OMRON

MEMS Thermal Sensors

D6T

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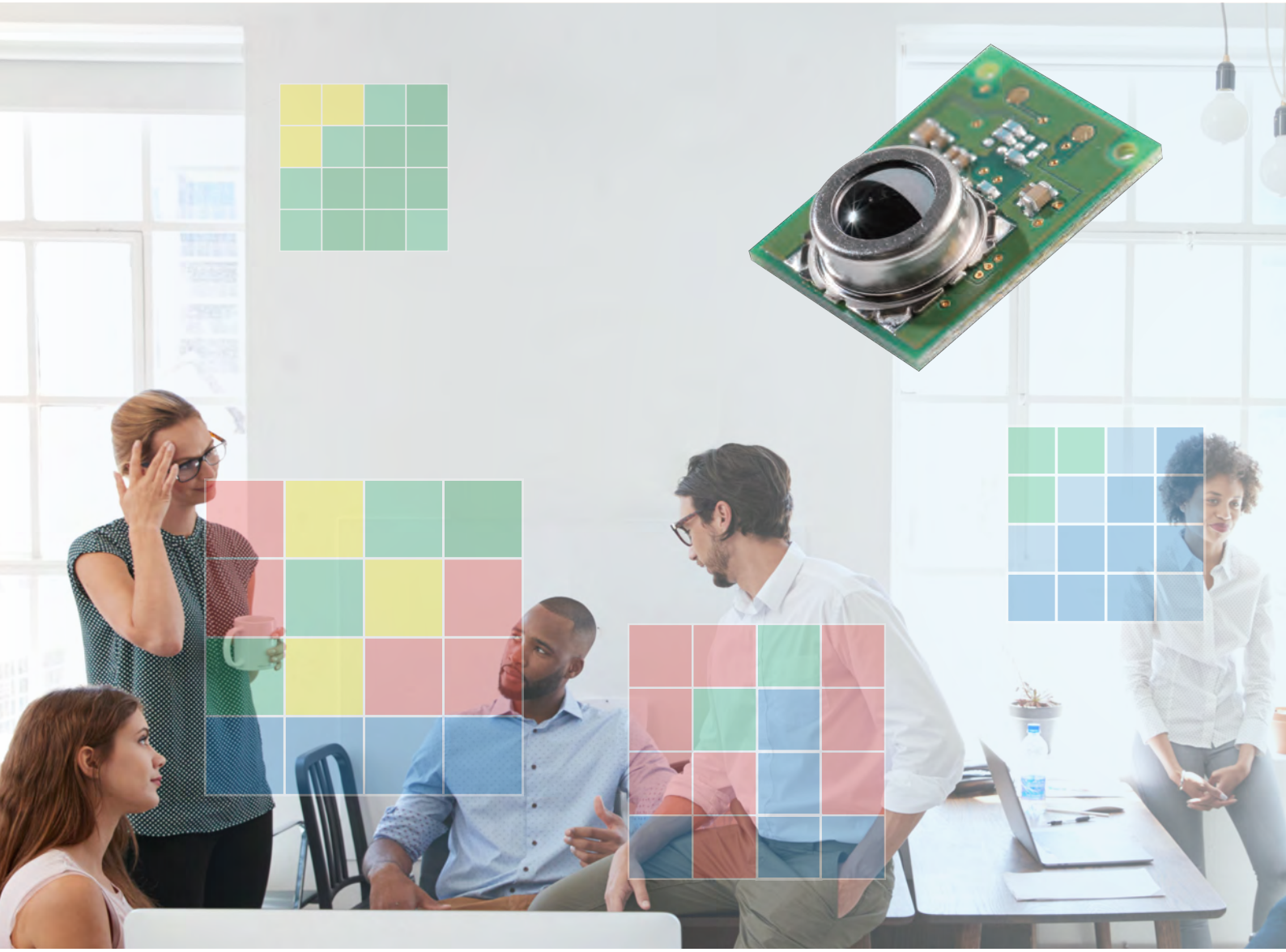
High Accuracy, Smaller Footprint, East to Work With



OMRON's unique MEMS technology allows combining thermopile elements and ASICs into one package resulting to ultra-compact footprint.

MEMS Thermal (IR* sensor) measures the surface temperature of objects without touching them when the thermopile element absorbs the amount of radiant energy from the object.

*IR: Infrared Ray

Low noise

Achieving the highest level of SNR* in the world *2

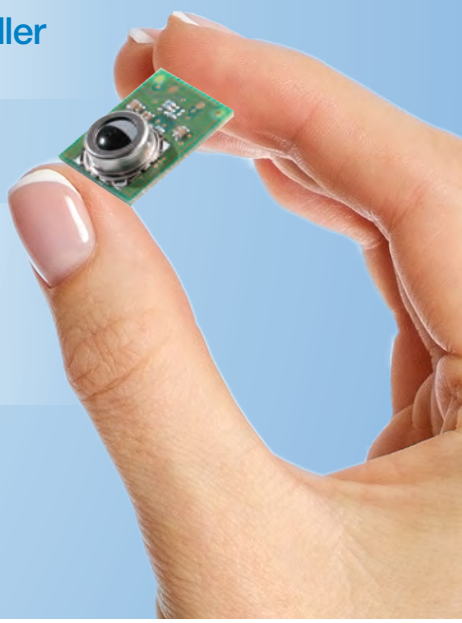
* SNR: Signal-to-Noise Ratio. Compares the level of a signal to the level of background noise
*2 As of December 2017, according to OMRON research

Easy connection

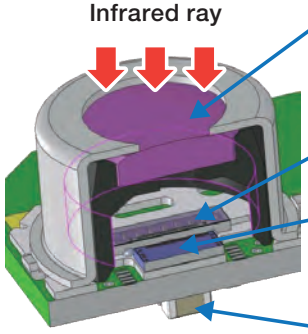
Converts sensor signal to digital temperature output allowing easy use of microcontroller

Compact size

Space-saving design, well-suited for embedded applications



Cross-section view of D6T sensor



Detect wavelengths in the range 8-12 μm

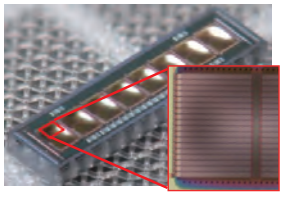
Silicon lens
far-infrared focusing

MEMS thermopile
Electromotive force occurrence

ASIC
Low noise amplifier

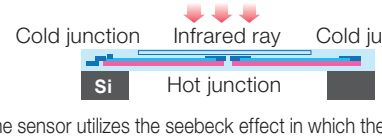
MCU
A/D conversion, calculation, I2C and I/F

☐ **MEMS thermopile**



Thermopile

☐ **Detection principle**



The sensor utilizes the seebeck effect in which thermoelectric force is generated due to the temperature difference that occurs across the junction points of two different types of metal.

