PIO36 User Manual

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Revision	**Comments**
0	Original Issue
1	Updated register table

1 General

1.1 Scope of document

This document provides detailed information required for system integration of the Innova PIO36 board. The purpose of the document is to provide a clear understanding of the features of the device as well as the operation limits and interface requirements.

1.2 References and abbreviations

1.2.1 References

Ref.	Document ID	Rev.	Date	Document Name
1	NA	V1.1b3	26.04.2012	MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3
2	NA	V1.0b	24.10.2006	MODBUS Messaging on TCP/IP Implementation Guide V1.0b
3	NA	NA	29.08.2008	IEEE 754-2008 – IEEE Standard for Floating-Point Arithmetic

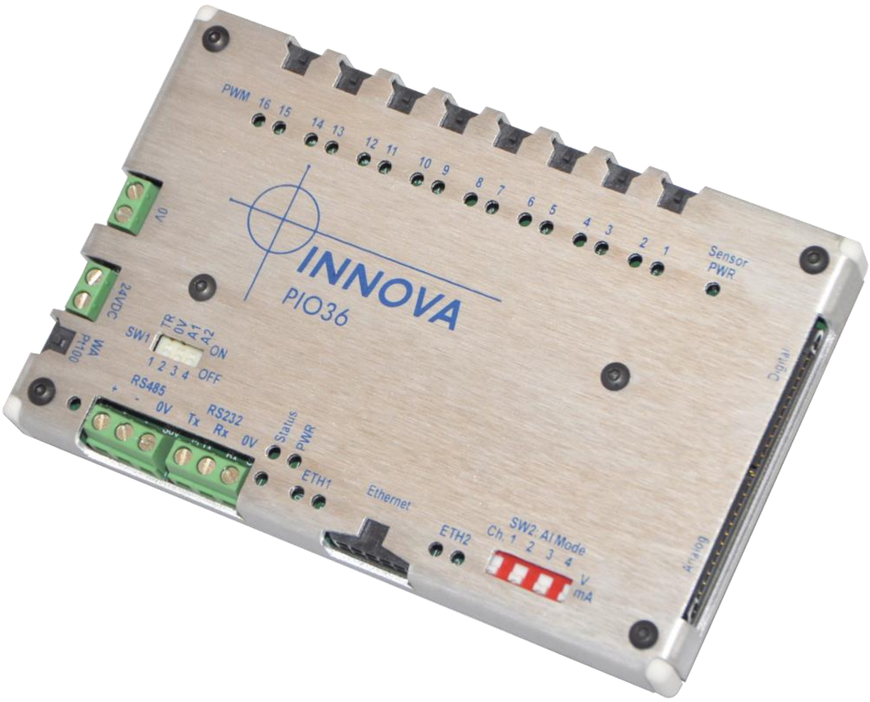
1.2.2 Abbreviations

EMC	Electro Magnetic Compatibility
ESD	Electrostatic Discharge
I/O	Input / Output
PCB	Printed Circuit Board
PWM	Pulse Width Modulation
RIP	Remote Intervention Protocol
SW	Software
WA	Water ingress Alarm

1.3 ESD precautions

The unit contains components that are sensitive to the high voltages that can be generated by the human body due to static charges. To prevent ESD damage, the unit must be stored and handled in accordance with IEC 61340-5-1: Protection of electronic devices from electrostatic phenomena – General requirements.

2 Description



The PIO36 board is designed to control 16 individual proportional 24VDC loads. The design allows the unit to be installed in a pressurised environment e.g., compensated submerged oil-filled enclosure. Typical applications are solenoid or proportional hydraulic valve operation for marine/subsea environments. Proportional control is possible by pulse width modulated (PWM) control of the load. The unit has the following I/O:

- 16x PWM outputs for driving solenoids.
- 16x analogue inputs 4-20mA signal, for instance pressure or temperature transmitters.
- 4x isolated digital inputs are available and can be used to monitor end switches or other on/off conditions, or to count pulses or gray2 encoder signals.
- 16x power outputs for loop powered 4-20mA transmitters.
- 4x power outputs for analogue / digital sensors.
- 1x input for Pt100 temperature sensor input.
- 1x connection for water alarm probe.

Remote control is possible via Modbus TCP over Ethernet or Modbus RTU over either RS232 or multi drop RS485 communication.

The unit is enclosed in an aluminium cover with marking for the terminal connections.

3 Features

Power supply: 10 - 30VDC, 10A max.

16 x 24V PWM or on/off function 2A each (maximum 10A simultaneous load for all channels), 16-bit resolution 0-100%

LED indicators on all PWM outputs

16 x Analogue inputs 4-20mA 16-bit resolution, 4 of these channels can be configured for 0 - 10V.

16 x current limited (max 25mA) power outputs for 4-20mA transmitters.

4 x isolated digital inputs 12 - 24V, with pulse counting.

4 x power outputs for digital / analogue sensors.

Water ingress alarm

Temperature reading from external PT100 sensor.

Ethernet, RS232 or RS485 communication

Fail safe in case of communication error (user defined state)

Designed to work submerged in oil at a pressure of up to 300bar.

4 Functional description

4.1 Concept

The PIO36 controller is a slave controller designed to execute commands as requested by a master system. All physical I/O is available from the master via Modbus TCP or RTU. The board is designed as a single compact unit.

4.2 Communication interfaces

The PIO36 can communicate with a master by Ethernet, RS232 or RS485 interface.

4.2.1 Ethernet interface

The Ethernet interface is usable up to 100m distance. The PIO36 supports 10 and 100Mbps, it has 2 ports with internal switch that allows easy daisy chaining of several units.

4.2.2 RS232 interface

The RS232 interface can only be used in the event where the master or node is within the range of the RS232 limits (15m). The physical connection of RS232 does not allow multiple controllers on the same port. A local master may however use multiple RS232 ports to control several PIO36 slave units.

4.2.3 RS485 interface

The RS485 interface allows extended distance between the master and slave (up to 1000m) as well as multi drop capability (several units on the same line). Up to 32 units can be connected to a RS485 line. However, having multiple units on the same line will slow down the responses of the units connected.

4.2.4 Software and communication

Communication between the master and the slave (PIO36) are either Modbus TCP over Ethernet or Modbus RTU over either RS232 or multi drop RS485 communication.

4.3 PWM output channels

The PWM output channels are based on high side drivers feeding the load with 24V power on fixed frequency square wave. The load is connected between the PIO36 output and 0V. The duty cycle can be individually varied from the master controller. The frequency can be set from 1 to 500 Hz. The PWM frequency is set in groups of 4 channels, so it is possible to utilize different PWM frequency for different types of hydraulic valves. This feature allows corrections in the event of valve oscillation etc.

The duty cycle has a resolution of 16bits and is set as a value between 0-100%.

The output channels are configured with freewheeling diode protection to reduce the voltage over an inductive load when switching. However, any inductive loads connected should have local freewheeling diode mounted near the coil. This will reduce the noise level as well as heat generated on the board. Innova SVB boards (PN 1041586) contain freewheeling diode and LED indicating valve status and are designed for this purpose.

PWM outputs are short circuit protected and thermal protected.

4.4 Isolated digital inputs

Four optically isolated digital inputs are available. These inputs accept a 12 - 24VDC input level.

4.4.1 Counters

The digital inputs count number of rising edges on digital input 1-4. Additionality digital input 1 and 2 counts as a gray2 encoder under encoder 1, and digital input 3 and 4 counts as a gray2 encoder under encoder 2.

4.4.2 Counter frequency

Each counter also calculates the frequency of the input signal by checking the number of pulses over the last second.

4.5 Analogue input channels

The PIO36 has 16 analogue inputs with 16-bit resolution. These inputs read 0-20mA and are designed to accept 4-20mA signals typically from pressure/temperature transmitters. 4 of these input channels can be configured to 0-10V voltage inputs instead of 0-20mA by SW2 switches.

5 Connections

The figure below shows the layout of the PIO36 terminals.

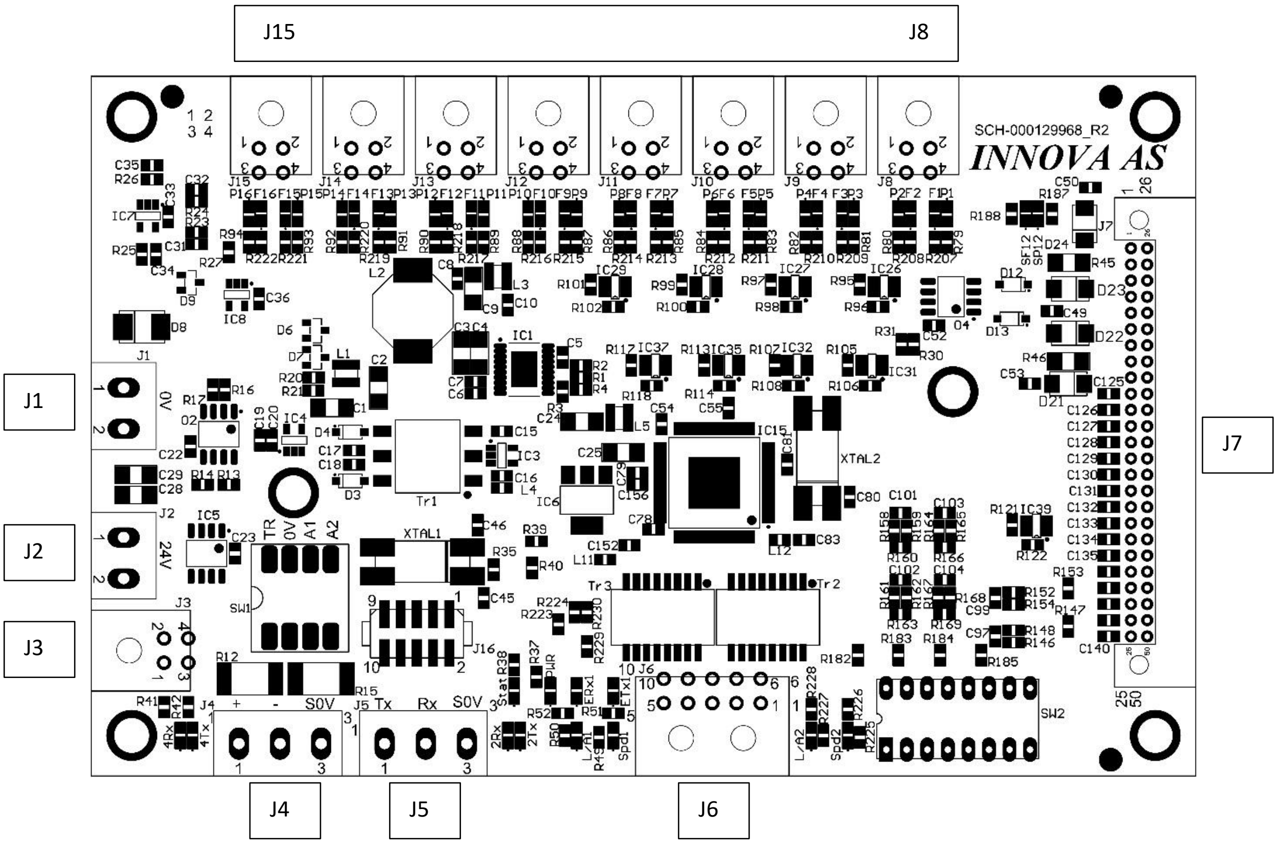


Figure 1

The following terminals are available on the PIO36:

Power	Screw terminal (J1 & J2)
RS232	Screw terminal (J5)
RS485	Screw terminal (J4)
Ethernet	Connector (J6)
PWM outputs	Connectors (J8 - J15)
Analogue and Digital Inputs	Connector (J7)
WA and PT100	Connector (J3)

Cables for the signal inputs and PWM outputs should be kept as short as possible and certainly less than 3m.

