

1. Features

- **Integrated PHT sensor**
- **Isolated open-drain output**
- **Programmable CANopen interface**
- **On-board self-monitoring**
- **Field firmware updates over CAN**
- **Wide DC supply**
- **Compact 50 × 30 mm PCB**
- **Fully configurable via Object Dictionary**

2. Applications

- Environmental sensing on a CAN bus
- Remote isolated DC load switching
- Autonomous threshold and alarm logic
- Self-diagnostic CANopen node
- Smart sensor / actuator endpoints

3. Description

The Pressor is a programmable CANopen sensor and actuator node in a compact form factor. It combines an integrated pressure - humidity - temperature (PHT) sensor, a board self-monitoring chain and one galvanically isolated low-side switch, exposing everything over a CAN bus.

Built on a 32-bit Arm Cortex-M0 microcontroller, the device runs a configurable application firmware on top of an industry-standard CANopen stack. Calibration, thresholds and output behaviour are entries of the Object Dictionary – retuned in the field over the bus, with no reflash required.

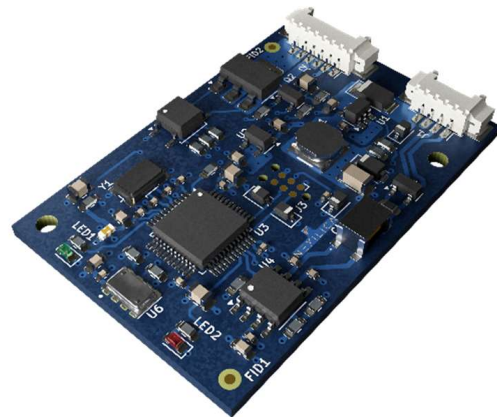


Figure 1: Pressor



4. Technical Characteristics

Absolute maximum ratings

Stresses beyond those listed in [Table 1](#) may cause permanent damage to the device. These are stress ratings only; functional operation at or beyond the values listed under *Electrical characteristics* is not implied.

PARAMETER	MIN	MAX	UNIT
Supply voltage	-33	33	V
Storage temperature	-40	+85	°C
Output drain-source voltage	—	60	V
Output peak drain current (single pulse)	—	9	A
Overpressure	—	6000	mbar

Table 1: Absolute maximum ratings



Electrical characteristics

PARAMETER	MIN	TYP	MAX	UNIT
Supply voltage	9	12	28	V
Supply current	—	20	35	mA
Operating temperature	-25	—	+85	°C
Operating pressure range	300	—	1300	mbar
Extended pressure range ⁽¹⁾	10	—	2000	mbar
Humidity range	0	—	100	% RH
Temperature range	-40	—	+85	°C
Resolution pressure (OSR 8192)	—	0.016	—	mbar
Resolution humidity (OSR 4096)	—	0.04	—	% RH
Resolution temperature (OSR 8192)	—	0.002	—	°C
Output supply	10	—	37	V
Output current	—	—	2	A

Table 2: Electrical characteristics

⁽¹⁾ Outside the linear operating range of the pressure cell. Refer to [Figure 3](#) for typical absolute error versus pressure across the specified temperature range.

Sensor oversampling (OSR)

The on-board PHT sensor integrates two independent ADCs: a 24-bit converter for the piezo-resistive pressure/temperature cell, and a 14-bit converter for the capacitive humidity cell. Both ADCs support per-conversion oversampling (OSR) control, letting the firmware tune the balance between resolution and throughput on each reading. On the pressure/temperature ADC, conversion time ranges from 0.56 ms at OSR 256 to 17.2 ms at OSR 8192; the humidity ADC ranges from 2.12 ms at OSR 256 to 15.89 ms at OSR 4096 ([Table 3](#) lists the full set of operating points). The two ADCs expose distinct OSR ranges



and are configured through different interfaces:

- **Pressure / Temperature ADC** – OSR 256, 512, 1024, 2048, 4096, **8192** (max). The setting is encoded in the conversion command itself, so it can be changed on every reading.
- **Humidity ADC** – OSR 256, 1024, 2048, **4096** (max). The setting is written once into the sensor’s user register and applies to all subsequent humidity reads until changed.

