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New generation of industrial pressure sensors with Qvar

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MEMS and Sensors Marketing



Agenda

1 Technology

4 Use cases

2 ST Qvar

5 Q&A

3 Portfolio

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ST Technology for Pressure Sensors

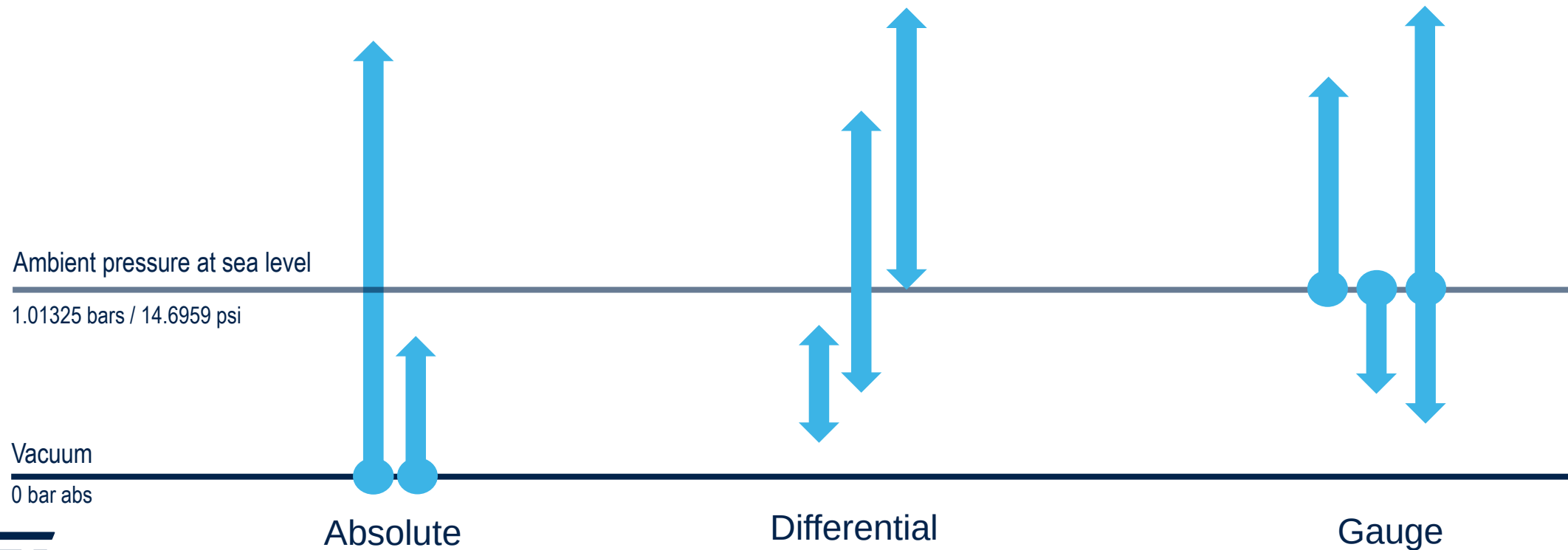


Types of pressure measurement

Absolute pressure is defined as the pressure measured relative to a perfect vacuum

Differential pressure is the pressure difference measured between two pressure sources

When one source is the ambient pressure, this is then called **gauge or relative pressure**



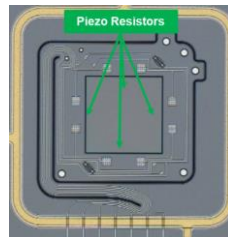
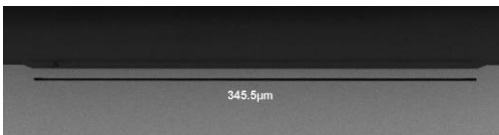


MEMS Absolute Pressure Sensors

MEMS Sensing Element

Suspended membrane manufactured using a proprietary process

When pressure is applied, the membrane deflection induces an imbalance in the Wheatstone bridge piezo-resistances



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ASIC

Output signal is converted by the IC interface

Digital output for connection to host microcontroller/processor

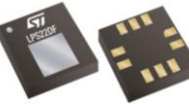
Factory calibration (trimming parameters stored on the device)

+

Package

Unique fully-molded package

- Ultra-thin package
- Shock and vibration suppression
- Improved dust/moisture resistance



Water-resistant package option

- Cylindrical design & O-ring compatibility
- Potting gel & grounded metal cap
- Low-stress encapsulation

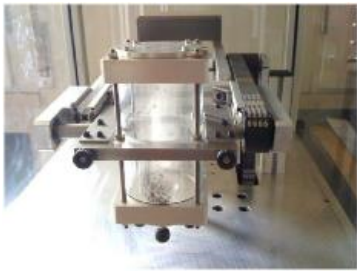


ST advantages

Dust-resistant and Water-resistant Packages

Dust contamination test

100 cycles (with dust particles)
all parts passed showing no significant output drift



