

INTERNATIONAL STANDARD

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**Railway applications – Energy measurement on board trains –
Part 6: Requirements for purposes other than billing**

**Applications ferroviaires – Mesure d'énergie à bord des trains –
Partie 6: Exigences à des fins autres que la facturation**



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INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Railway applications – Energy measurement on board trains –
Part 6: Requirements for purposes other than billing**

**Applications ferroviaires – Mesure d'énergie à bord des trains –
Partie 6: Exigences à des fins autres que la facturation**

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**RAILWAY APPLICATIONS –
ENERGY MEASUREMENT ON BOARD TRAINS –****Part 6: Requirements for purposes other than billing****FOREWORD**

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International Standard IEC 62888-6 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This standard supplements and/or amends the requirements specified in IEC 62888-1 to IEC 62888-5 which are based on EN 50463.

The text of this standard is based on the following documents:

FDIS	Report on voting
9/2431/FDIS	9/2450/RVD

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 62888 series, published under the general title *Railway applications – Energy measurement on board trains*, 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

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INTRODUCTION

Three levels are introduced for categorizing EMS as described in Clause 1.

This is Part 6 of the IEC 62888 series which consists of the following parts, under the general title *Railway applications – Energy measurement on board trains*:

Part 1: General

Part 2: Energy measurement

Part 3: Data handling

Part 4: Communication

Part 5: Conformance test

Part 6: Requirements for purposes other than billing

This series of International Standards follows the functional guidelines description in Annex A, “Principles of conformity assessment”, of ISO/IEC 17000:2004 tailored to the Energy Measurement System (EMS).

The Energy Measurement System (EMS) provides measurement and data suitable for applications such as energy management, energy saving, billing and others.

This series of International Standards uses the functional approach to describe the EMS. These functions are implemented in one or more physical devices. The user of this series of standards is free to choose the physical implementation arrangements.

Structure and main contents of the IEC 62888 series

This series of International Standards is divided into six parts. The titles and brief descriptions of each part are given below:

IEC 62888-1 – General

The scope of IEC 62888-1 is the Energy Measurement System (EMS).

IEC 62888-1 provides system level requirements for the complete EMS and common requirements for all devices implementing one or more functions of the EMS.

IEC 62888-2 – Energy measurement

The scope of IEC 62888-2 is the Energy Measurement Function (EMF).

The EMF provides measurement of the consumed and regenerated active energy of a traction unit. If the traction unit is designed for use on AC traction supply systems, the EMF also provides measurement of reactive energy. The EMF provides the measured quantities via an interface to the Data Handling System.

The EMF consists of the three functions: Voltage Measurement Function, Current Measurement Function and Energy Calculation Function. For each of these functions, accuracy classes are specified and associated reference conditions are defined. This part also defines all specific requirements for all functions of the EMF.

The Voltage Measurement Function measures the voltage of the contact line (CL) system and the Current Measurement Function measures the current taken from and returned to the CL system. These functions provide signal inputs to the Energy Calculation Function.

The Energy Calculation Function inputs the signals from the Current and Voltage Measurement Functions and calculates a set of values representing the consumed and regenerated energies. These values are transferred to the Data Handling System and are used in the creation of Compiled Energy Measured Data.

All relevant metrological aspects are covered in this part of IEC 62888.

IEC 62888-2 also defines the conformance test of the EMF.

IEC 62888-3 – Data handling

The scope of IEC 62888-3 is the Data Handling System (DHS).

The on board DHS receives, produces and stores data, ready for transmission to any authorised receiver of data on board or on ground. The main goal of the DHS is to produce Compiled Energy Measured Data and transfer it to an on-ground Data Collection Service (DCS). The DHS can support another functionality on board or on-ground with data, as long as this does not conflict with the main goal.

IEC 62888-3 also defines the conformance test of the DHS.

IEC 62888-4 – Communication

The scope of IEC 62888-4 is the communication services.

This part of IEC 62888 gives requirements and guidance regarding the data between the functions implemented within EMS as well as between such functions and other on board units where data are exchanged using a communications protocol stack over a dedicated physical interface or a shared network.

It includes the on board to ground communication service and covers the requirements necessary to support data transfer between DHS and DCS.

IEC 62888-4 also defines the conformance test of the communications services.

IEC 62888-5 – Conformance test

The scope of IEC 62888-5 is the conformance test procedures for the EMS.

IEC 62888-5 also covers re-verification procedures and conformance test in the event of the replacement of a device of the EMS.

IEC 62888-6 – Requirements for purposes other than billing

The scope of IEC 62888-6 is to specify the requirements for EMS to be used for benchmarking, daily energy consumption monitoring, technical research and development.

This part provides the requirements for monitoring consumed energy on-board in daily services in an easy way and the measured data are applicable for general purposes in industry such as energy management, energy saving, etc. However, this part is not applicable for billing purposes.

EMS functional structure and dataflow

Figure 1 illustrates the functional structure of the EMS, the main sub-functions and the structure of the dataflow and is informative only. Only the main interfaces required by this standard are displayed by arrows.

Since the communication function is distributed throughout the EMS, it has been omitted for clarity. Not all interfaces are shown.

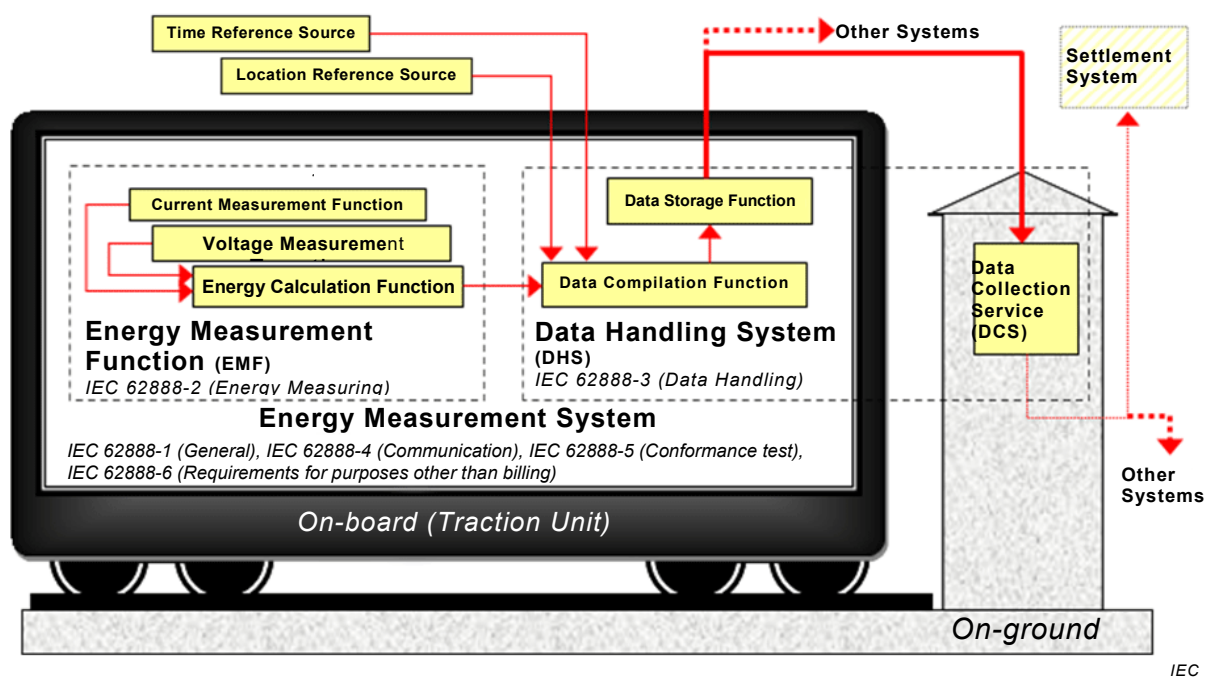


Figure 1 – EMS functional structure and dataflow diagram

RAILWAY APPLICATIONS – ENERGY MEASUREMENT ON BOARD TRAINS –

Part 6: Requirements for purposes other than billing

1 Scope

This part of IEC 62888 specifies the specific requirements for EMS to be used for benchmarking, daily energy consumption monitoring, technical research and development.

This document provides the requirements for monitoring consumed energy on board in daily services in an easy way and the measured data are applicable for general purposes in industry such as energy management, energy saving, etc. However, this document is not applicable for billing purposes.

The practical purposes in industrial fields are, e.g.:

- a) monitoring daily energy consumption of vehicles;
- b) obtaining data on influential factors, such as operational commands and surrounding conditions, in order to analyse relations between operations and energy;
- c) energy management of power flow between vehicles and fixed installations;
- d) implementing investigation tests of research and development for vehicle systems;
- e) energy cost forecasting for analysing overall efficiency and consumption.

The requirements specified in this document supplement and/or amend the requirements specified in IEC 62888-1 to IEC 62888-5.

The energy measurement system (EMS) is categorized in 3 Levels as described in IEC 62888-1:2018, Table 1. This document applies to Level 2 and Level 3.

In this document unless levels are specially mentioned, both Level 2 and Level 3 apply. If a requirement applies only to one level between Level 2 and Level 3, this condition is clearly specified.

In the following clauses and subclauses square brackets, e.g. [IEC 62888-3:2018, 4.6.1] in the title indicate relevant clauses and subclauses of other parts.

When lower subclauses of other parts are not listed, provisions of higher subclauses apply to the lower subclauses.

Table 1 – Levels of performance [IEC 62888-1:2018, Table 1]

Levels	Description	Notes
Level 1	Level for measuring energy consumption on board for applications like energy management, energy saving, billing and others.	This is the only level applicable for billing
Level 2	Level for measuring energy consumption on board for applications like energy management, energy saving, benchmarking by suppliers or train operators and others. This level is not applicable for billing.	Level 2 is applied when accuracy requirements need to be raised to ones equivalent to Level 1 by agreement by the Parties for international comparison or benchmarking purposes.
Level 3	Level for daily energy measurement, for instance: technical research and development. This level is not applicable for billing.	– Based on users requests. – Both measuring performance and service conditions can be less severe than Level 1. Power and energy are calculated based on voltage and current data acquired from existing sensors installed in converter systems, etc.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60044-8, *Instrument transformers – Part 8: Electronic current transformers*

IEC 60850:2014, *Railway applications – Supply voltages of traction systems*

IEC 61287-1, *Railway applications – Power converters installed on board rolling stock – Part 1: Characteristics and test methods*

IEC 62236-3-2, *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

IEC 62313:2009, *Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock*

IEC 62497-1, *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*

IEC 62625-1, *Electronic railway equipment – On board driving data recording system – Part 1: System specification*

IEC 62888-1:2018, *Railway applications – Energy measurement on board trains – Part 1: General*

IEC 62888-2:2018, *Railway applications – Energy measurement on board trains – Part 2: Energy measurement*

IEC 62888-3:2018, *Railway applications – Energy measurement on board trains – Part 3: Data handling*

IEC 62888-4:2018, *Railway applications – Energy measurement on board trains – Part 4: Communication*

IEC 62888-5:2018, *Railway applications – Energy measurement on board trains – Part 5: Conformance test*

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62888 (all parts) and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

3.1.1

involved party

entity that is involved in designing, manufacturing, supplying and/or using the EMS or parts/components of the EMS

Note 1 to entry: Involved party can be a purchaser, supplier, manufacturer or user. Members of involved parties do not necessarily consist of all of them. Members of the involved parties depend on the provisions of subclauses in this document and are appropriately interpreted.