Consequently the resolution figures in Table 2 are quoted at the maximum OSR available on each ADC – OSR 8192 for pressure and temperature, OSR 4096 for humidity.

OSR	P res. [mbar]	T res. [°C]	H res. [% RH]	Conv. P/T [ms]	Conv. H [ms]
8192	0.016	0.002	—	17.2	—
4096	0.021	0.003	0.04	8.61	15.89
2048	0.028	0.004	0.09	4.32	8.03
1024	0.039	0.006	0.18	2.17	4.08
512	0.062	0.009	—	1.10	—
256	0.11	0.012	0.7	0.56	2.12

Table 3: PHT sensor: RMS resolution and max conversion time per OSR. The humidity ADC only supports OSR 256, 1024, 2048, 4096; “—” marks unsupported settings or values not specified by the silicon vendor.

PHT accuracy

Absolute accuracy of the on-board PHT sensor, in the conditions specified by the silicon vendor. The @ 25 °C row applies when the device is operated near room temperature; the over-temperature row applies across the sensor’s full -20 to +85 °C range.

CONDITION	Pressure	Humidity	Temperature
@ 25 °C	±2 mbar	±3 % RH	±1 °C
-20 to +85 °C	±4 mbar	±5 % RH	±2 °C

Table 4: Absolute accuracy of the PHT sensor. Pressure range 300–1100 mbar; humidity range 20–80 % RH @ 25 °C and 5–95 % RH over temperature.



Typical pressure error in linear range

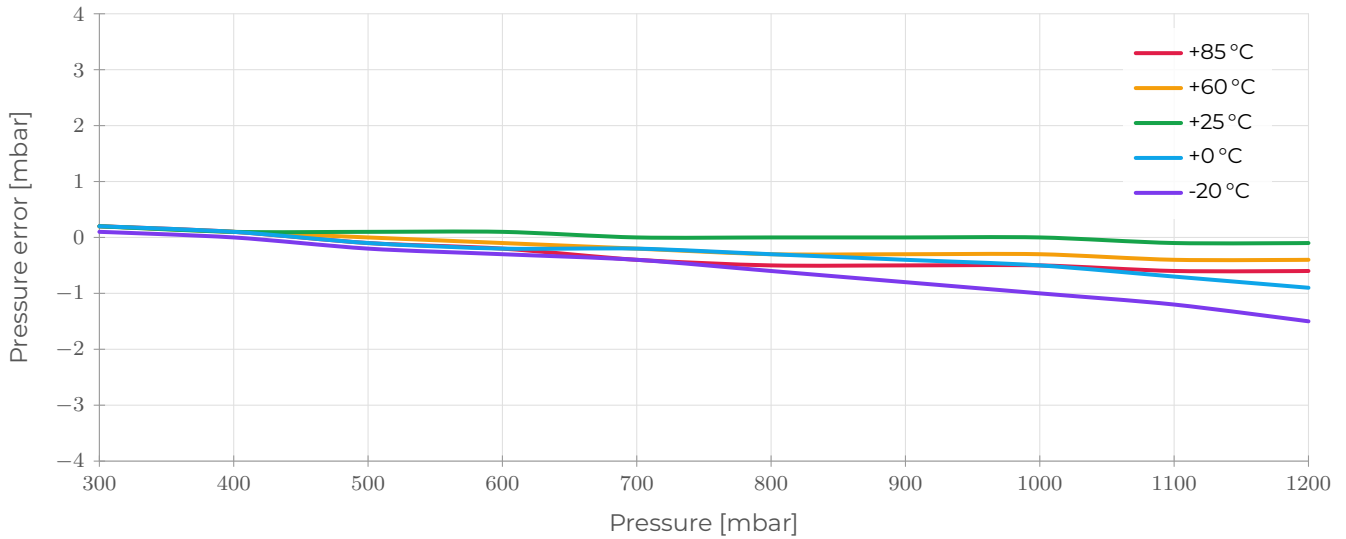


Figure 2: Typical absolute pressure error with 2nd-order compensation in the linear operating range.

