Current Status of IEEE 1451.4 Transducer Electronic Data Sheet (TEDS)

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For dissemination of IEEE 1451.4 info only

1451.4™ Standard

IEEE Standard for A Smart Transducer

Interface for Sensors and Actuators—

Mixed-Mode Communication Protocols

and Transducer Electronic Data Sheet

(TEDS) Formats

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Motivation for 1451.4 TEDS

- Plug and Play for instrumentation
- Electronic Data Sheet
  - Sensitivity, model number, serial number, etc.
- Simplification of cable identification
- Elimination of data entry error and system setup
- Participation in 1451 vision
- Legacy compatibility
  - Existing accelerometer (sensor) users

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History

- NIST TC9 sponsorship

- 1993-1996 IEEE 1451.1 & .2 formed

- 1996 IEEE 1451.3 WG (multi-drop)

- 1997 IEEE 1451.4 WG formed

- Balloted and accepted May 2004

- Corrigendum in late 2005

- Up for review in 2009

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1451.4 Participants

- Mostly everybody in the accelerometer community:
  - PCB, B&K, Endevco, Kistler, Wilcoxon
- The Modal Shop
- Oak Ridge National Labs
- National Instruments
- Dallas Semiconductor
  - 1-wire technology (key piece of technology that allowed implementation of the memory in the sensor)
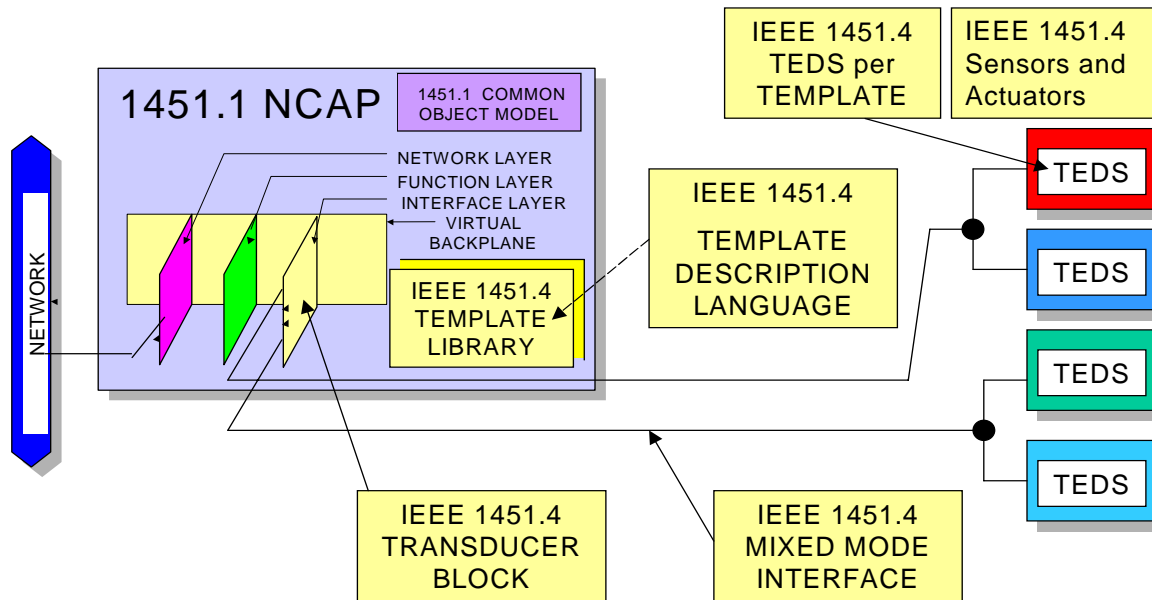
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Implementation

