

MANUAL

## R2100 - CANopen Protocol



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# 1 Commissioning

## 1.1 Supported Features and Standards

The CANopen interface on the Pepperl+Fuchs R2100 supports the following CANopen standards:

- Network management (NMT)
- Node guarding
- Heartbeat
- Layer setting services (LSS)
- SDOs contain: distance, echoes, and X/Y-coordinates
- PDOs (up to 12) for mapping the SDOs
- PDOs are sent periodically
- Time service
- Layer setting services (LSS) for configuring the node ID and baud rate
- Store/restore configuration

The CANopen interface for the R2100 works with the following standard configuration:

- Node ID: 16
- Bit rate: 500 kBit/s (CiA)

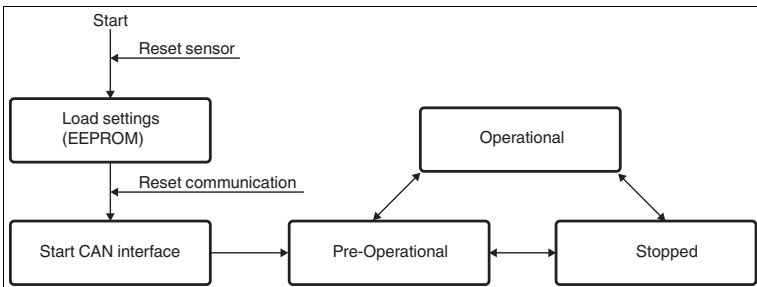
The CANopen Interface supports a switchable CAN Termination of ISO 11898 required nominal cable impedance of 120 Ω.

## 1.2 Network Management (NMT)

The CANopen standard CiA301 specifies three possible states for the sensor node.

- Pre-operational
- Operational
- Stopped

The node can be set to any of these states as required. When activated, a sensor always starts in preoperational state and issues a startup message.



**Pre-operational**

PDO (process data) messages cannot be sent in the preoperational state; as such, this state is used to parameterize the sensor or indicate a standby state.

**Operational**

In the "operational" state, all communication services are performed and process data is exchanged during operation.

**Stopped**

In the "stopped" state, only NMT (network management) messages can be sent; redundant or defective sensors can be isolated from the bus almost completely in this state.

The master or network manager can issue NMT messages to prompt the sensor to change from one state to another. Other NMT functions include two reset commands for resetting either the entire sensor or bus communication only.

**Example of an NMT message sent by the master**

0x000	0x80	0x10	0	0	0	0	0	0
CAN-ID	Command	Node	not used					
	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7	Data byte 8

**CAN-ID: 000h**, NMT message from the master

**Command: 80h**, switch to preoperational state

**Command: 02h**, switch to stopped state

**Command: 01h**, switch to operational state

**Command: 82h**, reset communication

**Command: 81h**, reset sensor

**Node: 01h–7Fh**, to activate nodes 1–127 individually

**Node: 00h**, to activate all nodes in the network simultaneously

1.3 **Setting the Baud Rate and Node ID**

CANopen specifies the LSS (CiA 305) for this purpose. In the default state, the following addresses are defined as CAN-IDs:

- 0x7E5 for master -> slave communication
- 0x7E4 for slave -> master communication

A detailed description can be found in the LSS specification CiA 305. The baud rate can be configured via the LSS.

## 1.4 Heartbeat Function

The interval after which status messages are sent can be set via the object 1017h "Producer heartbeat time".

Entering the value 0 will deactivate the function. Every other 16-bit value determines the heartbeat interval in milliseconds.

### Example of writing an object with max. 4 bytes of data

0x710	0x04	0	0	0	0	0	0	0
CAN-ID	Status	not used						
	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7	Data byte 8

**CAN-ID: 710h**, status message from the node with node number 16

**Status: 7Fh**, sensor in "preoperational" state

**Status: 04h**, sensor in "stopped" state

**Status: 05h**, sensor in "operational" state

## 1.5 Node Guarding Function

The objects 100Ch "Guarding time" and 100Dh "Life time factor" are available in the object directory to control the node guarding function. The guarding time indicates the maximum response time of the sensor after the "Remote transmit request" (RTR) message is received. If this time is exceeded, the master detects a sensor fault. To calculate the interval time during which the sensor waits for the RTR messages, multiply the guard time by the life time factor. If the sensor detects a master fault, it issues an error message with the error code 3081h and switches to "preoperational" state. For additional safety, the system toggles to the highest bit in the "status" byte for every status message.

