PowerKnowz™

Intelligent Gas Detector

FEATURES

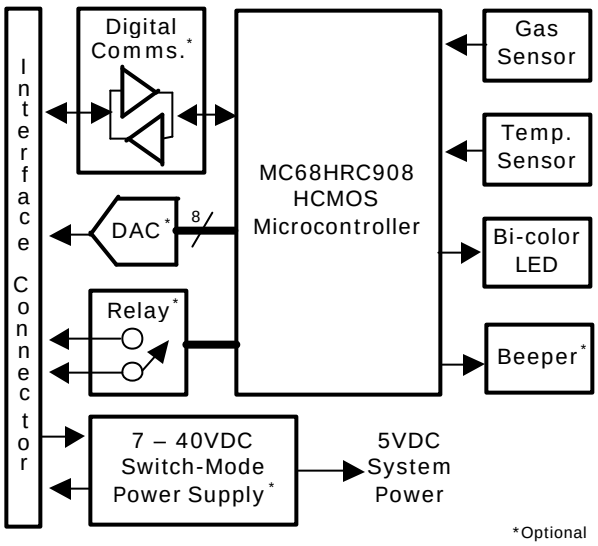
- MOS Sensor & HCMOS microcontroller
- Hydrogen, methane, propane & CO versions
- 0-50% LEL measurement (0-450 ppm CO)
- 50/100 ppm logical resolution (2 ppm CO)
- 30 seconds start-up time
- 4 secs. T90 response time (240 secs. CO)
- 10 secs. T10 recovery time (300 secs. CO)
- Normal, Warning, Alarm & Error states
- Table look-up (software) linearization
- Bi-color LED status indicator
- Optional NO or NC dry relay
- Manual reset or auto-resetting operation
- Optional 0-to-5V proportional output (8 bit)
- Optional binary operation (TTL output)
- Optional alarm beeper
- *PK-Port*™ compatible digital communications
- User-settable alarm/warning via *PK-Port*™
- Digital FLASH-based calibration
- Each device factory pre-calibrated
- Field re-programmable firmware
- -20 to +70 Celsius active compensation
- Sensor & temperature error detection
- 5VDC @ 80mA (400 mW) operation (I1)
- Optional 7-40VDC input power version (I2)
- Optional 7-60VDC input power version (I3)
- 61mm x 48mm x 26mm circuit-only size
- 74mm x 56mm x 26mm enclosed size

PowerKnowz™ front view (enclosed)

DESCRIPTION

The Neodym PowerKnowz™ is an intelligent gas detector intended for safety applications in power generation equipment. Linear measurement of hydrogen, methane, and propane concentrations is possible up to 50% of LEL with 50 to 100 ppm resolution (up to 450 ppm with 2 ppm resolution in the case of CO). The devices are actively temperature compensated from –20 to +70 degrees Celsius. Each device is factory calibrated for accuracy and linearity. Calibration values are FLASH memory-based and are field-adjustable via Neodym's *PK-Port*™ PC interface. The device operates at 5VDC and consumes about 400mW. Wide input supply versions are available. Custom form factors, connector types and mounting provisions are available by special order.

BLOCK DIAGRAM



*Optional

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1 - FUNCTIONAL DESCRIPTION

1.1 - OVERVIEW

Neodym PowerKnowz™ gas detectors comprise of an HCMOS microcontroller, a MOS gas sensing element, a semiconductor temperature sensor, a bi-color indicator LED and various optional signaling devices such as an alarm beeper, dry relay and D-to-A converter.

Standard devices operate with 5VDC regulated input power. Wide input supply versions are available that accept 7-40VDC (or 7-60VDC).

A one-wire bi-directional digital interface (*PK-Port*™) may be used for set-up, calibration and remote monitoring via a PC.

Each time that power is applied the device enters a brief warm-up state after which active gas sensing functions commence. Gas concentrations and sensing state indications become available after the warm-up period has elapsed.

Gas sensor signals are continuously sampled by an 8-bit A-D subsystem and are digitally filtered to reject burst noise and other spurious events. The gas sensor signal is actively compensated over the operating range using data from a co-located temperature transducer. The filtered and compensated signal is then stripped of its baseline component and is spanned according to its memory-resident calibration values. The normalized signal has a logarithmic response to gas and a table look-up algorithm is applied to the signal to produce linear readings of gas concentration that may be accessed in real-time via the output signal DAC or the *PK-Port*™ interface.

1.2 – SYSTEM COMPONENTS

This section describes the function of various PowerKnowz™ system components. Certain items may not be present depending on the options selected at order time.

SENSOR (Standard)

The employed gas-sensing element is a metal-oxide semiconductor (MOS) type offering high sensitivity to the target gas, rapid response/recovery time, no "inverted response" at high gas concentrations, modest power requirements and long life.

Gas sensing is performed on a diffusion basis and materials that would impede the convection of the sampled atmosphere to the sensor should therefore never obstruct the sensor opening.

MOS sensors have an exponential (non-linear) response to increasing gas concentrations. The *PowerKnowz?* microprocessor re-maps the sensor's raw response into a quasi-linear function to facilitate interpretation of measured gas concentrations. This linearization is performed over the detector's measurement range within the limits of the specified accuracy and resolution.

OFFSET BUTTON (Optional)

This user control is used to "zero" the gas reading in response to contaminated environments or sensor drift. More details are available in the section titled CALIBRATION.

SPAN TRIMPOT (Optional)

This user control is used to span the gas reading during calibration. The spanning procedure entails exposure of the sensor to a reference gas concentration. More details are available in the section titled CALIBRATION.

RESET BUTTON (Optional)

This user control is used to manually reset a

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latched relay or TTL output signal. Please see RELAY and TTL OUTPUT SIGNAL.

LED (Standard)

A bi-color (red/green) light-emitting diode is used to provide visual indication of the detector's state. For more details, please see the section titled DEVICE STATES.

OUTPUT SIGNAL (Optional)

The output signal is accessible via the INTERFACE CONNECTOR. Depending on device options, the output signal may be binary (TTL) or proportional (0-5V output option).

The TTL output function may be configured at order time (or using PK-Port™) as normally high or normally low; latching or auto-resetting. It may further be configured to respond to the Warning level, the Alarm level, or both.

For more details on interpreting the 0-5V output function, please see the section titled OUTPUT READING.

BEEPER (Optional)

This piezzo transducer is used to provide audible indication of the detector's state. For more details, please see the section titled DEVICE STATES.