5.1 Power

Power consumption depends on type of load, number of PWM channels driven and maximum duty cycle. Make sure to use a 24VDC power supply capable of supplying the necessary power. Use sufficiently thick wires for 24VDC and 0V connections when using high power output from the PIO36. Power supply 0V connects to terminal J1 which has 2 terminals. Power supply 24V connects to J2, also with 2 terminals. Use both terminals for the power connections when using high power loads on the PWM outputs.

5.2 RS232

The RS232 port is configured with the screw terminals on connector J5.

The default communication parameters are Baud rate 115200, 8 data bits, No parity and 1 stop bit. No handshake signals are used.

5.3 RS485

The RS485 is connected to screw terminal J4. The RS485 line should carry a separate ground wire (G) terminated at the RS485 port in both ends. The + and – signal should be carried in a twisted pair with a characteristic impedance close to 120 Ω. This is especially important when communicating over a long distance.

The RS485 port on the PIO36 is galvanic isolated. The shield should be terminated at the master protective ground. This configuration has proved to be sufficient to prevent problems due to different ground levels at master and PIO36 and provide protection against large transients.

A RS485 line must be terminated with a termination resistance (120Ω) at each end. This can be done on the PIO36 by setting dip switch marked TR on the PIO36 cover (SW1A) to the on position (as shown on the switch). On a line with several nodes a terminal resistor is required in each end of the line. Normally this is on the master (usually at one end) and at the node at the most remote end of the line, all the other nodes should not have termination resistors fitted. If the line has only a master and one slave, both should have a termination resistance.

If there is no individual 0V for RS485 the switch marked 0V on the PIO36 cover (SW1B) have to be set to the On position (as shown on the switch) to connect local 0V to RS485 0V.

The default communication parameters are Baud rate 115200, 8 data bits, No parity and 1 stop bit.

5.4 Ethernet

2 Ethernet ports are provided at connector J6. Use suitable ethernet cables for 10/100Mbit and keep the twisting of the pairs as close as possible to the connector.

5.5 PWM outputs

The 16 PWM outputs are numbered 1, 2, ..., 16. The PIO36 uses high side drivers, supplying 24V during the on-time of the PWM pulse. If the duty cycle is set to 100% the output is continuously ON and can be used as a power output for sensors, lights or similar loads not designed for PWM. The external load must be connected between the PIO36 output and 0V. The PIO36 connectors for PWM output are 4 pins, with 2 pins for 2 output channels and 2 pins for 0V.

5.6 Analogue inputs

The analogue inputs are designed for accepting 4-20mA signals, typically from pressure/temperature transmitters. The analogue inputs are connected to connector J7 (also used for digital inputs).

Inputs 1 to 4 can be configured for 0-10V inputs signals instead of 4-20mA by switching the corresponding switch (SW2A - SW4B) to the on position (as shown on the switch).

5.7 Digital inputs

The digital inputs are galvanic isolated from the PIO36 by use of optocouplers. The input contains current limiting resistors which makes the inputs suitable for 12 - 24VDC input level. The digital inputs are connected to connector J7 (also used for analogue inputs).

5.8 Status LEDs

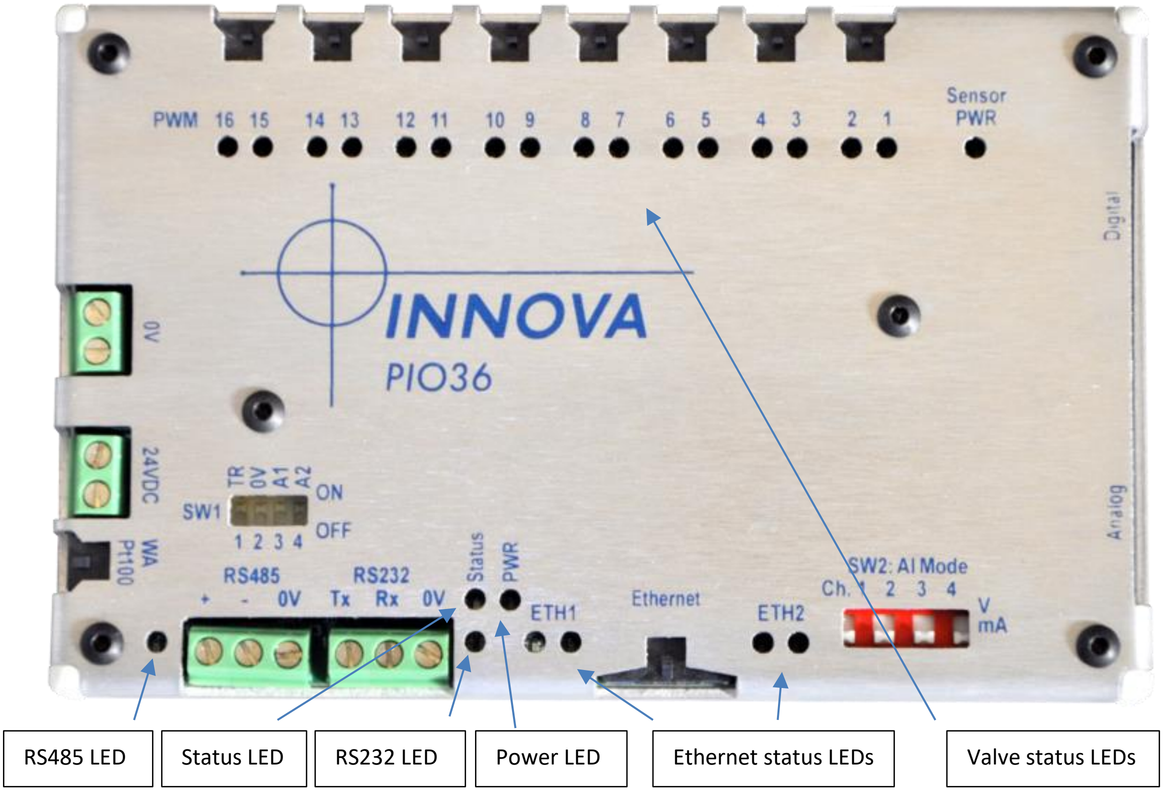
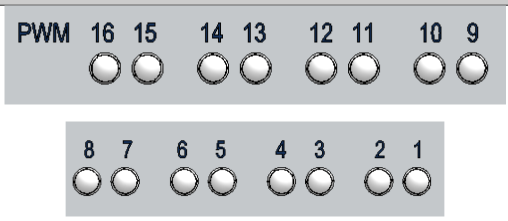


Figure 2 - Valve driver board LED indicators

The PIO36 valve driver board uses the following LEDs:

Marking		Description
PWR		• Continuous GREEN – 24 VDC supply power OK
Status		• Blinking 1 Hz RED – SW running OK
Sensor PWR 1)		• Continuous GREEN – 24 VDC power output to J7 is On • Continuous RED – 24 VDC power output to J7 detects open circuit (when power is off) or the load is short circuited
ETH1		Left LED: • Continuous GREEN, link • Blinking GREEN, activity on Ethernet Right LED: • Off, 10 Mbit/s • Continuous Green, 100 Mbit/s

ETH2		Left LED: • Continuous GREEN, link • Blinking GREEN, activity on Ethernet Right LED: • Off, 10 Mbit/s • Continuous Green, 100 Mbit/s
PWM 1 to 16 1)		• No light – Output deactivated and a load is present on output • Continuous GREEN – Output activated • Continuous RED – Fault, open circuit (when the output is inactive) • Continuous ORANGE (GREEN and RED) – Fault, short circuit

1) The sensor power and PWMx LED consists of two LEDs, one green and one red.

5.9 DIP switches

The PIO36 has 2 DIP switches with 4 switches each, these are summarised in the tables below:

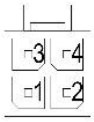
SW1 DIP switch	
SW1A	Enable / disable RS485 termination
SW1B	Connects isolated RS485 0V to PIO36 input power 0V
SW1C	Least significant address bit
SW1D	Most significant address bit

SW2 DIP switch	
SW2A	Analogue input 1, mA or V
SW2B	Analogue input 2, mA or V
SW3C	Analogue input 3, mA or V
SW2D	Analogue input 4, mA or V

5.10 Connector pinouts

5.10.1 J3 - WA and Pt100

Mating connector: Molex 43025-0400, pins: 43030-0007



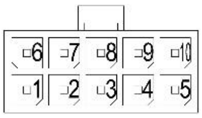
J3 - WA and Pt100	
Pin #	**Function**
1	WA probe
2	WA probe
3	Pt100
4	Pt100

The 2 WA probe pins are connected to a water detection probe designed and placed such that any sea water leaked into the enclosure will conduct a electrical current between the pins.

The Pt100 pins connects to a Pt100 resistor.

5.10.2 J6 - Ethernet

Mating connector: Molex 43025-1000, pins: 43030-0007

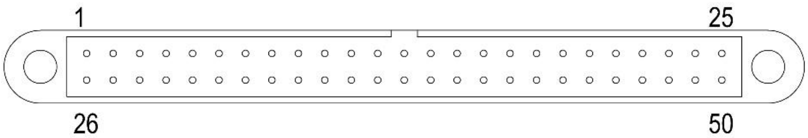


J6 - Ethernet	
Pin #	**Function**
1	Ethernet 1, Tx+
2	Ethernet 1, Rx+
3	Factory defaults
4	Ethernet 2, Tx+
5	Ethernet 2, Rx+
6	Ethernet 1, Tx-
7	Ethernet 1, Rx-
8	Factory defaults
9	Ethernet 2, Tx-
10	Ethernet 2, Rx-

If the 2 Factory defaults pins are shorted, the persistent storage is not loaded at start-up, and all values will use their default values. The user then must set all variables to their desired value, then flush the persistent storage. Or power cycle the board without the pins shorted.

