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Tractors and machinery for agriculture and forestry — Electrical high-power interface 700 V DC / 480 V AC —

Part 6: Communication signals

Tracteurs et matériels agricoles et forestiers — Interface électrique haute puissance 700VDC/480VAC —

Partie 6: Signaux de communication

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Contents

Foreword vii
Introduction viii
1 Scope 1
2 Normative references 1
3 Terms and definitions 2
4 Voltage classes 4
5 General system overview 4
5.1 General 4
5.2 Basic AC-system topology 5
5.3 Basic DC-system topology 7
6 Communication process and system handshake 9
6.1 System handshake phases 9
6.2 Conditions for system handshake 10
6.3 HPI connection status monitoring 11
6.4 Interaction with TIM function state machine 11
7 Fieldbus 19
8 HPI interlock function 19
8.1 Functional requirements 19
8.2 Functional principle 20
9 Fieldbus-based system 21
9.1 Identification sequence using fieldbus 21
9.2 Initialization sequence using fieldbus 24
9.3 Normal operation sequence using fieldbus 27
9.4 Sequence definition for normal system shutdown using fieldbus 29
10 IL-based system 30
10.1 Identification and initialization of an IL-based system 30
10.1.1 General 30
10.1.2 CS identification of an IL-based system 31
10.1.3 Identification procedure 31
10.1.4 Additional conditions 32
10.2 Determining the topology of the VC-B2 network of an IL-based system 35
10.3 System Initialization of an IL-based system 35
10.3.1 General 35
10.3.2 System handshake of an IL-based system 38
10.4 Sequence definition for normal start-up of an IL-based system 38
10.5 Sequence definition for normal system shutdown of an IL-based system 41

iTeh Standards (https://standards.iteh.ai) Document Preview
ISO/FDIS 23316-6
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10.6 Sequence diagrams for system handshake of an IL-based system 43
11 Isolation resistance and insulation monitoring 49
11.1 General 49
11.2 Communication 51
11.2.1 General 51
11.2.2 OIM initialization 51
11.2.3 Minimum isolation resistance initialization 52
11.2.4 Isolation resistance online measurement (operation of the completed system) 54
Annex A (normative) Communication signals 55
Annex B (informative) ISOBUS messages and message sets 74
Annex C (informative) Example for determining the topology of the network 76
Annex D (informative) Diagnostic trouble codes 79
Annex E (informative) Example: Isolation resistance and insulation monitoring 83
Bibliography 85

~~Foreword 5~~
~~Introduction 6~~
~~1 Scope 8~~
~~2 Normative References 8~~
~~3 Terms and definitions 9~~
~~4 Voltage classes 18~~
~~5 General system overview 19~~
~~5.1 Basic AC system topology 19~~
~~5.2 Basic DC system topology 21~~
~~6 Communication process and system handshake 22~~
~~6.1 System handshake phases 22~~
~~6.2 General 22~~
~~6.3 HPI connection status monitoring 23~~
~~6.4 Interaction with TIM function state machine 24~~
~~7 Fieldbus 27~~
~~7.1 Background 27~~
~~7.2 Physical layer 27~~
~~7.3 Initialization data 27~~
~~7.4 Cyclic control feedback data 27~~
~~8 HPI interlock function 27~~
~~8.1 Functional requirements 27~~
~~8.2 Functional principle 28~~

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Document Preview
ISO/FDIS 23316-6
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9 Fieldbus-based system 29
9.1 Identification sequence using fieldbus 29
9.2 Initialization sequence using fieldbus 30
9.3 Normal operation sequence using fieldbus 32
9.4 Sequence definition for normal system shutdown using fieldbus 33
10 IL-based system 34
10.1 Identification and initialization of an IL-based system 34
10.1.1 CS identification of an IL-based system 34
10.1.2 Identification procedure 35
10.1.3 Additional conditions 35
10.2 Determining the topology of the VC-B2 network of an IL-based system 37
10.3 System Initialization of an IL-based system 37
10.3.1 System handshake of an IL-based system 38
10.4 Sequence definition for normal start-up of an IL-based system 39
10.5 Sequence definition for normal system shutdown of an IL-based system 40
11 Isolation resistance and insulation monitoring 42
11.1 General 42
11.2 Communication 43
11.2.1 OIM initialization 44
11.2.2 Minimum isolation resistance initialization 44
11.2.3 Isolation resistance online measurement (operation of the completed system) 44
Annex A (normative) Communication signals 46
A.1 General communication signals for AC mode according to ISO 23316-4 and DC mode according to ISO 23316-5 47
A.2 Communication AC mode according to ISO 23316-4 62
A.2.1 ISOBUS signals 62
A.2.2 Load specific signals 81
A.2.2.1 LLB addressing 103
A.3 Communication DC mode according to ISO 23316-5 105
A.3.1 Signals 105
Annex B (informative) ISOBUS message sets 115
B.1 TIM control message sets 117
B.2 Control message sets 121
B.3 Parameterization message sets 130
Annex C (informative) Example for determining the topology of the network 149
Annex D (informative) Diagnostic Trouble Codes (DTCs) 151
Annex E (informative) TIM function state machine 155
Annex F (informative) Example: Isolation resistance and insulation monitoring 156

