Prime3RP

Reduced Power Infrared Gas Sensor

Reduced-power infrared Carbon dioxide measurement — 15 mA average typical operating current, with 0.4–2.0 V linear voltage output.



0.01 % vol
Digital resolution over 0–6 % vol

15 mA
Average typical operating current

3.0–5.0 V
45 mW typical power at 3.0 V supply

01 Key Features

- **Operates independent of supply polarity** — simple, polarity-independent integration
- 0.4–2.0 V linear voltage output plus UART serial communications
- **Sensing ranges** — 0–10 % volume up to 0–100 % volume CO_2
- **Flexible electronic configuration access** — wide operating temperature range
- **Microprocessor-generated linear voltage output** — independent of supply polarity
- **Operating voltage range 3.0 V – 5.0 V** — 15 mA average typical operating current
- **All metal construction with isolated housing** — small internal volume
- **Fast response** — immunity from 'poisoning'

02 At a Glance

ITEM	SPECIFICATION
Target gas	Carbon dioxide
Measuring ranges	0–10 % volume up to 0–100 % volume CO_2
Minimum resolution	At zero <0.5% of range. At range: <2% of range
Output formats	linear voltage, serial communications
Supply voltage	3.0 V – 5.0 V (15 mA average typical)
Response time (T90)	< 30 s
Operating temperature	−30 °C to +50 °C
Weight	18.0 g
Approvals / IP	Not Ex approved; house in a suitable Ex enclosure in hazardous areas
Patent	GB2449433

Operation & carbon dioxide response

03 Description and Operation

The Prime3RP sensor uses the non-dispersive infrared method to detect the presence of carbon dioxide. The sensor contains an infrared radiation source, a dual element custom infrared detector, a unique optical waveguide into which gas diffuses and internal microprocessor-based electronics to provide a voltage output which is independent of the power supply polarity.

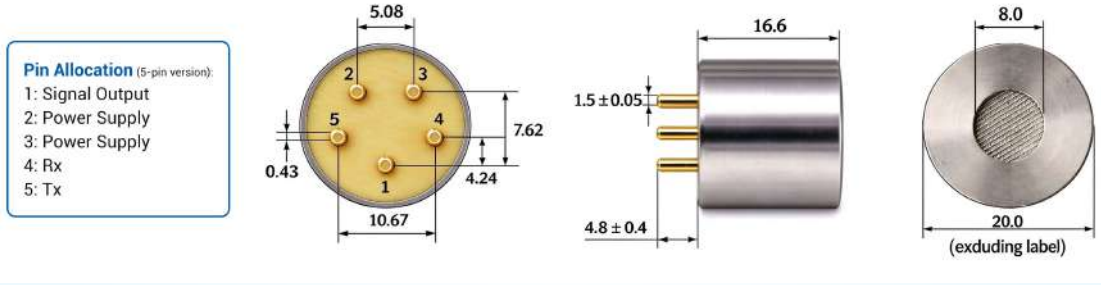
The sensor provides a linear voltage output, typically 0.4 V – 2.0 V over range with respect to the negative supply pin. In addition, the output can be read and the internal configuration can be accessed by a serial communication link. The communication link contacts are pads in the 3-pin version Prime3RP. The linear voltage output is referenced to the negative supply pin and is independent of supply polarity.

The internal electronics perform all the functions of driving the optical parts of the sensor, extracting the detector signals, converting the signals to a concentration, applying temperature compensation and scaling the output. The Prime3RP is not currently Ex approved so should be housed in a suitable Ex enclosure when used in hazardous areas.

Technical support on implementation and application notes are available from Clairair Limited.

04 Pin Allocation (5-pin version)

All dimensions in millimetres (±0.1 mm unless noted). Rx and Tx are pads in the 3-pin format. The sensor body is an all-metal construction with an isolated housing and a small internal volume. Mechanical outline drawings, 3-pin and 5-pin footprint details, and recommended PCB socket information are available from Clairair on request.



05 Carbon Dioxide Response Characteristics

Unless otherwise specified, the Prime3RP is calibrated during manufacture to provide a high-resolution output signal linearised over the range 0–100 % volume CO_2.

OUTPUT RESOLUTION

0.01 % vol DIGITAL / 0–6 % vol	**0.1** % vol DIGITAL / 6–100 % vol	**0.04** % vol VOLTAGE / 0.4–2.0 V	**CO_2** Dedicated detection

⚠ **Dedicated to carbon dioxide detection. For hydrocarbon or methane applications, use PrimePell or Prime-PellRP.** Typical response characteristics are available from Clairair on request.

Performance & diagnostics

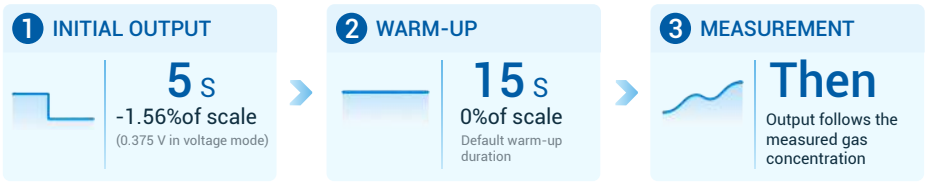
06 Performance and Diagnostics

6.1 Temperature Compensation

The Prime3RP is temperature compensated for both zero and span at the calibration gas concentration level.

