

EncoderSSI - FCT640

Application note

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1. Italiano

1.1. Introduzione

Questa application note ha lo scopo di guidare l'utente alla configurazione di un modulo TB20 SSI con un controllore FCT640, riportando un esempio di utilizzo. Si consiglia di conservare questo documento assieme al prodotto. Per informazioni più complete riguardo al modulo o al controllore, fare riferimento ai documenti disponibili nel sito <http://www.cmz.it> o rivolgersi a CMZ SISTEMI ELETTRONICI S.r.l..

L'esempio riportato nel presente documento consiste nel collegare un Encoder SSI dell'Eltra con codifica Gray a 13bit (8192 impulsi di onda primaria) al Modulo 640-320-7AA01 e provare le varie funzionalità previste dal modulo sul:

1. HBUS del FCT640
2. Coupler EtherCAT

3. Coupler CANopen

1.2. Impostazione “Encoder Type” e “Total Steps of Absolute Encoder”

L'impostazione del tipo di encoder sembra non funzionare in quanto l'unica configurazione ammissibile è "SSI 15 bit" (configurazione di Default).

Se imposto il tipo di encoder a "SSI 13 bit", il led rosso del modulo lampeggia Rosso “parameter assignment error”.

Causa: la non coerenza tra impostazione Encoder “SSI 13 bits” e il parametro “Total steps of Absolute Encoder”

FCT640:

General					
Diagnostic alarm	BOOL		TRUE	FALSE	
Gray-/Dual Converter	Enumeration of USINT		Gray	Gray	
Encoder type	Enumeration of USINT	SSI 13 Bits		SSI 15 Bits	
Total steps of absolut encoder	UDINT(16..2147483648)	SSI 8 Bits		32768	
Number of trailing bits	USINT(0..15)	SSI 9 Bits		0	
Parity	Enumeration of USINT	SSI 10 Bits		None	
Repetition	Enumeration of USINT	SSI 11 Bits		Inactive	
Baud rate	Enumeration of USINT	SSI 12 Bits		125 kHz	
Monoflop time	Enumeration of USINT	SSI 13 Bits		32 µs	
Comparator 1	Enumeration of USINT	SSI 14 Bits		Inactive	
Comparator 2	Enumeration of USINT	SSI 15 Bits		Inactive	
Scaling	BOOL	SSI 16 Bits		FALSE	
Reversal of rotational direction	BOOL	SSI 17 Bits		FALSE	
Latch	Enumeration of USINT	SSI 18 Bits		Inactive	

- Configurazione corretta:

CHZ-HBUS Parameters						CHZ-HBUS I/O Mapping						CHZ-HBUS IEC Objects						Status		Information	
Find						Filter						Show all						Add FB for I/O Channel...		Go to Instance...	
Parameter	Type	Current Value	Prepared Value	Value	Default Value	Unit	Variable	Mapping	Channel	Address	Type	2830	Current Value								
General							Application-PLC_PRG.Counter		Encoder value	%D0.0	BOOL	TRUE									
Diagnostic alarm	BOOL	TRUE	TRUE	TRUE	FALSE			Ready for operation	%D0.1	BOOL	FALSE										
Gray-/Dual Converter	Enumeration of USINT	Gray	Gray	Gray	Gray			Error absolute encoder	%D0.2	BOOL	FALSE										
Encoder type	Enumeration of USINT	SSI 13 Bits	SSI 13 Bits	SSI 13 Bits	SSI 15 Bits			Error auxiliary power supply	%D0.3	BOOL	FALSE										
Total steps of absolut encoder	UDINT(16..2147483648)	8192	8192	8192	32768			Latch-mode active	%D0.4	BOOL	FALSE										
Number of trailing bits	USINT(0..15)	0	0	0	0			Status DI	%D0.5	BOOL	FALSE										
Parity	Enumeration of USINT	None	None	None	None			Status DN	%D0.6	BOOL	FALSE										
Repetition	Enumeration of USINT	Inactive	Inactive	Inactive	Inactive			Status LP	%D0.7	BOOL	FALSE										
Baud rate	Enumeration of USINT	125 kHz	125 kHz	125 kHz	125 kHz			Comparison value 1 reached	%D0.8	BOOL	FALSE										
Monoflop time	Enumeration of USINT	32 µs	32 µs	32 µs	32 µs			Comparison value 2 reached	%D0.9	BOOL	FALSE										
Comparator 1	Enumeration of USINT	Forward direction	Forward direction	Forward direction	Inactive			Load function error	%D0.10	BOOL	FALSE										
Comparator 2	Enumeration of USINT	Forward direction	Forward direction	Forward direction	Inactive			Load function running	%D0.11	BOOL	FALSE										
Scaling	BOOL	FALSE	FALSE	FALSE	FALSE			Comparison value 1 or 2	%D0.12	BOOL	FALSE										
Reversal of rotational direction	BOOL	FALSE	FALSE	FALSE	FALSE			Acknowledgement of error	%D0.13	BOOL	FALSE										
Latch	Enumeration of USINT	With rising edge DI	With rising edge DI	With rising edge DI	Inactive			Acknowledgement of latch-mode	%D0.14	BOOL	FALSE										
								Load comparison value 1	%D0.15	BOOL	FALSE										
								Load comparison value 2	%D0.16	BOOL	FALSE										

