



SENSOR TECHNOLOGIES

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|---------------------------------------|-----------------------------|
| 1 - Air Bubble | 6 - Position |
| 2 - Force/Load | 7 - Pressure |
| 3 - Humidity | 8 - Pulse Oximetry |
| 4 - Liquid Level | 9 - Temperature |
| 5 - Piezo Film/
Ceramic Technology | 10 - Vibration/Acceleration |

MEDICAL DEVICE SENSOR SOLUTIONS

Proven in the medical marketplace, TE Connectivity (TE) has teamed with many OEMs to pioneer the use of sensor technology in commercially successful medical devices and disposables. See reverse side for medical application solutions.

- Ablation Catheter ^{2,9}
- Angioplasty Balloon Inflating Pump ^{7,9}
- Assisted Baby Delivery ⁷
- Blood Pressure Monitoring ^{5,7}
- Blood Transfusion ^{7,9}
- Body Weight ²
- Bone Density ⁵
- Brain Tumor Hypodermic Needle Probes ⁹
- Contrast Die Infusion ⁷
- Dialysis Machines ^{1,2,4,7,9}
- Discrete Vital Signs Monitoring ⁵
- Disposable Blood Pressure ⁷
- Drug Delivery Pumps ^{2,7}
- Electronic Stethoscope
- Heart Rhythm Monitoring ⁵
- Hospital Beds ^{2,5,6,7,9}
- Hospital Gas Monitoring ⁷
- Infusion Pump ^{1,2,4,6,7,9}
- Intrauterine Pressure Sensor ⁷
- Kidney Dialysis ^{4,7,9}
- Myocardial Needle Probes ⁹
- Non-Contact Body Temperature ⁹
- Ocular Surgery ⁷
- Oral/Esophageal/Rectal Thermometers ⁹
- Organ Transportation ⁷
- Oxygen Concentrators ⁷
- Oxygen Tanks ^{2,75}
- Pacemaker ⁵
- Patient Fall Detection ^{7,10}
- Patient Warming / Cooling ⁹
- Premature Newborn Cabinet ^{2,3,5,9}
- Pulse Oximetry ⁸
- Robotic Surgery ^{2,6}
- Skin Temperature ⁹
- Sleep Apnea ^{3,7,8,9}
- Surgical Power Tools ^{2,6,7,9}
- Thermo Dilution Sensor ⁹
- Thermometers ⁹
- Urinary Catheters ^{7,9}
- Ultrasound Imaging ^{5,6,9}
- Ventilator and Respirator ^{3,4,6,7,8,9}

ASSEMBLIES

Device Subassembly – Low cost subassembly done in our offshore manufacturing facility.

CARDIOVASCULAR TREATMENT

Ablation Catheter – Force transducer measures the force applied to the arterial walls during heart ablation. Temperature sensor measures the heat on the tissues.

Angioplasty Balloon Inflating Pump – Silicon MEMS pressure sensor measures the pressure applied for inflating the balloon.

Blood Transfusion – Silicon MEMS-based stainless steel pressure sensor used in a blood separation device and temperature sensor measures return blood.

Contrast Die Infusion – Silicon MEMS pressure sensor can control the injection of contrast solution during angioplasty procedure and temperature sensor for solution temperature control.

Discrete Vital Signs Monitoring – Piezo film mat used to monitor the heart beat and the respiration rate.

Myocardial Needle Probes – As the heart is cooled during surgery, hypodermic needles are inserted into myocardial muscles to monitor temperature.

Oxygen Tanks – Microfused load cells measure remaining oxygen level in tank. Low range pressure sensors are used to conserve the oxygen in the tank.

Pacemaker – Piezoelectric film sensor used as an activity monitor (vibration sensor) detecting patient movement.

Ventilator and Respirator – Silicon MEMS pressure sensor measure air flow in breathing machine, moisture and temperature measurements. Liquid level for water tank level. Position sensors for cabinet safety interlock. Optical sensors measure saturated oxygen levels.

HOME HEALTHCARE

Wearable Patches Vital Sign Monitoring – Optical sensors measure SpO₂ and temperature sensors measure skin temperature for patient parameters.

Medical Devices for Home Use – Temperature, pressure, force and bubble detection sensors allow dialysis equipment to monitor and control it's own functions. Precision force sensors allow remote monitoring of daily weight fluctuations. Piezofilm sensors to monitor the bedridden patients from leaving the bed, the heartbeat and respiration rate.

PATIENT MONITORING AND DIAGNOSIS

Body Weight – Microfused load cell used on a scale for patient weighing.

Bone Density – Piezoelectric film used as an ultrasound transducer to measure bone density.

