

## QGS Pyroelectric Infrared Gas Sensors, I<sup>2</sup>C-SMD

### Overview

KEMET's QGS thin film digital pyroelectric IR sensors for gas detection and concentration measurement combine high sensitivity with fast response times and high dynamic range to ensure rapid and accurate detection of target gases.

These high quality sensors, in their small SMD package, integrate a digital, current mode read-out that enables lower IR-emitter duty cycles, thereby saving significantly on system level power consumption, while maintaining high SNR. Industry standard I<sup>2</sup>C communication enables plug-and-play connectivity to microcontrollers and allows easy tuning and calibration. Programmable gain and filtering offer maximum flexibility in system design, and various optical filter options are also available. These sensors can be connected together in linear series to allow synchronized sampling across devices.

Their long and maintenance-free operational lifetime makes them ideal for highly demanding automotive or medical applications.

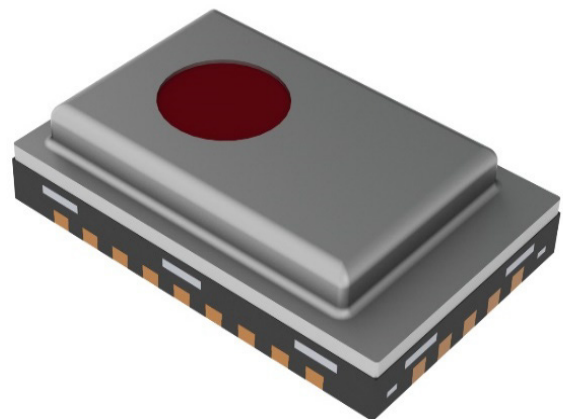
For additional sources of information, please refer to the [Environmental Sensors page on KEMET.com](https://www.kemet.com/en-us/products/environmental-sensors)

### 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 optical filter options
- Integrated configurable amplifier, filter and ADC
- Low power consumption
- Sensor modules and digital evaluation kit available for easy evaluation and quick prototype development (ref QGSM Series)

### Applications

- Gas and gas flues
- HVAC (refrigerant or CO<sub>2</sub>-driven ventilation system)
- Industrial process and safety
- Medical capnography and anesthesia
- Handheld breath analysis and breath rate measurement
- Breath actuated dispenser
- Automotive cabin air quality
- Exhaust (CO<sub>2</sub> content)
- Home and building technology
- Environmental monitoring (ambient CO<sub>2</sub> level)
- Pollution air quality in home, office and car (excessive CO<sub>2</sub> level)



## Ordering Information

| USE            | QGS                      | E                 | A                                                             | C821                                                                            | 8                  | 0       |
|----------------|--------------------------|-------------------|---------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------|---------|
| Product Family | Series                   | Sensor Type       | Mounting Type                                                 | Specification                                                                   | Packaging          | Version |
| Sensors        | QGS = SMD IR Gas Sensors | E = Serial output | A = Sensor only, low profile<br>H = Sensor only, high profile | C821 = CO <sub>2</sub><br>CH41 = CH <sub>4</sub><br>N8L1 = NO<br>9501 = 9.50 μm | 8 = 7" Tape & Reel | 0       |

## Environmental Compliance

All KEMET Gas 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: Gas Sensors (QGC, QGS & QGSM 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 gas 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 gas sensors (Piezoceramic products):*