- Electrical reprogrammable memory added to **sensor**/actuator
- Memory contains ROM (permanent) and RAM (alterable)
- Information out is serial bit-stream
- Operations limited to $-40°C$ to $85°C$
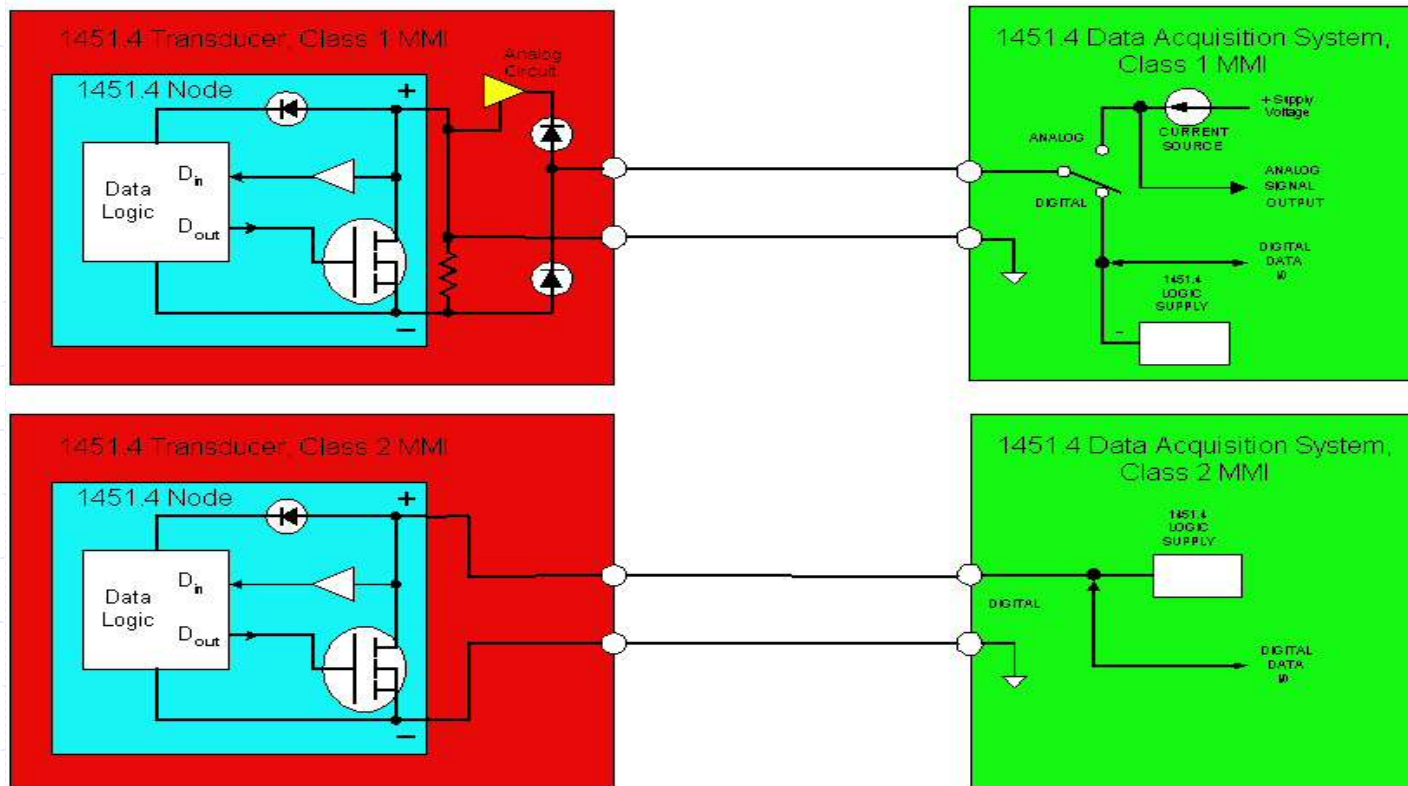- Based on Maxim/Dallas 1-wire (DS2430A)

