



# A Minimal Dot4 NCAP with a Compatible Sensor Bus

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# Goals

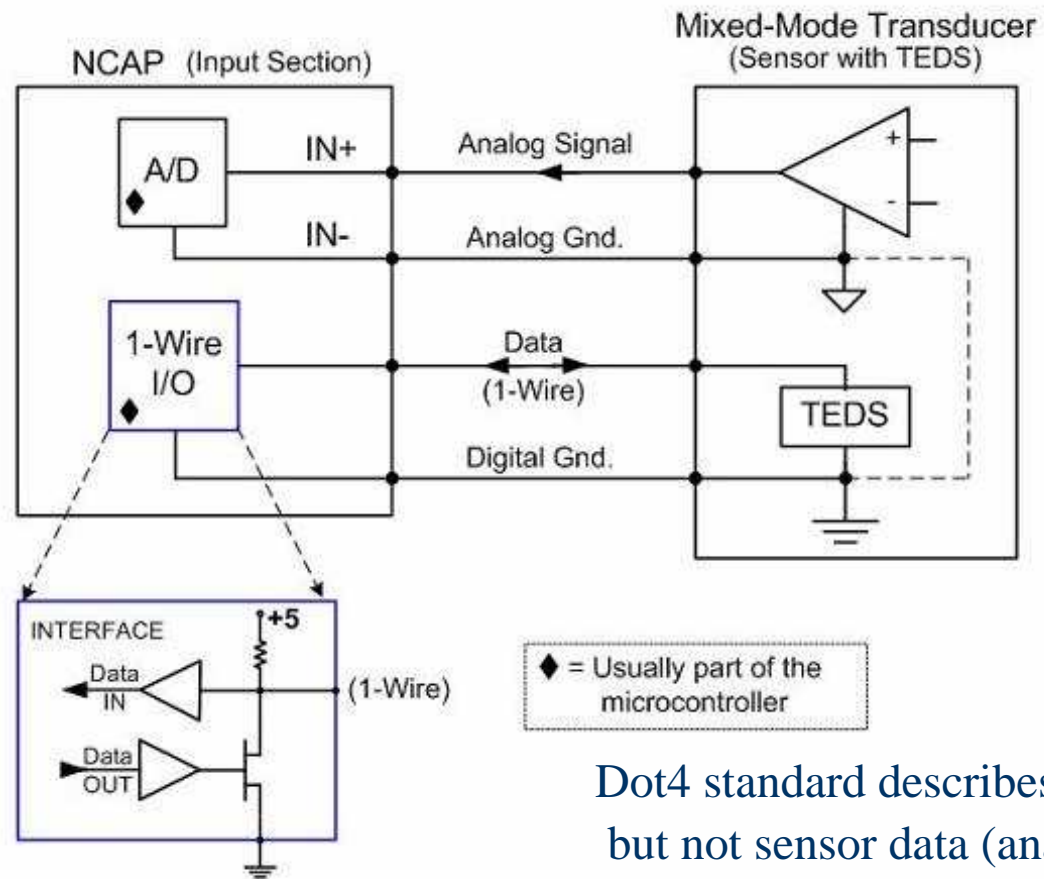
- ◆ Develop sensors with a IEEE 1451.4 (Dot4) TEDS
- ◆ Build a Dot4 TEDS Reader and Writer
- ◆ Develop a sensor bus (Dot4 bus) which will connect multiple analog sensors with TEDS
- ◆ Test a minimal Dot4 NCAP with a RS232 serial link to a PC

# IEEE 1451 Parts

- ◆ IEEE 1451.0 Protocols & formats (nearly done)
- ◆ IEEE 1451.1 Object model (approved 1999)
- ◆ IEEE 1451.2 Interface (approved 1997)\*
- ◆ IEEE 1451.3 Local network (approved 2003)
- ◆ IEEE 1451.4 Analog & TEDS (approved 2004)
- ◆ IEEE 1451.5 Wireless (final approval process)
- ◆ IEEE 1451.6 Open CAN (early approval process)

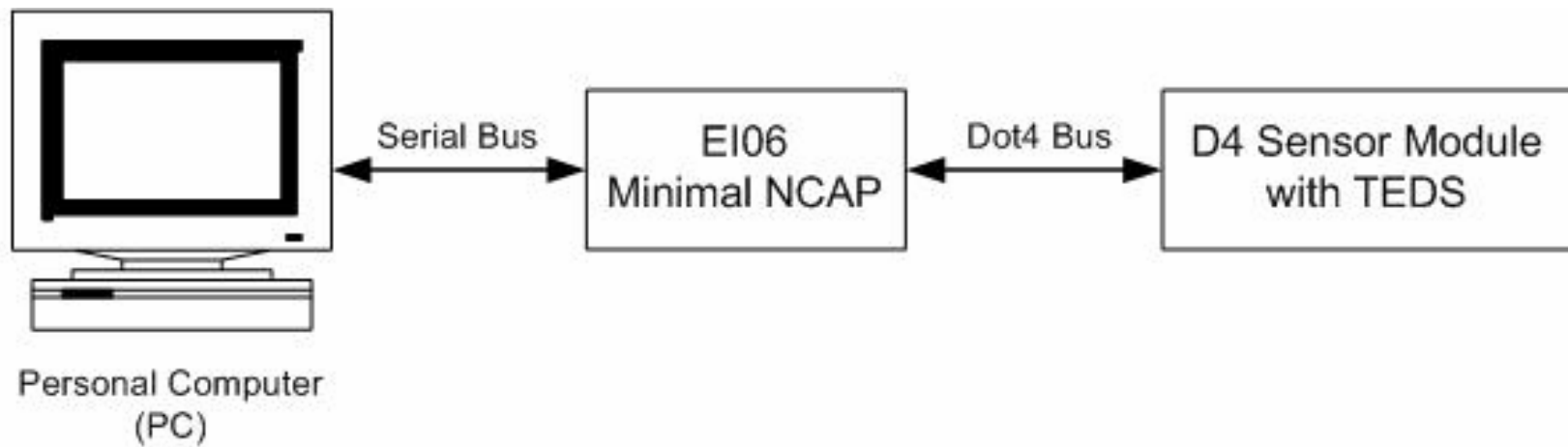
\* Enhancement /revision working group in process

