



# SLOVENSKI STANDARD

## SIST EN 61491:2001

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### Electrical equipment of industrial machines - Serial data link for real-time communication between controls and drives

Electrical equipment of industrial machines - Serial data link for real-time communication between controls and drives

Elektrische Ausrüstung von Industriemaschinen - Serielle Datenverbindung für Echtzeit-Kommunikation zwischen Steuerungen und Antrieben

Équipement électrique des machines industrielles - Liaison des données sérielles pour communications en temps réel entre unités de commande et dispositifs d'entraînement

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Ta slovenski standard je istoveten z: **EN 61491:1998**

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EUROPEAN STANDARD

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August 1998

ICS 35.240.50

Descriptors: Machines, electrical equipment, digitally controlled drives, interface for numerical control, transfer medium, data transfer, protocol structure, data contents, layers, error handling, functional sequences, identification numbers

English version

**Electrical equipment of industrial machines  
Serial data link for real-time communication between  
controls and drives  
(IEC 61491:1995, modified)**

Équipement électrique des machines  
industrielles  
Liaison des données sérielles pour  
communications en temps réel entre  
unités de commande et dispositifs  
d'entraînement  
(CEI 61491:1995, modifiée)

Elektrische Ausrüstung von  
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Comité Européen de Normalisation Electrotechnique  
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## Foreword

The text of the International Standard IEC 61491:1995, prepared by IEC TC 44 Safety of machinery - Electrotechnical aspects, together with the common modifications prepared by the Technical Committee CENELEC TC 44X, Safety of machinery: electrotechnical aspects, was submitted to the formal vote and was approved by CENELEC as EN 61491 on 1998-08-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1999-08-01
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Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A to E and ZA are normative and annexes F to K are informative.

Annexes K and ZA have been added by CENELEC.

In this European Standard the common modifications to the International Standard are indicated by a vertical line in the left margin of the text.

The document also includes a number of non identified editorial corrections to the text of IEC 61491:1995.

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## 1 Scope

This International Standard defines a real-time optical serial interface between the control unit and its associate drives which is utilized to transmit periodic and non periodic data.

This interface is intended to apply to industrial machines, such as machine tools, with multiple drives and can be operated in torque, velocity, or position interface operation modes.

NOTE – In this standard, SYSTEM interface refers to this serial data link for real-time communication between controls and drives.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of the IEC and ISO maintain registers of currently valid International Standards.

IEC 60874-2: 1993, *Connectors for optical fibres and cables – Part 2: Sectional specification for fibre optic connector – Type F-SMA*

ISO/IEC 646:1991, *Information technology – ISO 7-bit coded character set for information interchange*

ISO/IEC 3309: 1993, *Information technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures – Frame structure*

ISO/IEC 7498: 1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO 7776: 1986, *Information processing systems – Data communications – High-level data link control procedures – Description of the X.25 LAPB-compatible DTE data link procedures*

## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of this International Standard, the following definitions shall apply.

3.1.1 **access procedure**: Procedure by which one station gains access to the network and transmits data.

3.1.2 **attenuation**: Fact that the optical power at the receiver is less than at the transmitter.

3.1.3 **bit stuffing**: After five logical '1's, the transmitter automatically inserts a zero which is then removed again by the receiver. This zero causes a change in signal edges which makes it possible for the receiver to retrieve a receiving clock (see ISO/IEC 3309).

3.1.4 **broadcast**: Transmission to all devices in a network without any acknowledgment by the receivers.

3.1.5 **coded character set; code**: Set of unambiguous rules that establishes a character set and the one-to-one relationship between the characters of the set and their representation by one or more bit combinations.

- 3.1.6 **communication cycle**: Accumulation of all telegrams between two master synchronization telegrams.
- 3.1.7 **control word**: Two adjacent bytes inside the master data telegram containing commands for the addressed drive.
- 3.1.8 **cycle time**: Time span between two consecutive cyclically recurring events.
- 3.1.9 **cyclic communication**: The periodic exchange of telegrams.
- 3.1.10 **cyclic data**: The part of the telegram which does not change its meaning during cyclic operation of the interface.
- 3.1.11 **cyclic operation**: Devices in the communication network are addressed and queried one after the other at fixed, constant time intervals.
- 3.1.12 **data exchange - demand dependent; non cyclic transmission** (service channel): Transmission of information after a request was sent by the master.
- 3.1.13 **drive enable**: Command to close the feedback loop(s).
- 3.1.14 **drive on**: Command that the power stage can be activated.
- 3.1.15 **drive (amplifier) telegram (AT)**: Telegram sent by the drive (slave).
- 3.1.16 **F-SMA connector**: Connector meeting the F-SMA standard in accordance with IEC 60874-2.
- 3.1.17 **feedback**: Measured process values.
- 3.1.18 **feedforward**: Command value used to compensate the lag in the control loop.
- 3.1.19 **fibre optic cable**: Transmission medium for serial data transmission of optical signals.
- 3.1.20 **fill signals**: Sequence of seven '1's followed by a '0'.
- 3.1.21 **frame check sequence (FCS)**: Check character sequence consists of 16 bits which is generated by means of a cyclic redundancy check (CRC) character polynomial in accordance with the ITU-T X.25. [See ISO/IEC 3309 and ISO 7776].
- 3.1.22 **identification number (IDN)**: Designation of operating data under which a data block is preserved with its attribute, name, unit, minimum and maximum input values, and the data.
- 3.1.23 **SYSTEM interface**:
- 1) physical characteristics of the interface circuits;
  - 2) protocol and access method;
  - 3) application.
- 3.1.24 **ISO/OSI reference model**: Communication layers which are architecture guidelines for defining communication protocols [see ISO/IEC 7498]
- 3.1.25 **machine zero point**: Machine-related point (in each axis) to which all position data are referred.
- 3.1.26 **master data telegram (MDT)**: Telegram transmitted by the master sending data to the slave(s) in a single ring.
- 3.1.27 **master synchronization telegram (MST)**: Telegram transmitted by the master sending a time synchronization signal to the slave(s) in a single ring.