3.2 Abbreviated terms

CEMD	Compiled Energy Measured Data
CL	Contact Line
CMF	Current Measurement Function
DCS	Data Collection Service
DHS	Data Handling System
DSI	Data Handling System to service Interface
ECF	Energy Calculation Function
EMDI	EMF to DHS Interface
EMF	Energy Measurement Function
EMS	Energy Measurement System
ESI	Energy Measuring Function to service Interface
MCF	Mobile Communication Function
PF	Power Factor
PICS	Protocol Implementation Conformity Statement
PIXIT	Protocol Implementation Extra Information for Testing
RAMS	Reliability, Availability, Maintainability and Safety
TCN	Train Communication Network
TRP	Time Reference Period
UTC	Coordinated Universal Time
VEI	VMF/CMF to ECF interface
VMF	Voltage Measurement Function

3.3 Symbols

f_n	rated frequency
$I_{CMF,cth}$	rated continuous thermal current
$I_{CMF,dyn}$	rated dynamic current
$I_{CMF,th}$	rated short-time thermal current
$I_{n,CMF}$	rated primary current of the CMF
$I_{n,ECF}$	rated primary current of the ECF
$I_{n,EMF}$	rated primary current of the EMF
$t_{s,r}$	response time
U_{max2}	highest non permanent voltage according to IEC 60850
U_{max3}	highest long term overvoltage according to IEC 60850
U_{min1}	lowest permanent voltage according to IEC 60850
U_{min2}	lowest non permanent voltage according to IEC 60850
$U_{n,VMF}$	rated primary voltage of the VMF
ε_{CMF}	maximum percentage (ratio) error allowed in accordance with the selected accuracy class for the CMF
ε_{ECF}	maximum percentage error allowed in accordance with the selected accuracy class for the ECF
ε_{VMF}	maximum percentage (ratio) error allowed in accordance with the selected accuracy class for the VMF

4 Requirements

4.1 General

4.1.1 Overview

The requirements specified in this document apply only in applications not related to billing. These requirements supplement and/or amend the requirements specified in IEC 62888-1 to IEC 62888-5. Individual permissions and requirements applicable to Level 2 and Level 3 are specified in this document. Clauses not mentioned in this document are covered by IEC 62888-1 to IEC 62888-5.

The differences between Level 1, Level 2 and Level 3 are summarized in Annex C.

4.1.2 Applications and usage

At present the traction equipment and the auxiliary equipment onboard are mainly controlled by microcomputers installed in the control units. These equipments are equipped with voltage and current sensors. They can calculate energy using these data.

Using these existing infrastructures can make a convenient energy measurement system on board.

The data obtained by these systems may be used in applications other than billing purposes.

For these various purposes EMS functions may be different from Level 1.

Level 2 is applied to the following applications:

Level 2 is the level for measuring energy consumption on board for applications like energy management, energy saving, benchmarking by suppliers or train operators and others. This level is not applicable for billing.

Level 2 is applied when accuracy requirements need to be raised to ones equivalent to Level 1 by agreement between the involved parties for international comparison or benchmarking purposes.

For instance, energy measurement in Level 2 is applied to the following cases:

- evaluation and comparison of energy consumption of trains among different railway operators;
- evaluation and comparison of energy consumption of trains measured by different parties;
- annual technical report or statistics on energy consumption of trains; and
- evaluation of achievement of technical development of new trains.

Level 3 is applied to the following applications:

On board and board to ground communication networks also become very common and various data can be transferred on the transmission line. This network communicates with the traction equipment and the auxiliary equipment and transfers various data, which can include the voltage, the current and the energy data calculated.

For instance, energy measurement in Level 3 is applied to the following cases:

- internal evaluation of energy consumption of trains in a railway operator;
- pursuit of long term variation of energy consumption of a train;
- evaluation of energy consumption differences depending on different train operation methods;
- display of energy consumption for train drivers in order to assist their energy-saving operation effort;
- accumulation of fundamental energy data for technical development of smart automatic train operation;
- data acquisition for evaluation and improvement of train operation skill;
- acquisition of "Big Data" for train operation assisting system;
- acquisition of relevant energy factor for comprehensive evaluation of train operational skill; and
- statistic analysis of energy consumption trend based on the "Big Data".

4.1.3 Measurement system configuration

For allocating EMS to on board devices, the following system configurations are possible:

- allocating EMF (VMF, CMF and ECF) to separated devices from DHS;
- allocating VMF, CMF and ECF to separate devices or installing them in separate equipment;
- implementing ECF and DHS in same device;
- allocating ECF to on ground DCS (e.g. for research in laboratories).

As stated in 4.1.2, the communication function is distributed throughout the EMS. The obtained data may be not always transferred through the communication networks. On board data can be transferred to ground via data storage media (e.g. removable disk or memory devices) or data download system.

In Annex A (informative), some examples of the systems are presented.

4.1.4 Data to be acquired

The data handled in EMS shall be all or part of the following:

- time data;
- energy data (energy value, or voltage data and current data);
- location data;

and separate recording is accepted, e.g.:

- (time data, energy data);
- (time data, location data).

Measures for matching separate data shall be provided, e.g. time data.

4.2 Requirement amendments to IEC 62888-1

4.2.1 General [IEC 62888-1:2018, 4.1]

The general requirements in IEC 62888-1:2018, 4.1 are applicable to Level 2 and Level 3.

4.2.2 System level requirements [IEC 62888-1:2018, 4.2]

4.2.2.1 General [IEC 62888-1:2018, 4.2.1]

IEC 62888-1:2018, 4.2.1 is applicable to Level 2 and Level 3.

4.2.2.2 Accuracy [IEC 62888-1:2018, 4.2.2]

IEC 62888-1:2018, 4.2.2 is applicable to Level 2 and Level 3.

4.2.2.3 EMS operation and power supply [IEC 62888-1:2018, 4.2.3]

IEC 62888-1:2018, 4.2.3 is applicable to Level 2 and Level 3.

4.2.2.4 EMS measuring input [IEC 62888-1:2018, 4.2.4]

4.2.2.4.1 Installation point of the VMF and CMF [IEC 62888-1:2018, 4.2.4.1]

IEC 62888-1:2018, 4.2.4.1 is applicable to Level 2 and Level 3 with the following amendments.

Measuring points and methods of summation and any other constraints (e.g. losses, wiring, cabling) derived by the actual configuration of the system shall be agreed upon by the involved parties and documented.

Measured data are voltage, current, energy.

The reactive energy should be recorded by agreement between the involved parties.

Summation of measurements is accepted in case of measurement functions distributed in other equipment, e.g. traction converters and auxiliary converters.

It shall be considered that the summation of measurements corresponds to the input of CL. When the power to the auxiliary converter is supplied from CL, measurements from the traction equipment or the auxiliary converter shall be summed individually. When the power to the auxiliary converter is supplied from the traction equipment, e.g. DC link of the traction converter, only measurements of the traction equipment shall be summed.

Examples of installation points are shown in Annex A (informative).

Depending on a purpose, energy measurement may be limited only to propulsion energy. The measurement of the reactive energy and the energy of auxiliary circuit is optional by agreement between the involved parties

For AC power supply, taking into account the efficiency and loss of the transformer, the use of secondary or tertiary winding of the transformer for the point of VMF shall be agreed upon by the involved parties.

4.2.2.4.2 Characteristics of traction system [IEC 62888-1:2018, 4.2.4.2]

IEC 62888-1:2018, 4.2.4.2 is applicable to Level 2 and Level 3.

4.2.2.5 Data handling [IEC 62888-1:2018, 4.2.5]

4.2.2.5.1 Traction supply system change [IEC 62888-1:2018, 4.2.5.1]

IEC 62888-1:2018, 4.2.5.1 is applicable to Level 2 and Level 3.

4.2.2.5.2 Consumption point Identification (CPID) [IEC 62888-1:2018, 4.2.5.2]

IEC 62888-1:2018, 4.2.5.2 is applicable to Level 2 and Level 3 with the following amendments.

Consumption point identification (CPID) according to IEC 62888-1 is optional. The method for the identification of the measurement point shall be agreed upon by the involved parties.

4.2.2.6 Reliability, Availability, Maintainability and Safety (RAMS) [IEC 62888-1:2018, 4.2.6]

IEC 62888-1:2018, 4.2.6 is applicable to Level 2 and Level 3.

4.2.3 Device level requirements [IEC 62888-1:2018, 4.3]

4.2.3.1 Marking and availability of essential data [IEC 62888-1:2018, 4.3.1]

IEC 62888-1:2018, 4.3.1 is applicable to Level 2 and Level 3.

4.2.3.2 Interfaces [IEC 62888-1:2018, 4.3.2]

4.2.3.2.1 General [IEC 62888-1:2018, 4.3.2.1]

IEC 62888-1:2018, 4.3.2.1 is applicable to Level 2 and Level 3.

4.2.3.2.2 Mandatory interfaces [IEC 62888-1:2018, 4.3.2.2]

4.2.3.2.2.1 Maintenance and service interfaces [IEC 62888-1:2018, 4.3.2.2.1]

IEC 62888-1:2018, 4.3.2.2.1 is applicable to Level 2 and Level 3 with the following amendments.

The maintenance and service interfaces may be used to download the energy data as well.

Access protection shall comply with 4.2.3.2.3.

4.2.3.2.2.2 Operational interfaces [IEC 62888-1:2018, 4.3.2.2.2]

IEC 62888-1:2018, 4.3.2.2.2 is applicable to Level 2 and Level 3.

4.2.3.2.2.3 Test interfaces [IEC 62888-1:2018, 4.3.2.2.3]

IEC 62888-1:2018, 4.3.2.2.3 is applicable to Level 2 and Level 3 with the following amendments.

If the measurement is carried out temporarily, test interfaces may be omitted by agreement between the involved parties.

In case of EMS as a function included in the function of other equipment, e.g. traction converters or auxiliary converters, internal test functions may be included in order to perform self-testing. In case self-testing is included, the test interfaces may be omitted.

4.2.3.2.3 Access security [IEC 62888-1:2018, 4.3.2.3]

IEC 62888-1:2018, 4.3.2.3 is applicable to Level 2 and Level 3 with the following amendments.

In case of EMS as a function included in the function of other equipment, e.g. traction equipment or auxiliary equipment, access to the EMSs is limited to the authorised maintenance persons. Manual logging of access to data like a management table is accepted.

The authorised maintenance persons shall be trained for access to the equipment and the training record shall be maintained for a certain period and be traced by quality system.

4.2.3.3 Data processing and transfer [IEC 62888-1:2018, 4.3.3]

IEC 62888-1:2018, 4.3.3 is applicable to Level 2 and Level 3.

4.2.3.4 Software [IEC 62888-1:2018, 4.3.4]

4.2.3.4.1 General [IEC 62888-1:2018, 4.3.4.1]

IEC 62888-1:2018, 4.3.4.1 is applicable to Level 2 and Level 3.

4.2.3.4.2 Identification of functions implemented in software [IEC 62888-1:2018, 4.3.4.2]

IEC 62888-1:2018, 4.3.4.2 is applicable to Level 2 and Level 3.

4.2.3.4.3 Identification and protection of software [IEC 62888-1:2018, 4.3.4.3]

IEC 62888-1:2018, 4.3.4.3 is applicable to Level 2 and Level 3 with the following amendments.

In case of EMS as a function included in the function of other equipment, e.g. traction equipment or auxiliary equipment, access to the EMSs is limited to the authorised maintenance persons. Personnel control may be regarded as protection of software by intentional change. Corruption of the software can be detected as a watch-dog timer of control software.

NOTE When a special tool is necessary for changing software, control of the special tool is regarded as protection of software.

4.2.3.4.4 Protection of CEMD and CEMD-related data [IEC 62888-1:2018, 4.3.4.4]

IEC 62888-1:2018, 4.3.4.4 is applicable to Level 2 and Level 3 with the following amendments.

In case of EMS as a function included in the function of other equipment, e.g. traction equipment or auxiliary equipment, access to the EMSs is limited to the authorised maintenance persons. Personnel control may be regarded as protection of CEMD and CEMD-related data by intentional change.

The security provisions of the EMS, providing protection of software, system parameters and ensuring this requirement, including any hardware and software solutions, shall be documented and agreed upon by the involved parties.