RELAY (Optional)

This SPST reed relay provides two dry contacts that can be used to switch a modest external load.

The device may be configured at order time (or using PK-Port™) as normally open or normally closed; latching or auto-resetting. It may further be configured to respond to the Warning level, the Alarm level, or both.

Auto-resetting relays return to their normal state after the condition that caused the relay's activation has been removed. Latching relays, once activated, maintain their activation state until deliberately reset via the RESET button.

INTERFACE CONNECTOR (Standard)

This connection permits application of input power and connection to the relay contacts and output signal. For pin details, please see the section titled ELECTRICAL INTERFACE.

1.3 - DEVICE STATES

Five device states are supported, viz. warm-up, normal, warning, alarm and error. Each state asserts specific signaling conditions. EG, devices can be configured to activate the TTL output signal during the warning state and to activate the relay during the alarm state.

WARM-UP STATE

The warm-up state is entered whenever the device is powered-on and lasts approximately 30 seconds. This period permits the gas sensor to reach its proper operating temperature and allows the sensor signal to stabilize after periods of inactivity. During the warm-up state gas sensing is not active and zero value gas readings are returned. The LED blinks green/off during the warm-up period.

NORMAL STATE

The normal state is entered upon the expiry of the warm-up period. During the normal state the LED remains steady green. The normal state is maintained while the power level is valid and while there is an absence of error conditions or actionable gas concentrations. All other states return to the normal state upon their expiry or resolution.

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WARNING STATE

The warning state reports a gas concentration that is a specific percentage of the alarm state. This action percentage is stored in memory and is usually configured at order time. *PK-Port*™ may be used to modify the action level. During the warning state the LED blinks red/green.

ALARM STATE

The alarm state is entered when the gas concentration reaches or exceeds a predetermined threshold. The action level is stored in memory and is usually configured at order time although it may be reconfigured using *PK-Port*™. During the alarm state the LED blinks red/off.

ERROR STATE

The error state is asserted whenever the device is prevented from providing reliable readings. The error sources are gas sensor failure/removal, temperature out of bounds and loss of firmware integrity (detectable via a checksum failure). During the error state gas concentration readings are invalid and return full-scale values for failsafe operation. During the error state the LED remains off and briefly pulses red about every 10 seconds. Normal device operation resumes dynamically when the error condition is resolved.

Please note: The device features a Low Voltage Inhibit function and a Computer Operating Properly watchdog timer. A fault from either source does not produce an error state but rather device reset. If such faults should persist then they are detectable via continuous return to the warm-up state.

TABLE 1.2.1 – Device States Summary

State	Stimulus	Reading	LED	Beeper
Warm-up	Power-on, software error	Zero	Blink green/off	Inactive
Normal	Ambient conditions	Valid	Steady green	Inactive
Warning	Warning threshold reached	Valid	Blink red/green	Inactive
Alarm	Alarm threshold reached	Valid	Blink red	½ second beeps
Error	Sensor failure, temperature error	Full scale	Off, pulse red	10 second beeps

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1.4 – OUTPUT READING

Gas concentration indications are available as a proportional output voltage in devices with the 0-5V output option (DAC).

OUTPUT STEPS

The gas concentration is encoded as one step per logical reading unit (see below) where each step is about 20mV (19.6 mV precisely). The system's 8-bit DAC makes available a total of 256 steps - minus the steps required to output the 0.5V safety offset voltage.

SAFETY OFFSET

A 0.5V (510mV, 26 steps) starting offset is used to signal proper device operation even in the absence of target gas concentrations. The absence of this offset voltage may be used to indicate a system error condition or that there has been a break/short in the output signal wiring. This offset voltage must be subtracted from the gross signal value to derive net signal deflection that encodes the gas concentration.

READING UNITS

Reading units (RU) are a logical representation of gas concentration and vary according to gas type. The expression of gas concentration in RUs permits the system's 8-bit DAC to represent large ppm values, and furthermore insulates the user from the varying effective resolving capability of the gas sensor over its operating range.

Devices not equipped with a DAC may access RU values using PK-Port™.

READING RANGE

The range of output reading is limited to the finite number of DAC steps, the size of each reading unit, the need to accommodate the signaling of the safety offset, and limits imposed by the firmware to restrict measurement to an area of operation where the sensor demonstrates adequate resolving capability.

The following table lists the logical resolution (reading units) and maximum output reading according to target gas type.

TABLE 1.4.1 – Sensing Capability Summary

Gas	Resolution	Range
Hydrogen	100 ppm	0 – 20,000 ppm
Methane	100 ppm	0 – 25,000 ppm
Propane	50 ppm	0 – 10,000 ppm
CO	2 ppm	0 – 450 ppm

OUTPUT SIGNAL INTERPRETATION

The output signal voltage may be converted to a gas concentration using the following formula:

$ppm = ((V_{OUT} - V_{OFS}) / StepSize) \times Resol.$

where

ppm is the gas concentration

V_{OUT} is the total output signal voltage

V_{OFS} is the offset voltage (510mV)

StepSize is the DAC step voltage (19.6mV)

Resol. is the RU size as per the gas type

For example:

A hydrogen PowerKnowz™ with an output signal voltage of 3.2344V would be indicating the following gas concentration:

((3.2344V – 0.510V) / 0.019.6V) x 100 ppm

= 13,900 ppm

i.e. 139 net steps of 100 ppm each

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1.4 – SENSING PERFORMANCE

Sensing performance is only guaranteed over the range of electrical and environmental conditions cited in the specifications sections. The following remarks are provided for general guidance.

ACCURACY

Sensing accuracy is dependent on proper device calibration and the absence of abusive handling. Please see the Use, Care & Maintenance section for recommended handling and usage procedures.

Accuracy is defined as the ability of the sensor to correctly indicate the real gas concentration – whether from the point of view of short-term repeatability or long-term stability.

The specified accuracy error budget takes into account the following factors.

- Supply voltage variation
- Sensing and calibration resolution
- Inherent non-linearity of gas sensor signal
- Sampling jitter due to electrical noise
- Math rounding-off errors

For advanced sensing performance please consult the gas sensing element's manufacturer datasheet: Figaro Engineering Inc. – www.figarosensor.com – product part number TGS2610.