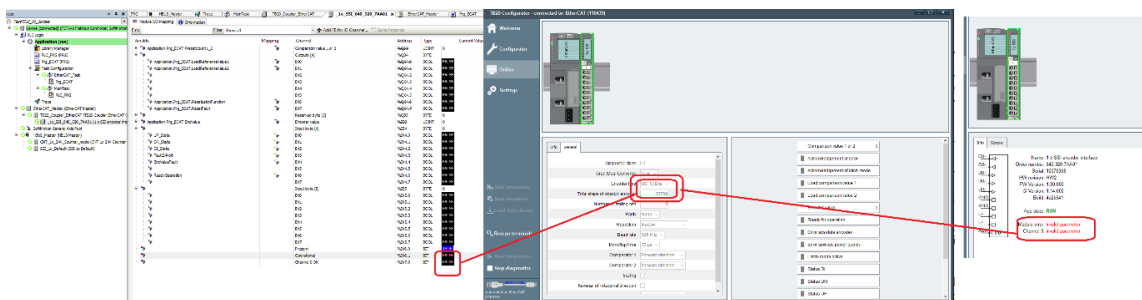
- Configurazione errata, il modulo non funziona, il led rosso è acceso e a livello IEC non viene riportata nessuna info:

Parameter	Type	Current Value	Prepared Value	Value	Default Value	Unit	Variable	Mapping	Channel	Address	Type	Current Value
Diagnostic alarm	BOOL	TRUE	TRUE	TRUE	FALSE		Application.PLC_PRG.Counter	Encoder value	Ready for operation	%QW0.0	BOOL	FALSE
Gray-Dual Converter	Enumeration of USINT	Gray	Gray	Gray	Gray			Error auxiliary power supply	Error absolute encoder	%QW0.1	BOOL	FALSE
Encoder Type	Enumeration of USINT	SSI 13 Bit	SSI 13 Bit	SSI 13 Bit	SSI 13 Bit			Latch-mode active	Status DI	%QW0.2	BOOL	FALSE
Total steps of absolute encoder	UDINT(16...2147483648)	32768	32768	32768	32768			Status DI	Status DI	%QW0.3	BOOL	FALSE
Number of trailing bits	USINT(0...15)	0	0	0	0			Status DI	Status DI	%QW0.4	BOOL	FALSE
Parity	Enumeration of USINT	None	None	None	None			Status DI	Status DI	%QW0.5	BOOL	FALSE
Repetition	Enumeration of USINT	Inactive	Inactive	Inactive	Inactive			Status DI	Status DI	%QW0.6	BOOL	FALSE
Baud rate	Enumeration of USINT	125 kHz	125 kHz	125 kHz	125 kHz			Comparison value 1 reached	Comparison value 1 reached	%QW0.7	BOOL	FALSE
Monitor time	Enumeration of USINT	32 µs	32 µs	32 µs	32 µs			Comparison value 2 reached	Comparison value 2 reached	%QW0.8	BOOL	FALSE
Comparator 1	Enumeration of USINT	Forward direction	Forward direction	Forward direction	Inactive			Load function error	Load function error	%QW0.9	BOOL	FALSE
Comparator 2	Enumeration of USINT	Forward direction	Forward direction	Forward direction	Inactive			Load function running	Load function running	%QW0.10	BOOL	FALSE
Scaling	BOOL	FALSE	FALSE	FALSE	FALSE			Comparison value 1 or 2	Comparison value 1 or 2	%QW0.11	UDINT	0
Reversal of rotational direction	BOOL	FALSE	FALSE	FALSE	FALSE			Acknowledgement of error	Acknowledgement of error	%QW0.12	BOOL	FALSE
Latch	Enumeration of USINT	With rising edge DI	With rising edge DI	With rising edge DI	Inactive			Acknowledgement of latch-mode	Acknowledgement of latch-mode	%QW0.13	BOOL	FALSE
								Load comparison value 1	Load comparison value 1	%QW0.14	BOOL	FALSE
								Load comparison value 2	Load comparison value 2	%QW0.15	BOOL	FALSE

