Technical Article

Integrated Smart Sensor Health Monitoring for ADAS and Autonomous Driving

Monitoring the status of a growing network of automotive camera, radar and other high-speed sensor modules is becoming increasingly complex. Although smart sensors with a local processor can supervise their own health status, raw data sensors often lack a local microcontroller to perform this task, leaving the central electronic control unit (ECU) processor to monitor every sensor individually.

Raw data sensors need not be “dumb,” however. Integrating smart health-monitoring features into the serializer and deserializer (SerDes) link chipset relieves the central processor from constantly polling sensors for their operational status. In this post, I’ll take a look at one such implementation.

Multisensor Advanced Driver Assistance Systems (ADAS)

See **advanced driver assistance systems (ADAS)**.

Next-generation vehicles may have a dozen or more remote raw data sensors (Figure 1). Supervising the health status of every sensor increases software overhead in the central ECU processor. The ECU must monitor factors such as sensor status, module voltage, module temperature, link operation (in both directions) and other indicators across multiple sensors, serializers, deserializers and other chips to generate a complete picture of sensor health. You could add a small microcontroller to each remote-sensor module for health monitoring and housekeeping, but this increases module size and cost – and the central ECU must still examine each sensor and link individually.

Integrating health-monitoring functions into the SerDes chipset enables collective monitoring of multiple sensor modules as well as their links, so that the central ECU receives only a single, consolidated interrupt warning.

Link Status and Protection

The first layer in autonomous sensor monitoring is the link integrity itself. The link must provide a robust control channel as well as link data-protection and diagnostic features. The link monitors cable faults (open, short to ground, short to Vbatt) as well as bit errors, and reports alerts back to the ECU. Both the forward channel and back channel are supervised by the SerDes chipset for faults. In addition, the DS90UB953-Q1 serializer performs a parity check on data input of the serializer, allowing the system to determine if potential errors originate from the sensor or from the link. Finally, the deserializer’s adaptive equalizer provides a cable health-quality measurement, enabling the system to warn of cable deterioration.