Small vent holes: 6x holes for redundancy
& small hole to avoid contamination inside IC



Robustness to high air overpressure stress tests

the device demonstrated robustness under specific conditions, with **no failures**

Figure 17. LPS27HHW immersed in water for air overpressure



Robustness to corrosive agents

Hot chlorine, bromine, saltwater and detergent tests showed high stability, with **no impact on accuracy or other performance issues**, robustness to potential corrosive agents

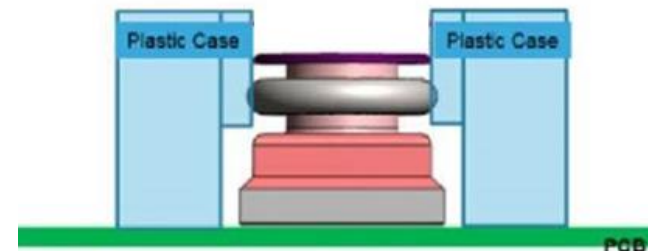
Figure 16. Chlorine, bromine, saltwater and detergent tests



❖ Test under each bottle of Chlorine , Bromine and Salt water



❖ Test strip using to confirm test condition.



ST Qvar Technology





electric charge (= **Q**) variation (= **var**)

electrostatic sensor

enabling applications such as:

- motion detection
- gait analysis
- user interface
- water detection



Electrostatic charge sensing principle

Triboelectric Effect / Charging

- Electrostatic phenomena
- Electric charge is transferred from one object to another object upon contact/friction
- Transfer through the movement of electrons
- The direction of the transfer depends on the specific materials involved





Electrostatic charge sensing principle

Triboelectric Effect / Charging

- An **electrostatic charge** is expected on a material whenever it comes into contact with another material or a solid or liquid surface
- Electrostatic induction and/or physical contact
- The level of charge is usually unpredictable, but it can be detected by means of an **electrode** and an **electronic signal conditioning circuit**
- A signal is derived from the electronic circuit due to the fluctuations in the electric field resulting from the passage of the charged particles