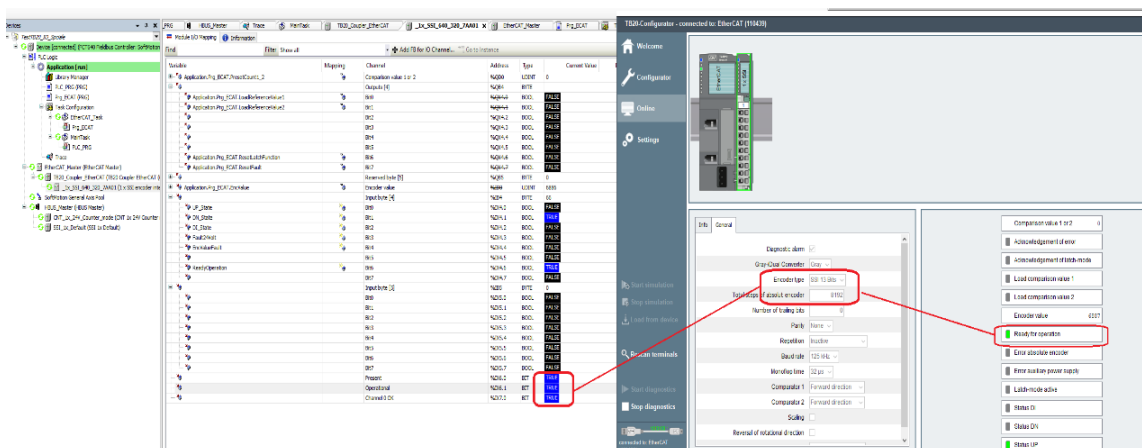
Coupler EtherCAT:

Per eseguire una corretta configurazione il valore di “Encoder Type” deve essere coerente con il “Total steps of absolute encoder”; in pratica il valore del parametro “total step absolute encoder” deve essere inferiore o uguale al massimo numero codificabile dall’Encoder Type.
Esempio: 13bit -> max codifica 8192 e non 32768.

- Configurazione corretta:



- Configurazione errata:



Coupler CANopen:

Vedere [Section 1.6, “Configurazione via CANopen”](#)

1.3. Reset della Quota Encoder

Tramite un ingresso si attiva la funzione di Reset Quota Encoder, dopo questa azione il modulo va in errore (il led Blu diventa Rosso Fisso) la quota encoder si resetta e rimane congelata finché non si resetta l'errore tramite il bit Acknowledgement of Error (vedere [Section 1.5, “Variabili per il Reset dei fault”](#)).

FCT640:

Variable	Mapping	Channel	Address	Type	Current
Application.PLC_Count		Encoder value	%I0.0	BOOL	FALSE
Ready for operation		%I0.1	BOOL	FALSE	
Error absolute encoder		%I0.2	BOOL	TRUE	
Error auxiliary power supply		%I0.3	BOOL	FALSE	
Latch-mode active		%I0.4	BOOL	FALSE	
Status DI		%I0.5	BOOL	FALSE	
Status DI		%I0.6	BOOL	FALSE	
Comparison value 1 reached		%I0.7	BOOL	FALSE	
Comparison value 2 reached		%I0.8	BOOL	FALSE	
Load function error		%I0.9	BOOL	FALSE	
Load function running		%I0.10	BOOL	FALSE	
Comparison value 1 or 2		%I0.11	BOOL	FALSE	
Acknowledgement of error		%I0.12	BOOL	FALSE	
Acknowledgement of latch-mode		%I0.13	BOOL	FALSE	
Load comparison value 1		%I0.14	BOOL	FALSE	
Load comparison value 2		%I0.15	BOOL	FALSE	

