7866 Thermal Conductivity Analyzer for Binary Gas Mixtures

**Overview**

The Honeywell 7866 Thermal Conductivity Analyzer is designed to provide a highly sensitive and accurate analysis of a binary (2-component) mixture of gases. The analyzer can also be calibrated to measure a single component of a multicomponent gas mixture, providing the background gases constitute a stable mixture (such as air), or have approximately the same thermal conductivity.

The 7866 analyzer, using the principles of thermal conductivity, determines the concentration of a sample gas through the measurement of thermal losses from two highly stable, matched thermistor probes inserted in a stainless steel block.

**Features**

- High speed of response
- High sensitivity
- Excellent stability
- Reliable solid state design
- Lower installation costs through optional remote mounting capability of the sensing unit (transmitter)
- General-purpose or explosion-proof housing of the sensing unit
- Signal transmission from the sensing unit up to 1000 feet over unshielded leadwires
- Panel-mounted control unit (receiver) with indicating meter
- Optional triple range for hydrogen-cooled generator applications
- Standard 30 VDC supply voltage to the field-mounted sensing unit
- Voltage or current output signals from the control unit
- Single or dual alarms with digital thumbwheels setters
- Optional switch-selectable dual-range capability

**Description**

The analyzer consists of two basic components—using the sensing unit (transmitter) and the control unit (receiver).

The sensing unit receives a continuous flow of the binary or multicomponent gas mixture, measures the concentration of the sample gas and transmits an electrical signal to the control unit. The sensing unit is ruggedly constructed to meet most environmental conditions and is designed to be mounted up to 1,000 feet from the control unit with only a single multiconductor non-shielded cable connecting the two, resulting in greater flexibility and lower installation costs.

The control unit receives the output signal from the sensing unit at the sampling site by way of the interconnecting cable. The same cable supplies the operating voltage (30 Vdc) to the sensing unit from the control unit.
The control unit is designed for simplified panel-mounting either at the sampling site if environmental conditions permit, or in a control room. The unit can provide a voltage or current output signal to an auxiliary instrument such as a strip-chart recorder, and, if desired, can be equipped with an indicating meter for direct readout and monitoring of the sample gas concentration. The control unit can also be supplied with one or two optional alarms with digital thumbwheel setpoint setters. When an alarm is detected, a relay contact is energized to activate an external annunciator or relay to initiate a shutdown procedure for the process. The relay is inherently fail-safe because it is normally energized and provides a contact closure on loss of power.

Some of the common applications of the 7866 Thermal Conductivity Analyzer are:

**Electric Power Industry Power Plants** - Accurate monitoring of hydrogen purity in hydrogen-cooled generators. The Triple Range Analyzer also monitors carbon dioxide in air and carbon dioxide in hydrogen insuring safe execution of the purge cycles.

**Chemical Industry** - Measurement of hydrogen in ammonia or nitrogen for dissociated ammonia applications. Also, measurement of hydrogen in oxygen, carbon dioxide, and methane.


The Sensor Assembly comprises two sections - the cell block assembly and the electronic assembly.

The Cell Block Assembly is of stainless steel construction with two identical internal cells, the measuring cell and the reference cell. The highly stable thermistor is mounted in each cell. These matched thermistors form the active arms of a bridge circuit; the unbalanced current of the bridge provides the means of measuring the relative ability of the sample and reference gases to conduct the heat away from their respective thermistors to the cell wall, which is held at a constant temperature. The reference gas chamber, with inlet and outlet openings drilled into the chamber from the base, can be opened or sealed. All zero-based standard ranges and the 20 to 50% H₂ Range have air filled, sealed reference cells. For hydrogen ranges starting above 50% as well as the 90-100% oxygen range, a flowing reference is used. The measuring chamber is open to the continuous sample gas flow.

The cells in which the thermistors are mounted are deadended so the sample gas enters only by diffusion, minimizing the effect of sample flow variations. In addition, the entire cell-block assembly is maintained at a constant optimum temperature through two heaters and a control thermistor that are located in the cell block assembly.

The Sensing Unit’s electronics assembly incorporates solid state electrical circuits. These circuits include:

**Current Regulator** - which supplies the constant current to the thermistor cell bridge circuit.

**Proportional Action Temperature Controller** - which maintains the entire cell block at a constant temperature.

**Voltage to Current Converter/Amplifier** - whose current output is transmitted to the analyzer’s Control Unit.

**Control Unit** - The control Unit houses the remaining measuring and power supply circuits in an extruded aluminum DIN standard case. In addition, the Control Unit contains the front-panel calibration adjustments for the analyzer system. These include the zero and span adjusters, and a span adjuster for the optional readout meter. A front-panel switch permits manually transferring the input to the unit from the sample gas to calibration gas for easy calibration. Test points for the control Unit’s output circuits are also provided.