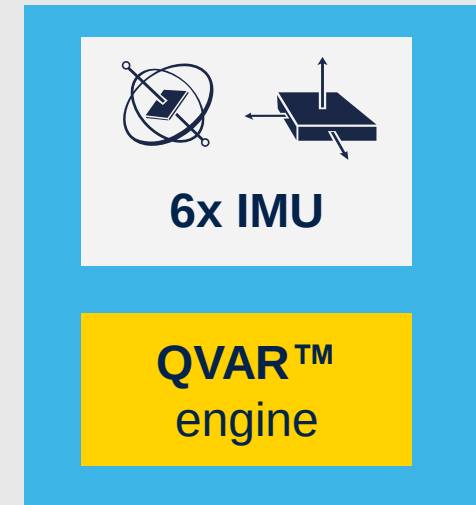
Adding Qvar to ST sensors



Sensing
Electrostatic
Charge
Variation

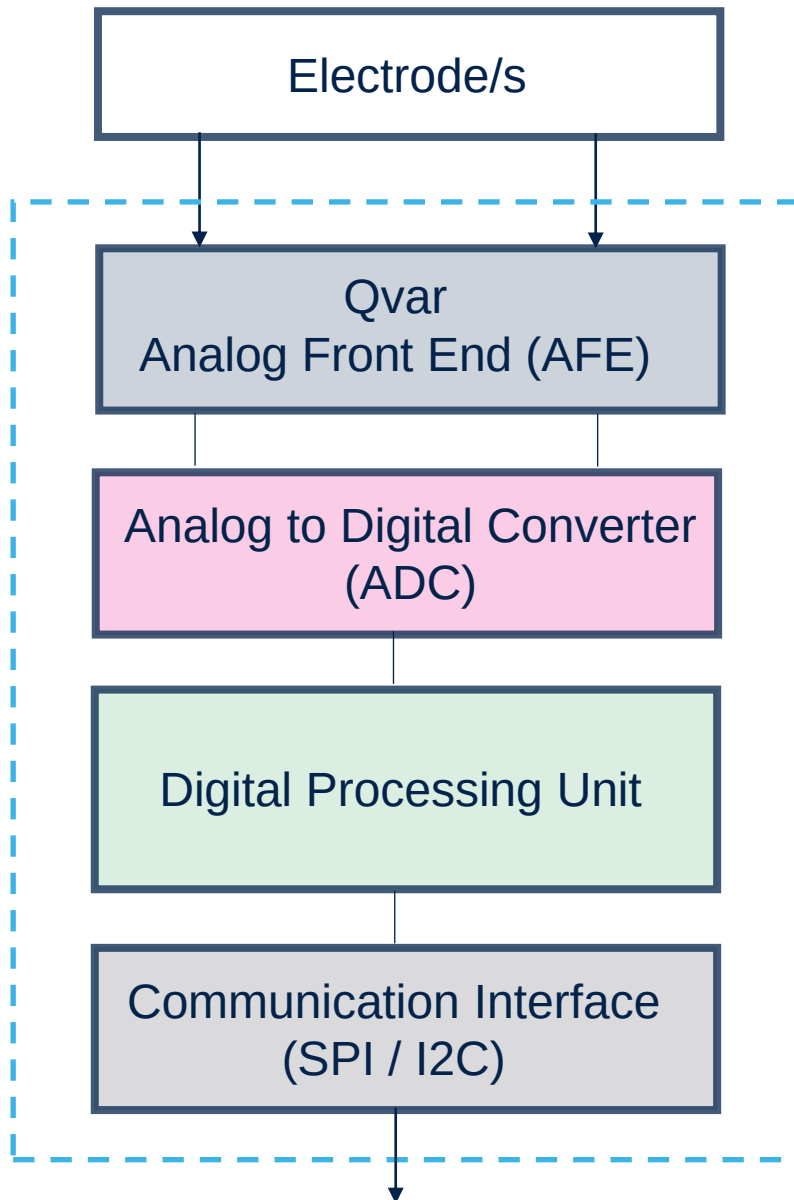


Qvar senses variations in the electrical fields in proximity or contact through electrodes



IMU = Inertial Measurement Unit

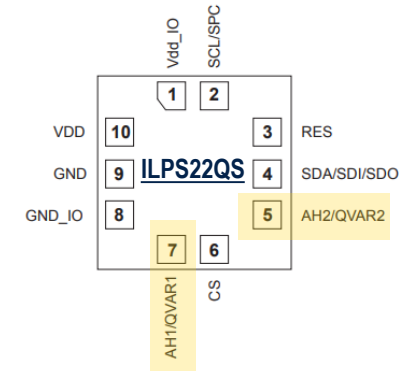
Qvar sensing channel architecture



Qvar sensing channel – detects the differential electric potential variation induced on the electrodes connected

Different Qvar channel results / application specific based on electrodes

- Number of electrodes (one or two)
- Size
- Shape
- Material
- Placement

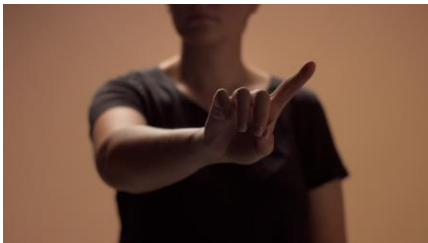


Example: user interface



enabling applications such as:

- motion detection
- gait analysis
- user interface
- water detection



Example: user interface

- **Touch** sensitive **interface**
- **Sensing charge variations** with high precision when the electrodes are in contact with the user
- Detect a **touch**, a **press** or **swipe**