Typical pressure error in extended range

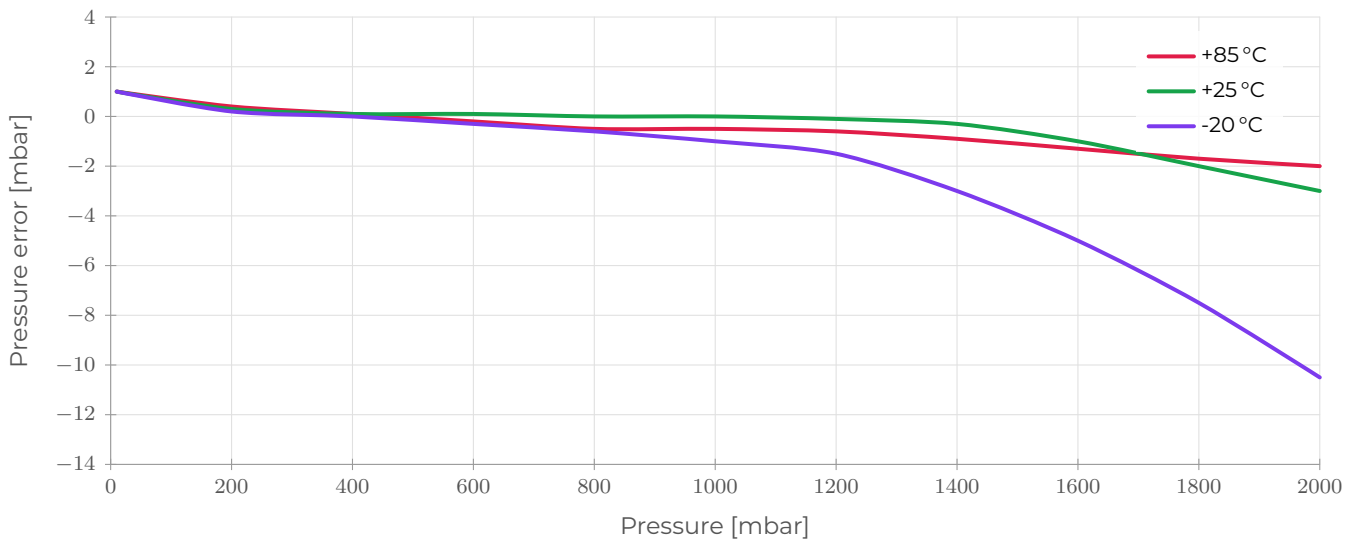


Figure 3: Typical absolute pressure error with 2nd-order compensation across the extended pressure range.