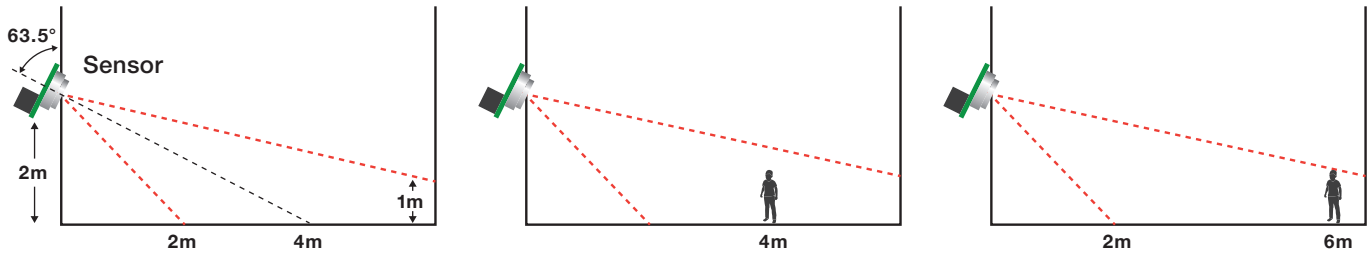
Human Detection

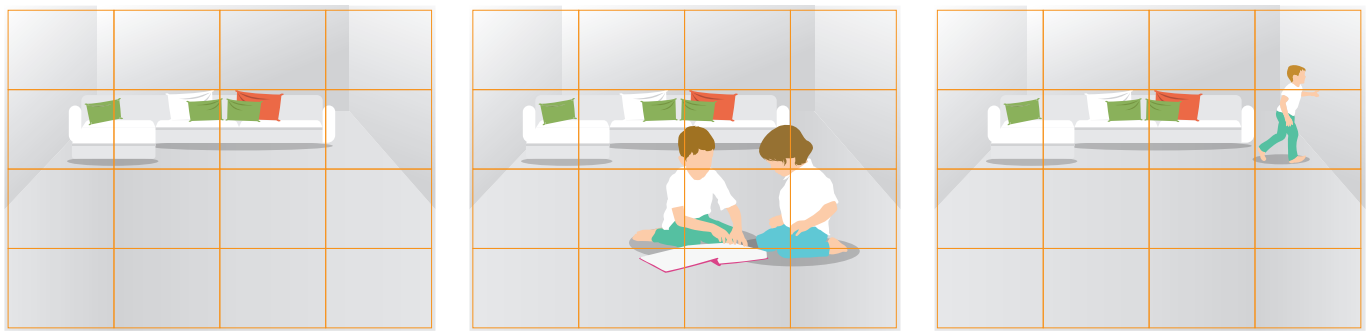
D6T series sensors can detect human presence by sensing changes in human body temperature with respect to the surrounding temperature.

D6T application fields	Air conditioners, lighting systems, security systems, nursing care and monitoring equipment

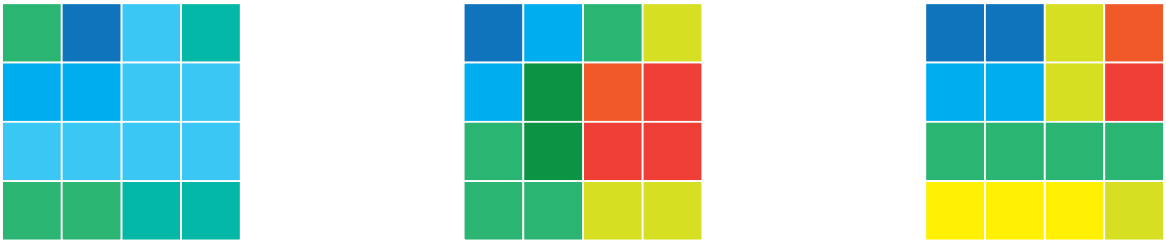
D6T series sensors can detect the slightest temperature changes that can be used in variety of applications including energy-efficient home appliances and security systems. The sensors can also be used in the application fields of HEMS (Home Energy Management System) and BEMS (Building Energy Management System).

Installation condition Recommended type: D6T-44L-06 (4x4-element / viewing angle: X=44.2 Y=45.7° / Object temperature range: 0 – 50degC)





Detection results of temperature distribution



Object Detection

D6T sensors can detect objects by pinpointing the target object temperature.

D6T sensors let you measure temperature without the need to physically touch the object.
This allows measuring temperature where it was not possible for contact thermal sensors due to space shortage.
The sensors can be used in a wide range of applications including FEMS (Factory Energy Management System).