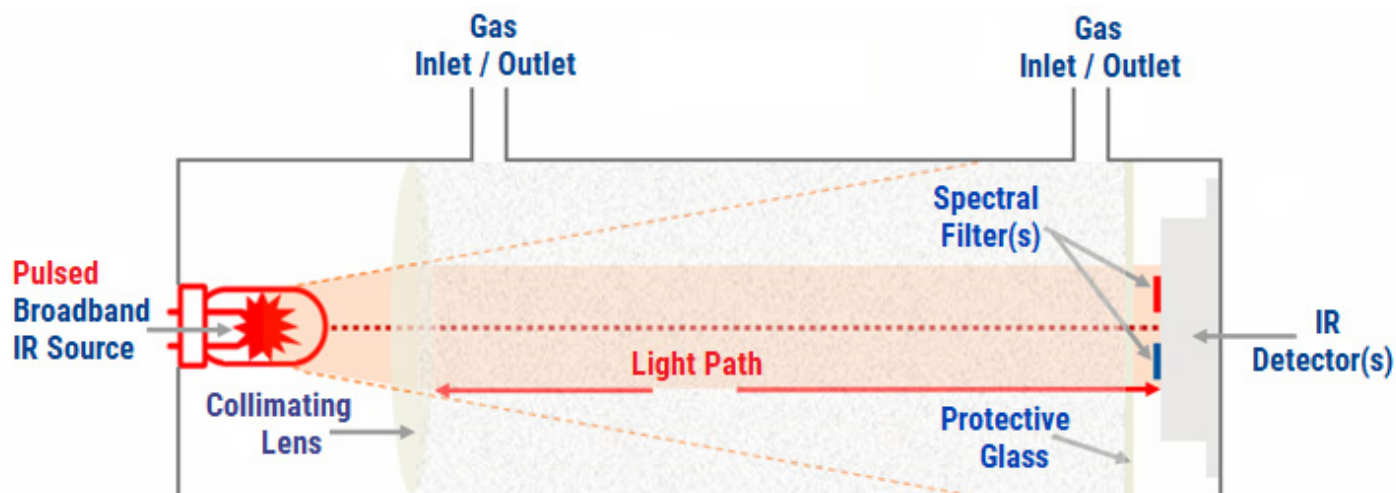
*The manufacturing technique of the "piezoceramic products" whose main ingredient is Lead Titanium Zirconium Oxide (PZT) has been established, and there is no alternative material that can exhibit superior performance than PZT at this moment. Please note that the piezoceramic is listed as an exempt on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

5. *The responsibility of piezoceramic manufacturers:*

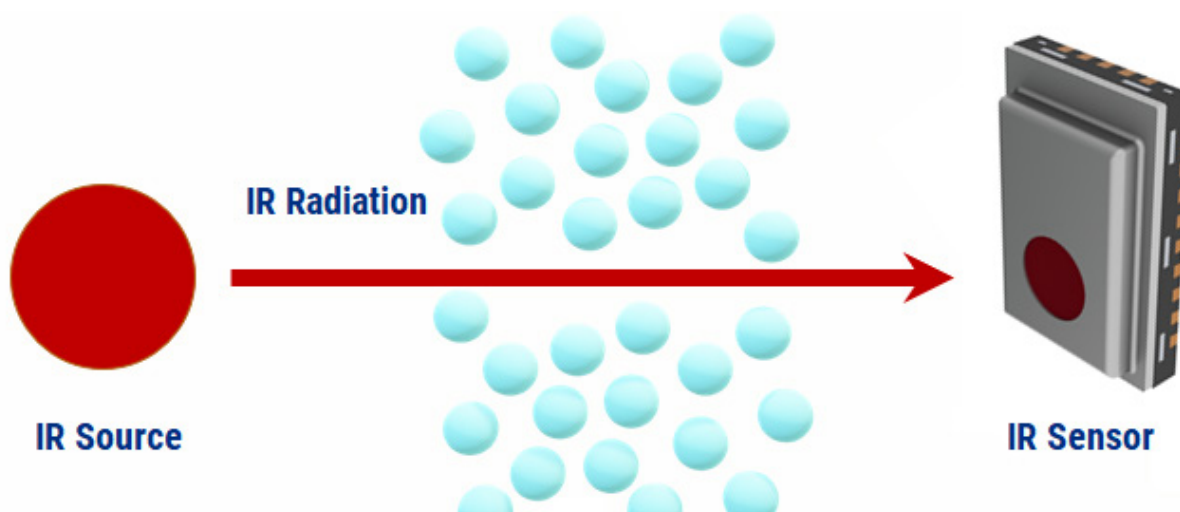
*Piezoceramic manufacturers report information regarding PZT containment in their products to the customers to obey the article 33 of the REACH regulation.*

## Infrared Spectroscopy

KEMET Infrared Sensors work in the MID Infrared Spectrum. They are a critical component -- but not the only component -- in a gas analysis system. An IR heat source and a suitable gas path “mechanical enclosure” are also required in order to complete the gas analysis system.



