The microelectromechanical systems (MEMS) sensors used in electric vehicles (EVs) include inertial sensors, such as:Accelerometers and gyroscopesMagnetometersPressure sensorsThermal sensorsGas sensorsOptical MEMSMEMS are used to improve safety for drivetrain monitoring and battery management. These sensors also support driver comfort, improving convenience and security, as well as other functions (Figure 1). This FAQ discusses the operation and applications for several types of MEMS sensors in EVs.Figure 1. MEMS sensors perform a variety of functions and are found in many locations in EVs.(Image: Atomica)Inertial sensorsInertial sensors like accelerometers and gyroscopes can be used individually or together. Accelerometers can measure static acceleration, gravity, or dynamic acceleration. These MEMS sensors generally work based on the piezoelectric effect or the movement of a weight attached to a spring. In piezoelectric-based MEMS accelerometers, the piezoelectric material is stressed by the acceleration and produces a corresponding voltage. In spring-based designs, the spring generates an electric signal when the weight moves.MEMS gyroscopes use vibrations to measure changes in angles. A common design uses a pair of vibrating tuning forks. While the tuning forks are moving in the same direction, there is no difference between their relative motions. If the tuning fork assembly is rotated, the force on the two forks is in opposite directions, and the resulting force differential is converted to a voltage corresponding to the rate or angular change.MEMS accelerometers and gyroscopes can be co-packaged into a single inertial measurement device (Figure 2). Inertial sensors are used in various advanced driver assistance (ADAS) systems. They can be used to measure lateral, longitudinal, vertical acceleration, yaw rate, and inclination. For example, a MEMS gyroscope can detect a rolling vehicle in a crash detection system.Figure 2. MEMS inertial sensor including the gyroscope and accelerometer elements.(Image: STMicroelectronics)MagnetometersA MEMS magnetometer is a magnetic field sensor that detects and measures magnetic fields like those produced by the Earth. The most common technology operates by measuring the effects of the Lorentz force, whereby a change in resonant frequency or voltage can be measured electronically, or optical techniques can be used to measure a mechanical displacement. Typical applications of MEMS magnetometers include miniaturized compasses for navigation or detecting nearby metal objects like another automobile or truck coming close to the front or rear of a car.Pressure sensorsMEMS pressure sensors use piezo resistors on a thin silicon diaphragm to convert varying pressures into electrical signals. There are three common types of MEMS pressure sensors:Absolute pressure sensors measure pressure relative to a vacuum. In an EV, this type of sensor can detect a pressure rise inside the battery pack, indicating a thermal runaway event of battery cell venting.Differential pressure sensors measure the pressure difference between two points. Theyre used in applications like measuring airflow in an HVAC system or monitoring the pressure drop across air filters.Gauge pressure sensors measure pressure relative to atmospheric pressure. Theyre not generally used in EVs.Thermal sensorsMEMS thermal sensors are available in two designs: contact and non-contact. A contact thermal sensor uses a resistance temperature detector (RTD) element like a thin film of platinum, nickel, or copper to measure changes in electric resistance in response to changes in temperature. Non-contact infrared (IR) MEMS thermal sensors are available based on the Seeback effect that generates a thermoelectric output produced by the junction of two dissimilar materials.Thermal sensors are used in a wide variety of EV systems, including the battery pack, battery cells, traction motor, traction inverter, dc/dc converter, on-board charger, and external charging systems including the connecting cables and handles, in the cabin and under the hood.Gas sensorsMEMS gas sensors measure changes in the interaction between gas molecules and the sensor surface. Gas sensors are available based on various technologies, including electrochemical, pellistor (a solid state device based on a Wheatstone bridge), and photoionization. In an EV, they can be used to monitor the atmosphere in the cabin, but their most common application is to detect the presence of hydrogen in battery packs. Some of these sensors are available as complete subsystems with analog and I2C outputs housed in an IP 69K enclosure with a wiring harness (Figure 3).Figure 3. This MEMS gas sensor assembly is designed for use in EV battery packs. (Image: Posifa Technologies)Optical MEMSOptical MEMS (MOEMS) are available that operate from infrared to visible wavelengths and use micromirrors or microlenses to direct and detect light. The active elements are often photodiodes or photoresistors. MOEMS are used for steering lasers in LIDAR or heads-up displays and for directing smart adaptive headlights.SummaryAs new autonomous driving features are added, the number of MEMS sensors used in EVs is expected to grow. Heres a wide array of MEMS sensor technologies that enhance EV operation, safety, comfort, and