ifm electronic

CE

Device manual
Encoder
with CANopen interface

UK

efector400®

RM7
RN7

706362/01 08/2015

Contents

UK

1 Preliminary note

1.1 Symbols used

► Instruction
> Reaction, result
[…] Designation of pushbuttons, buttons or indications
→ Cross-reference

Important note
Non-compliance can result in malfunction or interference.

Information
Supplementary note

1.2 Warning signs used

NOTE

Warning of damage to property.

2 Safety instructions

These instructions are part of the device. They contain information and illustrations about the correct handling of the device and must be read before installation or use.

Observe the operating instructions.

Non-observance of the instructions, operation which is not in accordance with use as prescribed below, wrong installation or incorrect handling can affect the safety of operators and machinery.

The installation and connection must comply with the applicable national and international standards. Responsibility lies with the person installing the unit.

Only the signals indicated in the technical data or on the device label may be supplied to the connections or wires.

3 General information

3.1 CANopen technology

The CANopen communication profile is based on the CAN Application Layer (CAL) specification of the CiA organisation. CANopen is considered as a robust fieldbus with highly flexible configuration options. It is used in many various applications which are based on different application profiles. CANopen comprises a concept to configure and communicate real-time data using synchronous and asynchronous messages. Four message types (objects) are distinguished.

1. Administration messages (layer management, network management and identifier distribution)
2. Service Data Objects (SDO)
3. Process Data Objects (PDO)
4. Predefined Objects (synchronisation, time stamp, emergency)

For further information please refer to the CiA-CAN specification (CiA 406 - encoders, CiA 301 - CANopen).

3.1.1 Supported operating modes

Encoders with CANopen interface support the following operating modes:

- RTR (request)
  The position value is only given to the bus on request.
- EVENT time
  The position value is given to the bus cyclically (interval can be set).
- Cyclical-synchronous
  When the sync telegram has been received by the host, the absolute encoder transmits the current process value. A sync counter can be programmed so that the encoder does not send before a defined number of sync telegrams.

In addition other functions can be configured (direction of rotation, resolution etc.).

3.2 References

http://www.can-cia.org

CAN Application Layer, DS 201 …207	CiA
LSS profile	DS305 CiA
CAL-based communication profile,	DS 301 CiA
Device profile for encoders	DS 406 CiA
CAN specification version 2.0 A	Robert Bosch GmbH
CANary CAN controller	Atmel

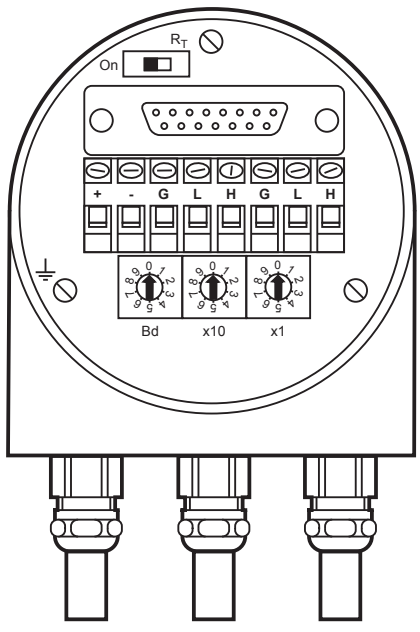
4 Functions and features

- There are 1 SDO server and 2 default value PDOs according to CiA DS 301. The PDO mapping can be changed (dynamic PDO mapping). The default value identifiers have been assigned according to the "predefined connection set" in the CANopen specification.
- The COB IDs of the PDOs and their baud rate can be configured.
- The module expects a sync object. The CAN identifier of the sync object can be configured.
- The module supports "node guarding" and "heartbeat".
- The module supports an emergency object. The COB ID of the EMCY object can be configured.
- The module stores the last error. The error code of the corresponding emergency object is stored.
- The module supports the load command (reset function to restore the factory settings).
- Alarms and warnings are not displayed.

5 Electrical connection

The encoder is connected with two or three cables depending on whether the power supply is integrated into the bus cable or connected separately. If the power supply is integrated into the bus cable, one of the cable glands can be fitted with a plug. The cable glands are suitable for cable diameters from 6.5 up to 9 mm.

Terminal	Description
⊥	Ground
+	24 V voltage supply
-	0 V voltage supply
G	CAN Ground
L	CAN low
H	CAN high
G*	CAN Ground
L*	CAN low
H*	CAN high
* are not connected, if the terminal resistor is ON	



The terminal cap contains a resistor which can be activated as terminating resistor if necessary. The resistor is to be switched to ON at the ends of the bus line in the device.

Participant X

Last participant

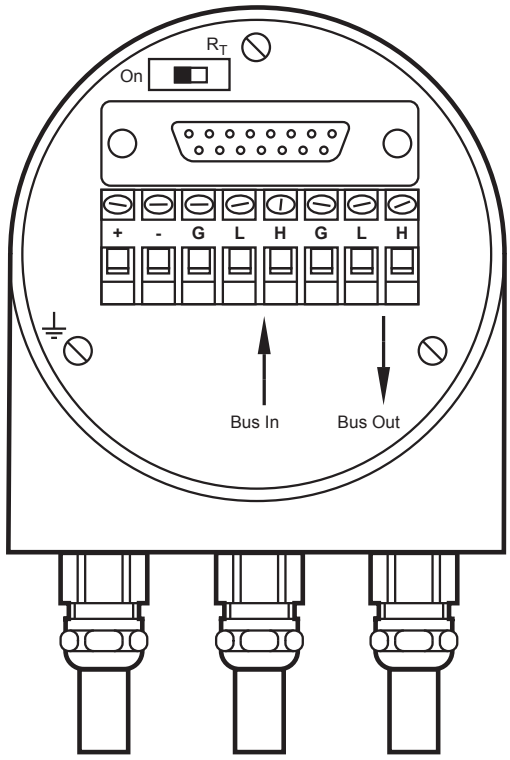
Terminating resistor R_T (resistor termination)

5.1 Bus connection

The terminal cap fulfils the function of a T-coupler. From there the wiring must be done according to the drawing on the left side.