Coupler EtherCAT:

Variable	Mapping	Channel	Address	Type	Current
Application.PLC_Count		Encoder value	%I0.0	BOOL	FALSE
Ready for operation		%I0.1	BOOL	FALSE	
Error absolute encoder		%I0.2	BOOL	TRUE	
Error auxiliary power supply		%I0.3	BOOL	FALSE	
Latch-mode active		%I0.4	BOOL	FALSE	
Status DI		%I0.5	BOOL	FALSE	
Status DI		%I0.6	BOOL	FALSE	
Comparison value 1 reached		%I0.7	BOOL	FALSE	
Comparison value 2 reached		%I0.8	BOOL	FALSE	
Load function error		%I0.9	BOOL	FALSE	
Load function running		%I0.10	BOOL	FALSE	
Comparison value 1 or 2		%I0.11	BOOL	FALSE	
Acknowledgement of error		%I0.12	BOOL	FALSE	
Acknowledgement of latch-mode		%I0.13	BOOL	FALSE	
Load comparison value 1		%I0.14	BOOL	FALSE	
Load comparison value 2		%I0.15	BOOL	FALSE	

1.4. Cattura Quota

Dopo un fronte sull'ingresso di cattura quota:

FCT640:

L'avvenuta cattura si notifica tramite il bit "Latch-mode Active", inoltre il bit 31 del Encoder Value si setta a TRUE ("sporcando" la quota dell'Encoder).

La quota Encoder rimane congelata finché non si setta il bit "Acknowledgement of latch-mode" (vedere [Section 1.5, "Variabili per il Reset dei fault"](#)).

Variable	Mapping	Channel	Address	Type	Current Value
Application.PLC_PRG.Counter		Encoder value	%ID2	UDINT	2147483648
		Ready for operation	%IX12.0	BOOL	TRUE
		Error absolute encoder	%IX12.1	BOOL	FALSE
		Error auxiliary power supply	%IX12.2	BOOL	FALSE
		Latch-mode active	%IX12.3	BOOL	TRUE
		Status DI	%IX12.4	BOOL	FALSE
		Status DN	%IX12.5	BOOL	TRUE
		Status UP	%IX12.6	BOOL	FALSE
		Comparison value 1 reached	%IX12.7	BOOL	FALSE
		Comparison value 2 reached	%IX13.0	BOOL	FALSE
		Load function error	%IX13.1	BOOL	FALSE
		Load function running	%IX13.2	BOOL	FALSE
		Comparison value 1 or 2	%QD2	UDINT	0
		Acknowledgement of error	%QX12.0	BOOL	FALSE
		Acknowledgement of latch-mode	%QX12.1	BOOL	FALSE
		Load comparison value 1	%QX12.2	BOOL	FALSE
		Load comparison value 2	%QX12.3	BOOL	FALSE

Coupler EtherCAT:

La quota Encoder rimane congelata finché non si setta il bit "Acknowledgement of latch-mode" (vedere [Section 1.5, "Variabili per il Reset dei fault"](#)).

Non è presente il bit "Latch-mode Active", ma solo il bit 31 della Encoder Value.

The screenshot shows the TIA Portal software interface for configuring an EtherCAT coupler. The 'Mapping' table is visible, showing the mapping of variables to channels and addresses. A red box highlights the 'Bit 31 -> DN' mapping. The 'Info' tab on the right shows the 'Encoder value' and 'Latch-mode active' status.

Variable	Mapping	Channel	Address	Type	Current Value
Application.PLC_PRG.Counter		Encoder value	%ID2	UDINT	2147483648
		Ready for operation	%IX12.0	BOOL	TRUE
		Error absolute encoder	%IX12.1	BOOL	FALSE
		Error auxiliary power supply	%IX12.2	BOOL	FALSE
		Latch-mode active	%IX12.3	BOOL	TRUE
		Status DI	%IX12.4	BOOL	FALSE
		Status DN	%IX12.5	BOOL	TRUE
		Status UP	%IX12.6	BOOL	FALSE
		Comparison value 1 reached	%IX12.7	BOOL	FALSE
		Comparison value 2 reached	%IX13.0	BOOL	FALSE
		Load function error	%IX13.1	BOOL	FALSE
		Load function running	%IX13.2	BOOL	FALSE
		Comparison value 1 or 2	%QD2	UDINT	0
		Acknowledgement of error	%QX12.0	BOOL	FALSE
		Acknowledgement of latch-mode	%QX12.1	BOOL	FALSE
		Load comparison value 1	%QX12.2	BOOL	FALSE
		Load comparison value 2	%QX12.3	BOOL	FALSE

1.5. Variabili per il Reset dei fault

FCT640 e Coupler EtherCAT

La struttura delle variabili è già precompilata. È importante notare che le variabili di reset dei fault nelle strutture dati precompilate hanno nomi diversi rispetto ai nomi riportati nei manuali dei moduli.