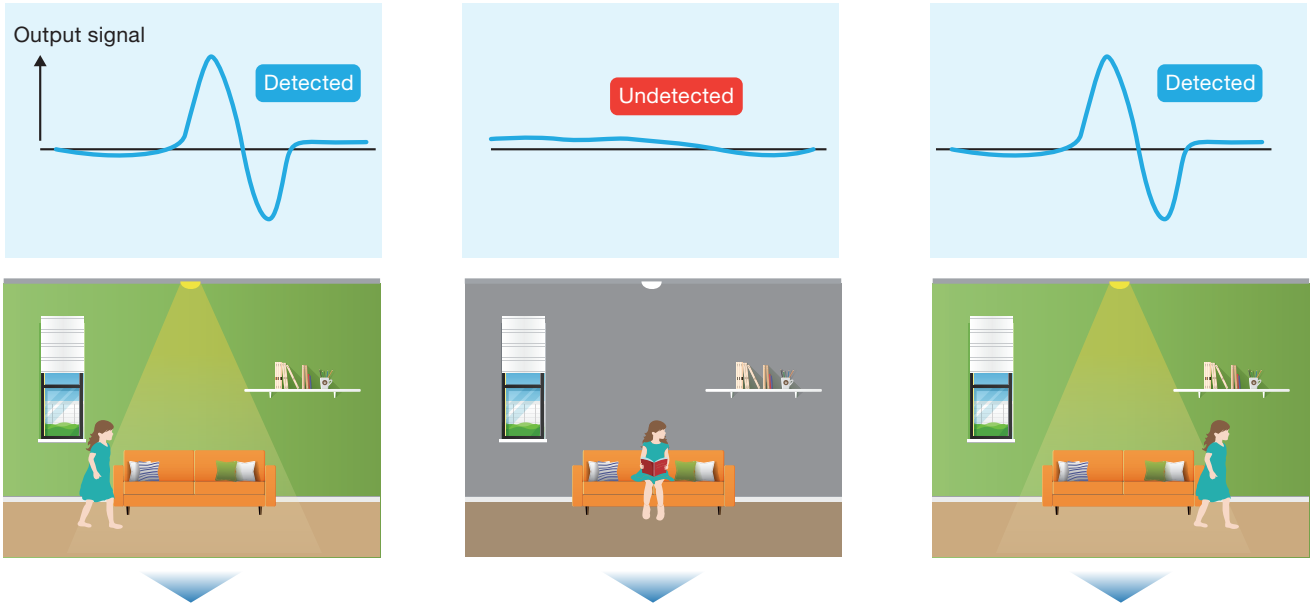
D6T sensor meets customer needs by providing a wide range of application support from home appliances to industrial use.

D6T application fields	Industrial equipment, non-contact thermometers, refrigerators, microwave ovens, IH cooking heaters, data centers

Comparison with Pyroelectric Sensor

Both the pyroelectric sensor and non-contact MEMS thermal sensor can detect even the slightest amount of radiant energy from objects such as infrared radiation and convert them into temperature readings. However, unlike pyroelectric sensor that relies on motion detection, non-contact MEMS thermal sensor is able to detect the presence of stationary humans (or objects).

Pyroelectric sensor Converts temperature readings only when detecting "temperature changes in the radiant energy" in its field of view.

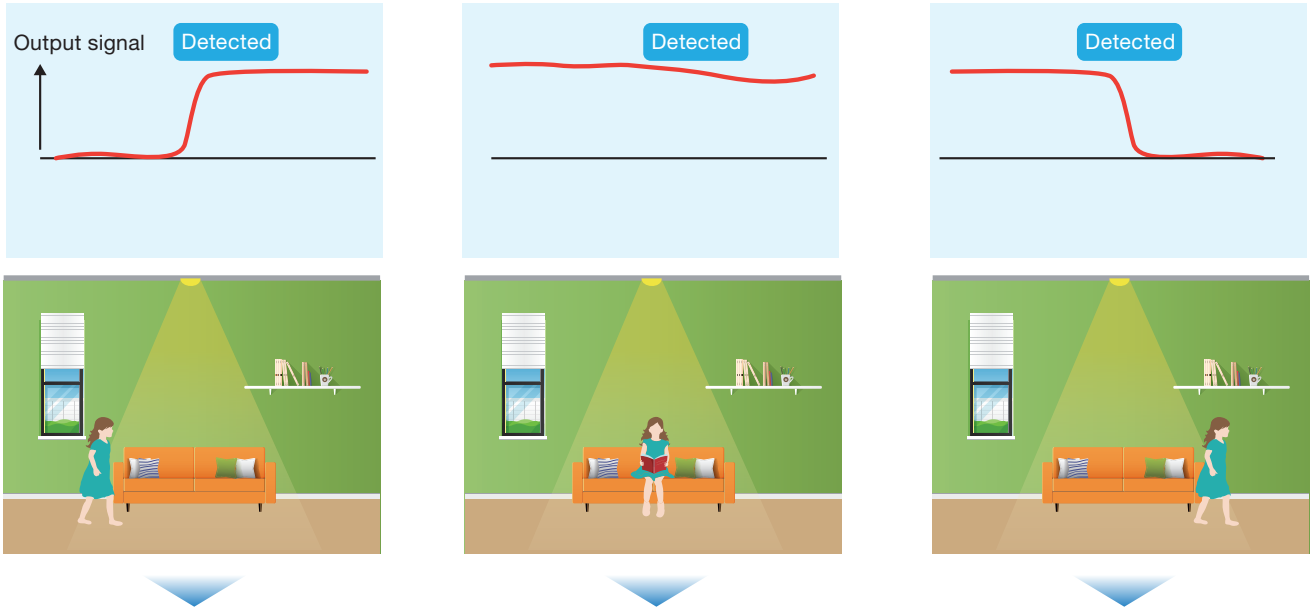


Able to detect human (object) motion

Unable to detect stationary human (object) presence

Able to detect human (object) motion

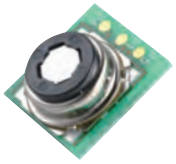
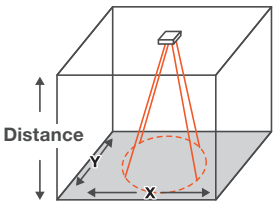
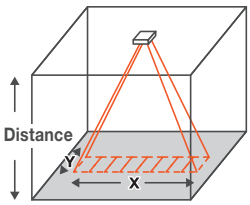
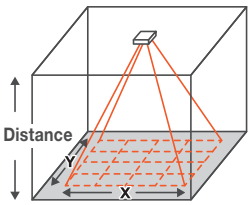
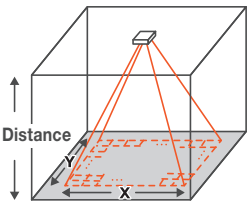
MEMS thermal sensor (thermopile) Converts temperature readings by "continuously detecting the temperature of radiant energy" in its field of view



Able to detect both stationary and motion state of humans (objects).

