

## QMS Pyroelectric Infrared Motion Sensors, I<sup>2</sup>C-SMD

### Overview

KEMET's QMS thin film digital pyroelectric IR sensors combine high sensitivity with fast response times to ensure rapid and accurate motion detection, and high dynamic range to allow motion detection nearby or over larger distances. The 2x2 pixel version of this device allows users to determine direction of motion.

These high quality sensors, in their small SMD package, integrate a digital, current mode read-out. Industry standard I<sup>2</sup>C communication enables plug-and-play connectivity to microcontrollers and allows easy tuning. Programmable gain and filtering offer maximum flexibility in system design, and various low power modes, including a wake-up by motion feature, are also available. These sensors can be connected together in linear series to allow synchronized sampling across devices.

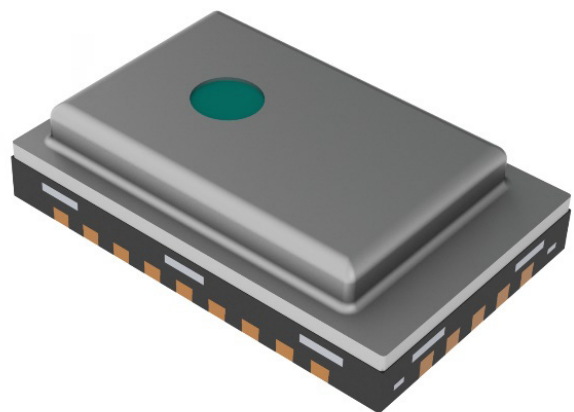
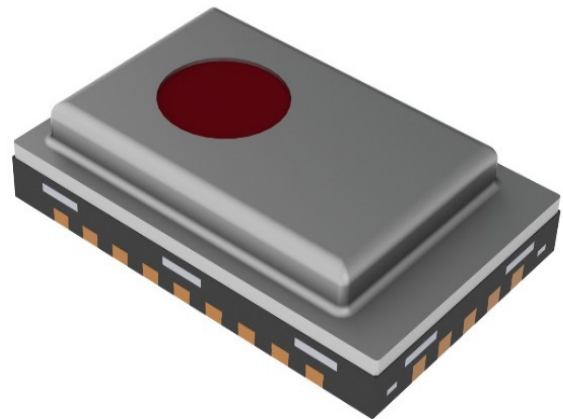
For additional sources of information, please refer to the [Environmental Sensors page on KEMET.com](#)

### Benefits

- High sensitivity with fast response time
- High dynamic range
- Small SMD package
- I<sup>2</sup>C communication
- Digital output
- Programmable gain and filtering
- Various pixel and aperture configurations
- Ultra-low power consumption and standby modes, motion triggered wake-up
- Sensor modules and evaluation kits available for easy evaluation and quick prototype development (ref QMSM Series)

### Applications

- Contactless switching
- Office automation equipment
- Home appliances
- Lighting
- Display products
- Air-conditioners
- TV
- PC monitors
- Rice cookers
- Smart toilets



## Ordering Information

| USE            | QMS                         | E                 | A               | 0116                                                                                                                                                       | 8                  | 0       |
|----------------|-----------------------------|-------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------|
| Product Family | Series                      | Sensor Type       | Mounting Type   | Specification                                                                                                                                              | Packaging          | Version |
| Sensors        | QMS = SMD IR Motion Sensors | E = Serial output | A = Sensor only | 0116 = 1x1 pixel, 1.65 aperture, 5.0 µm Long Pass<br>2216 = 2x2 pixel, 1.65 aperture, 5.0 µm Long Pass<br>2209 = 2x2 pixel, 0.9 aperture, 5.0 µm Long Pass | 8 = 7" Tape & Reel | 0       |

## Environmental Compliance

All KEMET Motion Sensors are RoHS and REACH Compliant.



Article 33(1) of the REACH Regulation states that manufacturers and importers of articles (products) are required to notify their customers of the presence of any Substances of Very High Concern (SVHC) in their products exceeding 0.1% by weight and provide instructions on safe use of the product.