Electrodes for **touch** sensing

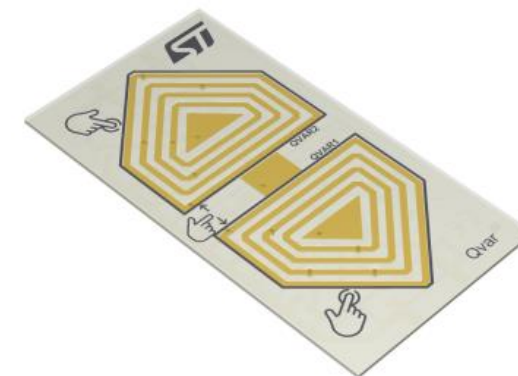


Flex electrode

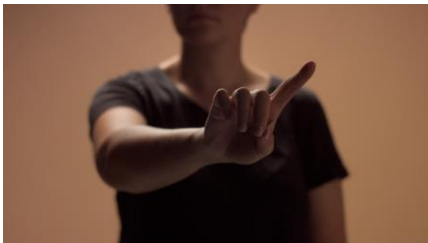


PCB electrode for touch detection

Electrodes for **swipe** sensing



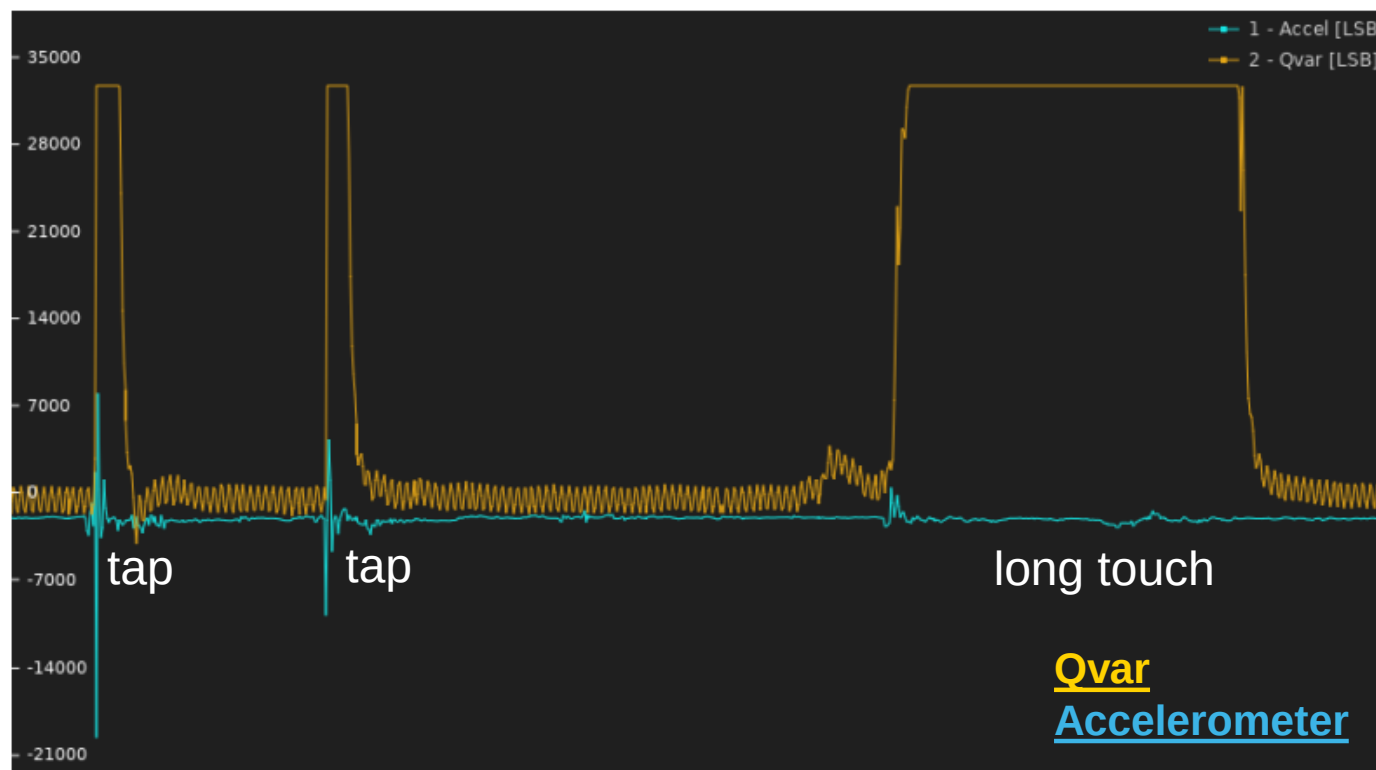
PCB electrode for swipe detection



Example: user interface

- **Accelerometer** sensor to detect **single or double tap** (small shock applied)
- Adding **Qvar** it is possible to distinguish whether the user is **tapping or touching** the device and to **distinguish a long touch**, which is not possible with an accelerometer sensor