# IEEE 1451.4 (Dot4) Mixed Mode Interface (MMI)

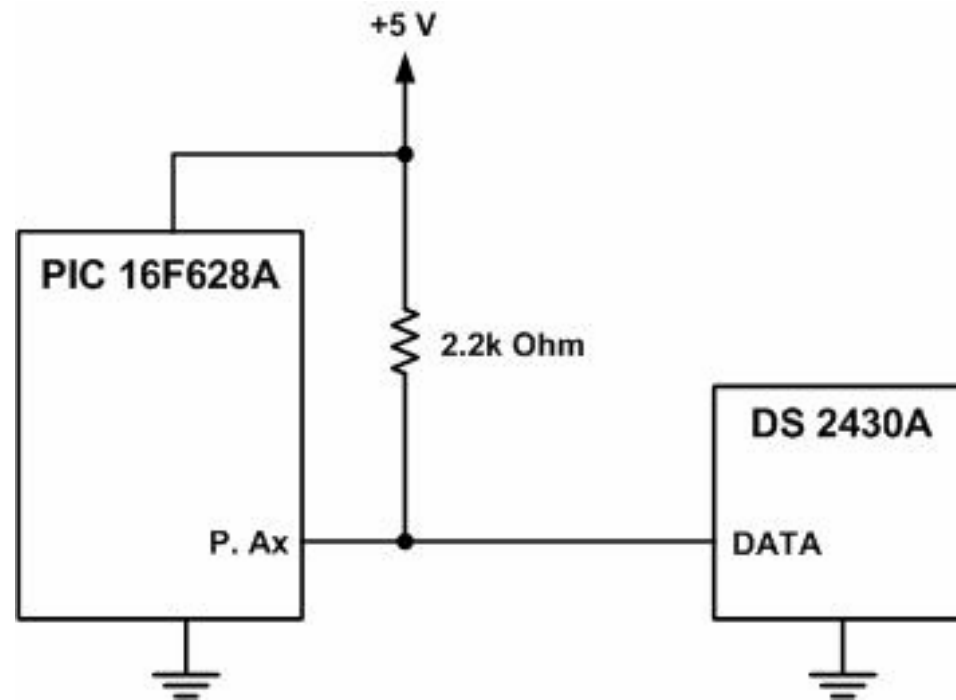


Dot4 standard describes TEDS  
but not sensor data (analog) signal

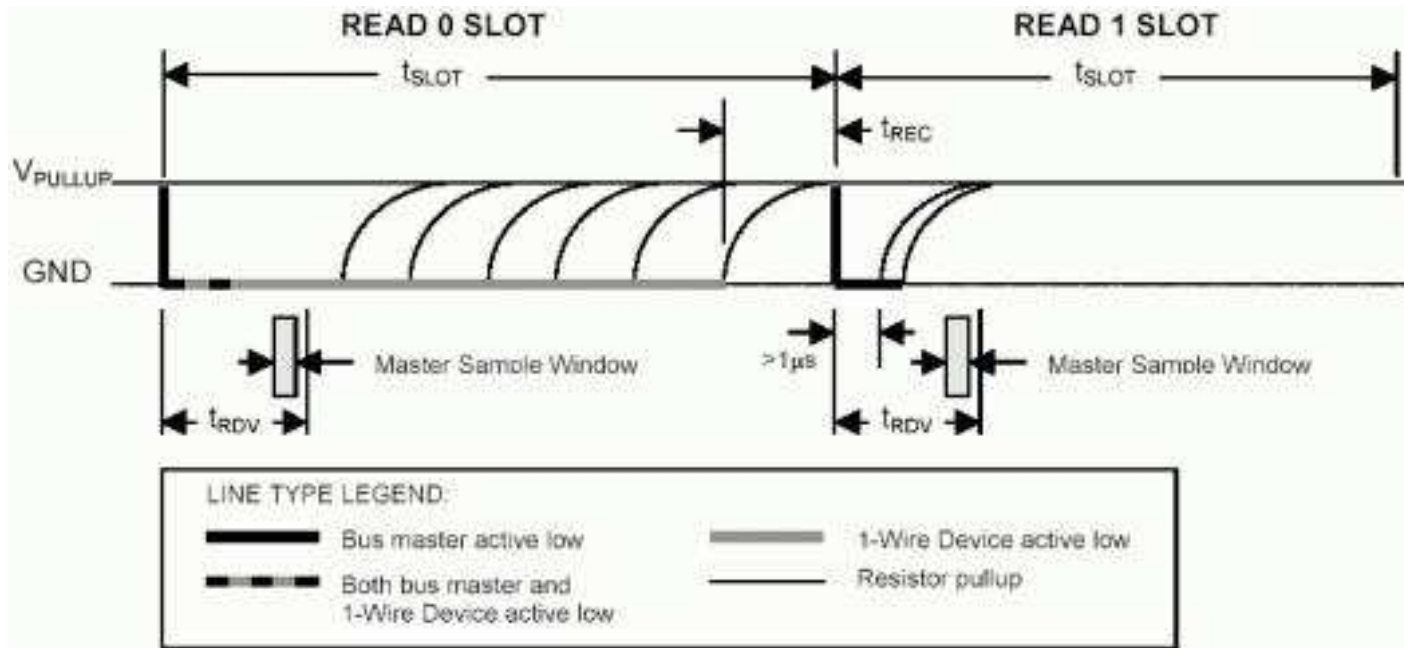
# Dot4 System Block Diagram



# A 1-Wire Interface to a Microcontroller



# 1-Wire Interface Timing Diagram





## Dot4 TEDS, part 1 -- UUID

- ◆ TEDS is divided into three parts
- ◆ UUID (Universal Unique Identifier) is used to identify sensor (every sensor of all manufacturers has unique number)
- ◆ A 6-byte (48-bit) binary code (plus 1-wire family code and CRC) which is supplied by the EEPROM manufacturer and controlled by the IEEE.



