

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

Marco Peres & Mark Schiefer
The Modal Shop, Inc. – Cincinnati, OH

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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



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



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



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)



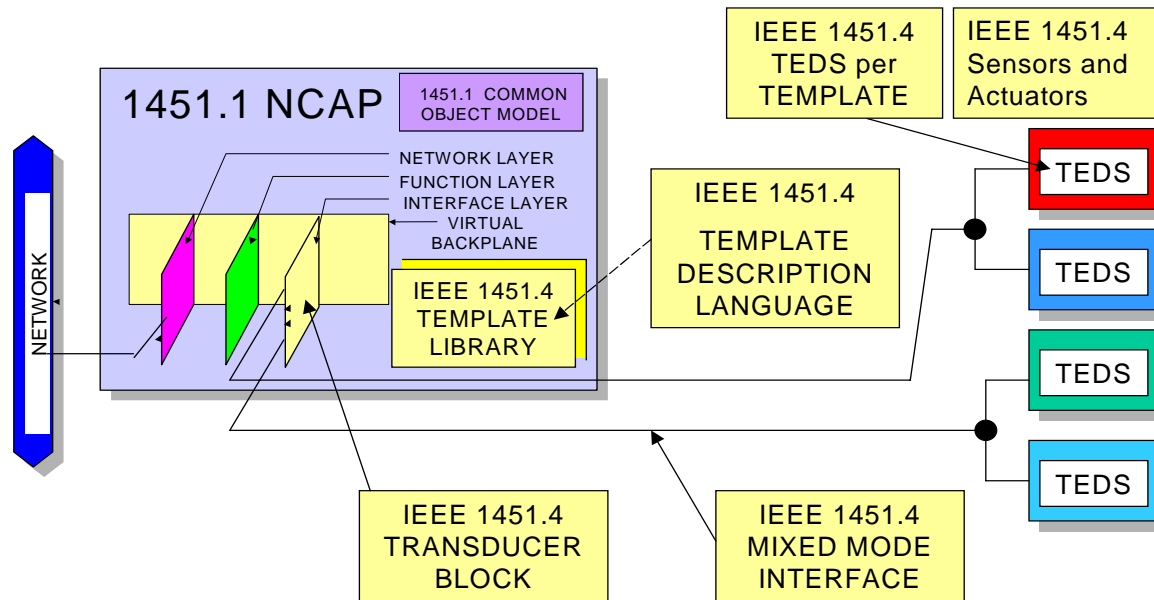
Implementation

- ◆ 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)