## IR Absorption - Active IR Sensing

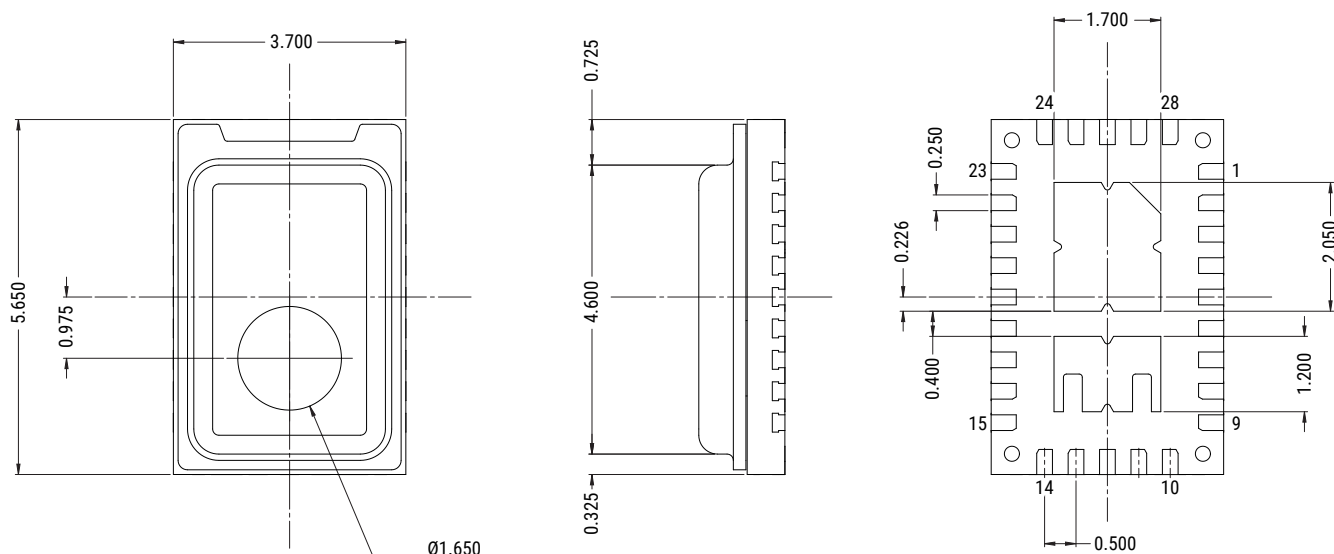


The IR source is directed as energy towards the sensor like an IR spotlight. Depending on the specific gas of interest or gas concentration levels between the IR source and the pyroelectric sensor, the IR transmitted is absorbed by the presence of the gas by a small amount. Understanding how much IR is being optically transmitted versus how much is received can indicate gas concentration levels.

Filters are used to shorten the optical spectrum of the sensor to specifically match the gas of interest. These filters are usually included within the sensor, but for special cases KEMET can make optimised filters to suit customers specific gas requirements.