► Observe the assignment of the incoming and outgoing bus signals.

Terminal cap bus In and bus Out



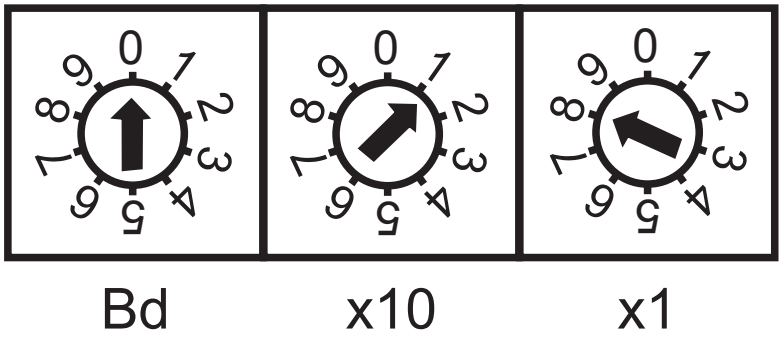
5.2 Setting the node number in the terminal cap

► To set the node number remove the terminal cap for the installation.

► Loosen both screws on the back of the encoder.

► Do not damage the seal since otherwise the protection rating will be lost.

The setting is done via coding switches: 0..9 (x1) or 10..90 (x10).



Internally, 1 is always added to the node number to avoid setting of the node number 0.

Example: The node number 10 has to be set via the coding switch with 0 9.

BCD-coded encoder (binary coded decimal number)	
	Device address 0...89
x1	Set the CAN-node number
x10	Address reserved 90…99
xBd	Set the baud rate

5.3 Protocol definition

x1	Device address 97
x10	Address reserved
x1	Device address 98
x10	Protocol selection according to DS301-V3
x1	Device address 99
x10	Protocol selection according to DS301-V4

5.4 Baud rate setting

Setting is done via baud rate switch (Bd).

The following baud rates are adjustable:

Baud rate in kBit/s	BCD rotary switch
20	0
50	1
100	2
125	3
250	4
500	5
800	6
1000	7
Reserved	8
Sets the SDO mode*	9
* SCO service data objects	

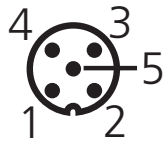
6 Installation of the encoder

6.1 Settings of the encoder

► Set the node address of the encoder, the baud rate and the bus termination before set-up of the device via software.

6.2 Signal assignment

Signal	5-pole M12 connector
CAN GND	pin 1
24 V supply voltage	pin 2
GND (PE)	pin 3
CAN high	pin 4
CAN low	pin 5



► Use screened cable.

6.3 Setting of the node number

6.3.1 Setting of the node number via SDO objects

For devices without terminal cap the address can only be set via SDO objects. The address of an encoder without terminal cap is set to 32 as standard. Details on changing the node number → chapter 7.4.

6.3.2 Setting of the baud rate via SDO objects.

For devices without terminal cap the baud rate can only be changed via SDO objects. The baud rate is set to 125 Kbits/s as default value. Details on changing the baud rate → chapter 7.4.

6.3.3 Setting the node number and the baud rate via LSS

Another possibility of how to set the node number and the baud rate for encoders is Layer Setting Services. Further information → chapter 6.3.6.

6.3.4 Bus termination

If the encoder is the last participant, an external terminating resistor or a terminating T connector has to be used.

6.4 LED indications

LED	Status	Description
red	flashes, 1 Hz	operating voltage OK, faulty bus connection
red	lights	"BUS OFF" caused e.g. by short circuit, wire break, faulty connector
green	flashes, 2.5 Hz	operating voltage OK, bus connection OK
green/red	green flashing, 2.5 Hz and red flashing 1x at each 3rd pulse of the green LED	guarding error, either node guard or heartbeat
green	flashes, 1 Hz	bus stopped
green	lights	master failure, encoder remains in the preoperational operating status > guard and heartbeat error are not indicated
green/red	green lights/ red flashing, 2.5 Hz	non reproducible indication (no clear description of the indication)

7 Configuration

This chapter describes the configuration of the parameters of an absolute encoder with CANopen interface.

7.1 Operating modes

7.1.1 General information

In the preoperational mode the encoder replies to the CAN bus after sending its boot up message.

Boot up message: 700 hex + node number (further details in the Communication Profile chapter 7.3.)

► Change parameters only in the preoperational mode.

This mode decreases the bus load and simplifies the control of the messages sent and received. It is not possible to send or receive PDO messages in this mode.

7.1.2 Preoperational mode

To set the encoder to the preoperational mode, the master must send the following message:

Identifier	Byte 0	Byte 1	Description
0 h	80 h	00	NMT PreOp, all nodes
0 h	80 h	NN	NMT PreOp, NN

NN: node number

It is possible to set all nodes (byte 1 = 0) or individual nodes (byte 1 NN) to the preoperational mode.

7.1.3 Start-operational mode

To set the encoder to the operational mode, the master must send the following message:

Identifier	Byte 0	Byte 1	Description
0 h	01 h	00	NMT start, all nodes
0 h	01 h	NN	NMT start, NN

NN: node number

It is possible to set all nodes (byte 1 = 0) or individual nodes (byte 1 NN) to the operational mode.