convenience.References Images Filed Under: Componentry, FAQs, SensorsTagged With: FAQ, mems, sensors As the focus of global mobility increasingly shifts to electric vehicles, we have developed new and innovative solutions to further ensure the highest levels of road safety and to improve performance. Ourunique sensors designed specifically for electric mobility protect essential components of the BEV (Battery Electric Vehicle) and increase the accuracy and efficiency of future electric mobility. Position and angle sensors are used in several electric vehicle (EV) components, including the traction motor and drivetrain, heating, ventilation, air-conditioning (HVAC) compressor, steer-by-wire, brake-by-wire, regenerative braking, accelerator position, active headlight aiming, active suspension systems, and more. This FAQ reviews some position and angle sensing technologies and how the use cases differ between internal combustion engine (ICE) vehicles and EVs. It closes with a brief overview of a few applications for position and angle sensors in EVs.Magnetic position sensorsTypical magnetic sensor technologies used for position and angle sensors include Hall effect, AMR (anisotropic magnetoresistive), GMR (giant magnetoresistive), and TMR (tunnel magnetoresistive) (Figure 1). In many applications, Hall effect sensors can provide a good combination of accuracy and low cost. The various magnetoresistive technologies have higher sensitivities, offering more reproducible measurements than Hall effect sensors. However, they can suffer from nonlinearity, hysteresis, and a temperature-dependent output that can reduce measurement accuracy.Figure 1. Basic structures and operation of AMR, GMR, and TMR sensors. (Image: TDK)InductiveMagnetic position and angle sensing technologies are well-established in ICE vehicles. The electrical environment in an EV is different and can make it more challenging to use sensors based on magnetic technologies (Figure 2). Those sensors induce a current in a metal plate. An oscillator generates a magnetic field picked up by the sensor. Two pickup coils are used and physically separated to generate different voltages that can be used to determine the position of the object being monitored. Inductive sensors use active demodulation to increase their immunity to external magnetic fields. And, since they dont use magnets, they can have better high-temperature performance.Figure 2. Examples of magnetic field sources in electric vehicles.(Image: Microchip)ResolversResolvers are electromagnetic sensors that operate like a transformer. There are several ways to implement a resolver. A variable reluctance (VR) resolver is commonly used in EV traction motors, consisting of a ferromagnetic rotor and a stator with multiple secondary coils. These resolvers work well in harsh environments and are used for generating rotational position signals. Other types of resolvers include magnetic resolvers that use Hall effect sensors and inductive resolvers that measure the position of a metallic target rotating in front of a set of inductive coils.EncodersEncoders involve disks with coded slots with a single track or quadrature resolution. The disk spins in front of an IR LED, and the light is interrupted by the rotation of the disk. A receiver on the opposite side of the disk from the IR source converts the resulting light pulses into an output signal. Encoders can measure the speed and direction of rotation. In addition to optical technology, other less common encoder implementations include magnetic and resistive. Encoders can be designed to provide relative or absolute measurements.Steering angle and torqueFrictionless inductive angle sensors are used in some steer-by-wire systems. Theyre compact assemblies that can be integrated into the steering mechanism. Some of these sensors measure torque and angle. The torque measures the force needed to turn the steering wheel, which varies based on driving speed, steering angle, and other factors.In addition, the sensor enables the steering wheel to provide feedback to the driver through dynamic steering force requirements.Braking and angular positionContactless magnetic sensor technology measures the brake pedal angles in electric brake assemblies in some EVs (Figure 3). These sensors record the required level of braking and send that information to an electronic control unit (ECU) that determines the necessary combination of hydraulic and regenerative braking. The sensors in these brake assemblies include redundant signal recording to enhance reliability.Figure 3. Contactless braking sensor module assembly. (Image: Bosch)Throttle and motor controlMechanical throttle potentiometers have mainly been replaced by contactless Hall effect or inductive angular position sensors that measure the distance and speed of movement of the gas pedal (throttle). In addition, the system usually includes a resolver on the motor shaft to provide feedback on motor speed to the traction inverter controller.Optical encoders and LIDAROptical encoders are used in mechanical LIDAR (Light Detection and Ranging) systems to provide the accurate position information needed by autonomous vehicles. Mechanical LIDAR provides a wide field of view (up to 360) and is typically used in prototype vehicle systems. LIDAR systems in the production of EVs and autonomous vehicles are generally based on solid-state LIDAR implementations that are more compact and consume less power.References ImagesFigure 1, TDKFigure 2, MicrochipFigure 3, BoschFiled Under: FAQs, SensorsTagged With: anglesensors, FAQ, lidar, magneticpositionsensors, resolvers, sensors Position and angle sensors are used in several electric vehicle (EV) components, including the traction motor and drivetrain, heating, ventilation, air-conditioning (HVAC) compressor, steer-by-wire, brake-by-wire, regenerative braking, accelerator position, active headlight aiming, active suspension systems, and more. This FAQ reviews some position and angle sensing technologies and how the use cases differ between internal combustion engine (ICE) vehicles and EVs. 