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IEEE 1451.4 Architecture

IEEE 1451.4 System Architecture

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Class of interface

IEEE 1451.4 Class 1 and 2 MMI Details

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TEDS Bitmaps

64 bit

256 bit

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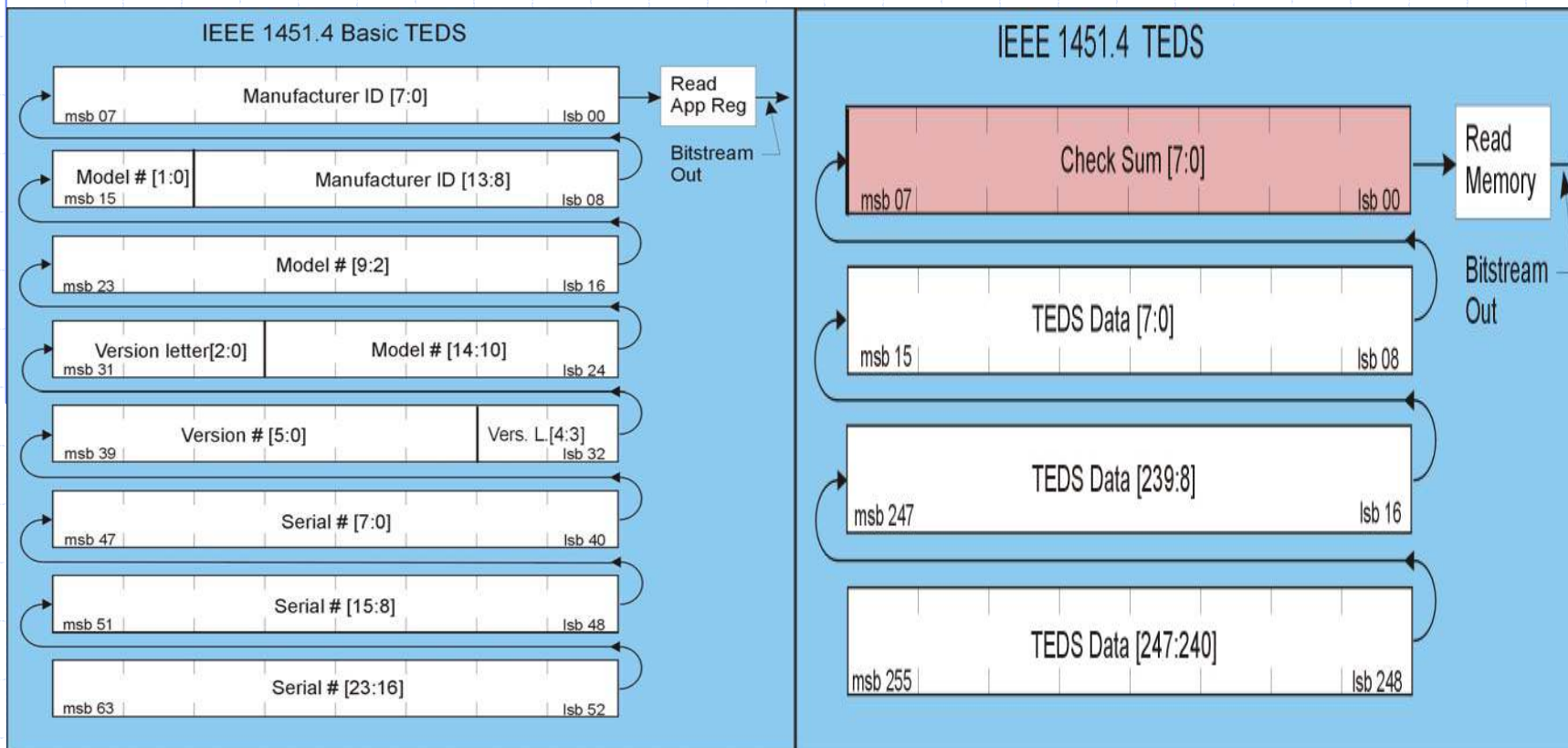
Differences

- The early producers agreed not to utilize the ROM memory
- Early templates crude (TEDS v0.9 vs TEDS v1.0)
- v1.0 incorporates TEDS Development Language (TDL) concept
- TDL development is encouraged
- IEEE is registration authority

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Example: Accelerometer programmed per IEEE P1451.4 (template 0)

label	Data	Units	Min	Max
Model number	333		0	65535
Version letter	B		A	Z
Version number	32		0	63
Serial no.	25451		0	33554431
Calibration Date	5/28/2007			
Sensitivity @ reference condition	0.010198	V/(m/s²)	1.00E-04	49.17322
Reference frequency (F ref)	159.753479	Hz	10.17502	1.91E+04
High pass cut-off frequency (F hp)	0.010061	Hz	0.01	35.75359
Polarity (Sign)	0		0	1
Sensitivity direction (x,y,z)	N/A			
Measurement location ID	0		0	511
User data (ascii)	template 0			

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Example: Accelerometer programmed per IEEE 1451.4 (template 25)

label	Data	Units	Min	Max
Model number	333		0	32767
Version letter	B		A	Z
Version number	32		0	63
Serial no.	25451		0	16777215
Sensitivity @ reference condition	0.010198	V/(m/s²)	5.00E-07	172.2408
High pass cut-off frequency (F hp)	0.010061	Hz	0.005	1.42E+04
Sensitivity direction (x,y,z)	N/A			
Transducer weight	3.83376	g	0.1	9.74E+03
Polarity (Sign)	0		0	1
Reference frequency (F ref)	159.753479	Hz	0.35	2.26E+03
Reference temperature (T ref)	25	°C	15	30.5
Calibration Date	5/28/2007			
Calibration Initials	MAP			
Calibration Period (Days)	365	days	0	4095
Measurement location ID	1		0	2047
User data (ascii)	template 25			

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What are accelerometer vendors supporting?