5.10.3 J7 - Analogue and digital inputs

Mating connector: Nicomatic 222S50M16 or Harwin M80-4615042



J7 - Analogue and digital inputs	
Pin #	**Function**
1	Digital input 1+
2	Digital input 1-
3	Digital input 2-
4	Digital input 2+
5	Digital input 3+
6	Digital input 3-
7	Digital input 4-
8	Digital input 4+
9	0V
10	Analogue input 1
11	Analogue input 2
12	Analogue input 3
13	Analogue input 4
14	Analogue input 5
15	Analogue input 6
16	Analogue input 7
17	Analogue input 8
18	Analogue input 9
19	Analogue input 10
20	Analogue input 11
21	Analogue input 12
22	Analogue input 13
23	Analogue input 14
24	Analogue input 15
25	Analogue input 16
26	Sensor power
27	0V

28	Sensor power
29	0V
30	Sensor power
31	0V
32	Sensor power
33	0V
34	Sensor power
35	Loop power 1
36	Loop power 2
37	Loop power 3
38	Loop power 4
39	Loop power 5
40	Loop power 6
41	Loop power 7
42	Loop power 8
43	Loop power 9
44	Loop power 10
45	Loop power 11
46	Loop power 12
47	Loop power 13
48	Loop power 14
49	Loop power 15
50	Loop power 16

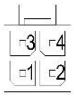
12 -24VDC is connected to the digital inputs, positive power to the + input and negative (0V) to the - input. Often devices with open collector are used to generate signals for the digital inputs, these come with 2 type of outputs: PNP and NPN. If an PNP device is used the output is connected to the digital input + and the digital input - is connected to 0V. If a NPN device is used the output is connected to the digital input - and the digital input + is connected to 24V.

Analogue 4-20mA outputs (or 0-10V for channel 1 – 4) are connected to the analogue inputs on J7. If loop powered transmitters are used these can be supplied from the Loop power outputs on J7. The loop power output is connected to the supply input of the transmitter and the signal output from the transmitter is connected to the analogue input on J7. The supply current on the loop power outputs is limited to approximately 25mA.

The sensor power output and 0V pins on J7 can be used to power transmitters which is not loop powered. Maximum current load on these outputs is 0.5A per pin and 2A total for all pins.

5.10.4 J8 - J15 - PWM outputs

Mating connector: Molex 43025-0400, pins: 43030-0007



J8 - J15 - PWM outputs	
Pin #	**Function**
1	0V
2	0V
3	PWM output 2
4	PWM output 1

The table above shows connections for channel 1 & 2 on J8. Pinout for channels 3 & 4 are on J9 with corresponding pinout. And so on for channels 5 - 16.

The load (solenoid coil) is connected between the output and 0V i.e., between pin 1 and 3 and between pin 2 and 4.

6 Physical layout, mounting

Size and mounting interface.

Size: 90x140x13mm (LxWxH)

Mounting: 6 M3 bolts from the underside. Always use the 4 corner bolts when mounting the PIO36. See drawing below for mounting hole positions. If used in a vibrating environment use all 6 mounting points.

Housing: Aluminium cover

Always mount the PIO36 on a metal surface connected to protective earth and place it inside a suitable enclosure (IP65 or higher depending on application). Never operate the system without the PIO36 in an enclosure as accidental shorts to the screw terminals can cause unpredictable operation of the PWM outputs or damage to the PIO36 or connected equipment.

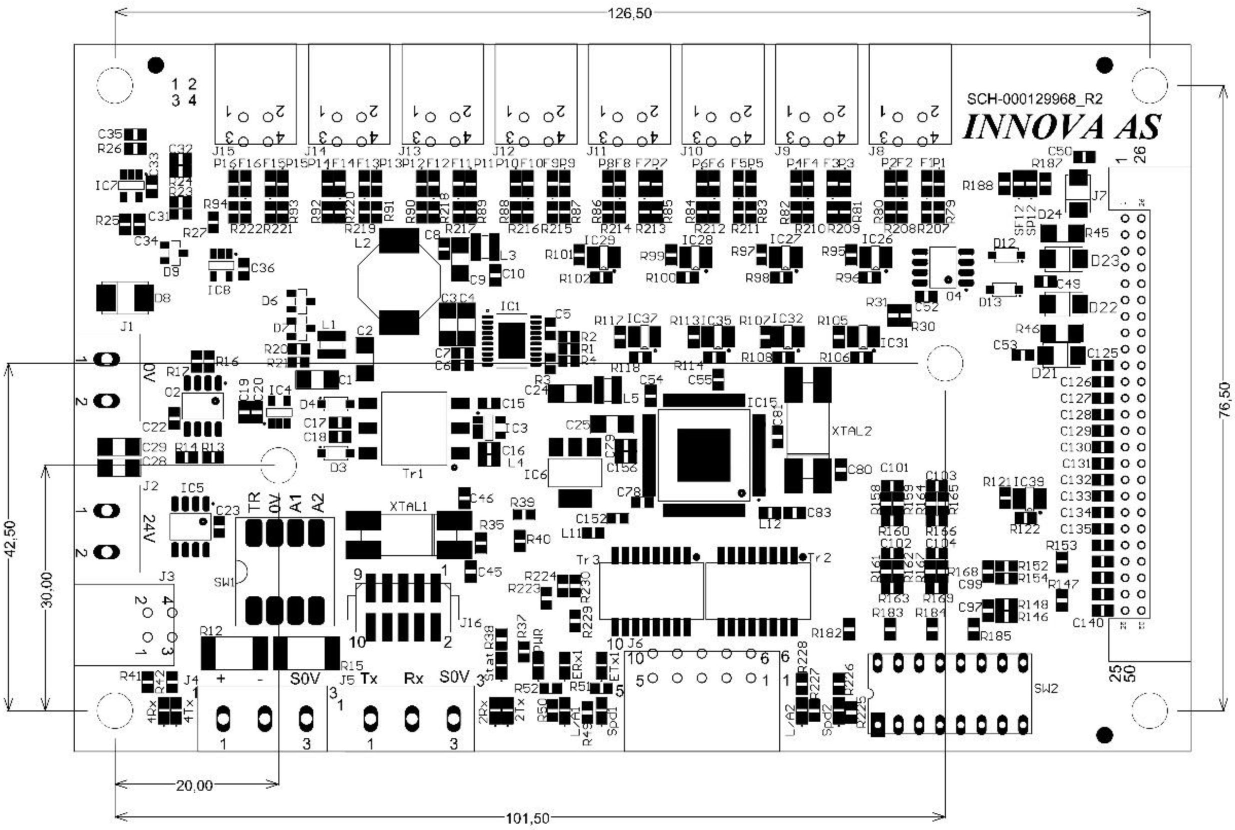


Figure 3 - Dimensions

7 Specification

Power supply voltage: Nominally 24 VDC (10 – 30 VDC)

Power supply current: 10 A, including all PWM and power outputs

PWM output current: 2 A each channel, 10 A total for all channels (including sensor power outputs)

PWM output resolution: 16-bit

Loop power supply: 25 mA

Sensor power supply: 0.5 A per output pin on J7, 2A total for all pins

Typical response time: 1.75 ms required Modbus RTU inter frame delay

Analogue inputs resolution: 16-bit

Analogue inputs sample rate: 500 Hz

Pt100 temperature measuring range: -10 - 120°C

Digital input nominal input voltage: 12 – 24VDC

Max digital input frequency: 4 kHz

Digital input threshold volage: 5V

Ambient pressure: 300 bar

Operating temperature: -20 to 50 °C [See Note 1 below]

Storage temperature: -40 to 85 °C

Humidity: 10 to 95 % RH Non-condensing

Power consumption (idle): 60 mA

Note 1:

The actual maximum operating temperature depends on the load connected to the unit and mounting conditions. A high load, that is the combination of load on each channel and number of channels in use, give an increase in power dissipation in the output drivers. The temperature rise on the output drivers depends on the power dissipation and cooling, i.e. how the unit is mounted: in still air, circulating air or oil. Oil providing the best cooling and still air the worst. The power loss in the output driver is greatly increased when using an inductive load (such as a solenoid valve) without a dedicated freewheeling diode across the load. In this case the back EMF from the load is dissipated in output driver. It is therefore always recommended to use dedicated freewheeling diodes across the load.

The output drivers contain internal temperature shutdown to protect the drivers if the driver temperature becomes too high.

8 Configuration instruction

8.1 Ethernet

The unit is addressed directly by its IP-address and does not use the *Unit Identifier* field in the MBAP header. The *Unit Identifier* value from the request is copied to the response. See *MODBUS Messaging on TCP/IP Implementation Guide [2]* for more details.

The board is supplied with the following default settings:

- IP address: 192.168.52.209
- Netmask: 255.255.248.0
- Default gateway: 192.168.48.1

The IP address settings are stored in the board's Modbus register. To change the settings, use a Modbus client to update the appropriate registers. To store the new values in EEPROM, the EEPROM flush command (register 400113) must be sent. The board will then remember the new settings after a reboot. See section 10 for details.

8.2 RS232 / RS485 address

The PIO36 can be set up with 4 different addresses by dip switch selector. The switches are marked A1 and A2 on the PIO36 cover. When using several PIO36 (or other devices) on a RS485 line, all units must have different addresses. The master must always address the PIO36 with the correct address, even when communicating with a single unit on RS232.

Address offset	AD1 (SW1C)	AD2 (SW1D)	
0	Off	Off	Base address (default 10)
1	On	Off	Base address + 1
2	Off	On	Base address + 2
3	On	On	Base address + 3

The base address is by default set to 10, the possible addresses set by the dip switches are then 10, 11, 12 & 13.

The base address and serial communication settings are stored in the board's Modbus register. To change the settings, use a Modbus client to update the appropriate registers. To store the new values in EEPROM, the EEPROM flush command (register 400113) must be sent. The board will then remember the new settings after a reboot. See section 10 for details.

Address detection is only performed at boot up of the system. The PIO36 need to be powered down and up again to detect changes in the status of the dip switches.

8.3 Serial communication mode

8.3.1 RS485 settings

RS485 termination resistor is switched in with the dip switch marked TR (SW1) on the PIO36 cover. Set this switch to the on position (as shown on the switch) on the unit at the end of the RS485 line, as described above.

The dip switch marked 0V on the PIO36 cover (SW1) connects the RS485 0V wire to 0V in the PIO36. This is only recommended used when an individual RS485 0V is not available.

9 Modbus

9.1 Supported Function Codes

The supported function codes are listed in

Function code	Description
0x03	Read Holding Registers
0x04	Read Input Registers
0x06	Write Single Register
0x10	Write Multiple Registers

Table 1.

Function code	Description
0x03	Read Holding Registers
0x04	Read Input Registers
0x06	Write Single Register
0x10	Write Multiple Registers

Table 1 - Supported Function Codes

9.2 Register Addressing

Register 300001 to register 365536 refer to a Modbus input register in the range 1 – 65536. Register 400001 to register 465536 refer to a Modbus holding register in the range 1 – 65536.

9.3 Datatypes

9.3.1 Uint16

Uint16 is an unsigned 16-bit word as defined in Modbus Application Protocol Specification [1].

9.3.2 Int16

Int16 is a two-complements signed 16-bit word stored in a single register.