### Example of an RTR message sent by the master

0x710	0	0	0	0	0	0	0	0
CAN-ID	not used							
	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7	Data byte 8

**CAN-ID: 710h**, RTR message to the node with node number 16

0x710	0x04	0	0	0	0	0	0	0
CAN-ID	Status	not used						
	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7	Data byte 8

**CAN-ID: 710h**, status message from the node with node number 16

**Status: 7Fh ... FFh**, sensor in "preoperational" state

**Status: 04h ... 84h**, sensor in "stopped" state

**Status: 05h ... 85h**, sensor in "operational" state

## 1.6 Switchable CAN-Termination

The switchable CAN-Termination meets the requirement of ISO 11898-2 which allows to switch an 120 Ohm resistor between CAN-H and CAN-L to terminate the BUS according to the application of the R2100.

See Chapter "Manufacturer-Specific Parameters" at Index 0x2101.

Storing the CAN-Termination settings permanently in EEPROM it requires writing ASCII <save> to sub-index 0x1 of Index 0x1010 Store Parameter.

## 2 Operation and Communication

### 2.1 Process Data Object (PDO)

A maximum of 8 bytes of useable data can be sent in each message using the process data object (PDO). This feature is only available in the operational state and can be activated in different modes set using the objects 0x1800 – 0x180B "PDOx parameter" and 0x1A00 – 0x1A0B "PDO mapping." The PDO message can be sent via RTR message either automatically or on request. It is also possible to define a minimum time between two PDO messages. The CAN identifier for this feature - which is defined as 180h + node ID by default - can also be modified.

A total of 12 transmit PDOs are supported; no receive PDOs are supported. The protocol supports dynamic PDO mapping.

Example of the PDO1 message for the first four segments of the R2100: This PDO message contains some of the distance measuring readings of the sensor that are sent periodically and automatically as soon as new values are available. The measurement rate of the R2100 cannot be configured. The configuration option "Event timer" (subindex 5) is not supported. Instead, the transmission rate is limited using the "Inhibit time" option (subindex 3).

0x190	0x4D3	0x4D4	0x4D3	0x4D5
CAN-ID	Distance segment 1	Distance segment 2	Distance segment 3	Distance segment 4
	Data word 1	Data word 2	Data word 3	Data word 4

**CAN-ID:** 190h, PDO1 channel of node 16

**Distance of beam segment 1:** 0x4D3, corresponds to 1235 mm

**Distance of beam segment 2:** 0x4D4, corresponds to 1236 mm

**Distance of beam segment 3:** 0x4D3, corresponds to 1235 mm

**Distance of beam segment 4:** 0x4D5, corresponds to 1237 mm

Transmit PDO messages PDO7–PDO12 are not used by default.

Individual PDOs can be disabled via "COB-ID" (e.g. 1800sub1). To do this, the highest bit must be set to "1." For example, for 1800sub1, the following would need to be set: \$NODEID+0x80000180. The distances are active and the echoes are disabled by default.



## 2.2 Service Data Object (SDO)

The R2100 from Pepperl+Fuchs is equipped with service data channel 1 as required by CiA301.

The channel is permanently set to CAN-IDs 580h + node ID for transmission and 600h + node ID for reception. A maximum of four bytes of usable data can be transmitted in a single message. Larger quantities of data are divided among several messages.