Comparison of tap
and long touch



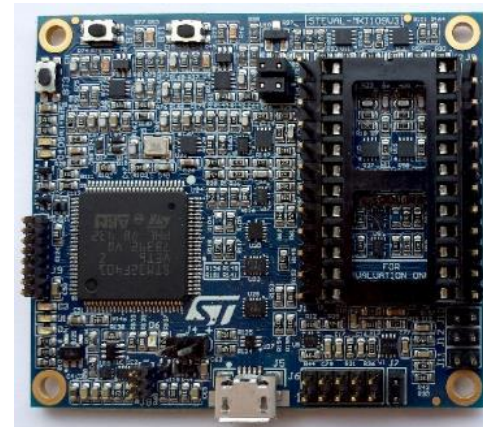
Demo – User Interface - Touch



Unico
Graphical User Interface



USB cable



STEVAL-MKI109V3
ProfiMEMS motherboard

+

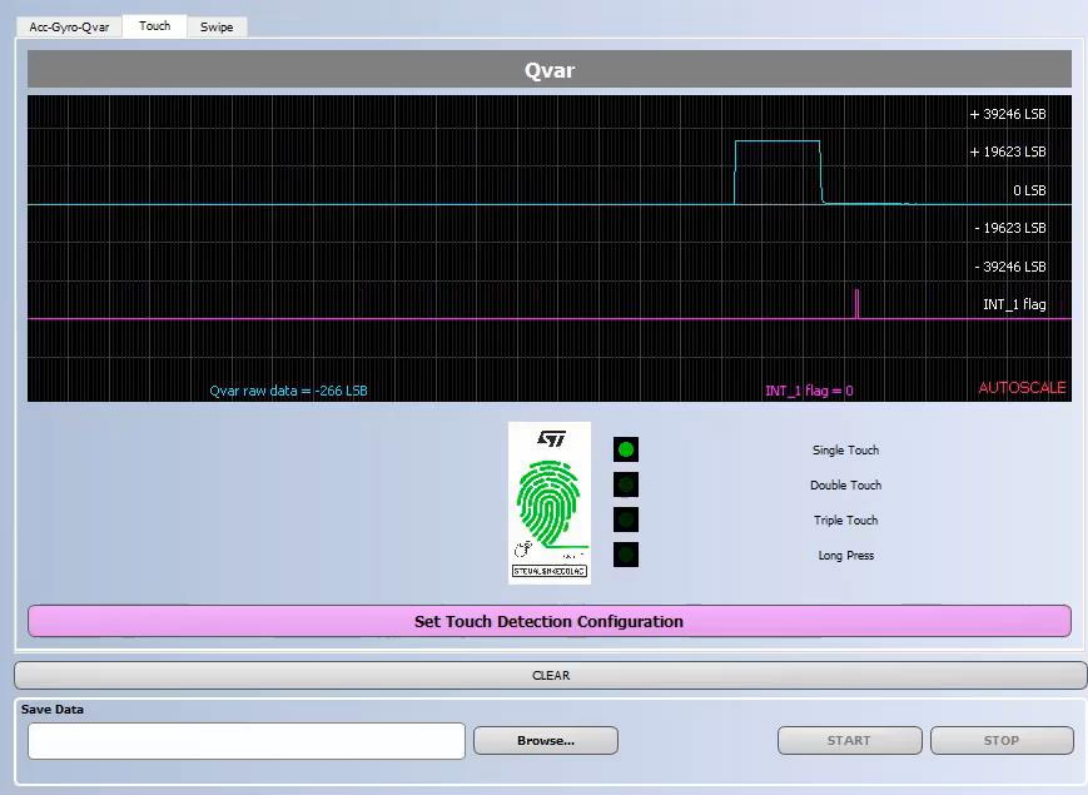


DIL24 adapter kit

+



Qvar Electrode
board



Example: water detection



enabling applications such as:

- motion detection
- gait analysis
- user interface
- water detection

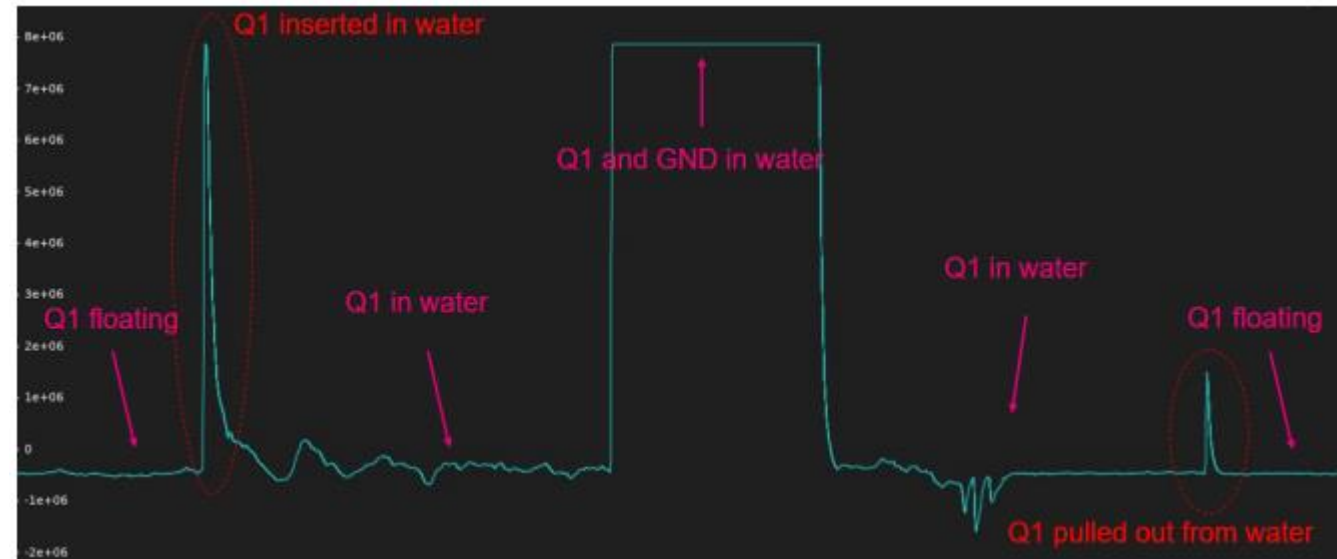
Example: water leak detection

- Water is a conductor, able to transfer charge
- Water-detection device placed horizontally or vertically on a surface

The wires that come from the outside are linked to the two metal rings fixed in the slots in the plastic section



