



TRM Project

TRM-2ENC

Ether**CAT**® 

Hardware Architecture

User Manual

Technical Documentation

DOCUMENT DATA

Data	10/12/2025
Revision	0
FileName	enTRM-2ENC.pdf
Document type	User manual
Authors	UT – TPA Srl
Department	DIP
Notes	Customer document
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REVISIONS

Revision Number	Data	List of changes
Rev.0	10/12/2025	

INDEX

REVISIONS.....	2
CONTENTS	4
1 FUNCTIONAL SPECIFICATION.....	5
2 MECHANICAL DATA	8
3 ETHERCAT COMMUNICATION.....	9
3.1 PDO's list.....	12
3.2 Object Dictionary.....	12
4 ENCODER COMMUNICATION	14
5 TRM-2ENC VIEW	15



CONTENTS

This document is the User Manual for TRM-2ENC device. TRM-2ENC belongs to the TRM series of devices by TPA s.r.l. which are bus field devices to remote the CNC action on a tool machinery or, generally, in a controlled system; the devices are connected to a standard EtherCAT bus. TRM-2ENC is a module which provides 2 complete Quadrature Incremental Encoder Interfaces. This document shows how to use TRM-2ENC, to connect it and all the technical specifications regarding the product.

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This description is only intended for the use of trained specialists in control and automation engineering who are invited to always use the currently valid documentation.

It is recommended that the documentation (notes, explanations, diagrams, ecc.) are followed when installing and commissioning these components.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The Company reserves the right to revise and modify the current documentation at any time.

The Company doesn't respond of uncorrect or improper use of the device.

Safeguard clause

If any information about this device will result not clear, please do not esitate to take contacts with TPA.srl Service.



Albatros - Logo



TPA S.r.l - Logo

1 FUNCTIONAL SPECIFICATION

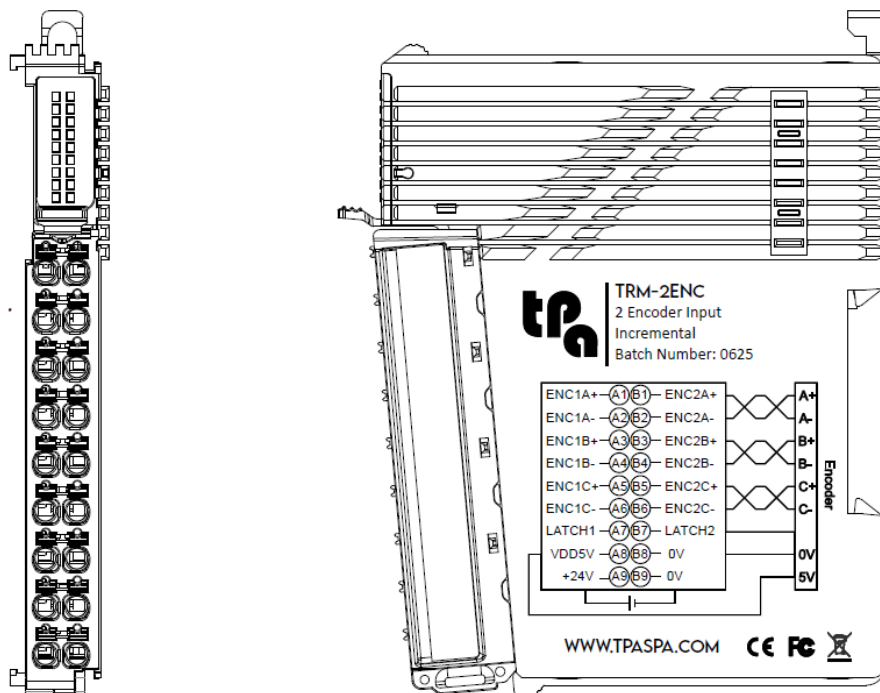
TRM-2ENC is a module which provides 2 complete Quadrature Incremental Encoder Interfaces. Input signals are differential RS422 standard signals (0..+5V); Phase A, Phase B and Phase C (which can be assumed as home reference signal).

The range of encoders' counters is -32768Dec..+32767Dec which corresponds to a 16bit resolution; an INT16 WORD and a Status Object are forwarded to the Control System by a TxPDO at ECAT rate.