Typical humidity error accuracy @ 25°C

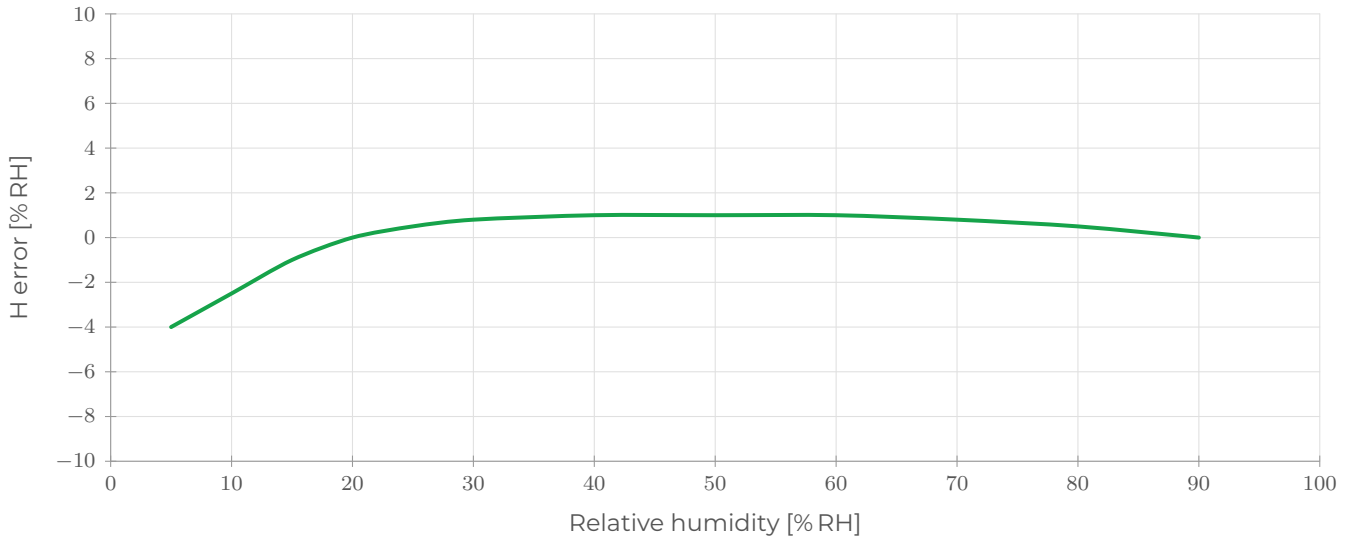


Figure 4: Typical relative humidity error vs. relative humidity @ 25°C.

Typical temperature error with 2nd-order compensation

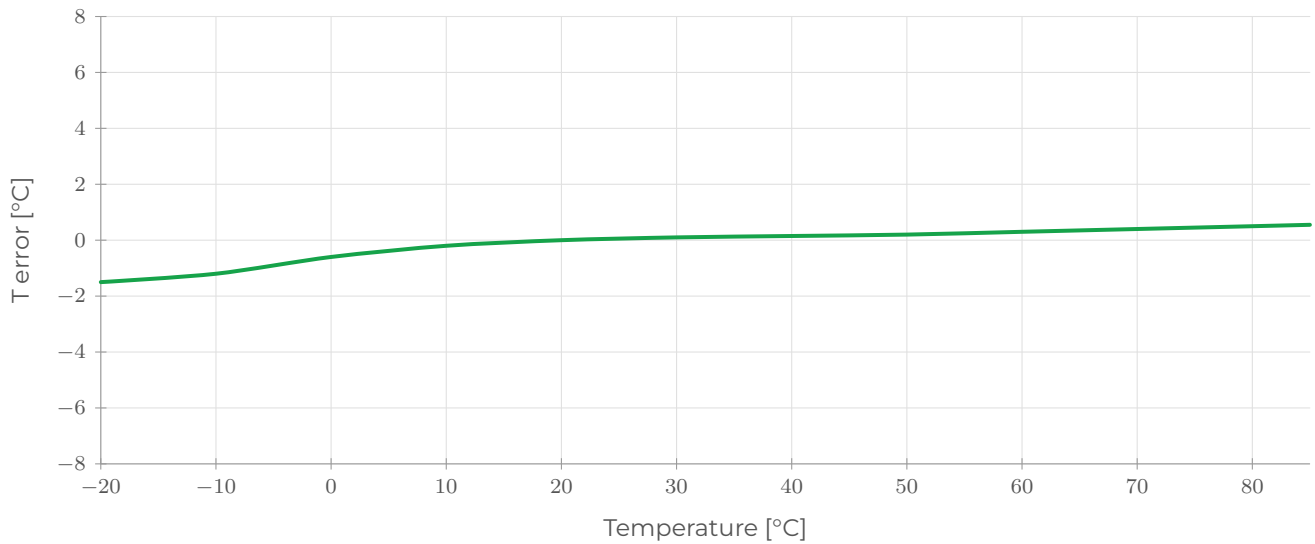


Figure 5: Typical temperature error vs. temperature with 2nd-order compensation.