Electrode for water leak detection



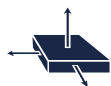
Example of water leak detection

Pressure Sensors Portfolio Overview





ST MEMS and sensors portfolio overview



Accelerometers / Inclination

LIS2DE12

LIS2DH12

LIS2DW12 / LIS2DTW12

H3LIS331DL

LIS2DU12

IIS2DLPC

IIS3DHHC

IIS2ICLX

IIS3DWB

AIS2DW12

AIS2IH



Magnetometers / e-Compass

LIS2MDL

LSM303AGR / LSM303AH

IIS2MDC

ISM303DAC



6-axis IMUs

LSM6DSO / LSM6DSOX
LSM6DSO32 / LSM6DSO32X

LSM6DSR / LSM6DSRX

ISM330DHCX

ASM330LHH / ASM330LHHX



Environmental

STLM20 / STTS751

STTS22H

LPS22HH / LPS22DF

LPS27HH(T)W / LPS28DFW

ILPS22QS

ILPS28QSW



Microphones

MP23ABS1

IMP23ABSU

MP34DT05-A

IMP34DT05

MP34DT06J

MP23DB01HP



Proximity and Ranging

VL53L0X

VL53L1CB

VL53L1CX

VL53L3CX

VL53L4CD

VL53L4CX

VL53L5CX

VL6180V1

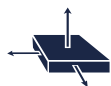
VL6180X

Ambient Light Sensor

VD6283TX



ST MEMS and sensors portfolio overview



Accelerometers / Inclination

LIS2DE12

LIS2DH12

LIS2DW12 / LIS2DTW12

H3LIS331DL

LIS2DU12

IIS2DLPC

IIS3DHHC

IIS2ICLX

IIS3DWB

AIS2DW12

AIS2IH



Magnetometers / e-Compass

LIS2MDL

LSM303AGR / LSM303AH

IIS2MDC

ISM303DAC



6-axis IMUs

LSM6DSO / LSM6DSOX
LSM6DSO32 / LSM6DSO32X

LSM6DSR / LSM6DSRX

ISM330DHCX

ASM330LHH / ASM330LHHX



Environmental

STLM20 / STTS751

STTS22H

LPS22HH / LPS22DF

LPS27HH(T)W / LPS28DFW

ILPS22QS

ILPS28QSW



Microphones

MP23ABS1

IMP23ABSU

MP34DT05-A

IMP34DT05

MP34DT06J

MP23DB01HP



Proximity and Ranging

VL53L0X

VL53L1CB

VL53L1CX

VL53L3CX

VL53L4CD

VL53L4CX

VL53L5CX

VL6180V1

VL6180X

Ambient Light Sensor

VD6283TX

Absolute Pressure Sensors Overview

LPS22HH



2 x 2 x 0.73 mm

LPS22DF



2 x 2 x 0.73 mm

- 260 to 1260 mbar
- **RMS noise 0.34Pa**
- Absolute accuracy 0.5hPa (@ -20 – 80°C)
- **Relative pressure accuracy 0.015hPa**
- **TCO : 0.45Pa/°C** (@ -20 – 65°C) / 660 – 1160hPa)
- ODR from 1 Hz to 200 Hz
- **Low power consumption:** 1.7µA / 9.4µA
- **1.08V IO supply voltage**
- **Compliance with E911 requirements**

ILPS22QS



2 x 2 x 0.73 mm

Dual full-scale

- 260 to 1260 mbar (mode1=M1)
- 260 to 4060 mbar (mode 2=M2)
- **RMS noise 0.34Pa (M1) // 0.57Pa (M2)**
- Absolute accuracy 0.5hPa @ -20 – 65°C (M1) // ±0.37% of input pressure (-40 – 105°C & up to 4bar, M2)
- **Relative pressure accuracy 0.015hPa (M1) // 1hPa (M2)**
- **TCO: 0.45Pa/°C** (@ -20 – 65°C, M1) // 3.5Pa/°C (@ 0 – 45°C, M2)
- ODR from 1 Hz to 200 Hz
- **Low power consumption:** 1.7µA / 9.4µA
- **Extended Temperature range -40° to 105°C**
- **Embedded Qvar**
- **Metal cap (ILPS28QSW)** optionally, connected to ground or left floating electrically in the application PCB layout
- **10 ATM Water Resistance (ILPS28QSW)**
- **10-year** product longevity guarantee

Dual full-scale water-resistant

- 260 to 1260 mbar (mode1=M1)
- 260 to 4060 mbar (mode 2=M2)
- **RMS noise 0.32Pa (M1) // 0.57Pa (M2)**
- Absolute accuracy 0.5hPa (@ 0 – 65°C, M1) // ±0.36% of input pressure (@ 0 – 45°C & up to 4bar, M2)
- **Relative pressure accuracy 0.015hPa (M1) // 1hPa (M2)**
- ODR from 1 Hz to 200 Hz
- **Low power consumption:** 1.7µA / 9.4µA
- **Metal cap**, optionally, connected to ground or left floating electrically in the application PCB layout