RESOLUTION

The sensing element's response to increasing gas concentrations is a logarithmic function. The system uses a table look-up and interpolation algorithm to provide linear output readings. Whereas the sensing element's sensitivity is better than 25 ppm at gas concentrations of less than 1,000 ppm, the resolving capability drops off rapidly at higher concentrations. The system provides reading indications using 8-bit logical reading units of fixed granularity. The Performance Specifications section cites the physical resolution of the sensing element over various gas concentrations. Care should be taken to establish reliable alarm points and action levels at concentrations where the resolving capability is adequate.

RESPONSE TIME

Whereas the raw gas signal response and recovery time is virtually immediate, the system employs software averaging and hysteresis to filter out spurious gas events and to prevent metastable indications. Please refer to the Electrical Specifications section for these AC characteristics.

ENVIRONMENTAL REQUIREMENTS

The employed sensing element is a tin dioxide type and senses gas based on superficial adsorption of gas molecules. In order for this reversible chemical reaction to take place reliably, the specified minimum relative humidity and atmospheric oxygen levels must be maintained.

CALIBRATION

All devices are individually factory calibrated and certified prior to delivery. Sensor calibration is performed digitally and values are stored in FLASH memory. Baseline offsets (zero) may be captured using the offset button or via PK-Port™. User/field modification of the Span value may be performed with the (optional) span trimpot or via the *PK-Port*™ interface and requires exposure of the device to calibration reference gas in a chamber of known volume.

Please note: Do **not** use pre-mixed calibration test gas with zero moisture content to perform calibrations or accuracy testing.

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1.5 – PERFORMANCE SPECIFICATIONS

Note: The following parameters apply under the Functional Operating Conditions stipulated in the Electrical Specifications section.

TABLE 1.5.1.1 – Hydrogen sensing characteristics (Model GH, MOS Sensor)

Parameter	Min	Typ	Max	Unit	Note
Sensing range	-	-	20,000	ppm	
Logical resolution	-	100	-	ppm	
Physical resolution 0-5,000 ppm: 5,000-10,000 ppm: 10,000-15,000 ppm: 15,000-20,000 ppm:	 - - - -	 100 400 1,000 2,000	 - - - -	ppm	
Accuracy	+/- 2,000	+/- 800	-	ppm	1
Linearity	+/- 1,200	+/- 600	-	ppm	2
Overdose detection	90,000	100,000	120,000	ppm	
Start-up time	27	30	33	Sec.	
Response time (T90)	-	4	10	Sec.	
Recovery time (T10)	-	10	20	Sec.	

TABLE 1.5.1.2 – Hydrogen sensing environmental requirements (Model GH)

Parameter	Min	Typ	Max	Unit	Note
Relative humidity	10	-	95	% R.H.	3
Operating temperature	-20	-	+70	Deg. C.	
Altitude/pressure	0.8	-	1.2	Atmos.	
Flow rate	-	-	3	m/sec.	4
Atmospheric oxygen	10	21	30	% vol.	

Notes: 1. Accuracy specified at 20% LEL (8,000 PPM). Please see Sensing Performance for error budget items.
2. Linearity specified at 10% LEL (4,000 PPM)
3. Non-condensing
4. Devices are factory calibrated in static air flow conditions

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TABLE 1.5.2.1 – Methane sensing characteristics (Model GM, MOS Sensor)

Parameter	Min	Typ	Max	Unit	Note
Sensing range	-	-	25,000	ppm	
Logical resolution	-	100	-	ppm	
Physical resolution 0-5,000 ppm: 5,000-10,000 ppm: 10,000-15,000 ppm: 15,000-20,000 ppm:	 - - - -	 100 300 500 700	 - - - -	ppm	
Accuracy	+/- 1,600	+/- 800	-	ppm	1
Linearity	+/- 1,200	+/- 600	-	ppm	2
Overdose detection	115,000	125,000	135,000	ppm	
Start-up time	27	30	33	Sec.	
Response time (T90)	-	4	10	Sec.	
Recovery time (T10)	-	10	20	Sec.	

TABLE 1.5.2.2 – Methane sensing environmental requirements (Model GM)

Parameter	Min	Typ	Max	Unit	Note
Relative humidity	10	-	95	% R.H.	3
Operating temperature	-20	-	+70	Deg. C.	
Altitude/pressure	0.8	-	1.2	Atmos.	
Flow rate	-	-	3	m/sec.	4
Atmospheric oxygen	10	21	30	% vol.	

Notes: 1. Accuracy specified at 20% LEL (10,000 PPM). Please see Sensing Performance for error budget items.
2. Linearity specified at 10% LEL (5,000 PPM)
3. Non-condensing
4. Devices are factory calibrated in static air flow conditions

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TABLE 1.5.3.1 – Propane sensing characteristics (Model GP, MOS Sensor)

Parameter	Min	Typ	Max	Unit	Note
Sensing range	-	-	10,000	ppm	
Logical resolution	-	50	-	ppm	
Physical resolution 0-2,500 ppm: 2,500-5,000 ppm: 5,000-7,500 ppm: 7,500-10,000 ppm:	 - - - -	 50 100 150 250	 - - - -	ppm	
Accuracy	+/- 600	+/- 300	-	ppm	1
Linearity	+/- 400	+/- 200	-	ppm	2
Overdose detection	32,000	40,000	48,000	ppm	
Start-up time	27	30	33	Sec.	
Response time (T90)	-	4	10	Sec.	
Recovery time (T10)	-	10	20	Sec.	

TABLE 1.5.3.2 – Propane sensing environmental requirements (Model GP)

Parameter	Min	Typ	Max	Unit	Note
Relative humidity	10	-	95	% R.H.	3
Operating temperature	-20	-	+70	Deg. C.	
Altitude/pressure	0.8	-	1.2	Atmos.	
Flow rate	-	-	3	m/sec.	4
Atmospheric oxygen	10	21	30	% vol.	

Notes: 1. Accuracy specified at 20% LEL (4,200 PPM). Please see Sensing Performance for error budget items.
2. Linearity specified at 10% LEL (2,100 PPM)
3. Non-condensing
4. Devices are factory calibrated in static air flow conditions

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TABLE 1.5.4.1 – Carbon monoxide sensing characteristics (Model GC, Pulsed MOS Sensor)

Parameter	Min	Typ	Max	Unit	Note
Sensing range	-	-	450	ppm	
Logical resolution	-	2	-	ppm	
Physical resolution 0-50 ppm: 50-100 ppm: 100-200 ppm: 200-450 ppm:	 - - - -	 2 4 10 14	 - - - -	ppm	
Accuracy	+/- 40	+/- 20	-	ppm	1
Linearity	+/- 16	+/- 8	-	ppm	2
Start-up time	27	30	33	Sec.	
Response time (T90)	-	240	480	Sec.	
Recovery time (T10)	-	300	720	Sec.	