Viewing Angle and Measurement Area

Choose your preferred sensor viewing angle to meet your application needs.

Sensor type	D6T-1A-01	D6T-1A-02	D6T-8L-09/09H	D6T-44L-06/06H	D6T-32L-01A
Appearance					
Number of elements	1(1x1)		8(1x8)	16(4x4)	1024(32x32)
Number of elements X-direction Y-direction	X = 58.0° Y = 58.0°	X = 26.5° Y = 26.5°	X = 54.5° Y = 5.5°	X=44.2° Y=45.7°	X=90.0° Y=90.0°
Size of measurement area					
Distance 1m	X = 111cm Y = 111cm	X = 47cm Y = 47cm	X = 103cm Y = 10cm	X = 81cm Y = 84cm	X = 200cm Y = 200cm
Distance 2m	X = 222cm Y = 222cm	X = 94cm Y = 94cm	X = 206cm Y = 20cm	X = 162cm Y = 169cm	X = 400cm Y = 400cm
Distance 3m	X = 333cm Y = 333cm	X = 141cm Y = 141cm	X = 309cm Y = 30cm	X = 244cm Y = 253cm	X = 600cm Y = 600cm

* The sizes of measurement area indicated above are for reference only.

* The size of measurement area changes according to sensor mounting angle.

D6T
MEMS Thermal Sensors

High Sensitivity Enables Detection of Stationary Human Presence

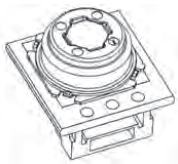
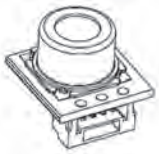
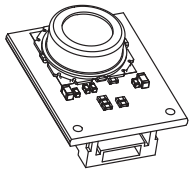
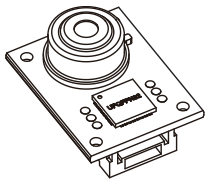
- **OMRON's unique MEMS and ASIC technology achieve a high SNR (except for the D6T-32L-01A).**
- **Superior noise immunity with a digital output.**
- **High-precision area temperature detection with low cross-talk field of view characteristics.**

RoHS Compliant

Refer to *Safety Precautions* on page 17.

Ordering Information

Thermal Sensors

Element type	Model	Shape
1×1	**D6T-1A-01**	
	D6T-1A-02	
1×8	**D6T-8L-09/09H**	
4×4	**D6T-44L-06/06H**	
32×32	**D6T-32L-01A**	

Accessories (Sold separately)

Type	Model
Cable Harness	**D6T-HARNESS-02**

Model Number Legend

D6T-□-□ □
(1) (2) (3)

(1) Number of elements
1A : 1 (1 × 1)
8L : 8 (1 × 8)
44L : 16 (4 × 4)
32L : 1024 (32 × 32)

(2) Viewing angle
01 : X direction, Y direction=58.0°
02 : X direction, Y direction=26.5°
09 : X direction=54.5°, Y direction=5.5°
06 : X direction=44.2°, Y direction=45.7°
01A : X direction, Y direction=90°

(3) Special Functions
H : High-temperature type
Non-display : Standard sensor

Others

MEMS thermal sensors can be connected to OMRON sensor evaluation boards.
Following 3 types of platform are applicable. Evaluation can be performed easily by connecting thermal sensor, evaluation board, and harness to the platform.

Platform	Evaluation Board	Harness for connection (Evaluation Board - D6T)	Sample Source Code
For Raspberry Pi *1	2JCIE-EV01-RP1	2JCIE-HARNESS-01	https://github.com/omron-devhub/d6t-2jcieev01-raspberrypi
For Arduino *2	2JCIE-EV01-AR1	2JCIE-HARNESS-01	https://github.com/omron-devhub/d6t-2jcieev01-arduino
For ESP32 Feather *3	2JCIE-EV01-FT1	2JCIE-HARNESS-01	https://github.com/omron-devhub/d6t-2jcieev01-arduino

For details of evaluation boards and sample source codes, refer to the following website.
(http://www.omron.co.jp/ecb/sensor/evaluation-board/2jcie)

*1. Raspberry Pi is a registered trademark of the Raspberry Pi Foundation.
*2. Arduino is a registered trademark of Arduino LLC and Arduino SRL.
*3. Feather is a registered trademark of Adafruit Industries LLC.

Ratings, Specifications, and Functions

Ratings

Item / Model	D6T-1A-01	D6T-1A-02	D6T-8L-09	D6T-8L-09H	D6T-44L-06	D6T-44L-06H	D6T-32L-01A
Power supply voltage	4.5 to 5.5 VDC						
Storage temperature range	-20 to 80°C	-40 to 80°C	-20 to 80°C (with no icing or condensation)		-10 to 60°C		-20 to 80°C
Operating temperature range	0 to 60°C	-40 to 80°C	0 to 60°C (with no icing or condensation)		0 to 50°C		-10 to 70°C
Storage humidity range	95% max.	95% max.	95% max. (with no icing or condensation)		85% max.		95% max.
Operating humidity range	20% to 95%	20% to 95%	20% to 95% (with no icing or condensation)		20% to 85%		20% to 95%

Characteristics

Item	Model	D6T-1A-01	D6T-1A-02	D6T-8L-09	D6T-8L-09H	D6T-44L-06	D6T-44L-06H	D6T-32L-01A
View angle *1	X direction	58.0°	26.5°	54.5°		44.2°		90°
	Y direction	58.0°	26.5°	5.5°		45.7°		90°
Object temperature output accuracy *2	Accuracy 1	±1.5°C max. Measurement conditions: Vcc = 5.0 V (1) Tx = 25°C, Ta = 25°C (2) Tx = 45°C, Ta = 25°C (3) Tx = 45°C, Ta = 45°C						Within ±3.0°C Measurement conditions: Vcc = 5.0 V Tx = 25°C, Ta = 25°C Central 16x16-pixel area
Current consumption		3.5 mA typical		5 mA typical				19 mA typical

