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Q-SENS FROM MEERSTETTER

NEXT-GENERATION HEAT FLUX SENSOR

TECHNOLOGY OVERVIEW

The Q-sens is an advanced thermoelectric device designed for **precise heat flux measurement**. Unlike conventional thermopile-based solutions, Q-sens generates an electromotive force perpendicular to the heat flux direction. This unique property enables **flexible sensor design, improved performance, and enhanced integration into industrial, analytic and medical systems**.

It is designed for seamless integration (Figure 1) into the Meerstetter control universe, with all necessary signal conditioning supplied directly by Meerstetter. Engineered for stability in harsh operating conditions, it is optimized for long-term monitoring in extreme thermal environments. Its property flexibility allows for the selection of various materials to achieve either low heat resistance and high operating temperatures or enhanced sensitivity, depending on application requirements. Operating passively, it is an ideal solution for remote sensing and embedded systems. Furthermore, its customizable geometry, enabled by a thermoelectric metamaterial composite design, allows for precise sensor tuning to meet specific needs, with the potential for effortless integration into existing industrial setups.

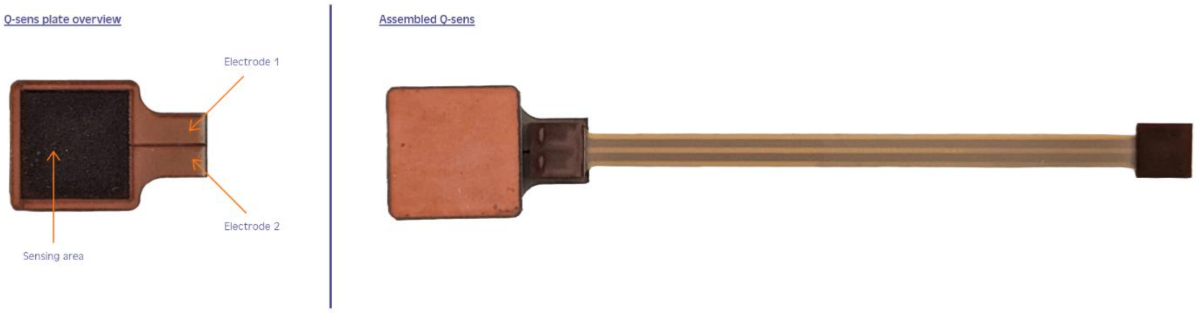

Figure 1: Q-sens plate overview and Assembled Q-sens

KEY FEATURES

- **Simplified and Robust Design** – Unlike thermopile-based sensors, Q-sens does not rely on a complex thermocouple network but instead utilizes a single thermoelectric metamaterial, reducing internal complexity and making the sensor easier to manufacture. With lower thermal resistance, it minimizes its impact on measurement accuracy and heat flow in various applications.
- **Ultra-Fast Response Time** – The electromotive force effect enables response times in the nanosecond range, making it ideal for shock tube experiments, transient heat flux monitoring, and rapid phase-change studies as well as (pulsed) laser applications

- **High Sensitivity & Stability** – Engineered for long-term monitoring in extreme thermal environments, with superior temperature resilience and consistent signal output.
- **High-Temperature Operation** – Specialized material combinations can withstand extreme temperatures as high as 1300 K, making it a robust solution for applications in aerospace, nuclear reactors, industrial furnaces, and high-temperature manufacturing.
- **Passive Operation** – making it ideal for remote sensing, IoT-based thermal monitoring, and embedded systems.
- **Compact and Scalable Design** – variety of available thicknesses and sizes enable seamless integration into industrial process monitoring, energy optimization systems, and advanced thermal diagnostics.
- **Customizable Geometry** – The sensor structure allows for precise mechanical tuning, adapting to specific application needs and facilitating integration into existing industrial and scientific setups.

