INTERNATIONAL STANDARD

ISO/IEC/ IEEE 21451-4

First edition
2010-05-15

Information technology — Smart transducer interface for sensors and actuators —

Part 4: Mixed-mode communication protocols and Transducer Electronic Data Sheet (TEDS) formats

Technologies de l'information — Interface de transducteurs intelligente pour capteurs et actuateurs —

Partie 4: Protocoles de communication en mode mixte et formats des feuilles de données électroniques du transducteur (TEDS)

Reference number
ISO/IEC/IEEE 21451-4:2010(E)

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ISO version published 2010

Published in Switzerland

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IEEE Std 1451.4™-2004

IEEE Standards

1451.4™

IEEE Standard for A Smart Transducer Interface for Sensors and Actuators—Mixed-Mode Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats

IEEE Instrumentation and Measurement Society

Sponsored by the
Technical Committee on Sensor Technology TC-9

IEEE

3 Park Avenue, New York, NY 10016-5997, USA

15 December 2004

Print: SH95225
PDF: SS95225

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Recognized as an
American National Standard (ANSI)

IEEE Std 1451.4™-2004

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Sponsor

Technical Committee on Sensor Technology
of the
IEEE Instrument and Measurement Society

Approved 25 August 2004
American National Standards Institute

Approved 25 March 2004
IEEE-SA Standards Board

Abstract: This standard defines the protocol and interface that allows analog transducers to communicate digital information with an IEEE 1451 object. It also defines the format of the Transducer TEDS. The Transducer TEDS is based on the IEEE 1451.2™ TEDS. The standard does not specify the transducer design, signal conditioning, or the specific use of the TEDS.
Keywords: appended TEDS, basic TEDS, device configuration file, family code, IEEE 1451.4 interface, IEEE 1451.4 transducer, mixed-mode Interface (MMI), mixed-mode transducer (MMXD-CR), network capable application processor (NCAP), plug-and-play, smart transducer, TEDS, template, template ID, transducer electronic data sheet (TEDS), template description language, transparent protocol, template description language, tbom schema, transducer block

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The Institute of Electrical and Electronics Engineers, Inc.
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Print: ISBN 0-7381-4007-4 SH95225
PDF: ISBN 0-7381-4008-2 SS95225

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Introduction

[This introduction is not part of IEEE Std 1451.4-2004, IEEE Standard for a Smart Transducer Interface for Sensors and Actuators—Mixed-Mode Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats.]

The main objectives of this standard are to

- Enable plug-and-play at the transducer level by providing a common IEEE 1451.4 Transducer communication interface compatible with legacy transducers.
- Enable and simplify the creation of smart transducers.
- Facilitate the support of multiple networks.
- Simplify the setup and maintenance of instrumentation systems.
- Provide a bridge between the legacy instrumentation systems and the smart mixed-mode transducers.
- Enable implementation of smart transducers with minimal use of memory.

There was previously no defined common digital communication interface standard between mixed-mode transducers and network capable application processors (NCAPs). Each transducer manufacturer defined its own interface. Consequently, transducer manufacturers could not support all of the control networks for which their products might be suitable. A universally accepted mixed-mode transducer interface standard will facilitate the development of compliant smart sensors and actuators and could lead to lower development costs. This common interface allows the transducer manufacturers to support multiple control networks easily and helps to preserve the user's investment if it becomes necessary to migrate to a different network standard. In addition, this standard will make systems much easier to implement and use.

This standard simplifies the development of smart mixed-mode transducers by defining hardware and software blocks that are independent of specific control networks. The standard describes the following:

- An IEEE 1451.4 Transducer containing a Mixed-Mode Interface (MMI) and a transducer electronic data sheet (TEDS).
- The MMI, which is a master-slave, multidrop, serial connection. It requires a master device to initiate each transaction with each slave or node according to a defined digital communication protocol. The MMI may contain circuitry to detect and report a hotswap of transducers. The MMI may use either separate digital and analog connections, or two wires for power supply and time-shared analog signal and digital TEDS data. The MMI is used to access the TEDS.
- The TEDS, which is fixed and dynamic data, contained in one or more memory nodes on the MMI.
- A template, which is a software object describing the data structure of TEDS. It is implemented in the Template Description Language and resides in the Transducer Block.
- The Template Description Language, which is a scripted and tagged language providing a standard method to describe the functionality of IEEE 1451.4 Transducer.
- A Transducer Block, which is a software object describing the IEEE 1451.4 Transducer. It resides in the NCAP, which is the master device (e.g., an instrument or data acquisition system). The Transducer Block is used to access, decode, and encode TEDS using the TDL.

Furthermore, the Working Group has defined a set of TEDS templates for various transducers to facilitate the creation of sensor systems containing plug-and-play smart transducers.

The IEEE 1451.4 Transducer provides a self-describing capability, via the TEDS. The TEDS contains fields that describe the identity, type, operation, and attributes of the transducer. The IEEE 1451.4 Transducer is a sensor or actuator with one or more addressable devices, referred to as nodes, on a 2-conductor digital bus. The TEDS is required to be either physically, or virtually, associated with the IEEE 1451.4 Transducer. The resulting hardware partition encapsulates the measurement aspects inside the IEEE 1451.4 Transducer, while the application related aspects may reside either in the NCAP or in the TEDS.