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ISO/FDIS 23316-6
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part~~-~~ 1. In particular, the different approval criteria needed for the different types of ISO ~~documents~~document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part~~-~~ 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry, Subcommittee SC 19, Agricultural electronics*.

The document is intended to be used in conjunction with the ISO 11783 series and the other parts of ISO 23316.

A list of all parts in the ISO 23316 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

~~0.1 General~~

Due to the requirements of modern agriculture, the precise control of implement functions is a key issue in agricultural technology. The required precision is difficult to achieve with mechanical or hydraulic devices; it is more efficient to provide control with electric and electronic means, i.e. electric power and ISOBUS. The use of electric power allows implement manufacturers to offer farmers improved implements that provide a higher degree of automation and navigation, resulting in greater precision, better power distribution, and better controllability.

The purpose of the ISO 23316 series is to provide a design and application standard covering implementation of electrical high-power interfaces operating with a nominal voltage of 700 V DC/480 V AC for manufacturers of agricultural machinery.

The ISO 23316 series specifies the physical and logical interface requirements that provide interoperability and cross compatibility for systems and equipment.

Conformance to the ISO 23316 series means all applicable requirements from ISO 23316-1 to ISO 23316-7 are met.

It is permitted for partial systems or components to conform to the ISO 23316 series by applying all applicable requirements, for example, for the plug, receptacle, or inverters, on a tractor or an implement.

NOTE 1 If a DC-mode only HPI is provided, it is not necessary to conform with ISO 23316-4 which describes AC-mode, as it is not applicable. If an AC-mode only HPI is provided, it is not necessary to conform with ISO 23316-5 which describes DC-mode, as it is not applicable.

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The ISO 23316 series defines an interface between a power providing device (supply system) and a power consuming device (consumer system), used within an automated electrified system in the agricultural industry. This series deals with electrical, mechanical and bus communication objectives and is used in conjunction with ISO 11783, which defines the ISOBUS. ~~Figure 1~~Figure 1 portrays the elements of typical equipment that involve the high-power interface.

The following aspects are not within the scope of ISO 23316:

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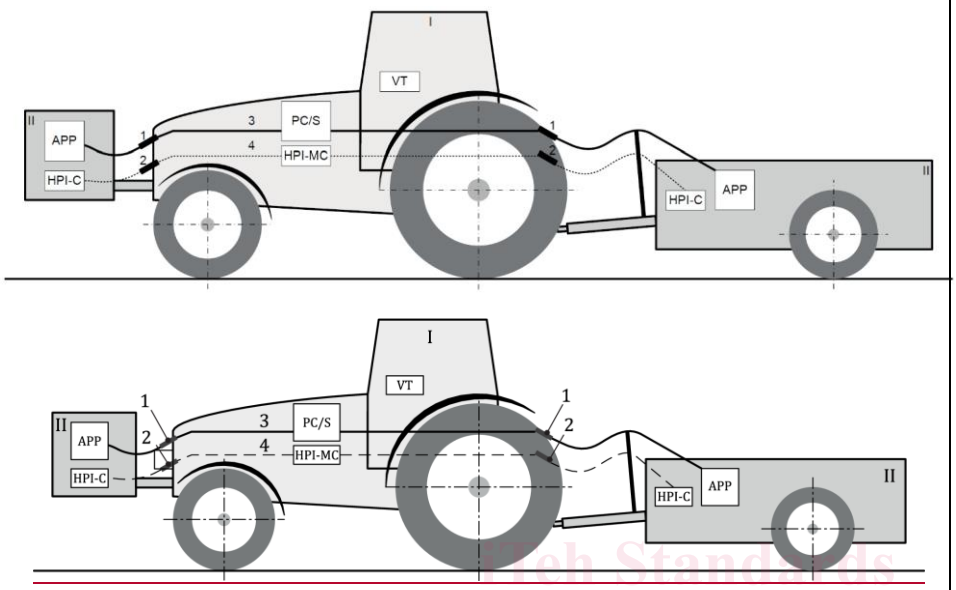
— ~~Service~~service, maintenance, and related diagnostics;
— ~~Functional~~functional safety;
— ~~Control~~control strategies for high-power supplies and loads;
— ~~Application~~application-specific strategies and operational modes;
— ~~Component~~component design;
— ~~Energy~~energy storage systems, e. g. supercapacitors or batteries;
— ~~Multiple~~multiple electrical power supplies to a common DC link.