KEMET Corporation reports regarding the Article 33(1) of REACH Regulation as follows:

1. *Applicable Product: Motion Sensors (QMS and QMSM series)*

2. *Report for the content of REACH SVHC list:*

*The product(s) above contains a substance by more than 0.1wt% per product weight that was published in the 8th update of the REACH SVHC substances (December 19, 2012).*

3. *Regarding the safety of the motion sensors (Piezoceramic products):*

*The Piezoceramic that is used in this product becomes ceramic by sintering powder containing PZT as the main ingredient. It is chemically stable, with minimum risks toward the human body or environment within the intended use of the product. Please note that risks could occur in the case of inhalation or accidental oral uptake of powder ceramics.*

4. *Technical product information on the motion sensors (Piezoceramic products):*

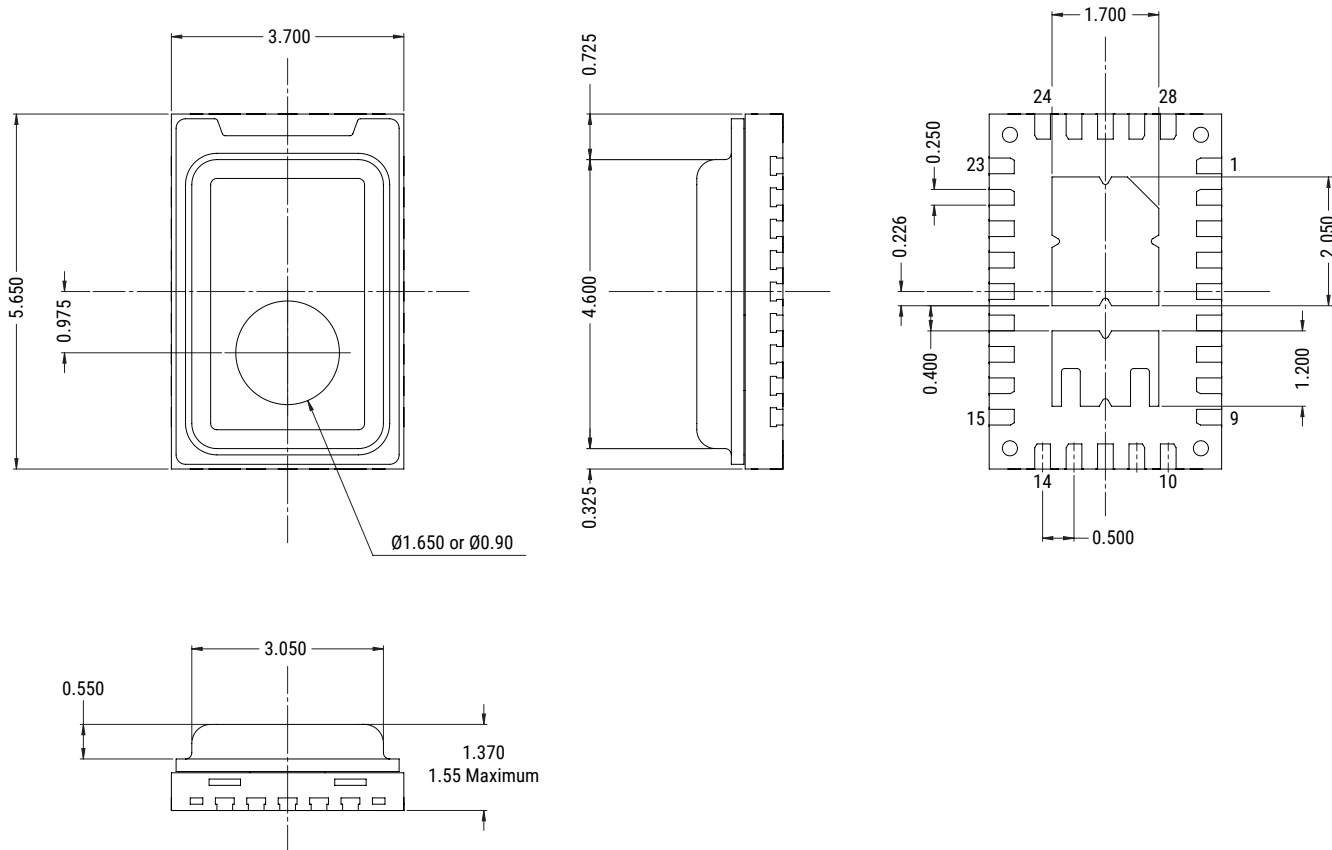
*The manufacturing technique of the "piezoceramic products" whose main ingredient is Lead Titanium Zirconium Oxide (PZT) has been established, and there is no alternative material that can exhibit superior performance than PZT at this moment. Please note that the piezoceramic is listed as an exempt on RoHS (2011/65/EU) AnnexIII (7c.1).*