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LIDAR systems in producing EVs and autonomous vehicles are generally based on solid-state LIDAR implementations that are more compact and consume less power.ReferencesAngular position sensor for electric brake pedals, BoschAngular position sensor: Functioning and areas of application, HellaAutomotive-qualified position & angle sensors, ams OsramMotor Position Sensors in EVs: Enhancing Performance and Efficiency, Lambda GeeksRethinking Position Sensing in the Age of the Electric Vehicle, MicrochipTMR Sensors, TDKxMR Sensor Signal Conditioner, Renesas Sensors are widely used in automotive power, chassis, body and other systems, and the new energy vehicles that have been on fire in recent years are no exception, and sensors play a very important role in the electronic regulation system of new energy vehicles. A car usually has dozens to hundreds of sensors. Let's take a look at the 8 kinds of sensors commonly used in new energy vehicles. 1. Pressure sensors Pressure sensors play an important role in the vehicle safety management system - enabling side airbag adjustment. Compared to accelerometers, pressure sensors are nearly three times faster than accelerometers at checking side impact speeds, with less probability of false response. In addition, pressure sensors are an important component in battery management systems and brake booster systems. The new energy vehicle brake booster system will use pressure sensors to check the vacuum level, and the battery management system will use pressure sensors to check the battery pack pressure for thermal runaway alarm. 2. Current Sensor Current sensors in new energy vehicles are mainly used in the battery system management, motor drive control, power supply module and other three electrical systems. The current sensor is able to perform accurate battery management on the vehicle battery, and hybrid vehicle power pack. For example: Open-loop current sensors that can use the principle of electromagnetic induction to protect against AC current signal overcurrent under isolated conditions, thus facilitating the implementation of switching outputs. Current sensors can also detect the current of charging and discharging to improve the efficiency of the vehicle battery. The current sensor can also collect the terminal voltage and temperature of each battery in the power battery pack of the electric vehicle, the charging and discharging current and the total voltage of the battery pack in real time to prevent the battery from over-charging or over-discharging. 3. Speed Sensor Speed sensor is one of the key sensors for motion measurement of new energy vehicles and is also a more widely used sensor. Speed sensor is mainly used to measure the speed sensor, including measuring the car motor rotation speed, driving speed, etc. 4. Acceleration sensor Acceleration sensors are widely used in the field of automotive electronics, mainly focusing on body control, safety systems and navigation, typical applications such as automotive airbags, ABS anti-lock braking system, electronic stability program (ESP), electronically controlled suspension system, etc. 5. Angular velocity sensor That is, the gyroscope, which together with the accelerometer constitutes the inertial navigation system, is the main factor that determines the accuracy of the inertial navigation system of new energy vehicles. 6. Environment Sensing Sensor Environment-aware sensors are the "eyes" of the car, and are the "major contributors" to the realization of the assisted driving function. They are mainly divided into on-board camera (image sensor), ultrasonic sensor, millimeter wave radar, and LIDAR. 7. Gas sensors By installing gas sensors in new energy vehicles, we can monitor PM, temperature and humidity, carbon dioxide, formaldehyde, VOC, ammonia, hydrogen, CO and other substances, which greatly increases the intelligence of the vehicle and also greatly enhances the experience of passenger safety and comfort. 