Questi ultimi si chiamano "Reset fault" e "Reset latch function", mentre nella struttura precompilata nell'FCT640 e nel Coupler EtherCAT si chiamano rispettivamente "Acknowledgment of error" e "Acknowledgment of latch-mode".

Status IEC	Variable	BOOL	Value
Status UP	%IX12.6	BOOL	FALSE
Comparison value 1 reached	%IX12.7	BOOL	FALSE
Comparison value 2 reached	%IX13.0	BOOL	FALSE
Load function error	%IX13.1	BOOL	FALSE
Load function running	%IX13.2	BOOL	FALSE
Comparison value 1 or 2	%QD2	UDINT	0
Acknowledgment of error	%QX12.0	BOOL	FALSE
Acknowledgment of latch-mode	%QX12.1	BOOL	FALSE
Load comparison value 1	%QX12.2	BOOL	FALSE
Load comparison value 2	%QX12.3	BOOL	FALSE

Reset fault

 This bit is used to reset the aforementioned faults/errors.

Reset latch function

 This bit is used to reset the latch function.

Load reference value 2

 This bit is used to start transmitting the preset count (from bytes 0 to 3) to comparator 2.

Load reference value 1

 This bit is used to start transmitting the preset count (from bytes 0 to 3) to comparator 1.

Coupler CANopen

La struttura delle variabili è definita dall'utente, quindi anche il loro nome. Viene riportato un esempio in [Section 1.6, "Configurazione via CANopen"](#).

1.6. Configurazione via CANopen

- Per la lettura dell'encoder ed il monitor dello stato della periferica da CODESYS, serve fare il mapping sul TPD come in figura:

Name	Object	Bit length
<input checked="" type="checkbox"/> 16#1800: Transmit PDO Communication Parameter 1	16#181 (\$NODEID+16#180)	64
Digital Input 1	16#1800:16#01	8
Digital Input 2	16#1800:16#02	8
SSI_EncValue	16#2101:16#01	32
SSI_State1	16#2101:16#02	8
SSI_State2	16#2101:16#03	8

Mappare le variabili IEC, come in figura:

EncSSI		SSI_EncValue	%ID4	DWORD
		SSI_State1	%IB20	BYTE
UpState		Bit0	%IX20.0	BOOL
DnState		Bit1	%IX20.1	BOOL
DiState		Bit2	%IX20.2	BOOL
Fault24V		Bit3	%IX20.3	BOOL
EncoderFault		Bit4	%IX20.4	BOOL
ReadyXOp		Bit5	%IX20.5	BOOL
		Bit6	%IX20.6	BOOL
		Bit7	%IX20.7	BOOL
		SSI_State2	%IB21	BYTE
LoadRun		Bit0	%IX21.0	BOOL
LoadError		Bit1	%IX21.1	BOOL
Comp2State		Bit2	%IX21.2	BOOL
Comp1State		Bit3	%IX21.3	BOOL
		Bit4	%IX21.4	BOOL
		Bit5	%IX21.5	BOOL
		Bit6	%IX21.6	BOOL
		Bit7	%IX21.7	BOOL

Input space length: 6 bytes

	7	6	5	4	3	2	1	0	
Bytes0-3	Bits 0-30 = Encoder value; bit 31 = Latch active								16#2101.1
Byte 4	Reserved	Ready for operation	Reserved	Encoder value fault	24-V encoder supply fault	DI state	DN state	UP state	16#2101.2
Byte 5	Reserved	Reserved	Reserved	Reserved	Comparator 1 state	Comparator 2 state	Loading function error	Loading function running	16#2101.3

Encoder value

Bytes 0 to 3 contain the current encoder value and a bit indicating whether the latch function is active. More specifically, bits 0 to 30 contain the current encoder value and bit 31 indicates that the encoder value is a stored value / that the latch function is active.