## Dot4 TEDS, part 2 -- Basic

- ◆ Used for Manufacturers model and serial numbers
- ◆ 8 bytes (binary)
- ◆ Consists of five parts:
  - Manufacturer ID (14 bits)
  - Model Number (15 bits)
  - Version Letter (5 bits, A-Z)
  - Version Number (6 bits)
  - Serial Number (24 bits)

## Dot4 TEDS, part 3 – IEEE/Manuf.

- ◆ Optional TEDS section for calibration and other information
- ◆ Compact binary format (typically <32 bytes but no limit)
- ◆ IEEE option has a variety of sensor templates (e.g. bridge)
  - A specialized program (normally hosted by PC) is needed to parse this TEDS data and expand it into a specification sheet form.
- ◆ Manufacturers option is unspecified
  - (often used for specialized calibration constants)
- ◆ Virtual TEDS at another site (e.g. website) is allowed also

# TEDS Data Reader (Screen Display)

The screenshot shows a grey background with a white border. At the top center is the Esensors Inc logo (a square with a stylized 'E' and a signal icon) followed by the text 'Esensors Inc'. Below this is 'IEEE 1451.4 Minimal NCAP Module' and 'TEDS READER'. There are three input fields: 'Family Code' with '14', 'Unique Serial Code' with '22D534010000', and 'CRC' with 'B6'. Below these is a section titled 'BASIC TEDS:' containing a list of parameters: 'SERIAL NO --101', 'VERSION NUMBER --1', 'VERSION LETTER --E', 'MODEL NO --6', and 'MANUFACTURER ID --34'. Below that is a 'STATUS:' section with the time '4 2:51:12 PM' and three lines of status: 'RESET...Passed', 'TEDS READ...Passed', and 'CRC TEST...Passed'. At the bottom are three buttons: 'READ', 'RESET', and 'BACK'.

**Esensors Inc**  
IEEE 1451.4 Minimal NCAP Module  
TEDS READER

Family Code	Unique Serial Code	CRC
14	22D534010000	B6

**BASIC TEDS:**  
SERIAL NO --101  
VERSION NUMBER --1  
VERSION LETTER --E  
MODEL NO --6  
MANUFACTURER ID --34

**STATUS:** 4 2:51:12 PM  
RESET...Passed  
TEDS READ...Passed  
CRC TEST...Passed

READ      RESET      BACK

# TEDS Writer (PC Screen Display)

**Esensors Inc**  
IEEE 1451.4 Minimal NCAP Module  
TEDS WRITER

Serial Number [24 BITS]	Version Number [6 BITS]	Version Letter [ 5 BITS ]	Model Number [15 BITS]	Manufacturer ID [ 14 BITS]
101010101010101010101010	111000	01010	110011001100111	00110011001100