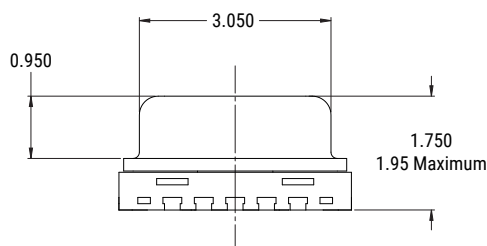
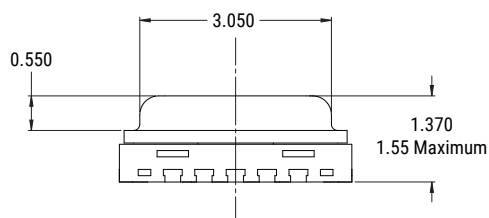
## Dimensions – Millimeters

### Sensor

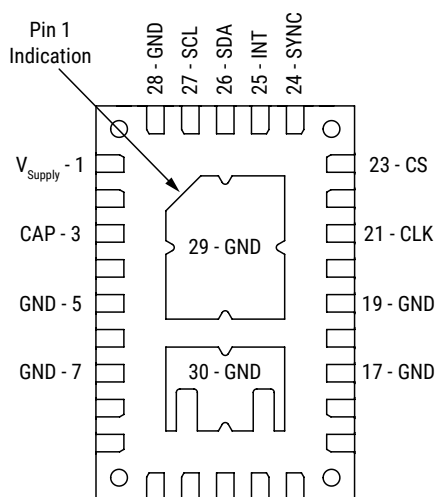


USEQGSEA\*\*\*\*\* Low Profile

USEQGSEH\*\*\*\*\* High Profile

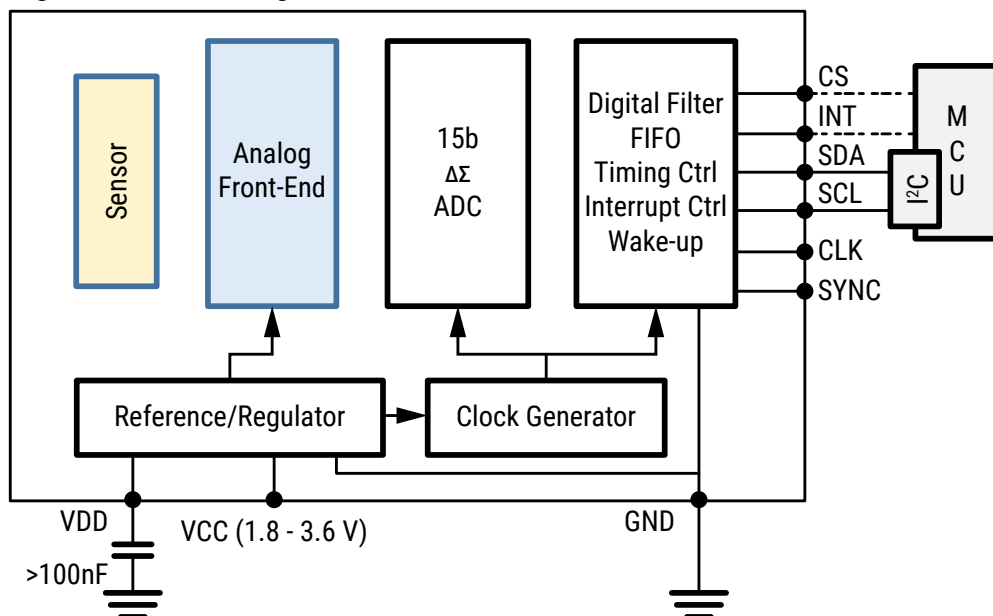


### Pin Configuration of the Sensor

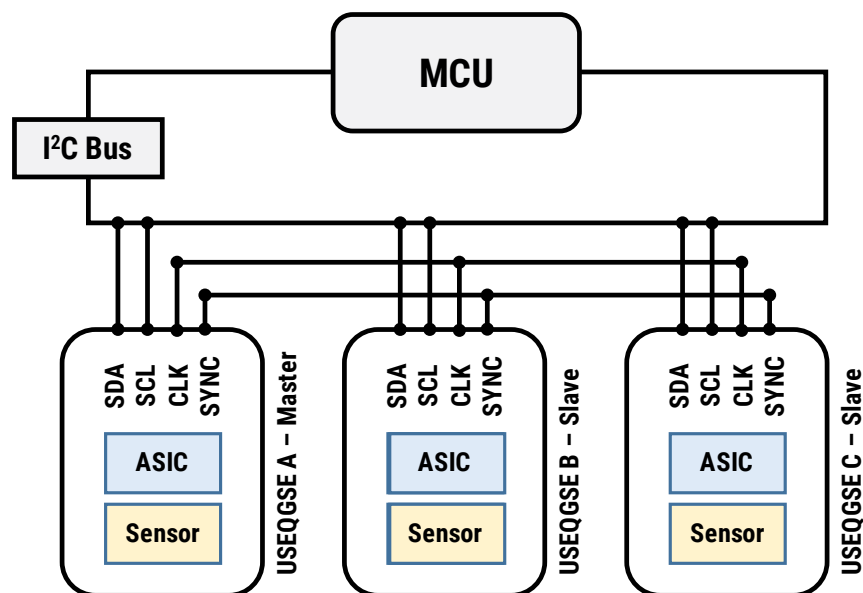


## Recommended Circuit Diagram

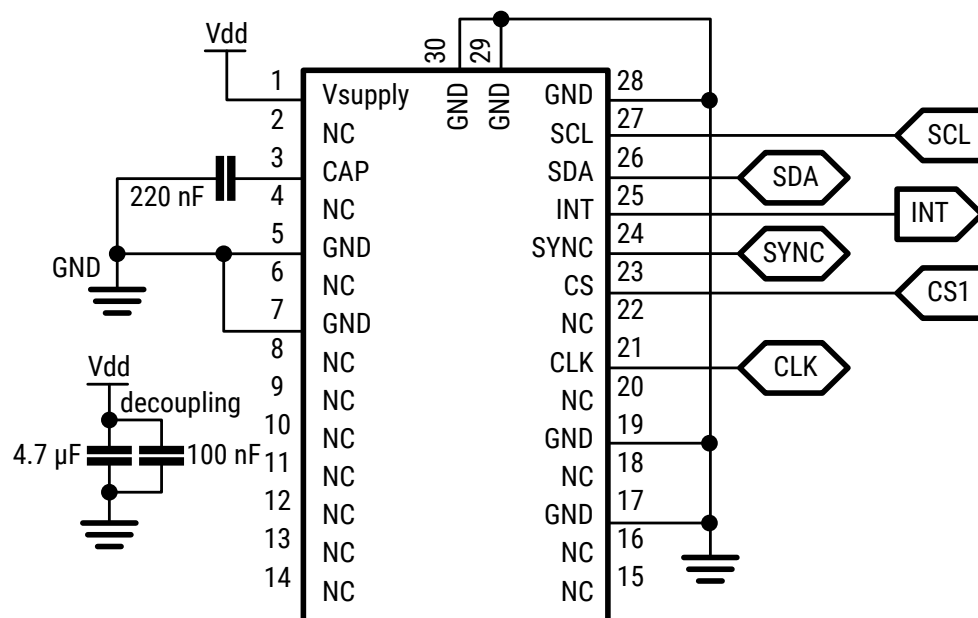
### Single Device Block Diagram



### Three Devices with Synchronised Sampling

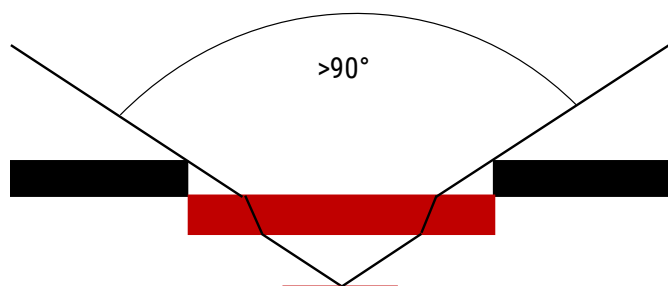


## Recommended Circuit Diagram cont.

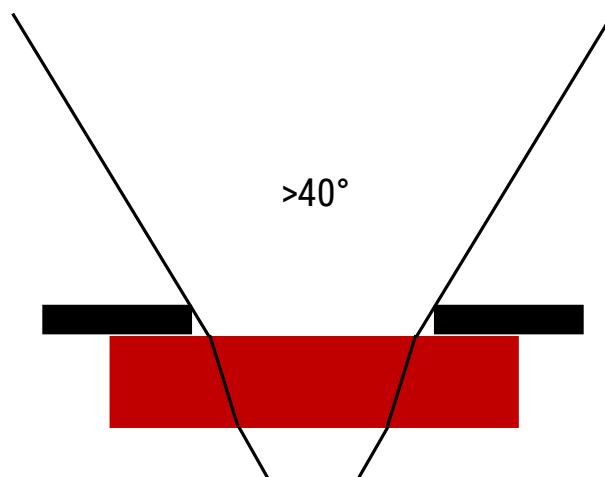


## Field of View

USEQGSEA\*\*\*\*\* Low Profile