**Integral Readout Meter on the Control Unit** - this meter, mounted on the front panel of the control unit, provides a continuous readout indication of the gas under analysis on a 0-100 uniform scale (calibration curve supplied with the instrument).

**Single or Dual alarms** - a single alarm (High or Low) or dual alarms (one High one Low, two High or two Low) can be provided. The alarm consists of a digital thumbwheel setpoint setter for each alarm level, an indicating lamp that is lit when an alarm is detected, and a relay output that can be used to actuate an external annunciator or to start a process shutdown device.

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**Equipment**

**Sensing Unit** - The 7866 Thermal Conductivity analyzer’s Sensor Assembly can be supplied in a general purpose or explosion proof housing. Both types of housing are of rugged cast aluminum construction that permits reliable operation under adverse ambient conditions.
Extruded Aluminum Case
Designed for Easy Panel Mounting

Aluminum Terminal Board Cover is Secured to Rear of Instrument Case

Knockouts at Top or Bottom for Sensing Unit Interconnecting Cable and Output Signal Conductors

Flip-Down Door, Magnetically Latched, for Easy Accessibility

Chassis Slides Out of Case for Routine Maintenance when Required

Alarm Output Relays with Failsafe Features

Control Unit - Internal View
Rugged, General-Purpose Waterproof and Dust Proof Cast-Aluminum Housing

Inlet and Outlet Ports for Sample Gas

Inlet and Outlet Ports to Measuring and Reference Cells

Stainless-Steel Cell-Block Assembly

Stainless-Steel Handle Facilitates Removal of Sensor Assembly

Rugged Threaded Cap Seals on Gasketed Housing

Current-Output Adjustment

Zero and Span Adjustments for Easy Calibration

Output-Circuit Test Points

Alarm Indication Lamps

"Measure/Calibrate" Switch for Input Gas Selection

Digital Alarm Setpoint Setters

Optional Indicating Meter for Readout of Percent Concentration

Control Unit - Front View

Sensor Assembly

Sensor Assembly
Sensing Unit

Constant Current Source

Cell - Block Assembly

Temperature Controller

Voltage/Current Converter Amplifier

Power Supply

Amplifier

Integral Alarms (1 or 2)

Integral Meter

Optional Recorder Output

Optional Current Output

Control Unit

Block Diagram of 7866 Thermal Conductivity Analyzer

Cross-Section of Sensing Unit

Measuring Thermistor Assembly

Reference Thermistor Assembly

Plug-In Connections

Cell Block

Housing

Sample Inlet

Sample Outlet

Reference-Cell Plug (or Additional Fitting for Flowing Reference Gas)
# Specifications