MSB							LSB
AA	AA	AA	E1	59	99	CC	CC

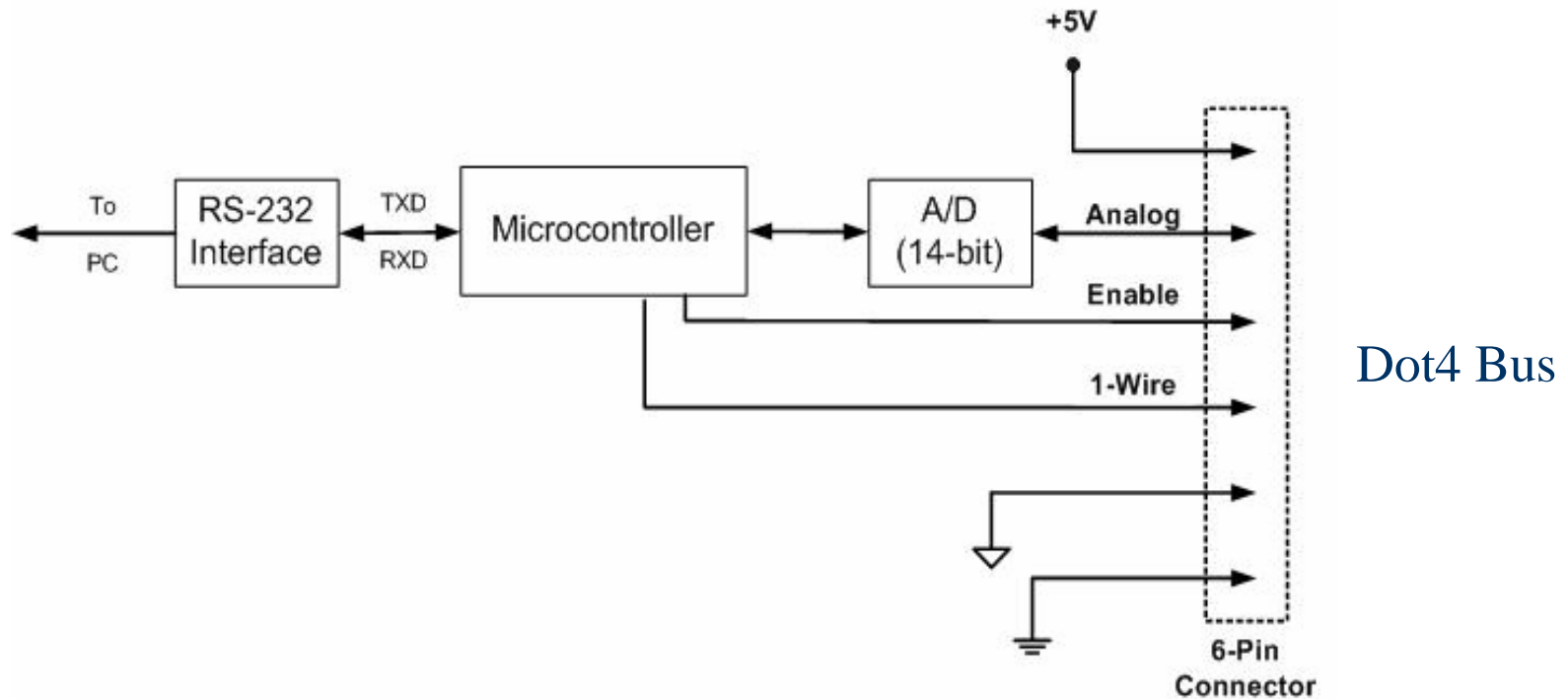
  

STATUS: 2:15:58 PM

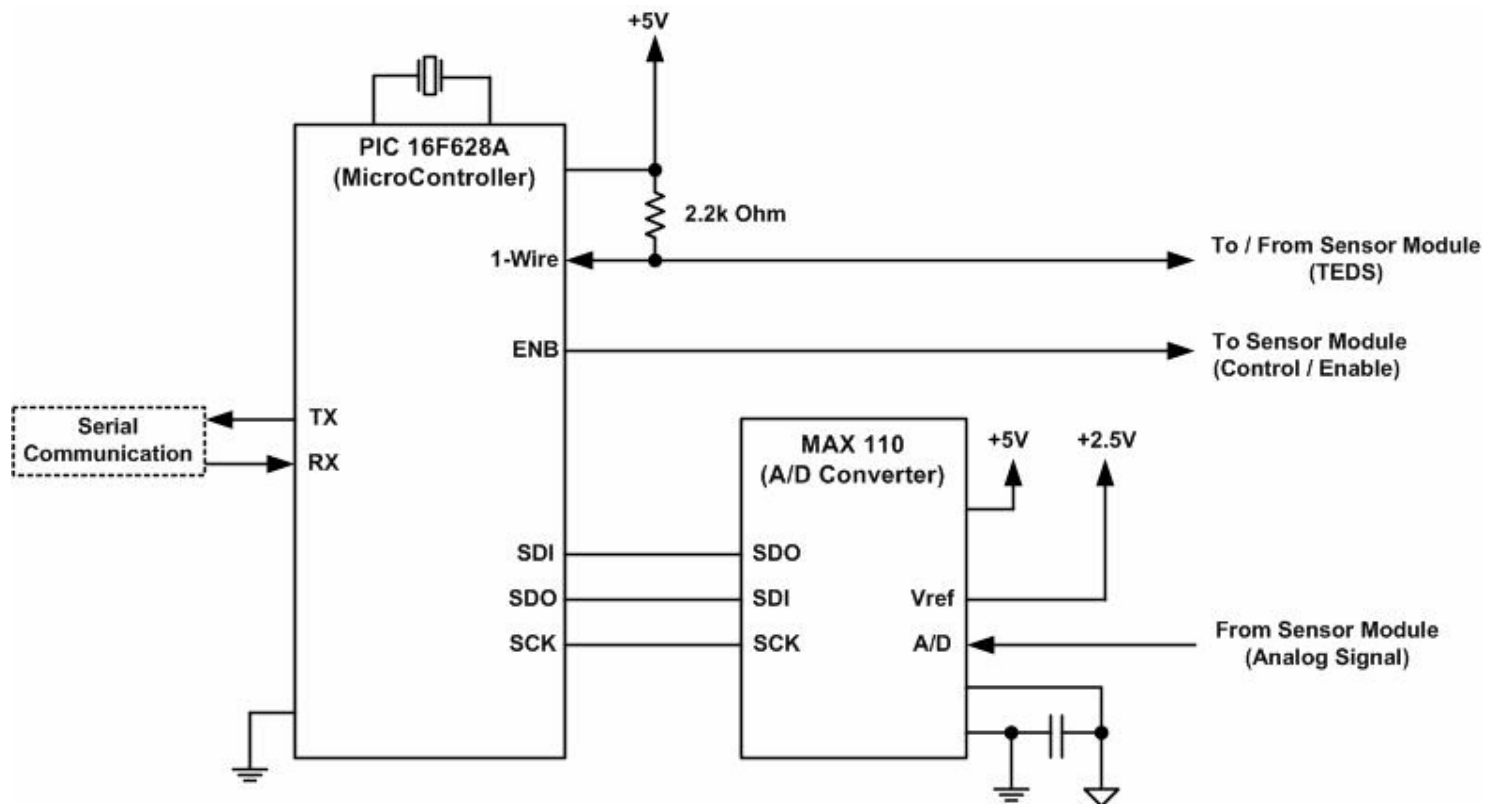
- Reset... Passed
- Verified ... Passed
- Programmed...Passed
- TEDS OK... failed

CONVERT    VERIFY    PROGRAM    RESET    BACK

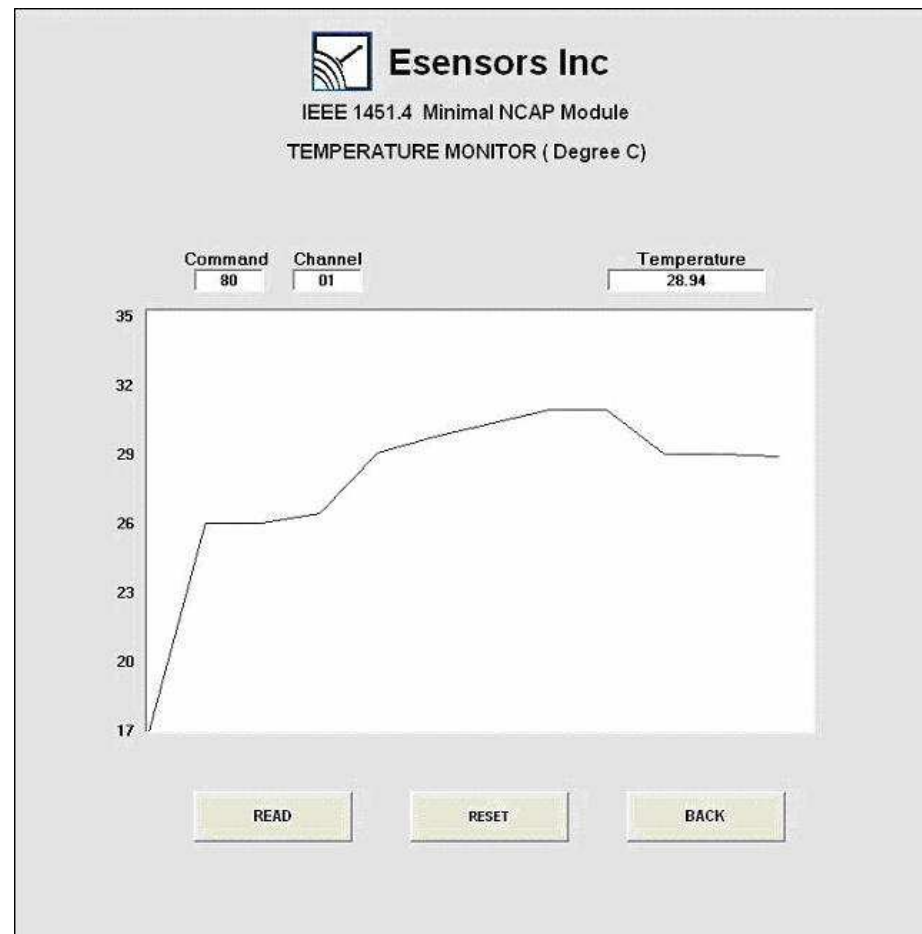
# Block Diagram of Minimal (RS232 type) NCAP



