INTERNATIONAL STANDARD

ISO 23316-4

First edition
2023-08

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

Part 4: AC operation mode

Reference number
ISO 23316-4:2023(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This document is intended to be used in conjunction with ISO 23316-1, ISO 23316-2, ISO 23316-3, ISO 23316-5, ISO/FDIS 23316-6:— and ISO 23316-7.

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.

Introduction

The purpose of the ISO 23316 series is to provide design and application standards covering implementation of electrical high-power interface with a nominal voltage of 700 V DC/480 V AC for agricultural and forestry machinery. The ISO 23316 series specifies the physical and logical interface requirements that provide interoperability and cross compatibility for systems and equipment.

In order to state compliance to the ISO 23316 series, all applicable requirements from ISO 23316-1 to ISO 23316-7 shall be met.

It is permitted for partial systems or components to be compliant to the ISO 23316 series by applying all applicable requirements e.g. for the plug, receptacle or inverters, on a tractor or implement.

NOTE For example, if a DC-mode only HPI is provided, it is not necessary to comply with this document describing AC-mode, as it is not applicable. If an AC-mode only HPI is provided, it is not necessary to comply with ISO 23316-5 describing DC-mode, as it is not applicable.

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

— service, maintenance, and related diagnostics;

— functional safety;

— control strategies for high-power supplies and loads;

— application-specific strategies and operational modes;

— component design;

— energy storage systems, e. g. supercapacitors or batteries;

— multiple electrical power supplies to a common DC-link.

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

Part 4: AC operation mode

1 Scope

This document specifies required measures applicable to the HPI AC Interface between a supply system (typically located on an agricultural tractor) and detachable electrical consumer system (typically located on an agricultural implement).

This document covers the following:

— HPI system topologies;

— interface relevant characteristics of the HPI providing AC or combined AC and DC;

— interface relevant characteristics of the HPI AC load (for relevant characteristics of a DC load, see ISO 23316-5);

— logical, operational and electrical characteristics of the HPI:

  — operating mode aspects, and

  — communication parameters

NOTE This document contains simplified electrical diagrams showing specific aspects of the required functionality.

2 Normative references

The following documents refer to 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.

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

ISO 23316-2:2023, *Tractors and machinery for agriculture and forestry — Electrical high-power interface 700VDC / 480-VAC — Part 2: Physical interface*

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

ISO//FDIS 23316-6:—[1)], *Tractors and machinery for agriculture and forestry — Electrical high-power interface 700VDC / 480-VAC — Part 6: Communication signals*

IEEE 802.3-2018, *Physical Coding Sublayer (PCS), Physical Medium Attachment (PMA) sublayer and baseband medium, type 100BASE-T1 (100 Mb/s Ethernet full duplex local area network over a single balanced twisted pair)*

1) Under preparation: Stage at the date of publication: ISO/FDIS 23316-6:2023.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 23316-1 and the following apply.

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

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

— IEC Electropedia: available at http://www.electropedia.org

3.1
AC-load
ACL
device capable of utilising AC voltage

EXAMPLE 3-phase motor, heat resistor, linear actuator.

3.2
actual value
feedback values of the electric drive's control within the agricultural application/process

Note 1 to entry: In torque control mode, it is an estimation based on current and electric machine's model.

3.3
application control
APP-C
control means to monitor and control the consumer system, typically located on the implement

3.4
combined AC and DC interface
interface be able to provide AC Mode or alternatively DC Mode functionality

3.5
DC-load
DCL
device capable of utilising DC voltage (e.g. power converter with inductive/resistive/capacitive load)

3.6
EtherCAT
industrial communication network according to IEC 61158 Type 12

Note 1 to entry: All uses of the term "fieldbus" in ISO23316 refer to this definition.

Note 2 to entry: EtherCAT is an Ethernet based fieldbus technology widely used for real-time distributed control applications. EtherCAT uses Ethernet frames according to IEEE 802.3. The frames are sent by the EtherCAT MainDevice, which typically also is the application controller. The frames contain process data and parameter data for the distributed nodes such as drives, sensors and general input/output devices which are called EtherCAT SubDevices. Each EtherCAT SubDevice reads the output data intended for it from the frame and writes the input data to be sent to the MainDevice into the frame. This is done on-the-fly in hardware with minimum delay while forwarding the frame to the next SubDevice. Due to this functional principle, switches are omitted, and the protocol overhead is minimized.

3.7
EtherCAT MainDevice
device integrated within inverter onboard supply system, controls actively the communication within the EtherCAT network and requests/receives data to/from the EtherCAT SubDevice in a cyclically and time-wise deterministic manner

3.8
EtherCAT SubDevice
device integrated within LLB on-board consumer system receives data (e.g. requests) from and provides data (e.g. feedback) to the EtherCAT MainDevice passively

3.9
fundamental component
sinusoidal component of the Fourier series of a periodic quantity (e.g. sinusoidal current or PWM voltage) having the frequency of the quantity itself

[SOURCE: IEC 60050-103]

3.10
induction machine
IM
asynchronous machine of which only one winding is energized

[SOURCE: IEC 60050-411]

3.11
load logical box
LLB
collects and transfers sensor data and specific parameters from the load to the PC/S via EtherCAT

Note 1 to entry: electronical device connected to EtherCAT as SubDevice and optionally topic electrical load internal communication bus; intended use as memory of load specific data (e.g. electric machine specific data) and load sensor electronics (e.g. for processing of temperature, speed, or position sensor signal).

