CEC Continuing Education Center

DesignNews

Techniques for Interfacing with Modern Sensors

DAY 1 : Introduction to Modern Sensor Interfacing

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THE SPEAKER

Jacob Beningo

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Beningo Embedded Group - President

Focus: Embedded Software Consulting

An independent consultant who specializes in the design of real-time, microcontroller based embedded software.
He has published two books:
- Reusable Firmware Development
- MicroPython Projects

Writes a weekly blog for DesignNews.com focused on embedded system design techniques and challenges.
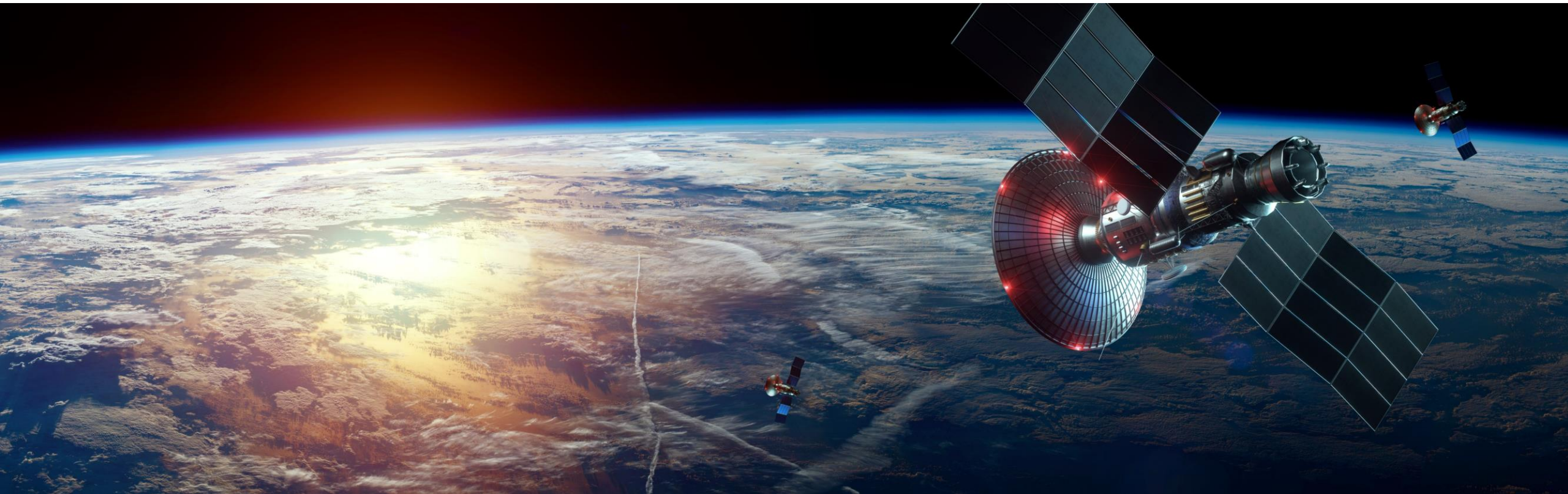
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Course Sessions

- Introduction to Modern Sensor Interfacing
- Designing Sensor Interfaces
- Sensor Driver Techniques Part 1
- Sensor Driver Techniques Part 2
- Leveraging C++ in Sensor Interfacing

Introduction

Sensor – A device that responds to a physical stimulus (such as heat, light, sound, pressure, magnetism, or motion) and transmits a resulting impulse (as for measurement or operating a control).

- Merriam Webster Dictionary

Example Sensors

- Voltage
- Current
- Temperature
- Humidity
- Acceleration
- Tension
- Optical
- Location
- Buttons
- Altitude

- Speed
- Rotation rate
- Light intensity
- Position
- Inertial
- State
- Pressure
- Intensity
- Vibration
- Shock

- Tilt
- Communication
  - CAN
  - Wi-Fi
 - BLE
  - Etc
- Watchdog
- etc

Do you consider communication interfaces to be a sensor?
- Yes
- No
- Undecided

Sensor Interfaces

- Digital Sensors
  - Is an electronic or electromechanical sensor, where data is digitally converted and transmitted (en.wikipedia.org/wiki/Digital_sensor)

- Analog Sensors
  - Produce a continuous output signal which a proportional to the quantity being measured.