7.1.4 Start/stop mode

To set the encoder to the stop mode, the master must send the following message:

Identifier	Byte 0	Byte 1	Description
0 h	02 h	00	NMT stop, all nodes
0 h	02 h	NN	NMT stop, NN

NN: node number

It is possible to set all nodes (byte 1 = 0) or individual nodes (byte 1 NN) to the stop mode.

7.1.5 Reinitialisation of the encoder

► Carry out reinitialisation in the event of incorrect function.

Identifier	Byte 0	Byte 1	Description
0 h	81 h	00	reset all nodes
0 h	81 h	NN	reset node

NN: node number

It is possible to reset all nodes (byte 1 = 0) or individual nodes (byte 1 NN). After reinitialisation the device replies again in the preoperational mode.

7.2 Standard operation (CAN transmission modes)

RTR mode	The connected host requests the current position value via a remote transmission request telegram. The encoder reads the current position, sets off set parameters (if applicable) and returns the position value via the same CAN identifier.
EVENT time	The absolute encoder cyclically sends the current position value - without any request by the host. The cycle time can be programmed in milliseconds for values between 1 ms and 65536 ms.
Sync Mode	When the sync telegram has been received by the host, the encoder transmits the current process value. If several nodes reply to the sync telegram, the individual nodes report one after the other according to their CAN identifier. The programming of an offset time is not necessary. A sync counter can be programmed so that the encoder does not send before a defined number of sync telegrams.

7.3 Storing parameters

7.3.1 Object directory

Object Index	Object description
1005h	COB ID Sync
100Ch	guard time
100Dh	life time factor
1016h	consumer heartbeat time

Object Index	Object description
1017h	producer heartbeat time
1020h	verify configuration
1800h	communication parameter PDO 1
1801h	communication parameter PDO 2
1A00h	transmit PDO1 mapping parameter
1A01h	transmit PDO2 mapping parameter
2100h	operating parameters
2101h	resolution per revolution
2102h	total resolution
2103h	preset value
2104h	limit switch, min.
2105h	limit switch, max.
2160h	customer storage
2200h	cyclic timer
3000h	node number (NN)
3001h	baud rate
6000h	operating parameter
6001h	steps per revolution
6002h	total resolution
6003h	preset value
6200h	EVENT

7.3.2 Saving process

The parameters are stored in a non-volatile EEPROM. The changes made are stored in the working memory of the encoder. Once all parameters have been checked, they can be transferred to the EEPROM in a write cycle.

The stored parameters are activated after a reset (power on, NMT reset).

7.3.3 Storing without reset

Once the saving process is completed by using the object 1010, there will be no automatic reset to activate the parameters.

7.3.4 Storing with reset

The object 2300 from the manufacturer-specific directory carries out storage via an automatic reset. The parameters become active at once. This has to be taken into account when the node number or the baud rate are changed since there may be interference on the bus.

7.3.5 Restoring the parameters

The factory-set parameters can be restored. The settings stored in the EEPROM are not overwritten. Only after the storage command has been sent again will the default settings be stored in the EEPROM non-volatilely. The restored parameters are identical for each CANopen encoder of this type and may possibly not correspond to the original parameters. Please check the restored parameters with regard to their validity before you perform the storage process again.

7.3.6 Layer Setting Service (LSS)

To configure the encoder via LSS, the encoder is handled like a slave. The controller must have LSS master functionality. The LSS master device requests the data of the encoder. The LSS master enquires the LSS information (vendor ID; product code, revision number, serial number) of the slave. In this case the slave is unambiguously recognised and the settings, node number and baud rate can be set.

8 Programmable parameters

The objects are based on the device profile CiA 406 DS V3.2: CANopen profile for encoders (www.can-cia.org)

Detailed description of the command byte

Command	Data length	Data type
43h	4 bytes	unsigned 32
47h	byte 3	unsigned 24
4Bh	byte 2	unsigned 16
4Fh	1 byte	unsigned 8
23h	4 bytes	unsigned 32
27h	byte 3	unsigned 24
2Bh	byte 2	unsigned 16
2Fh	1 byte	unsigned 8

8.1 Object directory

Data is transferred according to CAL exclusively via object-oriented message telegrams. These objects are classified into groups via an index register. Each index entry can be further subdivided via a sub index. The complete overview of the standard object directory is shown in the following table.

Index (hex)	Object
0000	not used
0001-001F	static data types
0020-003F	complex data types

Index (hex)	Object
0040-005F	manufacturer-specific data types
0060-0FFF	reserved
1000-1FFF	area of the communication profile
2000-5FFF	manufacturer-specific area
6000-9FFF	device-specific area
A000-FFFF	reserved

8.2 Programming example: preset value

The receipt of the SDO answer is to be monitored in the program since the request is sent permanently without confirmation of receipt.

If a CANopen device is connected to the bus and configured with correct baud rate and node number, it replies to the bus with a boot up message.

8.2.1 Set preset value (master to encoder with node number 1)

Set preset value (value 1000)

Identifier	DLC	Command	Index		Sub index	Service data			
NN 1		download	6003h			byte 4	byte 5	byte 6	byte 7
601	8	23h	03h	60h	00h	00h	10h	00h	00h

Response from the encoder

Identifier	DLC	Command	Index		Sub index	Service data			
NN 1		download	6003h			byte 4	byte 5	byte 6	byte 7
581	8	60h	03h	60h	00h	00h	00h	00h	00h

Read preset value from the encoder

Identifier	DLC	Command	Index		Subindex	Service data			
NN 1		download	6003h			byte 4	byte 5	byte 6	byte 7
601	8	40h	03h	60h	00h	00h	00h	00h	00h

Response from the encoder

Identifier	DLC	Command	Index		Sub index	Service data			
NN 1		download	6003h			byte 4	byte 5	byte 6	byte 7
581	8	43h	03h	60h	00h	00h	10h	00h	00h