8. Temperature sensor The temperature sensors in new energy vehicles mainly include: sensors for detecting battery temperature, temperature sensors for monitoring motors, and temperature sensors for battery cooling systems, etc. Multi-sensor fusion is an inevitable trend ADAS fusion of multiple sensors, driving the development of the sensor market. As the proportion of smart cars increases in the future, the ADAS market will accelerate its growth. According to Goldman Sachs Global Investment Research, the current global ADAS penetration rate is generally low, with only 8%-12% penetration in Europe, America and Japan. According to Gaixia Automotive Research Institute, the penetration rate of ADAS in China is around 2%-5%; judging from the life cycle, ADAS has achieved the leap from the introduction period to the growth period. In general, with the wave of smart driving and driverless, the level of car electronics and intelligence is increasing, and ADAS has great room for growth. As the hardware base of ADAS, the application of sensors is indispensable. The increase of ADAS penetration will lead to a significant increase in the demand of in-vehicle sensors, and the market scale of sensors will be further expanded in the future. Environmental perception sensor is the eyes of the car, millimeter wave radar comprehensive advantage is outstanding. In the background of the era of intelligence, environmental perception is particularly important, and different sensors have different principles and functions, which play their own advantages in different scenarios and are difficult to replace each other. Millimeter wave radar has outstanding comprehensive advantages and is expected to be the first to become the main sensor of ADAS system. Previous: 3 Ways MCU Can Solve 800V Electric Vehicle Traction Inverter Next: On-board chargers are a win-win solution Photo: GE6 September 2012New battery chemistries might help to get more electric vehicles on the road. But we still havent squeezed the optimum performance out of the designs we have, like the good old lithium-ion battery.With funding from the Advanced Research Projects AgencyEnergy (ARPA-E), two coalitions of companies are now making tiny, lightweight sensors that could make lithium-ion batteries smaller, cheaper, and safer. The devices, which are made of optical fibers or thin-film materials, could be integrated inside a battery, where they could spot tiny temperature jumps that could lead to overheating (and, potentially, fire) or help to precisely estimate how much juice is left in the battery.Battery packs in todays plug-in and hybrid-electric vehicles contain hundreds of individual battery cells wired together and coupled with control electronics. Sensors measure voltage, current, and temperature from outside the pack, relaying that data to the battery management system. But that doesnt reveal everything thats going on inside the packfor example, the exact amount of charge left in a single battery cell or if the middle of the battery pack is hotter than usual.Designers have to overprovision to compensate for that uncertainty, so batteries might be sized twice as big as the energy needed for a vehicle, says Rob McHenry, a program manager at the Palo Alto Research Center (PARC), in California, which ARPA-E has awarded more than US$4million. There is a long delay between when a fault occurs and [when it] has progressed enough that you see evidence externally. If each cell inside a battery pack could be carefully monitored, it would help size a battery to better match its application, cutting weight and cost, while making it more reliable, he says.Measuring variables inside a battery is difficult because of the harsh environment of corrosive electrolytes and high temperatures. You want something thats small, low cost, and immune to electrostatic discharge, says Ajay Raghavan, the scientist leading PARCs sensor project. So PARC researchers have turned to optical-fiber sensors that could be embedded inside each battery cell.Fiber sensors are limited by the bulky, costly detectors used to read the tiny shifts in light wavelength resulting from changes in the battery cells temperature, length, or chemical environment, which alter the fibers refractive index. The PARC team has developed a wavelength-shift detector about the size of a quarter. A single detector could handle optical fibers from many battery cells, and it should cost only a few hundred dollars, as opposed to $10000-plus for conventional detectors, which require lasers and charge-coupled device arrays. The new detector consists of an optical filter that converts wavelength shift to a change in the position of the light beam falling on a tiny photodetector array. The fiber-optic sensors can read wavelength shifts as small as 50 femtometers. This means they could pick up subtle flicks in temperature, chemical state, and other parameters in a cell.One of the projects goals is to figure out the best set of internal variables to monitor in a battery, says Raghavan. The researchers are also developing intelligent algorithms that would read the raw data from the sensors and translate it into relevant numbers for a cars battery-management system. Say cell5 is heating up, Raghavan explains. The fiber-optic sensor would relay that information to the management system, which would reduce current in the cell or shut it off, and would alert the operator so that the cell could be changed. Battery maker LG Chem Power, a partner on the project, will test the fiber-optic sensors in real batteries.GE Global Research is also developing battery-monitoring sensors with a $3million award from ARPA-E. GE already sells temperature sensors for car batteries, but the new thin-film sensors are one-twentieth the thickness, says scientist Aaron Knobloch, who is leading