



IEEE Standard for a Smart Transducer Interface for Sensors and Actuators— Common Functions, Communication Protocols, and Transducer Electronic Data Sheet (TEDS) Formats

IEEE Instrumentation and Measurement Society

Sponsored by the
Technical Committee on Sensor Technology (TC-9)

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Abstract: This standard provides a common basis for members of the IEEE 1451 family of standards to be interoperable. It defines the functions that are to be performed by a transducer interface module (TIM) and the common characteristics for all devices that implement the TIM. It specifies the formats for Transducer Electronic Data Sheets (TEDS). It defines a set of commands to facilitate the setup and control of the TIM as well as reading and writing the data used by the system. Application programming interfaces (APIs) are defined to facilitate communications with the TIM and with applications.

Keywords: actuator, application programming interface, communication protocol, network-capable application processor, sensor, smart transducer, transducer electronic data sheet, transducer interface module

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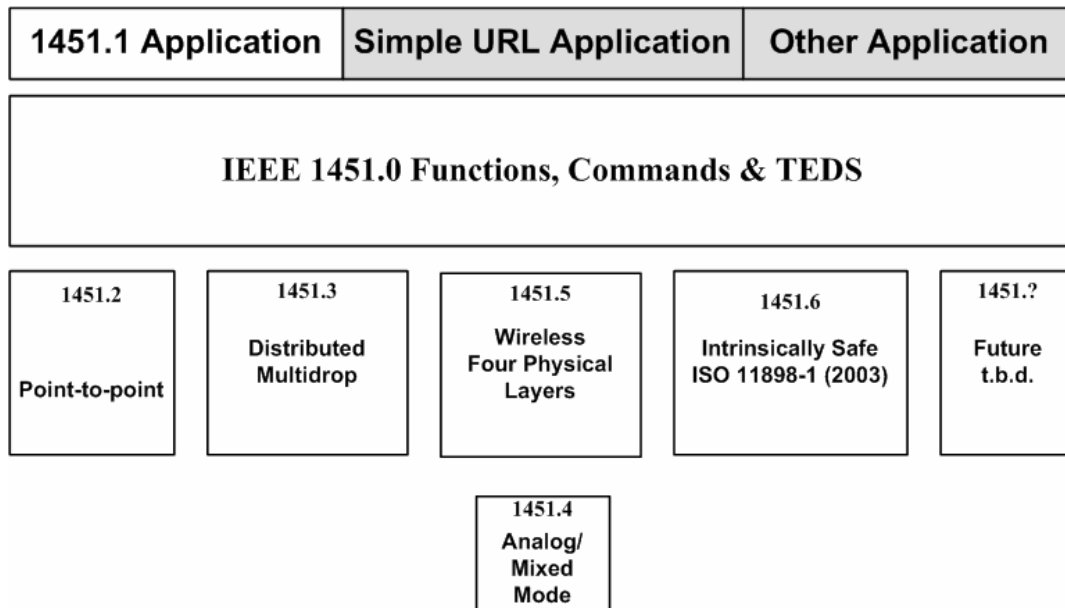
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Introduction

This introduction is not part of IEEE Std 1451.0-2007, IEEE Standard for a Smart Transducer Interface for Sensors and Actuators—Common Functions, Communication Protocols, and Transducer Electronic Data Sheet (TEDS) Formats.

This standard is intended to provide a basis for all future members of the IEEE 1451 family of standards that use digital interfaces. It should also be adopted by the existing members of the IEEE 1451 family of standards as they are revised in the future in order to provide the highest degree of compatibility among the members of the family. This standard does not apply to IEEE Std 1451.4™-2004, which only provides a size-constrained TEDS and an analog interface.

The relationships between this standard and the other members of the family are shown in the following diagram. Three of these standards were complete before this standard was started and do not comply with this standard but will in the future as they are revised. They are IEEE Std 1451.1™-1999, IEEE Std 1451.2™-1997, and IEEE Std 1451.3™-2003. IEEE Std 1451.1 is an application that, in the future, will fit between the user's network and this standard. IEEE Std 1451.2 and IEEE Std 1451.3 will also be modified to interface with this standard. When these changes are made, the functions of an IEEE 1451 transducer will be as defined in this standard as will be the commands and TEDS. IEEE 1451.5™-2007, which uses any of several different wireless communications media, and IEEE P1451.6™ have been written around the functions, commands, and TEDS as described in this standard. IEEE Std 1451.4 uses an analog signal interface and a TEDS that is not the same as that used by other members of the family. It may be used as the input to any of the other standards in the family but does not comply with the functions, commands, and TEDS defined in this standard. Items shown with a gray background are items that are not covered by any of the IEEE 1451 family of standards but that may be used.



The underlying purpose of this family of standards is to allow manufacturers to build elements of a system that are interoperable. To accomplish this goal, the IEEE 1451 family of standards divides the parts of a system into two general categories of devices. One is the network capable application processor (NCAP) that functions as a gateway between the users' network and the transducer interface modules (TIMs). The NCAP is a processor-based device that has two interfaces. The physical interface to the users' network is not specified in any of this family of standards. IEEE Std 1451.1 provides a logical object model for this

interface. Other applications may also be used at the manufacturer's discretion. The communications interface between the NCAP and the TIMs is defined in the remaining members of the family of standards. Different manufacturers may build the NCAPs and TIMs, and if both comply with this standard, they should be interoperable.