Non-volatile storage of the preset value

Identifier	DLC	Command	Index		Sub index	Service data			
NN 1		download	1010h			byte 4	byte 5	byte 6	byte 7
601	8	23h	10h	10h	01h	73h	61h	76h	65h

Response from the encoder

Identifier	DLC	Command	Index		Sub index	Service data			
NN 1		download	6003h			byte 4	byte 5	byte 6	byte 7
581	8	60h	10h	10h	00h	00h	00h	00h	00h

8.3 Communication-specific objects of the DS301 from 1000h to 1FFFh (communication profile DS301 V4.02)

Index	S-Idx	Name	Type, access	default value	Description
1000	0	Device type	u32, ro	N/A	Device type and device profile
1001	0	Error register	u8, ro	N/A	Indication internal device error 0b 0000 0000 generic error
1003	0	Pre-defined error field	u8, ro	0	An error list with 10 entries is supported
	1...10	Error history	u32, ro		S-Idx 1 last error S-Idx 2 second but last error ..... Deleting the error memory The error memory is deleted by writing a zero to the sub index 0.
1005	0	COB ID sync object	u32, rw	80h	The object contains the identifier for the SYNC object.
1006	0	Com cycle period	u32, rw	0h	The object defines the communication cycle (SYNC producer) in µs (max. time between 2 sync objects).
1007	0	Synchronous window length	u32, rw	0h	The object contains the sync windows length for synchronous PDOs in µs.
1008	0	Manufacturer device name	str, ro	RM9000	Device designation
1009	0	Manufacturer hardware version	str, ro	x.x	Hardware version
100A	0	Manufacturer software version	str, ro	x.x	Software version

Index	S-Idx	Name	Type, access	default value	Description
100C	0	Guard time	u16, rw	0	This object contains the 'guard time' in milliseconds.
100D	0	Life time factor	u8, rw	0	This object contains the life time factor parameter. The life time factor multiplied with the guard time results in the life time for the guarding protocol.
1010		Store parameters			This object is used to write the parameters to the non-volatile memory.
	0	Number of sub indices	u8, ro	1	
	1	Store all parameters	u32, rw	"save"	To write the parameters to the non-volatile memory the word "save" has to be sent to the corresponding node.

	Most significant word		Least significant word	
ASCII	e	v	a	s
Hex value	65h	76h	61h	73h

1011		Restore parameters			The object is used to restore the factory settings.
	0	Number of sub indices	u8, ro	1	
	1	Restore all parameters	u32, rw	"load"	To restore the factory settings the word "load" has to be sent to the corresponding node. When the parameters have been restored, please check the parameters before the store command is executed again. The restored parameters only become active after a reset or power up.

	Most significant word		Least significant word	
ASCII	d	a	o	l
Hex value	64h	61h	6Fh	6Ch

Index	S-Idx	Name	Type, access	default value	Description
1012	0	COB ID time stamp object	u32, rw	100h	The object contains the COB ID of the time stamp object.
1013	0	High resolution time stamp	u32, rw	0	The object contains a time stamp with a resolution of 1 µs.
1014	0	COB ID emergency object	u32, rw	80h + node ID	The object contains the EMCY emergency message identifier.
1016		Consumer heartbeat time			The consumer heartbeat time defines the heartbeat cycle time to be expected in ms. The encoder can only monitor one device. When the time is set to zero, this service is not activated. The set time must be higher than the corresponding time (object 1017) of the device to be monitored.
	0	Number of sub indices	u8, ro	1	
	1	Consumer heartbeat time	u32, rw	0	
	The contents of the sub index 1 is composed as follows:				

Bit	31 to 24	23 to 16	15 to 0
value	0h (reserved)	address of the device to be monitored	monitoring time (ms)

1017	0	Producer heartbeat time	u16, rw	0	This object contains the time interval in milliseconds during which it has to send the message.
1018		Identity object			This object contains the device information
	0	Number of entries	u8, ro	1	
	1	Vendor ID	u32, ro	0x0069666D	
	2	Product code	u32, ro	0x43 0x41	
	3	Revision number	u32, ro	0x10000	
	4	Serial number	u32, ro	see type label	

Index	S-Idx	Name	Type, access	default value	Description
1020		Verify configuration			The object indexes the loaded configuration, date and time.
	0h	Number of entries	u8, ro	2h	
	1h	Configuration date	u32, rw	0x0	
	2h	Configuration time	u32, rw	0x0	
1029		Error behaviour			The object shows the error behaviour.
	0h	Number of entries	u8, ro	1h	
	1h	Communication error	u8, rw	0x0	
1800		1st transmit PDO communication parameter			This object contains the communication parameters of the first transmit PDO.
	0	Number of sub indices	u8, ro	5	
	1	COB ID	u32, rw	180h + node number	
	2	Transmission mode	u8, rw	FE	
	3	Inhibit time	u32, rw	0	
	4	not available			
	5	Event timer	u32, rw	0x64 or 0	

Index	S-Idx	Name	Type, access	default value	Description
1801		2nd transmit PDO communication parameter			The object contains the communication parameters of the second transmit PDO. Please note! This object is only activated with C6 CANopen encoders.
	0	Number of sub indices	u8, ro	5	
	1	COB ID	u32, rw	280h node number	
	2	Transmission mode	u8, rw	1	
	3	Transmission mode	u32, rw	0	
	4	not available			
	5	Event timer	u32, rw	1	

The transmission mode is set and configured as follows:

	Transmission mode					
Value (decimal)	Cyclical	Acyclical	Synchro-nous	Asynchro-nous	Only RTR	Description
0		x	x			Transmit PDO to first sync messsage after an event
1...240	x		x			Transmit PDO every xth sync message
241...251	reserved					
252			x		x	Receive SYNC message and transmit PDO on remote request
253					x	Data update and transmit PDO on remote request
254, 255				x		Transmit PDO with event

Inhibit time

For "transmit PDOs". The "inhibit time" for PDO transmissions can be set as a 16-bit value. If data changes, the PDO checks if the inhibit time has elapsed since its last data transmission. Another data transmission is only possible once the inhibit time has elapsed. It is useful to set a time with asynchronous transmission (transmission modes 254 and 255) to avoid overlaods on the bus.