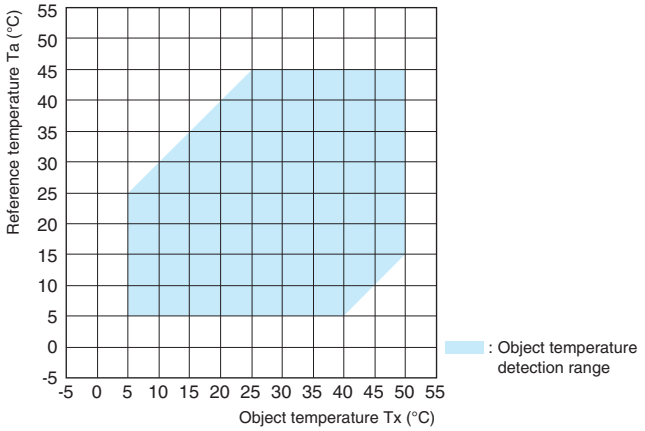
Functions

Item / Model	D6T-1A-01	D6T-1A-02	D6T-8L-09	D6T-8L-09H	D6T-44L-06	D6T-44L-06H	D6T-32L-01A
Object temperature detection range *2	5 to 50°C	-40 to 80°C	5 to 50°C	5 to 200°C	5 to 50°C	5 to 200°C	0 to 200°C
Ambient temperature detection range *2	5 to 45°C	-40 to 80°C	5 to 45°C	5 to 45°C	5 to 45°C	5 to 45°C	0 to 80°C
Output specifications	Digital values that correspond to the object temperature (Tx) and reference temperature (Ta) are output from a serial communications port.						
Output form (Object temperature detection)	Binary code (10 times the detected temperature (°C))			Binary code (5 times the detected temperature (°C))	Binary code (10 times the detected temperature (°C))		
Output form (Reference temperature inside the sensor)	Binary code (10 times the detected temperature (°C))						
Communications form	I2C compliant						
Temperature resolution (NETD) *3	0.02°C (Data update cycle 100 msec)	0.06°C (Data update cycle 100 msec)	0.03°C (Data update cycle 250 msec)	0.03°C (Data update cycle 250 msec)	0.06°C (Data update cycle 300 msec)	0.06°C (Data update cycle 300 msec)	0.33°C *4 (Data update cycle 200 msec)

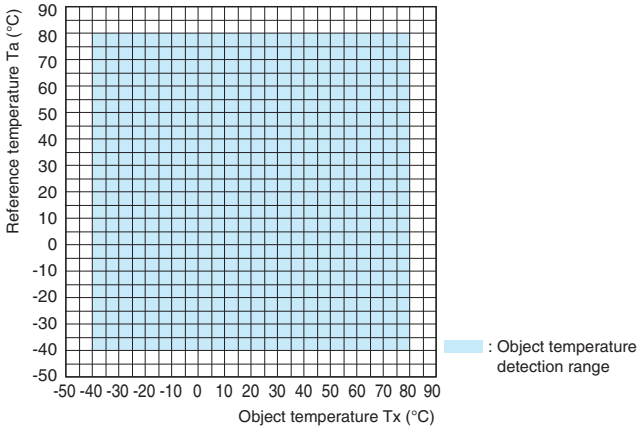
*1. Refer to *Field of View Characteristics*.
*2. Refer to *Object Temperature Detection Range*.
*3. Reference data
*4. Taken to be the average value of the central 4 pixels.

Object Temperature Detection Range

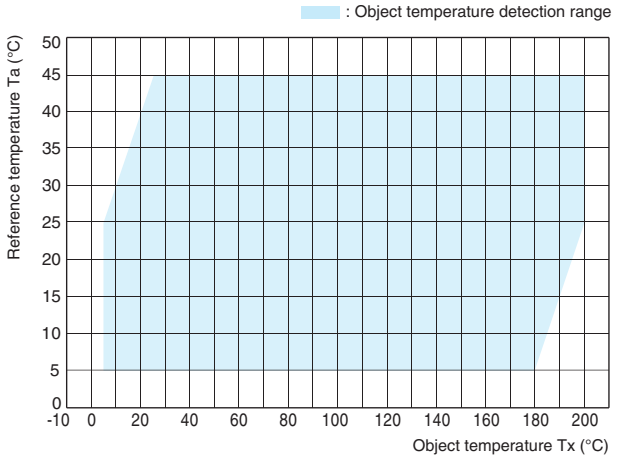
D6T-44L-06, D6T-8L-09, D6T-1A-01



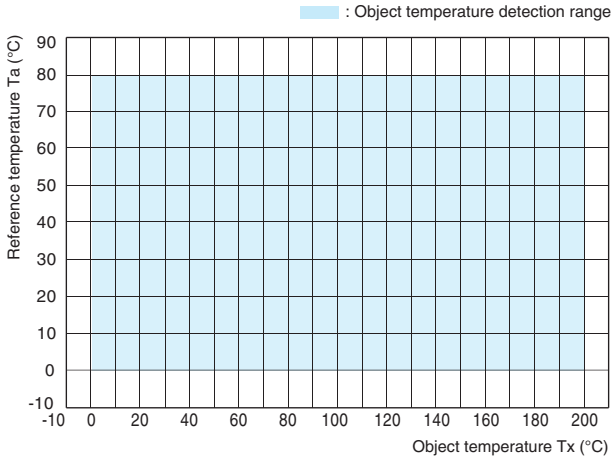
D6T-1A-02



D6T-44L-06H, D6T-8L-09H



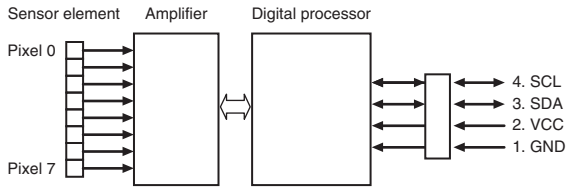
D6T-32L-01A



Connections

Thermal Sensor Configuration Diagram

<D6T-8L-09/09H>



Note: The D6T-44L-06/06H has pixels 0 to 15.
The D6T-1A-01/02 has pixel 0.
The D6T-32L-01A has pixel 0 to 1023.