USEQGSEH\*\*\*\*\* High Profile



## Performance Characteristics

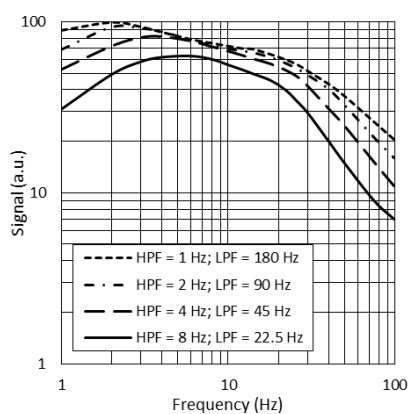
### Signal Filtering & Power Modes

| 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                                      |

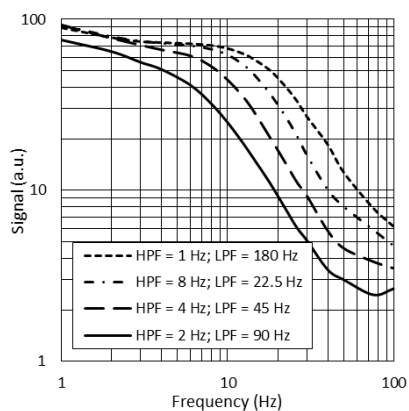
| Item              | Mode                  | Description                                         | Typical Current<br>Consumption<br>(1.8 V, room temperature)    |
|-------------------|-----------------------|-----------------------------------------------------|----------------------------------------------------------------|
| 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

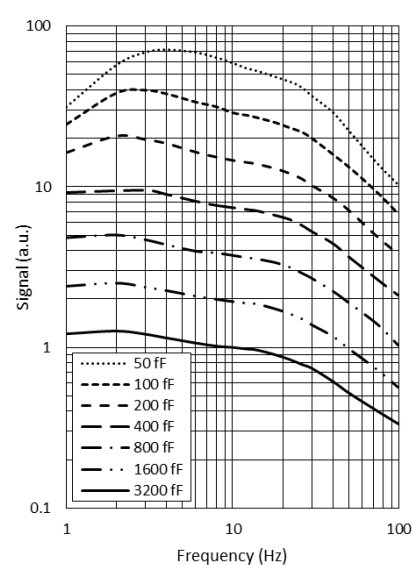
Typical Frequency Response in  
Normal Power Mode



Typical Frequency Response in  
Low Power Mode



Typical Frequency Response at  
Different Gain Settings



## Part Number Specifications

### Sensor Characteristics

| 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 | Field of View |
|----------------------|---------------------------------|--------------------|-----------------------------------|----------------------------------|-------------------------------------|---------------|
| φ 1.65               | 0.64 x 0.64                     | 5.65 x 3.70 x 1.55 | 2.5 x 10 <sup>8</sup>             | 2.7 x 10 <sup>-10</sup>          | ~10                                 | ~90°          |