For each encoder interface, a Latch fast input signal is provided to capture the position both on rising or falling edge with a hardware sampler. Settings about the Latch function are provided by standard COE Objects.

Power Supply of the Encoder Interfaces is +24Vdc from external pins; it produces a indoor +5Vdc power supply which is also tied to external pins for supplying the encoders.

All signals are protected and optoisolated towards the ECAT bus. Every signal can be checked to verify its connections. Thus, power supply is filtered, limited and checked to prevent damage. On the front of the device, some led indicate the state of single lines and signals and any errors.



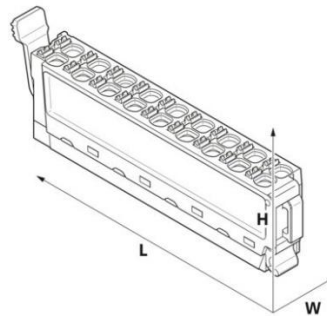
On the right side, a gray silkscreen is printed and it reports:

- the device Name and its main function
- the batch production number
- the consortium EtherCAT logo to specify the environment of use and compatibility
- the TPA reference - TPA's logo, QR code and site address
- CE certification logo
- a simplified schematic for input connections

TRM-2ENC can be directly joined to a bus coupler TRM-ECAT or in chain with other modules of the same serie.

The connection between TRM-2ENC and other TRM's serie moduls is made by the internal standard E-BUS, as described in IEC61158. It must be directly connected to the TRM-ECAT bus coupler or through another TRM's serie module. No other application is allowed.

The 2 Phase quadrature encoder interface, the Home signal and the Latch signal constitute an encoder interface set; TRM-2ENC provides 2 sets of complete encoder interfaces. All signals are tied on the main 18-positions front connector. The connector used is.



**HSCP-SP 1,5-18-IO-7035 color gray
producer code 1569965 - Phoenix**

Each lane input consists of two positions on the connector, due to the differential lane. Signals from encoders must be protected by EMI. Therefore, it's better to prefer single shielded twisted pairs cables, ($Z=100\Omega$) paying attention to connect the whole shield to GND. For each differential signal:

- Connect the positive phase of the signal to the (+) input
- Connect the negative phase of the signal to the (–) input
- Connect the shield to GND

(it is also possible to connect shield to 0V if it is joined with GND)

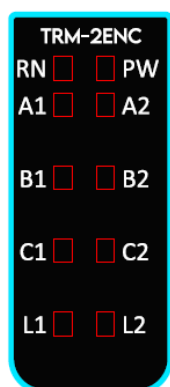
	TOP LEFT PIN	TOP RIGHT IN	
ENC1A+	A1	B1	ENC2A+
ENC1A–	A2	B2	ENC2A–
ENC1B+	A3	B3	ENC2B+
ENC1B–	A4	B4	ENC2B–
ENC1C+ (*)	A5	B5	ENC2C+ (*)
ENC1C– (*)	A6	B6	ENC2C– (*)
LATCH1	A7	B7	LATCH2
+5Vdc for ENC	A8	B8	0V
Power Supply +24Vdc	A9	B9	0V
	BOTTOM LEFT PIN	BOTTOM RIGHT PIN	

(*) Phase C can be considered Zero latch signal.

Attention! Every input of TRM-2ENC is NOT protected against overvoltage. A voltage excess can damage the input. Each input circuit has about 100 Ohm impedance for terminating the line. Then, a cut-off filter tuned limits the dynamic of the input and prevents it from EMI.

Attention! Every input of phase of TRM-2ENC is checked to verify the state of the encoder. Three conditions can be detected; the presence of the encoder, the presence of pulses (due to encoder motion), the absence of connection (fault). On the front of the device, some leds indicate the state of the encoders' signals.

Attention! Protect every couple of signals with a shield connectrd to GND. Signal couples must be twisted pairs

**LED**

RN	ECAT link status
PW	Logic power supply +5V from EBUS
L1	Latch 1 is ON (external Latch1)
A1	Status of Phase A1
B1	Status of Phase B1
C1	Status of Phase C1 (Latch1 Z)
L2	Latch 2 is ON (external Latch2)
A2	Status of Phase A2
B2	Status of Phase B2
C2	Status of Phase C2 (Latch2 Z)

On the top of the frontal image of TRM-2ENC a list of LED indicators is set.

