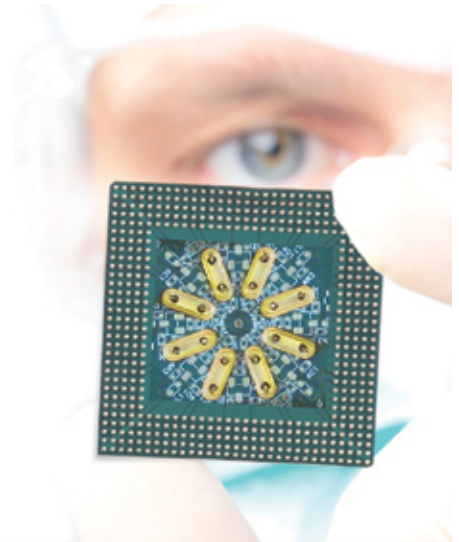# MS TECH
Advanced Sensor Technologies

# TF
## Tuning Fork Sensors

## Tuning Fork Sensors

MS Tech developed a wide range of Tuning Fork Sensors based on a multi-disciplinary approach that integrates: TF technology, plasma etching, chemical coating and deposition technologies, micro-mechanics, electronics, algorithms and digital data processing.

The scientific development includes a large bank of thin chemical coatings (polymers and SAM›s) that can be applied on the active surface of TF Sensors. Each of these coatings has a specific affinity to different substances and is designed to selectively interact with the target molecules.

The sensors are formed in a patented Sensor Matrix structure that offers high sensitivity and selectivity to a wide range of molecules (See Figure 1). The sensitivity of a TF sensor is proportional to a square of frequency of the quartz resonator and is defined by expression, in which the sensor frequency change depends on the adsorbed mass as follows:

$\Delta f = (-2.3 \times 10_{-6})\, f2\, \Delta M/A,$

*Where: $\Delta f$[Hz] – frequency change under the influence of adsorbed mass $\Delta M$;
F (Hz) – resonance frequency of quartz sensor;
A (cm2) – electrodes area (two sides) of quartz sensor where is accumulate of adsorbed mass $\Delta M$;

The TF Sensors have the capacity to detect and identify traces of materials in gas, vapor and liquid phases, even at very low concentrations. The sensors can be operated in a wide ambient temperature range (-10°C to +60°C) and at a humidity range of 5% to 95% RH without condensation.

### Scientific Principle of Operation

The TF Sensor Technology is an amalgamation of several scientific disciplines, digitally recreating the mammalian olfactory processes (See Figure 2) for Sensor Matrix interacting with molecules). It is based on the piezoelectric theory where molecules adsorbed on the surface of selective chemical coatings create changes in the mass weight of the TF Sensors. This process affects their resonating frequency and provides a unique digital signature or fingerprint for each target substance. The changes are accurately measured within seconds through a combination of TF Sensors and powerful pattern recognition algorithms.

### Feature Highlights
- Green technology
- No radioactive source
- High sensitivity & selectivity
- Short response
- Fast recovery time
- High stability
- Real-time transmission
- Energy efficient
- Low power consumption
- Resistance to humidity
- Resistance to barometric pressure
- Maintenance free sensors
- Low manufacturing costs

**Figure 1:** An Overview of TF Sensors developed by MS Tech

**Figure 2:**
An inside view of HF-QCM and TF Sensor Matrix

## Typical Response Curves

The dynamic range of resonating frequency of TF Sensors is typically between several to a few hundred MHz. In each sample analysis, the frequency responses of all sensors are measured over pre-determined time intervals. The sample identification process occurs when pattern recognition algorithms process the received digital signature

and match it with an existing database of substances stored in the instrument. The TF Sensors responses create a digital signature characterizing the TF Sensor Matrix reaction to a specific material inserted for analysis. The Sensor Matrix response for a given sample is systematically measured and consistent, to the extent that the likely ranges of target molecules and typical interferents have been previously inserted to the database. The distribution of the Sensor Matrix responses to analyzed samples can be plotted as histograms. This technological concept enables a fast adaptation and flexibility in "learning" to detect and identify new target substances while keeping low false alarm rates

## Design Review

The TF Sensor Matrix is designed as a "plug & play" chip that does not use any radioactive source or hazardous materials (See Figure 5). It can be integrated in a wide range of systems while maintaining sensitivity and selectivity during high-throughput analysis. Each TF Matrix can record and store thousands of samples performed since its installation. It can also be integrated in conjunction to Wi-Fi or Bluetooth and used for real-time transmission of alarms and/or test results to remote proxy servers. The result is compact, low-power consumption and humidity-resistant detection devices.

### Applications

**Security & People Screening**
- Explosives & improvised materials
- Narcotics & contraband
- Toxic Industrial Chemicals (TICs)
- Chem-bio agents

**Food Safety & Product Inspection**
- Pathogens
- Chemical contaminants
- Spoilage organisms
- Automatic Milking Systems (AMS)
- Fish & seafood
- Meat & poultry

**Bio-Medical Diagnostics**
- Non-invasive inspection
- Urine analysis
- Blood analysis
- Early disease detection
- Real-time diagnosis

**Others**
- Automotive (CO and NO2)
- Air quality (CO and VOCs)
- Safety (CH4, propane)
- Consumer (VOCs)



**Figure 5:**
Sensor Matrix Chip Design

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