5. Connectors pin-out

The board exposes two Molex PicoBlade headers. J1 carries the board supply and the CAN bus; J2 brings out the isolated output stage to the external load. No other electrical interface is fitted.

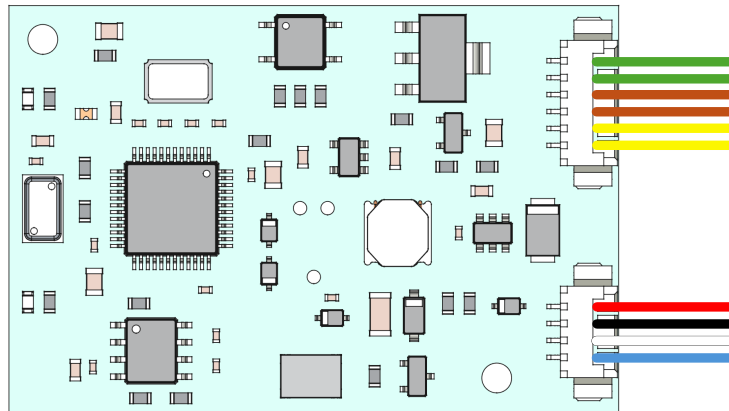


Figure 6: Connectors layout and pin assignment

PIN	SIGNAL	WIRE	RANGE	DESCRIPTION
1	CAN_L	● Blue	0 – 3.3V	CAN bus low (ISO 11898-2)
2	CAN_H	● White	0 – 3.3V	CAN bus high (ISO 11898-2)
3	VDD	● Red	9 – 28 V	Board supply
4	GND	● Black	0V (ref.)	Board return

Table 5: J1 – main connector (4-pin Molex PicoBlade, MPN 53261-0471)



PIN	SIGNAL	WIRE	RANGE	DESCRIPTION
1, 2	V_PU_EXT	● Yellow	10 – 37 V	External pull-up supply for the open-drain MOSFET output
3, 4	GND_EXT	● Brown	0 V (ref.)	External load return, isolated from board GND
5, 6	MOS_D	● Green	0 – 37 V, ≤ 2 A	MOSFET drain, open-drain to load

Table 6: J2 – output connector (6-pin Molex PicoBlade, MPN 53261-0671)

When wiring the load to J2, connect pins 1–2 (V_PU_EXT), 3–4 (GND_EXT) and 5–6 (MOS_D) using independent wires per pin. The pins are paralleled on the PCB for current capability; doubling them up in the harness is what enables the 2 A rating.

6. System architecture

The Pressor integrates sensing, processing, communication, and actuation into a single self-contained node. The architecture is organised around three functional planes: an *acquisition plane*, comprising the on-board PHT sensor and the board self-monitoring chain; a *control plane*, built around the microcontroller and its CANopen application stack; and an *actuation plane*, consisting of the galvanically isolated low-side switch that drives the external load.

The microcontroller orchestrates all three planes. It samples the sensors over an I²C link at an Object-Dictionary-configurable rate, executes the user application logic – thresholds, hysteresis, alarm latching, output patterns – and exchanges process and configuration data on the CAN bus through PDOs, SDOs, and EMCY frames. A parallel self-monitoring task reports supply voltage, board temperature, sensor liveness, and bus health back to the host using the same Object Dictionary as the user-facing channels, so a host can distinguish a healthy device from a degraded one without external instrumentation.

Galvanic isolation is concentrated where the operating risk is highest: between the control side (CAN, sensing, MCU, power supply) and the actuation side. The external load can be powered from an independent supply rail at a different reference potential without disturbing the rest of the board. All persistent configuration – calibration, thresholds, output behaviour, CAN parameters – lives in microcontroller flash, is CRC-protected, and is updated over the bus; routine retuning does not require reflashing firmware, and the field-deployable board exposes no debug interface.

