SENSOR SOLUTIONS FOR WEARABLES FROM TE CONNECTIVITY

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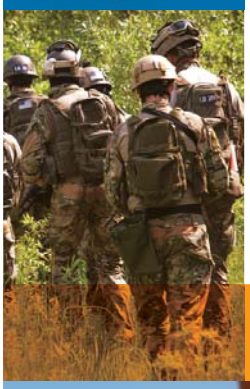
TE Connectivity (TE) is a global technology leader, providing connectivity and sensor solutions essential in today's increasingly connected world. TE is one of the largest sensor companies in the world. Our sensors are vital to the next generation of data-driven technology.

Whether it's an altimeter built into a wearable band to measure how many steps we climb each day, or a sports watch charting the ascent up one of the world's highest mountain peaks, our miniature sensors are used to convey critical information for the dashboard of our daily lives. Our dive computer sensors help provide safety in leisure activities, while our piezo film enables your bed to monitor your heart rate, breathing and even how well you sleep. We've been making sensors for wearables before there were wearables. TE is recognized for our technical skill in miniaturization, low power consumption, and high-performance. That's why our sensors are in harsh environments, from the world's highest parachute jump to the deepest dive.



SENSOR SOLUTIONS

- PRESSURE
- TEMPERATURE
- PIEZO FILM
- HUMIDITY
- PHOTO OPTIC
- POSITION
- FORCE
- VIBRATION

QUALITY STATEMENTS

- ISO 9001
- ISO 14001
- ISO 13485
- CE-MDD
- CMDR–Health Canada
- FDA
- Measuring Instruments Directive 2004/22/EC annex D
- TS 16949

CONSUMER WEARABLE SOLUTIONS

Altimeter Watch

- Humidity sensors monitor local relative humidity
- Pressure sensors monitor altitude
- Temperature sensors measure local air temperature

Multi-Mode Watch

- Pressure sensors monitor altitude changes
- Temperature sensors measure local air temperature or skin temperature
- Humidity sensors monitor local relative humidity or skin moisture (Sweat)
- Photo optic sensors measure heart rate and SpO_2 level

Diving Watch / Computer

- Pressure sensors monitor altitude
- Pressure sensors monitor dive depth
- Temperature sensors measure water temperature

Fitness Band

- Pressure sensors monitor altitude changes
- Temperature sensors measure local air temperature or skin temperature
- Humidity sensors monitor local relative humidity or skin moisture (Sweat)
- Piezo film sensors monitor user motion and general activity level

Martial Arts Vest

- Piezo cable determines impact location and intensity

Ski Goggles

- Pressure sensors monitor altitude changes for heads-up display data
- Humidity and temperature sensors help control goggle defogging fan

Sleep Monitoring

- Humidity sensors control moisture level in CPAP masks for comfort
- Temperature sensors measure skin temperature and respiration air for comfort
- Pressure sensors monitor inhalation and expiration cycles
- Photo optic sensors measure heart rate and SpO_2 level

MEDICAL WEARABLE SOLUTIONS

Fall Detection

- Piezo film sensors measure sudden impact and patient motions
- Pressure sensors measure rapid altitude change when patient falls to the floor

Heart Pacemaker

- Piezo film sensors monitor patient physical activity

Protective Vest

- Piezo cable determines impact location and intensity

Prosthetics

- Force sensors measure dynamic and static loads on the prosthesis
- Piezo film sensors monitor dynamic flexing and stresses on prosthetic components
- Position sensors monitor the location and motion of moving
- Vibration sensors monitor orientation of the patient and prosthetic parts

Vital Signs

- Photo optic sensors measure heart rate and SpO_2 level
- Temperature sensors measure skin and expiration temperatures
- Pressure sensors monitor inhalation and expiration activity

Sleep Apnea Treatment

- Photo optic sensors measure SpO_2 level and heart rate
- Temperature sensors monitor skin and expiration temperatures
- Humidity sensors measure ambient relative humidity and expiration humidity level
- Pressure sensors monitor inhalation and expiration activity
- Piezo film sensors monitor patient limb activity and Rapid Eye Movement (REM)

DEFENSE WEARABLE SOLUTIONS

Helmet Impact

- Piezo film sensors monitor impact intensity and location
- Vibration sensors measure the impact orientation and intensity

Soldier Activity

- Photo optic sensors monitor soldier heart rate and SpO_2 level
- Humidity sensors monitor skin moisture (Sweat)
- Vibration sensors measure soldier activity level or lack thereof
- Temperature sensors measure ambient and skin temperatures