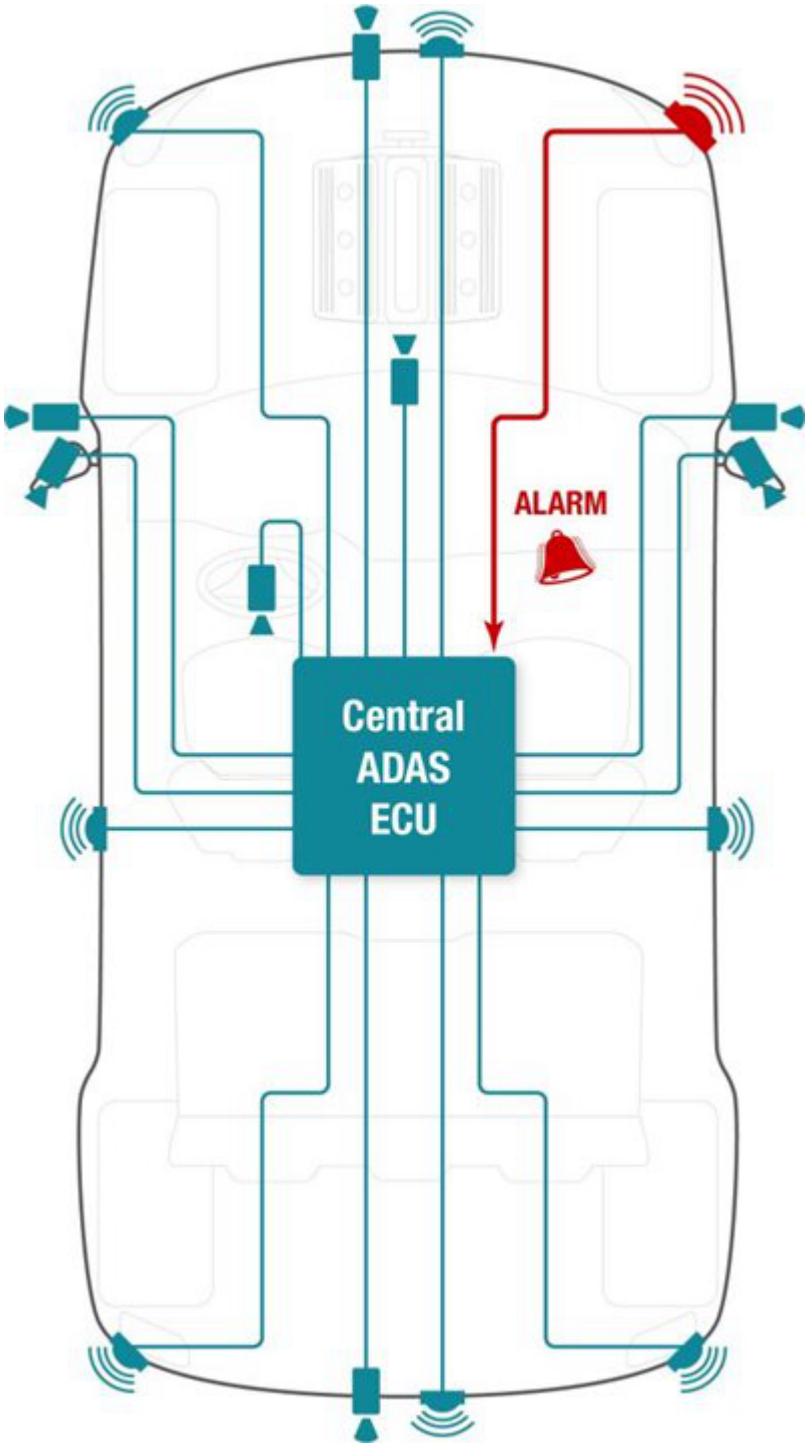

Figure 1. Example Deployment of Automobile Camera and Radar Sensors

Sensor Module Health Diagnostics

As sensors proliferate and system functional safety becomes more important, it is useful for individual sensor modules to provide some level of health monitoring. The DS90UB953-Q1 serializer, for example, incorporates a number of features to support this goal (Figure 2). Internally, the serializer supervises its own status, such as lock, valid clock and temperature. The serializer can also monitor external health factors such as power-supply voltages and incoming sensor data errors. A configurable alarm bit sent back continually to the deserializer warns the ECU if any monitored value is out of range. The serializer also reports if there are errors in the control channel communication to the sensor module. If an I^2C write error arises, the serializer does not propagate erroneous I^2C commands, thus helping to prevent sensor module misconfiguration. The deserializer delivers a warning to the central ECU so that the system can take further action such as control data retransmission.

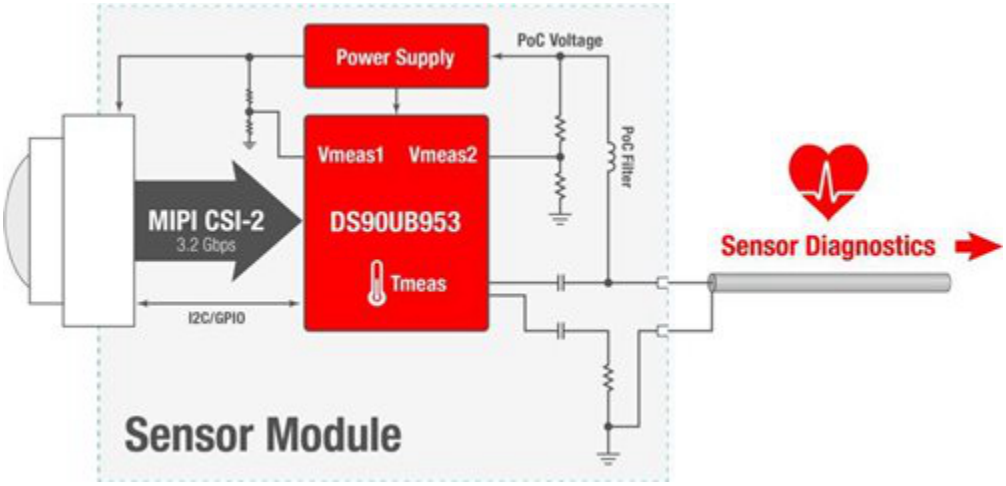

Figure 2. Example of Integrated Sensor Module Health Diagnostics

Aggregated Health Status

A multi-input deserializer hub such as the DS90UB960-Q1 aggregates the status of as many as four sensors to a single programmable open-drain interrupt pin (Figure 3). An alarm sent by any one of the multiple sensor serializers or links can trigger the interrupt. The local processor then reads the status registers to ascertain the nature and location of the warning. You can configure the deserializer interrupt pin to activate based on a number of programmable variables. Since the pin uses an open-drain structure, you can connect multiple interrupts together (wire OR'd) to combine interrupts from multiple chips, saving processor I/O pins.

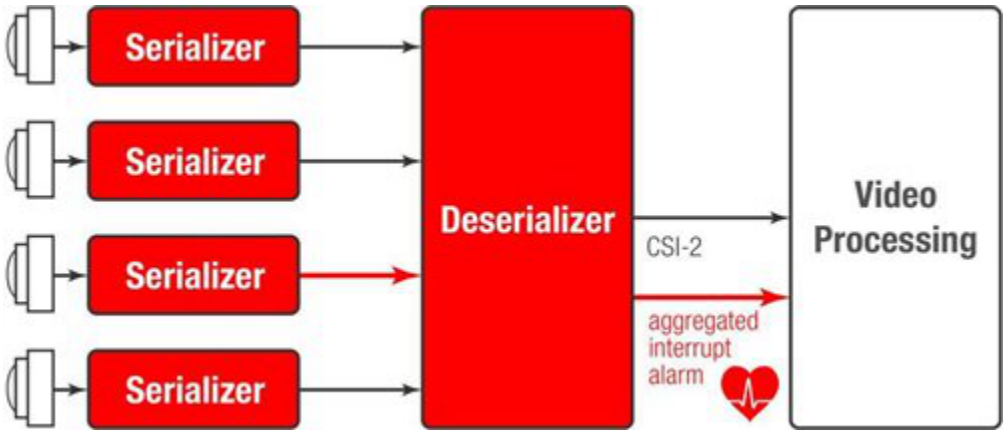

Figure 3. A Deserializer Hub Aggregates Alarms from Multiple Sensor Links

Smart Sensor Health

An increasing number of high-speed sensors are being used in automobiles, leading the way to autonomous driving. Today's raw data sensors can incorporate health-monitoring features to remotely and autonomously monitor for faults, saving processor resources and providing an extra layer of system protection. These "health-smart" modules make it easier to deploy the larger numbers of high-speed sensors that future vehicles will require. To learn more, check out TI's entire FPD-Link III SerDes portfolio for ADAS applications.

Additional Resources

- Also consider the DS90UB954-Q1 dual FPD-Link III deserializer hub.
- Pair one of our deserializer hubs with the TDA3x system-on-chip (SoC) processor for ADAS.
- Learn more about TI's ADAS solutions.

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