LED behaviour	Encoder state
Exstinguished	no encoder connected
Blinking	pulse signal is present
Bright	no pulse signal, encoder connected (no motion)

Regarding the RN ECAT status led

LED behaviour	ECAT State condition
Exstinguished	INIT State
Blinking (regular)	PreOP State
Single flash	SafeOP State
Bright	Operational

Regarding every signal of Phase

PW led ON means main logic power supply +5V by EBUS is present.

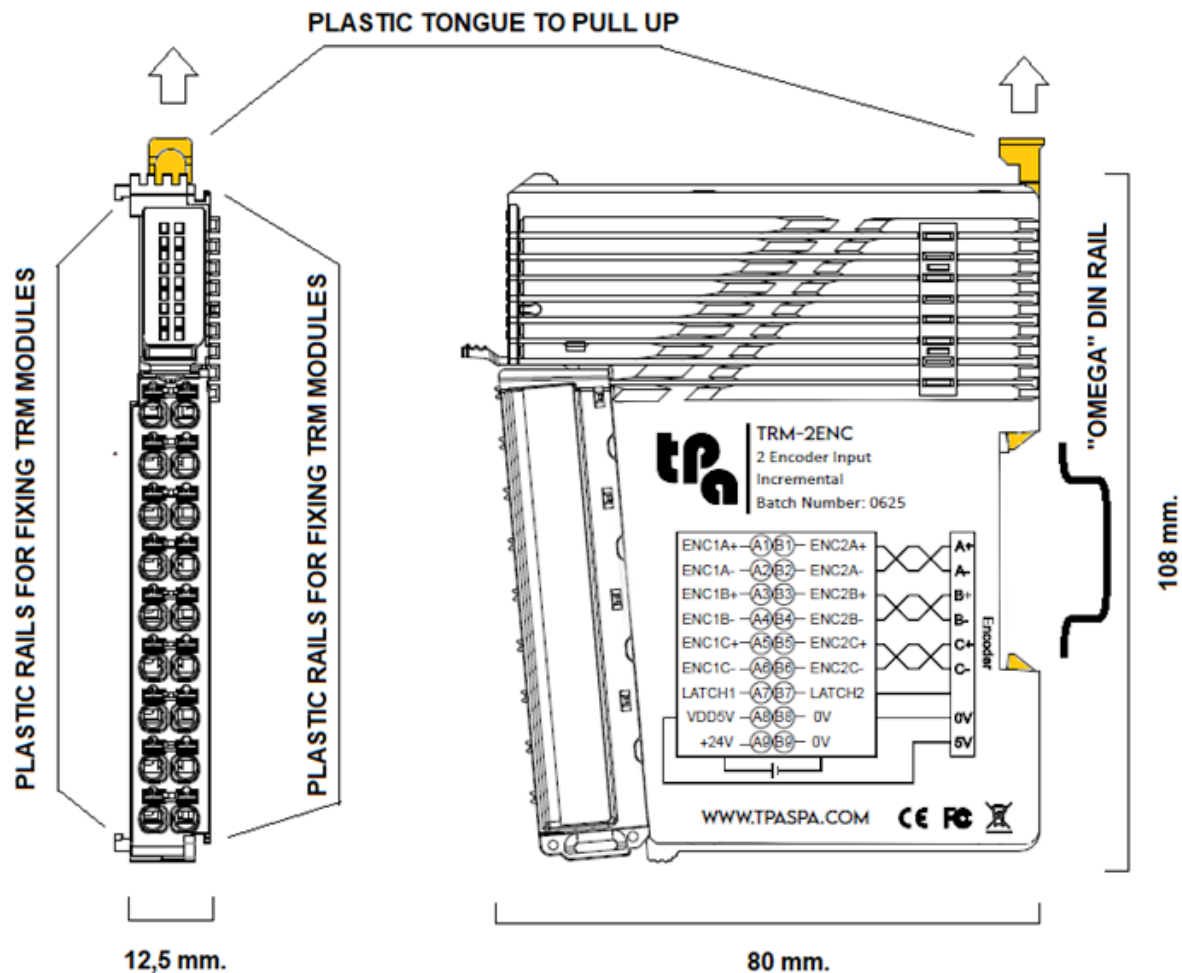
Field power supply +24V is not checked, source +5Vdc power supply for encoder is not checked.