NOTE 2 ~~Annex D (informative)~~Annex D lists some basic diagnostics by DTCs.

NOTE 3 For example, AEF guideline 007 handles some aspects of functional safety already.



Key

Symbol	Description	Symbol	Description	Symbol	Description
APP	application	1	high-power interface		power connection
			~~Solid line~~		
PC/S	power converter ~~/~~ /switch	2	ISOBUS connector		signal connection
			~~Dashed line~~		
HPI-C	high-power interface ~~-~~ control	3	power lines	I	supply system
HPI-MC	high-power interface ~~-~~ master control	4	ISOBUS	II	consumer system
VT	virtual terminal (user interface)				

Figure ~~-~~ 1 — Typical elements of system incorporating a high-power interface

~~**0.2 Patent**~~

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Tractors and machinery for agriculture and forestry — Electrical high-power interface 700 V DC / 480 V AC —

Part 6: Communication signals

1 Scope

This document specifies the communication interface, so that the transmitted parameters, signals and objects between a supply system (SS), with power converter / switch (PC/S) and High Power Interface - Master Control high power interface – master control (HPI-MC) including the Tractor Implement Management tractor implement management (TIM) server, and a Consumer System consumer system (CS), with Application application (APP) and High Power Interface - Control high power interface - control (HPI-C) including the TIM client and the task controller, can be used is in the agricultural industry. The mentioned signals are used during identification, initialization, operation, and shutdown modes of operation.

This document does not cover the definitions of Suspect Parameter Numbers suspect parameter numbers (SPNs) for the signals, within the Parameter Group Numbers parameter group numbers (PGNs) for messages and the message setup. These definitions are given in ISO 11783 and SAE J1939.

NOTE For information on messages (PGNs) see also Annex B. Annex B.

2 Normative References 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 60204:2016, *Safety of machinery - Electrical equipment of machines*

ISO / IEC / IEEE 8802-3:2021, *Telecommunications and exchange between information technology systems - Requirements for local and metropolitan area networks - Part 3: Standard for Ethernet*

ISO 16230-1:2015, Agricultural machinery and tractors — Safety of higher voltage electrical and electronic components and systems — Part 1: General requirements

ISO 23316 (all parts), -1, Tractors and machinery for agriculture and forestry — Electrical high-power interface 700 V DC / 480 V AC — *Part 1: General description*

ISO 23316-1:2022-2, Tractors and machinery for agriculture and forestry — Electrical high-power interface 700 V DC / 480 V AC — *Part 1: General description*

ISO 23316-2:2023, *Tractors and machinery for agriculture and forestry - Electrical high-power interface 700 V DC / 480 V AC - Part 2: Physical layer*

ISO 23316-3:2023, *Tractors and machinery for agriculture and forestry - Electrical high-power interface 700 V DC / 480 V AC - Part 3: Safety requirements*

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ISO 23316-5:2023, Tractors and machinery for agriculture and forestry — Electrical high-power interface 700 V DC / 480 V AC — *Part 5: DC operation mode*

ISO 23316-7, *Tractors and machinery for agriculture and forestry — Electrical high-power interface 700 V DC / 480 V AC — Part 7: Mechanical integration*

ISO 11783 (all parts), Tractors and machinery for agriculture and forestry — Serial control and communications data network

IEC 60204:2016, *Safety of machinery — Electrical equipment of machines*

SAE J1939DA ~~(2023, May),~~ *Serial Control and Communications Heavy Duty Vehicle Network* — Digital Annex

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 23316 ~~(all parts)~~ 1, ISO 23316-2, ISO 23316-4, ISO 23316-5, ISO 23316-7 and the following apply.

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

— ISO Online browsing platform: available at ~~https://www.iso.org/obp~~https://www.iso.org/obp

— IEC Electropedia: available at ~~https://www.electropedia.org/~~https://www.electropedia.org/

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3.1
direction of rotation
positive values for frequency or speed related to powering the power converter phases in the sequence U V W positive torque means torque in the direction of positive speed

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Note 1 to entry: If not stated otherwise (e.g. ground speed), the term 'speed' within this document refers always to rotational movement.

