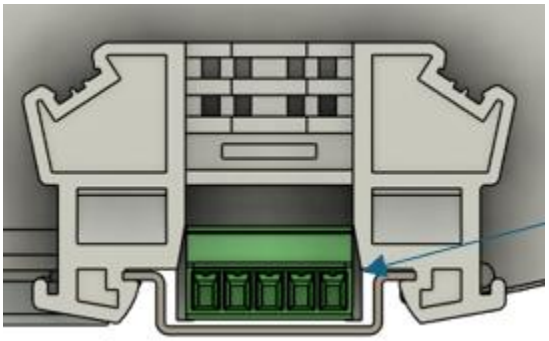
5. Contactor Booster Pump Station
    a. Power loss and bad battery digital inputs (0-24V)
    b. Optional flow meter input
    c. Run output - DO
    d. Run Input – DI
    e. Overload - DI
    f. Optional suction pressure (AI 4-20mA)
    g. Optional discharge pressure (AI 4-20mA)
    h. If two pumps are required, two modules will need to be used. Each module can handle 1 pump.

2 Enclosure

The enclosure we will be using is the ME MAX 22,5 3-3 KMGY from Pheonix Contact. This enclosure provides 6 separate 4 pin pluggable headers and a connector at the base that provides power and modbus.



3 C1 - Modbus Connector



Pin Order

1	2	3	4	5

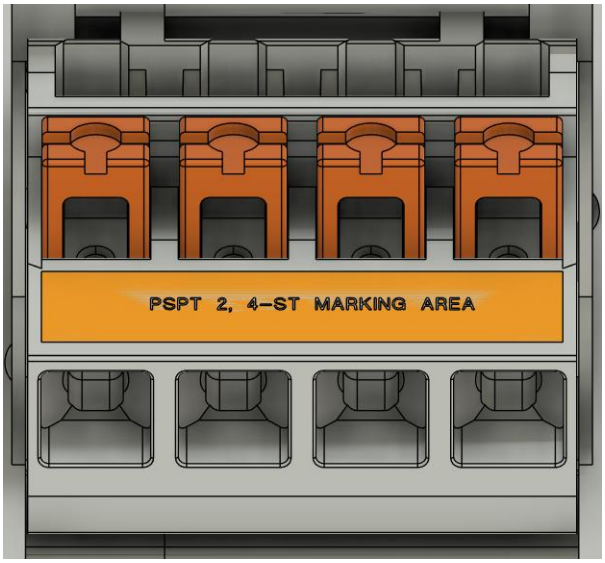
The IO module will have copper pads that are designed to allow insertion into the ME 22,5 TBUS 1,5/4P1S KGMY DIN rail buss connector (C1). This connector has 5 positions:

Pin	Description
1	V+
2	A(+)
3	GND
4	B(-)
5	GND

The IO module will internally measure the supply voltage and make it available as AI5. See the modbus mapping tables for more details. The input voltage range is 8-30V and the A/D channel needs to be designed to measure voltages in that range.

4 C2 thru C7 – IO Connectors

I/O connectors are 5mm pitch, 4 position pluggable headers with spring tension connections (screwless).



Pin Order

1	2	3	4

4.1 C2 – 0 to 30V Analog inputs (AI1-AI2)

This connector will be used to monitor solar/battery voltages.

Pin	Description
1	V+
2	AI1
3	AI2
4	GND

4.2 C3 – 4-20mA Analog Inputs (AI3-AI4)

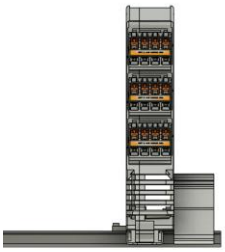
This connector will be used to monitor external sensors such as pressure sensors.

Pin	Description
1	V+
2	AI3
3	AI4
4	GND

4.3 C4 – Digital Input 5 and 6 (DI5-DI6)

This connector will normally be used to monitor power loss and bad battery outputs from our standard battery backup box.