4.2.3.4.5 Protection against influence by other parts of software [IEC 62888-1:2018, 4.3.4.5]

IEC 62888-1:2018, 4.3.4.5 is applicable to Level 2 and Level 3.

4.2.3.4.6 Protection against influence by connecting another device [IEC 62888-1:2018, 4.3.4.6]

IEC 62888-1:2018, 4.3.4.6 is applicable to Level 2 and Level 3.

4.2.3.5 Dataflow security [IEC 62888-1:2018, 4.3.5]

IEC 62888-1:2018, 4.3.5 is applicable to Level 2 and Level 3 with the following amendments.

In case of EMS as a function included in the function of other equipment, e.g. traction equipment or auxiliary equipment, access to the EMSs can be limited to the authorised maintenance persons. Personnel control may be considered as an adequate dataflow security.

4.2.3.6 Environmental conditions [IEC 62888-1:2018, 4.3.6]

IEC 62888-1:2018, 4.3.6 is applicable to Level 2 and Level 3.

4.2.3.7 Mechanical requirements, construction and design [IEC 62888-1:2018, 4.3.7]

IEC 62888-1:2018, 4.3.7 is applicable to Level 2 and Level 3.

4.2.3.8 Electrical requirements [IEC 62888-1:2018, 4.3.8]

IEC 62888-1:2018, 4.3.8 is applicable to Level 2 and Level 3.

4.3 Requirement amendments to IEC 62888-2

4.3.1 General [IEC 62888-2:2018, 4.1]

The general requirements in IEC 62888-2:2018, 4.1 are applicable to Level 2 and Level 3.

4.3.2 Energy Measurement Function (EMF) [IEC 62888-2:2018, 4.2]

4.3.2.1 General [IEC 62888-2:2018, 4.2.1]

4.3.2.1.1 Overview [IEC 62888-2:2018, 4.2.1.1]

For Level 2 and Level 3, the output data of VMF and CMF may be stored on board for a certain period and transferred with location data and time data to Data Collection Service (DCS) on ground. In this case, the ECF and DHS are realized in on-ground system.

For examples of measurement points see Annex A (informative).

NOTE For the amendments to Annex B in IEC 62888-2:2018, see 6.2.2.

4.3.2.1.2 General requirements [IEC 62888-2:2018, 4.2.1.2]

IEC 62888-2:2018, 4.2.1.2 is applicable to Level 2 and Level 3.

4.3.2.1.3 Identification and marking of the EMF [IEC 62888-2:2018, 4.2.1.3]

IEC 62888-2:2018, 4.2.1.3 is applicable to Level 2 and Level 3 with the following amendments.

In case of EMS as a function included in the function of other equipment, e.g. traction equipment or auxiliary equipment, marking of EMF, i.e. VMF, CMF and ECF, is optional and shall be agreed upon by the involved parties.

In case that those functions are installed in other equipment, the marking may be seen when its covers are open. The marking on the outside of the equipment is not required if the information contained is provided by e.g. documents.

For examples of measurement points see Annex A (informative).

4.3.2.1.4 Essential information [IEC 62888-2:2018, 4.2.1.4]

IEC 62888-2:2018, 4.2.1.4 is applicable to Level 2 and Level 3.

4.3.2.2 Electrical requirements [IEC 62888-2:2018, 4.2.2]**4.3.2.2.1 Rated voltages [IEC 62888-2:2018, 4.2.2.1]**

IEC 62888-2:2018, 4.2.2.1 is applicable to Level 2 and Level 3.

4.3.2.2.2 Rated current [IEC 62888-2:2018, 4.2.2.2]

IEC 62888-2:2018, 4.2.2.2 is applicable to Level 2 and Level 3 with the following amendments.

Other rated currents than listed ones in IEC 62888-1:2018, 4.2.2.2 may be used. The rated primary current ($I_{n,EMF}$) of the EMF shall be agreed upon by the involved parties and recorded into the documentation.

4.3.2.2.3 Rated frequency (f_n) [IEC 62888-2:2018, 4.2.2.3]

IEC 62888-2:2018, 4.2.2.3 is applicable to Level 2 and Level 3.

4.3.2.3 Accuracy requirements [IEC 62888-2:2018, 4.2.3]**4.3.2.3.1 General [IEC 62888-2:2018, 4.2.3.1]**

IEC 62888-2:2018, 4.2.3.1 is applicable to Level 2 and Level 3 with the following amendments.

In case functions built in traction converters and/or train communication network are used, the following shall be considered:

- number of digits;
- quantization error;
- sampling periods.

The actual accuracy of the measurement chain shall be recorded into the documentation.

Errors of interface circuits requiring parameter tuning between each function, accuracy of each function (VMF, CMF, ECF) and the total accuracy of EMF shall be stated in the document prepared by the manufacturer.

NOTE For the amendments to informative Annex C in IEC 62888-2:2018, see 6.2.3.

4.3.2.3.2 Limits of error for the EMF [IEC 62888-2:2018, 4.2.3.2]

IEC 62888-2:2018, 4.2.3.2 is applicable to Level 2 and Level 3.

4.3.2.3.3 Reference conditions [IEC 62888-2:2018, 4.2.3.3]

IEC 62888-2:2018, 4.2.3.3 is applicable to Level 2 and Level 3.

4.3.2.3.4 Limits of error due to variations in input quantities [IEC 62888-2:2018, 4.2.3.4]

IEC 62888-2:2018, 4.2.3.4 is applicable to Level 2.

For Level 3, percentage error limit given in Table 2 apply.

Table 2 – EMF percentage error limits at reference conditions for Level 3 [IEC 62888-2:2018, Table 2]

System type	Input quantity range			Percentage error limit	
	Value of current ^a	Value of voltage ^b	PF = Power Factor or $\sin \varphi$ ^c	Active energy	Reactive energy ^d
AC	$30 \% I_n \leq I \leq 120 \% I_n$	$U_{\min 2} \leq U \leq U_{\max 2}$	$0,85 \leq \text{PF}$ or $\sin \varphi = 1$ Inductive	5,2	15
DC	$30 \% I_n \leq I \leq 120 \% I_n$	$U_{\min 2} \leq U \leq U_{\max 2}$	N/A	5,2	N/A

^a I_n is the rated primary current of the EMF.

^b The values of $U_{\min 2}$ and $U_{\max 2}$ are as specified in IEC 60850:2014.

^c The Power Factor is taken from IEC 62313:2009, Table 1. The reactive energy cannot be measured accurately for Power Factor near 1. Therefore the reactive energy is tested at $\sin \varphi = 1$.

^d Percentage error limit is applicable only when the reactive energy measurement is performed.

4.3.2.3.5 Starting conditions [IEC 62888-2:2018, 4.2.3.5]

IEC 62888-2:2018, 4.2.3.5 is applicable to Level 2 and Level 3 with the following amendment.

Starting conditions are defined by agreement between the involved parties.

4.3.2.4 Traction supply system change [IEC 62888-2:2018, 4.2.4]

IEC 62888-2:2018, 4.2.4 is applicable to Level 2 and Level 3.

4.3.2.5 Re-verification [IEC 62888-2:2018, 4.2.5]

IEC 62888-2:2018, 4.2.5 is applicable to Level 2 and Level 3 with the following amendments.

In case of a short term measurement, e.g. when the measurement finishes within the guarantee period of accuracy, re-verification is not necessary.

In case of a term of measurement beyond the guarantee period of accuracy, an accuracy check should be carried out at the proper time in order to verify with the initial conditions.

For the application of Annex D in IEC 62888-2:2018, see 6.2.4.

4.3.3 Sensors [IEC 62888-2:2018, 4.3]

4.3.3.1 General [IEC 62888-2:2018, 4.3.1]

IEC 62888-2:2018, 4.3.1 is applicable to Level 2 and Level 3 with the following amendments.

Sensors built in equipment, e.g. traction converters, auxiliary converters, may be used as measuring sensors. The primary voltage and primary current may be measured on the secondary voltage or secondary current of the existing transformer (e.g. traction transformer, auxiliary transformer), as far as the measurements are converted to the primary voltage and primary current. Conversion may be carried out in the individual equipment which, in this case, performs as part of Energy Calculation Function (ECF).

The primary current may be calculated by summing the measurements of the distributed current sensors.

The energy at the consumption point may be calculated by the primary voltage and the summed primary current or by the individual energy calculated by the primary voltage and the individual converted primary current.

4.3.3.2 General requirements [IEC 62888-2:2018, 4.3.2]

4.3.3.2.1 General [IEC 62888-2:2018, 4.3.2.1]

IEC 62888-2:2018, 4.4.3.2.1 is applicable to Level 2 and Level 3.

4.3.3.2.2 Insulation requirements [IEC 62888-2:2018, 4.3.2.2]

IEC 62888-2:2018, 4.3.2.2 is applicable to Level 2 and Level 3 with the following amendment.

Insulation withstand of the primary side shall be according to IEC 62497-1.

4.3.3.2.3 Requirements for outputs [IEC 62888-2:2018, 4.3.2.3]

4.3.3.2.3.1 General [IEC 62888-2:2018, 4.3.2.3.1]

IEC 62888-2:2018, 4.3.2.3.1 is applicable to Level 2 and Level 3 with the following amendment.

The requirements on dataflow security are listed in 4.2.3.5.

4.3.3.2.3.2 Requirements for dedicated analogue outputs [IEC 62888-2:2018, 4.3.2.3.2]

IEC 62888-2:2018, 4.3.2.3.2 is applicable to Level 2 and Level 3.

4.3.3.2.3.3 Requirements for digital dedicated or digital shared outputs [IEC 62888-2:2018, 4.3.2.3.3]

IEC 62888-2:2018, 4.3.2.3.3 is applicable to Level 2 and Level 3 with the following amendment.

Requirements for communication protocols stack and communication security are listed in 4.5.2.2, 4.5.2.3 and 4.5.2.4.

4.3.3.2.3.4 Essential information [IEC 62888-2:2018, 4.3.2.3.4]

IEC 62888-2:2018, 4.3.2.3.4 is applicable to Level 2 and Level 3 with the following amendment.

In case that sensors built in the equipment on board of train are used for EMF, their specifications shall be given in an accompanying document.

4.3.3.3 Voltage sensors [IEC 62888-2:2018, 4.3.3]

4.3.3.3.1 Electrical requirements [IEC 62888-2:2018, 4.3.3.1]

4.3.3.3.1.1 Rated primary voltage ($U_{n,VMF}$) [IEC 62888-2:2018, 4.3.3.1.1]

IEC 62888-2:2018, 4.3.3.1.1 is applicable to Level 2 and Level 3.

4.3.3.3.1.2 Rated secondary values for analogue sensors [IEC 62888-2:2018, 4.3.3.1.2]

IEC 62888-2:2018, 4.3.3.1.2 is applicable to Level 2 and Level 3.

4.3.3.3.1.3 Rated secondary output signal for analogue sensors [IEC 62888-2:2018, 4.3.3.1.3]

IEC 62888-2:2018, 4.3.3.1.3 is applicable to Level 2 and Level 3 with the following amendment.

Considering that Level 2 and Level 3 may use built-in devices, the preferred values shall be intended as informative.

4.3.3.3.1.4 Rated output burden for analogue sensors [IEC 62888-2:2018, 4.3.3.1.4]

IEC 62888-2:2018, 4.3.3.1.4 is applicable to Level 2 and Level 3 with the following amendment.

Considering that Level 2 and Level 3 may use built-in devices, the preferred values shall be intended as informative.

4.3.3.3.1.5 Influence of input overvoltage [IEC 62888-2:2018, 4.3.3.1.5]

IEC 62888-2:2018, 4.3.3.1.5 is applicable to Level 2 and Level 3.