the new work. Whereas todays temperature sensors sit at the edge of a battery pack, the new ones are thin enough to slip in between individual battery cells inside the pack, where they would read temperature and surface pressure and understand how the behavior relates to state of charge and health.Scientists at the University of Michigan will develop advanced software models that will crunch the GE sensor data to predict battery life and health. They will also use those models to determine the ideal number of sensors needed for a battery and the best locations for those sensors. We dont want sensors all over the battery pack, because that would drive cost, Knobloch says. Finally, researchers at Ford will test the sensors on their cars in realistic conditions.Both the PARC and GE projects have plenty of unknowns, making them good fits for ARPA-E, which funds high-risk research with potentially large payoffs. No one has looked at pressure as a [battery health] parameter, says Knobloch. At this point we dont know what we dont know, but were hoping to make an impact on battery performance.About the AuthorPrachi Patel is a contributing editor to IEEE Spectrum. She reported on how new technology will improve forecasting and monitoring droughts in the September 2012 issue. You can also hear her on Spectrum Radio and Public Radio Internationals Living on Earth. Hello guys, welcome back to our blog. In this article, we will discuss the types of automotive sensors and actuators used in electric vehicles, and sensors used in the latest electric cars, and we will give a short description of each sensor and actuator.If you have any electrical, electronics, and computer science doubts, thenask questions. You can also catch me on Instagram CS Electrical & Electronics.Also, read:Types Of Automotive Sensors and ActuatorsThere are various kinds of sensors used in automotive or electric vehicles to read the real-time signals and take necessary actions to manage in-vehicle functions such as ignition time, ABS, speed control, etc. The types of automotive sensors and actuators are:01. Engine speed sensor02. Wheel speed sensor03. Vehicle speed sensor04. Throttle position sensor05. Temperature sensor06. Mass airflow (MAF) rate sensor07. Exhaust gas oxygen concentration sensor08. Crankshaft angular position/RPM sensor09. Manifold Absolute Pressure (MAP) sensor10. Accelerometer (knock sensors)These are the commonly used sensors. There may be other sensors based on the automotive application. All these sensors are associated with the power trains.General Block Diagram Types Of Automotive Sensors and Actuators01. Engine Speed SensorAn engine speed sensor is needed to provide input for the electronic controller for several functions. The reluctance sensor can be used to measure engine speed. The four tabs will pass through the sensing coil once for each crankshaft revolution. We count the pulses of voltage from the sensing coil in one minute and divide by four, we will know the engine speed in revolutions per minute (RPM). An electronic circuit is used to start and stop the counter circuit. The counter can be used to count the number of pulses through a special signal processing circuit.02. Wheel speed sensorUsed in ABS, Odometer. Contactless Magnetic or optical method. Magnetic method Hall effect. The sensor provides square wave output whose frequency is proportional to the wheel speed.Wheel-speed sensor using Hall technology incorporates the Hall-sensing element, signal amplifier, and signal processing all on a single chip. It consists of a transistor whose base is excited by the magnetic effect. The circuit is exposed to the changing magnetic field of the rotating encoder, which is either a multipole or a steel wheel. In the case of a steel wheel application, a magnet placed inside the sensor is needed. Changing the magnetic field around the Hall element induces an alternating voltage across the same.The alternating voltage is proportional to the changing magnetic field. The sinusoidal voltage is processed by the circuit into an alternating digital output signal. The frequency of the current pulses is directly proportional to the wheel speed. Detection of very low speed nearly up to stand-still (0.1km/h) is possible.03. Vehicle Speed SensorThe ECM (Engine control module) uses this information to modify engine functions such as ignition timing, air/fuel ratio, transmission shift points, and to initiate diagnostic routines. Used in ABS (wheel speed sensor), speedometer, and cruise control system. The Vehicle Speed sensor or VSS measures transmission/transaxle output. The Vehicle Speed sensor is typically located at the transmission or transaxle. The speed sensor can be implemented magnetically or optically.04. Throttle Position SensorA variable that must be measured for electronic engine control is the throttle plate angular position. The throttle plate is linked mechanically to the accelerator pedal. The throttle plate restricts the airflow into the intake manifold When the driver depresses the accelerator pedal, this linkage causes the throttle plate angle to increase, allowing more air to enter the engine and thereby increasing engine power. Most throttle angle sensors are essentially potentiometers.This potentiometer can be used to measure any angular rotation, in