Pin	Description
1	V+
2	DI5
3	DI6
4	GND



4.4 C5 – Digital Input 3 and 4 (DI3-DI4)

This connector will normally be used to monitor pulse inputs from flow meters

Pin	Description
1	V+
2	DI3
3	DI4
4	GND

4.5 C6 – Digital Input 1 and 2 (DI1-DI2)

This connector will normally be used to monitor VFD fault/Overload fault and

Pin	Description
1	V+
2	DI1
3	DI2
4	GND

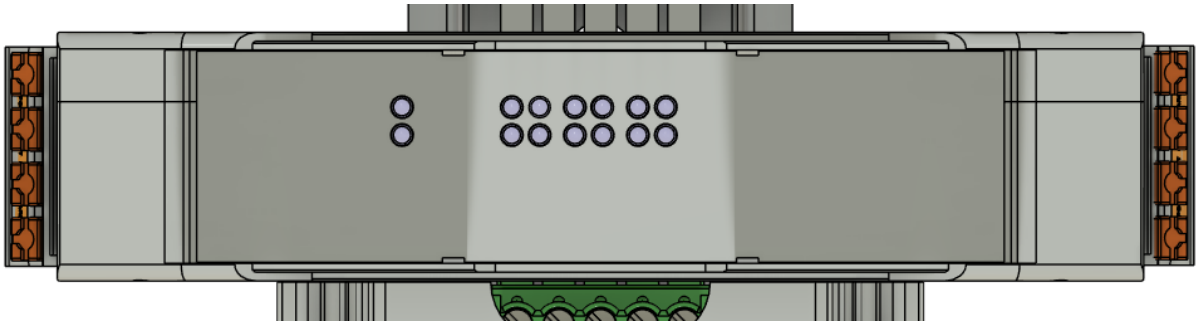
4.6 C7 – Digital/Analog Output (DO1/AO1)

This connector will normally be used to output Run signal (DO1) and if a VFD is used, the speed signal (AO1).

Pin	Description
1	V+
2	DO1
3	AO1
4	GND

5 Status LEDs

Right angle light pipes will bring 18 status LEDs to the top surface of the IO module:



The leftmost two LEDs are TX and RX indicators for Modbus. Each will blink when data is sent/received respectively. The top LED is the TX LED and the bottom LED is the RX LED.

The remaining 12 LEDs are defined as follows:

Top	1	2	3	4	5	6
DI	DI1	DI2	DI3	DI4	DI5	DI6
AI/DO/AO	AI1	AI2	AI3	AI4	DO1	AO1
Bottom	1	2	3	4	5	6

The AO1 LED should be on only when a valid value is set for this output. DO1 should light when the output is set to 1. AI1 through AI4 should light only when the measured value is in the valid 4-20mA range. DI1-DI6 will reflect the state of the inputs.

6 Modbus Register Map

Register	Address	Description
40001	0	DI1 – all digital inputs are 0 or 1
40002	1	DI2
40003	2	DI3
40004	3	DI4
40005	4	DI5
40006	5	DI6
40040	39	DI1 – total counts
40041	40	DI2 – total counts
40042	41	DI3 – total counts
40043	42	DI4 – total counts
40044	43	DI5 – total counts
40045	44	DI6– total counts
40080	79	DI1 – events per minute
40081	80	DI2 – events per minute
40082	81	DI3 – events per minute
40083	82	DI4 – events per minute
40084	83	DI5 – events per minute
40085	44	DI6 – events per minute
40100	99	DO1 – 0 or 1
40200	199	AO1 – valid range is 0 to 10000. Multiplier is 0.001.
40300	299	AI1 –valid values are 0 to 30000. Multiplier is 0.001.
40301	300	AI2 –valid values are 0 to 30000. Multiplier is 0.001.
40302	301	AI3 – valid values are 4000 to 20000. Multiplier is 0.001
40303	302	AI4 – valid values are 4000 to 20000. Multiplier is 0.001
40304	303	AI5 – internal power supply voltage. valid values are 0 to 30000. Multiplier is 0.001.