### Example of reading an object with max. 4 bytes of data

0x610	0x40	0x00	0x20	0x01	0x4D3	-	-	-
CAN-ID	Command	Object index		Subindex	Data			
	Data byte 1	Data byte 2	Data byte 3	Data byte 4	Data byte 5	Data byte 6	Data byte 7	Data byte 8

**CAN-ID:** 601h, SDO1 channel of node 16

**Command:** 40h, read object, 1 ... 4 bytes of usable data

### 3 Object Directory



**Note!**

Data Types correspond to Data Types defined by CANopen standard.

#### 3.1 Standard Network Objects

Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1000	0	Device type	u32	Read-only	0	No device profile available
0x1001	0	Error register	u8	Read-only		
0x1008	0	Manufacturer device name	String	Const	R2100	
0x1009	0	Manufacturer hardware version	String	Const		Not in use
0x100A	0	Manufacturer software version	String	Const		Not in use
0x100C	0	Guard time	u16	Read/write	0	Multiple of 1ms master query interval
0x100D	0	Life time factor	u8	Read/write	0	Max. response time of the slave Guard time * life time factor
0x1010	1	Save all parameters	u32	Read/write	0	
0x1011	1	Restore all default parameters	u32	Read/write	0	
0x1012	0	COB-ID time stamp message	u32	Read/write	0x80000100	
0x1017	0	Producer heartbeat time	u16	Read/write	0	
0x1018	Identity object					
	0	Number of entries	u8	Read-only	4	
	1	Vendor ID	u32	Read-only	0x000000AD	P+F, listed with the CiA
	2	Product code	u32	Read-only	0x00000000	
	3	Revision number	u32	Read-only	0x00000000	
	4	Serial number	u32	Read-only	0x00000000	

Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1200	Server SDO					
	0	Number of supported entries	u8	Read-only	2	
	1	Server SDO (receive)	u32	Read-only	0x600+nodeID	
	2	Server SDO (transmit)	u32	Read-only	0x580+nodeID	
0x1800	Transmit PDO1 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x180	
	2	Transmission type	u8	Read/write	0xFF	0x1...0xF0: for each nten sync message  0xFF: event-controlled transmission
	3	Inhibit time	u16	Read/write	0x0000	Disable time between PDOs Multiple of 100 us
0x1801	Transmit PDO2 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x280	
	2	Transmission type	u8	Read/write	0xFF	
	3	Inhibit time	u16	Read/write	0x0000	
0x1802	Transmit PDO3 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x380	
	2	Transmission type	u8	Read/write	0xFF	
	3	Inhibit time	u16	Read/write	0x0000	

Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1803	Transmit PDO4 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x80000480	
	2	Transmission type	u8	Read/write	0xFF	
0x1804	Transmit PDO5 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x80000200	
	2	Transmission type	u8	Read/write	0xFF	
0x1805	Transmit PDO6 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x80000300	
	2	Transmission type	u8	Read/write	0xFF	
0x1806	Transmit PDO7 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x80000400	
	2	Transmission type	u8	Read/write	0xFF	
0x1807	Transmit PDO8 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x80000500	
	2	Transmission type	u8	Read/write	0xFF	
	Transmit PDO8 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x80000500	
	2	Transmission type	u8	Read/write	0xFF	
	Transmit PDO8 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x80000500	
	2	Transmission type	u8	Read/write	0xFF	
	Transmit PDO8 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	\$NODEID+0x80000500	
	2	Transmission type	u8	Read/write	0xFF	

Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1808	Transmit PDO9 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	0x80000000	
	2	Transmission type	u8	Read/write	0xFF	
	3	Inhibit time	u16	Read/write	0x0000	
0x1809	Transmit PDO10 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	0x80000000	
	2	Transmission type	u8	Read/write	0xFF	
	3	Inhibit time	u16	Read/write	0x0000	
0x180A	Transmit PDO5 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	0x80000000	
	2	Transmission type	u8	Read/write	0xFF	
	3	Inhibit time	u16	Read/write	0x0000	
0x180B	Transmit PDO11 communication parameters					
	0	Highest subindex supported	u8	Const	3	
	1	COB-ID used by TPDO	u32	Read/write	0x80000000	
	2	Transmission type	u8	Read/write	0xFF	
	3	Inhibit time	u16	Read/write	0x0000	

Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1A00	0	Number of mapped application objects in TPDO	u8	Read/write	4	
	1	Application object	u32	Read/write	0x20000110	Distance segment 1
	2	Application object 2	u32	Read/write	0x20000210	Distance segment 2
	3	Application object 3	u32	Read/write	0x20000310	Distance segment 3
	4	Application object 4	u32	Read/write	0x20000410	Distance segment 4
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
	8	Application object 8	u32	Read/write		
0x1A01	PDO 5-8 mapping distance					
	0	Number of mapped application objects in TPDO	u8	Read/write	4	
	1	Application object	u32	Read/write	0x20000510	Distance segment 5
	2	Application object 2	u32	Read/write	0x20000610	Distance segment 6
	3	Application object 3	u32	Read/write	0x20000710	Distance segment 7
	4	Application object 4	u32	Read/write	0x20000810	Distance segment 8
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			

Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1A02	PDO 9-11 mapping distance					
	0	Number of mapped application objects in TPDO	u8	Read/write	3	
	1	Application object	u32	Read/write	0x20000910	Distance segment 9
	2	Application object 2	u32	Read/write	0x20000A10	Distance segment 10
	3	Application object 3	u32	Read/write	0x20000B10	Distance segment 11
	4	Application object 4	u32	Read/write		
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			
0x1A03	PDO 1-4 mapping echo					
	0	Number of mapped application objects in TPDO	u8	Read/write	4	
	1	Application object	u32	Read/write	0x20010110	Echo segment 1
	2	Application object 2	u32	Read/write	0x20010210	Echo segment 2
	3	Application object 3	u32	Read/write	0x20010310	Echo segment 3
	4	Application object 4	u32	Read/write	0x20010410	Echo segment 4
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			

Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1A04	PDO 5-8 mapping echo					
	0	Number of mapped application objects in TPDO	u8	Read/write	4	
	1	Application object	u32	Read/write	0x20010510	Echo segment 5
	2	Application object 2	u32	Read/write	0x20010610	Echo segment 6
	3	Application object 3	u32	Read/write	0x20010710	Echo segment 7
	4	Application object 4	u32	Read/write	0x20010810	Echo segment 8
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			
0x1A05	PDO 8-11 mapping echo					
	0	Number of mapped application objects in TPDO	u8	Read/write	3	
	1	Application object	u32	Read/write	0x20010910	Echo segment 9
	2	Application object 2	u32	Read/write	0x20010A10	Echo segment 10
	3	Application object 3	u32	Read/write	0x20010B10	Echo segment 11
	4	Application object 4	u32	Read/write		
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			



Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1A06	PDO mapping					
	0	Number of mapped application objects in TPDO	u8	Read/write	0	
	1	Application object	u32	Read/write		
	2	Application object 2	u32	Read/write		
	3	Application object 3	u32	Read/write		
	4	Application object 4	u32	Read/write		
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			
0x1A07	PDO mapping					
	0	Number of mapped application objects in TPDO	u8	Read/write	0	
	1	Application object	u32	Read/write		
	2	Application object 2	u32	Read/write		
	3	Application object 3	u32	Read/write		
	4	Application object 4	u32	Read/write		
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			

Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1A08	PDO mapping					
	0	Number of mapped application objects in TPDO	u8	Read/write	0	
	1	Application object	u32	Read/write		
	2	Application object 2	u32	Read/write		
	3	Application object 3	u32	Read/write		
	4	Application object 4	u32	Read/write		
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			
0x1A09	PDO mapping					
	0	Number of mapped application objects in TPDO	u8	Read/write	0	
	1	Application object	u32	Read/write		
	2	Application object 2	u32	Read/write		
	3	Application object 3	u32	Read/write		
	4	Application object 4	u32	Read/write		
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			

