

INTERNATIONAL
STANDARD

ISO/IEC/
IEEE
21451-7

First edition
2011-12-15

**Information technology — Smart
transducer interface for sensors and
actuators —**

**Part 7:
Transducer to radio frequency
identification (RFID) systems
communication protocols and
Transducer Electronic Data Sheet (TEDS)
formats**

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

*Partie 7: Protocoles de communication entre capteurs et systèmes
d'identification par radiofréquence (RFID) et feuilles de données
électroniques du transducteur (TEDS)*



Reference number
ISO/IEC/IEEE 21451-7:2011(E)



© ISO/IEC 2011
© IEEE 2011



COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2011
© IEEE 2011

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from ISO, IEC or IEEE at the respective address below.

ISO copyright office
Case postale 56
CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published by ISO in 2012
Published in Switzerland

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
E-mail inmail@iec.ch
Web www.iec.ch

Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York
NY 10016-5997, USA
E-mail stds.ipr@ieee.org
Web www.ieee.org

Contents

| | Page |
|--|------------|
| Foreword | vi |
| Introduction | vii |
| 1 Scope | 1 |
| 2 Conformance | 1 |
| 3 Normative references | 1 |
| 4 Terms and definitions | 2 |
| 5 Abbreviated terms | 2 |
| 6 Transducer and RFID system interface specification | 3 |
| 7 Air interface applicability (RFID and RTLS) | 4 |
| 7.1 General | 4 |
| 7.2 Overview | 4 |
| 7.3 Sensor security system basic operations | 5 |
| 7.3.1 Air interface security system support | 5 |
| 7.3.2 Direct sensor security support | 5 |
| 7.4 Sensor identifier | 7 |
| 7.5 Sensor characteristics TEDS (Type 1) | 8 |
| 7.5.1 TEDS type | 10 |
| 7.5.2 Sensor type | 10 |
| 7.5.3 Units extension | 10 |
| 7.5.4 Sensor map of supported measurement codes | 10 |
| 7.5.5 Data resolution | 11 |
| 7.5.6 Scale factors for transmitted data | 12 |
| 7.5.7 Data uncertainty | 13 |
| 7.5.8 Sensor reconfiguration | 13 |
| 7.5.9 Memory rollover capability | 13 |
| 7.5.10 Air interface security capability | 17 |
| 7.5.11 Sensor security capability | 17 |
| 7.5.12 Sensor authentication encryption capability map | 17 |
| 7.5.13 Sensor data encryption capability map | 18 |
| 7.5.14 Random number size | 18 |
| 7.5.15 Continuing authentication capability field | 18 |
| 7.5.16 Sensor authentication password/key size | 19 |
| 7.5.17 Sensor data encryption key size | 19 |
| 7.5.18 Data encryption capability field | 19 |
| 7.6 Sample and configuration record | 20 |
| 7.6.1 UTC timestamp at configuration and beginning of mission | 20 |
| 7.6.2 Sample interval | 21 |
| 7.6.3 Monitor delay | 21 |
| 7.6.4 Alarm values set | 21 |
| 7.6.5 Memory rollover enabled | 21 |
| 7.6.6 Air interface tag security status code | 22 |
| 7.6.7 Sensor command classes | 22 |
| 7.6.8 Air interface security function code | 23 |
| 7.6.9 Sensor security function code | 24 |
| 7.6.10 Sensor authentication encryption function code | 25 |
| 7.6.11 Sensor data encryption function code | 25 |
| 7.6.12 Security timer duration | 25 |
| 7.6.13 Secure session timer | 25 |

| | | |
|-----------------------|---|----|
| 7.6.14 | Upper alarm threshold value | 26 |
| 7.6.15 | Lower alarm threshold value | 26 |
| 7.7 | Event administration record | 26 |
| 7.7.1 | Code 10 sample capacity (C10SC) | 27 |
| 7.7.2 | Code 11 sample capacity (C11SC) | 27 |
| 7.7.3 | Code 12 sample capacity (C12SC) | 28 |
| 7.7.4 | Code 13 sample capacity (C13SC) | 28 |
| 7.7.5 | Sample count | 28 |
| 7.7.6 | Alarms triggered | 28 |
| 7.7.7 | Sample count at a predetermined time | 28 |
| 7.7.8 | Sample count and data following alarm event | 29 |
| 7.7.9 | Sample count of events outside either threshold | 29 |
| 7.7.10 | Sample count at the first threshold event | 29 |
| 7.7.11 | Mission in progress | 29 |
| 7.8 | Event records | 29 |
| 7.8.1 | Single event record | 30 |
| 7.8.2 | Single event with timestamp | 30 |
| 7.8.3 | Event counts | 30 |
| 7.8.4 | Data log of all sampled events | 30 |
| 7.8.5 | Data log plus time tick | 31 |
| 7.8.6 | Data log of all observations after initial alarm | 31 |
| 8 | Command overview | 31 |
| 8.1 | General | 31 |
| 8.2 | Read sensor identifier | 34 |
| 8.3 | Read primary characteristics TEDS | 35 |
| 8.4 | Write sample and configuration | 36 |
| 8.5 | Read sample and configuration | 39 |
| 8.6 | Read alarm status | 41 |
| 8.7 | Read single memory record | 43 |
| 8.8 | Read event administration record | 45 |
| 8.9 | Read event record segments | 47 |
| 8.10 | Read partial event record segment | 50 |
| 8.11 | Write event administration field 7 | 51 |
| 8.12 | Read any field | 53 |
| 8.13 | Erase event administration record | 54 |
| 8.14 | Erase event records | 55 |
| 8.15 | Erase sample and configuration record | 56 |
| 8.16 | Begin end mission | 57 |
| 8.17 | Challenge | 60 |
| 8.18 | Reader authenticate | 63 |
| 8.19 | ReadWriteLock keys | 65 |
| 8.20 | Request RN | 67 |
| 8.21 | Encryption on/off | 69 |
| 8.22 | Close secure session | 70 |
| 9 | RFID communications | 71 |
| 9.1 | Support for commands | 71 |
| 9.2 | Addressing and sub-addressing of sensors | 71 |
| Annex A (normative) | Sensor types | 73 |
| Annex B (normative) | Extension codes | 74 |
| Annex C (informative) | Physical interfaces | 75 |
| C.1 | Interface - Serial Bus | 75 |
| C.2 | 1-Wire | 75 |
| C.3 | SPI (Serial Peripheral Interface) | 75 |
| C.4 | I ² C (I Squared C) | 76 |
| Annex D (informative) | Integration of ISO/IEC/IEEE 21451-7 transducers with other ISO/IEC/IEEE 21451 devices | 77 |