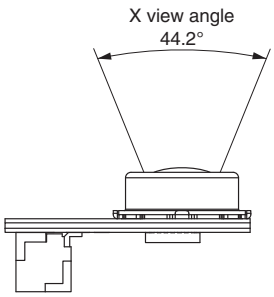
Terminal Arrangement

Terminal	Name	Function	Remarks
1	GND	Ground	
2	VCC	Positive power supply voltage input	
3	SDA	Serial data I/O line	Connect the open-drain SDA terminal to a pull-up resistor.
4	SCL	Serial clock input	Connect the open-drain SCL terminal to a pull-up resistor.

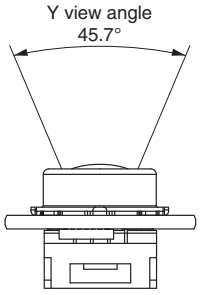
Field of View Characteristics

D6T-44L-06/06H

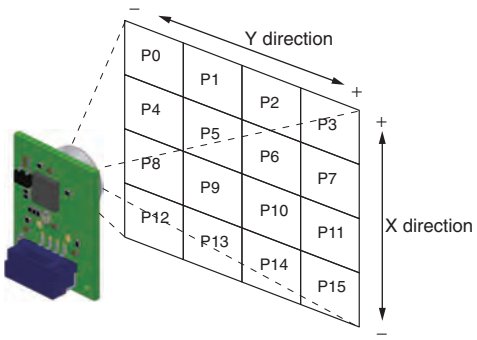
Field of view in X Direction



Field of view in Y Direction



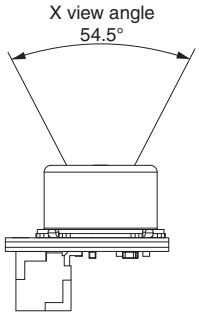
Detection Area for Each Pixel



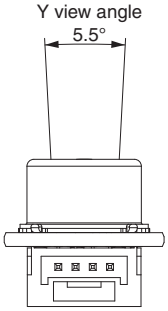
Note: Definition of view angle: Using the maximum Sensor output as a reference, the angular range where the Sensor output is 50% or higher when the angle of the Sensor is changed is defined as the view angle.

D6T-8L-09/09H

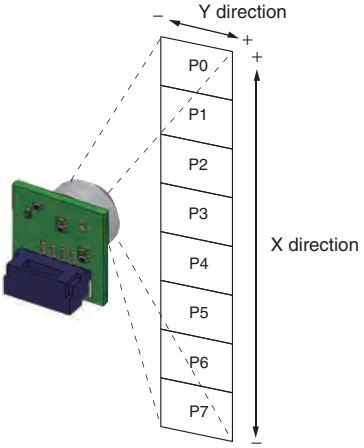
Field of view in X Direction



Field of view in Y Direction



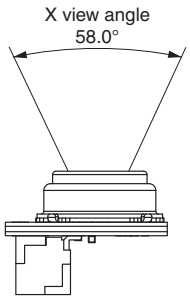
Detection Area for Each Pixel



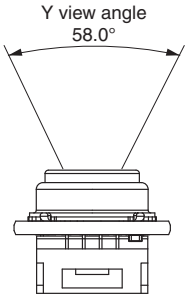
Note: Definition of view angle: Using the maximum Sensor output as a reference, the angular range where the Sensor output is 50% or higher when the angle of the Sensor is changed is defined as the view angle.

D6T-1A-01

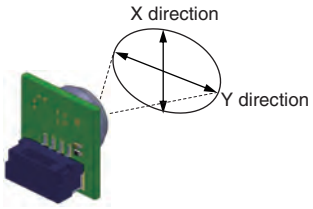
Field of view in X Direction



Field of view in Y Direction

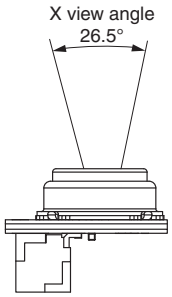


Detection Area for Each Pixel

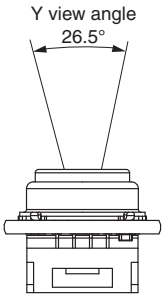


D6T-1A-02

Field of view in X Direction



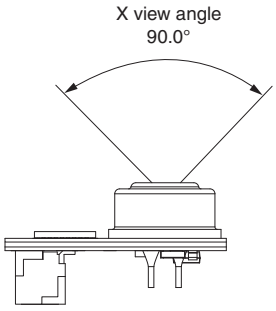
Field of view in Y Direction



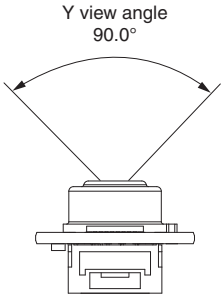
Note: Definition of view angle: Using the maximum Sensor output as a reference, the angular range where the Sensor output is 50% or higher when the angle of the Sensor is changed is defined as the view angle.

D6T-32L-01A

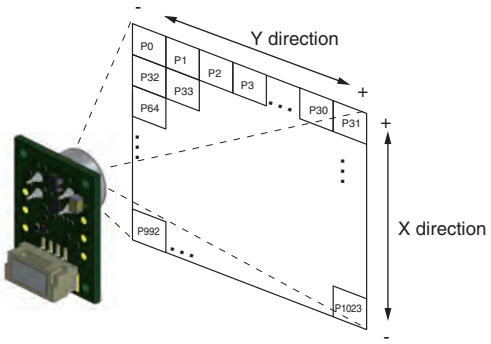
Field of view in X Direction



Field of view in Y Direction



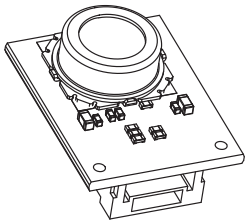
Detection Area for Each Pixel

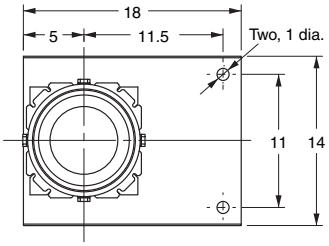


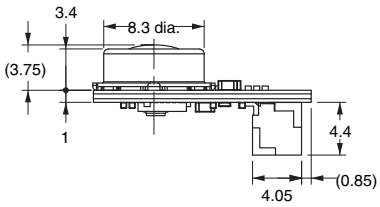
Note: Definition of view angle: Using the maximum Sensor output as a reference, the angular range where the Sensor output is 50% or higher when the angle of the Sensor is changed is defined as the view angle.