Electrical parameters	Values
Input signals	2 x incremental encoder
Encoder signals	A/B/C Phases – differencial – RS422 standard
Encoder IF counter	32 bit
Frequency limit	5Mbps
Power Supply Voltage	+24Vdc (-15% +20%), not disturbed, regulated
Encoder Supply	+5Vdc on pin A7
Pulse counting multiplier	4 times (default – in quadrature)
Pulse counting range	-2147483648 +2147483648 ()
RTC rate	500µs, 1ms, 2ms, 4ms
Frequency sampling rate	500us, 1ms, 2ms, 4ms – on ECAT IRQ
Electrical isolation	500V (from ECAT signals)
Storage Temperature	-40°C – 60°C
Relative humidity	5 – 95% (not condensating)
Dimensions	108x12,5x80mm.
Net weight	60g.
EMC	CE/FCC
Protection level	IP20

2 MECHANICAL DATA

TRM-2ENC module can be installed onto a metallic rail DIN 60715, with "OMEGA" profile, model 7,5mm. or 15mm.

To add a TRM-2ENC device to a TRM-ECAT or to another TRM module in a blackchain, let's introduce it along the right side of the TRM-2ENC module. There are two plastic rails on the TRM-2ENC that help to get the correct position of the TRM device. Then, throw up the orange tongue to fix it to the DIN rail.



Dimension	Value	Notes
Height	108 mm.	Let's consider the extension of the tongue and the possibility to have a min. extended space to handle it
Dept	80 mm.	Let's consider the extension of the connector and the curves of the cables
Thickness	12,5 mm.	

3 ETHERCAT COMMUNICATION

The TRM-2ENC module is compliant with standard EtherCAT normed by ETG in IEC61158. TRM-2ENC is a double quadrature incremental encoder interface and it is addressed as a station into the EtherCAT network; it can run only in an ECAT net.

Other TRM's serie devices can be mechanically and electrically joined to TRM-2ENC, to constitute a I/O remote block, connected in blockchain.



Data communication into the blockchain is supported by E-BUS, a local bus derived from ECAT. The communication is full-duplex, real time clocked and based on 100Base-Tx exchange on internal E-BUS. This bus is coupled toward ECAT by a TRM-ECAT modul. TRM-2ENC cannot be used not joined to TRM-ECAT.

The max exchange rate (the real Time Clock of the network) can be accorded in this range: 250µs, 500µs, 1ms, 2ms, 4ms or more. It is a Master station dependent parameter.

Sampling position is accorded with RTC timing; position is latched on ECAT IRQ, then passed by ECAT bus on the next communication session.

Methods to access and to run it are provided by a description ESI file (TRM-2ENC.xml is provided for setting up the device into the control system).

TRM-2ENC implements both PDO's communication for synchronous data and SDO's communication for setting and in general for asynchronous data.

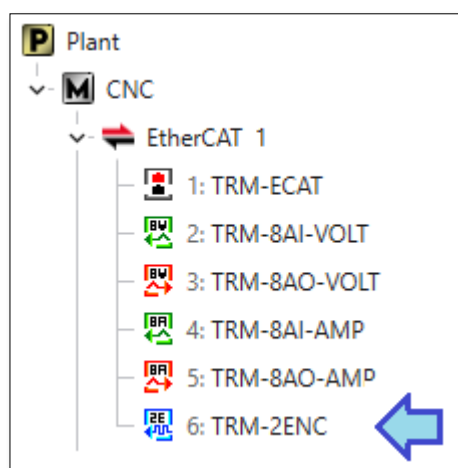
TRM-2ENC supports COE protocol; it presents standard and specific objects in its Object Dictionary. It is possible to have a limited selection of Objects - PDO Mapping (PDOs are already organized in set but admit a selection); all other objects are accessible by SDO protocol.

