Prime3

Voltage output Infrared
Gas Sensor for Carbon Dioxide

Patented GB2449433

Features

- High Resolution of 0.01% vol for 0-6% vol and 0.1%vol for 6 – 100% vol
- Operates independent of supply polarity
- Voltage or pellistor mimic bridge output
- Operating voltage range 3.0V – 5.0V
- Operating current 80mA typical
- Latest technology MEMS detectors
- Sensing ranges: 0-10% volume CO_2 up to 0-100%volume CO_2
- All metal construction with isolated housing
- Small internal volume
- Flexible electronic configuration access
- User calibration also enabled by hardware connections
- Wide operating temperature range
- Fast response

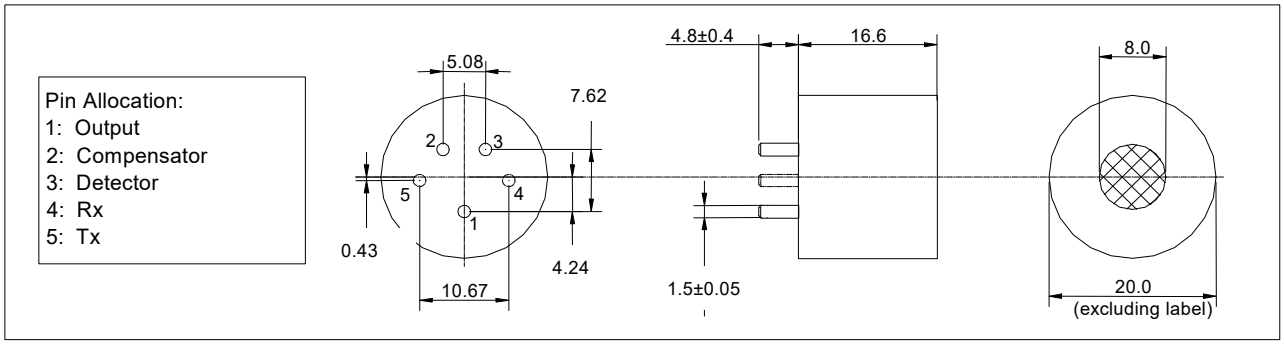
Description and Operation

The Prime3 sensor use the non-dispersive infrared method to detect the presence of carbon dioxide. The sensor contains an infrared radiation source, a dual element infrared detector, a unique optical waveguide into which gas diffuses and integrated ARM7 core microprocessor based electronics to provide a voltage output which is independent of the power supply polarity. The sensor can be configured to provide a linear voltage output, typically 0.4V – 2.0V over range with respect to the negative supply pin, or a pellistor format output, typically mid supply at zero with the voltage output increasing with respect to the detector pin by 100mV at range. In addition, the output can be read and the internal configuration can be accessed by a serial communications link. The communication link contacts are pads in the 3 pin version Prime3 and pins in the 5 pin version Prime3. 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. When in a pellistor configuration, the Prime3 can operate in existing pellistor circuitry subject to the power supply requirements. External components will be required to meet the power supply requirement when a Prime3 is used in constant current pellistor circuitry. The Prime3 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.

Outline Details

All dimensions in millimetres (±0.1mm unless noted)



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Temperature Compensation

The Prime3 is temperature compensated for both zero and span at the calibration gas concentration level.

Sensor Warmup

When power is first applied or when a reset has occurred or during recovery from a fault condition the Prime3 outputs –1.56% of scale (0.375V in voltage mode or –1.56mV in pellistor mode) for 5 seconds then outputs 0% of scale for a warmup period (default is 15 seconds). After this time the output follows the extracted gas value.

Fault Indication

The Prime3 continuously monitors several internal parameters to ensure that the internal hardware and software are operating correctly. If a fault condition is detected then the output is set to 0V in the case of a voltage output(equivalent to –25% FSD for a 4mA zero) or to approximately –200% scale in pellistor output, emulating a partly open compensator. Some faults are recoverable (e.g. a brown-out in incoming supply voltage) and the Prime3 continuously checks for possible recovery. If a fault can be recovered from then the output follows the sensor warmup sequence before following the extracted gas value.

Failure Modes Effects and Diagnostic Analysis (FMEDA)

An FMEDA on the Prime3 produced the following summary results:

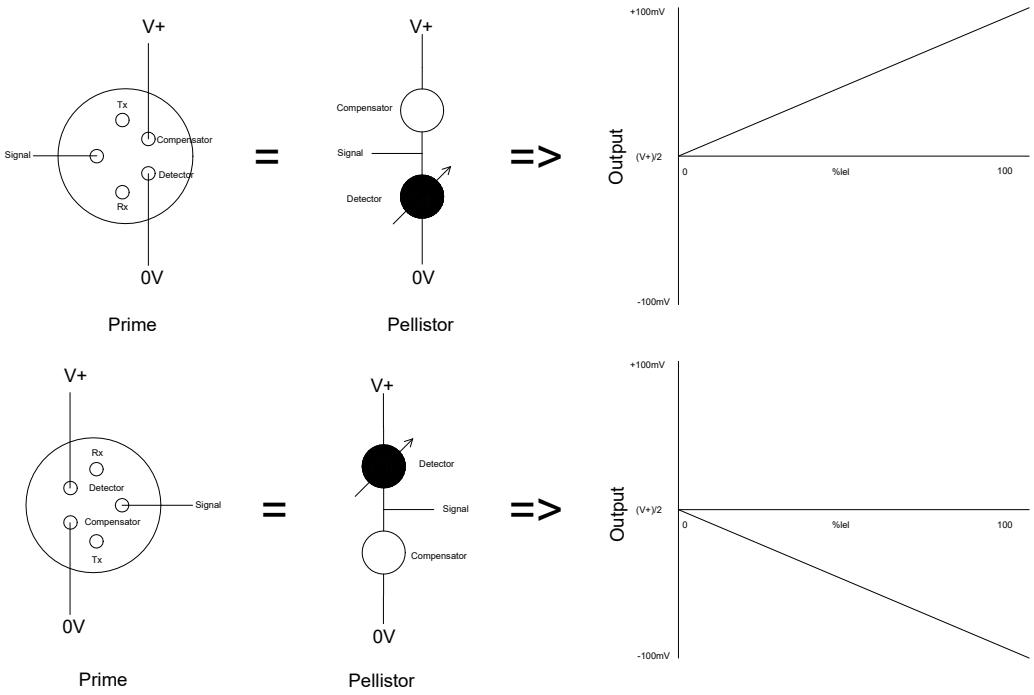
Conditions: Ground Fixed, JAN to MILHDBK217F
Subsystem type = B (Complex using microcontrollers or programmable logic),
Hardware Fault Tolerance = 0,
High Demand (Continuous Use of Operation):

λ_{SD} = 921 FIT, λ_{SU} = 3 FIT, λ_{DD} = 859 FIT, λ_{DU} = 96 FIT, SFF = 94.9%,
Probability of Dangerous Failure per Hour = 9.5×10^{-7}

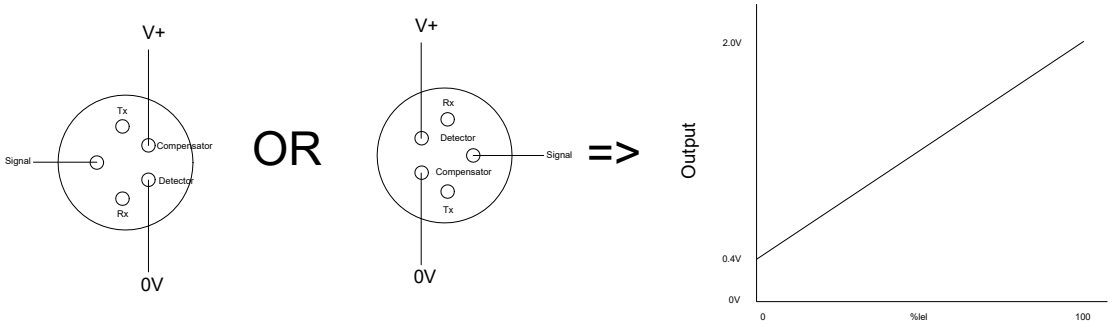
Output Formats

The Prime3 can be configured for a pellistor format output or a linear voltage output. Both output formats are independent of supply polarity as indicated below:

Pellistor Configuration:



Voltage Configuration:



Absolute Maximum Ratings

Ambient temperature range: -40°C to +80°C
Supply voltage (measured between pins 2 and 3): 5.5V

Handling Precautions

Electrostatic Sensitive Devices

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

Soldering to pins may seriously damage the sensor

Connections should be made via PCB sockets only.
Suggested socket: Wearnes Cambion reference 450-3326-01-06-00

Performance

Unless otherwise stated all data was taken using: Supply voltage of 3.5V. Ambient temperature (between 20°C and 25°C). Ambient pressure (between 995 hPa and 1020 hPa). Gases diluted in nitrogen. Gas Flowrate 1litre/min across sensor face.

Supply voltage range:	3.0V – 5.0V
Power consumption:	280mW typical
Default output range:	
Pellistor mode:	0 – 100mV from mid supply relative to detector pin
Voltage mode:	0.4V – 2.0V
Warm up time:	
To operation	< 60s
To specification	< 3 minutes
Nominal ranges:	0 – 100% volume CO_2
Response time (T_{90})	< 30s to a step change in gas concentration
Minimum resolution:	
At zero	0.01% of range (digital), 0.04% of range (0.4 – 2.0V 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:	38400 (default), 19200, 9600
Digital Interface Logic Levels:	V_{INL} Input low voltage: <0.8V V_{INH} Input high voltage: >2.0V V_{OL} Output low voltage: <0.4V V_{OH} Output high voltage: >2.4V
Weight:	18.0 grams
Vibration:	Complies with EN61779-1
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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