TABLE 1.5.4.2 – Carbon monoxide sensing environmental requirements (Model GC)

Parameter	Min	Typ	Max	Unit	Note
Relative humidity	10	-	95	% R.H.	3
Operating temperature	-10	-	+60	Deg. C.	
Altitude/pressure	0.8	-	1.2	Atmos.	
Flow rate	-	-	3	m/sec.	4
Atmospheric oxygen	10	21	30	% vol.	

Notes: 1. Accuracy specified at ½ FSD. Please see Sensing Performance section for error budget items.
2. Linearity specified at ¼ FSD.
3. Non-condensing
4. Devices are factory calibrated in static air flow conditions

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1.6 – RELIABILITY FEATURES

Various fault detection features have been implemented to provide indication of unacceptable sensing conditions. Devices are configured at order time (or via *PK-Port*™) to respond to error conditions by simply asserting the error state, or by triggering the alarm state.

SENSOR ERROR

This error is triggered by the removal of the sensor, or a break in the heater and/or electrode circuits. Heater damage due to gas overdoses can also trigger this error. The error state is released when the sensor is replaced.

TEMPERATURE ERROR

This error is triggered when the operating temperature is above or below levels for which compensation data is available. The error state is released automatically when the temperature returns to the acceptable range.

OVERDOSE RESPONSE

The sensor may be permanently damaged by even brief exposure to extremely high concentrations of target gas (typically >5 times the maximum sensing range). The effect of overexposure is usually decreased sensor sensitivity. In most cases such permanent damage is detectable from the signal signature and will trigger an error state. However, the damage from brief but frequent overexposures can be cumulative and may not manifest itself immediately as a sensor failure. Detection of degradation in accuracy due to overexposure is only possible by testing with a reference gas sample. For this reason, the system is designed to err on the side of safety by reacting to any overexposure events that last more than two seconds. Two response modes are configurable: 1. Self-adjust the calibration values and alarm level for high sensitivity, or 2. Set a flag in FLASH memory to assert a persistent error state.

Either situation is resolvable using *PK-Port*™ access once a calibration check has determined that the sensor has not been degraded beyond acceptable performance levels.

COP TIME-OUT

Electrostatic discharges or other electrical events that may alter system RAM and cause improper program operation will cause the Computer Operating Properly watchdog timer to reset the system (return to the warm-up state).

LOW VOLTAGE INHIBIT

The device will remain in the reset state if the supply voltage is below 4 VDC (nominal). Low system voltage inhibits the TTL output signal and relay, which may be used for power failure detection. Unstable system power levels manifest themselves as a continuous return to the warm-up state.

MEMORY CHECKSUMS

Abnormal electrical conditions that may cause a loss of integrity of the FLASH memory are detected via checksum calculations after each power-up. If the firmware checksum value is incorrect then the system will remain in the error state. A similar check and response applies to calibration and configuration values. Damaged firmware is in-circuit field reprogrammable via *PK-Port*™ adapters and a Neodym utility program.

BOUND OFFSET VALUE

The system prevents "zeroing-to-death" conditions by rejecting attempts to capture an offset in high gas concentrations.

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1.7 – USE, CARE & MAINTENANCE

PowerKnowz™ sensors can provide reliable readings for many years if properly handled and maintained. To derive the maximum serviceable lifetime from the device, please observe the following recommendations.

CHECK CALIBRATION PRIODICALLY

Although the devices feature several self-diagnosing functions, the only direct method to check accuracy and proper operation is via exposure of the sensor to a reference gas concentration and observing it to read correctly. Devices are delivered factory calibrated and certified, but the accuracy of the unit can and will degrade over time – especially if used in corrosive or hostile environments. It is recommended that calibration checking should be performed as often as is practical and no less frequently than once every six months.

GENERATING REFERENCE GAS

The recommended method for generating calibration test gas mixtures is to dilute pure target gas with clean, normal air in a leak-free chamber of fixed, known volume. A simple procedure is to inject a specific amount of pure target gas using a syringe into a sealed plastic lunch container. EG 50cc of pure target gas injected into a chamber with a net volume of 5 liters produces a concentration of 10,000 ppm. Gentle shaking or an enclosed fan may be used to assure proper dispersion of the gas mixture. In applications where it is impractical to immerse the module in such a gas mixture, a pump or aspirator may be used to flow the gas mixture over the sensor. Locate the sensor away from the injection port to avoid high concentration gas plumes from triggering the overexposure detection mechanism.

NO DESICCATED PRE-MIX CAL GAS

Pre-mixed calibration test gas that has been stripped of moisture content and designed for other sensing chemistries is not appropriate for PowerKnowz™ testing and calibration. The employed MOS sensor requires a minimum 10% R.H. moisture content to operate properly.

NOT A GENERAL LEAK DETECTOR

The device is to be used as a monitor in safety applications where high concentration gas releases are rare. If the device is employed as a general leak detector and is exposed to saturation levels of gas, the overexposure mechanism will be triggered. Very high gas concentrations of gas can permanently damage the sensor.

INTEFERENCE GAS

The employed MOS sensor is not specific to any one combustible gas. Detectors calibrated for (EG) hydrogen applications will read accurately in the presence of homogeneous hydrogen gas/air mixtures, but will also produce readings in the presence of other inorganic and organic vapors. Heterogeneous gas mixtures generally have a synergistic effect on the sensor, and in the absence of a target gas presence, the interference gases will manifest themselves as 'false' readings.

AVOID BUMP TESTING

Do not use bursts of high gas concentrations to test whether the sensor is 'alive'. Especially avoid exposing the sensor to blasts of butane gas – EG from a disposable cigarette lighter. The proper testing procedure is to expose the sensor to a reference gas whose concentration is stable and falls within the rated sensing range. A properly operating device reads out the concentration of the reference gas within the limits of the specified accuracy.

AVOID SENSOR OBSTRUCTION

The sensor samples the atmosphere based on

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the diffusion of gas through the mesh into the internal cavity. Please locate the sensor such that it is not pressed against a surface that will obstruct gas flow, and prevent materials such as dust and lint from clogging the sensor mesh.

PROPER PLACEMENT

For earliest warning of a possible gas hazard, locate the detector nearest to the most likely source of the gas leak. Also take into account the relative density of the gas of interest. In the cases of hydrogen and methane that are lighter than air, the module should be located above the leak source. The opposite applies in the case of propane.

