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Information technology — Smart transducer interface for sensors and actuators —

Part 2: Transducer to microprocessor communication protocols and Transducer Electronic Data Sheet (TEDS) formats

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

Partie 2: Protocoles de communication de transducteur à micro-processeur et formats des feuilles de données électroniques du transducteur (TEDS)

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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

IEEE Instrumentation and Measurement Society

Sponsored by
TC-9, Committee on Sensor Technology

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

Sponsor
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Abstract: A digital interface for connecting transducers to microprocessors is defined. A TEDS and its data formats are described. An electrical interface, read and write logic functions to access the TEDS and a wide variety of transducers are defined. This standard does not specify signal conditioning, signal conversion, or how the TEDS data is used in applications.
Keywords: communication protocol, digital interface, microprocessor, NCAP, sensor interface, smart actuator, smart sensor, smart sensor interface, smart transducer, smart transducer interface, STIM, TEDS, 1451

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Introduction

[This introduction is not part of IEEE Std 1451.2-1997, IEEE Standard for a Smart Transducer Interface for Sensors and Actuators—Transducer to Microprocessor Communications Protocols and Transducer Electronic Data Sheet (TEDS) Formats.]

The main objectives of this standard are to:

— Enable plug and play at the transducer (sensor or actuator) level by providing a common communication interface for transducers.
— Enable and simplify the creation of networked smart transducers.
— Facilitate the support of multiple networks.

The existing fragmented sensor market is seeking ways to build low-cost, networked smart sensors. Many sensor network or fieldbus implementations are currently available, each with its own strengths and weaknesses for a specific application class. Interfacing transducers to all these control networks and supporting the wide variety of protocols represents a significant and costly effort to transducer manufacturers. A universally-accepted transducer interface standard would not only allow for the development of smart sensors and actuators, it could also lead to lower development costs. Therefore, the objective of this project is not to propose another control network, but to develop a smart transducer interface standard that will isolate the choice of transducers from the choice of networks. This would relieve the burden from the manufacturer of supporting a cross product of sensors versus networks, and would help to preserve the user's investment if it becomes necessary to migrate to a different network standard.

There is currently no defined common digital communication interface standard between transducers and network capable application processors (NCAPs). Each transducer manufacturer builds its own interface. Consequently, transducer manufacturers cannot afford to support all of the control networks for which their products may be suited. It was concluded at a series of five transducer interface workshops held between 1994 and 1995 that a common transducer communication interface standard be proposed. This common interface would allow the transducer manufacturers to more easily support multiple control networks.

This standard will simplify the development of networked transducers by defining hardware and software blocks that do not depend on specific control networks. This project has developed a standard hardware interface to connect a smart transducer interface module (STIM) to an NCAP. While the project does not include specifications for signal conditioning or data conversion, it does provide a mechanism for specifying the combination of transducer, signal conditioning, and signal conversion to the rest of the system. This mechanism is the transducer electronic data sheet (TEDS). The working group has defined a TEDS which supports a wide variety of transducers as well as a digital interface to access the TEDS, read sensors, and set actuators. This allows transducer manufacturers competitive differentiation in areas of quality, feature set and cost, and at the same time affords the opportunity to design to a common interface which can be used in a wide variety of applications.

The TEDS, which provides for self-identifying transducers, is at the core of this effort. The TEDS contains fields that fully describe the type, operation, and attributes of one or more transducers. By requiring that the TEDS be physically associated with the transducer, the resulting hardware partition encapsulates the measurement aspects in a STIM on one side of the digital interface, and the application related aspects on the NCAP on the other side. In addition to control networks, STIMs can be used with microprocessors in a variety of applications such as portable instruments and data acquisition cards.

Data output by the STIM may be in integer, single precision real, or double precision real formats. The data is passed to the NCAP and from the NCAP to the rest of the system. Further processing of this data may take place both in the NCAP and in other processors in the larger system. Throughout this standard it is assumed, but not required, that all processing will be performed on data in a single- or double-precision real format.

All fields in the TEDS are specified based on the assumption that, unless specifically stated to the contrary, all data will be converted to single- or double-precision real before any processing is performed.

This standard provides areas that are "open to industry." It should be noted that any use of these areas compromises the "plug and play" potential of NCAPs and STIMs.

The IEEE 1451.2 transducer to microprocessor interface is compatible with the P1451.1[1] information model standard. The two parts form a standard interface for networked smart sensors and actuators.

Contents

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

1. Overview

This standard introduces the concept of a Smart Transducer Interface Module (STIM). A STIM can range in complexity from a single sensor or actuator to many channels of transducers (sensors or actuators). Seven types of transducer channels are recognized by this standard and provision has been made for other types to be added. The transducer channel types are specified in 4.2.

