



Edition 1.0 2019-11

INTERNATIONAL STANDARD



<u>IEC 60747-19-1:2019</u> https://standards.iteh.ai/catalog/standards/sist/88flc18d-1d36-420f-a196-2dbf695f3532/iec-60747-19-1-2019





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Semiconductor devices - STANDARD PREVIEW Part 19-1: Smart sensors - Control scheme of smart sensors

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 31.080.99

ISBN 978-2-8322-7606-8

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SEMICONDUCTOR DEVICES -

Part 19-1: Smart sensors – Control scheme of smart sensors

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The text of this International Standard is based on the following documents:

CDV	Report on voting
47E/642/CDV	47E/668/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60747 series, published under the general title *Semiconductor devices*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

The development of smart sensors which integrate analog-to-digital conversion and digital processing of the captured sensor signal(s) is in progress. A smart sensing unit, which comprises a smart sensor; a terminal module, to control the smart sensor and perform wireless communication; and a power supply for the smart sensor and the terminal module, can send the output data of the smart sensor wirelessly to the outside. Here, the power supply can be a plug-in power supply, a battery, an energy harvester, or their combination. A smart sensing network where a large number of smart sensing units are located in manufacturing factories, offices, and stores has been examined. With this network, environmental monitoring, sensing of operational situations of manufacturing equipment and sensing of other various events contribute to the realization of the following outcomes by analyzing the collected sensing data. Namely, energy saving, improvement in factory productivity such as operation rate, shortening of production lead time, preventive equipment maintenance, and product quality improvement can be achieved.

However, considering the three components of the smart sensing unit, namely, the smart sensor, terminal module, and power supply, standardization regarding control schemes to connect the components to each other and regarding the indication of specifications of the components has not been sufficiently established yet. This issue leads to the present situation, where the development of each component in the smart sensing unit has not proceeded efficiently.

The IEC 60747-19 series aims to address this issue. The IEC 60747-19 series comprises two parts and its structure is currently conceived as follows: REVIEW

Part 19-1: Smart sensors – Control scheme of smart sensors

Part 19-21: Smart sensors – Indication of specifications of smart sensors and power supplies to drive smart sensors://standards.iteh.ai/catalog/standards/sist/88f1c18d-1d36-420f-a196-2dbf695f3532/jec-60747-19-1-2019

Part 19-1 specifies a control scheme of the smart sensor from the terminal module in the smart sensing unit. Generally, the manufacturers of sensors have incorporated into the sensors various parameters and conditions for sensing operations to fulfil various requests and needs of the users. Therefore, it has been quite difficult for the users to understand how to set the parameters and conditions adequately and master the use of sensors. This issue has been a considerable obstacle in designing the smart sensing unit and smart sensing system. The main objective of this part is to solve this obstacle for future expansion of the smart sensors and smart sensing network systems.

Part 19-2 aims to provide guidelines to specify information that is required when the smart sensing unit is newly designed. When the smart sensing unit is newly designed especially to use an autonomous power supply, the designers have to appropriately arrange the selection of the components of the unit and their usage conditions to satisfy that the power capability of the power supply successfully exceeds the total power budget to be consumed in the unit as a whole. First, information about the detailed power consumption characteristics of the smart sensors is indispensable for this achievement. Namely, information about time-axis power profiles which is not necessarily described in the datasheet of sensors is essential when intermittent sensing operations are often adopted and a careful lower power design including time-axis characteristics of time-axis power profiles. Second, information about total power capability of the power capability of the power supply to drive the unit and the smart sensor(s) is essential. This power supply as a module comprises (a) primary battery(batteries), and(or) (a) secondary battery(batteries), and(or) (an) energy harvester(s), or their combinations.

¹ Under development.

Considering the not-so-simple configuration including power management circuits as a power supply, Part 19-2 also discusses the indication of specifications of the power supply. With the establishment of appropriate indications, the three components of the smart sensing unit can be easily selected and combined from a point of view of a low-power design, when the smart sensing unit is newly designed and the overall design of the smart sensing unit itself can be facilitated.

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SEMICONDUCTOR DEVICES –

Part 19-1: Smart sensors – Control scheme of smart sensors

1 Scope

This part of IEC 60747 specifies the control scheme of a sensor which is a device or a module which achieves a sensing function, data processing function and data output function, by employing a digital processing unit and a means of bidirectional communication between the sensor and an external terminal module.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses: (standards.iteh.ai)

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp.f-a196-

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3.1

smart sensor

sensor device or sensor module which integrates analog-to-digital conversion and digital processing of the captured sensor signal(s)

3.2

smart sensing unit

unit comprising a smart sensor, a terminal module, and a power supply, which can send output data of the smart sensor to the outside

3.3

terminal module

integrated circuit device or module which is a component of a smart sensing unit, and which controls the smart sensor, receives the output data of the smart sensor, and sends the output data to the outside