◆ All support 1.0, it is the default

◆ Most moving to 1.0 after testing

◆ All will offer "both" for quite some time

◆ Most require customer to specify

◆ Electronics / Software level is important

◆ Once you go 1.0, you don't go back!

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TEDS Sensors – all types

- Accelerometers – Uni-axial, Tri-axial
- Impact hammers, force sensors, impedance heads
- Microphones - all types
- Load Cells, Strain Gauges, Impedance
- Thermocouples, Pressure sensors
- Extended Functionality
- Charge converters (in-line)
- Legacy- "TEDS in a Tube"

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What does TEDS cost?

◆ Microphones - standard in most

◆ Accelerometers - US$25-55 additional

◆ Electronics – standard to US$1500

◆ Migration is $0 (with cal) to US$55

◆ Savings is justification for cost

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TEDS Sensors Manufactures

- ◈ **Accelerometers**
  - ■ PCB, B&K, Dytran, Endevco, Kistler, Wilcoxon, etc
- ◈ **Microphones**
  - ■ PCB, B&K, GRAS, etc
- ◈ **Strain Gage load cells**
  - ■ Lebow, HBM, Futek

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Electronics & Hand Held Devices

◆ PCB / The Modal Shop

◆ Dytran

◆ Endevco

◆ ATA

◆ NI PDA Toolkit is an enabler

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PC based Readers/Writers

◆ The Modal Shop: 400B76 (USB)

◆ B&K: BZ 5294 (RS-232)

◆ Endevco

◆ Dytran

◆ Kistler 5000M04

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Electronics - PC Cards

- **National Instruments**
  - PXI-4462, PCI-4461, NI 9233,9234
  - SCXI-1314T, Compact RIO NI 9237
- **VXI Technology**
  - VT1435
  - VT1436

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Electronics - Analyzers

- ◈ LMS: SCADAS III
- ◈ M+P International
- ◈ B&K: Pulse
- ◈ Oros
- ◈ Data Physics: Quattro, Abacus
- ◈ IOtech Wavebook
- ◈ LDS Dactron Focus II (only support to preliminary templates – TEDS v0.9 – at this time)
- ◈ Etc.
- ➔ Should *always* check with analyzer manufacturer on what TEDS sensors and templates are supported

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Electronics – Signal Conditioners & Recorders

◆ PCB   - 481, 498, 440 series

◆ NI   - SC-3250, BNC-2096

◆ B&K   - Deltatron, Nexus

◆ Endevco   - OASIS

◆ Sensotec   - SC2000, SC3400

◆ Precision Filters

◆ TEAC LX10, Sony EX Series

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TEDS and Calibration Systems

◆ What about re-calibration?

- Does your calibration system support TEDS?

- Does your calibration house support TEDS?

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Applications

- Geometry Information

- Sound Contour w/phase

- Large Channel count mapping

- Channel Identification

- Vibration controller security

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LMS (Geometry) Format

- IEEE 1451 Standard permits "private"
- LMS (Daimler,Airbus) needed geometry
- IEEE Working group didn't support
- Work progressing on defining 1.0 TDL
- Currently represents single largest channel count of installed 1451 sensors

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Additional Information

- IEEE

    http://standards.ieee.org/regauth/1451

- National Instruments

    http://www.ni.com/teds/

- TMS   - TEDS FAQ

- Wilcoxon - Multiple TEDS papers

- B&K   - extensive TEDS material

- Maxim/Dallas   - 1 wire products

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Summary

◆ IEEE 1451 is well-entrenched in market

◆ Est over 150,000 1451 sensors shipped

◆ More than 100 sensors type, 8+ vendors

◆ More than 20 electronics, 6+ vendors

◆ IEEE Manufacturer ID Public Listing

  ▪ 71 registered manufacturers

◆ IEEE 1451.4 continues to gain acceptance in the marketplace

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