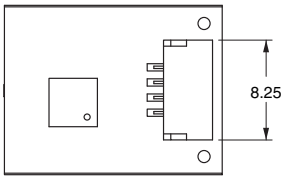
Dimensions (Unit: mm)

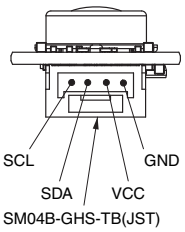
D6T-44L-06/06H



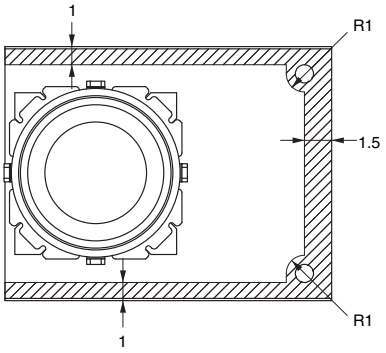




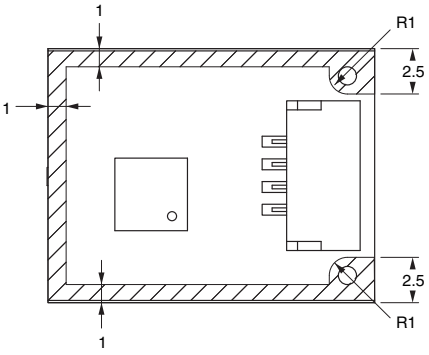




Supporting and Mounting Area (Shaded Portion)
Top View

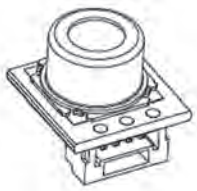


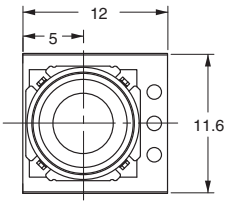
Bottom View

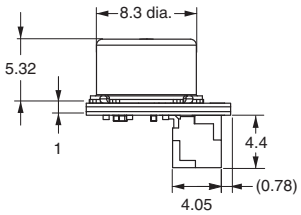


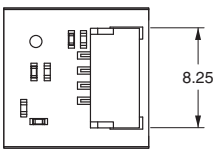
Note: Due to insulation distance limitations, do not allow metal parts to come into contact with the Sensor.

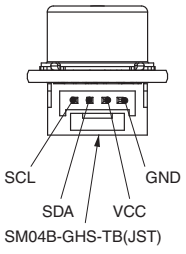
D6T-8L-09/09H



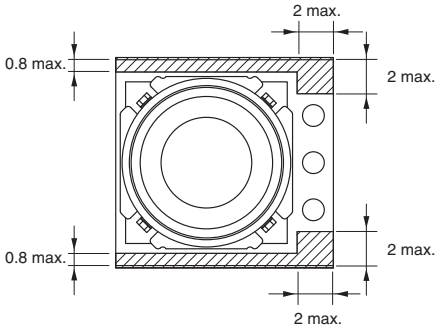




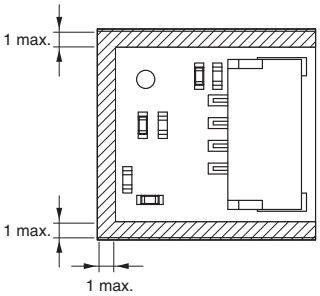




Supporting and Mounting Area (Shaded Portion)
Top View



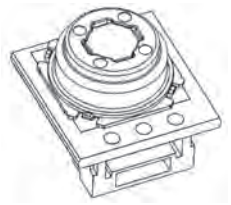
Bottom View

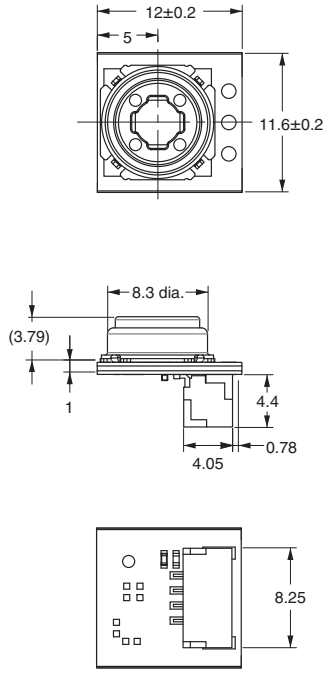


Note: Due to insulation distance limitations, do not allow metal parts to come into contact with the Sensor.

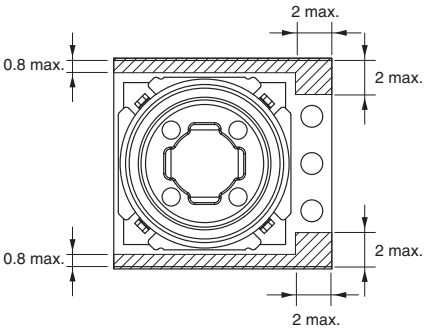
Note: Unless otherwise specified, a tolerance of ±0.3 mm applies to all dimensions.

