Infrared MEMS Thermal Sensor
D6T Product Series: Infrared MEMS Thermal Sensor

D6T positioning on thermal market:

- thermal sensor market is highly competitive and temperature is one of most measured parameters across many industries (if not all of them)

- non contact thermal measurement has benefits as response speed, no inter-reaction on measured object or long lasting measurement. Generally only the surface temperature can be measured.

- IR detecting systems include pyroelectric and thermopile technologies
D6T  Product Series:
Infrared MEMS Thermal Sensor

Product positioning in Omron MEMS:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Product series</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOW:</td>
<td>D6F</td>
</tr>
<tr>
<td>PRESSURE:</td>
<td>2SMPP, D8M</td>
</tr>
<tr>
<td>RF</td>
<td>2SMES</td>
</tr>
<tr>
<td>THERMAL</td>
<td>D6T</td>
</tr>
</tbody>
</table>
Market development expectations

- It is predicted significant growth in IR Thermal sensor market: **CAGR 2010-2016: +11%**
- Main areas to contribute to growth are: People motion detection in Building Automation and Home Appliances, low end temperature sensors and people counting or advanced people detection
- Research & development efforts already started, D6T is product in interest
D6T : Product Features

Function
To measure the surface temperature of the material by detecting intensity of the infrared radiation. Best fit for human detection and non-contact temperature measurement.

Technology
Incorporate state-of-the-art MEMS thermopile, custom designed sensor ASIC and signal processing micro processor and algorithm into tiny package.

- Unique MEMS, ASIC, and other application-specific parts to ensure high sensitivity
- Low visual field crosstalk characteristics enable high-precision area temperature detection
- Digital output with superior noise immunity
- High Signal to noise ratio (SNR) expressed as Noise-Equivalent Temperature Difference at 0.14 degrees Celsius
- Compact size with dimensions of 18x14x6.3mm
D6T Product Structure

Thermopile array

1×8 element

4×4 element

Connector

Microcontroller

PCB

Silicon Lens

ASIC

MEMS

Thermopile
D6T Operation principle

Silicon Lens
Gather radiated infrared on the thermopile

MEMS Thermopile Array (1x8 array, 3.2x0.8mm)
Transduce infrared light into electrical signal

Temperature Conversion Algorithm
Convert sensor signal to digital temperature output

Infrared Ray

Gather radiated infrared on the thermopile
Transduce infrared light into electrical signal
Convert sensor signal to digital temperature output
Thermocouple’s Seebeck effect

Thermopile is consist of the series of the thermocouple. Thermocouple generate voltage when any conductor (such as a metal) is subjected to a thermal gradient. It is known as Seebeck effect.

Material A (Poly Silicon)

Material B (Aluminum)

Hot junction

Cold junction

Temperature is same as ambient temperature because of Silicon’s high conductivity.

Temperature depend on flow speed.
D6T Operation Principle II.

Figure 2 Sensor Structure
<table>
<thead>
<tr>
<th>Chip</th>
<th>1x8 array</th>
<th>4x4 array</th>
<th>16x16 array</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>D6T-8L-06</td>
<td>D6T-44L-06</td>
<td>TBD</td>
</tr>
<tr>
<td>Status</td>
<td>Sample Available</td>
<td>Sample Available</td>
<td>Under development</td>
</tr>
<tr>
<td>Field of view</td>
<td>X:62.8° Y: 6.0°</td>
<td>X:44.2° Y: 45.7°</td>
<td>-</td>
</tr>
<tr>
<td>Photo</td>
<td><img src="image1.png" alt="1x8 array photo" /></td>
<td><img src="image2.png" alt="4x4 array photo" /></td>
<td><img src="image3.png" alt="16x16 array photo" /></td>
</tr>
</tbody>
</table>
## D6T Product Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature range [°C]</td>
<td>-10 to 60°C (with no ice or no dew condensation)</td>
</tr>
<tr>
<td>Operating temperature range [°C]</td>
<td>0 to 50°C (with no ice or no dew condensation)</td>
</tr>
<tr>
<td></td>
<td>* Guaranteed accuracy, see the figure on the next page.</td>
</tr>
<tr>
<td>Storage humidity range [%RH]</td>
<td>85%RH or less (with no dew condensation)</td>
</tr>
<tr>
<td>Operating humidity range [%RH]</td>
<td>20 to 85%RH (with no dew condensation)</td>
</tr>
<tr>
<td>Supply voltage [V]</td>
<td>4.5 to 5.5</td>
</tr>
<tr>
<td>Maximum output voltage [V]</td>
<td>0.8Vcc to Vcc</td>
</tr>
<tr>
<td>Minimum output voltage [V]</td>
<td>0 to 0.2Vcc</td>
</tr>
<tr>
<td>Current consumption [mA]</td>
<td>Typ.5</td>
</tr>
<tr>
<td>Output</td>
<td>Temperature values</td>
</tr>
<tr>
<td>Object temperature accuracy [°C]</td>
<td>±1.5</td>
</tr>
<tr>
<td>Digital interface</td>
<td>I2C (Synchronous serial communication)</td>
</tr>
<tr>
<td>Data update rate</td>
<td>Max.250ms</td>
</tr>
</tbody>
</table>
Temperature detecting range of the object
Dimensions of D6T

