



**DELPHIAN**

# INFRARED CHC DETERMINATOR GAS MONITORING SYSTEM

Bulletin 980-087e

## DESCRIPTION

The Delphian Determinator (Fixed Point Infrared) sensor is a smart infrared hydrocarbon gas detector. It has no moving parts. It detects hydrocarbons up to 999% of their Lower Explosive Limit (LEL). It can determine which hydrocarbon gas is being detected and transmit a 4-20 mA signal proportional to the LEL concentration of that gas or vapor. The Determinator displays the correct LEL as well as the gas detected on its five digit LED display. It can be set to show up to three gas alarm levels. An optional four-relay alarm module (SLAM) can be connected directly to the Determinator so that local alarms can be actuated in the event of a gas alarm or failure. The detector head is designed so that all normal operations, including checking calibration and changing alarm levels can be done in the field without declassifying the area. The Determinator is designed to be as failsafe as possible. The built-in self test continuously monitors the hardware and software. Minor fault conditions are displayed on the LED display. Four informational and six possible critical malfunctions are transmitted on the 4-20 mA line. Using a separate module, the Determinator can be interfaced with most digital protocols including HART and Fieldbus.

## DETERMINES GAS

Delphian's patented multiple active channel system allows the sensor to recognize and identify multiple hydrocarbon gases. The sensor detects hydrocarbon gases only. It cannot detect and will not be affected by hydrogen or other non-hydrocarbon gases. When complex mixtures of hydrocarbon gases are present, especially in substantial concentrations, it will display its best estimate of the correct LEL.

## ROUTINE MAINTENANCE

The Determinator is a very low maintenance instrument. It does not require span calibration. Zero point adjustments are required infrequently.



## PRINCIPLE OF OPERATION

A beam of infrared energy is directed to a detector through gas which is drawn into the sampling cell by a patented convection mechanism. The beam is filtered to match the absorption of hydrocarbon molecules. If a hydrocarbon gas is present in quantities over 5% LEL, it will absorb energy from the beam and the detector will register a drop in the total transmission of infrared energy. This drop in transmission can be directly related to the concentration of gas.

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# THEORY OF OPERATION

## SENSOR

The Delphian Determinator (Fixed Point Infrared) Combustible Hydrocarbon (CHC) sensor uses infrared light to probe for the presence of hydrocarbons. The detection process is independent of the fact that the gases of interest are combustible, therefore the presence of oxygen is immaterial.

## THE SCIENCE BEHIND THE SENSOR

All CHC gases have one or more hydrogen (H) atoms chemically bonded to a carbon (C) atom. The bond between the H and the C is elastic and the distance between the two atoms can oscillate. The oscillation is activated when energy, with a wavelength of about 3.3 micrometer (3.3  $\mu\text{m}$ , 0.00013 inch), strikes the molecule. The precise wavelengths that interact with any one gas are unique for that gas. The energy at 3.3  $\mu\text{m}$  is qualitatively no different from visible light, except that the human eye can not "see" the light. For this reason we call this kind of energy "infrared light."

Infrared-based CHC gas sensors differ from catalytic bead sensors in the variation range of the transfer factors for different gases relative to methane gas. Catalytic beads exhibit transfer factors between 0.6 and 4.0. For the common IR sensors with one reference and one active channel the transfer factors can easily vary in a range of 100 to 1. Therefore it is essential to know which gas is present at the sensor in order to obtain a reliable gas concentration in terms of % LEL.

The Delphian FPIR sensor consists of a gold-surfaced "light pipe" with an opening at the bottom and the top. The atmosphere containing the combustible gas enters the tube through a flame arrestor at the bottom opening and exits through an opening at the top. The gas diffusion is enhanced by a heater at the base of the pipe. A miniature infrared source at the bottom directs infrared into the pipe. At the opposite end of the pipe from the source is an infrared sensitive receiver with four custom filters. Each filter cuts a narrow slice out of all the wavelengths coming from the infrared source. Three filters transmit energy in

neighboring slices of wavelengths that interact with CHC gases. One filter transmits only energy that does not interact with CHC gases. The signals from the three detectors behind the interacting filters are called the active channels, and the fourth signal from the detector behind the non-interacting filter is the reference channel.