5. *The responsibility of piezoceramic manufacturers:*

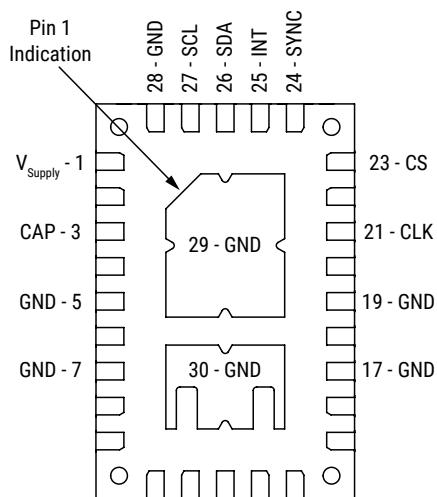
*Piezoceramic manufacturers report information regarding PZT containment in their products to the customers to obey the article 33 of the REACH regulation*

## Dimensions – Millimeters

### Sensor

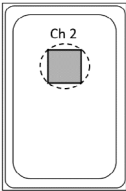
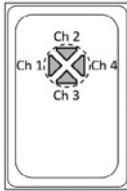
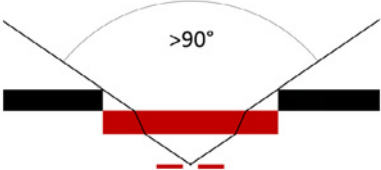
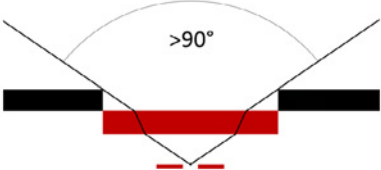
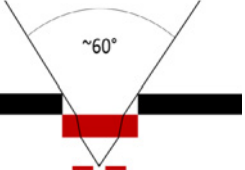