Index	Sub-index	Parameters	Data Type	Access	Default	Description
0x1A0A	PDO mapping					
	0	Number of mapped application objects in TPDO	u8	Read/write	0	
	1	Application object	u32	Read/write		
	2	Application object 2	u32	Read/write		
	3	Application object 3	u32	Read/write		
	4	Application object 4	u32	Read/write		
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			
0x1A0B	PDO mapping					
	0	Number of mapped application objects in TPDO	u8	Read/write	0	
	1	Application object	u32	Read/write		
	2	Application object 2	u32	Read/write		
	3	Application object 3	u32	Read/write		
	4	Application object 4	u32	Read/write		
	5	Application object 5	u32	Read/write		
	6	Application object 6	u32	Read/write		
	7	Application object 7	u32	Read/write		
8	Application object 8	u32	Read/write			

### 3.2 Manufacturer-Specific Parameters

Index	Sub-index	Name	Type	Access	Default	Description
0x2000	Distance values					
	0	NrOfObjects	u8	Const	11	Number of beams
	1	Read distance 0	u16	Read-only		[mm]
	2	Read distance 1	u16	Read-only		[mm]
	3	Read distance 2	u16	Read-only		[mm]
	4	Read distance 3	u16	Read-only		[mm]
	5	Read distance 4	u16	Read-only		[mm]
	6	Read distance 5	u16	Read-only		[mm]
	7	Read distance 6	u16	Read-only		[mm]
	8	Read distance 7	u16	Read-only		[mm]
	9	Read distance 8	u16	Read-only		[mm]
	10	Read distance 9	u16	Read-only		[mm]
11	Read distance 10	u16	Read-only		[mm]	
0x2001	Echo values					
	0	NrOfObjects	u8	Const	11	Number of beams
	1	Read echo 0	u16	Read-only		
	2	Read echo 1	u16	Read-only		
	3	Read echo 2	u16	Read-only		
	4	Read echo 3	u16	Read-only		
	5	Read echo 4	u16	Read-only		
	6	Read echo 5	u16	Read-only		
	7	Read echo 6	u16	Read-only		
	8	Read echo 7	u16	Read-only		
	9	Read echo 8	u16	Read-only		
	10	Read echo 9	u16	Read-only		
11	Read echo 10	u16	Read-only			

Index	Sub-index	Name	Type	Access	Default	Description
0x2002	x-coordinate					
	0	NrOfObjects	u8	Const	11	Number of beams
	1	Read x-coordinate 0	u16	Read-only		[mm]
	2	Read x-coordinate 1	u16	Read-only		[mm]
	3	Read x-coordinate 2	u16	Read-only		[mm]
	4	Read x-coordinate 3	u16	Read-only		[mm]
	5	Read x-coordinate 4	u16	Read-only		[mm]
	6	Read x-coordinate 5	u16	Read-only		[mm]
	7	Read x-coordinate 6	u16	Read-only		[mm]
	8	Read x-coordinate 7	u16	Read-only		[mm]
	9	Read x-coordinate 8	u16	Read-only		[mm]
	10	Read x-coordinate 9	u16	Read-only		[mm]
11	Read x-coordinate 10	u16	Read-only		[mm]	

Index	Sub-index	Name	Type	Access	Default	Description
0x2003	y-coordinate					
	0	NrOfObjects	u8	Const	11	Number of beams
	1	Read y-coordinate 0				[mm]
	2	Read y-coordinate 1				[mm]
	3	Read y-coordinate 2				[mm]
	4	Read y-coordinate 3				[mm]
	5	Read y-coordinate 4				[mm]
	6	Read y-coordinate 5				[mm]
	7	Read y-coordinate 6				[mm]
	8	Read y-coordinate 7				[mm]
	9	Read y-coordinate 8				[mm]
	10	Read y-coordinate 9				[mm]
11	Read y-coordinate 10				[mm]	
0x2010	0	Time stamp	u16	Read-only		[ms], can be set via TIME service
0x2100	0	Locator configuration	u8	Read/write		
0x2101	0	CAN-Termination configuration	u8	Read/write		Switchable CAN Termination of 120 Ohm 0x1 = enable

# FACTORY AUTOMATION – SENSING YOUR NEEDS



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