- 3.1.28 **master**: Station which assigns the other stations in the ring (i.e. slaves) the right to transmit.
- 3.1.29 **non-cyclic transmission**: Non-periodic exchange of data at the request of the master.
- 3.1.30 **no return to zero inverted (NRZI)** (coding of data): Signal exchanges taking place only at regular, fixed points in time in synchronization with the transmitting clock pulse of the bit rate. A signal edge change is assigned to a logical 0 only.
- 3.1.31 **operating cycle**: Period of the control loop within the drive or the control unit.
- 3.1.32 **phase locked loop [digital] (DPLL)**: Circuit which retrieves the receiving clock from the data stream received.
- 3.1.33 **physical layer** (bit transmission layer): First layer of the ISO-OSI reference model layers in which the bit transmission is defined.
- 3.1.34 **protocol**: Convention about the data formats, time sequences, and error correction in the data exchange of communication systems.
- 3.1.35 **recovery of clock**: Sufficiently frequent alternation of the signal making it possible for the receiver to retrieve the receiving clock from the data stream with the help of the phase locked loop.
- 3.1.36 **reference point**: Feedback-system related point (in each axis) to which the feedback and command values are referred after a homing procedure.
- 3.1.37 **repeater function**: Telegram that has been received is passed on reclocked and logically unchanged to the next station on the ring.
- 3.1.38 **ring structure**: Network topology in which the transmission medium is routed from station to station in the form of a ring. The information is transmitted only in one direction.
- 3.1.39 **scaling data**: Data which determines the weight of the transferred operation data.
- 3.1.40 **slave**: Device in the ring which is assigned by the master the right to transmit.
- 3.1.41 **status word**: Two adjacent bytes inside the drive telegram containing status information.
- 3.1.42 **(telegram) address field**: Address field (eight bits) containing the address of the device.
- 3.1.43 **telegram**: Message.
- 3.1.44 **(telegram) delimiter**: Beginning and ending identifiers of a telegram (eight bits: 01111110).
- 3.1.45 **topology**: Physical network architecture with respect to the connection between the stations of the communication system.
- 3.1.46 **transmission medium**: Collective term for the real form of the physical connection between the stations of a communication network, for instance, fibre optic cable.
- 3.1.47 **zero bit stream**: Consists exclusively of logical zeros which, in NRZI coding, results in a regular signal edge change on the transmission line (only used in test mode).

### 3.2 Abbreviations

For the purpose of this International Standard, the following abbreviations apply:

- 3.2.1 **A:** amplifier (drive)
- 3.2.2 **ADR:** address of a telegram. Drive address is XX [ $1 \leq XX \leq 254$ ]
- 3.2.3 **AHS:** service transport handshake of the drive
- 3.2.4 **AT:** drive (amplifier) telegram
- 3.2.5 **AT<sub>m</sub>:** drive (amplifier) telegram from drive XX which is assigned to data record m
- 3.2.6 **BOF:** begin of frame
- 3.2.7 **C1D:** class 1 diagnostic
- 3.2.8 **C2D:** class 2 diagnostic
- 3.2.9 **C3D:** class 3 diagnostic
- 3.2.10 **CCIT:** consultative committee on international telephone and telegraph
- 3.2.11 **CNA:** container for non-cyclic data transfer of the drive (amplifier)
- 3.2.12 **CNM:** container for non-cyclic data transfer of the master
- 3.2.13 **CZA:** container for cyclic data transfer of the drive (amplifier)
- 3.2.14 **CZM:** container for cyclic data transfer of the master
- 3.2.15 **CP:** communication phase
- 3.2.16 **CRC:** cyclic redundancy check
- 3.2.17 **DAT:** duration of drive telegram
- 3.2.18 **DMDT:** duration of master data telegram
- 3.2.19 **DMST:** duration of master sync telegram
- 3.2.20 **DPLL:** digital phase locked loop
- 3.2.21 **EOF:** end of frame
- 3.2.22 **FCS:** frame check sequence
- 3.2.23 **HS:** handshake (see AHS and MHS)
- 3.2.24 **IDLE:** data transmission interrupted
- 3.2.25 **IDN:** identification number
- 3.2.26 **i:** sequence of different rings on one control unit, labelled as  $i = 1 \dots I$
- 3.2.27 **I:** number of rings on one control unit
- 3.2.28 **INFO:** information