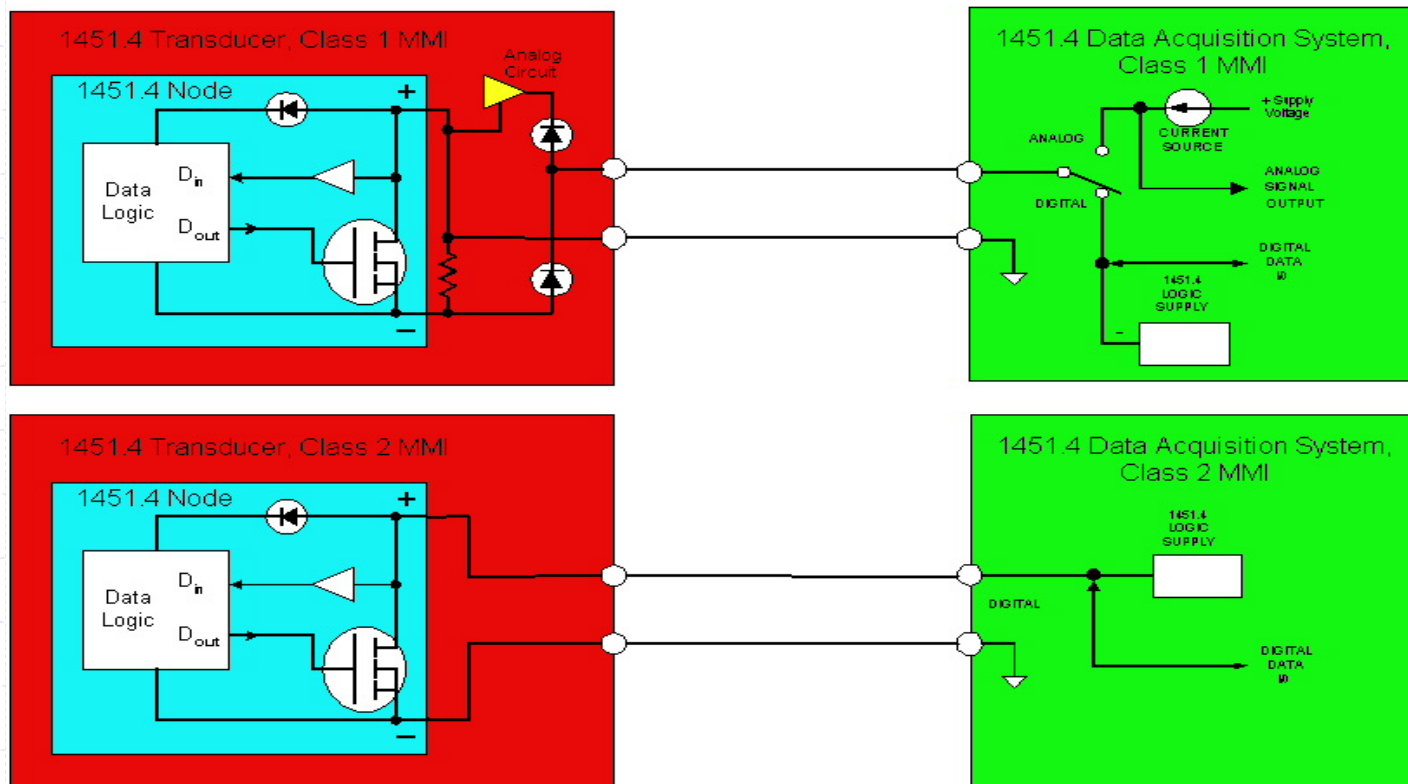
IEEE 1451.4 Architecture

IEEE 1451.4 System Architecture

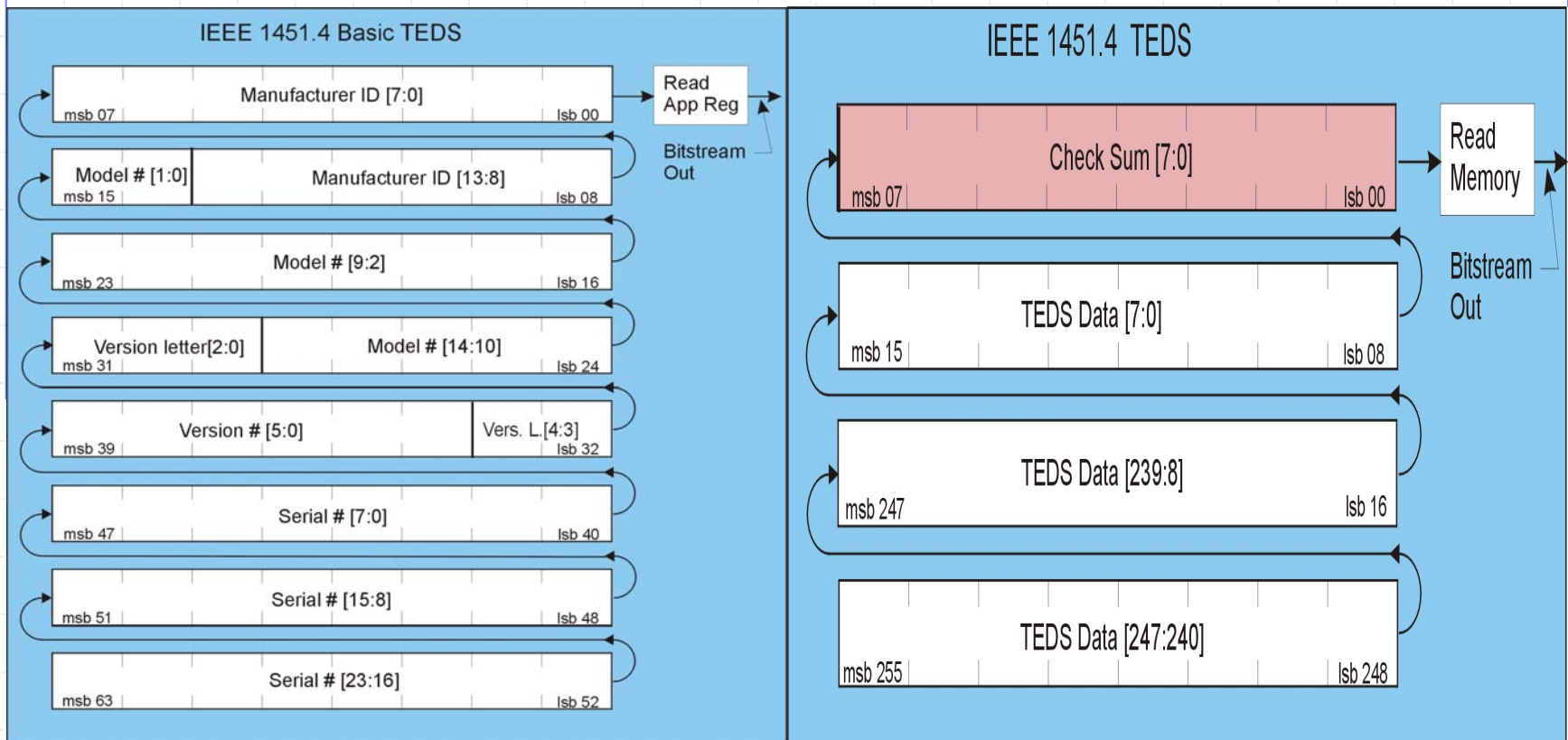


Class of interface

IEEE 1451.4 Class 1 and 2 MMI Details



TEDS Bitmaps



64 bit

256 bit

IMAC XXVII February 9-12 2009



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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



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/s ²)	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			



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/s ²)	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			



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!



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



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



Electronics & Hand Held Devices

- ◆ PCB / The Modal Shop
- ◆ Dytran
- ◆ Endevco
- ◆ ATA
- ◆ NI PDA Toolkit is an enabler



PC based Readers/Writers

- ◆ The Modal Shop: 400B76 (USB)
- ◆ B&K: BZ 5294 (RS-232)
- ◆ Endevco
- ◆ Dytran
- ◆ Kistler 5000M04



Electronics - PC Cards

◆ National Instruments

- PXI-4462, PCI-4461, NI 9233, 9234
- SCXI-1314T, Compact RIO NI 9237

◆ VXI Technology

- VT1435
- VT1436



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



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



TEDS and Calibration Systems

◆ What about re-calibration?

- Does your calibration system support TEDS?
- Does your calibration house support TEDS?



Applications

- ◆ Geometry Information
- ◆ Sound Contour w/phase
- ◆ Large Channel count mapping
- ◆ Channel Identification
- ◆ Vibration controller security



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



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



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