3.2
fieldbus maindevice
device integrated within inverter onboard supply system, controls actively the communication within the fieldbus network and requests/receives data to/from the *fieldbus subdevice* ~~(3.20,~~(3.3), subordinated controller) in a cyclically and time-wise deterministic manner

3.3
fieldbus subdevice
device integrated within LLB on-board consumer system receives data (e.g. requests) from and provides data (e.g. feedback) to the *fieldbus maindevice* ~~(3.19)~~(3.2) passively

3.4
insulation monitor
IM
device monitoring the ungrounded system between an active phase conductor and the equipotential bonding

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3.5
power converter / switch control
PC/S - C
control for AC mode, a power converter; for DC mode, a switch such as a contactor or solid-state switch, typically an integral part of the PC/S – C

3.6
minimum isolation resistance
MIR
value in failure free condition but at worst case ambient conditions (considering humidity, fluids, cooling type, etc. in operation)

3.7
multi consumer system
MCS
system of more than one consumer systems or consumer system trains, connected to the HPI in any combination of a series or parallel configuration

3.8
online insulation monitor
OIM
system to measure the overall system isolation resistance onboard of the initial supply system

3.9
parameter group number
PGN
~~a three~~3-byte CAN Message, 24 bit, representation of the ~~Extended Data Page, Data Page,~~ extended data page, data page, protocol data unit (PDU ~~Format~~) format, and group extension (GE) fields

[SOURCE: ISO 11783-1:2017, 3.44]

Note 1 to entry: The ~~Parameter Group Number~~parameter group number uniquely identifies a particular ~~Parameter Group~~parameter group.

3.10
pre-charge procedure
capacitor charging procedure to balance different DC link voltage levels

3.11
pre- and discharge unit
unit to pre- or discharge the DC link connected via HPI, typically an integral part of the PC/S – C

3.12
supply system master
SS-M
supply system that includes the initial power source, such as generator/rectifier unit or fuel cell, commonly the tractor, typically the HPI-MC also resides there

3.13
suspect parameter number
SPN
19-bit number used to identify a particular element, component, or parameter associated with a control function

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[SOURCE: ISO 11783-1:2017, 3.58]

Note 1 to entry: Suspect parameter numbers are assigned to each individual parameter in a parameter group, and to items that are relevant to diagnostics but are not presently a parameter in a parameter group.

Note 2 to entry: See SAE J1939 definitions for more details.

4 Voltage classes

~~Table 1~~Table 1 indicates the range of voltages (as defined in ISO 23285).

Table 1 — Voltage classes

Voltage class	Maximum working voltage	
	V DC	V AC RMS
VC-A	0 < U ≤ 60	0 < U ≤ 30
VC-A1	0 < U ≤ 32	0 < U ≤ 21
VC-A2	32 < U ≤ 60	21 < U ≤ 30
VC-B	60 < U ≤ 1 500	30 < U ≤ 1 000
VC-B1	60 < U ≤ 75	30 < U ≤ 50
VC-B2	75 < U ≤ 1 500	50 < U ≤ 1 000
U = nominal voltage		

NOTE 1 The definition of RMS values in ~~Table 1~~Table 1 is related to a pure sine wave form or the fundamental frequency of a modulated signal. The RMS value of a modulated signal may differ from them.

NOTE 2 Unipolar PWM is DC. Bipolar PWM is AC.

5 General system overview

5.1 General

Initially, the basis for the communication between supply system (SS) and consumer systems (CSs), high power interface (HPI) controllers (shown in ~~Figure 2~~Figure 2 and ~~Figure 3)~~Figure 3) shall use the ISOBUS as specified ~~by~~in the ISO 11783 ~~(all parts)~~series.

NOTE 1 High speed ISOBUS and other alternative communication media such as Automotive Ethernet and EtherCAT ™ [1] based technologies can be used but likely need an update to this document. For information, ISO technical committees TC 82, TC 23 and TC 127 are collaboratively working on high-speed secure communication interfaces.

NOTE 2 Topologies showed in this clause are only examples, implementations can differ from them (e.g. in number of interfaces).

If applicable, as basis for the communication between Power Converter ~~/~~ /Switch Controller (PC/S ~~-~~-C) and application (APP~~) / (~~/load (shown in ~~Figure 2~~Figure 2) the fieldbus as defined in ~~Clause 7~~Clause 7 may be used.

[1] EtherCAT ™ is a Tradename of Beckhoff used as an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

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