40400	399	AI1 Filter Window. This is the number of samples used to calculate running average. If no filtering is desired, set to 0.
40401	400	AI2 Filter Window. This is the number of samples used to calculate running average. If no filtering is desired, set to 0.
40402	401	AI3 Filter Window. This is the number of samples used to calculate running average. If no filtering is desired, set to 0.
40403	402	AI4 Filter Window. This is the number of samples used to calculate running average. If no filtering is desired, set to 0.
40404	403	AI5 Filter Window. This is the number of samples used to calculate running average. If no filtering is desired, set to 0.
41000	999	Baud rate – 0=9600, 1=19200, 2=38400, 3=115200. Default is 0.
41001	1000	Slave ID. Default is 1
41002	1001	Sample Rate – rate at which analog and digital inputs are sampled. In 10mSec increments. Default is 10 (0.1 second or 10 hz).
41225	1224	Solar Voltage – use to read AI1 when solar controller uses V+ as common. Connect solar panel V- to AI1 (pin 2) on C2.

7 Application Information

7.1 Pumping Station / Well

Each Universal I/O module can be used to monitor/control a single pump. In a pumping station with 2 pumps, two modules will be used, each with different slave ID settings: pump 1 will be slave ID=1 and pump 2 will be slaveID=2. Please note that the first 4 connections are for pump 1 only. Connectors C3-C4 will not be used on pumps 2 through pump *n*.

Connector	Pin	Function	Modbus Register	Notes
C3	2	Suction Pressure	40302	Pump 1 only
C3	3	Discharge Pressure	40303	Pump 1 only
C4	2	UPS Power Loss	40005	Pump 1 only
C4	3	UPS Bad Battery	40006	Pump 1 only
C5	2	Pump Run Feedback	40003	
C5	3	Pump Fault/OC	40004	
C6	2	Flow Meter	40080	For rate (gpm)
			40040	For total (gal)
C7	2	Pump Run Out	40100	
C7	3	Pump Speed	40200	For VFD only (0-10V)

7.2 Tower

Connector	Pin	Function	Modbus Register	Notes
C2	2	Solar V-	41225	
C2	3	Battery V+	40301	
C3	2	Tower Level	40302	

7.3 Master Meter (Stand Alone)

Connector	Pin	Function	Modbus Register	Notes
C2	2	Solar V-	41225	
C2	3	Battery V+	40301	
C6	2	Flow Meter	40080	Rate (gpm)
			40040	Total (gal)

7.4 Lift Station

The exact configuration of a Lift Station will depend on whether we are controlling and monitoring or just monitoring. Pay attention to the notes in the following table.

Two modules will be required for a duplex pumping station.

Module #1 (Slave ID=1)

Connector	Pin	Function	Modbus Register	Notes
C3	2	Pump Current	40302	Pump run/seize sensor
C4	2	UPS Power Loss	40005	
C4	3	UPS Bad Battery	40006	
C5	2	Pump 1 Run Feedback	40003	
C5	3	Pump 1 Fault/OC	40004	
C6	2	Float 1	40001	
C6	3	Float 2	40002	
C7	2	Pump 1 Run Out	40100	Control only

Module #2 (Slave ID=2)

Connector	Pin	Function	Modbus Register	Notes
C3	2	Pump Current	40302	Pump run/seize sensor
C4	2	UPS Power Loss	40005	
C4	3	UPS Bad Battery	40006	
C5	2	Pump 2 Run Feedback	40003	
C5	3	Pump 2 Fault/OC	40004	
C6	2	Float 3	40001	
C6	3	Float 4	40002	
C7	2	Pump 2 Run Out	40100	Control only