4.3.3.3.1.6 Response time ($t_{s,r}$) [IEC 62888-2:2018, 4.3.3.1.6]

IEC 62888-2:2018, 4.3.3.1.6 is applicable to Level 2 and Level 3.

4.3.3.3.1.7 Bandwidth requirements for electronic sensors [IEC 62888-2:2018, 4.3.3.1.7]

IEC 62888-2:2018, 4.3.3.1.7 is applicable to Level 2 and Level 3.

4.3.3.3.1.8 Power frequency withstand voltage for earthed terminals [IEC 62888-2:2018, 4.3.3.1.8]

IEC 62888-2:2018, 4.3.3.1.8 is applicable to Level 2 and Level 3.

4.3.3.3.2 Short circuit withstand and fault protection for analogue sensors [IEC 62888-2:2018, 4.3.3.2]

IEC 62888-2:2018, 4.3.3.2 is applicable to Level 2 and Level 3 except for the time delay for which the following requirements apply.

The delay time between removal of the short circuit and the outputs returning within specified accuracy limits shall be agreed upon by the involved parties.

4.3.3.3.3 Limit of temperature rise [IEC 62888-2:2018, 4.3.3.3]

IEC 62888-2:2018, 4.3.3.3 is applicable to Level 2 and Level 3.

4.3.3.3.4 Accuracy requirements [IEC 62888-2:2018, 4.3.3.4]

IEC 62888-2:2018, 4.3.3.4 is applicable to Level 2.

For Level 3, the VMF may be assigned an accuracy class selected from Table 3 in addition to the accuracy class specified in IEC 62888-2:2018, Table 3.

Table 3 – Level 3 additional percentage error limits – VMF [IEC 62888-2:2018, Table 3]

Accuracy class	± Maximum percentage voltage (ratio) error at voltage defined in IEC 60850:2014	± Maximum phase displacement at voltage defined in IEC 60850:2014
	ε_{VMF}	AC VMF (minutes) at rated frequency
	$U_{min2} \leq U \leq U_{max2}$	$U_{min2} \leq U \leq U_{max2}$
1,0 L3 ^a	1,0	40
3,0 L3	3,0	agreed upon by parties
^a L3 is the class for Level 3.		

4.3.3.3.5 Effect of temperature on error limits [IEC 62888-2:2018, 4.3.3.5]**4.3.3.3.5.1 Limits of error including the effects of ambient temperature variation [IEC 62888-2:2018, 4.3.3.5.1]**

IEC 62888-2:2018, 4.3.3.5.1 is applicable to Level 2.

For Level 3, the temperature dependency of the percentage voltage error in the ambient temperature variation range shall be described in the accompanying document by agreement between the involved parties.

Table 4 and Figure 4 in IEC 62888-2:2018 are not applicable.

4.3.3.3.5.2 Mean temperature coefficient of a VMF [IEC 62888-2:2018, 4.3.3.5.2]

IEC 62888-2:2018, 4.3.3.5.2 is applicable to Level 2.

For Level 3, the maximum percentage error limits, including the effects of temperature variation shall be described in the accompanying document by agreement between the involved parties.

Table 5 in IEC 62888-2:2018 is not applicable.

4.3.3.3.6 Limits of additional error due to influence quantities [IEC 62888-2:2018, 4.3.3.6]

IEC 62888-2:2018, 4.3.3.6 is applicable to Level 2 and Level 3 with the following amendments.

In the case of traction converters, effects of the electromagnetic interference are tested according to IEC 61287-1 and IEC 62236-3-2. Sensors of functions of the traction converters shall comply with IEC 61287-1 and IEC 62236-3-2. The additional percentage error limits of the effects of the electromagnetic interference shall be described in the accompanying document by agreement between the involved parties.

The additional percentage error limit of the variations of supply voltage shall be described in the accompanying document by agreement between the involved parties.

Table 6 in IEC 62888-2:2018 is not applicable.

4.3.3.4 Current sensors [IEC 62888-2:2018, 4.3.4]

4.3.3.4.1 Electrical requirements [IEC 62888-2:2018, 4.3.4.1]

IEC 62888-2:2018, 4.3.4.1 is applicable to Level 2 and Level 3 with the following amendment.

Considering that Level 2 and Level 3 may use built-in devices, the preferred values shall be intended as informative.

4.3.3.4.2 Limit of temperature rise [IEC 62888-2:2018, 4.3.4.2]

IEC 62888-2:2018, 4.3.4.2 is applicable to Level 2 and Level 3.

4.3.3.4.3 Accuracy requirements [IEC 62888-2:2018, 4.3.4.3]

IEC 62888-2:2018, 4.3.4.3 is applicable to Level 2.

For Level 3, the CMF may be assigned an accuracy class selected from Table 4 or Table 5 in addition to the accuracy class specified in IEC 62888-2:2018, Table 7 or Table 8.

Table 4 shall be used for AC current sensors.

**Table 4 – Level 3 additional percentage error limits –
AC CMF [IEC 62888-2:2018, Table 7]**

Accuracy class	$\pm$ Maximum percentage current (ratio) error at percentage of rated current (I_n) shown below, AC CMF			$\pm$ Maximum phase displacement at percentage of rated current (I_n) shown below, AC CMF		
	ϵ_{CMF}			AC CMF, (min) at rated frequency		
	$5 \% I_n \leq I < 20 \% I_n$	$20 \% I_n \leq I < 30 \% I_n$	$30 \% I_n \leq I \leq 120 \% I_n$	$5 \% I_n \leq I \leq 20 \% I_n$	$20 \% I_n \leq I \leq 30 \% I_n$	$30 \% I_n \leq I \leq 120 \% I_n$
0,5 L3 ^a	1,5	0,75	0,5	90	45	30
1,0 L3	3,0	1,5	1,0	180	90	60
3,0 L3	15,0	6,0	3,0 (50 % ~ 120 % I_n)	To be agreed upon by involved parties	To be agreed upon by involved parties	To be agreed upon by involved parties

^a L3 is the class for Level 3.

Table 5 shall be used for DC current sensors.

**Table 5 – Level 3 additional percentage error limits –
DC CMF [IEC 62888-2:2018, Table 8]**

Accuracy class	± Maximum percentage current (ratio) error at percentage of rated current (I_n) shown below, DC CMF		
	ε_{CMF}		
	$5 \% I_n \leq I < 20 \% I_n$	$20 \% I_n \leq I < 30 \% I_n$	$30 \% I_n \leq I \leq 120 \% I_n$
1,0 L3 ^a	10,0	2,0	1,0
3,0 L3	30,0	6,0	3,0

^a L3 is the class for Level 3.

4.3.3.4.4 Effect of temperature on error limits [IEC 62888-2:2018, 4.3.4.4]

4.3.3.4.4.1 Limits of error including the effects of ambient temperature variation [IEC 62888-2:2018, 4.3.4.4.1]

IEC 62888-2:2018, 4.3.4.4.1 is applicable to Level 2.

For Level 3, the maximum percentage error limits, including the effects of ambient temperature variation, are not specified.

The temperature dependency of the percentage current error in the ambient temperature variation range shall be described in the accompanying documents and agreed upon by the involved parties.

Table 9 and Figure 5 in IEC 62888-2:2018 are not applicable.

4.3.3.4.4.2 Mean temperature coefficient of a CMF [IEC 62888-2:2018, 4.3.4.4.2]

IEC 62888-2:2018, 4.3.4.4.2 is applicable to Level 2.

For Level 3, the maximum percentage error limits, including the effects of ambient temperature variation, shall be described in the accompanying documents and agreed upon by the involved parties.

Table 10 in IEC 62888-2:2018 is not applicable.

4.3.3.4.5 Limits of error with harmonics [IEC 62888-2:2018, 4.3.4.5]

IEC 62888-2:2018, 4.3.4.5 is applicable to Level 2 and Level 3 with the following amendment.

The sensor complying with IEC 60044-8 may be accepted. In this case Table 11 in 4.3.4.5 of IEC 62888-2:2018 is not applicable.

4.3.3.4.6 Limits of additional error due to influence quantities [IEC 62888-2:2018, 4.3.4.6]

IEC 62888-2:2018, 4.3.4.6 is applicable to Level 2 and Level 3 with the following amendments.

In case traction converters:

- Effects of the electromagnetic interference are tested according to IEC 61287-1 and IEC 62236-3-2. Sensors shall comply with IEC 61287-1 and IEC 62236-3-2. The additional percentage error limits of the effects of the electromagnetic interference shall be described in the shared documents and agreed upon by the involved parties.

- The additional percentage error limit of the variations of supply voltage shall be described in the shared documents and agreed upon by the involved parties.
- Table 12 in IEC 62888-2:2018 is not applicable.

4.3.4 Energy Calculation Function (ECF) [IEC 62888-2:2018, 4.4]

4.3.4.1 General [IEC 62888-2:2018, 4.4.1]

IEC 62888-2:2018, 4.4.1 is applicable to Level 2 and Level 3 with the following amendment.

The voltage and current may be individual values measured by the sensors installed in the equipment as stated in 4.3.3.1.

4.3.4.2 General requirements [IEC 62888-2:2018, 4.4.2]

4.3.4.2.1 Calculation of energy data [IEC 62888-2:2018, 4.4.2.1]

IEC 62888-2:2018, 4.4.2.1 is applicable to Level 2 and Level 3 with the following amendments.

The non active power may be treated as the reactive power.

The details are given in the informative Annex B.

For the application of Annex B in IEC 62888-2:2018, see 6.2.2.

4.3.4.2.2 k-factor [IEC 62888-2:2018, 4.4.2.2]

IEC 62888-2:2018, 4.4.2.2 is applicable to Level 2 and Level 3.

4.3.4.2.3 ECF registers [IEC 62888-2:2018, 4.4.2.3]

IEC 62888-2:2018, 4.4.2.3 is applicable to Level 2 and Level 3.

4.3.4.2.4 Index value overrun [IEC 62888-2:2018, 4.4.2.4]

IEC 62888-2:2018, 4.4.2.4 is applicable to Level 2 and Level 3 with the following amendments.

The minimum period defined of the storage time in DHS shall be defined by agreement between the involved parties in 4.4.8.1.

Other values than 60 days may be used as far as by agreement between the involved parties.

4.3.4.2.5 Essential information [IEC 62888-2:2018, 4.4.2.5]

IEC 62888-2:2018, 4.4.2.5 is applicable to Level 2 and Level 3.

4.3.4.2.6 Flags [IEC 62888-2:2018, 4.4.2.6]

IEC 62888-2:2018, 4.4.2.6 is applicable to Level 2 and Level 3.

For the application of Annex B in IEC 62888-2:2018, see 6.2.2.

4.3.4.3 Electrical requirements [IEC 62888-2:2018, 4.4.3]

4.3.4.3.1 Analogue measuring input to ECF [IEC 62888-2:2018, 4.4.3.1]

4.3.4.3.1.1 General [IEC 62888-2:2018, 4.4.3.1.1]

IEC 62888-2:2018, 4.4.3.1.1 is applicable to Level 2 and Level 3.

4.3.4.3.1.2 Voltage inputs [IEC 62888-2:2018, 4.4.3.1.2]

IEC 62888-2:2018, 4.4.3.1.2 is applicable to Level 2 and Level 3 with the following amendment.

Considering that Level 2 and Level 3 may use built-in devices the indicated values shall be intended as preferred value.

4.3.4.3.1.3 Current inputs [IEC 62888-2:2018, 4.4.3.1.3]

IEC 62888-2:2018, 4.4.3.1.3 is applicable to Level 2 and Level 3 with the following amendment.

Considering that Level 2 and Level 3 may use built-in devices the indicated values shall be intended as preferred value.

4.3.4.3.2 Influence of input voltage [IEC 62888-2:2018, 4.4.3.2]**4.3.4.3.2.1 Voltage range on Contact Line [IEC 62888-2:2018, 4.4.3.2.1]**

IEC 62888-2:2018, 4.4.3.2.1 is applicable to Level 2 and Level 3.