AVOID EXPOSURE TO SILICONE VAPORS

Sealants such as caulking compounds, hoses, etc. may contain silicones. These items may continue to off-gas silicone vapors indefinitely, even after full curing – and especially under high temperature conditions. Extra care should be taken when testing the sensor in environmental chambers – many of which use silicones for thermal insulation. The effect of silicone vapors on the sensor is to make it gradually more sensitive to hydrogen, and **less** sensitive to methane and propane.

OTHER DELETERIOUS AGENTS

Avoid exposure to high concentrations (>5,000 ppm) of carbon monoxide (CO). Such exposures lead to short-term sensor poisoning that manifest themselves as elevated gas readings. Recovery from high CO exposures entails several hours of burning-off in clean air.

Avoid exposure to high concentrations (>50,000 ppm) of halogenated hydrocarbons such as solvents and refrigerant gases. As with elemental halogen family gases, they can corrode the sensor, lead to short-term poisoning, and reduce the sensor lifetime.

Avoid exposure to other corrosive environments such as salt-containing sea spray. For coastal and marine applications, modules are available with acrylic conformal coating to preserve circuit lifetime. However, the buildup of a salt crust over the sensor mesh will impede gas diffusion and will affect reliability.

NO STRONG ELECTROMAGNETIC FIELDS

While the circuit is relatively low impedance, avoid locating the sensor in the immediate vicinity (<10 cm) of strong and fluctuating field sources such as fans, pumps, motors, RF transmitters, etc. Close proximity to such fields may result in spurious gas readings. Also, make sure that the detector's power supply is adequately decoupled from fluctuations caused by the switching of large external loads.

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2 - INTERFACE

2.1 – ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Note: Maximum ratings are the extreme limits to which the device can be exposed without permanent damage. The devices are not guaranteed to operate properly at maximum ratings.

TABLE 2.1.1.1 - Absolute Maximum Ratings – 5VDC input models (I1)

Parameter	Symbol	Value	Unit
Supply voltage	V_{cc}	6.0	VDC

TABLE 2.1.1.2 - Absolute Maximum Ratings – 7-to-40VDC/60VDC input models (I2 & I3)

Parameter	Symbol	Value	Unit
Supply voltage I2 Models: I3 Models:	V_{SUP}	 45 60	VDC

FUNCTIONAL OPERATING RANGE

Note: Sensing accuracy deteriorates rapidly outside the specified operating voltage range. Permanent device damage may occur above the specified operated voltage range.

TABLE 2.1.2 – Operating Range – 5VDC input models (I1)

Parameter	Symbol	Value	Unit
Operating voltage range	V_{cc}	4.75 to 5.25	VDC

TABLE 2.1.2 – Operating Range – 7-to-40VDC/60VDC input models (I2 & I3)

Note: Input supply voltages in the specified range produce a system voltage (V_{CC}) of 5VDC +/- 3%.

Parameter	Symbol	Value	Unit
Operating voltage range I2 Models: I3 Models:	V_{SUP}	 7 to 40 7 to 60	VDC

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TEMPERATURE RATINGS

TABLE 2.1.3 - Temperature Ratings

Parameter	Symbol	Value	Unit
Storage temperature (all models)	t_{STG}	-40 to +125	Deg. C.
Operating temperature range Hydrogen, Methane & Propane: Carbon monoxide:	t_{OP}	 -20 to +70 -10 to +60	Deg. C.

POWER CONSUMPTION

TABLE 2.1.4.1 – Supply current - 5VDC input models (I1)

Parameter	Symbol	Min	Typ	Max	Unit
Supply current (V_{CC} = 5.0VDC) Hydrogen, Methane & Propane: Carbon monoxide:	I_{CC}	 - -	 85 45	 100 55	mA

TABLE 2.1.4.2 – Supply current - 7-to-40VDC/60VDC input models (I2 & I3)

Parameter	Symbol	Min	Typ	Max	Unit
Supply current (V_{SUP} = 12VDC) Hydrogen, Methane & Propane: Carbon monoxide:	I_{SUP}	 - -	 65 25	 75 30	mA

DEVICE RATINGS

TABLE 2.1.5 – Device ratings

Parameter	Symbol	Min	Typ	Max	Unit
Beeper (piezzo) sound level at 30cm		-	80	-	dB
Sealed reed relay (SPST)					
Switch voltage:		-	200	-	VDC
Switch current:		-	0.5	-	A
Carry current:		-	1.2	-	A
Contact resistance:		-	0.15	-	Ohm
Insulation resistance:		-	10^{10}	-	Ohm

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DC CHARACTERISTICS

TABLE 2.1.6 – DC Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
TTL high voltage (I_{LOAD}=-2.0mA)	V_{OH}	V_{CC}-0.8	-	-	V
TTL low voltage (I_{LOAD}=1.6mA)	V_{OL}	-	-	0.4	V
Low voltage inhibit reset voltage (V_{CC})	V_{LVR}	3.6	4.0	4.4	V
I/O pin capacitance	C_{IO}	10	12	15	pF
I/O pin termination resistors	R_{TERM}	-	10	-	K-Ohm

AC CHARACTERISTICS

TABLE 2.1.7 – AC Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
Fundamental operating frequency	f_{OP}	5.8	7.3	8.7	MHz
Power-on reset time	T_{PRES}	0.9	1	1.1	mS
COP watchdog time-out time	T_{CTO}	29	32	35	mS
COP time-out reset time	T_{CRES}	90	100	110	uS
Warm-up time	T_{WARM}	27	30	33	S
ADC sampling rate	T_{SAMP}	9	10	11	mS
Signal averaging period	T_{AVG}	450	500	550	mS
State debounce period	T_{DEB}	1.8	2	2.2	S
LED blink rate	T_{LBR}	180	200	220	mS
LED pulse on/off rate	T_{LPR}	0.18/9	0.2/10	0.22/11	S

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2.2 – INTERFACE CONNECTOR

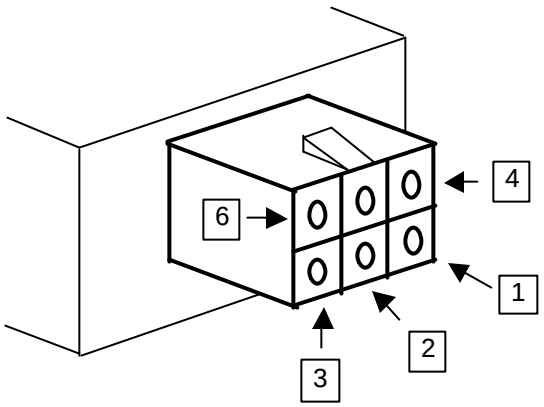
SIGNAL DEFINITIONS

TABLE 2.2.1 – Input/Output Signals

Name	Description
V_{CC}	Positive 5VDC regulated input voltage (I1 models).
V_{SUP}	Positive unregulated input voltage (I2 & I3 models)
GND	Common power and output signal ground.
V_{OUT}	Output signal. Proportional (analog) 0-to-5VDC in "O5" models. TTL output in case of O1/O2/O3/O4 models.
RLY1 & RLY2	Connections to relay's SPST electrically isolated switch (if relay installed).
PKP	PK-Port™ single-wire bi-directional digital communications port. Connect only to HCTTL compatible PK-Port™ communications adapter, or leave unconnected.