9.3.3 Uint8

Uint8 is an unsigned 8-bit word stored in a single register. The 8 most significant bits are ignored on writes and they read as 0.

9.3.4 Uint32

Uint32 is an unsigned 32-bit word, consisting of two sequential registers, with the MSB stored in the lowest numbered register (big-endian).

9.3.5 Int32

Int32 is a two-complements signed 32-bit word, consisting of two sequential registers, with the MSB stored in the lowest numbered register (big-endian).

9.3.6 Float

Float is a 32-bit single precision floating point type (binary32 in IEEE 754 [3]) stored in two sequential registers with the MSB stored in the lowest numbered register (big-endian).

9.3.7 IPv4 address

IPv4 addresses are stored as a 32-bit word, consisting of two sequential registers. The octets of the ip-address are stored little-endian, e.g., the ip-address 192.168.1.100 is stored the same as the Uint32 value 0x6401A8C0, the least significant byte is 192 (0xC0) and the most significant byte is 100 (0x64).

9.3.8 Addressing multi-registers values

All multi-register values are addressed using their lowest numbered register.

NOTE: Trying to access only part of a multi-register datatype (e.g., only one register of a float value) will result in a Modbus Illegal Data Address exception.

9.4 Gateway functionality

If the Modbus Gateway is enabled (see register 300149/400149), packets received on the rs232 interface, but not addressed to this board are transmitted on the rs485 port to allow the board to function as a gateway for other boards.

This is also true for Modbus TCP requests to port 503, those packets will be sent out on the rs485 port. If no response if detected a Modbus Gateway Target Device Failed to Respond exception (code 11) is sent as a response on the tcp connection.

10 Registers

Note: in the table below, a register longer than 16 bit (e.g. Uint32 values) are treated as one register, but consists of two subsequent Modbus addresses.

To write persistent changes to EEPROM (e.g. to change IP address or other communications parameters), the EEPROM flush command (register 400113) must be sent. The board will then remember the new settings after a reboot. See section 10.5.3 for details.

10.1 Table of registers

Name	Register	Datatype	Note
Product Number	300001	Uint32	
Serial Number	300003	Uint32	
Hardware Version	300005	Uint32	
FW version Major	300007	Uint16	
FW version Minor	300008	Uint16	
FW version Patch	300009	Uint16	
Firmware CRC	300010	Uint32	
Configuration CRC	300012	Uint32	
Heartbeat	300014	Uint16	
Ipv4 Address	300050	IPv4 Address	
Subnet Mask	300052	IPv4 Address	
Default Gateway	300054	IPv4 Address	
MAC address[0]	300056	Uint16	
MAC address[1]	300057	Uint16	
MAC address[2]	300058	Uint16	
Baudrate RS232	300059	Uint32	
Baudrate RS485	300061	Uint32	
Modbus Base Address	300063	Uint8	
Modbus Address	300064	Uint8	
Lost-coms timeout	300065	Uint16	
Lost-coms Keep Value	300066	Uint16	
Power-on default output 1	300067	Float	
Power-on default output 2	300069	Float	
Power-on default output 3	300071	Float	
Power-on default output 4	300073	Float	
Power-on default output 5	300075	Float	
Power-on default output 6	300077	Float	

Name	Register	Datatype	Note
Power-on default output 7	300079	Float	
Power-on default output 8	300081	Float	
Power-on default output 9	300083	Float	
Power-on default output 10	300085	Float	
Power-on default output 11	300087	Float	
Power-on default output 12	300089	Float	
Power-on default output 13	300091	Float	
Power-on default output 14	300093	Float	
Power-on default output 15	300095	Float	
Power-on default output 16	300097	Float	
Sensor Power configuration	300099	Uint16	
Uptime	300100	Float	
System Warnings	300102	Uint16	
Sensor Alarms	300103	Uint16	
PWM Faults	300104	Uint16	
Modbus Packet Count	300105	Uint32	
Modbus Dropped Packets Count	300107	Uint32	
EEPROM write counter	300109	Uint32	
Sensor Power Enable	300111	Uint8	
rs232_terminal	300115	Uint8	
rs485_terminal	300116	Uint8	
Lost COM’s output 1	300117	Float	From version 1.3.0
Lost COM’s output 2	300119	Float	From version 1.3.0
Lost COM’s output 3	300121	Float	From version 1.3.0
Lost COM’s output 4	300123	Float	From version 1.3.0
Lost COM’s output 5	300125	Float	From version 1.3.0
Lost COM’s output 6	300127	Float	From version 1.3.0
Lost COM’s output 7	300129	Float	From version 1.3.0
Lost COM’s output 8	300131	Float	From version 1.3.0
Lost COM’s output 9	300133	Float	From version 1.3.0
Lost COM’s output 10	300135	Float	From version 1.3.0
Lost COM’s output 11	300137	Float	From version 1.3.0
Lost COM’s output 12	300139	Float	From version 1.3.0

Name	Register	Datatype	Note
Lost COM's output 13	300141	Float	From version 1.3.0
Lost COM's output 14	300143	Float	From version 1.3.0
Lost COM's output 15	300145	Float	From version 1.3.0
Lost COM's output 16	300147	Float	From version 1.3.0
Modbus Gateway enabled	300149	Bool	From version 1.3.2
PWM Channel 1 Duty	301000	Float	
PWM Channel 2 Duty	301002	Float	
PWM Channel 3 Duty	301004	Float	
PWM Channel 4 Duty	301006	Float	
PWM Channel 5 Duty	301008	Float	
PWM Channel 6 Duty	301010	Float	
PWM Channel 7 Duty	301012	Float	
PWM Channel 8 Duty	301014	Float	
PWM Channel 9 Duty	301016	Float	
PWM Channel 10 Duty	301018	Float	
PWM Channel 11 Duty	301020	Float	
PWM Channel 12 Duty	301022	Float	
PWM Channel 13 Duty	301024	Float	
PWM Channel 14 Duty	301026	Float	
PWM Channel 15 Duty	301028	Float	
PWM Channel 16 Duty	301030	Float	
PWM Ignore faults	301033	Uint16	
PWM Frequency Channels 1-4	301034	Float	
PWM Frequency Channels 5-8	301036	Float	
PWM Frequency Channels 9-12	301038	Float	
PWM Frequency Channels 13-16	301040	Float	
PWM Channel 1 Dither Duty	301042	Float	
PWM Channel 2 Dither Duty	301044	Float	
PWM Channel 3 Dither Duty	301046	Float	
PWM Channel 4 Dither Duty	301048	Float	
PWM Channel 5 Dither Duty	301050	Float	
PWM Channel 6 Dither Duty	301052	Float	
PWM Channel 7 Dither Duty	301054	Float	

Name	Register	Datatype	Note
PWM Channel 8 Dither Duty	301056	Float	
PWM Channel 9 Dither Duty	301058	Float	
PWM Channel 10 Dither Duty	301060	Float	
PWM Channel 11 Dither Duty	301062	Float	
PWM Channel 12 Dither Duty	301064	Float	
PWM Channel 13 Dither Duty	301066	Float	
PWM Channel 14 Dither Duty	301068	Float	
PWM Channel 15 Dither Duty	301070	Float	
PWM Channel 16 Dither Duty	301072	Float	
PWM Channel 1 Dither Frequency	301074	Float	
PWM Channel 2 Dither Frequency	301076	Float	
PWM Channel 3 Dither Frequency	301078	Float	
PWM Channel 4 Dither Frequency	301080	Float	
PWM Channel 5 Dither Frequency	301082	Float	
PWM Channel 6 Dither Frequency	301084	Float	
PWM Channel 7 Dither Frequency	301086	Float	
PWM Channel 8 Dither Frequency	301088	Float	
PWM Channel 9 Dither Frequency	301090	Float	
PWM Channel 10 Dither Frequency	301092	Float	
PWM Channel 11 Dither Frequency	301094	Float	
PWM Channel 12 Dither Frequency	301096	Float	
PWM Channel 13 Dither Frequency	301098	Float	
PWM Channel 14 Dither Frequency	301100	Float	
PWM Channel 15 Dither Frequency	301102	Float	
PWM Channel 16 Dither Frequency	301104	Float	
Pwm Channel 1 Dither Phase	301106	Float	
Pwm Channel 2 Dither Phase	301108	Float	
Pwm Channel 3 Dither Phase	301110	Float	
Pwm Channel 4 Dither Phase	301112	Float	
Pwm Channel 5 Dither Phase	301114	Float	
Pwm Channel 6 Dither Phase	301116	Float	
Pwm Channel 7 Dither Phase	301118	Float	
Pwm Channel 8 Dither Phase	301120	Float	

Name	Register	Datatype	Note
Pwm Channel 9 Dither Phase	301122	Float	
Pwm Channel 10 Dither Phase	301124	Float	
Pwm Channel 11 Dither Phase	301126	Float	
Pwm Channel 12 Dither Phase	301128	Float	
Pwm Channel 13 Dither Phase	301130	Float	
Pwm Channel 14 Dither Phase	301132	Float	
Pwm Channel 15 Dither Phase	301134	Float	
Pwm Channel 16 Dither Phase	301136	Float	
Supply voltage	302000	Float	
Supply current	302002	Float	
CPU temperature	302004	Float	
PT100 value	302006	Float	
Analog Input Channel 1 (mA)	302008	Float	
Analog Input Channel 2 (mA)	302010	Float	
Analog Input Channel 3 (mA)	302012	Float	
Analog Input Channel 4 (mA)	302014	Float	
Analog Input Channel 5 (mA)	302016	Float	
Analog Input Channel 6 (mA)	302018	Float	
Analog Input Channel 7 (mA)	302020	Float	
Analog Input Channel 8 (mA)	302022	Float	
Analog Input Channel 9 (mA)	302024	Float	
Analog Input Channel 10 (mA)	302026	Float	
Analog Input Channel 11 (mA)	302028	Float	
Analog Input Channel 12 (mA)	302030	Float	
Analog Input Channel 13 (mA)	302032	Float	
Analog Input Channel 14 (mA)	302034	Float	
Analog Input Channel 15 (mA)	302036	Float	
Analog Input Channel 16 (mA)	302038	Float	
Analog Input Channel 1 (V)	302040	Float	
Analog Input Channel 2 (V)	302042	Float	
Analog Input Channel 3 (V)	302044	Float	
Analog Input Channel 4 (V)	302046	Float	
Analog Input voltage flags	302048	Uint16	