particular the throttle angle. The only disadvantage to the potentiometer for automotive applications is its analog output. For digital engine control, the voltage v(a) must be converted to digital format using an analog-to-digital converter.05. Temperature SensorTemperature is an important parameter throughout the automotive system. In an electronic fuel control system, it is vital to know the temperature of the coolant, the temperature of the inlet air, and the temperature of the exhaust gas oxygen sensor.Consists of a thermistor mounted in a housing that is designed to be inserted into the coolant stream. This housing is typically threaded with pipe threads that seal the assembly against coolant leakage. A thermistor is made of semiconductor material whose resistance varies inversely with temperature. For example, at 40C a typical coolant sensor has a resistance of 100,000 ohms. The resistance decreases to about 70,000 ohms at 130C.06. Air Flow Rate SensorThe correct operation of an electronically controlled engine requires a measurement of the mass flow rate of air (Rm) into the engine. This requires a sensor that can sense the airflow rate into the intake manifold of the engine. The sensor is normally mounted as part of the air cleaner assembly.Rhw is a heated filament resistor. The resistance of the filament changes as the temperature of the filament changes. This is used in Wheatstones network. The output of this n/w is given to a differential amplifier. The resulting analog output is fed to the V/F converter.The film element is electrically heated to a constant temperature above that of the inlet air. As air flows across the hot film, heat is carried away from the film by the moving air. The amount of heat carried away varies in proportion to the mass flow rate of the air. The heat lost by the film to the air tends to cause the resistance of the film to vary, which unbalances the bridge circuit, thereby producing an input voltage to the amplifier. This voltage is given to a V/F converter a variable-frequency oscillator whose frequency is proportional to the input voltage.07. Exhaust Gas Oxygen Concentration SensorFeedback control for fuel delivery is based on maintaining the air/fuel ratio at stoichiometry (i.e., 14.7:1 torque reaches a maximum for this ratio). In order to burn completely 1 kg of fuel, we need 14.7 kg of air. The amount of oxygen in the exhaust gas is used as an indirect measurement of the air/fuel ratio. Also known as lambda sensor.Equivalence ratio = (air/fuel)/(air/fuel at stoichiometry)The mixture at stoichiometry (ideal) when lambda=1The mixture is lean (lean fuel, more air) if lambda > 1The mixture is rich (more fuel, lean air) if lambda < 1 Two types of sensors: zirconium dioxide (ZrO2) titanium dioxide (TiO2). zirconium dioxide is the most commonly used.The EGO sensor consists of a thimble-shaped section of ZrO2 with thin platinum electrodes on the inside and outside of the ZrO2. The inside electrode is exposed to air, and the outside electrode is exposed to exhaust gas through a porous protective overcoat. Oxygen ions have two excess electrons and each electron has a negative charge; thus, oxygen ions are negatively charged. The ZrO2 has a tendency to attract oxygen ions, which accumulate on the ZrO2 surface just inside the platinum electrodes. The platinum plate on the air reference side (inside) of the ZrO2 is exposed to a much higher concentration of oxygen ions than the exhaust gas side.The air reference side becomes electrically more negative than the exhaust gas side. Therefore, an electric field exists across the ZrO2 material, and a voltage, Vo, results. The polarity of this voltage is positive on the exhaust gas side and negative on the air reference side of the ZrO2. The magnitude of this voltage depends on the concentration of oxygen in the exhaust gas and on the sensor temperature.The quantity of oxygen in the exhaust gas is represented by the oxygen partial pressure. (proportion of the total exhaust gas pressure/atmospheric pressure that is due to the quantity of oxygen.) EGO partial pressure for rich mixture is 1016 to 1032 of atmospheric pressure. for lean mixture is ~102 of atmospheric pressureConsequently, for a rich mixture, there is a relatively low oxygen concentration in the exhaust and a higher EGO sensor output. For a lean mixture, the exhaust gas oxygen concentration is relatively high resulting in a relatively low EGO sensor output. For a fully warmed EGO sensor, the output voltage is about 1 volt for a rich mixture and about .1 volt for a lean mixture.08. Crankshaft Angular Position/RPM SensorCrankshaft position measured directly using magnetic phenomena. This sensor consists of a permanent magnet with a coil of wire wound around it. A steel disk that is mounted on the crankshaft (usually in front of the engine) has tabs that pass between the pole pieces of this magnet. This sensor is of the magnetic reluctance type and is based on the concept of a magnetic circuit. Reluctance opposition to magnetic flux.A magnetic circuit is a closed path through a magnetic material. The magnetic circuit here is the closed path through the magnet material and across the gap between the pole pieces. When a tab on the steel disk passes through the gap, the flow of the magnetic flux changes