3.12
permanent magnet synchronous machine
PSM
machine in which the field system consists of one or more permanent magnets

[SOURCE: IEC 60050-411]

3.13
reluctance synchronous motor
RSM
synchronous motor with an unexcited rotor carrying a number of regular projections which may or may not have a cage winding for starting

[SOURCE: IEC 60050-411]

3.14
switched reluctance machine
SRM
type of stepper motor with isolated windings, but it contains a smaller number of poles

Note 1 to entry: The applied voltages are not sinusoidal; it is controlled by switched voltage blocks.

Note 2 to entry: Similarly, to the RSM, the SRM has only salient poles without magnetic excitation measures.

3.15
target value
commanded value for the controlled quantity of the electric drive within the agricultural application/ process

Note 1 to entry: other commonly used terms like command value, set value (point), reference value, demanded or desired value are not used therefore within this document.

3.16
tractor implement management
TIM
operator assistance system that enables clients to request the control of certain functions (for example speed, steering, hitch, PTO, hydraulic valves, etc.) from servers

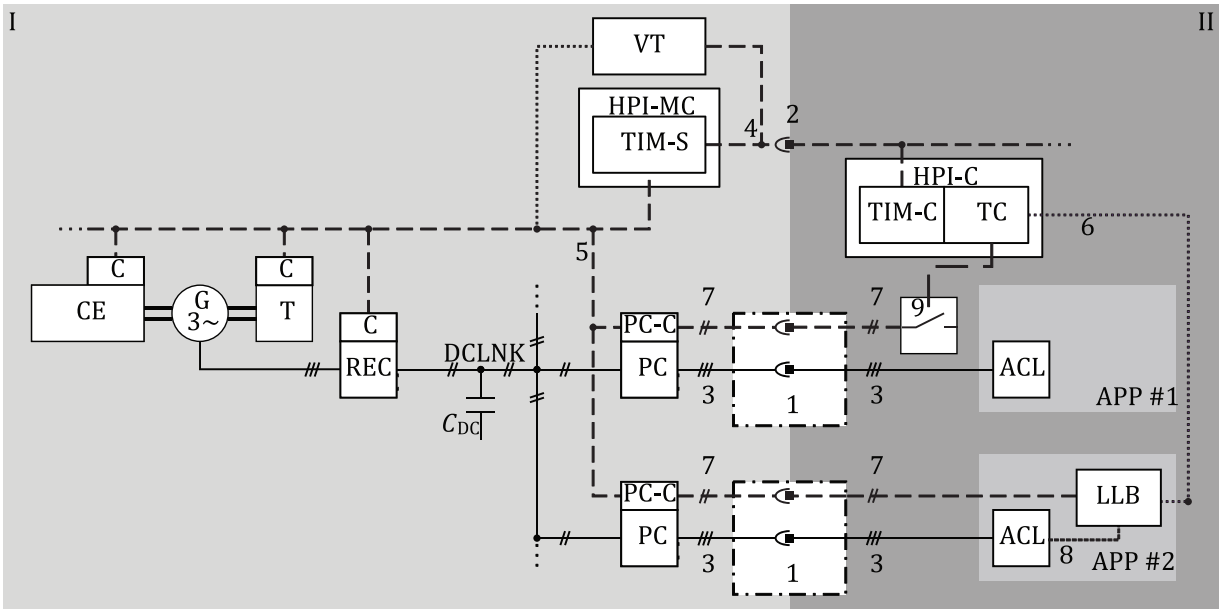
3.17
tractor implement management client
TIM-C
operator assistance system which represents TIM functions for the process optimization in the use of tractor implement combinations based on the ISOBUS communication protocol

3.18
tractor implement management server
TIM-S
participant that provides TIM functions or settings and is able to share these with TIM clients

4 AC System overview

4.1 Basic AC system topology

Figure 1 describes the basic AC system topology with two AC drives.



Key

———	power connection	C	controller of a device
– – –	signal/bus connection	C_{DC}	DC link capacitor
.....	optional signal connection	CE	combustion engine
I	supply system	DCLNK	DC link
II	consumer system	HPI-C	HPI - control
1	HPI (high-power interface)	HPI-MC	HPI – master control
2	ISOBUS connector	LLB	load logical box
3	power lines	PC	power converter
4	ISOBUS	PC-C	power converter controller
5	supply system communication bus (e.g. tractor bus)	REC	rectifier (AC/DC power converter)
6	consumer system communication bus (e.g. implement bus)	T	transmission
7	EtherCAT/interlock signal	TC	task controller
8	feedback signal (e.g. sensor signal)	TIM-C	TIM (tractor implement management) - client
9	interlock signal line breaker	TIM-S	TIM - server
ACL	AC load (e.g. electric motor)	VT	virtual terminal (user interface, e.g. display)
APP	application		

Figure 1 — AC topology example with two loads

A power supply provides at least one HPI.

A typical electric AC drive consists of one 3-phase inverter on the side of the power supply that is connected with at least one AC load on the side of an implement via one high power connector.

4.1.2 Rationale for basic AC-system topology:

— ISOBUS and EtherCAT are mandatory for closed-loop AC modes.