Name	Register	Datatype	Note
Analog Input Channel 1 (Scaled)	302049	Float	
Analog Input Channel 2 (Scaled)	302051	Float	
Analog Input Channel 3 (Scaled)	302053	Float	
Analog Input Channel 4 (Scaled)	302055	Float	
Analog Input Channel 5 (Scaled)	302057	Float	
Analog Input Channel 6 (Scaled)	302059	Float	
Analog Input Channel 7 (Scaled)	302061	Float	
Analog Input Channel 8 (Scaled)	302063	Float	
Analog Input Channel 9 (Scaled)	302065	Float	
Analog Input Channel 10 (Scaled)	302067	Float	
Analog Input Channel 11 (Scaled)	302069	Float	
Analog Input Channel 12 (Scaled)	302071	Float	
Analog Input Channel 13 (Scaled)	302073	Float	
Analog Input Channel 14 (Scaled)	302075	Float	
Analog Input Channel 15 (Scaled)	302077	Float	
Analog Input Channel 16 (Scaled)	302079	Float	
Digital Input Levels	302081	Uint16	
Digital Input 1 Count	302082	Uint32	
Digital Input 2 Count	302084	Uint32	
Digital Input 3 Count	302086	Uint32	
Digital Input 4 Count	302088	Uint32	
Digital Input 1 Frequency	302090	Float	
Digital Input 2 Frequency	302092	Float	
Digital Input 3 Frequency	302094	Float	
Digital Input 4 Frequency	302096	Float	
Encoder 1 Count	302098	Int32	
Encoder 2 Count	302100	Int32	
Encoder 1 Frequency	302102	Float	
Encoder 2 Frequency	302104	Float	
Flow 1	302106	Float	
Flow 2	302108	Float	
Flow 3	302110	Float	
Flow 4	302112	Float	

Name	Register	Datatype	Note
Accumulated Flow 1	302114	Float	
Accumulated Flow 2	302116	Float	
Accumulated Flow 3	302118	Float	
Accumulated Flow 4	302120	Float	
Analog Input Channel 01 range	303000	Float	
Analog Input Channel 02 range	303002	Float	
Analog Input Channel 03 range	303004	Float	
Analog Input Channel 04 range	303006	Float	
Analog Input Channel 05 range	303008	Float	
Analog Input Channel 06 range	303010	Float	
Analog Input Channel 07 range	303012	Float	
Analog Input Channel 08 range	303014	Float	
Analog Input Channel 09 range	303016	Float	
Analog Input Channel 10 range	303018	Float	
Analog Input Channel 11 range	303020	Float	
Analog Input Channel 12 range	303022	Float	
Analog Input Channel 13 range	303024	Float	
Analog Input Channel 14 range	303026	Float	
Analog Input Channel 15 range	303028	Float	
Analog Input Channel 16 range	303030	Float	
Analog Input Channel 01 Gain	303032	Float	
Analog Input Channel 01 Offset	303034	Float	
Analog Input Channel 02 Gain	303036	Float	
Analog Input Channel 02 Offset	303038	Float	
Analog Input Channel 03 Gain	303040	Float	
Analog Input Channel 03 Offset	303042	Float	
Analog Input Channel 04 Gain	303044	Float	
Analog Input Channel 04 Offset	303046	Float	
Analog Input Channel 05 Gain	303048	Float	
Analog Input Channel 05 Offset	303050	Float	
Analog Input Channel 06 Gain	303052	Float	
Analog Input Channel 06 Offset	303054	Float	
Analog Input Channel 07 Gain	303056	Float	

Name	Register	Datatype	Note
Analog Input Channel 07 Offset	303058	Float	
Analog Input Channel 08 Gain	303060	Float	
Analog Input Channel 08 Offset	303062	Float	
Analog Input Channel 09 Gain	303064	Float	
Analog Input Channel 09 Offset	303066	Float	
Analog Input Channel 10 Gain	303068	Float	
Analog Input Channel 10 Offset	303070	Float	
Analog Input Channel 11 Gain	303072	Float	
Analog Input Channel 11 Offset	303074	Float	
Analog Input Channel 12 Gain	303076	Float	
Analog Input Channel 12 Offset	303078	Float	
Analog Input Channel 13 Gain	303080	Float	
Analog Input Channel 13 Offset	303082	Float	
Analog Input Channel 14 Gain	303084	Float	
Analog Input Channel 14 Offset	303086	Float	
Analog Input Channel 15 Gain	303088	Float	
Analog Input Channel 15 Offset	303090	Float	
Analog Input Channel 16 Gain	303092	Float	
Analog Input Channel 16 Offset	303094	Float	
PT100 Gain	303096	Float	
PT100 Offset	303098	Float	
Flow 1 k-factor	303100	Float	
Flow 2 k-factor	303102	Float	
Flow 3 k-factor	303104	Float	
Flow 4 k-factor	303106	Float	
Analog Input 1 Filter Constant	303108	Float	
Analog Input 2 Filter Constant	303110	Float	
Analog Input 3 Filter Constant	303112	Float	
Analog Input 4 Filter Constant	303114	Float	
Analog Input 5 Filter Constant	303116	Float	
Analog Input 6 Filter Constant	303118	Float	
Analog Input 7 Filter Constant	303120	Float	
Analog Input 8 Filter Constant	303122	Float	

Name	Register	Datatype	Note
Analog Input 9 Filter Constant	303124	Float	
Analog Input 10 Filter Constant	303126	Float	
Analog Input 11 Filter Constant	303128	Float	
Analog Input 12 Filter Constant	303130	Float	
Analog Input 13 Filter Constant	303132	Float	
Analog Input 14 Filter Constant	303134	Float	
Analog Input 15 Filter Constant	303136	Float	
Analog Input 16 Filter Constant	303138	Float	
PT100 Filter Constant	303140	Float	
PT100 Low Limit	303142	Float	
PT100 High Limit	303144	Float	
Analog Input 1 Raw value	304000	Int16	
Analog Input 2 Raw value	304001	Int16	
Analog Input 3 Raw value	304002	Int16	
Analog Input 4 Raw value	304003	Int16	
Analog Input 5 Raw value	304004	Int16	
Analog Input 6 Raw value	304005	Int16	
Analog Input 7 Raw value	304006	Int16	
Analog Input 8 Raw value	304007	Int16	
Analog Input 9 Raw value	304008	Int16	
Analog Input 10 Raw value	304009	Int16	
Analog Input 11 Raw value	304010	Int16	
Analog Input 12 Raw value	304011	Int16	
Analog Input 13 Raw value	304012	Int16	
Analog Input 14 Raw value	304013	Int16	
Analog Input 15 Raw value	304014	Int16	
Analog Input 16 Raw value	304015	Int16	
Analog Input 1 mA Gain	304016	Float	
Analog Input 1 mA Offset	304018	Float	
Analog Input 2 mA Gain	304020	Float	
Analog Input 2 mA Offset	304022	Float	
Analog Input 3 mA Gain	304024	Float	
Analog Input 3 mA Offset	304026	Float	

Name	Register	Datatype	Note
Analog Input 4 mA Gain	304028	Float	
Analog Input 4 mA Offset	304030	Float	
Analog Input 5 mA Gain	304032	Float	
Analog Input 5 mA Offset	304034	Float	
Analog Input 6 mA Gain	304036	Float	
Analog Input 6 mA Offset	304038	Float	
Analog Input 7 mA Gain	304040	Float	
Analog Input 7 mA Offset	304042	Float	
Analog Input 8 mA Gain	304044	Float	
Analog Input 8 mA Offset	304046	Float	
Analog Input 9 mA Gain	304048	Float	
Analog Input 9 mA Offset	304050	Float	
Analog Input 10 mA Gain	304052	Float	
Analog Input 10 mA Offset	304054	Float	
Analog Input 11 mA Gain	304056	Float	
Analog Input 11 mA Offset	304058	Float	
Analog Input 12 mA Gain	304060	Float	
Analog Input 12 mA Offset	304062	Float	
Analog Input 13 mA Gain	304064	Float	
Analog Input 13 mA Offset	304066	Float	
Analog Input 14 mA Gain	304068	Float	
Analog Input 14 mA Offset	304070	Float	
Analog Input 15 mA Gain	304072	Float	
Analog Input 15 mA Offset	304074	Float	
Analog Input 16 mA Gain	304076	Float	
Analog Input 16 mA Offset	304078	Float	
Analog Input 1 V Gain	304080	Float	
Analog Input 1 V Offset	304082	Float	
Analog Input 2 V Gain	304084	Float	
Analog Input 2 V Offset	304086	Float	
Analog Input 3 V Gain	304088	Float	
Analog Input 3 V Offset	304090	Float	
Analog Input 4 V Gain	304092	Float	

Name	Register	Datatype	Note
Analog Input 4 V Offset	304094	Float	
Supply voltage Gain	304096	Float	
Supply voltage Offset	304098	Float	
Supply current Gain	304100	Float	
Supply current Offset	304102	Float	
CPU Temperature Gain	304104	Float	
CPU Temperature Offset	304106	Float	
Raw Water Alarm value	304108	Uint16	
WA pin time	304109	Uint32	
WA wait time	304111	Uint32	
WA Low Limit	304113	Uint16	
WA High Limit	304114	Uint16	
Supply Voltage Low Limit	304115	Float	
Supply Voltage High Limit	304117	Float	
Supply Current Low Limit	304119	Float	
Supply Current High Limit	304121	Float	
CPU Temperature Low Limit	304123	Float	
CPU Temperature High Limit	304125	Float	
Supply Voltage Filter Constant	304127	Float	
Supply Current Filter Constant	304129	Float	
PT100 Filter Constant	304131	Float	
CPU Temperature Filter Constant	304133	Float	
Ipv4 Address	400050	Uint32	
Subnet Mask	400052	Uint32	
Default Gateway	400054	Uint32	
MAC address[0]	400056	Uint16	
MAC address[1]	400057	Uint16	
MAC address[2]	400058	Uint16	
Baudrate RS232	400059	Uint32	
Baudrate RS485	400061	Uint32	
Modbus Slave Base Address	400063	Uint8	
Lost-coms timeout	400065	Uint16	
Lost-coms Keep Value	400066	Uint16	

Name	Register	Datatype	Note
Power-on default output 1	400067	Float	
Power-on default output 2	400069	Float	
Power-on default output 3	400071	Float	
Power-on default output 4	400073	Float	
Power-on default output 5	400075	Float	
Power-on default output 6	400077	Float	
Power-on default output 7	400079	Float	
Power-on default output 8	400081	Float	
Power-on default output 9	400083	Float	
Power-on default output 10	400085	Float	
Power-on default output 11	400087	Float	
Power-on default output 12	400089	Float	
Power-on default output 13	400091	Float	
Power-on default output 14	400093	Float	
Power-on default output 15	400095	Float	
Power-on default output 16	400097	Float	
Sensor Power configuration	400099	Uint16	
System Warnings	400102	Uint16	
Sensor Alarms	400103	Uint16	
PWM Faults	400104	Uint16	
Sensor Power Enable	400111	Uint8	
Restart command	400112	Uint8	
EEPROM flush command	400113	Uint8	
EEPROM clean-up command	400114	Uint8	
rs232_terminal	400115	Uint8	
rs485_terminal	400116	Uint8	
Lost COM's output 1	400117	Float	From version 1.3.0
Lost COM's output 2	400119	Float	From version 1.3.0
Lost COM's output 3	400121	Float	From version 1.3.0
Lost COM's output 4	400123	Float	From version 1.3.0
Lost COM's output 5	400125	Float	From version 1.3.0
Lost COM's output 6	400127	Float	From version 1.3.0
Lost COM's output 7	400129	Float	From version 1.3.0