### Pin Configuration of the Sensor



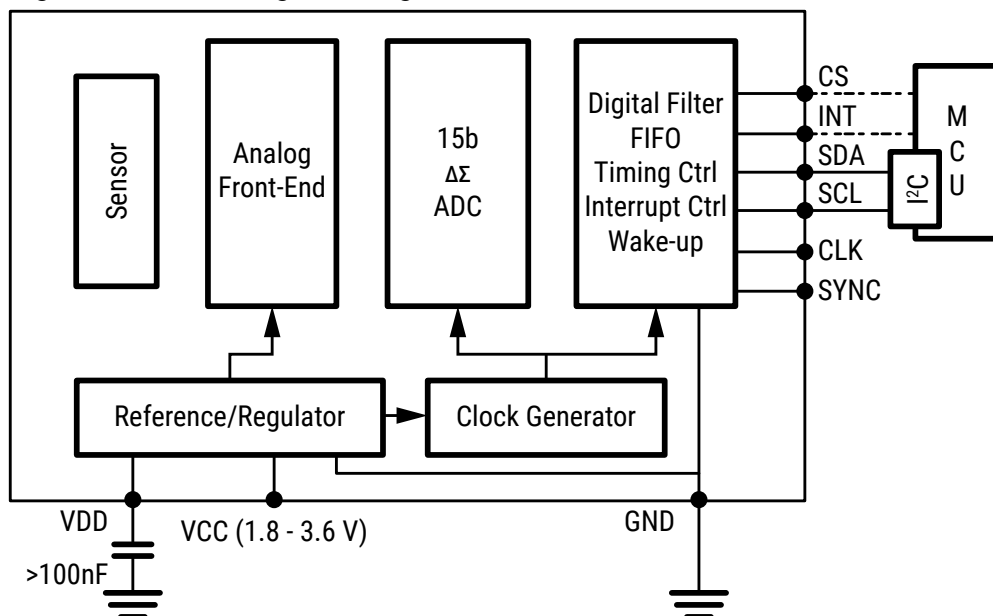
Transparent Top View

## Field of View

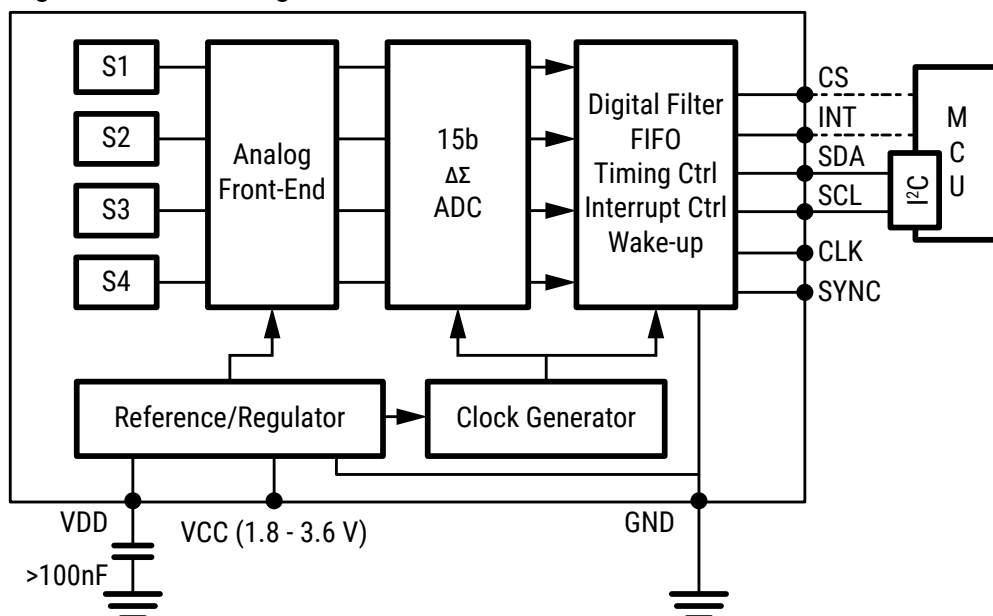
|                | Single Element                                                                     | 2x2 Array                                                                                                                                                                                                                                      |
|----------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sensor Element |   |                                                                                                                                                             |
| Pixel Mapping  |   |                                                                                                                                                             |
| Field of View  |  | <div>  <p>Large Aperture</p> </div> <div>  <p>Small Aperture</p> </div> |