There are 4 Sync Manager (SM) set to provide COE asynchronous communications (MailBoxes) and buffer mode:

SM0 = Mail Box Out	→ start address 0x1000
SM1 = Mail Box In	→ start address 0x1200
SM2 = buffer mode RxPDO	→ start address 0x1400
SM3 = buffer mode TxPDO	→ start address 0x1800

Encoder data (counter sampling) can be synchronized in DC mode or in free running.

In Albatros SW by TPA, you need to introduce a TRM-ECAT node to convert EtherCAT signals into EBUS format. In the hardware configuration window, under the EtherCAT bus symbol, it is possible to select the TRM-2ENC device.



The hardware configuration window in Albatros.

20: TRM-2ENC	Index	In/Out	Sm	Tags	Size	Name
☒	0x1A00	In	3	F	10.0	ENC Status Channel 1
☐	0x1A01	In		F	6.0	ENC Status Compact Channel 1
☐	0x1A02	In		F	8.0	ENC Status Counter Channel 1
☐	0x1A03	In		F	6.0	ENC Status Compact Counter Channel 1
☒	0x1A0D	In	3	F	10.0	ENC Status Channel 2
☐	0x1A0E	In		F	6.0	ENC Status Compact Channel 2
☐	0x1A0F	In		F	8.0	ENC Status Counter Channel 2
☐	0x1A10	In		F	6.0	ENC Status Compact Counter Channel 2
☒	0x1600	Out	2	F	6.0	ENC Control Channel 1
☐	0x1601	Out		F	4.0	ENC Control Compact Channel 1
☐	0x1602	Out		F	6.0	ENC Control Counter Channel 1
☐	0x1603	Out		F	4.0	ENC Control Compact Counter Channel 1
☒	0x1606	Out	2	F	6.0	ENC Control Channel 2
☐	0x1607	Out		F	4.0	ENC Control Compact Channel 2
☐	0x1608	Out		F	6.0	ENC Control Counter Channel 2
☐	0x1609	Out		F	4.0	ENC Control Compact Counter Channel 2

Here is the Process Data window in Albatros SW, clicking on TRM-2ENC icon.

In the picture a pre-selected PDO mapping is operated over a set of Objects.

TxPDOs 0x1A00 and 0x1A0D are selected to pass all the information about encoder channel 1 and 2.

The passed Objects as entries of the PDO are:

- Encoder counter (INT32)
- Status Word (INT16)
- Last Latched value of the counter (on Latch signal event) (INT32)

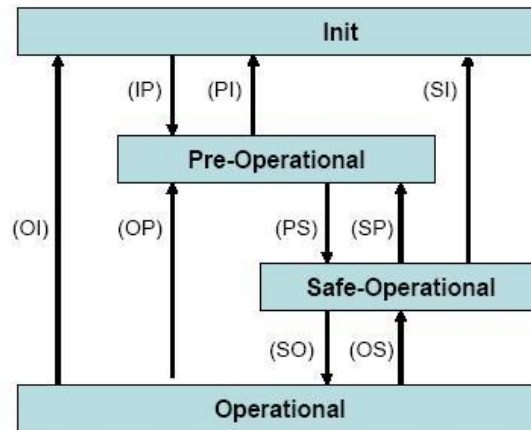
RxPDOs 0x1600 and 0x1606 are selected to send all the commands to set the encoder interface for channel 1 and 2.

The passed Objects as entries of the PDO are:

- Control Word (INT16)

This selection grants the most efficient throughput of all information between the encoder interfaces and the system control.

The EtherCAT State Machine shown in figure is applicable to TRM-2ENC. Latch signals are operative only in OPERATIONAL state. Sampling the counter is active in PREOPERATIONAL, SAFE OPERATIONAL and OPERATIONAL state. Control Word and Status Word are manageable in all states.