PIN CONNECTIONS

FIGURE 2.2.1 – Pin connections



Connector (shown) part no. 39-29-1068 (Molex)

Mating receptacle part no. 39-01-2060 (Molex)

Pin	Symbol	Function
1	V_{CC}/V_{SUP}	Input power (+)
2	GND	Common ground return
3	V_{OUT}	Output signal[1]
4	RLY1	Dry relay contact #1[2]
5	RLY2	Dry relay contact #2[2]
6	PKP	PK-Port™ digital I/O[3]

Notes: 1. 0-5V analog (O5 models), else TTL
2. Models with installed relay
3. Proprietary protocol. Requires adapter.

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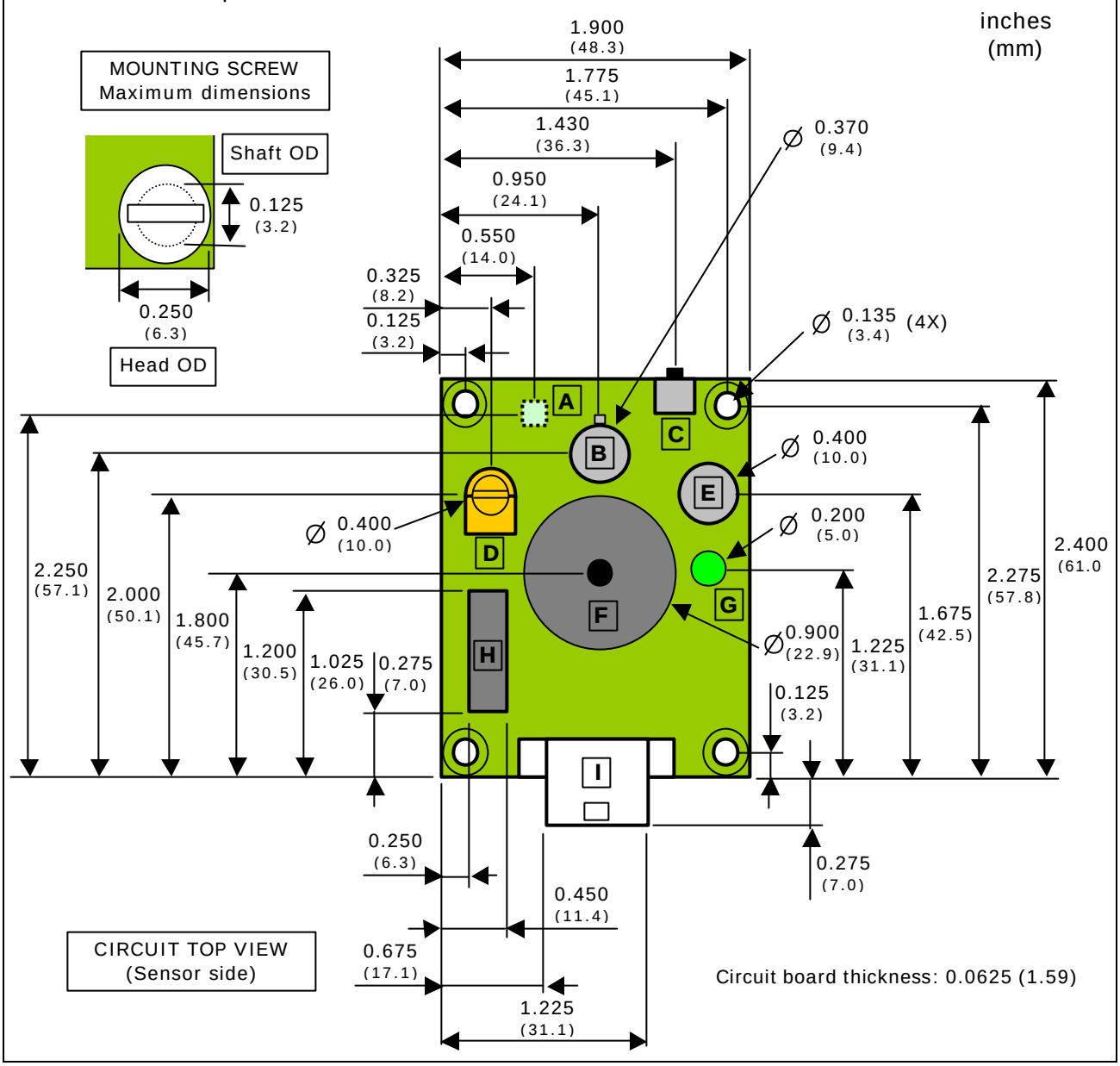
3.1 – PHYSICAL DIMENSIONS – OPEN FRAME

FIGURE. 3.1.1 – Open frame circuit dimensions



COMPONENT CLEARANCES

The table on the right lists the height above the surface of the circuit board of the indicated components.

Allow 0.400 (10.0) below the circuit board for bottom-mounted components. Stand-offs 0.500 (12.7) in length are recommended.