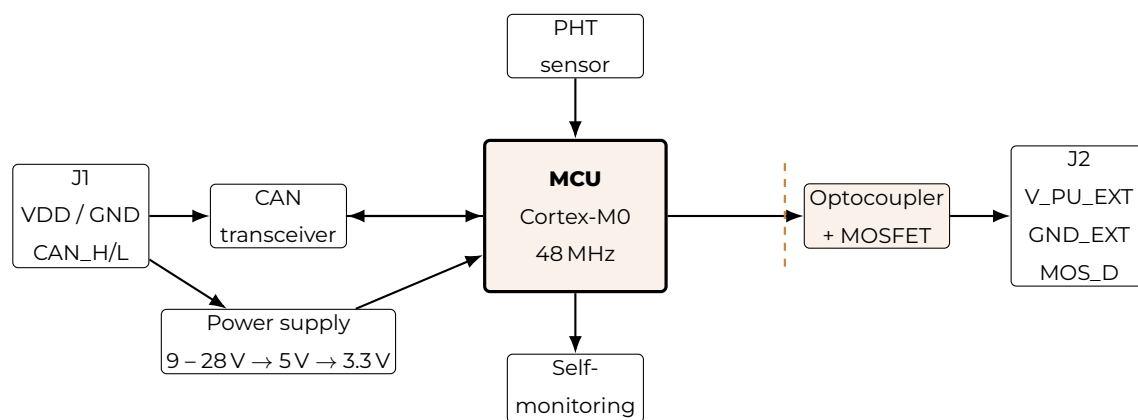


Figure 7: System block diagram. The dashed line marks the galvanic isolation between the control side and the output stage.



7. Hardware

7.1 Power supply

The board operates from a single 9–28V DC input. Reverse-polarity protection is provided by a series Schottky diode; fast transients on the supply line are clamped by a wide-band TVS. A synchronous buck converter generates a 5V intermediate rail for the CAN transceiver and for the input network of the output optocoupler. A low-noise LDO derives the 3.3V rail that supplies the microcontroller, the PHT sensor and the I²C pull-up network. Quiescent input current is 20–35 mA over the full input range.

7.2 MCU subsystem

The processing core is a 32-bit Arm Cortex-M0 microcontroller clocked at 48MHz, with 128kB of program flash and 16kB of SRAM. The peripheral complement includes a native Classic-CAN controller, a multi-channel ADC with DMA, and the timer and communication blocks required by the application firmware.

7.3 CAN front-end

The CAN interface complies with ISO 11898-2 (Classic CAN). A 3.3V single-channel transceiver interfaces directly with the microcontroller logic and produces a 2V (typ.) differential dominant signal on the bus. A common-mode choke and an ESD/EFT protection network are inserted between the transceiver and the connector. The CAN side shares the board reference; galvanic

isolation is implemented on the output stage (see [Isolated output stage](#)).

7.4 PHT sensor

A combined pressure, humidity and temperature sensor with factory calibration coefficients is fitted on the board and communicates with the microcontroller over I²C. Measurement ranges are 10–2000 mbar absolute pressure, 0–100 % RH and -40 to +85 °C. Relative-pressure and dew-point channels are derived in firmware from the primary measurements.

7.5 Self-monitoring

A DMA-driven ADC chain samples the supply voltage through a resistive divider with low-pass filtering, an on-board NTC thermistor placed close to the DC-DC inductor, and the microcontroller internal temperature and voltage references. The acquired values feed configurable supply-voltage and temperature window comparators and the power-loss save sequence described in [Firmware](#).

7.6 Isolated output stage

A galvanically isolated low-side switch is implemented with an optocoupler driving an N-channel MOSFET. The control side and the load side share no electrical reference. The load supply may range up to 37V; maximum continuous drain current is 2A. Supported



output modes are static on/off, periodic blink with optional pause phase, and software-PWM fade-in / fade-out transitions.