<table>
<thead>
<tr>
<th>Performance</th>
<th></th>
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<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td>±2% of span (output signal) at reference conditions for binary gas mixtures</td>
</tr>
<tr>
<td><strong>Linearity</strong></td>
<td>Within ±2% of span for most standard ranges. If linearity exceeds ±2% a correction curve is supplied with the analyzer.</td>
</tr>
</tbody>
</table>
| **Meter**         | Accuracy: ±2% of span  
|                   | Dead-end: Less than 0.5% of span  
|                   | Scale Length: 58.5 mm (29/32”) |
| **Repeatability** | Short term: ±0.3% of span |
| **Reproducibility** | 24 hour: ±1% of span |
| **Response Time** | Maximum, for 4 cfh (2000 cc/min.) flow:  
|                   | for H₂; initial, less than 1 second;  
|                   | 63%: 13 seconds  
|                   | 90%: 23 seconds  
|                   | 99%: 40 seconds  
|                   | For CO₂; initial, less than 2 seconds;  
|                   | 63%: 24 seconds  
|                   | 90%: 45 seconds  
|                   | 99%: 80 seconds |
| **Max. Drift**    | Zero: ±2% of span  
|                   | Span: ±2% of span |
| **Ambient Temperature Influence** | At sensing unit: Depends on range; typically less than 1% F.S. over entire temperature range  
<p>|                   | At control: ±0.01% per°C (±0.005% of span per °F) |
| <strong>Atmospheric Pressure Influence</strong> | ±0.05% of span °C (±0.01% of span per °F) |
| <strong>Sample Flow Rate Influence</strong> | Less than ±0.5% of span over flow range of 0.2 to 4 cfh (100 to 2000 cc/min) |
| <strong>Line Voltage Influence</strong> | Max. 0.02% of span for each 1% change of line voltage |</p>
<table>
<thead>
<tr>
<th>Operating</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Measuring Range</strong></td>
<td>One, two or three ranges, as specified. For standard ranges, see Selection Guide Table in the Model Selection Guide. Where two ranges are specified, they must be zero-based and the same type of gas.</td>
</tr>
</tbody>
</table>
| **Output Ranges** | 0-20 mA into 0-500 ohm load  
4-20 mA into 0-500 ohm load  
0-10 mV across 5000-ohm minimum load  
0-100 mV across 50,000-ohm minimum load  
0-1 V across 120,000-ohm minimum load  
0-10 V across 2000-ohm minimum load |
| **Alarm Circuits** | Setpoint resolution: 1%  
Contact ratings: 3 amps at 120 Vac (resistive) or 3 amps at 28 Vdc (resistive) failsafe design, SPDT |
| **Sample Requirements** | Sample Flow: 0.2 to 4.2 cfh (100 cc/min to 2000 cc/min)  
Sample Pressure: 37 mm Hg (20" H2O) minimum (with filter and flowmeter) |
| **Reference Gas Requirements** | None required, except for ranges 080, 095, 098, 506, 508, 512, and 516; these require pure hydrogen reference gas flow, 0.02-0.2 cfh (10-100 cc/min). Ranges 103, 601 and 703 require flowing air as the reference gas. |
| **Ambient Requirements** | Relative Humidity: 90% maximum  
Temperature Range: -10°C to +50°C (14°F to 122°F)  
Storage Temperature: 70°C maximum (158°F) |
| **Power Requirements** | (Control Unit only) 117 ±10 V or 230 ±20 V, 50/60 Hz, 30 watts |
| **Materials contacting Sample Gas** | Sample contacts 316 stainless steel, Buna N, Teflon, glass and Viton |
| **Physical Specifications** | **Sensing Unit**  
Weight: General purpose-7 kg (15 lb)  
Explosion proof-8.5 kg (18 ¾ lb)  
Dimensions: General purpose-Approx. 150 x 150 x 290 mm (6 x 6 x 1 ½")  
Explosion proof-Approx. 150 x150 x325 mm (6 x 6 x 12 ¾")  
Finish: Gray textured enamel  
**Control Unit**  
Weight: 3 kg (6 ½ lb)  
Dimensions: 72 x 144 x 385 mm (2 7/7 x 5 5/8 x 15")  
Finish: Gray textured enamel (bezel), black enamel (front plate), extruded aluminum case |
| **Connections** | Sample inlet and outlet: ¼" OD tubing (compression fittings supplied)  
Reference gas inlet and outlet: ¼" OD tubing (compression fittings supplied)  
Electrical power inlet: Opening for ½" conduit (control unit only)  
Sensing unit power inlet (24 Vdc from control unit): ½" NPT (female conduit) |
| **Miscellaneous** | General purpose sensing unit: NEMA 4 (water-tight and dust-tight)  
Explosion-proof sensing unit: Designed to meet NEMA 7, Class 1, Division 1, Groups A, B, C and D  
Control unit: NEMA 1 (general-purpose indoor)  
Analyzer temperature: Sensing unit thermostated at 50°C (122°F) |
<table>
<thead>
<tr>
<th>Single % Range (no price adder)</th>
<th>Measurement Component</th>
<th>Background</th>
<th>Table III Background Gas Code</th>
<th>Table IV Range</th>
<th>Table VII Sensing Unit</th>
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<tr>
<td>0-1</td>
<td>%H&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Air or N&lt;sub&gt;2&lt;/sub&gt; or O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>1</td>
<td>001000</td>
<td>1 or 3</td>
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<td>0-30</td>
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<td>030000</td>
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<td>0-75 disassociated ammonia</td>
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<td>% CO&lt;sub&gt;2&lt;/sub&gt;</td>
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<td>519000</td>
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<tr>
<td>0-100</td>
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<td>CO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>1</td>
<td>111000</td>
<td>1 or 3</td>
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<tr>
<td>50-100</td>
<td>% H&lt;sub&gt;2&lt;/sub&gt;</td>
<td>CH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>1</td>
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<td>1 or 3</td>
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<tr>
<td>0-30</td>
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<td>H&lt;sub&gt;2&lt;/sub&gt;</td>
<td>6</td>
<td>512000</td>
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<td>5-15</td>
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<td>Air</td>
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<td>517000</td>
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<tr>
<td>70-100</td>
<td>% He</td>
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<td>5</td>
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<tr>
<td>95-100</td>
<td>% O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>H&lt;sub&gt;2&lt;/sub&gt;</td>
<td>4</td>
<td>090000</td>
<td>1 or 3</td>
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<tr>
<td>Dual Ranges (Note 1)</td>
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<td></td>
<td></td>
<td>992992</td>
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</tbody>
</table>

| 0-100 & 100-0                    | % H<sub>2</sub>        | In CO<sub>2</sub> | 1                             | 601000         | 7 (Note 2)             |
|                                 | % CO<sub>2</sub>       |            |                               |                |                        |
|                                 |                        |            |                               |                |                        |

**Triple Range:** For hydrogen cooled generator applications, see DPM-11 for pricing on 7866H and DPM-13 for Optional 7872 Sampling System.

**Notes:**
1. Must use same zero gas for both ranges.
2. Range 601 requires flowing air as the reference gas.

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