4.3.4.3.2.2 Voltage variations and short interruptions of the contact line [IEC 62888-2:2018, 4.4.3.2.2]

IEC 62888-2:2018, 4.4.3.2.2 is not applicable to Level 2 and Level 3, the following requirement apply.

Voltage variations and short interruptions in the voltage circuits should not produce a change in the recorded data. The maximum change, allowed in the recorded data, shall be agreed upon by the involved parties and described in the accompanying documents

4.3.4.3.3 Influence of short-time overcurrents [IEC 62888-2:2018, 4.4.3.3]

IEC 62888-2:2018, 4.4.3.3 is applicable to Level 2 and Level 3 with the following amendment.

The specified variation of error and Table 13 in IEC 62888-2:2018 shall be intended as informative.

4.3.4.3.4 Influence of self-heating [IEC 62888-2:2018, 4.4.3.4]

IEC 62888-2:2018, 4.4.3.4 is applicable to Level 2 and Level 3 with the following amendment.

The variation of error due to self-heating specified in IEC 62888-2:2018, 4.4.3.4 according to Table 14 shall be relaxed by agreement between the involved parties and described in the accompanying documents.

4.3.4.3.5 Limit of temperature rise [IEC 62888-2:2018, 4.4.3.5]

IEC 62888-2:2018, 4.3.3.5 is applicable to Level 2 and Level 3.

4.3.4.3.6 Digital input from VMF/CMF [IEC 62888-2:2018, 4.4.3.6]

IEC 62888-2:2018, 4.4.3.6 is applicable to Level 2 and Level 3.

4.3.4.4 Accuracy requirements [IEC 62888-2:2018, 4.4.4]

4.3.4.4.1 General [IEC 62888-2:2018, 4.4.4.1]

IEC 62888-2:2018, 4.4.4.1 is applicable to Level 2 and Level 3 with the following amendment.

ECF shall have an accuracy class assigned according to Table 6.

4.3.4.4.2 Percentage error limits for active energy measurement [IEC 62888-2:2018, 4.4.4.2]

IEC 62888-2:2018, 4.4.4.2 is applicable to Level 2.

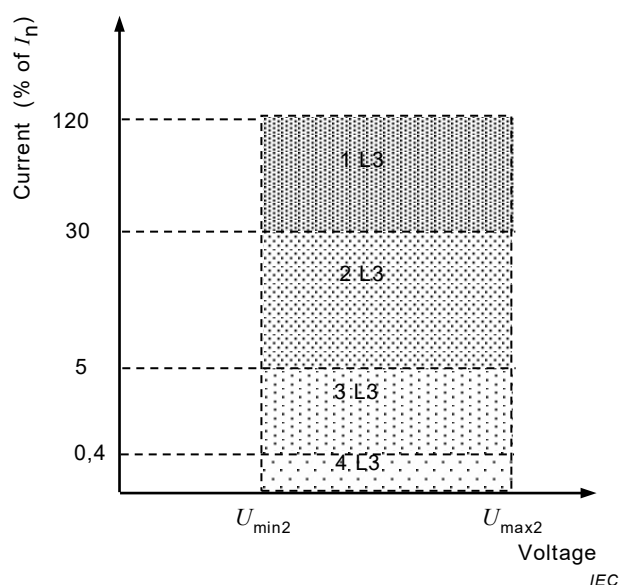
For Level 3, Table 6 specifies the additional percentage error limits for active energy measurement to those specified in IEC 62888-2:2018, Table 15 under reference conditions as given in Table 1 in 4.2.3.3 of IEC 62888-2:2018.

**Table 6 – Level 3 ECF additional percentage error limits for active energy
[IEC 62888-2:2018, Table 15]**

Accuracy class	± Maximum percentage energy (ratio) error (ε_{ECF}) at percentage of rated current shown below and at voltage defined in IEC60850:2014				
	Area 1 L3 ^a 30 % $I_n \leq I \leq 120$ % I_n and $U_{\text{min}2} \leq U \leq U_{\text{max}2}$	Area 2 L3 5 % $I_n \leq I \leq 30$ % I_n and $U_{\text{min}2} \leq U < U_{\text{max}2}$	Area 3 L3 0,4 % $I_n \leq I < 5$ % I_n and $U_{\text{min}2} \leq U \leq U_{\text{max}2}$	Area 4 L3 0 % $I_n < I < 0,4$ % I_n and $U_{\text{min}2} \leq U \leq U_{\text{max}2}$	$I = 0$ % I_n ($I = 0$ A)
	0,85 ≤ PF				
	1,0 L3 ^a	1,0	4,0	ECF shall measure but accuracy is not specified	ECF may measure but accuracy is not specified
3,0 L3	3,0	12,0			

^a L3 is the class for Level 3.

Areas 1 L3, 2 L3, 3 L3 and 4 L3 for primary current and primary voltage listed in Table 6 are shown in Figure 2.

**Key**

- I_n Rated primary current of the current sensor
 $U_{\max 2}$ Highest non-permanent voltage of the primary voltage
 $U_{\min 2}$ Lowest non-permanent voltage of the primary voltage

NOTE The values of $U_{\min 2}$ and $U_{\max 2}$ are as specified in IEC 60850:2014.

Figure 2 – Primary current and voltage ranges [IEC 62888-2:2018, Figure 6]

4.3.4.4.3 Percentage error limits for reactive energy measurement [IEC 62888-2:2018, 4.4.4.3]

IEC 62888-2:2018, 4.4.4.3 is applicable to Level 2.

In case of Level 3, IEC 62888-2:2018, 4.4.4.3 is applicable but Table 6 in this document shall be used instead of Table 15 in IEC 62888-2:2018.

4.3.4.5 Effect of temperature on error limits [IEC 62888-2:2018, 4.4.5]

4.3.4.5.1 Limits of error including the effects of ambient temperature variation [IEC 62888-2:2018, 4.4.5.1]

IEC 62888-2:2018, 4.4.5.1 is applicable to Level 2.

For Level 3, the maximum percentage error, including the effects of ambient temperature variation, shall be agreed upon by the involved parties and described in the accompanying documents.

Table 16 and Figure 7 in IEC 62888-2:2018 are not applicable.

4.3.4.5.2 Mean temperature coefficient of an ECF [IEC 62888-2:2018, 4.4.5.2]

IEC 62888-2:2018, 4.4.5.2 is applicable to Level 2.

For Level 3, the mean temperature coefficient shall be agreed upon by the involved parties and described in the accompanying documents.

Table 17 in IEC 62888-2:2018 is not applicable.

4.3.4.6 Limits of additional error due to influence quantities [IEC 62888-2:2018, 4.4.6]

4.3.4.6.1 General [IEC 62888-2:2018, 4.4.6.1]

IEC 62888-2:2018, 4.4.6.1 is applicable to Level 2 and Level 3 with the following amendment.

The application of 4.4.6.1 of IEC 62888-2 and the values of the influence quantities in Table 18 of IEC 62888-2 shall be agreed upon by the involved parties and described in the accompanying documents.

NOTE In case that ECF is a part of built-in functions of electrical equipment, the effects of the electromagnetic interference are tested according to the relevant product standard and IEC 62236-3-2. If the electric equipment is a traction converter, IEC 61287-1 applies. Sensors are compliant with IEC 61287-1 and IEC 62236-3-2.

4.3.4.6.2 Magnetic induction [IEC 62888-2:2018, 4.4.6.2]

IEC 62888-2:2018, 4.4.6.2 is not applicable.

4.3.4.6.3 Odd harmonics and sub-harmonics in the AC current circuit [IEC 62888-2:2018, 4.4.6.3]

IEC 62888-2:2018, 4.4.6.3 is not applicable.

4.3.4.7 Electromagnetic compatibility [IEC 62888-2:2018, 4.4.7]

4.3.4.7.1 Immunity to electromagnetic disturbance [IEC 62888-2:2018, 4.4.7.1]

4.4.7.1.1 of IEC 62888-2:2018 is applicable to Level 2 and Level 3, except in the case that ECF is a part of built-in functions of electrical equipment. It is considered that the effects of the electromagnetic interference are tested according to the relevant product standard and IEC 62236-3-2, or, in case of traction converters, according to IEC 61287-1.

4.4.7.1.2 to 4.4.7.1.6 of IEC 62888-2:2018 are applicable except the requirements of the register change.

4.3.4.7.2 Radio interference suppression [IEC 62888-2:2018, 4.4.7.2]

4.4.7.2 of IEC 62888-2:2018 is applicable except the requirements of the register change.

4.3.4.8 Data transfer from ECF to DHS [IEC 62888-2:2018, 4.4.8]

IEC 62888-2:2018, 4.4.8 is applicable to Level 2 and Level 3 with the following amendments.

TRP shall be defined by agreement between the involved parties as specified in 4.4.7.2.

Data transfer from ECF to DHS shall comply with the following subclauses of this document:

4.4.7.2, 4.5.2.2, 4.5.2.3 and 4.5.2.5.

4.4 Requirement amendments to IEC 62888-3

4.4.1 General [IEC 62888-3:2018, 4.1]

For allocating EMF to on board devices, the following system configurations are possible:

- allocating EMF to separate devices from DHS;
- implementing ECF and DHS in same device;
- allocating ECF to on ground DCS (for research in laboratories).

As stated in 4.1.3, the communication function is distributed throughout the EMS. The obtained data may not always be transferred through the communication networks. On board data can be transferred to on ground via data storage media (e.g. removal disk or memory devices) or data download system.

The data handled in EMS shall be all or part of the following:

- time data;
- energy data (energy value, or voltage data and current data);
- location data;

and separated recording is accepted, e.g.:

- (time data, energy data),
- (time data, location data).

Measures for matching separated data shall be provided, e.g. time data.

4.4.2 Time data [IEC 62888-3:2018, 4.2]

4.4.2.1 Source [IEC 62888-3:2018, 4.2.1]

IEC 62888-3:2018, 4.2.1 is applicable to Level 2 and Level 3 with the following amendments.

In case of distributed energy measurement, time sources may be individual internal sources as far as they are synchronised. Procedure of time synchronization shall be agreed upon by the involved parties.

4.4.2.2 Reference time source [IEC 62888-3:2018, 4.2.2]

IEC 62888-3:2018, 4.2.2 is applicable to Level 2 and Level 3 with the following amendments.

The internal time source shall use as its reference Standard UTC time/date.

The involved parties shall agree on the correction of the internal time source to the time zone (e.g. UTC +0, UTC +9).

4.4.2.3 Format [IEC 62888-3:2018, 4.2.3]

IEC 62888-3:2018, 4.2.3 is applicable to Level 2 and Level 3.

4.4.2.4 Resolution level [IEC 62888-3:2018, 4.2.4]

IEC 62888-3:2018, 4.2.4 is applicable to Level 2 and Level 3.

4.4.2.5 Stability [IEC 62888-3:2018, 4.2.5]

IEC 62888-3:2018, 4.2.5 is applicable to Level 2 and Level 3 with the following amendments.

Appropriate stability shall be ensured to match energy data and location data as defined in IEC 62625-1.

The internal time source should have a stability of 20×10^{-6} or better.

4.4.2.6 Synchronisation [IEC 62888-3:2018, 4.2.6]

IEC 62888-3:2018, 4.2.6 is applicable to Level 2 and Level 3 with the following amendments.

The deviation of the internal time source against the reference time source shall be agreed upon by the involved parties.

If the automatic synchronisation to the reference time source is not available, synchronisation shall be executed by manual setting in the periodical maintenance. The agreed deviation shall apply also in case of manual synchronisation.

Procedure of time synchronization shall be agreed upon by the involved parties.

4.4.2.7 Flags for time data [IEC 62888-3:2018, 4.2.7]

IEC 62888-3:2018, 4.2.7 is applicable to Level 2 and Level 3 with the following amendment.