- 3.2.29 **J**: jitter
- 3.2.30  **$J_{\text{noise}}$** : jitter of the optical signal
- 3.2.31  **$J_{t_1}$** : jitter in  $t_1$
- 3.2.32  **$J_{t_2}$** : jitter in  $t_2$
- 3.2.33  **$J_{t_{\text{scyc}}}$** : jitter in  $t_{\text{scyc}}$
- 3.2.34 **K**: number of data records in the MDT (see also M)
- 3.2.35  **$K_V$  ( $K_V$ -factor)**: gain of the position loop regulator
- 3.2.36 **k**: time sequence of data records in the MDT, labelled as  $k = 1 \dots K$
- 3.2.37  **$k_{\text{os}}$** : optical power overshoot
- 3.2.38 **LED**: light emitting diode
- 3.2.39 **LSB**: least significant bit
- 3.2.40 **M**: number of drives in one ring (see also K)
- 3.2.41 **m**: time sequence of the ATs, labelled as  $m = 1 \dots M$
- 3.2.42 **MDT**: master data telegram
- 3.2.43 **MHS**: service transport handshake of the master
- 3.2.44 **MSB**: most significant bit [SIST EN 61491:2001](https://standards.iteh.ai/catalog/standards/sist/0967c14e-758e-4a4e-aa9e-804816d071e2/sist-en-61491-2001)
- 3.2.45 **MST**: master sync telegram <https://standards.iteh.ai/catalog/standards/sist/0967c14e-758e-4a4e-aa9e-804816d071e2/sist-en-61491-2001>
- 3.2.46  **$n$** : velocity
- 3.2.47  **$n_{\text{min}}$** : shot-off velocity in the drive after C1D error
- 3.2.48  **$n_x$** : velocity threshold
- 3.2.49 **NBYCA**: number of bytes in the configurable data record of the AT
- 3.2.50 **NBYCM**: number of bytes in the configurable data record of the MDT
- 3.2.51 **NC**: numerical control (also control unit or controller)
- 3.2.52 **NRZI**: no return to zero inverted
- 3.2.53 **OSI**: open system interconnection
- 3.2.54 **P**: power
- 3.2.55  **$P_{R\text{maxH}}$** : maximum received power at optical high level
- 3.2.56  **$P_{R\text{maxL}}$** : maximum received power at optical low level
- 3.2.58  **$P_{R\text{minH}}$** : minimum received power at optical high level
- 3.2.58  **$P_{T\text{maxH}}$** : maximum transmission power at optical high level

- 3.2.59  $P_{TmaxL}$ : maximum transmission power at optical low level
- 3.2.60  $P_{minH}$ : minimum transmission power at optical high level
- 3.2.61  $P_x$ : power threshold
- 3.2.62  $RxCLK$ : receiving clock
- 3.2.63  $RxD$ : received data
- 3.2.64  $SLKN$ : slave identification parameter, slave arrangement
- 3.2.65  $T$ : torque
- 3.2.66  $T_f$ : additive torque command value (feed forward)
- 3.2.67  $T_{limit}$ : limit value for the torque
- 3.2.68  $T_x$ : threshold torque
- 3.2.69  $t_1$ : AT transmission starting time
- 3.2.70  $t_{1,m}$ : AT transmission starting time with data record m of drive XX
- 3.2.71  $t_{1min,m}$ : shortest AT transmission starting time with data record m of drive XX after receiving the MST
- 3.2.72  $t_{1min}$ : shortest AT transmission starting time
- 3.2.73  $t_2$ : MDT transmission starting time
- 3.2.74  $t_3$ : command value valid time
- 3.2.75  $t_4$ : feedback acquisition capture point
- 3.2.76  $t_5$ : minimum feedback processing time
- 3.2.77  $t_{5,m}$ : the minimum time which drive XX with data record m needs to process its captured feedback value for the next AT
- 3.2.78  $t_{ATAT}$ : transmit to transmit recovery time in a slave with several drives
- 3.2.79  $t_{ATMT}$ : transmit/receive transmission time
- 3.2.80  $t_{ATMT,M}$ : transmit/receive transmission time which drive M needs between transmitting its AT and being prepared for receiving an MDT
- 3.2.81  $t_{ATRP}$ : maximum transition time in a slave to switch from transmitting an AT to repeater function
- 3.2.82  $t_{ATRP;1}$ : maximum transition time in slave 1 to switch from transmitting an AT to repeater function
- 3.2.83  $t_{BIT}$ : arithmetic mean value of the bit transmission time in normal operating mode
- 3.2.84  $t_{BITtest}$ : arithmetic mean value of the bit transmission time in zero bit stream test mode
- 3.2.85  $t_{BITnom}$ : nominal value of the bit transmission time