SENSOR SOLUTIONS FOR WEARABLES

FORCE SENSORS

	MEAS FX19	MEAS FS20	MEAS FC22	MEAS FC23
Package	Low profile “coin cell” design	Miniature; drop in replacement for industry standard	Plastic housing, button, flange mounting	Stainless steel housing button shape for higher weight loads
Operating Mode	Compression	Compression	Compression	Compression
Unique Features	• Ultra low cost, low strain design • Essentially unlimited cycle life	• Load cell design operates at very low strains • Not subject to lead die fatigue	• Low cost button shape • Essentially unlimited cycle life	• Industry standard low profile all stainless steel design • Resistant to off-axis loads
Ranges (Lbf)	10, 25, 50, 100	1.5, 3	25, 50, 100	250, 500, 1,000, 2,000
Max. Over-range	2.5X	10 lbf	2.5X	1.5X and 2.5X
Output/Span	100 mV	1.0 to 4.0 V	100 mV, 0.5 to 4.5 VDC	100 mV
Combined Linearity & Hysteresis	±1.0% FSO	±1.0% FSO	±1.0% FSO	±1.0% FSO
Operating Temp.	-40°C to 85°C	0°C to 70°C	-40°C to 85°C	-40°C to 85°C
Dimensions (mm)	Ø25.00 x 29.50 x 8.00	30.708 x 17.272 x 8.255	Ø26.00 x 42.00 x 19.50	Ø31.75 x 10.20
Typical Applications	Consumer OEM, physical therapy, pumps, medical devices	Infusion pumps, contact sensing, medical devices	Infusion pumps, robotics end-effectors, contact sensing	Robotics, pumps

HUMIDITY SENSORS

	MEAS HTU2X Series
Package	DFN type
Type	Digital RH and NTC temperature
Operating RH Range	0 to 100% RH
Operating Temp.	-40°C to 125°C
Unique Features	• Low power consumption • Fast response time • Very low temperature coefficient • I^2C interface or PWM interface or SDM interface
Accuracy	±3% RH at 25°C (10 to 95% RH) ±0.3°C at 25°C
Dimensions (mm)	3.0 x 3.0 x 1.0
Typical Applications	Humidity and temperature plug and play transducers for OEM demanding applications, medical, humidifier

PIEZO FILM SENSORS

	MEAS Piezo Cable	MEAS LDTC Family
Package	Shielded coaxial 20 gage piezo cable	Piezo film elements with or without mass
Type	Polymer jacketing; armored jacketing	Cantilever beam with vertical or horizontal pins
Range	µPa sensitivity	±10 g (Typical)
Unique Features	• Continuous lengths of up to 1 km • Shielded construction	• Very low cost • High sensitivity (1 V/g) • Ultra-low power (Self generating)
Accuracy	±20% (Typical)	±20% (Typical)
Operating Temp.	-40°C to 85°C	-40°C to 70°C
Dimensions (mm)	Ø3 (Continuous lengths)	19.05 x 6.35 x 6.35
Typical Applications	Impact sensors, vital signs monitor	Wake-up switch, impact sensing, vital signs monitoring

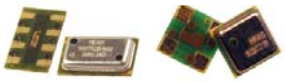
PHOTO OPTIC SENSORS

	MEAS ELM 4000	MEAS EPM 4001
Package	Lead frame construction	Lead frame construction
Type	Emitter assembly	Detector assembly
Range	660 nm / 880-940 nm	—
Unique Features	• Low cost • Dual drive • Clear epoxy lens	• Low cost • Fast response • High efficiency
Accuracy	Sensor dependent	Sensor dependent
Operating Temp.	-55°C to 70°C	-55°C to 70°C
Dimensions (mm)	4.4 x 5.1 x 1.9	4.4 x 5.1 x 1.8
Typical Applications	Pulse oximetry, finger and ear probes, disposable, medical devices	Pulse oximetry, finger and ear probes, disposable, medical devices

POSITION SENSORS

	MEAS KMT32B / KMT37	MEAS KMA36
Package	TDFN, SO-8	TSSOP
Type	Angle sensor	Angle sensor
Range	180° angle	360° angle
Unique Features	• High accuracy • High resolution	• Low cost MR encoder for rotational and incremental measurements
Output	Sine and cosine signals with output voltage range 20 mV/V	Voltage 0 - 5 V, I²C, customer specific
Resolution	Typ. 0.01° to 0.1°	Typ. 0.1°
Accuracy	Typ. 0.1° to 1.0°	Typ. 0.3°
Operating Temp.	-40°C to 150°C (175°C on request)	-25°C to 85°C
Dimensions (mm)	TDFN: 2.5 x 2.5 x 0.8 SO-8: 5 x 4 x 1.75	TSSOP20: 6.5 x 6.4 x 1.2
Typical Applications	Position measurement	Knobs, small robotics, angular / linear position