# NCAP Circuit Diagram

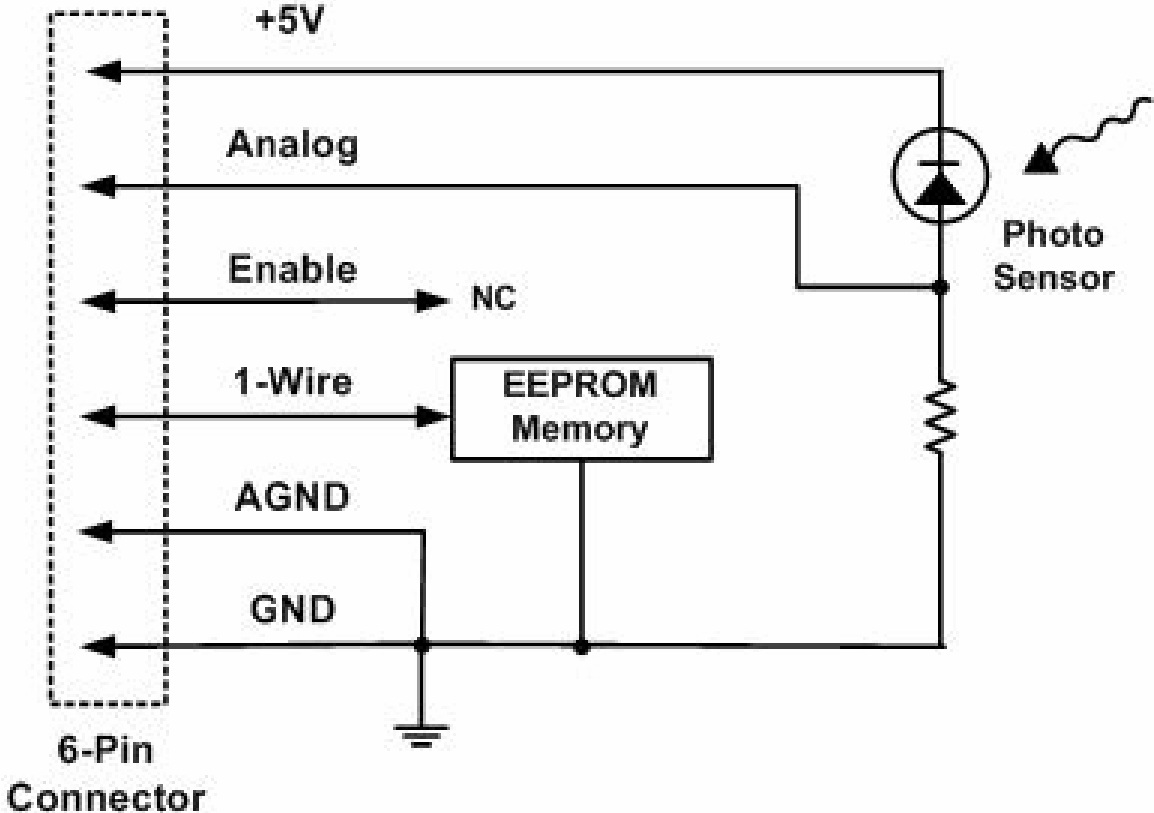


# Example of PC Display of Sensor Data



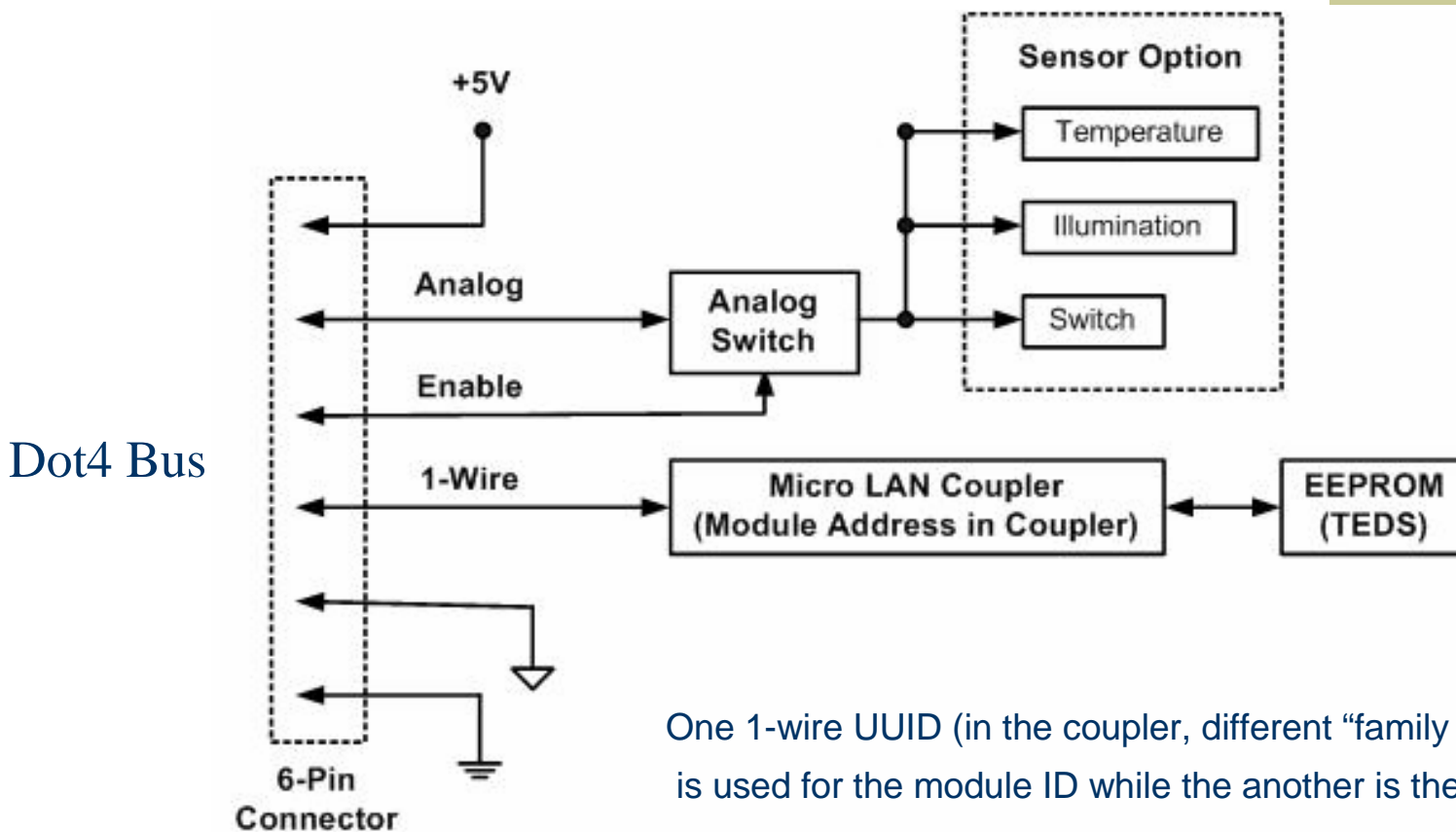
# Single Sensor Module

Dot4 Bus



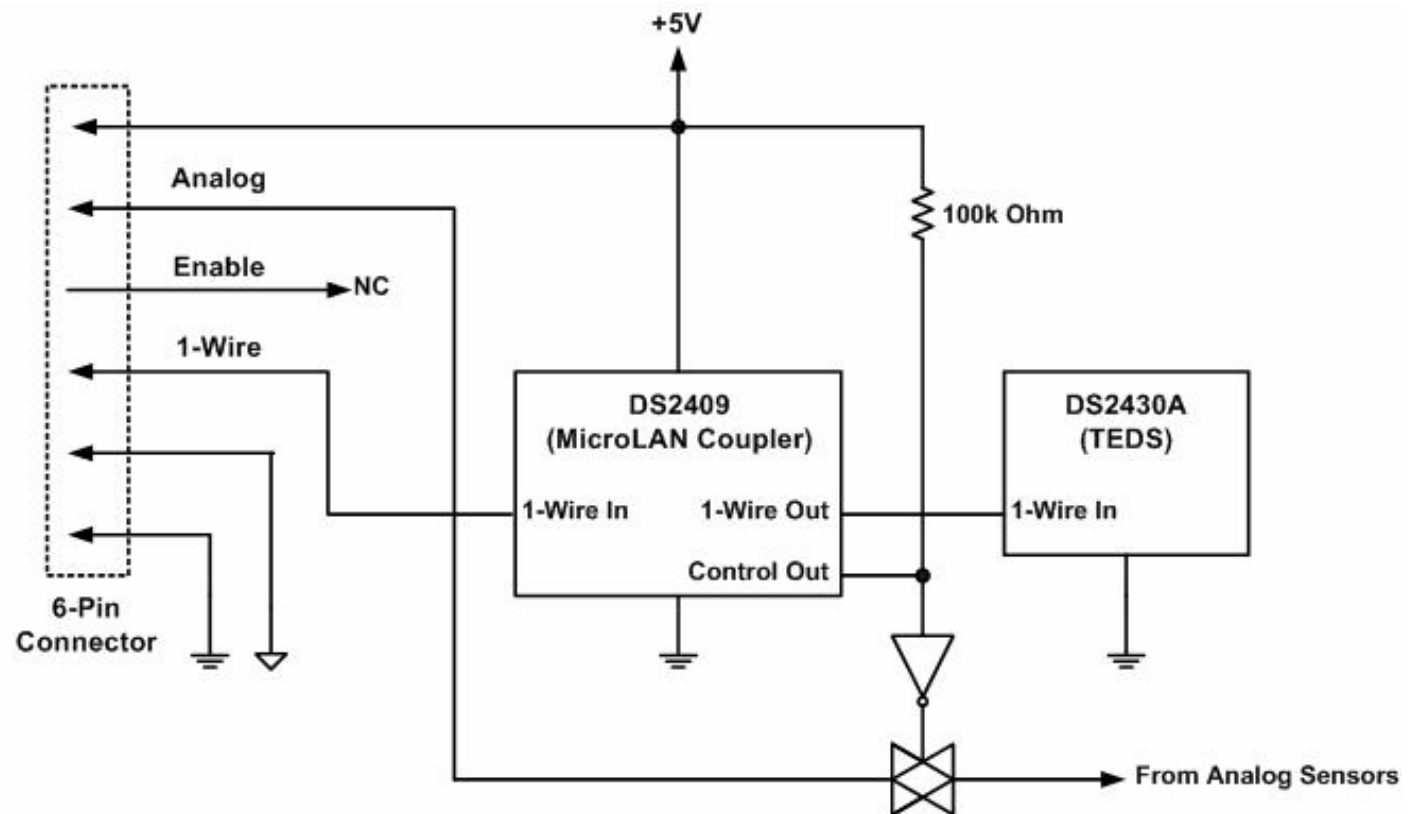


# Block Diagram of Multi-drop Sensor Module

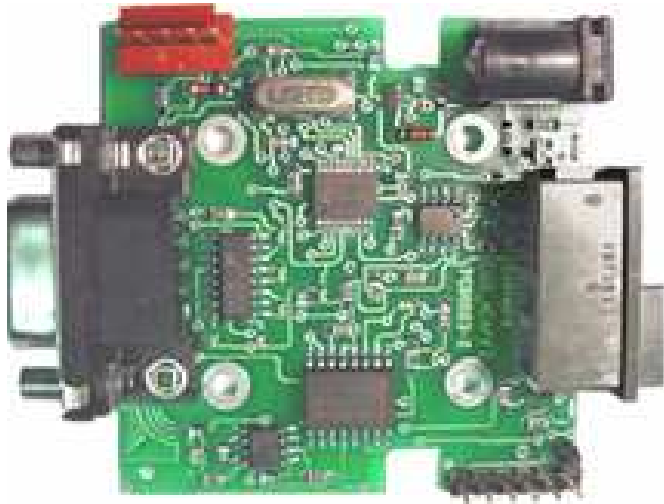


# Circuit Diagram of Multi-drop Sensor Module

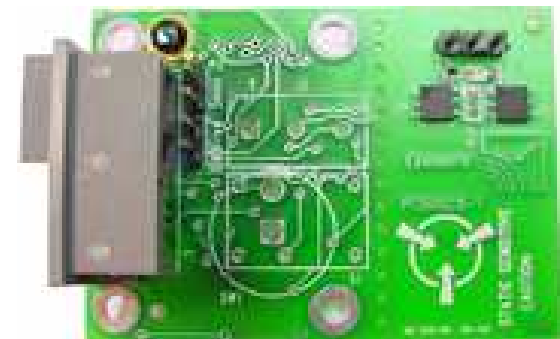
Dot4 Bus



# Photo of Printed Circuit Boards

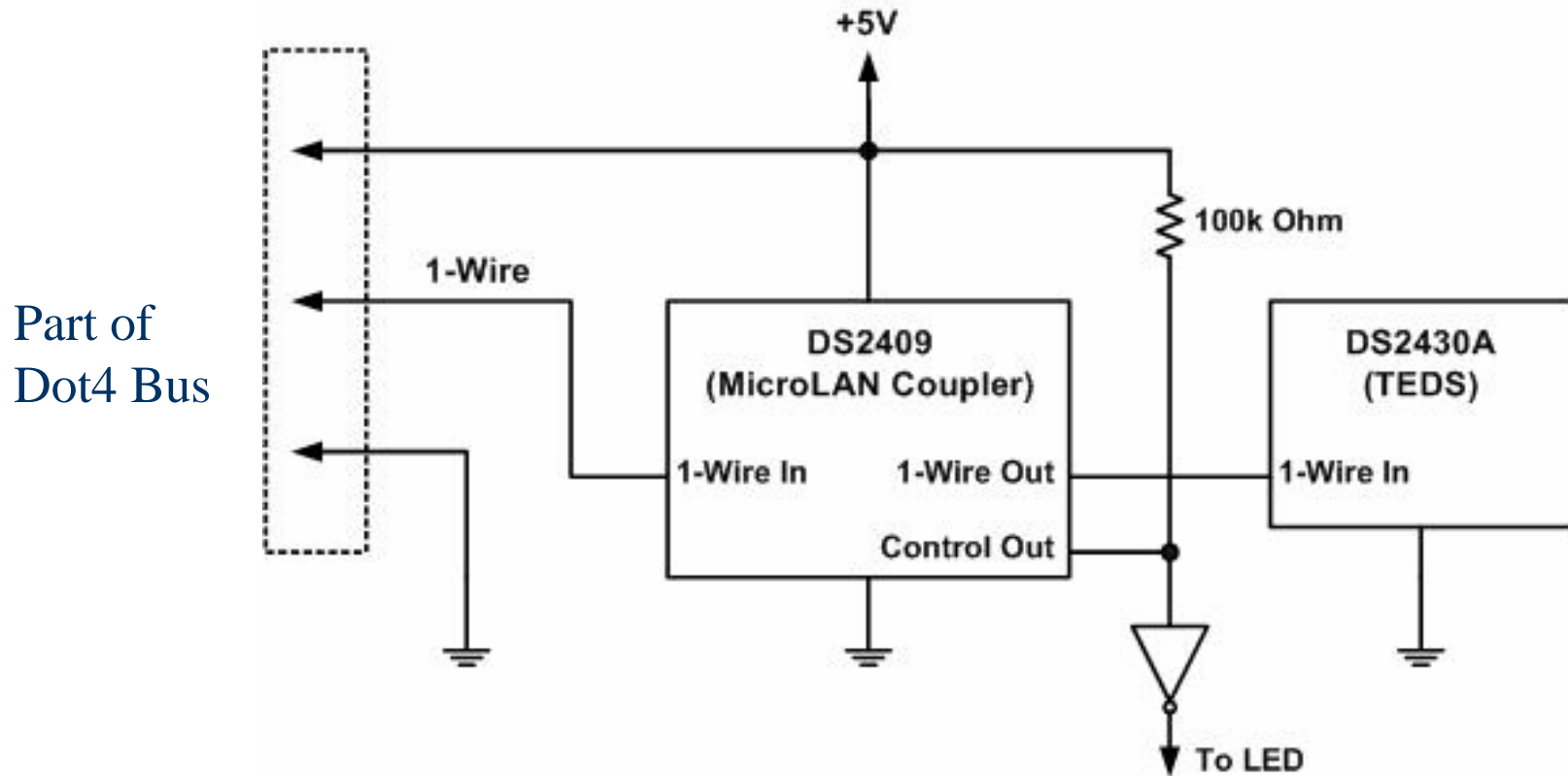


**Minimal Dot4 NCAP**



**Sensor Module**

# TEDS-only Dot4 Tag



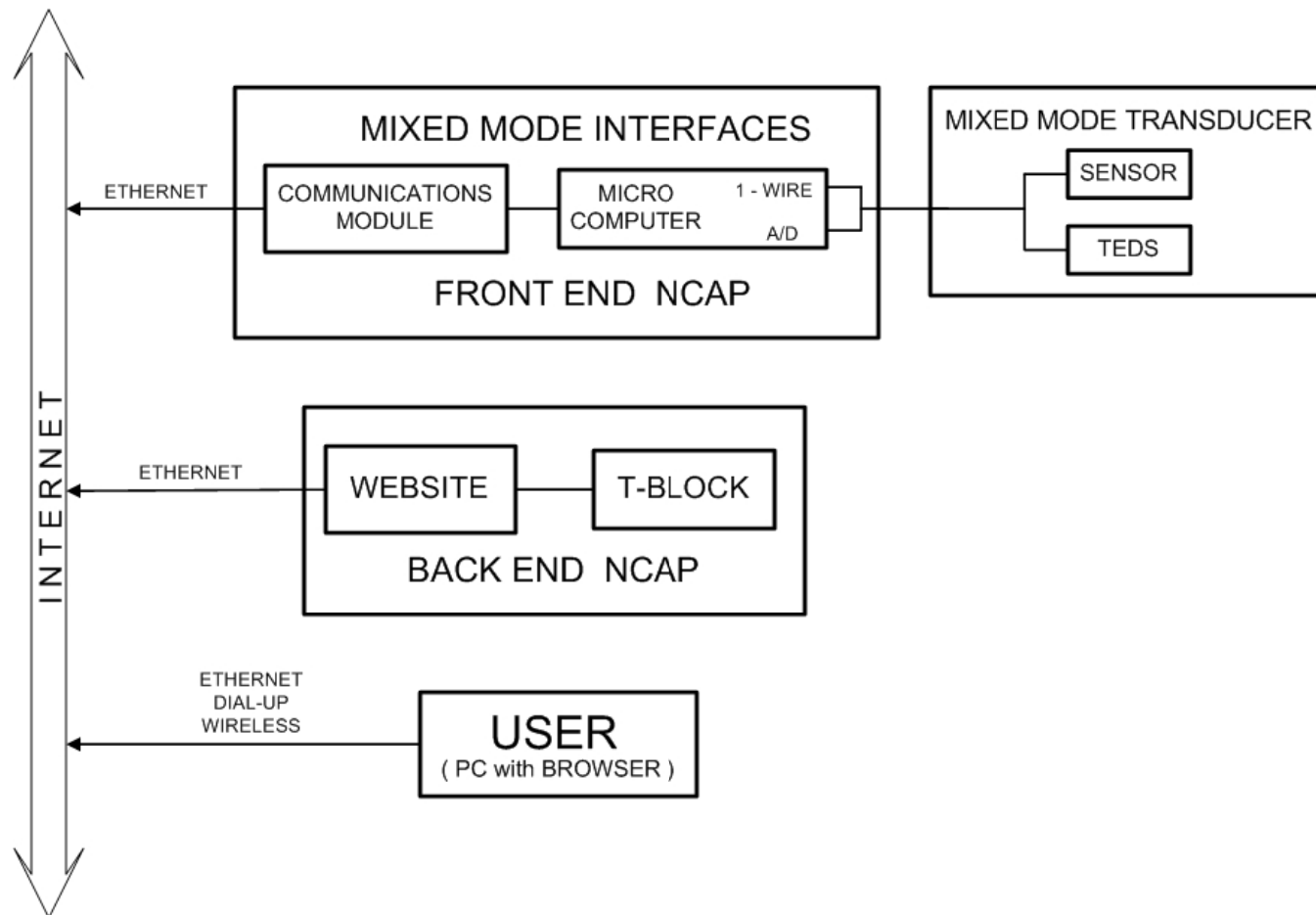