6.2 Sensor Warm-up

When power is first applied or when a reset has occurred or during automatic recovery from a fault condition the Prime3RP outputs −1.56 % of scale (0.375 V in voltage mode) for 5 seconds then outputs 0 % of scale for a warm-up period (default is 15 seconds). After this time the output follows the extracted gas value.



6.3 Fault Indication

The Prime3RP continuously monitors several internal parameters to ensure that the internal hardware and software are operating correctly. If a fault condition is detected, the voltage output is set to 0 V. Some faults are recoverable (e.g. a brown-out in the incoming supply voltage) and the Prime3RP continuously checks for possible recovery. If a fault can be recovered from, the output follows the sensor warm-up sequence before following the extracted gas value.

6.4 Reliability — Failure Modes Effects and Diagnostic Analysis (FMEDA)

An FMEDA on the Prime3RP produced the following summary results.

ITEM	VALUE
Conditions	Ground fixed, JAN to MILHDBK217F
Subsystem type	B (complex, using microcontrollers or programmable logic)
Hardware fault tolerance	0
Mode	High demand (continuous use of operation)
Probability of dangerous failure per hour	9.5×10^{-7}

ITEM	VALUE
λSD	921 FIT
λSU	3 FIT
λDD	859 FIT
λDU	96 FIT
SFF	94.9 %

07 Output Formats

The Prime3RP provides a linear voltage output independent of supply polarity.The output is not a bridge (ratiometric) output; it is a ground-referenced linear voltage generated by the internal microprocessor.

Linear voltage

0.4–2.0 V

0.4 V – 2.0 V over range with respect to the negative supply pin

Serial communications

Rx / Tx

Output can be read and the internal configuration accessed over a serial link (pads in the 3-pin version, pins in the 5-pin version)

Ratings & specification

08 Absolute Maximum Ratings

Ambient temperature range

−40 °C to +80 °C

Supply voltage (between pins 2 and 3)

5.5 V

09 Handling Precautions

Electrostatic sensitive devices

The Prime range of sensors contains electrostatic sensitive components. Anti-static handling precautions should be observed when handling these products.

Soldering and mounting

Soldering to the pins may seriously damage the sensor. Connections should be made via PCB sockets only.

- Recommended socket: Wearnes Cambion reference 450-3326-01-06-00
- 3-pin version: Rx and Tx are brought out as pads

10 Specification

Unless otherwise stated, all data was taken using: supply voltage 3.5 V; ambient temperature 20 °C to 25 °C; ambient pressure 995 hPa to 1020 hPa; gases diluted in nitrogen; gas flow rate 1 litre/min across the sensor face.

PARAMETER	VALUE
Supply voltage range	3.0 V – 5.0 V
Power consumption	45 mW typical at 3.0 V supply
Nominal ranges	0 – 100 % volume CO_2 (0 – 10 % volume CO_2 option)
Default output range — voltage mode	0.4 V – 2.0 V
Warm-up time — to operation	< 60 s
Warm-up time — to specification	< 3 minutes
Response time (T90)	< 30 s to a step change in gas concentration
Minimum resolution	At zero: 0.01 % of range (digital), 0.04 % of range (0.4 – 2.0 V analogue voltage) or 0.1 % of range (analogue pellistor mimic) / At range: 0.1 % of range
Zero repeatability	± 1 % of range
Accuracy	± 3 % of range up to 50 % of range; ± 5 % of range above 50 % of range
MTBF	> 5 years
Digital interface format	8 data bits, 1 stop bit, no parity
Digital interface baud rate	38 400 (default), 19 200, 9 600
Digital interface logic levels	VINL input low: < 0.8 V / VINH input high: > 2.0 V / VOL output low: < 0.4 V / VOH output high: > 2.4 V
Weight	18.0 grams
Vibration	Complies with EN 61779-1
Relative humidity	0 – 95 % RH non-condensing
Operating temperature range	−30 °C to +50 °C
Storage temperature range	−40 °C to +80 °C
Operating pressure range	700 – 1300 hPa

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Configure your Prime3RP

11 Ordering Information

The Prime3RP is available in the configurations listed below. Please specify the required configuration when ordering.

Prime3RP / 5 / 0–100% CO_2

Range:

0-10% vol
0-100% vo1
Q =Customized

Pin number & certification:

3 =3 pins Not Ex approved
5 =5 pins Not Ex approved
3Ex =3 pins with Ex approved
5Ex =5 pins with Ex approved

All Prime Reduced Power series sensors have both serial communications and analogue voltage outputs.

Please quote the model, pin configuration, calibration gas and range, LEL basis (where applicable) and output format with your order. For custom calibrations, quantities and lead times, please contact Clairair.

12 Contact and Support

Technical support on implementation and application notes are available from Clairair Limited.

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