significantly. The reluctance of a magnetic circuit is inversely proportional to the magnetic permeability of the material along the path.The magnetic permeability of steel is a few thousand times larger than air; therefore, the reluctance of steel is much lower than air. The steel has a lower reluctance than air, and the flow of magnetic flux increases to a relatively large value. This rate of change of flux induces a voltage across the coil. A peak in voltage indicates a tab crossing the pole piece as shown.09. Manifold Absolute Pressure (MAP) SensorThe MAP sensor measures the absolute pressure inside the intake manifold of the engine. MAP Sensor- Silicon diaphragm diffused strain gauge.Piezoresistivity occurs in certain semiconductors so that the actual resistivity (a property of the material) changes in proportion to the strain (fractional change in length). The strain induced in each resistor is proportional to the diaphragm deflection, which, in turn, is proportional to the pressure on the outside surface of the diaphragm. This pressure is the manifold pressure. Wheatstone bridge is used for measurement of strain.10. Accelerometer (knock sensors)Another sensor having application in closed-loop engine control is the so-called knock sensor. This sensor is employed in closed-loop ignition timing to prevent undesirable knock. Knock can be described generally as a rapid rise in cylinder pressure during combustion. It occurs most commonly with high manifold pressure and excessive spark advance. Knocking has to be detected and prevented so as tominimize engine and valve damage.One way of controlling knocking is to sense when knocking begins and then retard the ignition until the knocking stops. A knock sensor using magnetostriction to sense or detect knock. Other sensors use piezoelectric crystals or the piezoresistance of a doped silicon semiconductor. Magnetostriction is a phenomenon whereby the magnetic properties (magnetic susceptibility or permeability) of a ferromagnetic material change depending on stress.The forces associated with knock cylinder pressure are transmitted through the mounting frame to the magnetostrictive rods. When sensing knock, the magnetostrictive rods, which are in a magnetic field, change the flux field in the coil due to knock-induced forces. This change in flux produces a voltage change in the coil. This voltage is used to sense excessive knock. Possible measures to overcome knocking are retarding the timing, adding fuel, reducing boost pressure, etc. The frequency of knock is specific and depends on the bore (piston) diameter of the engine. DSPs improve the SNR (signal-to-noise ratio) to detect knock.This was about Types Of Automotive Sensors and Actuators. I hope this article Types Of Automotive Sensors and Actuators may help you all a lot. Thank you for reading.Also, read:100 + Electrical Engineering Projects For Students, Engineers1000+ Automotive Interview Questions With Answers1000+ Electronics Projects For Engineers, Diploma, MTech Students1000+ MATLAB Simulink Projects For MTech, Engineering Students50 Advanced Level Interview Questions On CAPL Scripting500+ Embedded System Projects For Engineer, Diploma, MTech, PhD500+ Projects For Diploma Electrical, Electronics Student, Diploma Project8051 Microcontroller Timers, TCON Register, TMOD Register About The Author 1/ Position2/ Current3/ Voltage4/ TemperatureExploring the world of Electric Vehicles (EVs) involves understanding the sophisticated array of sensors that power these innovative machines. EV sensors play a pivotal role in monitoring, controlling, and optimizing various aspects of electric vehicles performance and safety. From measuring battery health to regulating motor torque, each sensor brings unique functionalities to the table. There are several parameters about measurement principles to consider in the sensor system of electric vehicles, such as position, current, voltage, and temperature. In this comprehensive post, we will explore various types of EV sensors corresponding to the mentioned parameters and their standout features, shedding light on the technology driving the future of automotive engineering.1/ PositionSensor typesLocationFeaturesMotor control positionEstimates the traction motor position using a resolver to control brushless DC operation.Gathering the mechanical motion data from the traction motors to guarantee that the system runs in harmony. After the angular position data is recorded, a motor controller or motor control unit (MCU) converts it into electric impulses to start the feedback loop.Motor control angleEstimates the traction motor angle using a resolver to control brushless DC operation.Motor control speedEstimates the traction motor speed using a resolver to control brushless DC operation.Click on this article to explore a comprehensive and detailed source of information about silicone material solutions for components in electric vehicles researched and provided by Prostech.2/ CurrentSensor typesLocationFeaturesOnboard charger current sensorLocated on the primary as well as the secondary side for control-loop operations and protection from overcurrent faults. Current sensing in power factor correction schemes improves the ON/OFF sequences.Showing us how much energy, we used and avoiding the overcurrent. In