## Circuit Diagram

### Single Device Block Diagram - Single Element

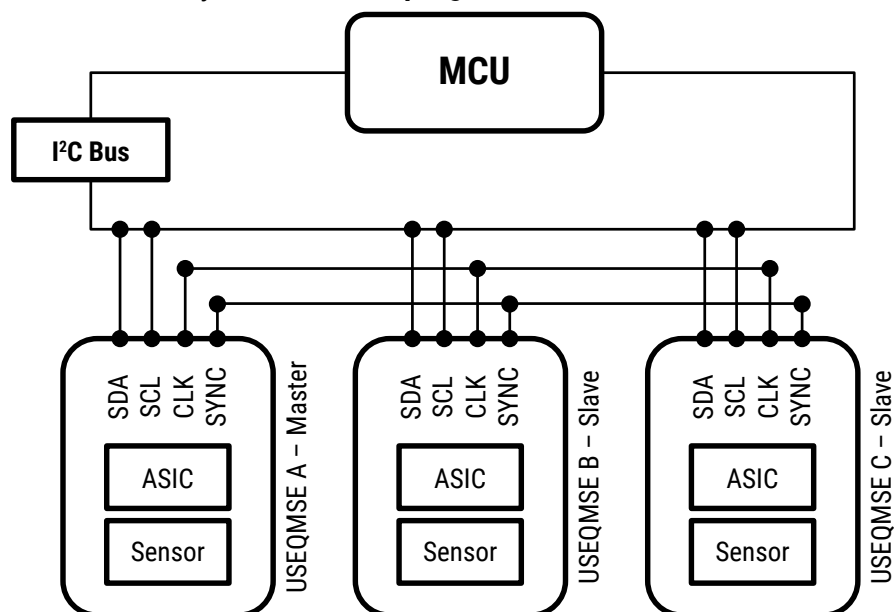


### Single Device Block Diagram - 2 x 2 Pixel

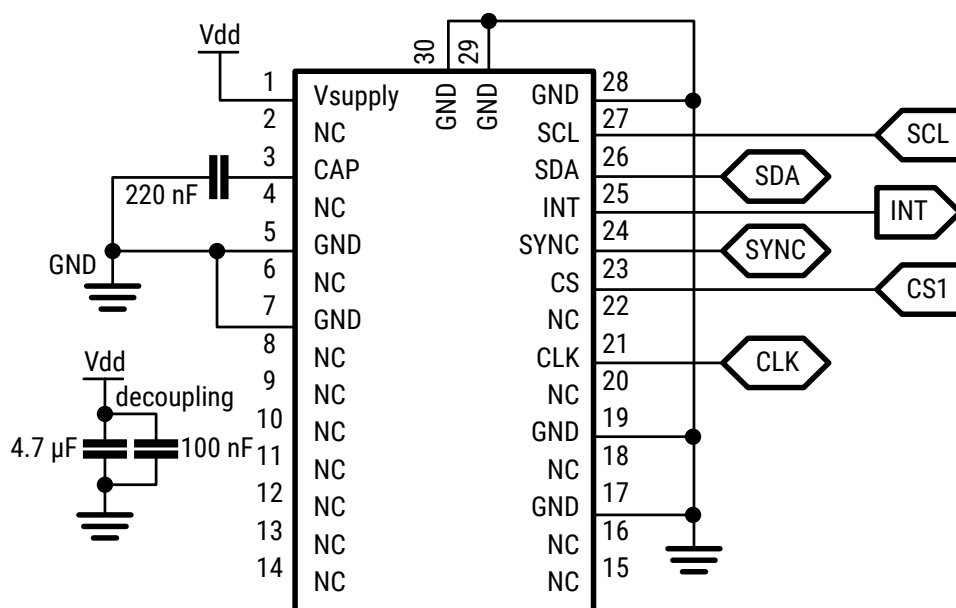


## Circuit Diagram cont.

### Three Devices with Synchronised Sampling



### Recommended Circuit Diagram



## Performance Characteristics

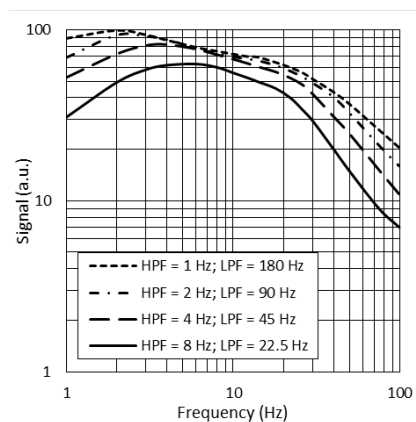
### Signal Filtering & Power Modes

| Power Mode<br>(base sample rate) | High Pass Filter – Analog<br>(Hz) |      |      |      |      | Fixed Analog<br>Low Pass<br>Filter (Hz) | Fixed Digital Low<br>Pass Filter<br>(Hz) | Digital Low Pass<br>Filter (Hz) |       |      |      | Maximum<br>ADC<br>Sampling Rate<br>(sps) |
|----------------------------------|-----------------------------------|------|------|------|------|-----------------------------------------|------------------------------------------|---------------------------------|-------|------|------|------------------------------------------|
| Normal Power Mode                | Off                               | 1.0  | 2.0  | 4.0  | 8.0  | 600                                     | 250                                      | 180.0                           | 90.0  | 45.0 | 22.5 | 1,000                                    |
| Low Power Mode                   | Off                               | 0.17 | 0.33 | 0.66 | 1.30 | 100                                     | 42                                       | 30.00                           | 15.00 | 7.50 | 3.75 | 166                                      |