Event time

The "event timer" only works in asynchronous transmission modes (transmission modes 254 and 255). If the data changes before the event timer elapses, a temporary telegram is sent. If the value of the timer is >0, the data will be sent

after the timer has elapsed. The value of the timer is written in subindex 5 of the respective PDO. The data is also transferred without any changes to the data. The value range is between 1-65536 ms.

Index	S-Idx	Name	Type, access	default value	Description
1A00		1st transmit PDO mapping parameter			The object contains the mapping parameters of the 1st transmit PDO
	0	Number of sub indices	u8, ro	2	
	1	1st mapped object	u32, rw	-	
1A01		2nd transmit PDO mapping parameter			The object contains the mapping parameters of the 2nd transmit PDO.
	0	Number of sub indices	u8, ro	2	
	1	2nd mapped object	u32, rw	-	
1F50		Download program area			This is a special object for the boot loader functionality. Use this entry to read the Intel hex file with the program data. For detailed information about the domain download and the block transfer see CiA Draft Standard 301 application layer and communication profile.
	0h	Number of sub indices	u8, ro	2h	
	1h		Domain, wo		
1F51		Program Control			This is a special bootloader object to update the firmware. This data area controls the program in the index 0X1F50.
	0h	Number of program control entries	u8, ro		
	1h		u32, rw		The sub index 1h and higher verifies the storage block functionality. They can have the following values: write: 1 - start downloading the program 4 - delete flash memory

8.4 Manufacturer-specific objects from 2000h to 5FFFh

Index	S-Idx	Name	Type, access	default value	Description
2000	0	Position value	u32, ro		
2100	0	Operating parameters	u16, rw	0h	The counting direction of the encoder as an operating parameter can be changed and the two limit switches can be switched on or off. The parameter counting direction (complement) determines the counting direction of the encoder. With the same direction of rotation the value can be indicated either adding or substracting. The counting direction is set by bit 0 of the object to 2100h. In addition the two limit switches can be switched on or off. Bit 1 and bit 2 are used for this purpose. Note: The counting direction is always seen looking at the shaft. With clockwise direction of the shaft (CW) the counting direction is increasing. Calculation example: Goal: encoder with counting direction decreasing (CCW) and both limit switches off Bit matrix: bit 0 = 1 direction decreasing (CCW) bit 1 = 0 limit switch min. disabled bit 2 = 0 limit switch max.disabled result = 01h
2101	0	Resolution per revolution	u16, rw		Requested steps per revolution (single turn resolution up to 13 bits)
	0	Resolution per revolution	u32, rw		Requested steps per revolution (single turn resolution > 13 bits) If the requested resolution per revolution exceeds the physical resolution, the set value is not transmitted. ► Set correct resolution.

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<table>
<tr><th>Index</th><th>S-Idx</th><th>Name</th><th>Type, access</th><th>default value</th><th>Description</th></tr>
<tr><td>2102</td><td>0</td><td>Total resolution</td><td>u32, rw</td><td>0x1000000</td><td rowspan="2">Total resolution of the encoder
This parameter is used to set the requested total resolution. The parameter must not exceed the physical measuring range of the encoder. The total resolution and the resolution per revolution must be entered using the following formula:
GA = (PGA x AU) / PAU
PGA
total physical resolution of the encoder (see type label)
PAU
physical resolution per revolution of the enocder (see type label)
GA
total resolution (customer-specific)
AU
resolution per revolution (customer-specific)
If the requested total resolution is lower than the total physical resolution, the total resolution parameter must be a multiple of the physical resolution per revolution.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2103</td><td>0</td><td>Preset value</td><td>u32, rw</td><td>0</td><td>The preset value is a position value which is to be indicated at a certain physical position of the axis. The preset value must not exceed the total physical resolution to avoid runtime errors.</td></tr>
<tr><td rowspan="2">2104</td><td>0</td><td>Limit switch, min.</td><td>u32, rw</td><td>0</td><td>Two position vaues can be programmed as limit switch positions. When one of these values has been reached, one of the 32-bit position values is set. Both values must not exceed the total physical resolution of the encoder to avoid runtime errors.</td></tr>
<tr><td colspan="5">The limit switch (min) sets bit 30 = 1 with the next telegram transmitted when the set position value has been reached or fallen below.
<table>
<tr><td>Function</td><td colspan="2">Status bit</td><td colspan="5">Process value</td></tr>
<tr><td>Bit</td><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25.....0</td></tr>
<tr><td></td><td>0</td><td>1</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
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<table>
<tr><th>Index</th><th>S-Idx</th><th>Name</th><th>Type, access</th><th>default value</th><th>Description</th></tr>
<tr><td rowspan="2">2105</td><td>0</td><td>Limit switch, max.</td><td>u32, rw</td><td>0</td><td>Two position vaues can be programmed as limit switch positions. When one of these values has been reached, one of the 32-bit position values is set. Both values must not exceed the total physical resolution of the encoder to avoid runtime errors.</td></tr>
<tr><td colspan="5">The limit switch (max) sets bit 31 = 1 with the next telegram transmitted when the set position value has been reached or fallen below.
<table>
<tr><td>Function</td><td colspan="2">Status bit</td><td colspan="4">Process value</td></tr>
<tr><td>Bit</td><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25.....0</td></tr>
<tr><td></td><td>1</td><td>0</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
</table></td></tr>
<tr><td rowspan="6">2160</td><td></td><td>Customer storage</td><td>u8, rw</td><td>4h</td><td>The object enables the user to store any value.</td></tr>
<tr><td>0h</td><td>Number of sub indices</td><td>u32, rw</td><td>0x0</td><td></td></tr>
<tr><td>1h</td><td>Customer storage 1</td><td>u32, rw</td><td>0x0</td><td></td></tr>
<tr><td>2h</td><td>Customer storage 2</td><td>u32, rw</td><td>0x0</td><td></td></tr>
<tr><td>3h</td><td>Customer storage 3</td><td>u32, rw</td><td>0x0</td><td></td></tr>
<tr><td>4h</td><td>Customer storage 4</td><td>u32, rw</td><td>0x0</td><td></td></tr>
<tr><td>2200</td><td>0</td><td>Cyclic timer PDO</td><td>u16, ro</td><td>0</td><td>The object contains the value of the event timer in ms.</td></tr>
<tr><td>2300</td><td>0</td><td>Save parameter with reset</td><td>u32, wo</td><td>55AAAA55h</td><td>With this object the set parameters can be written to the non-volatile memory. After successful transmission of the access code a reset will be made.</td></tr>
<tr><td>3000</td><td>0</td><td>Node number</td><td>u8, rw</td><td>-</td><td>The object contains the node number of the device.
The node number must be ≠ 0.
► Always add a 1 to the node number.
Example: 1Fh+1h = 20h = 32 (dec)</td></tr>
<tr><td>3001</td><td>0</td><td>Baud rate</td><td>u8, rw</td><td>0x3</td><td>The object contains the baud rate of the device.</td></tr>
</table>