Name	Register	Datatype	Note
Lost COM's output 8	400131	Float	From version 1.3.0
Lost COM's output 9	400133	Float	From version 1.3.0
Lost COM's output 10	400135	Float	From version 1.3.0
Lost COM's output 11	400137	Float	From version 1.3.0
Lost COM's output 12	400139	Float	From version 1.3.0
Lost COM's output 13	400141	Float	From version 1.3.0
Lost COM's output 14	400143	Float	From version 1.3.0
Lost COM's output 15	400145	Float	From version 1.3.0
Lost COM's output 16	400147	Float	From version 1.3.0
Modbus Gateway Enabled	400149	Bool	From version 1.4.0
PWM Channel 1 Duty	401000	Float	
PWM Channel 2 Duty	401002	Float	
PWM Channel 3 Duty	401004	Float	
PWM Channel 4 Duty	401006	Float	
PWM Channel 5 Duty	401008	Float	
PWM Channel 6 Duty	401010	Float	
PWM Channel 7 Duty	401012	Float	
PWM Channel 8 Duty	401014	Float	
PWM Channel 9 Duty	401016	Float	
PWM Channel 10 Duty	401018	Float	
PWM Channel 11 Duty	401020	Float	
PWM Channel 12 Duty	401022	Float	
PWM Channel 13 Duty	401024	Float	
PWM Channel 14 Duty	401026	Float	
PWM Channel 15 Duty	401028	Float	
PWM Channel 16 Duty	401030	Float	
PWM synchronization command	401032	Uint8	
PWM Ignore faults	401033	Uint16	
PWM Frequency Channels 1-4	401034	Float	
PWM Frequency Channels 5-8	401036	Float	
PWM Frequency Channels 9-12	401038	Float	
PWM Frequency Channels 13-16	401040	Float	
PWM Channel 1 Dither Duty	401042	Float	

Name	Register	Datatype	Note
PWM Channel 2 Dither Duty	401044	Float	
PWM Channel 3 Dither Duty	401046	Float	
PWM Channel 4 Dither Duty	401048	Float	
PWM Channel 5 Dither Duty	401050	Float	
PWM Channel 6 Dither Duty	401052	Float	
PWM Channel 7 Dither Duty	401054	Float	
PWM Channel 8 Dither Duty	401056	Float	
PWM Channel 9 Dither Duty	401058	Float	
PWM Channel 10 Dither Duty	401060	Float	
PWM Channel 11 Dither Duty	401062	Float	
PWM Channel 12 Dither Duty	401064	Float	
PWM Channel 13 Dither Duty	401066	Float	
PWM Channel 14 Dither Duty	401068	Float	
PWM Channel 15 Dither Duty	401070	Float	
PWM Channel 16 Dither Duty	401072	Float	
PWM Channel 1 Dither Frequency	401074	Float	
PWM Channel 2 Dither Frequency	401076	Float	
PWM Channel 3 Dither Frequency	401078	Float	
PWM Channel 4 Dither Frequency	401080	Float	
PWM Channel 5 Dither Frequency	401082	Float	
PWM Channel 6 Dither Frequency	401084	Float	
PWM Channel 7 Dither Frequency	401086	Float	
PWM Channel 8 Dither Frequency	401088	Float	
PWM Channel 9 Dither Frequency	401090	Float	
PWM Channel 10 Dither Frequency	401092	Float	
PWM Channel 11 Dither Frequency	401094	Float	
PWM Channel 12 Dither Frequency	401096	Float	
PWM Channel 13 Dither Frequency	401098	Float	
PWM Channel 14 Dither Frequency	401100	Float	
PWM Channel 15 Dither Frequency	401102	Float	
PWM Channel 16 Dither Frequency	401104	Float	
Pwm Channel 1 Dither Phase	401106	Float	
Pwm Channel 2 Dither Phase	401108	Float	

Name	Register	Datatype	Note
Pwm Channel 3 Dither Phase	401110	Float	
Pwm Channel 4 Dither Phase	401112	Float	
Pwm Channel 5 Dither Phase	401114	Float	
Pwm Channel 6 Dither Phase	401116	Float	
Pwm Channel 7 Dither Phase	401118	Float	
Pwm Channel 8 Dither Phase	401120	Float	
Pwm Channel 9 Dither Phase	401122	Float	
Pwm Channel 10 Dither Phase	401124	Float	
Pwm Channel 11 Dither Phase	401126	Float	
Pwm Channel 12 Dither Phase	401128	Float	
Pwm Channel 13 Dither Phase	401130	Float	
Pwm Channel 14 Dither Phase	401132	Float	
Pwm Channel 15 Dither Phase	401134	Float	
Pwm Channel 16 Dither Phase	401136	Float	
Reset digital input 1 count	402082	Uint8	
Reset digital input 2 count	402084	Uint8	
Reset digital input 3 count	402086	Uint8	
Reset digital input 4 count	402088	Uint8	
Reset encoder 1 count	402098	Uint8	
Reset encoder 2 count	402100	Uint8	
Analog Input Channel 01 range	403000	Float	
Analog Input Channel 02 range	403002	Float	
Analog Input Channel 03 range	403004	Float	
Analog Input Channel 04 range	403006	Float	
Analog Input Channel 05 range	403008	Float	
Analog Input Channel 06 range	403010	Float	
Analog Input Channel 07 range	403012	Float	
Analog Input Channel 08 range	403014	Float	
Analog Input Channel 09 range	403016	Float	
Analog Input Channel 10 range	403018	Float	
Analog Input Channel 11 range	403020	Float	
Analog Input Channel 12 range	403022	Float	
Analog Input Channel 13 range	403024	Float	

Name	Register	Datatype	Note
Analog Input Channel 14 range	403026	Float	
Analog Input Channel 15 range	403028	Float	
Analog Input Channel 16 range	403030	Float	
Analog Input Channel 01 Gain	403032	Float	
Analog Input Channel 01 Offset	403034	Float	
Analog Input Channel 02 Gain	403036	Float	
Analog Input Channel 02 Offset	403038	Float	
Analog Input Channel 03 Gain	403040	Float	
Analog Input Channel 03 Offset	403042	Float	
Analog Input Channel 04 Gain	403044	Float	
Analog Input Channel 04 Offset	403046	Float	
Analog Input Channel 05 Gain	403048	Float	
Analog Input Channel 05 Offset	403050	Float	
Analog Input Channel 06 Gain	403052	Float	
Analog Input Channel 06 Offset	403054	Float	
Analog Input Channel 07 Gain	403056	Float	
Analog Input Channel 07 Offset	403058	Float	
Analog Input Channel 08 Gain	403060	Float	
Analog Input Channel 08 Offset	403062	Float	
Analog Input Channel 09 Gain	403064	Float	
Analog Input Channel 09 Offset	403066	Float	
Analog Input Channel 10 Gain	403068	Float	
Analog Input Channel 10 Offset	403070	Float	
Analog Input Channel 11 Gain	403072	Float	
Analog Input Channel 11 Offset	403074	Float	
Analog Input Channel 12 Gain	403076	Float	
Analog Input Channel 12 Offset	403078	Float	
Analog Input Channel 13 Gain	403080	Float	
Analog Input Channel 13 Offset	403082	Float	
Analog Input Channel 14 Gain	403084	Float	
Analog Input Channel 14 Offset	403086	Float	
Analog Input Channel 15 Gain	403088	Float	
Analog Input Channel 15 Offset	403090	Float	

Name	Register	Datatype	Note
Analog Input Channel 16 Gain	403092	Float	
Analog Input Channel 16 Offset	403094	Float	
PT100 Gain	403096	Float	
PT100 Offset	403098	Float	
Flow 1 k-factor	403100	Float	
Flow 2 k-factor	403102	Float	
Flow 3 k-factor	403104	Float	
Flow 4 k-factor	403106	Float	
Analog Input 1 Filter Constant	403108	Float	
Analog Input 2 Filter Constant	403110	Float	
Analog Input 3 Filter Constant	403112	Float	
Analog Input 4 Filter Constant	403114	Float	
Analog Input 5 Filter Constant	403116	Float	
Analog Input 6 Filter Constant	403118	Float	
Analog Input 7 Filter Constant	403120	Float	
Analog Input 8 Filter Constant	403122	Float	
Analog Input 9 Filter Constant	403124	Float	
Analog Input 10 Filter Constant	403126	Float	
Analog Input 11 Filter Constant	403128	Float	
Analog Input 12 Filter Constant	403130	Float	
Analog Input 13 Filter Constant	403132	Float	
Analog Input 14 Filter Constant	403134	Float	
Analog Input 15 Filter Constant	403136	Float	
Analog Input 16 Filter Constant	403138	Float	
PT100 Filter Constant	403140	Float	
PT100 Low Limit	403142	Float	
PT100 High Limit	403144	Float	

10.2 Identification block

Register addresses 300001 – 300014.

10.2.1 Product Number

This register contains the product number of the PIO36 board and always contains the value 2210100 for the standard version.

10.2.2 Serial Number

This register contains the serial number of the PIO36 board.

10.2.3 Hardware Version

This register contains the revision number of the pcb-board.

10.2.4 Firmware Version

These registers contain the firmware version of the currently running firmware.

10.2.5 Firmware CRC

This register contains the CRC of the flash storage for the firmware.

10.2.6 Configuration CRC

This register contains the CRC of the values stored in the persistent storage.

10.2.7 Heartbeat

This register counts seconds since initialization is completed.

10.3 Configuration block

Register addresses 300050 – 300117 and 400050 – 400117.

10.3.1 IPv4 address

This register specifies the IPv4 address the PIO36 uses on its ethernet interface.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

This register requires a power cycle or restart for changes to apply.

10.3.2 Subnet mask

This register specifies the subnet mask the PIO36 uses on its ethernet interface.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

This register requires a power cycle or restart for changes to apply.

10.3.3 Default gateway

This register specifies the default router the PIO36 uses on its ethernet interface.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

This register requires a power cycle or restart for changes to apply.

10.3.4 MAC address

These registers specify the MAC address for the PIO36 ethernet interface.

The first register contains the first two octets, the second the third and fourth octets and the last register the last two octets. For each register the MSB gives the first octet of its octets.

E.g., the MAC-address 0E-EC-A7-6D-9C-B5 is stored as the three Uint16 values 0x0EEC, 0xA76D and 0x9CB5.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

This register requires a power cycle or restart for changes to apply.

10.3.5 Baudrate RS232

This register specifies the baudrate given in bauds of the RS232 connection.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

This register requires a power cycle or restart for changes to apply.

10.3.6 Baudrate RS485

This register specifies the baudrate given in bauds of the RS485 connection.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

This register requires a power cycle or restart for changes to apply.

10.3.7 Modbus Base Address

This register specifies the base-address (before taking the switches into account) for the Modbus interface on the PIO36 board.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

This register requires a power cycle or restart for changes to apply.

