Sensata’s Pressure and Temperature Sensor for R744 AC applications: ‘a sensor that makes sense’

Renske Eissens
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- Cabin Comfort Solutions

Part 2
- Why Sensors?
- R744 AC Sensor solutions
- Digital output compared to analog
- Customer choices

Summary
Introduction

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- Product Manager Cabin Comfort sensor solutions
- Based in Almelo, The Netherlands

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Sensata At A Glance

*Leading* supplier of sensors and electrical protection with revenue over $1 billion in 2006

*Technical expertise and proven capabilities*

*Global* presence with more than 10,000 employees

*Cost advantage* through volume scale and best cost producing sites
Cabin Comfort sensor solutions

Pressure sensors
Combined pressure and temperature sensors
Optical (Solar, Twilight, Tunnel)
Humidity
Defogging
Air Quality

Comfort and Safety

Comfort and Air Quality

Comfort and Fuel Economy
## Why sensors?

<table>
<thead>
<tr>
<th></th>
<th>R134a AC</th>
<th>&gt;&gt;</th>
<th>R744 AC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Needed information</strong> (Optional)</td>
<td>Pressure</td>
<td></td>
<td>Pressure + Temperature</td>
</tr>
<tr>
<td></td>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Used for</strong></td>
<td>FAN control</td>
<td></td>
<td>same</td>
</tr>
<tr>
<td></td>
<td>Over pressure protection</td>
<td></td>
<td>same + temperature</td>
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<tr>
<td></td>
<td>Cooling performance</td>
<td></td>
<td>same</td>
</tr>
<tr>
<td></td>
<td>COP* optimization</td>
<td></td>
<td>COP* optimization</td>
</tr>
<tr>
<td></td>
<td>Leakage detection/ diagnostics</td>
<td></td>
<td>Leakage detection/ diagnostics</td>
</tr>
<tr>
<td></td>
<td>Heat pump control</td>
<td></td>
<td>Heat pump control</td>
</tr>
<tr>
<td><strong>Sensor Technology</strong></td>
<td>Capacitive Ceramic</td>
<td></td>
<td>Strain Gauges,</td>
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<tr>
<td></td>
<td>In production since 1987: sold over 150MIO! WW market leader</td>
<td></td>
<td>hermetic design</td>
</tr>
<tr>
<td><strong>Experience</strong></td>
<td>Sensata; samples available</td>
<td></td>
<td>Technology known within</td>
</tr>
<tr>
<td></td>
<td>Already NOMINATED today!</td>
<td></td>
<td>Sensata; samples available</td>
</tr>
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</table>

* COP: coefficient of performance

Note: the end use of the sensor is in some cases dependent on several other component choices within an AC system, e.g. type of expansion valve)
R744 AC Sensor solutions

- Dual Analog
- LIN
- PWM

- Accuracy
  - Pressure
  - Temperature
- Response time
  - Pressure
  - Temperature
- Envelope
- Needed pins/ wires (3, 4 or 5)
- Connector type
- Others

LIN = digital signal; Local Interconnected Network
PWM = digital signal, Pulse With Modulation
Accuracy of LIN versus analog (1/4)

Sensata believes that on **system level**, a LIN approach can offer almost **double the accuracy** compared to a dual analog P+T sensor

The Sensata LIN solution offers:

+/-1.0…2.0 bar pressure accuracy from 0 … 170 bar
+/-3 °C temperature accuracy @ 0 °C, 25 °C and 155 °C

Pressure and temperature response time < 7.5ms

The next 2 slides illustrate this with simplified block schematics
P-Accuracy of LIN versus analog (2/4)

LIN bus

Sensor → ADC / DSP → ECU

Digital communication

Noise

V+ → ECU

Analog

Sensor → Analog communication → ECU

ADC / DSP

ECU
T-Accuracy of LIN versus analog (3/4)
Overview LIN versus Analog

- LIN offers higher accuracy over the full pressure and temperature range
- LIN has a fast response time
- Lower cost in overall system and cabling
- Less EMC sensitivity
- Additional embedded diagnostics
Customer choices

- type of signal preferred (LIN, PWM, Analog)
- pressure accuracy
- temperature accuracy
- preferable size of the sensor
- response time
- test specifications
- total cost at system level

Sensata’s engineering team leaders ready to meet demanding requirements:

<table>
<thead>
<tr>
<th>Electrical Engineering</th>
<th>Mechanical Engineering</th>
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</thead>
<tbody>
<tr>
<td><strong>Tim Tiek</strong></td>
<td><strong>Werner Kleissen</strong></td>
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</tr>
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</table>
‘a sensor that makes sense’

- enables optimized AC efficiency (cooling performance)
- helps maximizing the COP > improves Fuel Economy and less CO₂ Emission
- makes it possible to diagnose filling rate/ leakage detection
- protects components like the compressor and gas-cooler for high pressure and temperatures
- enables heat pump functionality

And, is available today!
Thank You