ILPS28QSW



2.8 x 2.8 x 1.95 mm

Coming Soon

LPS27HH(T)W



2.7 x 2.7 x 1.7 mm

LPS28DFW



2.8 x 2.8 x 1.95 mm



ILPS22QS

Dual full-scale, Absolute digital output barometer for industrial applications



HLGA-10L
2.0 x 2.0 x 0.73 mm

HIGHLIGHTS

ST's 1st industrial pressure sensor (temp. range -40 °C to **+105 °C**)

Analog hub sensing functionality to implement the **QVAR technology** for **sensing charge variation** (implement water leakage detection and user interface gesture like tap, double tap, long press, and L/R - R/L swipe)

The device is **factory calibrated & unique fully molded package**

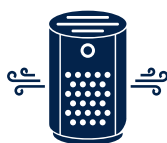
KEY FEATURES

- Selectable **dual full scale** absolute pressure range
 - Mode 1: 260 to 1260 hPa // Mode 2: 260 to 4060 hPa
- **Current consumption** down to 1.8 μ A
- Absolute pressure **accuracy** 0.5 hPa (Mode 1) / 0.28% (Mode 2)
- **Low noise** 0.34 Pa (Mode 1) / 0.57Pa (Mode 2)
- High performance TCO 0.45 Pa/°C (Temperature coefficient offset)
- Embedded temperature compensation

TARGET APPLICATIONS



Altimeters and barometers



Smart filters



Ventilators and CPAP equipment

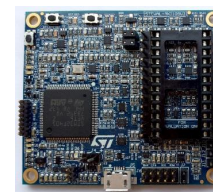


Gas metering
Leakage detection



Man-down detection

EVALUATION BOARDS



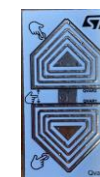
STEVAL-MKI109V3
ProfiMEMS motherboard

+



STEVAL-MKI228KA
DIL24 adapter kit

+



STEVAL-MKE001A
Qvar Electrode board



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Smart filters



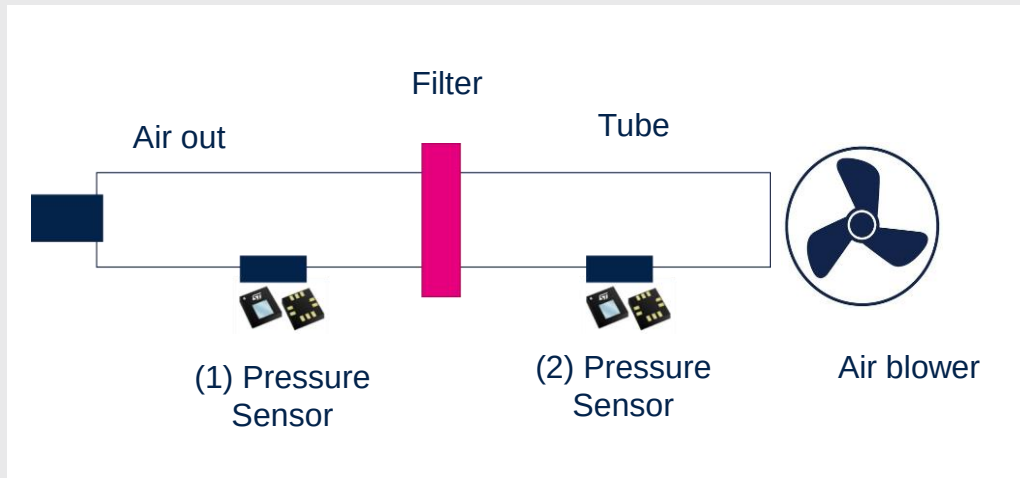
Vacuum cleaners
Floor type / Bag level

Pressure sensors for air filters

Smart filters application description

Measure **air flow and filter state**, and notify when filter should be replaced (reduced air flow)

Industrial environments with **extended temperature range**



Key application requirements

Current consumption

**Noise
Temp range**

ILPS22QS

1.8 μ A @ 1Hz one-shot

RMS pressure noise
0.34 Pa RMS (mode 1)
0.57 Pa RMS (mode 2)

Robustness to dust contamination

-40°C to 105°C



ILPS28QSW

Dual full-scale, Absolute digital output barometer with water-resistant package for industrial applications



HIGHLIGHTS

ST's 1st industrial pressure sensor (temp. range -40 °C to +105 °C)

Analog hub sensing functionality to implement the **QVAR technology** for **sensing charge variation** (implement water leakage detection and user interface gesture like tap, double tap, long press, and L/R - R/L swipe)

The device is **factory calibrated & Potting gel** to protect the electronics components inside the sensor