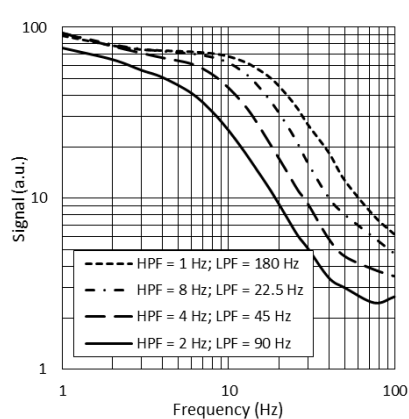
| Item              | Mode                  | Description                                         | Typical Current<br>Consumption<br>(1.8 V, room temperature)    |
|-------------------|-----------------------|-----------------------------------------------------|----------------------------------------------------------------|
| Power consumption | Normal Power Mode     | Normal power consumption, 1 kHz maximum sample rate | 22 $\mu$ A                                                     |
|                   | Low Power Mode        | Low power consumption, 166 Hz maximum sample rate   | 3.5 $\mu$ A                                                    |
| Operational state | Normal Operation Mode | Sensor signal readout over I <sup>2</sup> C         | 22 $\mu$ A                                                     |
|                   | Sleep Mode            | Hardware interrupt on infrared trigger              | 21 $\mu$ A (Normal Power Mode)<br>3.5 $\mu$ A (Low Power Mode) |
|                   | Power Down Mode       | Sensor is disabled                                  | 1.1 $\mu$ A                                                    |

### Infrared Frequency Characteristics

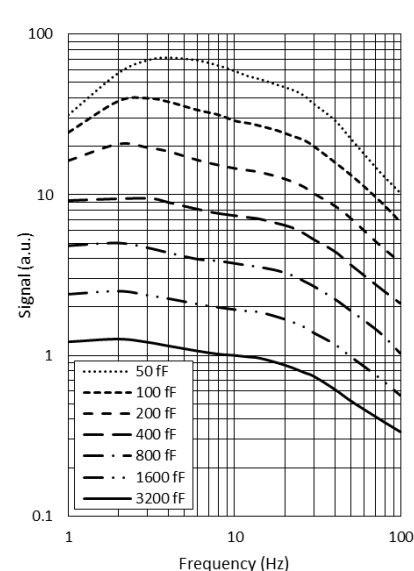
**Typical Frequency Response in Normal Power Mode**



**Typical Frequency Response in Low Power Mode**



**Typical Frequency Response at Different Gain Settings**



## Part Number Specifications

### Electrical Characteristics

| Supply Voltage (V) | Supply Current (μA) Typical | Digital I/O                       | ΔΣ ADC at 1 ksp | Operating Temperature Range (°C) | Storage Temperature Range (°C) | Sensor Read-out | Configurable                                              |
|--------------------|-----------------------------|-----------------------------------|-----------------|----------------------------------|--------------------------------|-----------------|-----------------------------------------------------------|
| 1.75 to 3.60       | 1 to 23                     | I <sup>2</sup> C (FM+ compatible) | 15 bit          | -40 to +85                       | -40 to +110                    | Current mode    | Gain<br>Digital filtering<br>Sampling rate<br>Power modes |

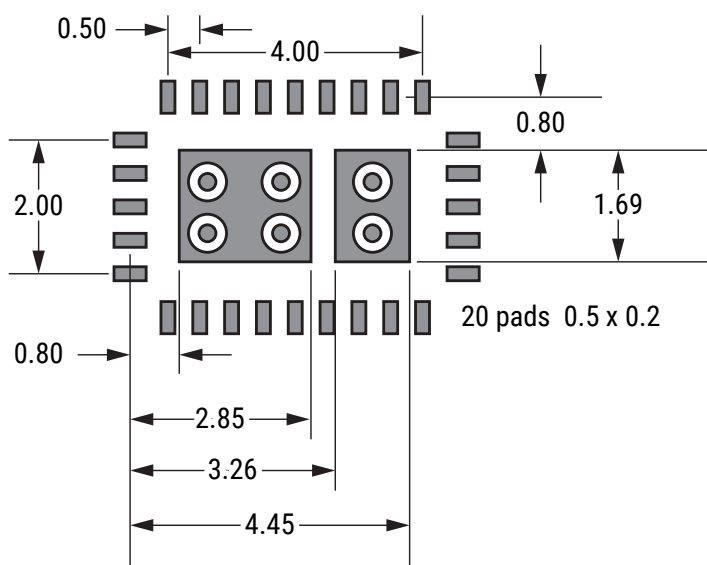
### Part Number (Sensor)