The minimum deviation time other than 2 s shall be agreed upon by the involved parties as specified in 4.4.2.6.

4.4.3 Energy data [IEC 62888-3:2018, 4.3]

IEC 62888-3:2018, 4.3.1 is applicable to Level 2 and Level 3 with the following amendments.

The DHS shall be able to receive energy data not only from one or more ECF but also from one or more EMF (VMF and CMF) directly.

DHS (e.g. TCN) which receives voltage and current data from VMF and CMF (e.g. the traction equipment and the auxiliary equipment, etc.) and has the function of ECF to calculate the energy data shall be agreed upon by the involved parties and described in the accompanying documents.

In such cases the requirements specified in 4.3.4 shall apply for the function of DHS.

IEC 62888-3:2018, 4.3.3 is applicable to Level 2 and Level 3 with the following amendments.

The reactive energy is recorded as option by agreement between the involved parties.

Depending on the application of the energy data, instantaneous energy monitoring may not be required. For example, gross value of the energy consumption is necessary for annual report or statistical analysis of the consumed energy based on the train types.

In case a variable period for TRP in 4.4.7.2 is adopted, start time and end time of recording shall be recorded.

Other subclauses in IEC 62888-3:2018, 4.3 are applicable to Level 2 and Level 3.

4.4.4 Location data [IEC 62888-3:2018, 4.4]

IEC 62888-3:2018, 4.4.1 is applicable to Level 2 and Level 3 with the following amendments.

Location data shall be absolute position (e.g. based on the World Geodetic System, revision WGS 84) or relative distance from the reference point.

In case of internal source integration of speed may be used. This shows relative location, distance from the starting points.

The relative distance shall be ensured to match energy data and intermittent external position data.

When using absolute position, 4.4.2 in IEC 62888-3:2018 is applicable to Level 2 and Level 3.

When using relative distance, the data format should be relative distance from the starting point:

- relative distance in unit of metres.

Resolution of relative distance shall be defined by agreement between the involved parties.

Location of the starting point may not be recorded if the operating line of the vehicles is identified.

Other subclauses in IEC 62888-3:2018, 4.4 are applicable to Level 2 and Level 3.

4.4.5 Other received or produced data [IEC 62888-3:2018, 4.5]

IEC 62888-3:2018, 4.5 is applicable to Level 2 and Level 3.

4.4.6 Consumption point ID [IEC 62888-3:2018, 4.6]

IEC 62888-3:2018, 4.6 is applicable to Level 2 and Level 3.

4.4.7 Production of CEMD [IEC 62888-3:2018, 4.7]

4.4.7.1 Type of data [IEC 62888-3:2018, 4.7.1]

IEC 62888-3:2018, 4.7.1 is applicable to Level 2 and Level 3 with the following amendments.

The items listed in IEC 62888-3:2018, 4.7.1 could be selected according to the applications.

Other items can be added by agreement between the involved parties.

4.4.7.2 Time Reference Period [IEC 62888-3:2018, 4.7.2]

IEC 62888-3:2018, 4.7.2 is applicable to Level 2 and Level 3 with the following amendments.

TRPs shall be defined by the involved parties.

For TRP a variable period shall be agreed upon by the involved parties.

4.4.7.3 Energy data [IEC 62888-3:2018, 4.7.3]

IEC 62888-3:2018, 4.7.3 is applicable to Level 2 and Level 3 with the following amendments.

The following energy values shall be agreed upon by the involved parties:

- of unit kWh for active energy and kvarh for reactive energy;
- or
- voltage data, current data, if ECF is implemented in DHS or offline sites.

4.4.7.4 Location data [IEC 62888-3:2018, 4.7.4]

IEC 62888-3:2018, 4.7.4 is applicable to Level 2 and Level 3.

4.4.7.5 Format [IEC 62888-3:2018, 4.7.5]

IEC 62888-3:2018, 4.7.5 is applicable to Level 2 and Level 3.

4.4.7.6 Missing input data [IEC 62888-3:2018, 4.7.6]

IEC 62888-3:2018, 4.7.6 is applicable to Level 2 and Level 3.

4.4.7.7 Data integrity [IEC 62888-3:2018, 4.7.7]

IEC 62888-3:2018, 4.7.7 is applicable to Level 2 and Level 3.

4.4.7.8 Flags [IEC 62888-3:2018, 4.7.8]

IEC 62888-3:2018, 4.7.8 is applicable to Level 2 and Level 3.

4.4.8 DHS data storage [IEC 62888-3:2018, 4.8]

4.4.8.1 Storage time [IEC 62888-3:2018, 4.8.1]

IEC 62888-3:2018, 4.8.1 is applicable to Level 2 and Level 3 with the following amendment.

The DHS shall store data for the minimum period agreed upon by the involved parties.

4.4.8.2 Memory capacity [IEC 62888-3:2018, 4.8.2]

IEC 62888-3:2018, 4.8.2 is applicable to Level 2 and Level 3 with the following amendments.

The DHS data storage capacity shall ensure all data storage needs are met without operational problems. It shall be more than the predefined margin above the estimated maximum memory usage.

4.4.9 Transmission of CEMD from DHS to DCS [IEC 62888-3:2018, 4.9]

4.4.9.1 General [IEC 62888-3:2018, 4.9.1]

IEC 62888-3:2018, 4.9.1 is applicable to Level 2 and Level 3 with the following amendments.

Transmission method from EMF to DHS, from DHS to DCS is not limited to online transmission. Use of off line data handling, e.g. memory device, shall be agreed upon by the involved parties.

4.4.9.2 Type of information [IEC 62888-3:2018, 4.9.2]

IEC 62888-3:2018, 4.9.2 is applicable to Level 2 and Level 3 with the following amendments.

It shall be agreed upon by the involved parties that CEMD is transferred as one of the data from the communication network acting DHS to DCS.

The priority of the data shall be agreed upon by the involved parties.

4.4.9.3 Time between each transfer [IEC 62888-3:2018, 4.9.3]

IEC 62888-3:2018, 4.9.3 is applicable to Level 2 and Level 3 with the following amendment.

A procedure for transfer of CEMD from DHS to DCS shall be agreed upon by the involved parties.

4.4.9.4 Communication channel [IEC 62888-3:2018, 4.9.4]

IEC 62888-3:2018, 4.9.4 is applicable to Level 2 and Level 3 with the following amendments.

Transmission from DHS to DCS is not limited to online transmission. Use of off line data handling (e.g. memory device, direct connection of a personal computer) shall be agreed upon by the involved parties.

4.4.9.5 Security [IEC 62888-3:2018, 4.9.5]

IEC 62888-3:2018, 4.9.5 is applicable to Level 2 and Level 3.

For the detail methods see 4.5.2.3.

4.4.10 Marking and essential information [IEC 62888-3:2018, 4.10]

IEC 62888-3:2018, 4.10 is applicable to Level 2 and Level 3.

4.4.11 Event recording [IEC 62888-3:2018, 4.11]

IEC 62888-3:2018, 4.11 is applicable to Level 2 and Level 3.

4.4.12 DCS [IEC 62888-3:2018, 4.12]

IEC 62888-3:2018, 4.12 is applicable to Level 2 and Level 3 with the following amendments.

Transmission from DHS to DCS is not limited to online transmission. Use of off line data handling (e.g. memory device, direct connection of a personal computer) shall be agreed upon by the involved parties.

Such application procedure shall be agreed upon by the involved parties.

For the online transmission procedures, 4.12 in IEC 62888-3:2018 is applicable to Level 2 and Level 3.

4.5 Requirement amendments to IEC 62888-4

4.5.1 Overview [IEC 62888-4:2018, 4.1]

IEC 62888-4:2018, Clause 4 is applicable to Level 2 and Level 3 with the following amendments.

IEC 62888-4:2018 and this part of IEC 62888 specify the wireless data communication between the DHS and the on ground server. Off line data handling like a memory device or the data down loaded by the direct connection of a personal computer are not covered. For such applications, protocol of the data download shall be defined and agreed upon by the involved parties.

4.5.2 On board communication subsystem [IEC 62888-4:2018, 4.2]

4.5.2.1 General [IEC 62888-4:2018, 4.2.1]

IEC 62888-4:2018, 4.2.1 is applicable to Level 2 and Level 3 with the following amendments.

In Figure 4 in IEC 62888-4:2018, use of off line data handling instead of MCF shall be agreed upon by the involved parties. The interface used to retrieve the stored data in DHS by the off line is regarded as a maintenance port.

4.5.2.2 Communication protocols stack [IEC 62888-4:2018, 4.2.2]

IEC 62888-4:2018, 4.2.2 is applicable to Level 2 and Level 3 with the following amendment.

Communication protocol stack executed by each on board physical interface should be in accordance with IEC 62888-4:2018, 4.2.2.

4.5.2.3 Communication security [IEC 62888-4:2018, 4.2.3]

IEC 62888-4:2018, 4.2.3 is applicable to Level 2 and Level 3 with the following amendment.

If the communication security is ensured by software, the general requirements in 4.2.3.4.3, 4.2.3.4.4, 4.2.3.4.5, 4.2.3.4.6 and 4.2.3.5 shall be agreed upon by the involved parties.

4.5.2.4 VMF/CMF to ECF Interface (VEI) [IEC 62888-4:2018, 4.2.4]

IEC 62888-4:2018, 4.2.4 is applicable to Level 2 and Level 3 with the following amendments.

If this interface is digital, it shall be implemented according to the requirements listed in 4.3.3, 4.3.4, 4.5.2.2 and 4.5.2.3.

An example of implementation given in IEC 62888-4:2018, informative Annex B is applicable.

For the amendments to Annex B in IEC 62888-4:2018, see 6.4.2.

4.5.2.5 EMF to DHS interface (EMDI) [IEC 62888-4:2018, 4.2.5]

IEC 62888-4:2018, 4.2.5 is applicable to Level 2 and Level 3 with the following amendment.

The interface shall transfer at least the data in accordance with 4.3 and 4.4.

4.5.2.6 Maintenance/testing interfaces (DSI and ESI) [IEC 62888-4:2018, 4.2.6]

IEC 62888-4:2018, 4.2.6 is applicable to Level 2 and Level 3 with the following amendments.

If maintenance/testing interfaces exist, requirements in IEC 62888-4:2018, 4.2.6 shall be respected.

The access shall be controlled according to the requirements specified in 4.2.3.2.2.1 and 4.2.3.2.3.

4.5.2.7 DHS to location function [IEC 62888-4:2018, 4.2.7]

IEC 62888-4:2018, 4.2.7 is applicable to Level 2 and Level 3 with the following amendments.

If this interfaces is implemented by means of the consist network digital interface, requirements are given in 4.5.2.9.

The interface shall transfer location information in accordance with 4.4.4.

For the time data the amendments in 4.4.2 shall apply.

4.5.2.8 DHS to UTC source [IEC 62888-4:2018, 4.2.8]

IEC 62888-4:2018, 4.2.8 is applicable to Level 2 and Level 3 with the following amendments.

The requirement of the time data and UTC shall comply with 4.4.2.

If this interfaces is implemented by means of the consist network digital interface, requirements are given in 4.5.2.9.

The communication shall ensure that the synchronisation error, due to the communication itself, is less than 1 s.

For the requirement for the time data and synchronisation, the amendments of 4.4.2 shall apply.

4.5.2.9 DHS to Consist Network digital interface (CNI) [IEC 62888-4:2018, 4.2.9]

IEC 62888-4:2018, 4.2.9 is applicable to Level 2 and Level 3.

DHS to Consist Network digital interface shall be in accordance with IEC 62888-4:2018, 4.2.9.

4.5.3 On board to ground communication subsystem [IEC 62888-4:2018, 4.3]

IEC 62888-4:2018, 4.3 is applicable to Level 2 and Level 3 with the following amendments.