SAMPLE SET UP: Q-SENS INTEGRATION INTO THE MEERSTETTER ECOSYSTEM

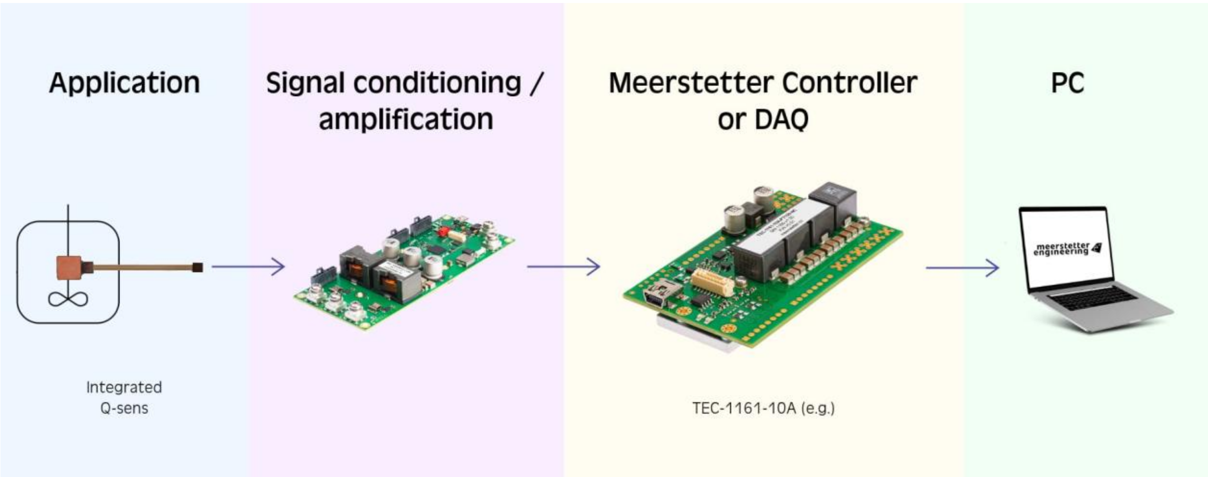

Figure 2: Implementation example

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Q-SENS GENERATION 1 DEVICE FACTSHEET

The **Q-Sens Generation 1 Heat Flux Sensor** is designed to deliver high-precision, real-time heat flux measurements with superior performance over traditional thermopile-based sensors. Q-Sens provides faster response, enhanced stability, and adaptability to extreme environments, making it ideal for high-speed thermal monitoring, industrial applications, and aerospace systems.

Property	Value
Sensing plate size	from 5x5 to 20x20 mm, larger sizes on-demand
Thickness	0.8 mm standard, 0.5 mm possible
Working temperature	-50°C to 500°C
Sensitivity	5 - 20 µV/W (area dependent)
Thermal conductivity	~300W/(m*K)
Additional options	Available per request

Table 1: Q-sens Gen. 1 properties

APPLICATIONS & USE CASES

This sensor technology has been researched since 1960's but never commercialized. That is why a huge application heritage is available:

- **Industrial Process Monitoring** – Real-time heat flux tracking for process optimization and energy efficiency
- **Energy Harvesting** – Thermoelectric waste heat conversion for power generation.
- **Aerospace and Space Systems** – High-precision thermal diagnostics for extreme environments, including vacuum conditions.
- **Battery and Electronics Cooling** – Advanced heat dissipation management for critical electronic systems.
- **Condensation and Phase Change Studies** – Heat flux measurement in boiling, evaporation, and condensation processes, aiding nuclear reactor cooling and power plant efficiency.
- **Automotive & Electric Vehicles (EVs)** – Optimization of thermal regulation in electric motors, battery packs, and vehicle power electronics.
- **Laser Processing & Welding** – Measurement of heat flux in laser-based cleaning, welding, and material processing applications.
- **Biomedical Applications** – Medical device thermal monitoring and controlled therapeutic heating.
- **Scientific Research & Fundamental Studies** – Applications in experiments involving heat transfer, material thermodynamics, and advanced energy system development.

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NEXT-GENERATION DEVELOPMENT

While the first Generation of commercial sensors is available, ongoing R&D explores advanced sensors for enhanced performance. Future developments will focus on expanding applications in thermoelectric control, energy harvesting, and smart sensor networks. Collaborations with academic and industrial partners will drive the evolution of the sensor technology to meet diverse market needs.

Q-SENS: SUMMARY

Q-sens heat flux sensors provide high-speed, high-accuracy thermal sensing with unique advantages over conventional heat flux gauges. Their ability to function in extreme conditions, decouple electrical and thermal pathways, and offer ultra-fast response times makes them a promising technology for scientific and industrial applications.

To gain an advantage with our sensor technology, off-the-shelf sensor samples are readily available for immediate testing and implementation. Signal conditioning and amplification are supplied by Meerstetter, ensuring seamless integration into existing systems. While sensor integration typically involves a small engineering project for customization and optimization tailored to the customer's specific needs, our team provides full support throughout the process.

To explore how our sensors can fit your application, contact us via email or use our booking link to schedule a web meeting directly with our experts. Not sure if your application can benefit from the sensors? **Talk to our experts.**