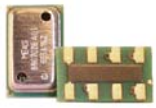
PRESSURE SENSORS



	MEAS MS5607, MS5611, MS5637	MEAS MS5837	MEAS MS5805
Package	Surface mountable	Surface mountable	Surface mountable
Type	Absolute	Absolute	Absolute
Pressure Range	10 - 2K mbar	0 - 2 to 30 Bar	10 - 2K mbar
Output / Span	24-bit ADC I²C or SPI protocol	24-bit ADC I²C	24-bit ADC I²C
Resolution	0.012 mbar (MS5611) 0.016 mbar (MS5637) 0.024 mbar (MS5607)	0.016 mbar (2 bar) / 0.2 mbar (30 bar)	0.02 mbar
Unique Features	• 24-bit digital sensor • 13 cm resolution (MS5607, MS5637) • 10 cm resolution (MS5611) • Supply voltage: 1.5 to 3.6 V (MS5637) Supply voltage: 1.8 to 3.6 V (MS5607, MS5611) • Low power, 0.6 µA (Standby ≤ 0.1 µA at 25°C)	• Supply voltage: 1.5 to 3.6 V • Excellent long term stability • Hermetically sealable for outdoor devices • Sealing designed for 1.8 x 0.88 mm o-ring	• 24-bit digital sensor • 20 cm resolution • Supply voltage: 1.8 to 3.6 V • Sealing designed for 2.5 x 1 mm o-ring • Silicone gel protection
Linearity/Absolute Accuracy	±1.5 mbar at 25°C (MS5611, MS5607) ±2 mbar at 25°C (MS5637)	±4 mbar (MS5837-02BA) ±100 mbar (MS5837-30BA)	±2.0 mbar at 25°C
Overpressure	6 bar	10 bar (MS5837-02BA) 50 bar (MS5837-30BA)	5 bar
Operating Temp.	-40 to 85°C	-20 to 85 °C	-40 to 85°C
Dimensions (mm)	3 x 3 x 0.9 (MS5637) 5 x 3 x 1 (MS5607, MS5611)	3.3 x 3.3 x 2.75	4.5 x 4.5 x 3.5
Typical Applications	Smart phones, tablets , personal navigation devices	Mobile water depth measurement systems, diving computers, adventure or multi-mode watches, data loggers	Mobile altimeter and barometer systems, bike computers, adventure or multi-mode watches, variometers, data loggers

PRESSURE SENSORS

	MEAS MS5803	MEAS MS5540	MEAS MS4515DO
Package	Surface mountable	Surface mountable	8 pin DIL
Type	Absolute	Absolute	Gage, compound
Pressure Range	0 - 1 to 30 bar	10 to 1,100 mbar	0 - 2 to 30″ H_2O
Output / Span	24-bit I^2C and SPI (Mode 0, 3)	16-bit 3-wire SPI-like serial interface	14-bit ADC SPI or I^2C
Resolution	12 µbar (MS5803-01BA) 0.5 mbar (MS5803-30BA)	0.1 mbar	—
Unique Features	• 24-bit digital sensor, software calibration and temperature compensation (I^2C and SPI), no external components • Supply voltage 1.8 to 3.6 V	• 16-bit digital sensor, very low noise (±0.1 mbar), software calibration and temperature compensation, pressure and temperature measurement (35 ms/meas.) • Low power, low voltage (2.2 to 3.6 V / <4 / 0.1 µA) • No external components required, small SMD ceramic carrier	• Optional gel coat, low power • Pressure and temperature measurement • Single supply of 3.3 or 5.0 VDC • Top, side barbed or manifold o-ring port • J lead or thru hole pins
Linearity/Absolute Accuracy	±1.5 mbar at 25°C (MS5803-01BA) ±250 mbar at 0°C to 40°C (MS5803-30BA)	±1.5 mbar at 25°C	0.25% / 1% TEB
Overpressure	110 bar (1, 2 bar), 30 bar (5, 7, 14 bar) 50 bar(30 bar)	10 bar (1 bar), 30 bar (14 bar)	300 psi
Operating Temp.	-40°C to 85°C	-40°C to 85°C	-10°C to 85°C
Dimensions (mm)	6.4 x 6.2 x 2.9	6.4 x 6.2 x 2.9	12.5 x 9.9
Typical Applications	Precision altimeter, diving and multi-mode watches, in-building navigation, variometers/flight instruments	Mobile altimeter, barometer systems, weather monitoring systems, adventure or multi-mode watches, GPS receivers, diving computers and divers' watches	Medical instruments, air flow measurements