Hospital Bed Vital Signs – Piezo film sensors are used for monitoring breathing patterns, heart rate and patient occupancy. Position sensors for back rest angle and bed height. Thermopile sensors for non contact body temperature. Force sensors for patient weight measurements.

Non-Contact Body Temperature – Thermopile sensors used in ear thermometers and forehead thermometers to measure patient temperature.

Oral/Esophageal/Rectal Thermometers – Reusable or disposable sensors for continuous monitoring of patient temperature.

Patient Fall Detection – High resolution pressure sensors detect if a patient suddenly collapses, accelerometer measures impact upon hitting the floor.

Skin Temperature – Reusable or disposable skin sensors for continuous monitoring of patient temperature.

Urinary Catheters – Temperature sensors monitor the core body temperature while draining bladder.

CARDIOVASCULAR MONITORING AND DIAGNOSIS

Disposable Blood Pressure Sensor – Low-cost miniature silicon MEMS pressure sensor used in-line with IV to monitor patient blood pressure.

Electronic Stethoscope – Piezoelectric film used as a contact microphone to receive heartbeat and breathing sounds.

Heart Rhythm Monitoring – Piezoelectric film vibration sensor monitors heart rhythms and signals 911 call through telemetry for emergency care.

Pulse Oximetry – Photo optic sensors used to measure blood oxygen saturation (SpO₂) and pulse.

Thermo Dilution Sensor – Measures blood volume coming out of the heart by using invasive NTC thermistors to measure changes in blood temperature.

Ultrasound Imaging – Piezo ultrasonic transducers designed into miniature imaging probes for custom configurations. Temperature sensors monitor ultrasound head and magnetoresistive (MR) sensors monitor head position.

SURGICAL/DELIVERY

Assisted Baby Delivery – Silicon MEMS pressure sensor used to monitor pressure on vacuum-assist baby delivery system.

Brain Tumor Hypodermic Needle Probes – Miniature temperature sensors at needle tip monitor freezing or warming of the brain during procedure to kill cancerous cells.

Intrauterine Pressure Sensor – Low-cost miniature Silicon MEMS pressure sensor monitors contraction frequency and amplitude during labor.

Organ Transportation – Disposable blood pressure sensors enable flow through organs during transport to extend organ life. Temperature sensors used for monitoring during transport.

Ocular Surgery – Silicon MEMS pressure sensor maintains fluid pressures in the eyeball during surgery.

Patient Warming / Cooling – Temperature sensors to maintain/return patient temperature during/after surgery to improve recovery time.

Robotic Surgery – MR used to mimic surgical motions from a remote location.

Surgical Power Tools – Performance of the pneumatic tools can be controlled by the air pressure applied and the force.

PATIENT TREATMENT

Bubble and Level Detection – Ultrasonic sensors detect bubbles and medication levels during infusion.

Dialysis Machines – Air-bubble sensors for detection in return tube, liquid level sensors for bottle volume, pressure/force sensors for in-line pressure and temperature sensors for fluid temperature.

Hospital Gas Monitoring – Silicon MEMS pressure sensors detect gas flow for hospital medical gas systems.

Infusion Pump – Silicon MEMS pressure sensors or Microfused load cells used to detect presence and/or rate of flow, occlusion, presence of needle. Magnetic encoder determines medication flow rate through piston position.

Premature Newborn Cabinet – Humidity and pressure sensors for control of air flow provide optimized, safe ambiance.

Sleep Apnea – Silicon MEMS low pressure sensor maintains positive airflow to breathing mask. Humidity sensor maintains humidity for comfort. CO₂ and temperature sensor can be used during exhalation cycle. SpO₂ for blood oxygen levels.

Air Bubble

Ultrasonic piezo film/ceramic

Force

Microfused silicon bonded strain gage

Humidity

Capacitive thin film

Liquid Level

(Single, Multi Point and Continuous Indication)

Float/magnet and reed switch

Ultrasonic probes

Piezo Film and Ceramic Technology

Vibration sensors

Force (Impact) and activity sensors

Speakers

Microphones

Ultrasound imaging

Ultrasonic position sensors

Position (Linear & Rotary)

Electromagnetic sensors

Linear string potentiometers

Magnetic (MR)

Optical encoders

Tilt-capacitive fluid

Pressure

Bonded foil strain gage

Microfused silicon bonded strain gage

Piezoresistive silicon MEMS board level

Piezoresistive silicon MEMS stainless steel oil-filled

Pulse Oximetry

Photo optic sensors

Temperature

IR thermopiles (non-contacting)

Micro-thermocouples

NTC thermistors

Vibration/Acceleration

Piezoelectric ceramic