Coupler needed if more than one TEDS on bus

# Alternate NCAP

## (Split NCAP with Internet/Ethernet Capability)

- ◆ Sensor data is transmitted over Internet via Ethernet to Website for further processing
- ◆ Needed because full Dot4 Software too complex for a small NCAP at sensor end (Front-end)
- ◆ Complex section (T-block) is moved to PC/Website (Back-end)
- ◆ Fully processed data is available over Internet from any Internet browser
- ◆ System is compatible with appended (virtual) TEDS

# Split Dot4 NCAP Block Diagram



# References

- ◆ R. Johnson, et al “A Standard Smart Transducer Interface”  
[http://ieee1451.nist.gov/Workshop\\_04Oct01/1451\\_overview.pdf](http://ieee1451.nist.gov/Workshop_04Oct01/1451_overview.pdf)
- ◆ IEEE Std. 1451.2-1907 “IEEE Standard for a Smart Transducer Interface for Sensors and Actuators – Transducer to Microprocessor Communication Protocols and Transducer Electronic Data Sheet (TEDS) Format” <http://ihome.ust.hk/~yangrd/pdf/ieee14512.pdf>
- ◆ R. Frank “Understanding Smart Sensors”, 2<sup>nd</sup> edition, Artech House (2000)
- ◆ D. Wobschall, “Websensor Design – Smart sensors with an Internet Address” Proceeding Sensors Expo (Philadelphia, Oct. 2001)
- ◆ [www.eesensors.com/IEEE1451](http://www.eesensors.com/IEEE1451)

# Summary

- ◆ An IEEE 1451.4 (Dot4) Minimal NCAP with MMI (analog signal and TEDS) has been described.
- ◆ A Dot4 TEDS reader and writer are included.
- ◆ Sensors with a TEDS-enabled analog switch were also included.
- ◆ A Dot4 compatible multi-drop sensor bus was featured.
- ◆ A TEDS-only tag is available.
- ◆ An Internet-capable (Split Dot4 NCAP) was briefly described.

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