BMS, it provides charging and discharging cycle information by reporting the status of battery SOH.DC/DC current sensorLocated mainly on the primary side as well as the secondary side for protection purposes on the primary side and for control-loop operations on the secondary side.Battery-management current sensorStand-alone and onboard current sensors are required in battery management systems for state-of-charge and state-of-health calculations.Traction motor current sensorLocated on the hot side for protection purposes and on the low side or in phase of the field-effect transistors for motor drive operations.Motor current sensorFor various kinds of motors in the vehicle, current sensors on the low side are used for motor diagnostics and control loop operations.Transmission current sensorProportional solenoids use current sensing to accurately monitor current and send the information to the microcontroller, where the PWM duty cycle percentage is adjusted to make the solenoid drive more efficient.Through successful experimentation and collaborative efforts within electric vehicle projects, Prostech has acquired specialized material solutions aimed at improving different facets of electric vehicles. This invaluable information is easily accessible to you with just a click within this article.3/ VoltageSensor typesLocationFeaturesOnboard charger voltage sensorThe voltage sense monitors the voltage magnitude of the DC/DC input/ output. A resistive divider is normally used to divide the high voltage. Galvanic isolation is normally needed to prevent electric hazards from the high voltage.Measure the voltage in various ways, from measuring high voltages to detecting low current levels, which ensures no insulation damage in the battery pack and each cell.DC/DC voltage sensorThe voltage sensor on the primary side monitors the voltage magnitude of the high-voltage battery. A resistive divider is normally used to divide the high voltage.Battery-management voltage sensorBattery monitoring ICs measure cell voltages along with current and temperature and perform cell balancing to monitor and protect the cells.4/ TemperatureThe temperature sensor plays an incredibly important role in electric vehicles, helping individuals have better and safer experiences throughout their journeys. Our Prostech team has researched and tested to develop a comprehensive solution for temperature sensors in electric vehicles. If interested, please click on this post to receive more information.Sensor typesLocationFeaturesOnboard charger temperature sensorTemperature monitoring circuitry maintains the health of the power transistors during their active operation by checking the case or internal temperature depending on where the sensor is positioned. It immediately shuts down the system once the temperature is above the threshold.In a battery system, it is installed directly into the battery cells, giving accurate temperature measurements and regulating the heating and cooling processes to keep each cell operating within a safe range. In the case of overheating, continuous monitoring can initiate safety steps, such as disconnecting the battery or lowering charging rates, and enable the assessment of battery health.In an e-motor, it is used to measure the temperature of the motor windings (sensors with shrink tube insulation), the temperature in the bearings, and other parts of the motor. They also ensure the motors dependability and ensure that there are no defects relating to torque production, control, or efficiency.DC/DC temperature sensorTemperature monitoring circuitry maintains the health of the power transistors during their active operation by checking the case or internal temperature depending on where the sensor is positioned. It immediately shuts down the system once the temperature is above the threshold.Battery-management temperature sensorBattery monitoring ICs measure temperature and perform cell balancing to monitor and protect the cells.Traction motor temperature sensorIGBTs temperature is monitored to protect the system from overtemperature faults.In addition to providing extensive and top-notch material solutions, Prostech also offers design and component solutions to tackle the existing issues encountered by electric vehicles. If you are genuinely interested, feel free to get in touch with to us explore solutions tailored to your electric vehicle needs.CONCLUSIONIn conclusion, the diverse array of Electric Vehicle (EV) sensors showcased a remarkable spectrum of capabilities, each designed to enhance performance, safety, and efficiency in the realm of electric mobility. From precision monitoring of battery health to real-time environmental data collection, these sensors serve as the backbone of EV technology, propelling the industry toward a sustainable future. Understanding the nuanced features of each sensor type empowers manufacturers, engineers, and consumers alike to harness the full potential of electric vehicles, driving innovation and advancement in automotive engineering. Reach out to Prostech for more detailed information regarding electric vehicle-related issues.

Electric vehicle sensors. What type of sensors does tesla use. Sensors used in cars. What sensors do tesla use. What sensors are used in tesla cars. Sensors which one to use.