Other:
Weight: aprox. 3.5g
ROHS / REACH compliant
Package: plastic tray 50pcs, box 4 trays
# FOV : Field of View

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>dir</th>
<th>FOV (all) [deg.]</th>
<th>FOV/2 [deg.]</th>
<th>D = 2 m (2D x tan)</th>
<th>D = 3 m (2D x tan)</th>
<th>D = 5 m (2D x tan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D6T-44L</td>
<td>X</td>
<td>44.2</td>
<td>22.1</td>
<td>1.62 m</td>
<td>2.44 m</td>
<td>4.06 m</td>
</tr>
<tr>
<td>4x4</td>
<td>Y</td>
<td>45.7</td>
<td>22.8</td>
<td>1.69 m</td>
<td>2.53 m</td>
<td>4.21 m</td>
</tr>
<tr>
<td>D6T-8L</td>
<td>X</td>
<td>62.8</td>
<td>31.4</td>
<td>2.44 m</td>
<td>3.66 m</td>
<td>6.10 m</td>
</tr>
<tr>
<td>1x8</td>
<td>Y</td>
<td>6.0</td>
<td>3.0</td>
<td>0.21 m</td>
<td>0.31 m</td>
<td>0.52 m</td>
</tr>
</tbody>
</table>

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![Diagram of FOV and sensor types](image-url)
Field of view (1x8 type)

Detection area of each pixel

FOV each pixel

Center of FOV

FOV (Direction X)

FOV (Direction Y)
Field of view (1x8 type) - example

Sensor

1x8

3m

1m

2.44m

0.2m

0.31m

3.66m

Direction-X

Direction-Y
Field of view (4x4Type)

Detection area of each pixel

Center of FOV

FOV each pixel

Ex. P1/P5/P9/P15
FOV (Direction X)

Ex. P4/P5/P6/P7
FOV (Direction Y)
Field of view (4x4Type)- example
Benefit of Omron MEMS IR Sensor I.

**Human detection - Energy management, people safety/security**

Sensor structure is very suitable for human detection, even for objects **in stationary position**. PIR structure finds limits in static detection. Therefore easy to capable monitor area for people (energy saving, people safety, security)

![Diagram](image)
Benefit of Omron MEMS IR Sensor.

<table>
<thead>
<tr>
<th></th>
<th>Competitor (Pyro electric)</th>
<th>OMRON (Thermopile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature measure</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Moving human</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Static human</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Output I/F</td>
<td>Analog, On/Off</td>
<td>Digital value</td>
</tr>
<tr>
<td>Field of View (Total)</td>
<td>Wide (Lens)</td>
<td>63 deg 45 deg</td>
</tr>
<tr>
<td>Sensor Array</td>
<td>1</td>
<td>1x8 4x4</td>
</tr>
</tbody>
</table>

Pyroelectric Sensor

- detected
- Not detected

MEMS IR sensor D6T

- detected
- detected

OMRON Electronic & Mechanical Components Company
Benefit of Omron MEMS IR Sensor II.

Temperature output – information for system adjustments or emergency actions
Sensor is capable to provide temperature information ie. to monitor the temperature level in of room resp. sensed area. It can easily maintain optimal room temperature levels, instantly detect unusual changes in temperature (detecting factory line stoppages, or discover areas of overheating for early prevention of machine damage or even fire outbreaks, etc.)
Benefit of Omron MEMS IR Sensor III.

Full Sensing area coverage – entire overview with positioning function

Sensor can measure the temperature of an entire area contactlessly. Signals generated by sensor output allows assign temperature information to particular cell (1x8=8 resp. 4x4=16 pixels) and to determine position of sensed object. Thus sensor can monitor the changes and trigger to make corrections with high efficiency in case of need.
Application note (D6T 44L-06)

High sensitivity and Low Noise

- 4x4 array sensor outputs in total 16 temperature values for each element.
- higher temperature is observed where human is present
Application note (D6T 44L-06)

Human Thermal Image from D6T
Thermal image may be used for more accurate human detection.
Application note (D6T 44L-06)

- sensing area: 5m x 5m divided into 8 x 8 elements
- used 4 sensors with 4 x 4 elements IR sensor.
Application note (D6T 44L-06)

- Build a quad 4x4 array sensor module on ceiling to get higher resolution and/or wider space coverage (left photo)
- Output example (right photo).
Application note (D6T 8L-06)

Floor heating: High sensitivity and Low Noise
Accurate Floor temperature measures regardless Human presence.
Application areas

- Comfortable
- Safety/Security
- Ecology
- Saving Energy
- Sensing Temperature
- Movement in dark areas
D6T Application fields

- Energy management in Home appliances
- Light / AC control
- Security systems
- Medical care
- Safety function
  - ...People counting, Digital signage, ...
- BEMS/OEMS/HEMS
- Factory automation
D6T: Promotion tools

• Samples available

• Demonstration kit available on request

• Technical documentation available
  – datasheet, application note, algorithm document

• Marcom Materials available:
  – leaflet, advertisement, photos, etc

• Thermal MEMS Sensor video:
  http://www.youtube.com/watch?v=4UT1GBTdmzQ
D6T Application Note

- Application Note: description how to use D6T
- Contents:
  - Electrical connection
  - SW data examples
  - FOV definitions
  - Distance and temperature factors
  - Human detection
- Recommended to send AN with datasheet
- Software algorithm document to be provided soon