3.1 PDO's list

Real Time Objects - PDOs

Index(hex)	Name	Data	Size(Byte)
0x1A0n	Encoder Status Channel n	Encoder Status Channel n	14.0
0x160n	Encoder Control Channel n	Encoder Control Channel n	6.0

For Channels= 0≤n≤1 – RxPDO/TxPDO Selection

3.2 Object Dictionary

0x1000 Device Type

Index(hex)	Name	Data	Data type	Marker	Default
1000.0	Device Type	EtherCAT type of the device	UINT32	RO	0x00001389 (5001 Dec)

0x1008 Device Name

Index(hex)	Name	Data	Data type	Marker	Default
1008.0	Device Name	EtherCAT name of the device	STRING	RO	TRM-2ENC

0x1009 Hardware version

Index(hex)	Name	Data	Data type	Marker	Default
1009.0	Device HW version	EtherCAT data about HW version	STRING	RO	1.00

0x100A Software version

Index(hex)	Name	Data	Data type	Marker	Default
100A.0	Device SW version	EtherCAT data about SW version	STRING	RO	1.00

0x1018 Id of the node in ECAT net

Index(hex)	Name	Data	Data type	Marker	Default
1018.0	Identity	To identify the device from station information	UINT8	RO	0x04
1018.01	Vendo ID	EtherCAT from the station supplier ID	UINT32	RO	0x000002EA
1018.02	Product Code	EtherCAT from the station product ID	UINT32	RO	0xC0043238
1018.03	Revision	EtherCAT from the station revision NrD	UINT32	RO	0x00000100
1018.04	Serial Number	EtherCAT from the station Serial Nr	UINT32	RO	0x00000000

TxPDO 0x1A0n: PDO mapped objects

0x60(n)0 Latch Setting

Index(hex)	Name	Data	Data type	Marker	Default
60n0.00	Latch n setting	Maximum Subindex	UINT8	RO	0x16 (22 Dec)
60n0.01	Status_Latch Z valid	Status bit. External lock: 1 = in effect 0 = ineffectiveness	BIT	RO	0 (0 Dec)
60n0.02	Status_Latch extern valid	Status bit. External lock: 1 = in effect 0 = ineffectiveness	BIT	RO	0 (0 Dec)
60n0.03	Status Set Counter Done	Status bit. Set the count to complete: 1 = in effect 0 = ineffectiveness	BIT	RO	0 (0 Dec)
60n0.04	Status TxPDO State	TxPDO Status bit	BIT	RO	x (x Dec)
60n0.05	Enable vendor calibration	Status bit. Directional reverse monitoring: 1 = reverse 0 = forward	BIT	RO	x (x Dec)
60n0.06	Status_Counter value Out-of-range	Status bit. The counter is overflowed: 1 = overflowed 0 = unoverflowed	BIT	RO	0 (0 Dec)
		Not used	BYTE + BIT2	RO	0x00 + 00
60n0.08	Counter value	Encoder count	DINT	RO	0x00000000. .00000000 (0 Dec)
60n0.09	Latch value	External lock count	DINT	RO	0x00000000. .00000000 (0 Dec)
60n0.0A	Latch Z value	Z phase lock counting value	DINT	RO	0x00000000. .00000000 (0 Dec)

For Channels= 1≤n≤2

RxPDO 0x160n: PDO mapped objects**0x70(n)0 Encoder Control**

Index(hex)	Name	Data	Data type	Marker	Default
70n0.00	Encoder n Control	Maximum Subindex	UINT8	RO	0x07 (7 Dec)
70n0.01	Control_Enable Latch Z	Status bit. Z lock: 1 = enable 0 = not enable	BIT	RW	0 (0 Dec)
70n0.02	Control_Enable Latch on external positive edge	Enable external rise to latch 1 = enable 0 = not enable	BIT	RW	0 (0 Dec)
70n0.03	Control_Set counter	Set count	BIT	RW	0 (0 Dec)
70n0.04	Control_Enable Latch on external negative edge	Enable external rise to latch 1 = enable 0 = not enable	BIT	RW	0 (0 Dec)
70n0.05	Control_Set counter on latch Z	Set the count at the Z phase lock moment	BIT	RW	0 (0 Dec)
		Not used	BYTE + BIT3	RO	0x00 + 000
70n0.07	Set Counter value	Set count	DINT	RW	0x00000000. .00000000 (0 Dec)