7.7 Status indicators

Two surface-mount LEDs are driven by the CANopen stack as the RUN (green) and ERR (red) indicators specified by CiA 303-3. Both LEDs are visible from the top side of the board in any open-frame mounting.

PATTERN	STATE (CiA 303-3)
Green: single flash	STOPPED
Green: blinking	PRE-OPERATIONAL
Green: on	OPERATIONAL
Red: off	No CAN error
Red: single flash	Bus error frame
Red: blinking	Heartbeat / SYNC event
Red: on	Bus-off

Table 7: Status indicator code

7.8 Connectors and mounting

External electrical interfacing is implemented through two Molex PicoBlade headers (4-pin J1 and 6-pin J2). Two M2 mounting holes are provided on the PCB. The board is shipped without enclosure; mechanical integration is the responsibility of the system integrator.

7.9 Programming and field update

Initial programming is performed on the production line through the SWD test pads on the PCB. Subsequent firmware updates are pushed over the production CAN bus through the on-board bootloader; no debug interface is exposed on the field-deployable board.



8. Firmware

8.1 Architecture

The application firmware runs on a real-time operating system in two tasks: a higher-priority task owns the sensor pipeline and the output state machine, a lower-priority task owns the CANopen stack and the self-monitoring chain. Cross-task communication happens through the Object Dictionary, with a single-writer convention per entry.

8.2 Boot and initialization

Reset enters the bootloader, which either accepts a firmware update on CAN within a short backdoor window or hands over to the application. The application relocates its vector table, brings up the peripherals, loads the persistent configuration from flash and starts the RTOS scheduler. From reset to the first application loop iteration is in the order of one and a half seconds, dominated by the bootloader backdoor wait.

8.3 CANopen stack

A CiA 301-compliant stack provides NMT, SDO server, TPDOs, RPDOs, EMCY producer, heartbeat and LSS. PDO mapping and timing are configurable at runtime through standard CANopen objects. A bus-health monitor wraps the standard error counters in a state machine that can optionally drive an automatic recovery from PRE-OPERATIONAL after a transient fault.

8.4 Sensor pipeline

The PHT sensor is sampled at an OD-configurable period; raw readings are compensated using the device's PROM coefficients and exposed in engineering units in the Object Dictionary. A freeze detector watches for stuck readings or absent I²C acknowledges and can re-initialise the bus on demand. Per-quantity gain / offset calibration is configurable via the OD.

8.5 Alarm and output engine

The firmware evaluates a configurable threshold with hysteresis on the sensor reading and drives the isolated output accordingly. Output modes include steady on/off, blink with configurable period and optional pause phase, and software-PWM-driven fade-in / fade-out transitions. The alarm decision is taken locally; the host observes the result via PDO or EMCY but is not in the loop.

8.6 Configuration and storage

All user-facing parameters live in the Object Dictionary. A subset is mirrored to internal flash, protected by a hardware CRC32 and validated at every boot. On checksum mismatch the firmware falls back to safe defaults; the host can then re-push the deployment-specific configuration. Forward-compatible migration is supported across firmware versions.



8.7 Diagnostics and recovery

The firmware reports CAN bus state, sensor freeze events, supply window violations and uptime statistics through the Object Dictionary and through CANopen EMCY frames. The independent watchdog (IWDG) catches runtime faults; on power loss the cumulative uptime counter is written to flash through an emergency-save sequence that completes within the residual energy of the on-board bulk

capacitance.

8.8 Field firmware update

Application firmware updates are pushed over the production CAN bus through the OpenBLT-based bootloader, using XCP-over-CAN. No external programmer or debug interface is required after first programming, which keeps the field-deployable board free of exposed debug connectors.



9. Use cases

The Pressor is designed as a general-purpose programmable node, not a fixed-function pressure switch. Specific deployments combine one or more of the application families below into a single configuration of the same hardware and firmware.

9.1 Sense

Publish absolute pressure, relative humidity, temperature, dew point, supply voltage and board temperature on the bus, with per-channel calibration and configurable PDO mapping. Useful as an environmental reference, a calibration-bench node or a climate sensor on a CAN backbone.