SYMBOL	DEVICE	INCHES	MM
A	Temperature transducer	-0.115	-2.9
B	Gas sensor	0.45	11.4
C	Offset pushbutton	0.285	7.3
D	Span trimpot	0.200	5.0
E	Reset pushbutton	0.550	14.0
F	Beeper	0.375	9.5
G	LED	0.550	14.0
H	Relay	0.285	7.3
I	Interface connector	0.400	10.0

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3.2 – PHYSICAL DIMENSIONS - ENCLOSED

FIGURE. 3.2.2.1 – Enclosure dimensions

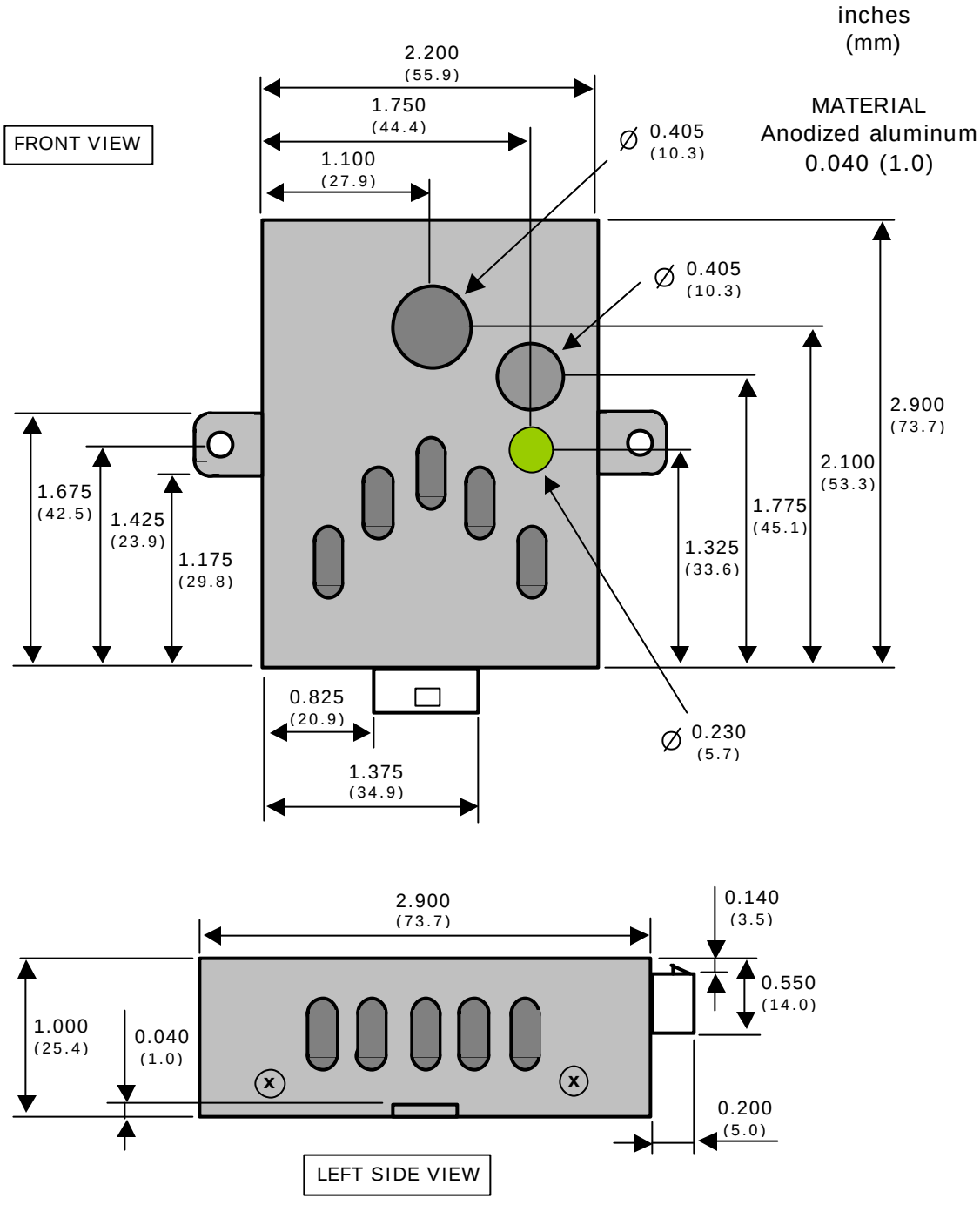
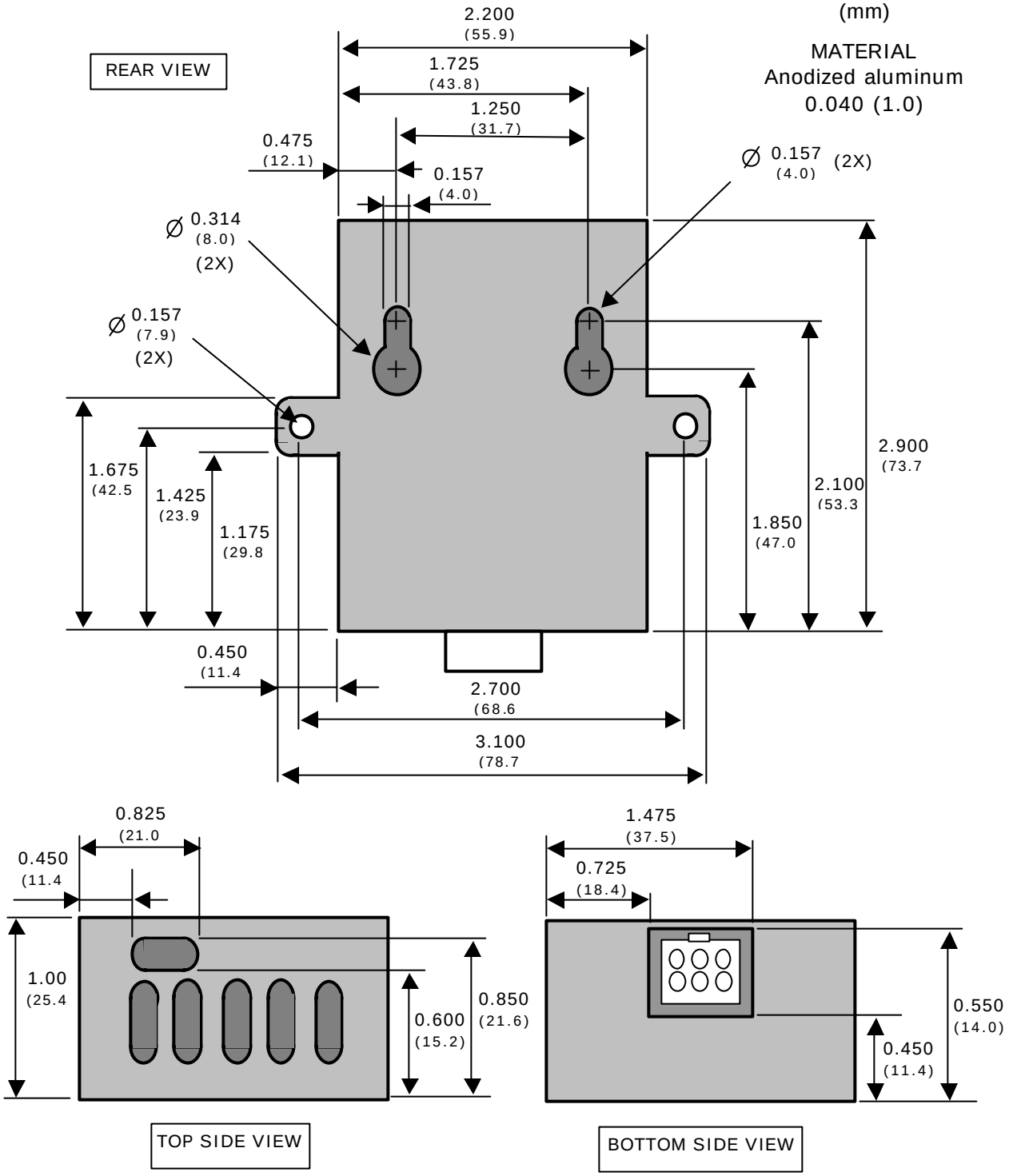