3.4

digital processing circuit

integrated circuit device or a module performing digital arithmetic and(or) logic operations on digital data

3.5

register

local storage area on a digital processing circuit, which holds digital data that is being processed by the digital processing circuit

3.6

operation mode

operation type of an electronic device or module predetermined by its manufacturer, and in some cases, determined by its user

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3.7

sleep mode

power-saving mode for an electronic device or module in which all unnecessary components in the device or module are shut down

3.8

status information

information regarding the current condition of an electronic device or module

3.9

data ready

type of status information, which is a piece of digital data to mark when a data preparing operation has been conducted and when data has been available in an electronic device or module

3.10

error flag

type of status information, which is a piece of digital data to mark when an error event has occurred in an electronic device or module iTeh STANDARD PREVIEW

3.11

(standards.iteh.ai)

inter-integrated circuit 1²C

widely used two-line digital serial communication9bus019

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2dbf695f3532/jec-60747-19-1-2019

serial peripheral interface

3.12 SPI

widely used three-line or four-line digital serial communication bus

4 Construction of smart sensor's control scheme

4.1 General

Figure 1 provides a block diagram of the hardware configuration regarding the smart sensor's control scheme from the terminal module in the smart sensing unit. The smart sensor's control scheme utilizes registers which a digital processing circuit embedded in the smart sensor possesses. The smart sensor's control scheme is established by operations in which both the terminal module and the smart sensor mutually read and write data to the registers. Each register is of 1 byte. Table 1 provides the byte assignment of the registers in the control scheme. Here, the name, address, and content of each register are defined, and the type of each register is shown. "R/W" means that the terminal module can read and write data to the register and "R" means that the terminal module can only read data from the register. In addition, the default value of each register is defined. For mandatory register possession, 4 bytes (or 4 registers) shall be prepared in this control scheme. The maximum number of registers, including optional possession, is 256 bytes (or 256 registers) in the control scheme.

4.2 Assignment of the smart sensor's registers in the control scheme

The operation mode of the smart sensor is specified by writing data as in the manner determined in Table 1. That is, the two bytes of the registers with the register addresses of 0x00h and 0x01h shall be used for specifying the operation mode of the smart sensor.

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When the data of "0x00h" is written to the "MODE1" register, the operation mode shall be specified to the default mode. When the data of "0x01h" is written to the "MODE1" register, the operation mode shall be specified to the sleep mode. When the data from "0x02h" to "0xFFh" is written to the "MODE1" register, the operation mode corresponding to the number of written data shall be specified. The operation contents of the default operation mode and the operation modes corresponding to the operation mode numbers are defined by the manufacturer of the smart sensor and are described in the datasheet of the smart sensor. With the corresponding numbers from "0x02h" to "0xFFh," 254 operation modes can be prepared. The 254 operation modes and the default mode result in 255 operation modes to be defined in total.

The "MODE2" register shall be prepared and may be optionally used to specify the operation modes in combination with the "MODE1" register. More than 255 operation modes become available using the "MODE2" register.

The "STATUS1" register shall be assigned to the status information of the smart sensor. The "STATUS2" register shall be assigned to the status information of the smart sensor as an option in combination with the "STATUS1" register. For example, as a status information, a data ready bit and(or) an error flag bit may be defined. The content and definition of the status information shall be defined freely by the manufacturer of the smart sensor, and its assignment is described in the datasheet of the smart sensor. The "DATA" registers with the addresses from 0x04h to 0xFFh may be assigned to the output or input data of the smart sensor. The output or input data do not contain any information about their units. The information about the units and forms of data is described in the datasheet of the smart sensor in addition to the explanation of each operation moder VIEW.

In addition, the "MODE2" register may be used to specify the parameters for an operation of the smart sensor. For example, when data processing of the filtering or judgement is performed against the acquired sensing data in a smart sensor, the parameters required for such data processing may be set using the "MODE2" register. Furthermore, although the registers assigned for the setting of the operation modes are only 2 bytes which are the "MODE1" and "MODE2" registers, the "DATA" registers may be utilized by describing this additional specification in the datasheet, in case of shortage of the available number of operation modes.

4.3 Operation procedure of control scheme

The basic operation procedure of the smart sensor's control scheme is explained as follows. First, the terminal module writes the operation mode number to the "MODE1" register among the registers which a digital processing circuit embedded in the smart sensor possesses. (Here, if the terminal module reads the "MODE1" register, the terminal module can confirm the previously specified number of the operation mode.) Second, the smart sensor reads data stored in the "MODE1" register and performs the operation corresponding to the read operation's mode number. Then, the smart sensor stores its output data in the "DATA" registers, as well as its status information in the "STATUS1" register. Finally, the terminal module comprehends the status information of the smart sensor by reading data stored in the "STATUS1" register and comprehends the output data of the smart sensor by reading the data stored in the "DATA" registers.