10.3.8 Modbus Address

This register contains the actual address used for the Modbus interface.

This register is read-only and any attempt to read or write the associated holding register are ignored.

10.3.9 Lost-coms timeout

This register gives the lost-coms timeout value in seconds. A value of 0 disables the lost-coms alarm.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.3.10 Lost-coms Keep Value

This register specifies the lost-coms behaviour for the PWM outputs. Each bit in this register controls the behaviour of a different output, the least significant bit controls PWM 1 and the most significant bit control PWM 16.

If the associated bit is set, then the output keeps its current value in the case of a lost-coms alarm, otherwise the output value is set to the value specified in Lost-coms duty.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.3.11 Lost COM's output

These registers specify the lost COM's value for each output. A value of 0 (or less, including -inf and NaN) is fully off and a value of 100 (or more, including +inf) is fully on.

These registers are stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.3.12 Power-on default output

These registers specify the power-on value for each output. A value of 0 (or less, including -inf and NaN) is fully off and a value of 100 (or more, including +inf) is fully on.

These registers are stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.3.13 Sensor Power configuration

This register controls the lost-coms and power-on configuration for the Sensor power output. The register is a bitmask with 4 bits defined below.

This register is stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.3.13.1 Bit 0: Ignore fault

If this bit is set, the sensor power output ignores the sensor power fault signal and allows to enable the output if the fault is set. As there are two separate transistors for the outputs and their faults are combined, this may be necessary if there is no load connected to one of them as the open-circuit detection will otherwise fault the output as long as it is off.

10.3.13.2 Bit 1: Lost-coms keep

If this bit is set, the sensor power output keeps its current value in the case of a lost-coms alarm, otherwise the Lost-coms Value is used.

10.3.13.3 Bit 2: Lost-coms Value

If Lost-coms keep is not set, this value is applied to the sensor power output in the case of a lost-coms alarm.

10.3.13.4 Bit 3: Power-on value

This value specifies the power-on value for the sensor power output.

10.4 Diagnostics block

10.4.1 Uptime

This register gives the time since power-on in seconds.

10.4.2 System Warnings

This register is a bitmask of warnings from the system. Only the input register contains the actual values if read, and to clear the warnings write the corresponding bit in the holding register to 1. Writing a value of 0 to a bit has no effect.

10.4.2.1 Bit 0: Unexpected restart

This bit is set if the onboard watchdog has restarted the program.

10.4.2.2 Bit 1: Hardware fault

This bit is set if the CPU fails initialize one or more of its internal or external peripherals.

10.4.2.3 Bit 2: Persistent storage fault

This bit is set if one or more persistent values failed to load from the persistent storage.

10.4.3 Sensor Alarms

This register is a bitmask of alarms from the sensors. Only the input register contains the actual values if read, and to clear the alarms write the corresponding bit in the holding register to 1. Writing a value of 0 to a bit has no effect.

10.4.3.1 Bit 0: Water Alarm

This bit is set if the water probe has detected water.

10.4.3.2 Bit 1: Low supply voltage

This bit is set if the PIO36 supply voltage falls below its warning threshold.

10.4.3.3 Bit 2: High supply voltage

This bit is set if the PIO36 supply voltage exceeds its warning threshold.

10.4.3.4 Bit 3: High supply current

This bit is set if the supply current exceeds its warning threshold.

10.4.3.5 Bit 4: High CPU temperature

This bit is set if the temperature of the CPU gets too high.

10.4.3.6 Bit 5: Low PT100 temperature

This bit is set if the measured temperature of the external temperature sensor falls below the given threshold.

10.4.3.7 Bit 6: High PT100 temperature

This bit is set if the measured temperature of the external temperature sensor goes above the given threshold.

10.4.3.8 Bit 7: Sensor power fault

This bit is set if the sensor power driver detects a fault situation, either a short circuit or an open circuit.

10.4.3.9 Bit 8: Lost-coms

This bit is set if the PIO36 is without Modbus communication for at least the number of seconds given in the Lost-coms timeout register.

10.4.4 PWM Faults

This register is a bitmask of PWM output faults. Only the input register contains the actual values to read, and to clear the faults write the corresponding bit in the holding register to 1. Writing a value of 0 to a bit has no effect.

Bit 0 – 15 corresponds to PWM output fault 1 – 16.

10.4.5 Modbus Packet Count

This register contains the number of valid Modbus packets received that are addressed to this unit.

10.4.6 Modbus Dropped Packet Count

This register contains the number of Modbus packets dropped due to bad crc or other malformed packets. It does not count the number of valid packets received that are not addressed to this unit.

10.4.7 EEPROM write counter

This register contains the number of write cycles to the persistent storage.

10.5 System commands block

10.5.1 Sensor Power Enable

This register controls and show the state of the Sensor Power output. Writing a non-zero value to this register will enable the sensor power output (unless it is faulted and the ignore fault flag is not set).

10.5.2 Restart System

Writing a non-zero value to this register will restart the pio36 board.

10.5.3 EEPROM flush command

Writing a non-zero value to this register will flush any pending changes down to the persistent storage.

10.5.4 EEPROM cleanup command

Writing a non-zero value to this register will prune any unused values from the persistent storage. This is normally not needed but may be necessary after a firmware update.

10.5.5 RS232 terminal mode

Writing a non-zero value to this register will set the RS232 interface into terminal mode. If this interface is used for Modbus communication, it will respond to its current packet before switching.

10.5.6 RS485 terminal mode

Writing a non-zero value to this register will set the RS485 interface into terminal mode. If this interface is used for Modbus communication, it will respond to its current packet before switching.

10.6 PWM block

10.6.1 PWM duty

These registers control the duty of the PWM outputs. A value of 0 (or less, including -inf and NaN) is fully off and a value of 100 (or more, including +inf) is fully on.

10.6.2 PWM synchronization command

Writing a non-zero value to this register synchronizes the dither counters.

10.6.3 PWM Ignore faults

This register is a bitmask for the 16 pwm output, bit 0 – 15 corresponds to PWM output 1 – 16. If the corresponding bit is set that output ignores the fault bit, preventing the output to be disabled if a fault occurs and allows enabling it if a fault has not been cleared.

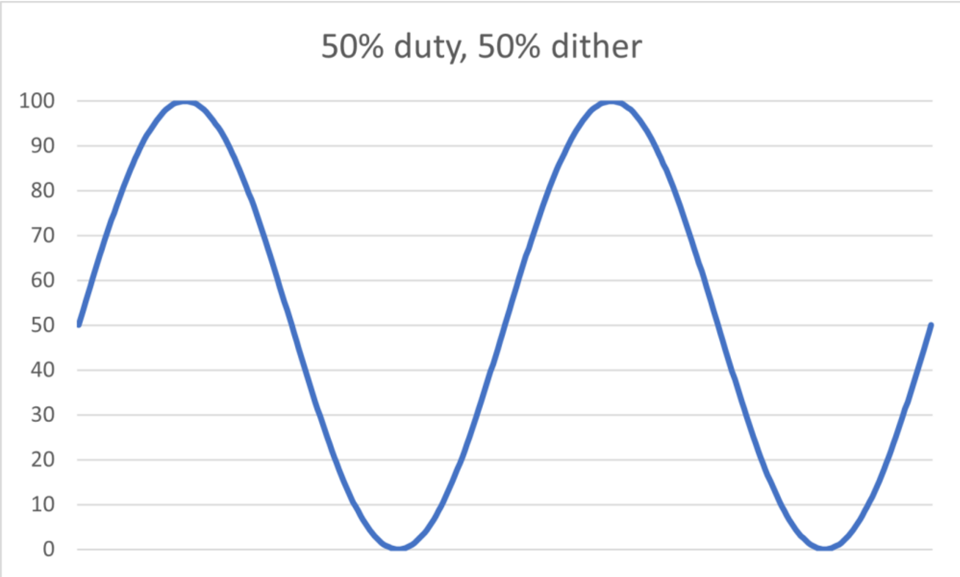
10.6.4 PWM Frequency

These registers control the PWM frequency of the outputs in Hz. The outputs are grouped by 4 which must have the same PWM frequency. Values written to these registers are limited (and clipped to if outside) to the range 1 – 500 Hz.

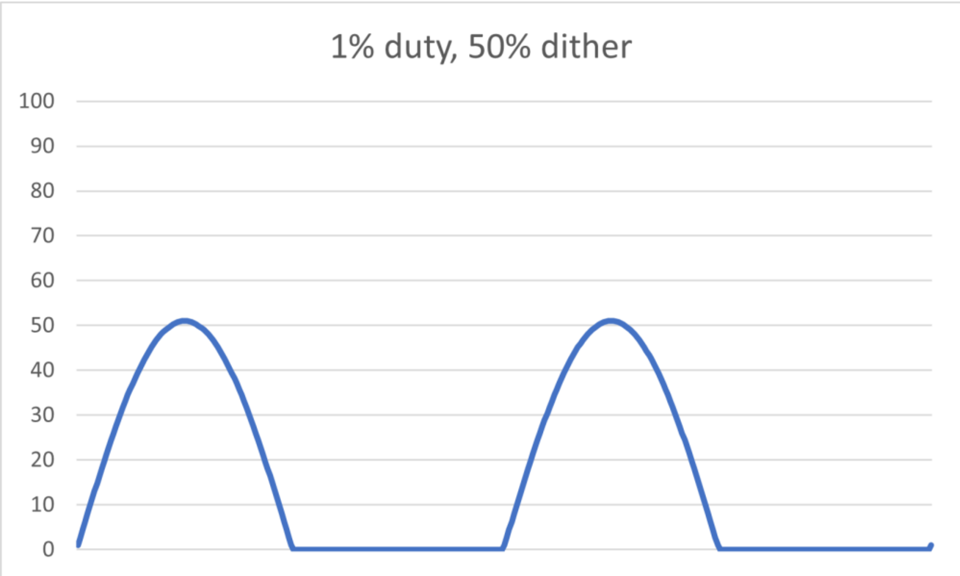
10.6.5 PWM dither duty

These registers control the dither of each output. The value is given the same as for PWM duty but represent the amplitude of a sine wave that modifies the PWM duty. The combined duty is clipped the same way as the PWM duty is.