Analog Sensors
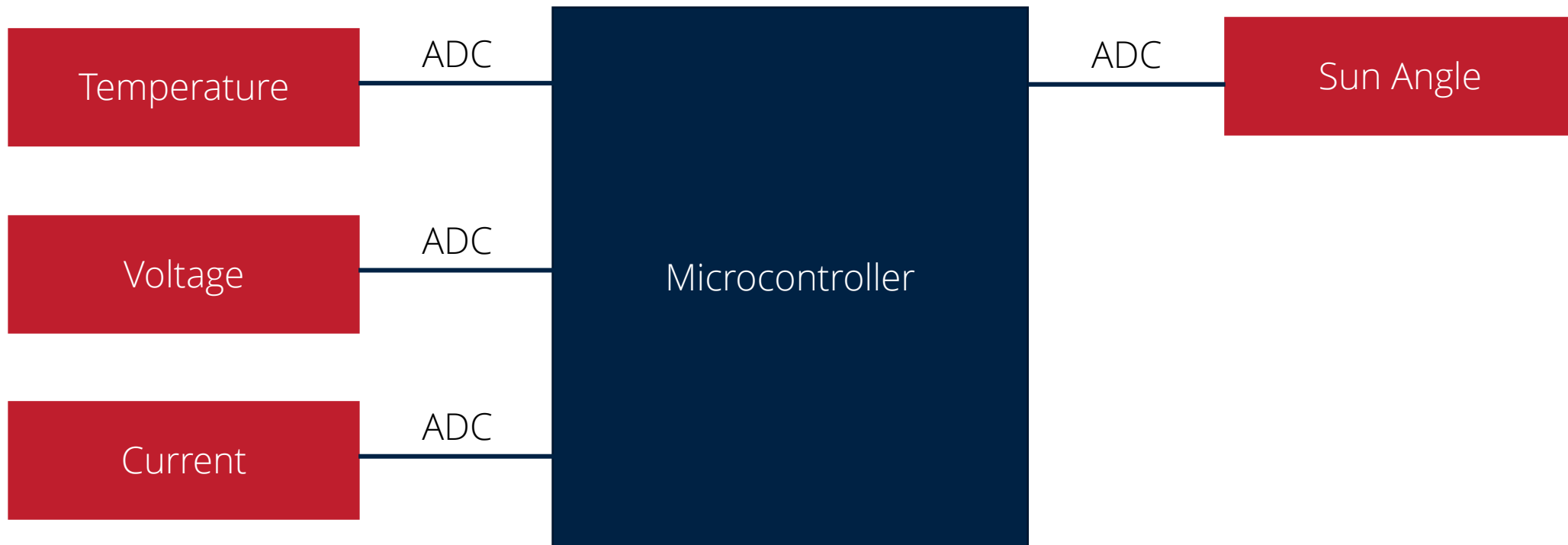
Analog Sensors

Design Considerations with Analog Sensors:
- Scale the input voltage to the analog to digital converter
- Sample rate (Nyquist)
- Instantaneous or average?
- Filtering (Hardware versus Analog)
- Conversion Factors
  - Onboard or offboard?

Analog Sensors - Conversions

Example Temperature Sensor:

Convert to Voltage:
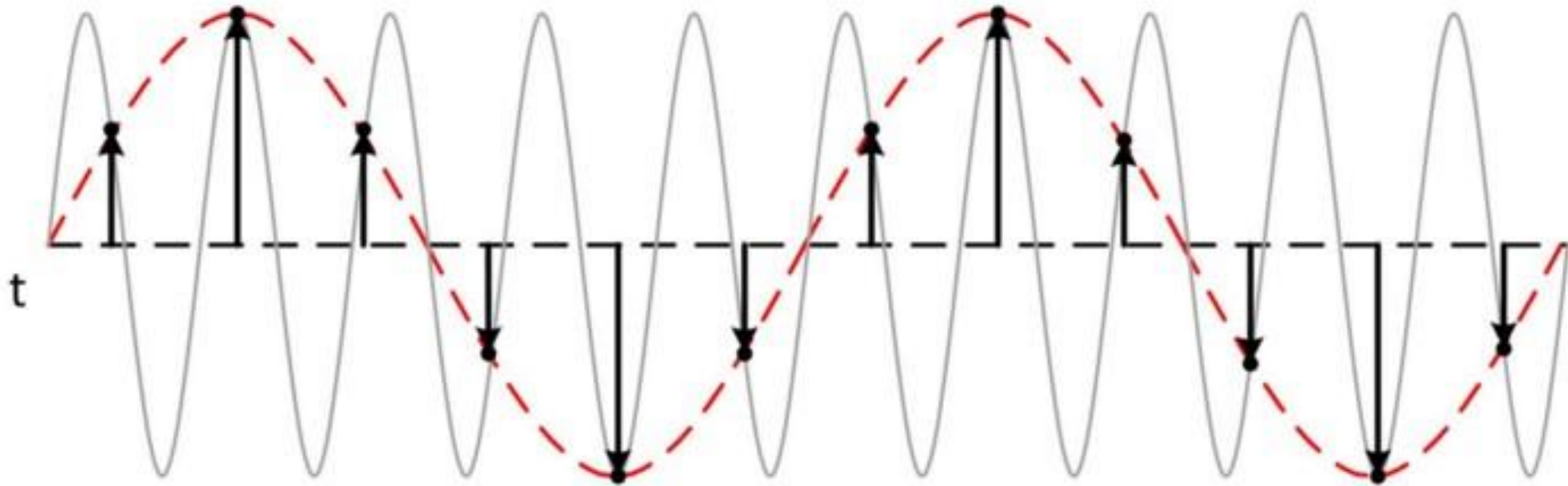
Adc Count / 4095 * ADCref