Annex A in IEC 62888-4:2018 is an example solution. For Level 2 and Level 3, other solutions agreed upon by the involved parties may be used.

For the amendments to Annex A in IEC 62888-4:2018, see 6.4.1.

According to IEC 62888-4:2018, 4.3, any kind of IP based bearer can be used. Another solution can be used by agreement between the involved parties.

Off line data handling like a memory device or the data down loaded by the direct connection of a personal computer are not covered. For such applications, protocol of the data download shall be defined and agreed upon by the involved parties.

4.5.4 Access security [IEC 62888-4:2018, 4.4]

IEC 62888-4:2018, 4.4 is applicable to Level 2 and Level 3 with the following amendment.

Access to the EMS data and data structures shall be under access control according to 4.2.3.2.2.1 and 4.2.3.2.3.

4.6 Amendments to conformance test approach in IEC 62888-5

4.6.1 General [IEC 62888-5:2018, 4.1]

IEC 62888-5:2018, 4.1 is applicable to Level 2 and Level 3 with the following amendments.

If the EMS is a subfunction of some systems, the conformance test of stage 2 can be integrated in the conformance test of such systems. The conformance test procedure shall be agreed upon by the involved parties.

4.6.2 Situation of applicability [IEC 62888-5:2018, 4.2]

IEC 62888-5:2018, 4.2 is applicable to Level 2 and Level 3.

4.6.3 General methodology [IEC 62888-5:2018, 4.3]

IEC 62888-5:2018, 4.3 is applicable to Level 2 and Level 3 with the following amendment.

The management of the documents requested for the conformance test folder is shared between the involved parties in ensuring the access and the traceability.

4.6.4 EMS system level specific methodology [IEC 62888-5:2018, 4.4]

IEC 62888-5:2018, 4.4 is applicable to Level 2 and Level 3.

5 Conformance test

5.1 General

The clauses/subclauses of IEC 62888-1 to IEC 62888-5, which shall be amended for Level 2 and Level 3, are stated in this document. Individual permissions and requirements applicable to Level 2 and Level 3 are specified in this document. For clauses/subclauses, which are not mentioned in this document, those of IEC 62888-1 to IEC 62888-5 apply.

5.2 Conformance test amendments to IEC 62888-2

5.2.1 General [IEC 62888-2:2018, 5.1]

5.2.1.1 Conformance test requirements [IEC 62888-2:2018, 5.1.1]

Clause 5 in IEC 62888-2:2018 is applicable to Level 2 and Level 3 with the amendments in 4.3 and 5.2.

5.2.1.2 Applicability [IEC 62888-2:2018, 5.1.2]

IEC 62888-2:2018, 5.1.2 is applicable to Level 2 and Level 3 with the following amendment.

The conformance test described in IEC 62888-2:2018, Clause 5 applies to any device performing any function covered by IEC 62888-2 with the amendments in 4.3.

5.2.1.3 Methodology [IEC 62888-2:2018, 5.1.3]

5.2.1.3.1 General [IEC 62888-2:2018, 5.1.3.1]

IEC 62888-2:2018, 5.1.3.1 is applicable to Level 2 and Level 3.

5.2.1.3.2 Device design review [IEC 62888-2:2018, 5.1.3.2]

IEC 62888-2:2018, 5.1.3.2 is applicable to Level 2 and Level 3.

5.2.1.3.3 Device type test [IEC 62888-2:2018, 5.1.3.3]

IEC 62888-2:2018, 5.1.3.3 is applicable to Level 2 and Level 3 with the amendments in 4.3 and 5.2.

5.2.1.3.4 Device routine test [IEC 62888-2:2018, 5.1.3.4]

IEC 62888-2:2018, 5.1.3.4 is applicable to Level 2 and Level 3.

5.2.2 Testing framework [IEC 62888-2:2018, 5.2]

5.2.2.1 General [IEC 62888-2:2018, 5.2.1]

IEC 62888-2:2018, 5.2.1 is applicable to Level 2 and Level 3 with the amendments in 4.3 and 5.2.

5.2.2.2 Reporting [IEC 62888-2:2018, 5.2.2]

IEC 62888-2:2018, 5.2.2 is applicable to Level 2 and Level 3 with the following amendments.

The report should include the information listed in IEC 62888-2:2018, 5.2.2.

For the amendments to informative Annex C in IEC 62888-2:2018, see 6.2.3.

5.2.3 Design review [IEC 62888-2:2018, 5.3]

5.2.3.1 General [IEC 62888-2:2018, 5.3.1]

IEC 62888-2:2018, 5.3.1 is applicable to Level 2 and Level 3.

5.2.3.2 Device design review [IEC 62888-2:2018, 5.3.2]

5.2.3.2.1 Interfaces [IEC 62888-2:2018, 5.3.2.1]

IEC 62888-2:2018, 5.3.2.1 is applicable to Level 2 and Level 3.

5.2.3.2.2 Access security [IEC 62888-2:2018, 5.3.2.2]

IEC 62888-2:2018, 5.3.2.2 is applicable to Level 2 and Level 3 with the amendments in 4.2.3.2.3.

5.2.3.2.3 Software [IEC 62888-2:2018, 5.3.2.3]

IEC 62888-2:2018, 5.3.2.3 is applicable to Level 2 and Level 3.

5.2.3.2.4 Safety [IEC 62888-2:2018, 5.3.2.4]

IEC 62888-2:2018, 5.3.2.4 is applicable to Level 2 and Level 3.

5.2.3.2.5 Clearance and creepage distances [IEC 62888-2:2018, 5.3.2.5]

IEC 62888-2:2018, 5.3.2.5 is applicable to Level 2 and Level 3.

5.2.3.2.6 RAMS [IEC 62888-2:2018, 5.3.2.6]

IEC 62888-2:2018, 5.3.2.6 is applicable to Level 2 and Level 3.

5.2.3.3 EMF design review [IEC 62888-2:2018, 5.3.3]

5.2.3.3.1 EMF maximum percentage error [IEC 62888-2:2018, 5.3.3.1]

IEC 62888-2:2018, 5.3.3.1 is applicable to Level 2.

For Level 3, 5.3.3.1 in IEC 62888-2:2018 is applicable with the amendments for the percentage error limit in 4.3.2.3.4.

5.2.3.3.2 Device compatibility [IEC 62888-2:2018, 5.3.3.2]

IEC 62888-2:2018, 5.3.3.2 is applicable to Level 2 and Level 3.

5.2.3.3.3 Re-verification [IEC 62888-2:2018, 5.3.3.3]

IEC 62888-2:2018, 5.3.3.3 is applicable to Level 2 and Level 3 with the amendments in 4.3.2.5.

5.2.4 Type testing [IEC 62888-2:2018, 5.4]

5.2.4.1 General [IEC 62888-2:2018, 5.4.1]

IEC 62888-2:2018, 5.4.1 is applicable to Level 2 and Level 3.

5.2.4.2 Common type testing [IEC 62888-2:2018, 5.4.2]

IEC 62888-2:2018, 5.4.2.10.2 is applicable to Level 2 and Level 3 with the following amendment.

For the NOTE of 5.4.2.10.2 in IEC 62888-2:2018, 5.2.4.3.6 and 5.2.4.4.2.1.2, corresponding to 5.4.3.6 (sensor) and 5.4.4.2.1.2 (ECF) in IEC 62888-2:2018, shall apply by agreement between the involved parties.

IEC 62888-2:2018, 5.4.2.10.3 is applicable to Level 2 and Level 3 with the following amendment.

The amendments in 5.2.4.4.2.1.2 for the specific requirements of the ECF in IEC 62888-2:2018, 5.4.2.10.3 c) shall apply.

IEC 62888-2:2018, 5.4.2.10.5 is applicable to Level 2 and Level 3 with the following amendments.

In case VMF, CMF and/or ECF are a part of some electrical equipment, total load of the electrical equipment shall be measured by agreement between the involved parties instead of the measurement of the load as a single function of VMF, CMF and/or ECF.

IEC 62888-2:2018, 5.4.2.13 is applicable to Level 2 and Level 3 with the following amendments.

The amendments of the requirement of the access control in 4.2.3.2.3 shall apply.

The requirement amended in 4.2.3.2.3 shall be tested.

Other subclauses in IEC 62888-2:2018, 5.4.2 are applicable to Level 2 and Level 3.

5.2.4.3 Sensor type test [IEC 62888-2:2018, 5.4.3]

5.2.4.3.1 General [IEC 62888-2:2018, 5.4.3.1]

IEC 62888-2:2018, 5.4.3.1 is applicable to Level 2 and Level 3 with the amendments in 5.2.4.2.

5.2.4.3.2 Voltage withstand tests for analogue sensors [IEC 62888-2:2018, 5.4.3.2]

IEC 62888-2:2018, 5.4.3.2 is applicable to Level 2 and Level 3 with the following amendments.

In case electronic analogue sensors are a part of some electrical equipment, installed in it and the influence of lightning surge is not expected, impulse withstand test for the low voltage circuits shall be agreed upon by involved parties.

The amendments of the requirements in 4.3.3.2.2 corresponding to 4.3.2.2.1 and 4.3.2.2.2 in IEC 62888-2:2018 shall apply.

5.2.4.3.3 Test of response time ($t_{s,r}$) [IEC 62888-2:2018, 5.4.3.3]

IEC 62888-2:2018, 5.4.3.3 is applicable to Level 2 and Level 3.

5.2.4.3.4 Accuracy tests [IEC 62888-2:2018, 5.4.3.4]

5.2.4.3.4.1 Basic accuracy tests for VMF [IEC 62888-2:2018, 5.4.3.4.1]

IEC 62888-2:2018, 5.4.3.4.1 is applicable to Level 2.

For Level 3, 5.4.3.4.1 in IEC 62888-2 is applicable with the following amendments.

Additional accuracy classes and percentage error limits of Table 3 in 4.3.3.3.4 shall apply by agreement between the involved parties.

Tests shall be made at each value of voltage given in Table 3: $U_{\min 2}$, $U_{\max 2}$ and at rated primary voltage ($U_{n,VMF}$).

5.2.4.3.4.2 Basic accuracy tests for CMF [IEC 62888-2:2018, 5.4.3.4.2]

IEC 62888-2:2018, 5.4.3.4.2 is applicable to Level 2.

For Level 3, additional accuracy classes and percentage error limits of Table 4 and Table 5 in 4.3.3.4.3 shall apply by agreement between the involved parties.

Tests shall be made at each value of current given in Table 4 and Table 5: 5 %, 20 %, 100 %, 120 % of rated primary current ($I_{n,CMF}$) for each polarity.

5.2.4.3.4.3 Accuracy tests with temperature influence quantity [IEC 62888-2:2018, 5.4.3.4.3]

5.2.4.3.4.3.1 Limits of error including the effect of ambient temperature variation [IEC 62888-2:2018, 5.4.3.4.3.1]

IEC 62888-2:2018, 5.4.3.4.3.1 is applicable to Level 2.

For Level 3, the maximum percentage error limits, including the effects of temperature variation, in 4.3.3.3.5.1 and 4.3.3.4.4.1 shall apply by agreement between the involved parties.

5.4.3.4.3.1 in IEC 62888-2:2018 shall apply by agreement between the involved parties.

5.2.4.3.4.3.2 Mean temperature coefficient [IEC 62888-2:2018, 5.4.3.4.3.2]

IEC 62888-2:2018, 5.4.3.4.3.2 is applicable to Level 2.

For Level 3, amendments of the maximum percentage error, including the effects of temperature variation in 4.3.3.3.5.2 and 4.3.3.4.4.2 shall apply.

5.4.3.4.3.2 in IEC 62888-2:2018 shall apply by agreement between the involved parties.

5.2.4.3.5 Test of the influence of harmonics on an AC CMF [IEC 62888-2:2018, 5.4.3.5]

IEC 62888-2:2018, 5.4.3.5 is applicable to Level 2 and Level 3 with the following amendments.