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

### 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 (μm) | Filter BW (nm) | Use             | Weight (gr) |
|----------------|-------------|----------------|-----------------|-------------|
| USEQGSEAC82180 | 4.26        | 180            | CO <sub>2</sub> | 0.07        |
| USEQGSEACH4180 | 3.30        | 160            | CH <sub>4</sub> | 0.07        |
| USEQGSEAN8L180 | 5.30        | 180            | NO              | 0.07        |
| USEQGSEH950180 | 9.50        | 400            | Sugar, Ethanol  | 0.08        |

Below flame sensors from the QFS series can also be used for gas detection or analysis, more details about these products available on [https://content.kemet.com/datasheets/KEM\\_SE0211\\_QFS.pdf](https://content.kemet.com/datasheets/KEM_SE0211_QFS.pdf)

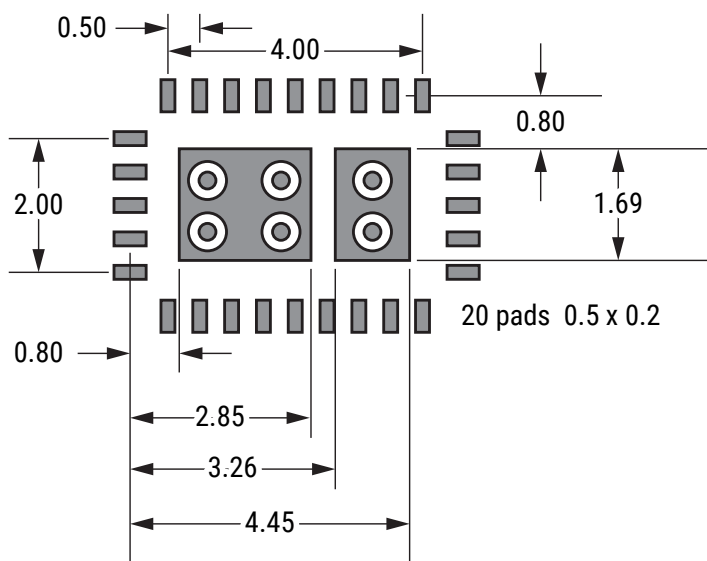
| Part Number                 | Filter (μm) | Filter BW (nm) | Use       | Weight (gr) |
|-----------------------------|-------------|----------------|-----------|-------------|
| USEQFSEA391180              | 3.91        | 90             | Reference | 0.07        |
| USEQFSEA22L180 <sup>1</sup> | 2.20        | Long pass      | Broadband | 0.07        |
| USEQFSEA50L180 <sup>1</sup> | 5.00        | Long pass      | Broadband | 0.07        |
| USEQFSEA464180 <sup>2</sup> | 4.64        | 180            | CO        | 0.07        |

<sup>1</sup> Used with bespoke, customer or application-specific (narrowband) filters mounted externally.

<sup>2</sup> Used as gas or active filter.

## Landing Pattern

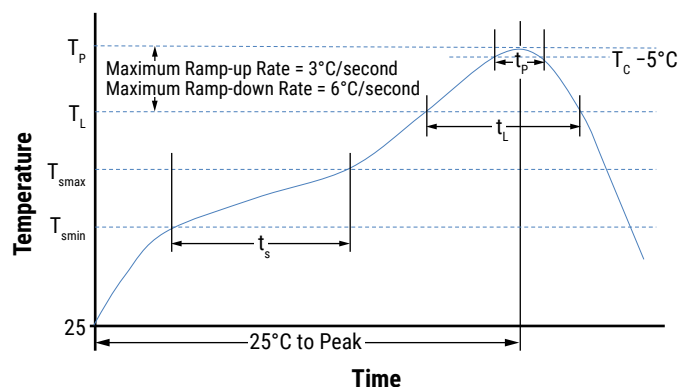
### Recommended PCB Landing Pattern – Millimeters