| Part Number    | Filter Aperture (mm) | Element Size (mm <sup>2</sup> ) | SMD Package (mm)   | D* <sup>1</sup> (cm·√Hz/W) Typical | NEP <sup>1</sup> (W/√Hz) Typical | Time Constant (ms) at 10–20 Hz peak | Filter           | Weight (gr) |  |
|----------------|----------------------|---------------------------------|--------------------|------------------------------------|----------------------------------|-------------------------------------|------------------|-------------|--|
| USEQMSEA011680 | φ 1.65               | 0.410 (1 pixel)                 | 5.65 x 3.70 x 1.55 | 2.5 x 10 <sup>8</sup>              | 2.7 x 10 <sup>-10</sup>          | ~10                                 | 5.0 μm Long Pass | 0.07        |  |
| USEQMSEA221680 | φ 1.65               | 4 x 0.057 (4 pixel)             |                    | 5.5 x 10 <sup>8</sup>              | 0.4 x 10 <sup>-10</sup>          |                                     |                  | 0.07        |  |
| USEQMSEA220980 | φ 0.90               | 4 x 0.057 (4 pixel)             |                    |                                    |                                  |                                     |                  | 0.07        |  |

<sup>1</sup> 10 Hz, 500 K, room temperature, without window and optics.

## Landing Pattern

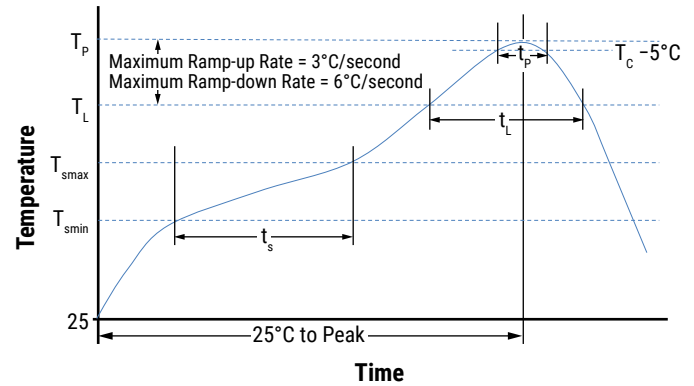
### Recommended PCB Landing Pattern - Millimeters



## Soldering Process

### Recommended Reflow Soldering Profile

| Profile Feature                                                    | Pb-Free Assembly   |
|--------------------------------------------------------------------|--------------------|
| <b>Preheat/Soak</b>                                                |                    |
| Temperature Minimum ( $T_{smin}$ )                                 | 150°C              |
| Temperature Maximum ( $T_{smax}$ )                                 | 200°C              |
| Time ( $t_s$ ) from $T_{smin}$ to $T_{smax}$                       | 60 – 120 seconds   |
| Ramp-Up Rate ( $T_L$ to $T_P$ )                                    | 3°C/second maximum |
| Liquidous Temperature ( $T_L$ )                                    | 217°C              |
| Time Above Liquidous ( $t_L$ )                                     | 60 – 150 seconds   |
| Peak Temperature ( $T_P$ )                                         | 260°C              |
| Time within 5°C of Maximum Peak Temperature ( $t_p$ ) <sup>1</sup> | 30 seconds maximum |
| Ramp-Down Rate ( $T_P$ to $T_L$ )                                  | 6°C/second maximum |
| Time 25°C to Peak Temperature                                      | 8 minutes maximum  |

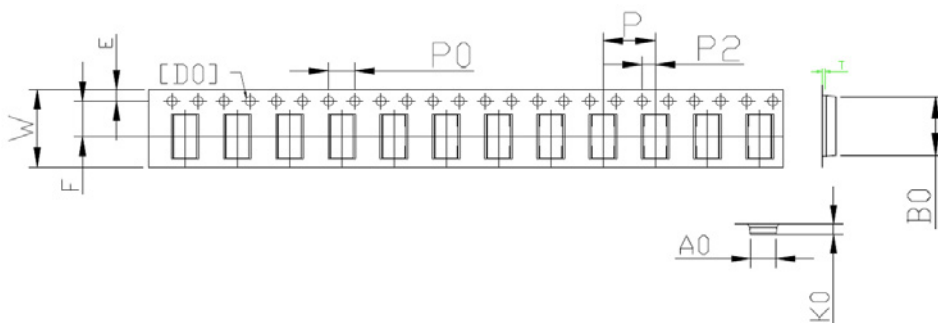


<sup>1</sup> Tolerance for peak profile temperature (TP) is defined as a supplier minimum and as a user maximum.