| | |
|---|-----------|
| Annex E (informative) Sensor authentication and encryption | 79 |
| E.1 Need for authentication and encryption | 79 |
| E.2 Use of a stream cipher for encryption..... | 79 |
| E.3 Authentication using a stream cipher | 80 |
| E.4 Recommendations | 81 |
| Bibliography..... | 82 |

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of ISO/IEC JTC 1 is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is called to the possibility that implementation of this standard may require the use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. ISO/IEEE is not responsible for identifying essential patents or patent claims for which a license may be required, for conducting inquiries into the legal validity or scope of patents or patent claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance or a Patent Statement and Licensing Declaration Form, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from ISO or the IEEE Standards Association.

ISO/IEC/IEEE 21451-7 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*, in cooperation with the Technical Committee on Sensor Technology (TC9) of the IEEE Instrumentation and Measurement Society, under the Partner Standards Development Organization cooperation agreement between ISO and IEEE.

ISO/IEC/IEEE 21451 consists of the following parts, under the general title *Information technology — Smart transducer interface for sensors and actuators*:

- *Part 1: Network Capable Application Processor (NCAP) information model*
- *Part 2: Transducer to microprocessor communication protocols and Transducer Electronic Data Sheet (TEDS) formats*
- *Part 4: Mixed-mode communication protocols and Transducer Electronic Data Sheet (TEDS) formats*
- *Part 7: Transducer to radio frequency identification (RFID) systems communication protocols and Transducer Electronic Data Sheet (TEDS) formats*

Introduction

This part of ISO/IEC/IEEE 21451 describes communication methods, data formats and provides a Transducer Electronic Data Sheet (TEDS) for sensors working in cooperation with radio frequency identification (RFID) systems. This part of ISO/IEC/IEEE 21451 does not outline, recommend, or prescribe any specific air-interface protocol. This part of ISO/IEC/IEEE 21451 is intended to be air-interface agnostic.

In the ISO/IEC/IEEE 21451 series of standards, transducers (sensors or actuators) are connected to a transducer interface module (TIM), which is connected to a network capable application processor (NCAP) to allow network access of transducer data. ISO/IEC/IEEE 21450 defines a set of common functionality, commands, and TEDS for the ISO/IEC/IEEE 21451 series of smart transducer standards.

ISO/IEC/IEEE 21450 provides a common basis for members of the ISO/IEC/IEEE 21451 series of standards to be interoperable. It defines the functions that are to be performed by a TIM and the common characteristics for all devices that implement the TIM. It specifies the formats for 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. ISO/IEC/IEEE 21451-1 defines a smart transducer object model and communication methods to facilitate the access of smart transducers in a network. ISO/IEC/IEEE 21451-2 defines serial interfaces for connecting transducer modules to a network processor. ISO/IEC/IEEE 21451-4 defines a mixed-mode transducer interface that allows the transfer of digital transducer electronic data sheet and analogue sensor signals on the same wires.

Information technology — Smart transducer interface for sensors and actuators —

Part 7: Transducer to radio frequency identification (RFID) systems communication protocols and Transducer Electronic Data Sheet (TEDS) formats

1 Scope

This part of ISO/IEC/IEEE 21451 defines communication methods and data formats for transducers (sensors and actuators) communicating with RFID tags. This part of ISO/IEC/IEEE 21451 also defines Transducer Electronic Data Sheet (TEDS) formats based on the ISO/IEC/IEEE 21451 series of standards and protocols for accessing TEDS and transducer data. It adopts necessary interfaces and protocols to facilitate the use of technically differentiated, existing technology solutions. It does not specify transducer design or signal conditioning.

There is currently no openly defined independent interface standard between transducers and RFID tags. Each vendor builds its own interface. Without such a standard, transducer interfacing and integration to RFID tags and systems are time-consuming and all vendors' duplicated efforts are economically unproductive. The purpose of this part of ISO/IEC/IEEE 21451 is to provide interfaces and methods for interfacing transducers to RFID tags and reporting transducer data within the RFID infrastructure. It also provides the means for device and equipment interoperability.

2 Conformance

Conformance to this part of ISO/IEC/IEEE 21451 requires that all non-optional sections be implemented in the vendor device.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 19762 (all parts), *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

IEEE Std 100-2000, *The Authoritative Dictionary of IEEE Standards Terms, Seventh Edition*