Most hydrocarbons exhibit characteristic ratios of interaction with IR energy in the three wavelength slices. The microprocessor in the Delphian sensor evaluates the signals and deduces from the ratios of the three active channels which hydrocarbon has entered the light pipe. Once the gas has been identified, the % LEL is computed for that gas.

**WARNING:** *The IR-based sensor can accurately measure the concentration of only one CHC gas at one time. A mixture of two or more CHC gases of concentrations above 5% LEL may be either misinterpreted by the instrument as a different gas than either of the present gases, or, more likely, the instrument may not identify the gas at all. In this case the microprocessor computes a % LEL gas concentration based on a gas that it believes provides the highest margin of safety (worst case). This kind of uncertainty can only occur if similar concentrations of different gases are present, such as 10% LEL of methane and 8% LEL of butane. A background of multiple gases, each in concentrations of less than 1% LEL will not severely impact the identification of a CHC above 15-20% LEL concentration.*

## CONSTRUCTION

The sensor and conduit box are explosion proof. The conduit box is epoxy coated to prevent corrosion. The internal sensor components, as well as all connectors exposed to the atmosphere, are gold plated.

All components are designed to plug into an Interface Module. This module makes wiring the Detector Head easy as well as permitting rapid replacement of components.

Sensors are designed to withstand "hot plugging" in and out of the Interface Module while power is supplied.

All connectors are unique and are keyed to prevent incorrect connections.

All working electronics are encapsulated to prevent deterioration from dust and humidity.

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# SPECIFICATIONS

## Dimensions (inches)

Conduit box with sensor:  
13" length x 6½" width x 4½" depth

## Vibration and Shock

Tests show no sensitivity to normal shock and vibration

**MTBF at 70° F:** 8 years

## Accuracy

5% LEL ( up to 120% LEL).  
20% of reading (from 120%LEL to 999%LEL).

**Repeatability** +/- 3% up to 120% LEL

## Response Time

< 40 seconds to 90% of gas concentration without splash guard

## Recovery Time

< 40 seconds to 10% of gas concentration without splash guard

**Measurement Range:** 5-999% LEL

## Humidity

The Determinator is not affected by 0-99% relative humidity, non-condensing in a temperature range of 0-70C.

## Flooding

The detector is not flooded by high concentrations of gas. It will read up to 999% LEL on the LED display and will transmit up to 120% LEL on the 4-20 mA output.

## Operating Temperature

-30C to +70C (-22F to +158F)

## Power

Input voltage: 24 VDC nominal (20 to 32 VDC)

Power: < 4 watts

Input is voltage polarity protected.

Input lines have surge suppressors and are fused to prevent damage from electrical transients.

## Output Signal

Detector is jumper selectable to transmit either 4-20 mA or 1-5 mA (used by Delphian's analog Micro 550 Controllers). The detector provides RS422/485 output and is also HART and Fieldbus compatible.

**Limited Warranty** 2 years

## Cable Length

3-wires, unshielded (+,-, signal)

Controller to Interface Module & Transmitter - 5,000 feet max

## Hazard Classification

USA: Class 1, Division 1, Groups A,B,C,D

Canada: Class 1, Division 1, Groups B,C,D

## Approvals

Designed to meet FMRC and CSA requirements.

## RFI Immunity

Less than 1% LEL change with transceiver keyed within three feet of the detector head.

**Poisoning Gases:** None

**Blocking Gases:** Acetylene

## Pressure

Normal variations in atmospheric pressure will not affect the detector.

## Calibration

Zero calibration required infrequently.

Span calibration not required.

## Sensor Health Monitoring

The Determinator features a rich complement of sensor health monitoring features, some of which are capable of advanced warning of impending failure.