9.2 Actuate

Drive any DC load within the 10 – 37V / 2A envelope through the isolated output: pilot lamps, signal LEDs, beacons, DC solenoids, small valves, relay or contactor coils, resistive heaters, DC buzzers and sirens. The output can be controlled locally by the alarm engine or directly from the bus through an RPDO or SDO write.

9.3 Alarm

Run autonomous threshold logic on any measurement, with hysteresis, configurable output pattern and optional EMCY notification. Latching and non-latching modes, pre-alarm / alarm pairs and window-style alarms (out-of-band) are all supported.

9.4 Monitor

Report the device's own state on the bus – CAN bus health, sensor freeze events, supply-voltage window violations, MCU and board temperature, cumulative uptime and high-temperature exposure. The diagnostic surface lets a host distinguish a healthy device from a degraded one without external instrumentation.

9.5 Compose

Combine the families above into a self-contained smart node. Examples include a smart pressure switch (sense + alarm + actuate + monitor), a stand-alone climate node with a heater output, an autonomous vent controller on a pressurised vessel, a high-rate environmental publisher, and a distributed safety witness emitting latched EMCYs across an installation.

10. Mechanical dimensions

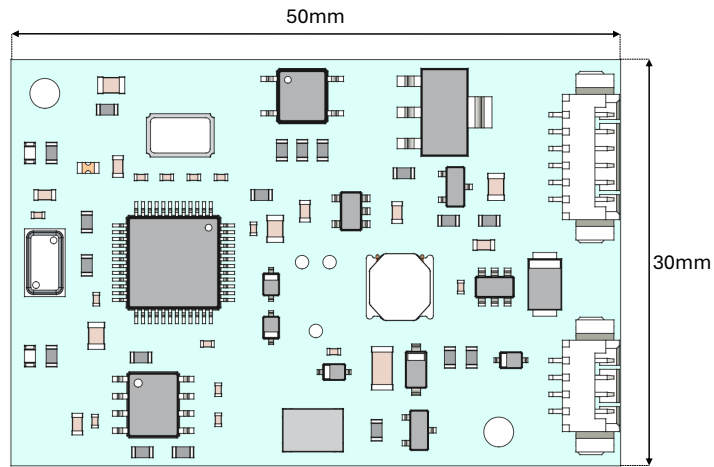


Figure 8: Board outline and overall dimensions

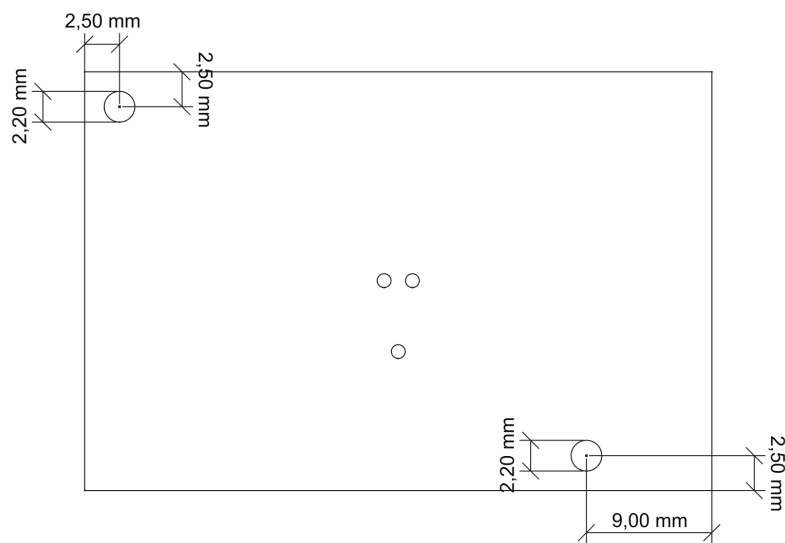


Figure 9: Board holes dimensions