KEY FEATURES

- Selectable **dual full scale** absolute pressure range
 - Mode 1: 260 to 1260 hPa // Mode 2: 260 to 4060 hPa
- **Current consumption** down to 1.8 μ A
- Absolute pressure **accuracy** 1 hPa (Mode 1) / 0.43% (Mode 2)
- **Low noise** 0.32 Pa (Mode 1) / 0.57Pa (Mode 2)
- Embedded temperature compensation

TARGET APPLICATIONS



Altimeters and barometers



Smart filters



Home appliance



Gas metering
Leakage detection



Water depth
monitoring

EVALUATION BOARDS



STEVAL-MKI109V3
ProfiMEMS motherboard

+



STEVAL-MKI223V2
DIL24 adapter kit



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Water depth monitoring



Home appliance



Scuba

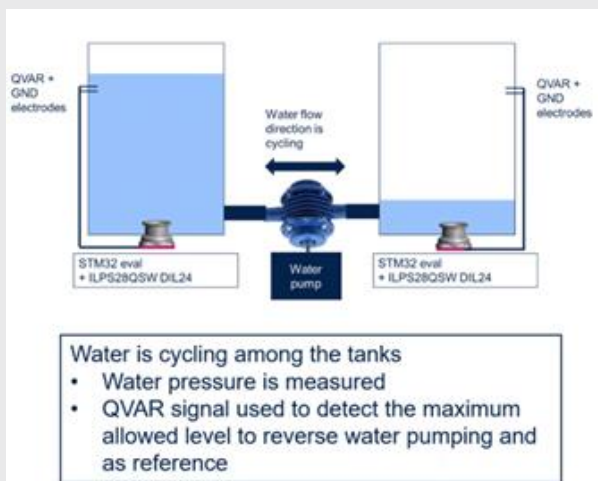
Pressure sensors to measure liquid levels

Liquid level application description

Selectable scale for depth in deep water and presence out of water

Dual full-scale mode to provide wide coverage on both altimeter and water depth (up to 30 meters)

Current consumption and noise features



Key application requirements

Current consumption

Noise Package

Supply current @ 1Hz output data rate
1.7 μ A

1 hPa (Mode 1)
0.6% of input pressure (Mode 2)

ILPS28QSW

Supply current in power-down mode
1 μ A

Water-proof package

Takeaways



Documentation for Pressure Sensors

Application Notes:

- [AN5209](#): LPS22HH MEMS nano pressure sensor
- [AN5227](#): LPS22HH digital pressure sensor: hardware guidelines for system integration
- [AN5699](#): LPS22DF low-power and high-precision MEMS nano pressure sensor
- [AN5387](#): LPS27HHW MEMS pressure sensor with water-resistant package
- [AN5606](#): LPS27HHW digital pressure sensor: guidelines for system integration
- [AN5758](#): LPS28DFW dual full-scale absolute digital output barometer with water-resistant package
- [AN5764](#): ILPS22QS dual full-scale absolute digital output barometer with embedded Qvar electrostatic sensor
- [AN5755](#): Qvar sensing channel

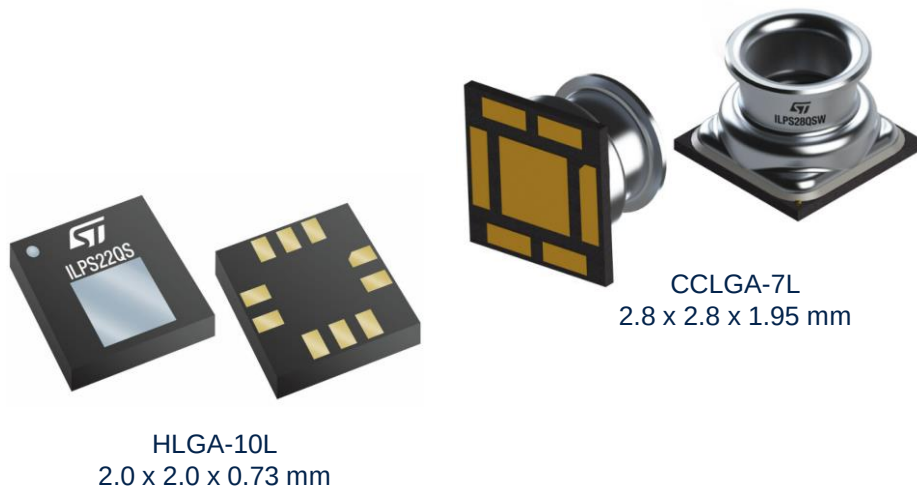
Design Tips & Technical Notes:

- [TN0018](#): Surface mounting guidelines for MEMS sensors in an LGA package



Takeaways

- ST Absolute pressure sensors and Qvar a great fit for multiple applications
- Unique fully-molded and water-resistant package options
- Documentation, tools and development kit for thorough evaluation
- ST support is one click away



Our technology starts with You



Find out more at <http://www.st.com/sensors>

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