	MEAS MS5525DSO	MEAS MS8607	MEAS 1620
Package	SOIC-14	Surface mountable	Hybrid assembly
Type	Gage, absolute, differential, compound	Absolute	Gage
Pressure Range	0 - 1 to 150 psi	10 - 2K mbar	-30 to 300 mmHg
Output / Span	24-bit ADC SPI or I^2C protocol	24 bit ADC I^2C	5 µV/V/mmHg
Resolution	—	0.016 mbar	—
Unique Features	• 24-bit digital small outline sensor • Pressure and temperature measurement • Single supply of 1.8 or 3.6 VDC • Top straight / barb, flat top, o-ring seal	• Integrated pressure, humidity and temperature • Supply voltage: 1.5 to 3.6 V • Fully factory calibrated sensor	• Low cost, disposable design • Supplied in tape and reel • Compliant to AAMI spec • ISO13485 certified
Linearity/Absolute Accuracy	0.25% / 2.5% TEB	±4 mbar	±1.0% FSO
Overpressure	3X range	6 bar	—
Operating Temp.	-40°C to 125°C	-40°C to 85°C	10°C to 40°C
Dimensions (mm)	12.5 x 7.9	5 x 3 x 1	11.43 x 8.13 x 4.20
Typical Applications	Medical respirators, ventilators	Smart phones and tablets	Disposable blood pressure, medical instrumentation

TEMPERATURE SENSORS

	MEAS Patient Monitoring Probes	MEAS Temperature System Sensor (TSYS) Series	MEAS Ni1000SOT
Package	Sensor with cable and connector	QFN16, TDFN8	SOT23, RTD
Type	Reusable: Skin; 10FR and 12FR GP Disposable: Skin; 9FR and 12FR GP; 12FR, 18FR, 24FR Esoph/Stethoscope; 14FR, 16FR, 18FR Foley catheter	I²C, SPI, PWM, SDM (Convertible to analog voltage)	Thin film nickel structure on silicon substrate, protected with a passivation layer
Sensor Range	400 series, 700 series (Reusable only)	16-bit digital output	1000Ω at 0°C
Unique Features	• Autoclavable reusables • Sterile disposables	• Low power • Small size • Calibrated and ready to use	• Analog output • Very small dimensions • Very short response time • Good thermal connection of sensing element through leadframe-pin
Accuracy	±0.1°C at 25°C to 45°C ISO-80601-2-56: ±0.2°C at 35°C to 42°C	Up to ±0.1°C at -5°C to 50°C	-3Ω / +2Ω at 0°C
Operating Temp.	-40°C to 100°C Patient: 0°C to 50°C	-40°C to 125°C	-55°C to 160°C
Dimensions (mm)	Reusable: 3 m cable with sensor Disposable: Sensor <1 m; 3 m reusable adapter cable	QFN16: 4 x 4 x 0.85 TDFN8: 2.5 x 2.5 x 0.75	SOT23: 2.1 x 2.5 x 2.1
Typical Applications	Patient monitoring	Replacement of precision RTDs, thermistors and NTCs	Smart watches, fitness watches and equipment, medical wearables

VIBRATION SENSORS

	MEAS 832/832M1
Package	SMD
Type	Board mount
FS Range (g)	±25, 50, 100, 200, 500
Unique Features	• Low cost • Hermetically sealed • Piezo-ceramic
Accuracy	±2.0% non-linearity
Operating Temp.	-20°C to 80°C (832) -40°C to 125°C (832M1)
Dimensions (mm)	18.8 x 14.22 x 4.32
Typical Applications	Data logging, impact monitoring

Note: The sensors and typical applications listed in this brochure can be used for various wearable applications, the examples included are for variety of uses across many markets.

PRODUCT AND APPLICATION MATRIX

		Force	Humidity	Piezo Film	Photo Optic	Position	Pressure	Temperature	Vibration
CONSUMER	Altimeter Watch		●				●	●	
	Multi-Mode Watch						●		
	Diving Watch/Computer						●		
	Fitness Band		●				●	●	
	Smart Glasses		●				●	●	
	Martial Arts Vest			●					
	Sleep Monitoring		●	●	●		●	●	
	Skin Temperature							●	
MEDICAL	Blood Pressure Monitor						●		
	Pacemaker			●					
	Fall Detection Monitor			●			●		
	Sleep Apnea Treatment		●	●	●		●	●	
	Blood Oxygen and Pulse Monitor				●				
	Prosthetics	●		●		●			●
DEFENSE	Helmet Impact			●					●
	Vest Impact			●					●
	Soldier Alive/Dead/Down			●	●		●	●	●

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