The IEEE 1451.4 Transducer is a sensor or actuator with one, or more, addressable devices, which herein will be referred to as nodes, containing TEDS.

A digital communication protocol is defined for transactions on the bus. The transactions are as follows:

— Read (Read TEDS)

— Write (Write TEDS)

— Configure (Set Gain, Change Mode, Set Filter)

— Check status (Read Settings)

The IEEE 1451.4 MMI may be used for control networks and data acquisition in a variety of applications, such as portable instruments and data acquisition plug-in cards for PCs.

The Transducer Block object located in the NCAP describes the behavior of the IEEE 1451.4 Transducer. It interprets TEDS data according to the data structure defined in templates. Further processing of the data may take place both in the NCAP and in other processors in larger systems. The NCAP includes an IEEE 1451.1 object model with an IEEE 1451.4 Transducer Block.

The standard does not constrain competitive differentiation in areas of quality, feature set, and cost, and at the same time, offers the opportunity to design to a common interface, which can be used in a wide variety of applications.

Acknowledgements

The working group would like to acknowledge the following individuals who made special contributions to the development of this standard:

Steven Chen, Former Chair, who proposed the mixed-mode transducer interface concept and initiated the development of the standard.

Jørgen Bække, Former Vice Chair, who was instrumental in getting the 2-conductor bus interface and transducer description language concept accepted by the group.

The IEEE has defined a common digital communication interface standard for mixed-mode transducers utilizing a single wire serial bus technology developed by Maxim/Dallas Semiconductor Corporation.

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Contents

IEEE Standard for a Smart Transducer Interface for Sensors and Actuators—Mixed-Mode Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats

1. Overview

This standard is divided into nine clauses. Clause 1 provides the scope of this standard. Clause 2 lists references to other standards that are useful in applying this standard. Clause 3 provides definitions that are either not found in other standards or have been modified for use with this standard. Clause 4 describes the IEEE 1451.4™ Interface and the IEEE 1451.4 Transducer and levels of compliance with this standard. Clause 5 describes the TEDS. Clause 6 describes the usage of the template structure. Clause 7 describes the syntax and semantics of the language used in the templates. Clause 8 describes the Mixed-Mode Transducer Interface (MMI) that ensures the robust transfer of an analog transducer signal and the digital TEDS data. Clause 9 describes the Transducer Block, which is the collective logic required to manage the transducer bus and all external components.

This standard also contains several annexes. Annex A lists the IEEE templates. Annex B lists the definitions of properties used in templates. Annex C contains the Template Description Language (TDL) formal grammar. Annex D gives a template file checksum example. Annex E gives information about the Family Code in the Unique Registration Number (URN). Annex F gives the Device Configuration File format needed for a parser to be able to understand Family Codes and act accordingly. Annex G contains an XML device description schema to be used to add support for new devices. Annex G contains information about the transparent protocol facilitating the communication with 2-conductor bus devices. Annex H describes the procedure for adding new IEEE templates and TDL items. Annex I contains information about the early draft of the standard IEEE P1451.4, version 0.9. Annex J lists the IEEE 1451.4 Manufacturer IDs. Annex K gives the IEEE 1451.4 Transducer Block Object Model (TBOM) schema. Annex L defines the Transducer Block adapter class that shall be used to represent transducers adhering to IEEE 1451.4 within an IEEE 1451.1™ environment.[1] Annex M is the bibliography.

[1]Information on references can be found in Clause 2.

1.1 Scope

This standard defines the protocol and interface that allows analog transducers to communicate digital information with an IEEE 1451 object. It also defines the format of the Transducer TEDS. The Transducer TEDS is based on the IEEE 1451.2™ TEDS. The standard does not specify the transducer design, signal conditioning, or the specific use of the TEDS.

1.2 Purpose

An independent and openly defined standard for MMI and TEDS serves the following purposes:

— Provide interoperability, which enables plug-and-play capability

— Simplify the implementation of mixed-mode smart transducer systems

— Accelerate the emergence and acceptance of the MMI and TEDS

1.3 Conformance, shall, should, may, and can

Several keywords are used to differentiate among various levels of requirements, as follows:

The word *shall* is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (shall equals *is required to*).

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The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

2. References

This standard shall be used in conjunction with the following standards publications. When the following standards are superseded by an approved revision, the revision shall apply.

ANSI X3.4-2000, US-ASCII. Coded Character Sets—7-Bit American Standard Code for Information Interchange.[2]

IEEE Std 754™-1985 (Reaff 1990), IEEE Standard for Binary Floating-Point Arithmetic.[3,4]

IEEE Std 1451.1-1999, IEEE Standard for a Smart Transducer Interface for Sensors and Actuators—Network Capable Application Processor (NCAP) Information Model.

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IEEE Std 1451.2-1997, IEEE Standard for a Smart Transducer Interface for Sensors and Actuators—Transducer to Microprocessor Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats.

ISO/IEC 10646-1:2000, Information technology—Universal Multiple-Octet Coded Character Set (UCS)—Part 1: Architecture and Basic Multilingual Plane.[5]

Le Système international d'unités (SI), The International System of Units (SI), 7th Edition (1998), with Supplement 2000.[6]

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