If the sensor complies with IEC 60044-8, it is not required to test the influences of harmonics specified in IEC 62888-2:2018, 4.3.4.5.

5.4.3.5 in IEC 62888-2:2018 shall apply by agreement between the involved parties.

5.2.4.3.6 Accuracy tests with auxiliary power supply influence quantities [IEC 62888-2:2018, 5.4.3.6]

IEC 62888-2:2018, 5.4.3.6 is applicable to Level 2 and Level 3 with the following amendments.

The additional percentage error limit of the variations of supply voltage is not specified in 4.3.3.3.6 and 4.3.3.4.6.

Items a) and b) specified in IEC 62888-2:2018, 5.4.3.6 shall apply by agreement between the involved parties.

For Level 3, items c) specified in IEC 62888-2:2018, 5.4.3.6 shall apply with the amendments of the additional accuracy classes in Table 3 in 4.3.3.3.4 for a voltage sensor and in Table 4 and Table 5 in 4.3.3.4.3 for a current sensor.

5.2.4.3.7 Test on influence of input overvoltages for VMF [IEC 62888-2:2018, 5.4.3.7]

IEC 62888-2:2018, 5.4.3.7 is applicable to Level 2.

For Level 3, 5.4.3.7 in IEC 62888-2:2018 shall apply with the amendments of the additional accuracy classes in Table 3 in 4.3.3.3.4.

5.2.4.3.8 Accuracy test with magnetic induction of external origin [IEC 62888-2:2018, 5.4.3.8]

IEC 62888-2:2018, 5.4.3.8 is applicable to Level 2 and Level 3 with the following amendments.

For Level 2, the test should be carried out according to the test procedure described in IEC 62888-2:2018, Annex A. Another test method, which generates a unique magnetic field as specified, shall be used by agreement between the involved parties.

For the amendments to Annex A in IEC 62888-2:2018, see 6.2.1.

For the starting current the amendments in 4.3.2.3.5 shall apply.

For Level 3, additional percentage error limits of the effects of the electromagnetic interference are not specified in 4.3.3.3.6 and 4.3.3.4.6.

For Level 3, 5.4.3.8 in IEC 62888-2:2018 is not applicable.

5.2.4.3.9 EMC tests [IEC 62888-2:2018, 5.4.3.9]

IEC 62888-2:2018, 5.4.3.9 is applicable to Level 2 and Level 3 with the following amendments.

In case sensors installed in a traction converter, effects of the electromagnetic interference are tested according to IEC 61287-1 and IEC 62236-3-2. Sensors shall comply with IEC 61287-1 and IEC 62236-3-2. The test shall be carried out with the sensors installed in the traction converter by agreement between the involved parties.

The additional percentage error of the effects of the electromagnetic interference is not specified.

For Level 3, the variation of error is not applicable.

5.2.4.3.10 Temperature-rise test [IEC 62888-2:2018, 5.4.3.10]

IEC 62888-2:2018, 5.4.3.10 is applicable to Level 2 and Level 3.

5.2.4.3.11 Short circuit withstand test [IEC 62888-2:2018, 5.4.3.11]

5.2.4.3.11.1 Short circuit withstand test for current sensors [IEC 62888-2:2018, 5.4.3.11.1]

IEC 62888-2:2018, 5.4.3.11.1 is applicable to Level 2 and Level 3.

5.2.4.3.11.2 Short circuit withstand test for analogue output voltage sensors [IEC 62888-2:2018, 5.4.3.11.2]

IEC 62888-2:2018, 5.4.3.11.2 is applicable to Level 2 and Level 3 with the amendments in 4.3.3.3.2.

5.2.4.4 ECF type test [IEC 62888-2:2018, 5.4.4]**5.2.4.4.1 General [IEC 62888-2:2018, 5.4.4.1]**

IEC 62888-2:2018, 5.4.4.1 is applicable to Level 2 and Level 3 with the amendments in 5.2.4.2.

5.2.4.4.2 Tests of electrical requirements [IEC 62888-2:2018, 5.4.4.2]**5.2.4.4.2.1 Test on ECF with analogue inputs [IEC 62888-2:2018, 5.4.4.2.1]****5.2.4.4.2.1.1 Power consumption test of measuring inputs [IEC 62888-2:2018, 5.4.4.2.1.1]**

IEC 62888-2:2018, 5.4.4.2.1.1 is applicable to Level 2 and Level 3 with the amendments in 4.3.4.3.1.2 and 4.3.4.3.1.3.

5.2.4.4.2.1.2 Tests of the effects of power supply voltage interruptions and overvoltages [IEC 62888-2:2018, 5.4.4.2.1.2]

For Level 2 and Level 3, 5.4.4.2.1.2 in IEC 62888-2:2018 is not applicable as the amendments in 4.3.4.3.2.2.

5.2.4.4.2.1.3 Test of influence of short-time input overcurrent [IEC 62888-2:2018, 5.4.4.2.1.3]

IEC 62888-2:2018, 5.4.4.2.1.3 is applicable to Level 2 and Level 3 with the amendments in 4.3.4.3.3.

The variation of error shall apply by agreement between the involved parties.

5.2.4.4.2.1.4 Test of influence of self-heating [IEC 62888-2:2018, 5.4.4.2.1.4]

IEC 62888-2:2018, 5.4.4.2.1.4 is applicable to Level 2 and Level 3 with the amendments in 4.3.4.3.4.

5.2.4.4.2.2 Temperature-rise test [IEC 62888-2:2018, 5.4.4.2.2]

IEC 62888-2:2018, 5.4.4.2.2 is applicable to Level 2 and Level 3.

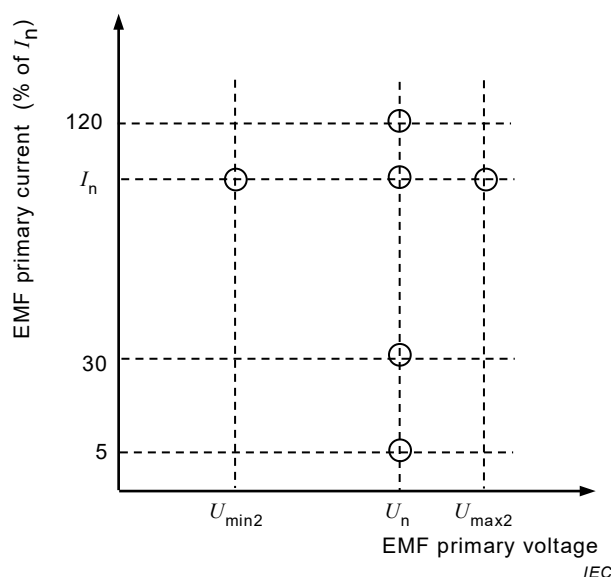
5.2.4.4.3 Accuracy tests [IEC 62888-2:2018, 5.4.4.3]**5.2.4.4.3.1 Type test of the accuracy requirements [IEC 62888-2:2018, 5.4.4.3.1]**

IEC 62888-2:2018, 5.4.4.3.1 is applicable to Level 2.

For Level 3, the amendments of the accuracy requirements of the ECF in 4.3.4.4 and the additional accuracy classes and percentage error limits of Table 6 in 4.3.4.4.2 shall apply.

The percentage error shall be measured at the 6 points identified in Figure 3 by inputting appropriate signals at the input test points of the ECF.

The percentage error shall not exceed the limits given in Table 6.



Key

- I_n Rated primary current of the current sensor
- U_n Nominal voltage of the primary voltage
- U_{max2} Highest non-permanent voltage of the primary voltage
- U_{min2} Lowest non-permanent voltage of the primary voltage
- Test points for testing the accuracy requirements on the ECF

Figure 3 – Test point matrix for ECF accuracy tests (type test)
[IEC 62888-2:2018, Figure 8]

5.2.4.4.3.2 Accuracy tests with temperature influence quantity [IEC 62888-2:2018, 5.4.4.3.2]

5.2.4.4.3.2.1 Limits of error including the effect of ambient temperature variation [IEC 62888-2:2018, 5.4.4.3.2.1]

IEC 62888-2:2018, 5.4.4.3.2.1 is applicable to Level 2.

For Level 3, the maximum percentage error limits, including the effects of ambient temperature variation, shall be agreed upon by the involved parties as stated in 4.3.4.5.1.

5.2.4.4.3.2.2 Mean temperature coefficient [IEC 62888-2:2018, 5.4.4.3.2.2]

IEC 62888-2:2018, 5.4.4.3.2.2 is applicable to Level 2.

For Level 3, the mean temperature coefficient shall be agreed upon by the involved parties as stated in 4.3.4.5.2.

5.2.4.4.3.3 Test of no-load condition [IEC 62888-2:2018, 5.4.4.3.3]

IEC 62888-2:2018, 5.4.4.3.3 is applicable to Level 2 and Level 3 with the amendments in 4.3.2.3.5 and 4.3.4.3.2.2.

5.2.4.4.3.4 Test of starting condition [IEC 62888-2:2018, 5.4.4.3.4]

IEC 62888-2:2018, 5.4.4.3.4 is applicable to Level 2 and Level 3 with the amendments in 4.3.2.3.5.

The value agreed upon by the involved parties shall be used.

5.2.4.4.4 Test of influence quantities [IEC 62888-2:2018, 5.4.4.4]**5.2.4.4.4.1 General [IEC 62888-2:2018, 5.4.4.4.1]**

IEC 62888-2:2018, 5.4.4.4.1 is applicable to Level 2.

For Level 3, additional error limits related to the influence quantities specified in IEC 62888-2:2018, 4.4.6, shall be agreed upon by the involved parties as stated in 4.3.4.6.

5.2.4.4.4.2 Test of the influence of auxiliary power supply voltage variations [IEC 62888-2:2018, 5.4.4.4.2]

IEC 62888-2:2018, 5.4.4.4.2 is applicable to Level 2.

For Level 3, 5.4.4.4.2 in IEC 62888-2:2018 is not applicable.

5.2.4.4.4.3 Test of the influence of frequency variations [IEC 62888-2:2018, 5.4.4.4.3]

IEC 62888-2:2018, 5.4.4.4.3 is applicable to Level 2.

For Level 3, 5.4.4.4.3 in IEC 62888-2:2018 is not applicable.

5.2.4.4.4.4 Accuracy test in the presence of harmonics (ECF with AC inputs only) [IEC 62888-2:2018, 5.4.4.4.4]

IEC 62888-2:2018, 5.4.4.4.4 is applicable to Level 2 and Level 3 with the following amendment.

If the sensor complies with IEC 60044-8, it is not required to test the influences of harmonics specified in IEC 62888-2:2018, 4.3.4.5.

5.2.4.4.4.5 Tests of the influence of odd harmonics and sub-harmonics (ECF with AC inputs only) [IEC 62888-2:2018, 5.4.4.4.5]

IEC 62888-2:2018, 5.4.4.4.5 is not applicable as stated in 4.3.4.6.3 .

5.2.4.4.4.6 Continuous magnetic induction of external origin [IEC 62888-2:2018, 5.4.4.4.6]

IEC 62888-2:2018, 5.4.4.4.6 is applicable to Level 2 and Level 3 with the following amendments.

Additional percentage error limits of the effects of the electromagnetic interference shall be agreed upon by the involved parties as stated in 4.3.4.6.

For the amendments to Annex A in IEC 62888-2:2018, see 6.2.1.

5.2.4.4.4.7 Magnetic induction of external origin [IEC 62888-2:2018, 5.4.4.4.7]

IEC 62888-2:2018, 5.4.4.4.7 is applicable to Level 2 and Level 3 with the following amendments.

Additional percentage error limits of the effects of the electromagnetic interference shall be agreed upon by the involved parties as stated in 4.3.4.6.

For the amendments to Annex A in IEC 62888-2:2018, see 6.2.1.