<table>
<tr><th>Index</th><th>S-Idx</th><th>Name</th><th>Type, access</th><th>default value</th><th>Description</th></tr>
<tr><td></td><td colspan="5">Eight different baud rates are supported. Only one byte is used to set the baud rate.
<table>
<tr><th>Baud rate [kbits/s]</th><th>Byte</th></tr>
<tr><td>20</td><td>0x00</td></tr>
<tr><td>50</td><td>0x01</td></tr>
<tr><td>100</td><td>0x02</td></tr>
<tr><td>125</td><td>0x03</td></tr>
<tr><td>250</td><td>0x04</td></tr>
<tr><td>500</td><td>0x05</td></tr>
<tr><td>800</td><td>0x06</td></tr>
<tr><td>1000</td><td>0x07</td></tr>
</table></td></tr>
<tr><td rowspan="4">3010</td><td></td><td>Speed control</td><td></td><td></td><td>Speed measurement, the measurement is switched off in the factory setting.</td></tr>
<tr><td>0h</td><td>Number of sub indices</td><td>u8, ro</td><td>2h</td><td></td></tr>
<tr><td>1h</td><td>Enable speed</td><td>u8, rw</td><td>0h</td><td></td></tr>
<tr><td>2h</td><td>Speed mode</td><td>u8, rw</td><td>0h</td><td>Via this sub-index the filter interval and thus the latency time of the speed measurement can be set. There are three setting options:
<table>
<tr><th>Setting Speed mode</th><th>Delay time [ms]</th></tr>
<tr><td>0</td><td>5</td></tr>
<tr><td>1</td><td>50</td></tr>
<tr><td>2</td><td>500</td></tr>
</table></td></tr>
<tr><td>3011</td><td>0h</td><td>Speed value</td><td>u8, romap</td><td></td><td>Speed value [dig/s]</td></tr>
</table>

Index	S-Idx	Name	Type, access	default value	Description
4000	0h	Bootloader control	u32, wo		The object controls the bootloader functionality. If the security code is written to the object, the EEprom and the information in the flash memory are deleted. Furthermore the device is subjected to a reset. After another set-up, the bootloader verifies the user application and does not find any other information. The bootloader starts with a predefined CANopen node number (0x1) and a fixed baud rate of 125 Kbits. Activation of the bootloader entails an erasing process. Afterwards only a small number of objects are available. The encoder is waiting for new programming. Due to this behaviour the security code for prevention is not published in this manual but is only available from ifm on request.

8.5 Device-profile-specific objects from 6000h to 9FFFF

Index	S-Idx	Name	Type, access	default value	Description
6000		Operating parameters	u16, rw	1h	The object sets the counting direction, the diagnostic function and the scaling function. Note: The counting direction is always seen looking at the shaft. With clockwise direction of the shaft (CW) the counting direction is increasing.

Scaling function:

Using the scaling function the position value provided can be adapted to the requirements of the application via the software. The objects 6001 and 6002 of the device profile are scaling parameters. When the scaling bit has been set to zero, scaling is switched off.

Bit structure

Bit	15	14	13	12	11...4	3	2	1	0
Description	MS	MS	MS	MS	R	MD	SFC	CD	CS

Abbreviations:

MS = manufacturer-specific function (not available)

R = reserved

MD = measurement direction (not available)

SFC = scaling function (0 = off, 1 = on)

CD = commissioning diagnostic control (not available)

CS = counting direction 0 = CW (clockwise); 1 = CCW (counter-clockwise)