ADCref = 3.0, 3.3, 5.0, etc

Convert Voltage to Temp:

Temp (K) = Voltage / (1e-6 * Rsense)

Convert K to C:

Temp(C) = Temp(K) – 273.15

Analog Sensors - Nyquist

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Image Source: https://medium.com/@vinita.palaniveloo/nyquist-shannon-theorem-8e8fda1493f0

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What is the minimum sample rate for a sensor with a 20 KHz signal?
- 10 KHz
- 20 KHz
- 40 KHz
- 80 KHz

Analog Sensors
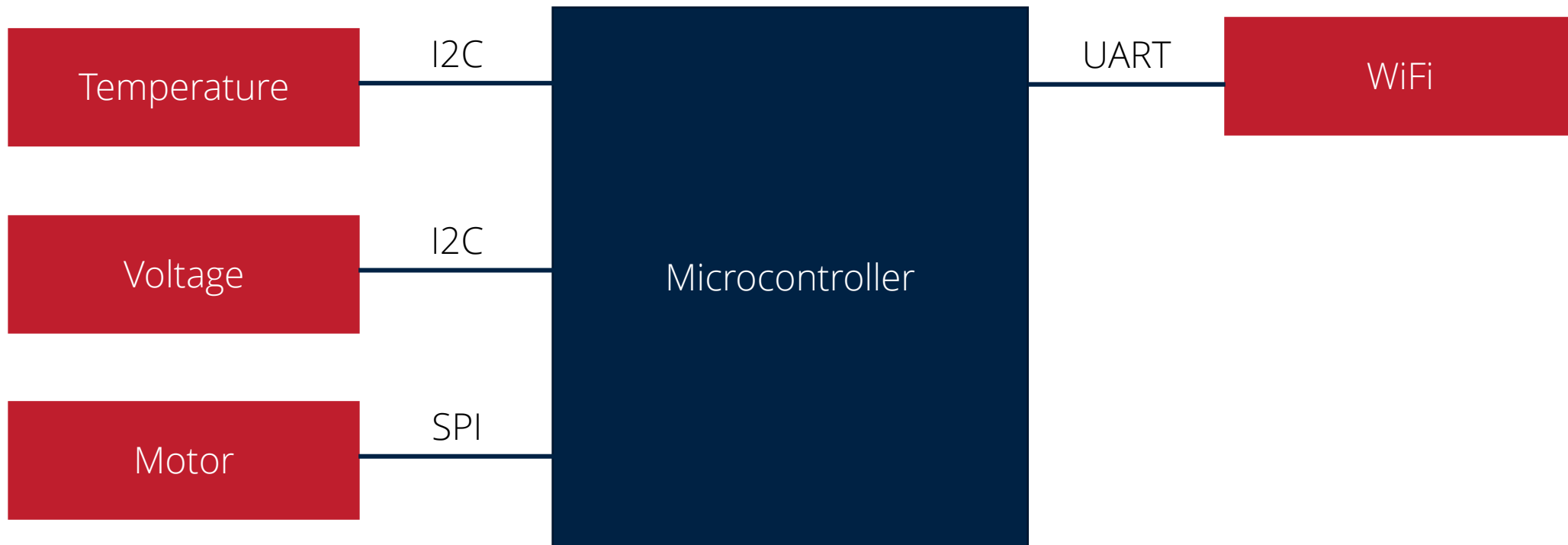
Digital Sensors

Design Considerations:
- The communication interface speed
- Leverage the hardware interrupt pin
- Identify exceptions in the registers
- How to handle faults
    - Ex: SPI bus failure will always provide 0xFFFF in readback
- Sample conversion rate
    - Ex: temperature and humidity sensors
- Managing Complexity
    - Ex: Motor control chips

Which sensor type would you rather work with?
- Analog
- Digital
- Combination sensors

Thank you for attending

Please consider the resources below:
- www.beningo.com

  - Blog, White Papers, Courses

  - Embedded Bytes Newsletter

    - http://bit.ly/1BAHYXm

From www.beningo.com under

   - Blog > CEC – Techniques for Interfacing with Modern Sensors