- Light emitted by filament

- Detector integrity

- Excessive optical path attenuation

  - (dirty Optics)

- Optical path obstruction

- Microprocessor functionality

- Electrical supply voltage

The local display at the sensor informs of the detected warnings and failures, as does the serial digital output signal. Failures that prevent the sensor from measuring CHC concentration are also transmitted on the 4 - 20 mA signal line. Warnings are shown on local display only.

## 4-20 mA Signals and Error Codes

The sensor displays all detected warnings and failures. The following messages are transmitted on the 4-20 mA signal line:

>23.2 mA	Over-range (>120%LEL)
20 mA	Full scale
3.6 to 23 mA	%LEL displayed
<3.6	Signal inverts to 0.2 mA
2.3 mA	CPU POST successful, no output
2.1 mA	Off-line
1.9 mA	Zero adjust failed - off-line
1.7 mA	Zero adjustment in progress -offline
1.5 mA	Voltage too high to function
1.3 mA	Sensor missing or not connected
1.1 mA	Optics dirty - light path blocked
0.9 mA	Lamp failed
0.7 mA	Low power line voltage
0.5 mA	Sensor Module circuit fault
0.3 mA	Processor Module circuit fault
<0.2 mA	No power, system fault

**NOTE:** In the event 1-5 mA option is chosen only the high and low gas alarms and system fail is transmitted.

## PART NUMBERS

Standard Configuration includes:  
conduit box, interface module and  
processor module:

**With aluminum sensor** — 364-850-01

**With stainless steel sensor** — 364-850-02

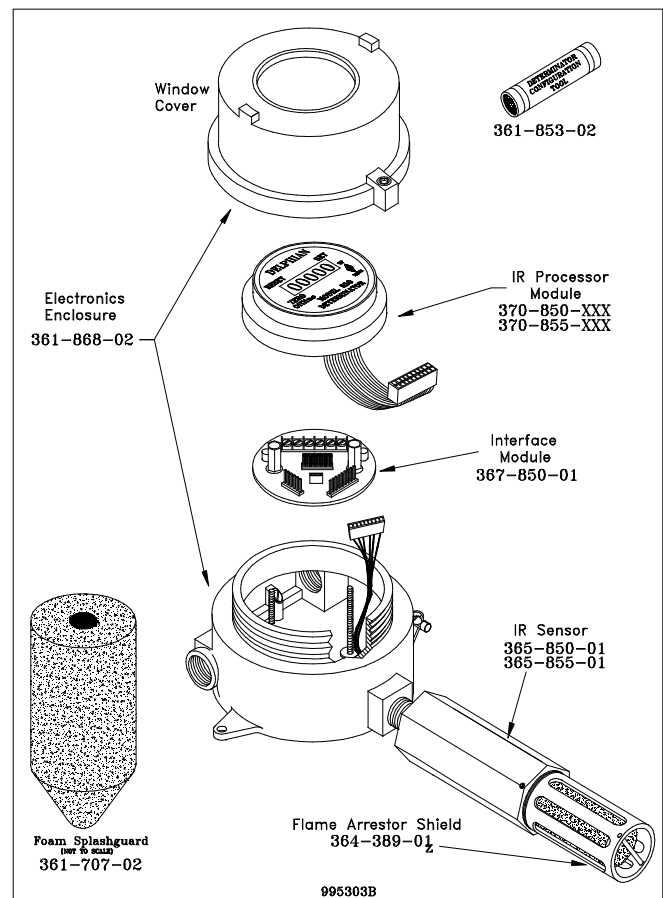
## OPTIONS

**Splash/Dust Guard**—for severe environmental and operational conditions.

**Lightning arrestor** —where high-energy transient suppression is necessary.

**SLAM**—local alarm relay module (relays for 3-gas alarms and one for fail) connects to Interface Module.

**Reclamation Adaptor** —to allow the sensor to be mounted externally to a duct or area outside of the sensor's temperature range.



**CALL TOLL FREE**  
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