Interfacing Industrial Analog Sensors to the Internet of Things

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Situation

- Networked digital sensors provide many benefits in the industrial environment (see list of references)
- The Industrial Internet of Things (IIoT) is the future for which sensors play a major role
- Sensors with built-in networked interfaces are ideal but many high performance sensors are available only with analog outputs
- Much industrial equipment is equipped with **legacy sensors** which work well and are expected to last for many years
- Adding an Internet compatible interface to convert analog sensors is often the easiest and cost effective near/mid-term solution for IIoT compatibility

Popular Analog Sensor Signal Outputs

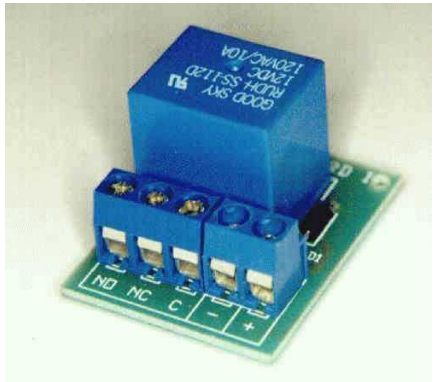
- Voltage
  - Output from signal conditioner is proportional to voltage, most often 0 to 5v
  - Popular with temperature and pressure sensors

- Current Loop
  - Sensor transmitter output is current from 4 to 20 mA (4mA is zero signal, 20mA is full scale)
  - Popular with temperature and pressure sensors

- Frequency/pulse
  - Signal is proportional to the frequency of pulse or square wave output
  - Popular with flow sensors
- Switches
  - Proximity sensors (inductive, capacitive, ultrasonic and photo) current output requiring load
  - Dry contact (microswitch or magnetic reed)

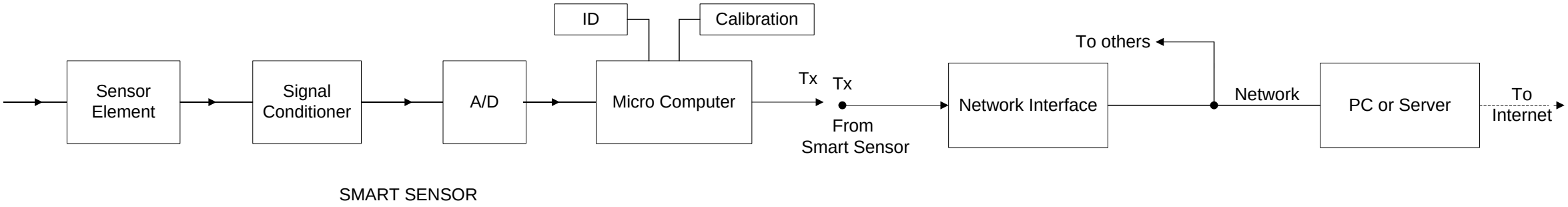
Actuators

- Digital interfaces are two-way and can control actuators as well as sensors
  - Smart transducers are both sensors and actuators
- Relays
  - Used to turn on/off motors or solenoids remotely
  - Typically switch 24 v ac/dc or 120 v AC at low current
- Visual Indicators
- Audio indicators
  - DC voltage output (via D/A)
  - For motor speed control and other



Sensor Block Diagram for Internet access

- Virtually all sensors are analog and require an analog signal conditioner which has a voltage or current output proportional to the sensor variable
- A smart sensor converts analog to digital and then a microcontroller to convert to easily read engineering units (and often calibration)
- The communication network transfers the sensor data to the Internet
- Sensor data is acquired, processed, stored and displayed on websites



Internet Communication Pathways -- Wired

Advantages -- Secure and reliable, can carry power but installation cost of wiring is higher

- Ethernet
  - Internet – outside world
  - Intranet – internal, private
- RS232
  - Easy to use with embedded microcontrollers (UART)
  - Longer range than USB
- RS485
  - Works with longer runs
  - Noise immune

Internet Communication Pathways -- Wireless

Advantages -- Easy, low-cost installation but more interference prone and has limited bandwidth, range and operating life with batteries

- WiFi
  - Gateways/hubs generally available -- moderate range
  - High bandwidth but power hungry
- Bluetooth
  - Low power, shorter range, best with mobile devices
- Mesh networks
  - Many choices – Zigbee, 5LoWAN, WirelessHart, ISA100 & proprietary
  - Good range, low-cost, limited bandwidth
  - Requires gateway for internet access

Data Formats on the Internet

- Basic Protocol: TCP/IP and UDP
- Data exchange
  - HTTP
  - XML
  - JSON
  - SNMP
  - XMPP

Transducer Data Formats

- Internet formats/protocols (e.g HTTP) and communication protocols (e.g. WiFi) do not specify meaning of data
- The type of sensor (e.g. temperature), units (e.g. PSI) and data format (e.g. floating point) must be known
- Sending or receiving transducer (sensor or actuator) data should not require operator intervention (e.g.be plug and play)
- Data should be compatible with the Internet of Things

Standards

- The Internet of Things overall is not fully standardized
  - A wide variety of limited domain and proprietary standards are in use or proposed
  - Special interests, silo thinking and unawareness of what is available prevents harmonization of standards for sensors
- Transducers require several levels of standards
  - Sensor data format (IEEE 21451 is special interest of author)
  - Communication protocol (e.g. WiFi IEEE 802.11b)
  - Internet data protocol (TCP/IP)
  - Data exchange formats (XMPP)
- End-to-end standards needed for full implementation of the Internet of Things
  - Full machine to machine (MtoM) communication without any human intervention depends on this

List of References

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  - http://internetofthingsagenda.techtarget.com/opinion/Manufacturing-embraces-the-Industrial-Internet-of-Things
- **The Role of Sensors in the Industrial IoT**
  - http://www.sensuron.com/industry-news/sensors-in-the-industrial-iot/
- **Sensors drive IIoT innovations**
  - http://analogictips.com/sensors-drive-iiot-innovations/
- **The IIoT Edge: Why is Industrial Sensing Difficult and Expensive?**
  - https://industrial-iot.com/2016/05/iiot-edge-industrial-sensing-difficult-expensive/

End

For specifications and ordering
of the Esensors IIoT interface:
http://eesensors.com/el32Land

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