FIGURE. 3.2.2.2 – Enclosure dimensions

inches
(mm)

MATERIAL
Anodized aluminum
0.040 (1.0)



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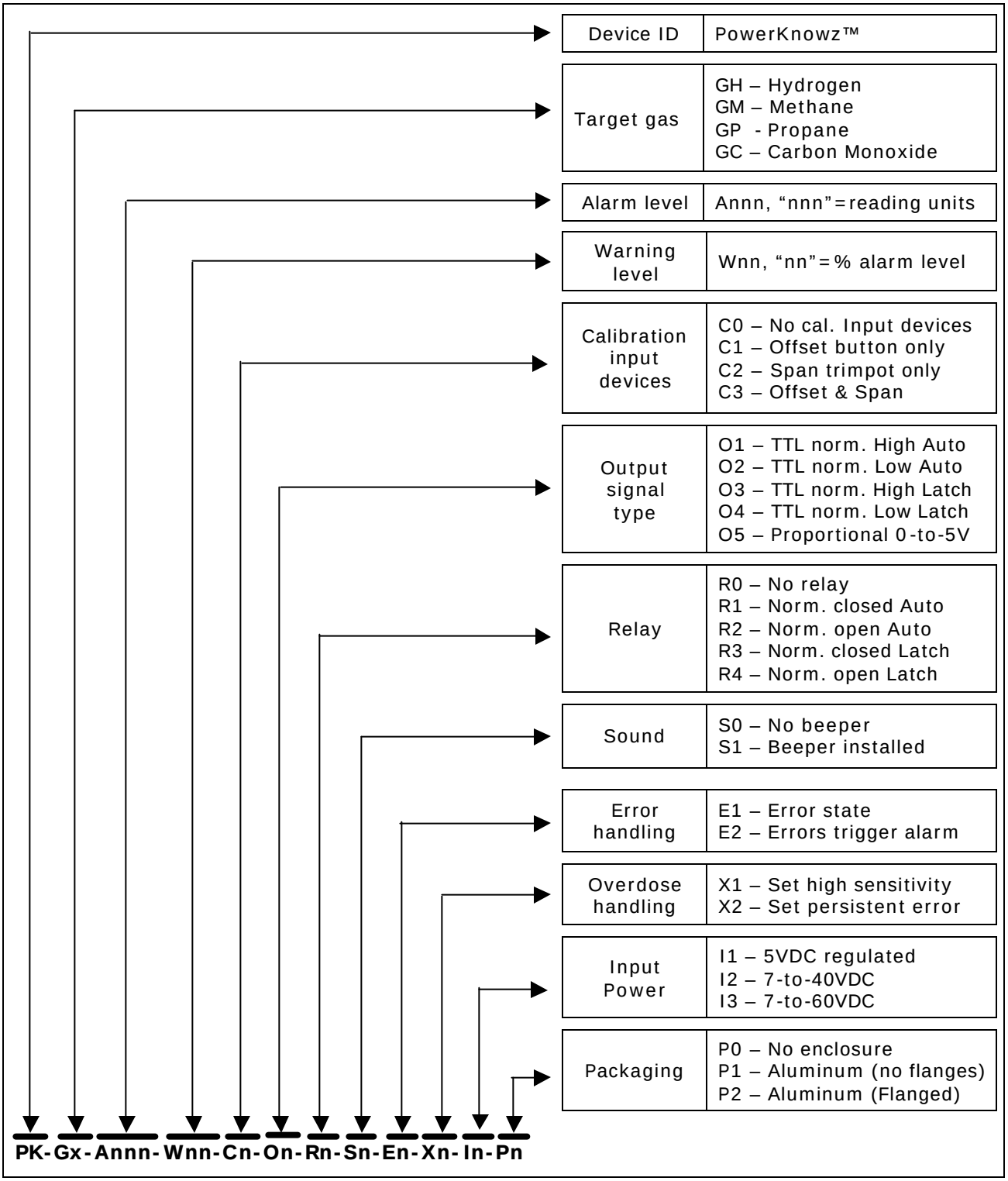
4 – SALES & TECHNICAL SUPPORT

4.1 – PART NUMBERING



Device ID	PowerKnowz™
Target gas	GH – Hydrogen GM – Methane GP - Propane GC – Carbon Monoxide
Alarm level	Annn, “nnn”=reading units
Warning level	Wnn, “nn”=% alarm level
Calibration input devices	C0 – No cal. Input devices C1 – Offset button only C2 – Span trimpot only C3 – Offset & Span
Output signal type	O1 – TTL norm. High Auto O2 – TTL norm. Low Auto O3 – TTL norm. High Latch O4 – TTL norm. Low Latch O5 – Proportional 0-to-5V
Relay	R0 – No relay R1 – Norm. closed Auto R2 – Norm. open Auto R3 – Norm. closed Latch R4 – Norm. open Latch
Sound	S0 – No beeper S1 – Beeper installed
Error handling	E1 – Error state E2 – Errors trigger alarm
Overdose handling	X1 – Set high sensitivity X2 – Set persistent error
Input Power	I1 – 5VDC regulated I2 – 7-to-40VDC I3 – 7-to-60VDC
Packaging	P0 – No enclosure P1 – Aluminum (no flanges) P2 – Aluminum (Flanged)

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4.2 – CONTACT INFORMATION

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