## 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  |

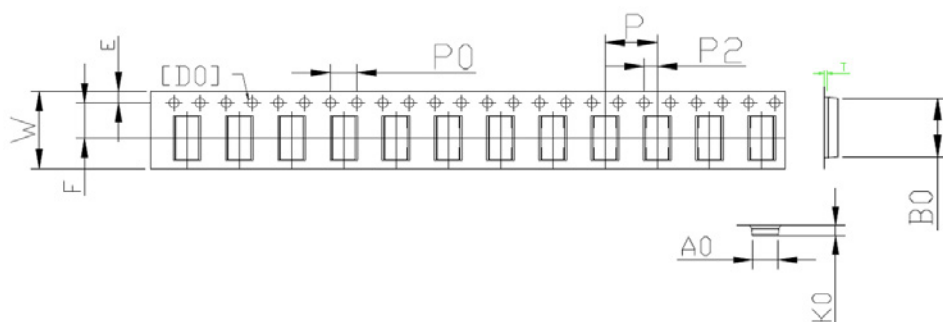


<sup>1</sup> Tolerance for peak profile temperature (TP) is defined as a supplier minimum and as a user maximum.

## Packaging

| Part Number | Packaging Type | Pieces Per Reel |
|-------------|----------------|-----------------|
| USEQGS***** | 7" Tape & Reel | 800             |

## Taping Specification



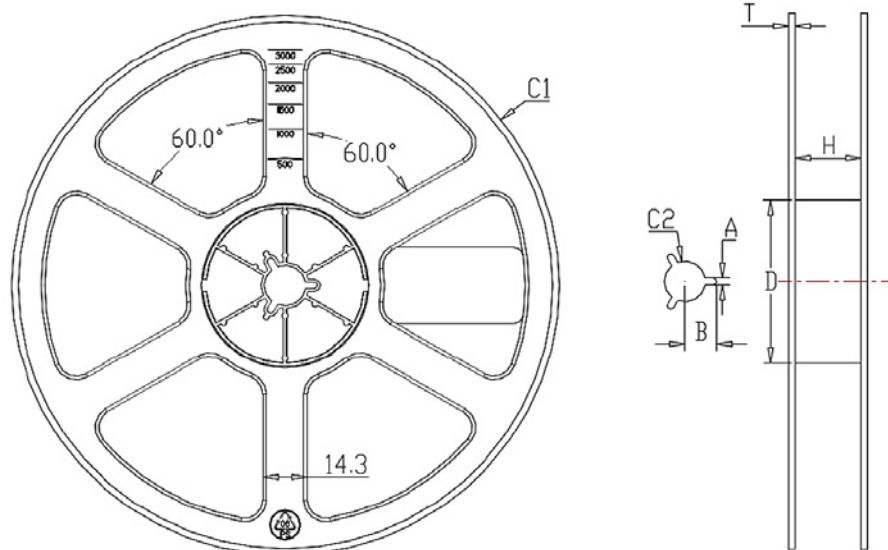
### USEQGSEA\*\*\*\*\* Low Profile

|         | 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 |

### USEQGSEH\*\*\*\*\* High Profile

|         | 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 | 2.05 | 1.65 | 5.40 | 1.50 |
| Typical | 4.00            | 8.00 | 0.30 | 2.00 | 12.00 | 4.00 | 5.95 | 2.15 | 1.75 | 5.50 | 1.50 |
| Maximum | 4.10            | 8.10 | 0.35 | 2.10 | 12.30 | 4.10 | 6.05 | 2.25 | 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 be 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.

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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Although KEMET designs and manufactures its products to the most stringent quality and safety standards, given the current state of the art, isolated component failures may still occur. Accordingly, customer applications which require a high degree of reliability or safety should employ suitable designs or other safeguards (such as installation of protective circuitry or redundancies) in order to ensure that the failure of an electrical component does not result in a risk of personal injury or property damage.

Although all product-related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicated or that other measures may not be required.

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