## Packaging

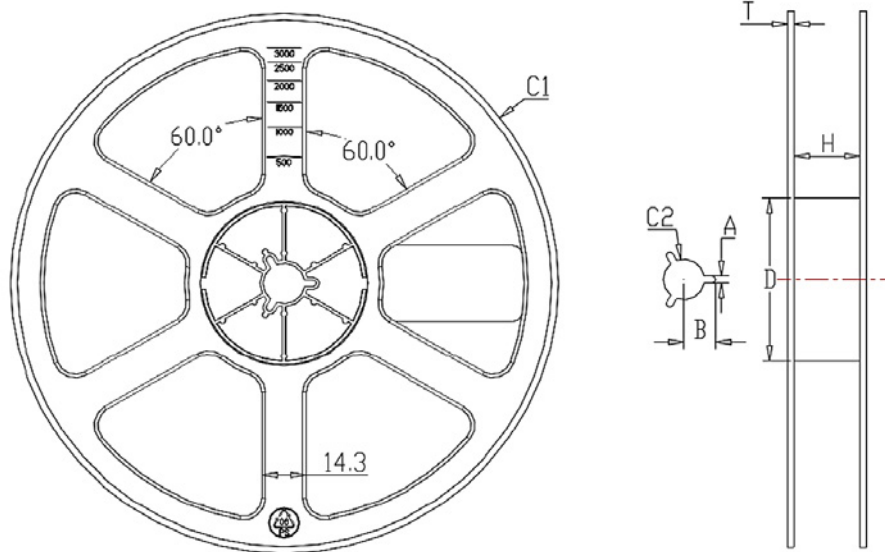
| Series | Packaging Type | Pieces per Reel |
|--------|----------------|-----------------|
| QMS    | 7" Tape & Reel | 800             |

## Taping Specification



|         | Dimensions (mm) |      |      |      |       |      |      |      |      |      |      |
|---------|-----------------|------|------|------|-------|------|------|------|------|------|------|
|         | P0              | P    | T    | P2   | W     | A0   | B0   | K0   | E    | F    | D0   |
| Minimum | 3.90            | 7.90 | 0.25 | 1.90 | 11.70 | 3.90 | 5.85 | 1.65 | 1.65 | 5.40 | 1.50 |
| Typical | 4.00            | 8.00 | 0.30 | 2.00 | 12.00 | 4.00 | 5.95 | 1.75 | 1.75 | 5.50 | 1.50 |
| Maximum | 4.10            | 8.10 | 0.35 | 2.10 | 12.30 | 4.10 | 6.05 | 1.85 | 1.85 | 5.60 | 1.60 |

## Reel Specification



|           | Dimensions (mm) |      |      |      |      |      |      |
|-----------|-----------------|------|------|------|------|------|------|
|           | C1              | C2   | A    | B    | H    | T    | D    |
| Tolerance | ±1.0            | ±0.2 | ±0.2 | ±0.2 | ±0.5 | ±0.2 | ±0.5 |
| Nominal   | Ø178            | 13.5 | 2.3  | 10.4 | 12.5 | 1.6  | Ø54  |

## Handling Precautions

Pyroelectric Infrared Sensors should be kept away from indirect and direct sunlight, the headlights of cars, wind, and exposure to strong vibration and strong shock.

Do not use in water, alcohol ETA, corrosive gas or under sea breeze.

Do not expose to corrosive substances.

Do not drop or apply any mechanical stress.

The performance of this device can be affected by ESD. Precautions should be used when handling and installing the sensor. Precision devices such as this sensor can be damaged or caused not to meet published specification due to ESD. Please note that there is limited ESD protection built-in as the device is optimised for low power consumption and low noise operation. Human Body Model (HBM), per JS-001: 2,000 V.

The sensor is classed as Moisture Sensitivity Level 3 (MSL-3). The package should be handled according to IPC/JEDEC J-STD-20.

Pyroelectric Infrared Sensors should be stored in normal working environments.

Solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long-term storage.

KEMET recommends that ambient storage conditions are < 30°C and < 60% relative humidity and that maximum storage temperature does not exceed 110°C. Atmospheres should be free of chlorine and sulfur-bearing compounds.

Temperature fluctuations should be minimized to avoid condensation on the parts.

For optimized solderability sensors stock should be used promptly, preferably within 24 months of receipt.

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