D6T-1A-01/02

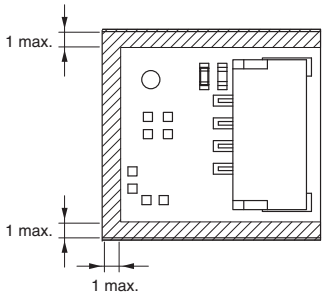




Supporting and Mounting Area (Shaded Portion)
Top View

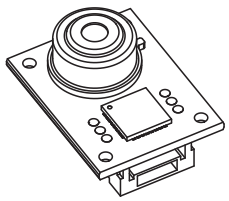


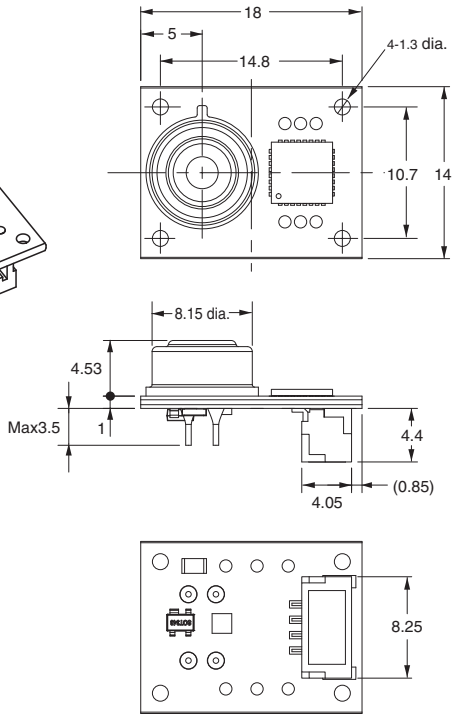
Bottom View



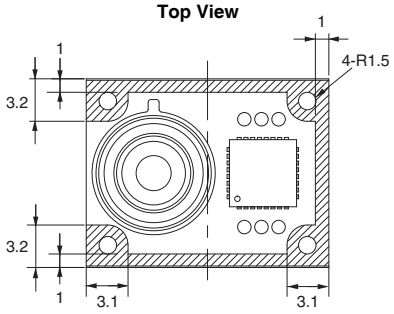
Note: Due to insulation distance limitations, do not allow metal parts to come into contact with the Sensor.

D6T-32L-01A

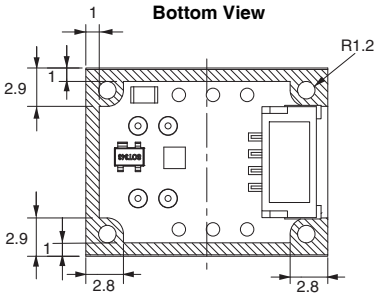




Supporting and Mounting Area (Shaded Portion)
Top View



Bottom View



Note: Due to insulation distance limitations, do not allow metal parts to come into contact with the Sensor.

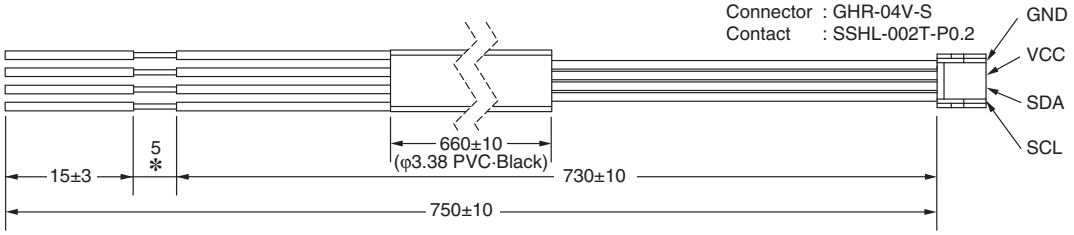
D6T-HARNESS-02 (Optional - sold separately)

Cable :UL1061.AWG#28
UL Tube : T-105-2 No.8
Connector : GHR-04V-S
Contact : SSHL-002T-P0.2

Cable Color

GND → BLACK Wire
VCC → RED Wire
SDA → BLUE Wire
SCL → YELLOW Wire

✻ Length of Cable removed sheath.



Note: Unless otherwise specified, a tolerance of ±0.3 mm applies to all dimensions.

Safety Precautions

Precautions for Correct Use

● Installation

- The Sensor may not achieve the characteristics given in this datasheet due to the ambient environment or installation location. Before using the Sensor, please acquire an adequate understanding and make a prior assessment of Sensor characteristics in your actual system.

● Operating Environment

- Do not use the Sensor in locations where dust, dirt, oil, and other foreign matter will adhere to the lens. This may prevent correct temperature measurements.
- Do not use the Sensor in any of the following locations.
  - Locations where the Sensor may come into contact with water or oil
  - Outdoors
  - Locations subject to direct sunlight.
  - Locations subject to corrosive gases (in particular, chloride, sulfide, or ammonia gases).
  - Locations subject to extreme temperature changes
  - Locations subject to icing or condensation.
  - Locations subject to excessive vibration or shock.

● Noise Countermeasures

- The Sensor does not contain any protective circuits. Never subject it to an electrical load that exceeds the absolute maximum ratings for even an instance. The circuits may be damaged. Install protective circuits as required so that the absolute maximum ratings are not exceeded.
- Keep as much space as possible between the Sensor and devices that generates high frequencies (such as high-frequency welders and high-frequency sewing machines) or surges.
- Attach a surge protector or noise filter on nearby noise-generating devices (in particular, motors, transformers, solenoids, magnetic coils, or devices that have an inductance component).
- In order to prevent inductive noise, separate the connector of the Sensor from power lines carrying high voltages or large currents. Using a shielded line is also effective.
- If a switching requlator is used, check that malfunctions will not occur due to switching noise from the power supply.

● Handling

- This Sensor is a precision device. Do not drop it or subject it to excessive shock or force. Doing so may damage the Sensor or change its characteristics. Never subject the connector to unnecessary force. Do not use a Sensor that has been dropped.
- Take countermeasures against static electricity before you handle the Sensor.
- Turn OFF the power supply to the system before you install the Sensor. Working with the Sensor while the power supply is turned ON may cause malfunctions.
- Secure the Sensor firmly so that the optical axis does not move.
- Install the Sensor on a flat surface. If the installation surface is not even, the Sensor may be deformed, preventing correct measurements.
- Do not install the Sensor with screws. Screws may cause the resist to peel from the board. Secure the Sensor in a way that will not cause the resist to peel.
- Always check operation after you install the Sensor.
- Use the specified connector (GHR-04 from JST) and connect it securely so that it will not come off. If you solder directly to the connector terminals, the Sensor may be damaged.
- Make sure to wire the polarity of the terminals correctly. Incorrect polarity may damage the Sensor.
- Never attempt to disassemble the Sensor.
- Do not use the cable harness to the other product.

MEMO