A transducer channel is denoted "smart" in this context because of the following three features:

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

A STIM is controlled by a Network Capable Application Processor (NCAP) module by means of a dedicated digital interface. This interface is not a network. The NCAP mediates between the STIM and a digital network, and may provide local intelligence.

This standard is divided into six clauses. Clause 1 provides the scope, the purpose, and the conformance requirements of this standard. Clause 2 lists references to other standards and documents 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, as well as a list of acronyms and abbreviations. Clause 4 specifies the functions required of a STIM and of each channel it comprises. Clause 5 specifies the TEDS structure. Clause 6 specifies the physical transducer interface between the STIM and the NCAP.

1.1 Scope

This standard defines a digital interface for connecting transducers to microprocessors. It describes a TEDS and its data formats. It defines an electrical interface, read and write logic functions to access the TEDS, and a wide variety of transducers. This standard does not specify signal conditioning, signal conversion, or how the TEDS data is used in applications.

1.2 Purpose

There is currently no defined independent digital communication interface standard between transducers and microprocessors. Each vendor builds its own interface. Without an independent, openly defined interface, transducer interfacing and integration are time-consuming and duplicated efforts by vendors are economically unproductive. This interface provides a minimum implementation subset that allows self-identification and configuration of sensors and actuators, and also allows extensibility by vendors to provide growth and product differentiation.

1.3 Conformance

The philosophy underlying the conformance requirements of this subclause is to provide the structure necessary to raise the level of interoperability of transducers and systems built to this standard, while leaving open opportunity for continued technical improvement and differentiation.

A STIM implementation shall be deemed in conformance with this standard provided that the following three requirements are met:

- The STIM supports the required functional performance specified in Clause 4.
- The STIM contains a TEDS that has the format specified in Clause 5.
- The STIM physical interface implements the lines, protocol and timing as defined in Clause 6.

An NCAP implementation shall be deemed in conformance with this standard provided that the following requirement is met:

- An interface that implements the lines, protocols, and timing as defined in Clause 6 is used to access a STIM.

1.3.1 Conformance levels

Several keywords are used to differentiate among various levels of requirements and optionality, as follows.

The word *shall* is used to indicate a mandatory requirement. Designers are required to implement all such mandatory requirements to ensure interoperability with other IEEE 1451.2 conformant products.

The word *recommended* is used to indicate flexibility of choice with a strong preference alternative. The word *should* has the same meaning.

The word *may* is used to indicate a course of action permissible within the limits of the standard, but with no implied preference.

2. References

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

ANSI X3.4-1986 (Reaff 1992), Coded Character Set—7-bit American National Standard Code For Information Interchange.[1]

CNS 11643: 1992, Standard Interchange Code for Generally-Used Chinese Characters.[2]

FSS-UTF, File System Safe UCS Transformation Format (FSS_UTF). X/Open CAE Specification C501 ISBN 1-85912-082.[3]

GB 2312-1980, China State Bureau of Standards. Coded Chinese Graphic Character Set for Information Interchange.

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

IEEE Std 1003.1b-1993, IEEE Standard for Information Technology—Portable Operating System Interfaces (POSIX®).

ISO 639: 1988, Code for the Representation of Names of Languages.[5]

ISO 8859-1: 1987, Information Processing—8-Bit Single-Byte Coded Graphic Character Sets—Part 1: Latin Alphabet No. 1.

ISO 8859-2: 1987, Information Processing—8-Bit Single-Byte Coded Graphic Character Sets—Part 2: Latin Alphabet No. 2.

ISO 8859-3: 1988, Information Processing—8-Bit Single-Byte Coded Graphic Character Sets—Part 3: Latin Alphabet No. 3.

ISO 8859-4: 1988, Information Processing—8-Bit Single-Byte Coded Graphic Character Sets—Part 4: Latin Alphabet No. 4.

ISO 8859-6: 1987, Information Processing—8-Bit Single-Byte Coded Graphic Character Sets—Part 6: Latin/Arabic Alphabet.

ISO 8859-7: 1987, Information Processing—8-Bit Single-Byte Coded Graphic Character Sets—Part 7: Latin/Greek alphabet.

ISO 8859-8: 1988, Information Processing—8-Bit Single-Byte Coded Graphic Character Sets—Part 8: Latin/Hebrew alphabet.

[1]ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

[2]CSBS documents can be obtained from the China State Bureau of Standards, P.O. Box 8010, 42 Hi Chun Road, Haidian District, Beijing 100088, China.

[3]This document is available by contacting X/Open Company Ltd—USA, 3141 Fairview Park Drive, Suite 670, Falls Church VA 22042-4501 USA.

[4]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

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