Index	S-Idx	Name	Type, access	default value	Description
6001	0	Measuring units per revolution	u32, rw	see type label	Setting steps per revolution
6002	0	Total measuring range in measuring units	u32, rw	see type label	Setting the total resolution of the measuring range
6003	0	Preset value	u32, rw	0	Setting the preset value for the encoder
6004	0	Position value	u32, romap	-	The object gets the position value
6030		Speed value			If the max. possible value is exceeded, the value stops there. The user can use the object 3010 (32 bits).
	0h	Number of sub indices	u8, ro	1h	
	1h	Speed value channel 1	integer 16, romap	-	
6200	0	Event time	u16, rw	0x64	This object contains the value of the event timer of the corresponding PDOs. The value can be set between 1 and 65538 ms.
6300		Cam state register			The object describes the cam state register. The object contains the current position of the cam from 1 to 8.
	0h	Number of sub indices	u8, ro	1h	
	1h	Cam state channel 1	u8, romap	4h	
6301		Cam enable register			The object describes the cam state.
	0h	Number of sub indices	u8, ro	1h	
	1h	Cam enable channel 1	u8, rw		
6302		Cam polarity register			The object describes the cam behaviour.
	0h	Number of sub indices	u8, ro	1h	
	1h	Cam polarity channel 1	u8, rw	0h	

List of cam objects

6310h			Cam 1 low limit			
	0h	VAR	Highest sub-index supported	u32	ro	0x1
	1h	VAR	Cam 1 low limit channel 1	u32	rw	0x0
6311h			Cam 2 low limit			
	0h	VAR	Highest sub-index supported	u32	ro	0x1
	1h	VAR	Cam 2 low limit channel 1	u32	rw	0x0
6312h			Cam 3 low limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 3 low limit channel 1	u32	rw	0x0
6313h			Cam 4 low limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 4 low limit channel 1	u32	rw	0x0
6314h			Cam 5 low limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 5 low limit channel 1	u32	rw	0x0
6315h			Cam 6 low limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 6 low limit channel 1	u32	rw	0x0
6316h			Cam 7 low limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 7 low limit channel 1	u32	rw	0x0
6317h			Cam 8 low limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 8 low limit channel 1	u32	rw	0x0
6320h			Cam 1 high limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 1 high limit channel 1	u32	rw	0x0
6321h			Cam 2 high limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 2 high limit channel 1	u32	rw	0x0
6322h			Cam 3 high limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 3 high limit channel 1	u32	rw	0x0
6323h			Cam 4 high limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 4 high limit channel 1	u32	rw	0x0
6324h			Cam 5 high limit			

	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 5 high limit channel 1	u32	rw	0x0
6325h			Cam 6 high limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 6 high limit channel 1	u32	rw	0x0
6326h			Cam 7 high limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 7 high limit channel 1	u32	rw	0x0
6327h			Cam 8 high limit			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 8 high limit channel 1	u32	rw	0x0
6330h			Cam 1 hysteresis			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 1 hysteresis channel 1	u32	rw	0x0
6331h			Cam 2 hysteresis			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 2 hysteresis channel 1	u32	rw	0x0
6332h			Cam 3 hysteresis			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 3 hysteresis channel 1	u32	rw	0x0
6333h			Cam 4 hysteresis			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 4 hysteresis channel 1	u32	rw	0x0
6334h			Cam 5 hysteresis			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 5 hysteresis channel 1	u32	rw	0x0
6335h			Cam 6 hysteresis			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 6 hysteresis channel 1	u32	rw	0x0
6336h			Cam 7 hysteresis			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 7 hysteresis channel 1	u32	rw	0x0
6337h			Cam 8 hysteresis			
	0h	VAR	Highest sub-index supported	u8	ro	0x1
	1h	VAR	Cam 8 hysteresis channel 1	u32	rw	0x0

Index	S-Idx	Name	Type, access	default value	Description
6400		Area state register			The object describes the area state register. In this object the status of the encoder value is indicated in the area defined before.
	0h	Measuring units per revolution	u8, ro	1h	
	1h	Total measuring range in measuring units	u8, romap	-	

Bit structure

7	6	5	4	3	2	1	0
R	r	r	r	r	Range underflow	Range overflow	Out of range
MSB							LSB

Signal	Value	Definition
Out of range	0	Position between low and high limit
	1	Position out of range (refer to module identification object, 650Ah) is reached
Range overflow	0	No range overflow
	1	Position is lower than the position value set in object 6402h "work area low limit“
Range underflow	0	No range underflow
	1	Position is higher than the position value set in object 6401h "work area high limit“
r	0	reserved

6401		Work area low limit		-	The objects shows the lower value of the work area. Bit 2 of the existing work area status in object 6400h will change when the work area is fallen below. This object is directly linked with object 2104h (limit switch min.).
	0h	Number of sub indices	integer 32, ro	1h	
	1h	Work area low limit channel 1	integer 32, rw	0h	

Index	S-Idx	Name	Type, access	default value	Description
6402		Work area high limit		-	The object indicates the upper value of the working area. Bit 1 of the working status existing in object 6400h will change when the working area is exceeded. This object is directly linked with object 2105h (limit switch max.).
	0h	Number of sub indices	integer 32, ro	1h	
	1h	Work area high limit channel 1	integer 32, rw	0h	
6500	0	Operating status	u16, ro	-	Operating status of the encoder. The operating status object is linked with the value of the object 6000.
6501	0	Single-turn resolution	u32, ro	see type label	The object indicates the physical resolution per revolution of the encoder.
6502	0	Number of distinguishable revolutions	u16, ro	see type label	The object indicates the physical number of revolutions of the encoder.
6504	0	Supported alarms	u16, ro	-	Not supported.
6507	0	Profile and software version	u32, ro	-	The object contains the implemented profile versions and the manufacturer-specific software version of the encoder.

MSB			LSB
Software version		Profile version	
Upper software version	Lower software version	Upper profile version	Lower profile version

6509	0	Offset value	integer 32, ro	0	Offset value of the encoder. This value is determined by the preset value and shifts the physical position by this offset value.