For Channels= 1≤n≤2

SDO service data Objects**0x80(n)0 Encoder input settings**

Index(hex)	Name	Data	Data type	Marker	Default
80n0.00	Encoder input settings	Maximum Subindex	UINT8	RO	0x06 (6 Dec)
80n0.01	Enable Z reset	Enable the Latch Z signal to reset the count value	BOOLEAN	RW	0 (0 Dec)
80n0.02	Enable external reset	Enable the external signal to reset the count value	BOOLEAN	RW	0 (0 Dec)
80n0.03	Enable inversion of direction	Enable the encoder to count in the opposite direction: 0 = positive 1 = negative	BOOLEAN	RW	0 (0 Dec)
80n0.04	Evaluation mode	Encoder counting multiplier mode selection: 0 = 4 octave 1 = 2 octave	BOOLEAN	RW	0 (0 Dec)
80n0.05	ENC filter settings	Encoder count filter settings, range 0..15 (default 8)	BIT4	RW	0x8 (8 Dec)
80n0.06	External Latch filter settings	Encoder Latch filter settings, range 0..15 (default 8)	BIT4	RW	0x8 (8 Dec)

For Channels= 1≤n≤2

0xF008 Parameter handling

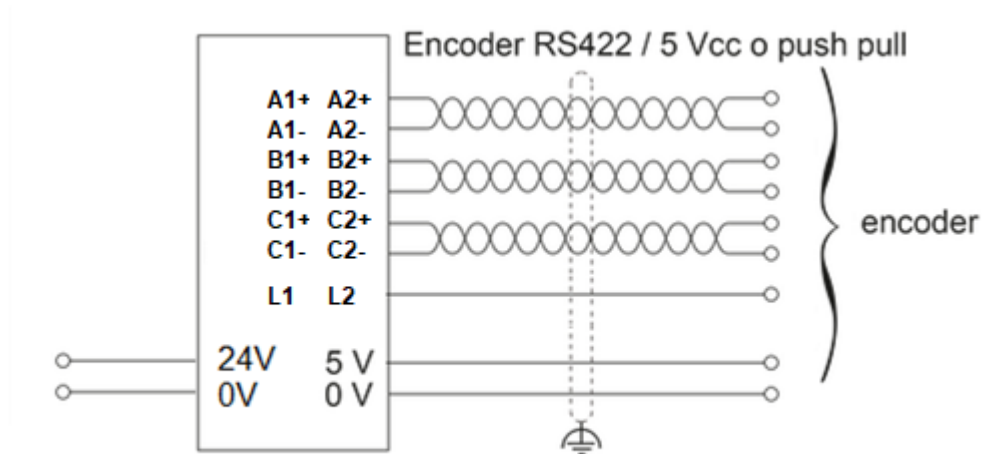
Index(hex)	Name	Data	Data type	Marker	Default
F008.00	Parameter handling	Maximum Subindex	UINT8	RO	0x04 (4 Dec)
F008.01	Save current parameters	Save the current set parameters: • enter code 0x1234 to save the parameters • read the value =0 after saving	UINT16	RW	0x0000 (0 Dec)
F008.02	Restore default parameters	Restore the default set parameters: • enter code 0x1234 to restore parameters • read the value =0 after restoring	UINT16	RW	0x0000 (0 Dec)
F008.03	Checksum	Parameters checksum	UINT16	RO	---
F008.04	Vendor Reserve	Vendor reserved	UINT16	RW	0x0000 (0 Dec)

4 ENCODER COMMUNICATION

The TRM-2ENC module can be connected in this way.

Pay attention! Standard RS422 encoder drive signals are compatible with TRM-2ENC. Also, single ended +5V encoder output signals can be used, but in this condition diagnostic of presence of encoder cables is not running.

Other kinds of encoder's output need to be adapted by external nets of resistors. Diagnostic check of the encoder presence might be lost.



Here is shown the schematic of encoder connection to TRM-2ENC. Signals C1+ (C2+) and C1- (C2-) can be used as Latch signal or Zero Home reference.

Each differential connection is terminated by a 220 Ohm resistor; so, max current is about 20mA. L1 (L2) signal is the external latch or Zero Home reference; it is referred to 0V.

5V power supply pin provides a limited current source for supplying the encoder; max 100mA for single ENC (200mA tot).

5 TRM-2ENC VIEW



TRM-2ENC
Front view



TRM-2ENC
Right side view