This standard provides a description of the functions that are to be performed by a transducer interface module or TIM. Provisions are made for a high level of addressing that is independent of the physical medium-level and low-level protocols that are used to implement the communications. It defines the common characteristics for all devices that implement the transducer modules. The timing of the acquiring or processing of the data samples is described. Methods of grouping the outputs from multiple transducers within one TIM are defined. Common status words are also defined.

A standard set of commands are defined to facilitate the setup and control of the transducer modules as well as to read and write the data used by the system. Commands are also provided for reading and writing the TEDS that supply the system with the operating characteristics that are needed to use the transducer modules. A method of adding manufacturer unique commands is included.

In addition, this standard provides formats for the TEDS. Several TEDS are defined in the standard. Four of these TEDS are required, and the remaining TEDS are optional. Some TEDS are provided to allow the user to define information and to store it in the TEDS.

This standard provides areas that are "open to manufacturers." It should be noted that any use of these areas may compromise the "plug-and-play" potential of controllers and TIMs.

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Participants

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Kang Lee, *Chair*
Victoria K. Sweetser, *Vice Chair*
Jay J. Nemeth-Johannes, *Secretary*
Lee H. Eccles, *Editor*
Jefferson B. Burch, *API Architect*

Pat Blakely
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David B. Perrussel
Andrew Segal
Mallikarjun Shankar
Robert Sinclair

Eugene Song
Rich Valde
Larry Whipple
James J. Wiczler
Darold Wobschall

Other individuals who have contributed to this standard are as follows:

Thurston Brooks
Wayne Catlin
Baozhi Chen
Stephen Chen
Ryan Coleman

Ken Cornett
Phil Ellerbrock
Peter Flitner
Fernando GenKuong
Robert N. Johnson
Alice Law

Myung Lee
Larry Malchodi
Loren Rittle
Jay Warrior
Stan Woods

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

William J. Ackerman
Chris B. Bagge
Jefferson B. Burch
Juan C. Carreon
Danila Chernetsov
Keith Chow
Tommy P. Cooper
Matthew T. Davis
David B. Droste
Lee H. Eccles
Michael D. Geipel
Fernando Genkuong
Sergiu R. Goma
Patrick S. Gonia
Randall C. Groves
Ryusuke Hasegawa
Werner Hoelzl
Dennis Horwitz

Jens Hult
Robert N. Johnson
Charles H. Jones
Innocent Kamwa
Piotr Karocki
James C. Kemerling
Edward Koch
Charles A. Lennon, Jr.
William Lumpkins
G. L. Luri
Joseph R. Marshall, Jr.
Gary L. Michel
Yinghua Min
Georges F. Montillet
Jerry R. Murphy
Jay J. Nemeth-Johannes
Michael S. Newman
Chris L. Osterloh

Howard W. Penrose
David B. Perrussel
Vikram Punj
Bogdan Seliger
Mallikarjun Shankar
Thomas M. Siep
Matthew L. Smith
Victoria K. Sweetser
Leroy O. Thielman
Stephen C. Webb
James J. Wiczler
Ernesto Jorge Wiedenbrug
Darold Wobschall
Derek T. Woo
Eric V. Woods
Oren Yuen
Janusz Zalewski

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Richard DeBlasio
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Kenneth S. Hanus
William B. Hopf

Richard H. Hulett
Hermann Koch
Joseph L. Koepfinger*
John D. Kulick
David J. Law
Glenn Parsons
Ronald C. Petersen
Tom A. Prevost

Narayanan Ramachandran
Greg Ratta
Robby Robson
Anne-Marie Sahazizian
Virginia C. Sulzberger
Malcolm V. Thaden
Richard L. Townsend
Howard L. Wolfman

*Member Emeritus

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

Satish K. Aggarwal, *NRC Representative*
Alan H. Cookson, *NIST Representative*

Jennie M. Steinhagen
IEEE Standards Program Manager, Document Development

Norma B. Davis
IEEE Standards Program Manager, Technical Program Development

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IEEE Standard for a Smart Transducer Interface for Sensors and Actuators—Common Functions, Communication Protocols, and Transducer Electronic Data Sheet (TEDS) Formats

1. Overview

This standard introduces the concept of a transducer interface module (TIM) and a network capable application processor (NCAP) connected by a media specified by another member of the IEEE 1451 family of standards. A TIM is a module that contains the interface, signal conditioning, analog-to-digital and/or digital-to-analog conversion and, in many cases, the transducer. A TIM may range in complexity from a single sensor or actuator to units containing many transducers (sensors and actuators). An NCAP is the hardware and software that provides the gateway function between the TIMs and the user network or host processor. Another member of the standards family provides the communications interface between an NCAP or host processor and one or more TIMs. Three types of transducers are recognized by this standard. They are sensors, event sensors, and actuators.

A transducer is denoted “smart” in this context because of three features:

- It is described by a machine-readable Transducer Electronic Data Sheet (TEDS).
- The control and data associated with the transducer are digital.
- Triggering, status, and control are provided to support the proper functioning of the transducer.

An NCAP or a host processor controls a TIM by means of a digital interface medium. The NCAP mediates between the TIM and a higher level digital network and may provide local intelligence.

This standard defines an application program interface (API) for applications that provide communications between the users’ network and the IEEE 1451.0 layer. An API is also provided between the IEEE 1451.0 layer and the underlying physical communications layers usually referred to in this standard as IEEE 1451.X. These API definitions are provided for systems that have visible interfaces. For TIMs and