Index	S-Idx	Name	Type, access	default value	Description
650A		Module identification			The object indicates the manufacturer-specific offset, the manufacturer-specific minimum and maximum of the position value.
	0	Largest sub index	integer 32, ro	3	
	1	Manufacturer-specific offset	integer 32, ro	-	
	2	Manufacturer-specific min. position value	integer 32, ro	-	
	3	Manufacturer-specific max. position value	integer 32, ro	-	
650B	0	Serial number	u32, ro	-	Serial number of the shaft encoder. If the serial number is not supported by the encoder, the value is always 0xffffffff.

9 Terms and abbreviations

0b ...	Binary value (for bit coding), e.g. 0b0001 0000
0d ...	Decimal value, e.g. 0d100
0x ...	Hexadecimal value, e.g. 0x64 (= 100 decimal)
Baud rate	Transmission speed (1 baud = 1 bit/s)
CAL	CAN Application Layer CAN-based network protocol on application level
CAN	Controller Area Network (bus system for the use in mobile vehicles)
CAN_H	CAN high; CAN connection/cable with high voltage level
CAN_L	CAN low; CAN connection/cable with low voltage level
CANopen	CAN-based network protocol on the application level with an open configuration interface (object directory).
CiA	"CAN in Automation e.V." (user and manufacturer organisation in Germany/Erlangen) definition and control body for CAN and CAN-based network protocols
CiA DS	Draft Standard (published CiA specification which usually has not been modified or supplemented for one year)
CiA DSP	Draft Standard Proposal (published CiA specification draft)
CiA WD	Work Draft (work draft accepted for discussion within CiA)
CiA DS 301	Specification concerning the CANopen communication profile; describes the basic communication mechanisms between the network participants such as the transfer of process data in real time, the data exchange between devices or the configuration phase. Completed by the following CiA specifications according to the application:
CiA DS 401	Device profile for digital and analogue I/O modules
CiA DS 402	Device profile for drives
CiA DS 403	Device profile for HMI
CiA DS 404	Device profile for measurement and control technology
CiA DS 405	Specification for interfaces to programmable systems (IEC 61131-3)
CiA DS 406	Device profile for encoders
CiA DS 407	Application profile for local public transport
COB	CANopen communication object (PDO, SDO, EMCY, ...)
COB ID	CANopen identifier of a communication object
Communication cycles	The synchronisation time to be monitored; max. time between 2 sync objects
EMCY object	Emergency object (alarm message; device signals an error)
Error reg	Error register (entry with an error code)
Guarding error	Node or network participant could or can no longer be found Guard MASTER: one or several SLAVES no longer reply Guard SLAVE: no polling of the device (SLAVE).
Guard Time	Within this time the network participant expects a "node guarding" of the network master
Heartbeat	Configurable cyclic monitoring among network participants. In contrast to "node guarding" no superior NMT master is required.
ID (also identifier)	Identifier; identifies a CAN message. The numerical value of the ID also contains a priority for the access to the bus system. ID 0 = top priority.
Idx	Index; together with the S index it forms the address of an entry in the object directory
Life Time Factor	Number of attempts in case of a missing guarding response
Monitoring	Is used to describe the error class (guarding monitoring, sync etc.).
NMT	Network Management
NMT master/slaves	The NMT master controls the operating statuses of the NMT slaves
Node Guarding	Adjustable cyclic monitoring of slave network participants by a

	higher-level master node as well as monitoring of this polling process by the slave participants.
Node ID	Nodal point identifier (identification of a participant in the CANopen network)
Object (also OBJ)	Term for data/messages which can be exchanged in the CANopen network
Object directory	Contains all CANopen communication parameters of a device as well as device-specific parameters and data. Access to the individual entries is possible via the index and S-index.
Operational	Operating status of a CANopen participant. In this mode SDOs, NMT commands and PDOs can be transferred.
PDO	Process Data Object; in the CANopen network to transfer process data in real time such as motor speed. PDOs have a higher priority than SDOs; in contrast to the SDOs they are transferred without confirmation. PDOs consist of a CAN message with identifier and up to 8 bytes of user data.
PDO mapping	Describes the application data transferred with a PDO.
Pre-Op	Preoperational; operating status of a CANopen participant. After application of the supply voltage each participant automatically goes into this state. In the CANopen network only SDOs and NMT commands can be transferred in this mode but no process data.
Prepared	(Also stopped) operating status of a CANopen participant. In this mode only NMT commands are transferred.
Rec PDO (also Rx PDO)	(Receive) Process Data Object
ro	read only (unidirectional)
rw	read-write (bidirectional)
Rx queue	Input buffer
s16	Data type signed 16 bits (incl. sign, 16-bit format)
SDO	Service Data Object With this object direct access to the object directory of a network participant is possible (read/write). An SDO can consist of several CAN messages. The transfer of the individual messages is confirmed by the addressed participant. With the SDOs, devices can be configured and parameters can be set.
Server SDO	Process and parameter set to make the object directory of a network participant available to other participants (clients).
S-Idx (also SIdx)	Sub index within the object directory of a CANopen-capable device
Start Guarding	Start node monitoring
str	Data type string (variable for strings such as text "load")
Sync error	Missing sync object OBJ in the adjustable synchronisation time
Sync OBJ	Synchronisation object for simultaneous update in the complete network or for accepting process data of the respective parameterised PDOs.
Sync windows	Time during which the synchronous PDOs have to be transferred.
Time stamp	Time stamp to align existing clocks in network participants
Trans Type	Type of process data transmission; synchronous, asynchronous
Trans PDO (also Tx PDO)	Transmit Process Data Object
Trans SDO (also Tx SDO)	(Transmit) Service Data Object

Tx queue (Transmit)	Transmission buffer
u8 (16, 32)	Data type unsigned 8 (16, 32) bits (without sign, 8 (16, 32) bit-format
wo	write only