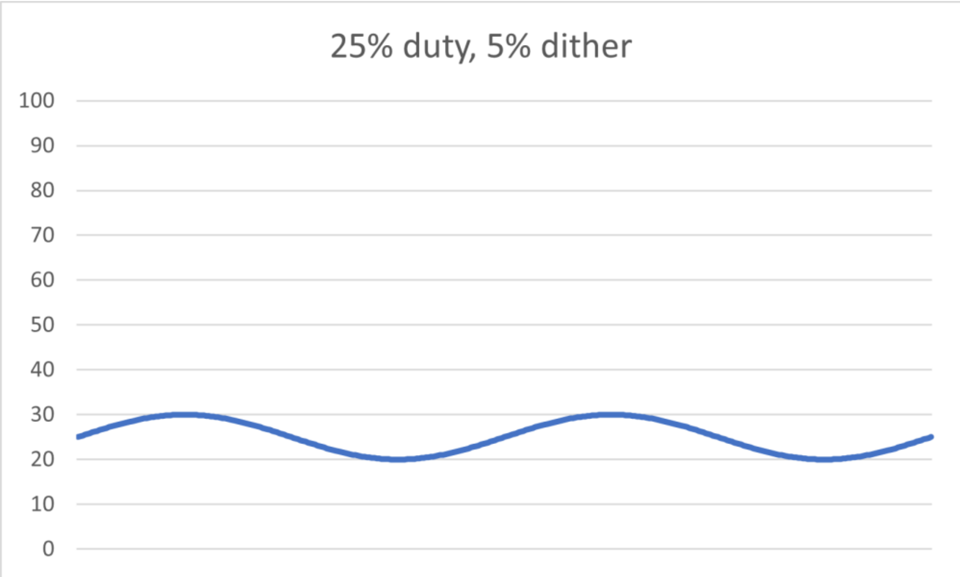
Note: If the PWM duty is set to 0 or below or to 100 or above, the dither is disabled.



Example 1: A PWM duty of 50 and a PWM dither duty of 50 results roughly in a sine wave with peak to peak of 0 – 100.



Example 2: A PWM duty of 1 and a PWM dither duty of 50.

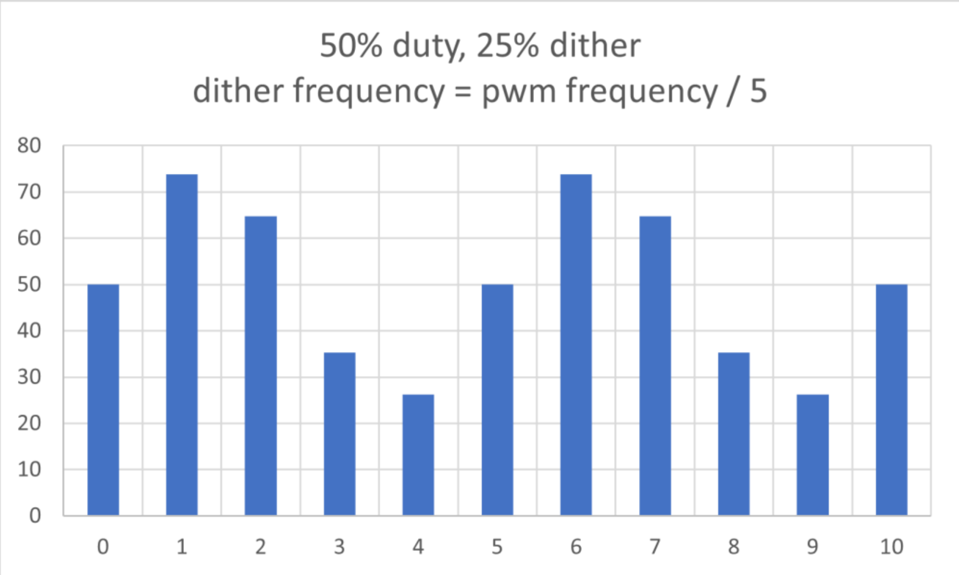


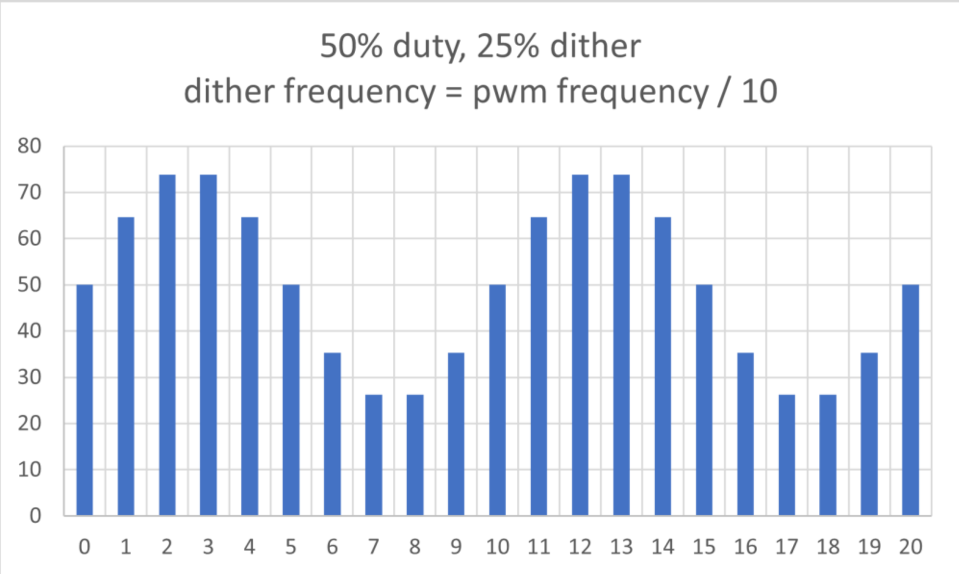
Example 3: A PWM duty of 25 and a PWM dither duty of 5.

10.6.6 PWM Dither Frequency

These registers control the PWM dither frequency in Hz. The dither is calculated every on every PWM update, thus dither frequencies above the Nyquist of the PWM frequency will not work. The ratio between the PWM frequency and the dither frequency gives the number of updates per dither period.

Example: With the dither frequency at a tenth of the PWM frequency the sine wave shape is more pronounced than when the dither frequency is a fifth of the PWM frequency.





10.6.7 PWM dither phase

These registers control the PWM dither phase offsets in degrees (0 – 360).

10.7 Sensors block

10.7.1 Supply voltage

This register contains the measured supply voltage in volt.

10.7.2 Supply current

This register contains the measured current in Ampere to the PWM outputs and the sensor power output.

10.7.3 CPU temperature

This register contains the measured CPU temperature in degrees Celsius.

10.7.4 PT100 sensor

This register contains the measured temperature from the PT100 sensor in degrees Celsius.

10.7.5 Analog Input Channels (mA/V)

Theses registers contains the measured current in mA. The first four channels can also measure voltage, dependent on switches on the board. If the switch is set in voltage mode, the current register will read as NAN otherwise if the switch is set to measure current the voltage register will read as NAN.

10.7.6 Analog Input voltage flags

This register is a bitmask with bit 0 – 3 showing if Analog Input Channel 1 – 4 is in voltage measuring mode. If the bit is set the channel measures voltage, otherwise it measures current.

10.7.7 Analog Input Channel (Scaled)

These registers contain the scaled value of the Analog input channels.

10.7.8 Digital Input levels

This register contains the current logical level of the digital inputs. Bit 0 – 3 corresponds to digital input 1 – 4.

10.7.9 Digital Input Counts

These registers contain the number of rising edges detected on the digital input. Reset the count back to 0 by writing a non-zero value to the holding register.

These registers may only be read through the input register and will always read as zero from the holding registers.

10.7.10 Digital Input Frequency

These registers contain the calculated frequency in Hz of the digital inputs.

10.7.11 Encoder 1 count

This register contains the gray2 count of combining digital input channel 1 and 2. Writing a non-zero value to the holding register resets the count back to 0.

This register may only be read through the input register and will always read as zero from the holding register.

10.7.12 Encoder 2 count

This register contains the gray2 count of combining digital input channel 3 and 4. Writing a non-zero value to the holding register resets the count back to 0.

This register may only be read through the input register and will always read as zero from the holding register.

10.7.13 Encoder Frequency

These registers contain the frequency in Hz of the encoder inputs.

10.7.14 Flow

These registers contain the flow values calculated from the digital input frequency from a flowmeter.

10.7.15 Accumulated Flow

These registers contain the accumulated flow values calculated from the digital input counts. These registers are zeroed when the corresponding digital input count is reset.

10.8 Sensor configuration block

10.8.1 Analog input range, gain and offset

These registers define the scaling values for the 4-20 mA sensor on the associated analogue input channel.

The values are scaled using the following formula:

$$Ain = \frac{mA}{20-4} * range * gain + offset$$

These registers are stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.8.2 PT100 gain and offset

These registers define calibration values for the PT100 sensor.

These registers are stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.8.3 Flow K-factors

These registers give the K-factors in pulses per litre for scaling the flow measurements.

These registers are stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.8.4 Analog Input Filter Constants

These registers define the filter for the analogue inputs. The filter is a simple IIR filter and the value is the fraction of previous measurement to use. A value of 0 results in an unfiltered value being used, and a value of 1 means the value will not be updated. Values below 0 or at and above 1 should not be used.

These registers are stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.8.5 PT100 Filter constant

This register defines the filter for the PT100 sensor. The filter is a simple IIR filter and the value is the fraction of previous measurement to use. A value of 0 results in an unfiltered value being used, and a value of 1 means the value will not be updated. Values below 0 or at and above 1 should not be used.

These registers are stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.8.6 PT100 Low Limit and PT100 High Limit

These registers define the alarm thresholds for respectively low and high PT100 temperature alarms.

These registers are stored in the persistent storage and must be flushed if it is to be remembered at next power cycle or restart.

10.9 Calibration block

10.9.1 Analog input raw value

These registers contain the raw value from the analogue input ADC.

10.9.2 Analog Input mA Gain and Offset

These registers contain the calibration values for the milliamperes measurement on the analogue inputs.

10.9.3 Analog Input V Gain and Offset

These registers contain the calibration values for the voltage measurements on the analogue inputs.

10.9.4 Supply Voltage Gain and Offset

These registers contain the calibration values for the supply voltage measurement.

10.9.5 Supply Current Gain and Offset

These registers contain the calibration values for the supply current measurement.

10.9.6 CPU Temperature Gain and Offset

These registers contain the calibration values for the CPU temperature measurement.

10.9.7 Raw Water Alarm value

This register contains the raw ADC value for the water intrusion detector.

10.9.8 WA pin time

This register contains the time in milliseconds the water intrusion detector probes for water.

10.9.9 WA wait time

This register contains the time in milliseconds between activating the water detector.

10.9.10 WA Limits

These registers define the allowed range for the water probe, used for triggering the WA alarm.

10.9.11 Supply Voltage Limits

These registers define the allowed range for the supply voltage, used for triggering the supply voltage alarms.

10.9.12 Supply Current Limits

These registers define the allowed range for the supply current, used for triggering the supply current alarm.

10.9.13 CPU Temperature Limits

These registers define the allowed range for the CPU Temperature, used for triggering the CPU temperature alarm.

10.9.14 Supply Voltage Filter Constant

This register defines the filter for the supply voltage. The filter is a simple IIR filter and the value is the fraction of previous measurement to use.

10.9.15 Supply Current Filter Constant

This register defines the filter for the supply current. The filter is a simple IIR filter and the value is the fraction of previous measurement to use.

10.9.16 CPU Temperature Filter Constant

This register defines the filter for the CPU temperature. The filter is a simple IIR filter and the value is the fraction of previous measurement to use.

Appendix A – Declaration of Conformity