Ready for operation

Byte 4, bit 6 is used to signal that the TB20 SSI module is ready for operation, i.e., that communications between the module and the connected encoder are OK.

Absolute encoder fault

Byte 4, bit 4 is used to signal faults such as wire breaks and parity errors detected when communicating with the absolute encoder. The corresponding fault needs to be reset before the module can be used.

24-V encoder supply fault

Byte 4, bit 3 is used to signal faults in the 24-V encoder supply.

The corresponding fault needs to be reset before the module can be used.

DI state

Byte 4, bit 2 is used to signal the state of the latch function's digital input.

DN state

Byte 4, bit 1 is used to signal a negative direction of movement.

UP state

Byte 4, bit 0 is used to signal a positive direction of movement.

Comparator 1 state

Byte 5, bit 3 is used to signal the state of comparator 1 (please refer to 8.1.6).

Comparator 2 state

Byte 5, bit 2 is used to signal the state of comparator 2 (please refer to 8.1.6).

Loading function error

Byte 5, bit 1 is used to indicate that an error occurred when attempting to execute the loading function. To eliminate the error bits "load reference value 2" and "load reference value 1" (output byte 4, bits 0 and 1) are to be set to 0.

Loading function running

Byte 5, bit 0 is used to signal that the loading function is active.

- Per gestire la periferica, il Reset Fault, l'attivazione del trigger ed il Reset Latch della quota, serve mappare l'RPD come in figura:

Receive PDOs (Master => Slave)		
+ Add PDO + Add Mapping Edit Delete Move Up Move Down		
Name	Object	Bit length
<input checked="" type="checkbox"/> 16#1400: Receive PDO Communication Parameter 1	16#201 (\$NODEID+16#200)	64
Digital Output Bit 1	16#0200:16#01	8
Digital Output Byte 2	16#0200:16#02	8
Digital Output Byte 3	16#0200:16#03	8
SSI_PresetCount	16#2201:16#01	32
SSI_CtrlByte	16#2201:16#02	8

Assegnare l'indirizzo alle variabili IEC come in figura:

SSI_SetQuota		SSI_PresetCount	%QD3	DWORD
		SSI_CtrlByte	%QB16	BYTE
LoadRefValue1		Bit0	%QX16.0	BOOL
LoadRefValue2		Bit1	%QX16.1	BOOL
		Bit2	%QX16.2	BOOL
		Bit3	%QX16.3	BOOL
		Bit4	%QX16.4	BOOL
		Bit5	%QX16.5	BOOL
ResetLatch		Bit6	%QX16.6	BOOL
ResetFault		Bit7	%QX16.7	BOOL

Output space length: 6 bytes

	7	6	5	4	3	2	1	0	
Bytes 0-3	Preset count for reference value 1 or 2								16#2201.1
Byte 4	Reset fault	Reset latch function	Reserved	Reserved	Reserved	Reserved	Load reference value 2	Load reference value 1	16#2201.2
Byte 5	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	

Preset count for reference value Used to specify the count that will be used as a reference value by the comparator.

Reset fault This bit is used to reset the aforementioned faults/errors.

Reset latch function This bit is used to reset the latch function.

Load reference value 2 This bit is used to start transmitting the preset count (from bytes 0 to 3) to comparator 2.

Load reference value 1 This bit is used to start transmitting the preset count (from bytes 0 to 3) to comparator 1.

- Per cambiare la configurazione del Modulo di acquisizione dell'Encoder_SSI si può procedere in due modi:

Info	Extended	General
Diagnostic alarm <input type="checkbox"/>		
Gray-/Dual Converter		Gray ▾
Encoder type		SSI 15 Bits ▾
Total steps of absolut encoder		32768
Number of trailing bits		0
Parity		None ▾
Repetition		Inactive ▾
Baud rate		125 kHz ▾
Monoflop time		32 μ s ▾
Comparator 1		Inactive ▾
Comparator 2		Inactive ▾
Scaling		<input type="checkbox"/>
Reversal of rotational direction		<input type="checkbox"/>
Latch		Inactive ▾

1. Tramite ToolBOX:

- a. Creare un progetto con tutti i moduli I/O presenti.
- b. Andare nella tab di configurazione del modulo SSI e cambiarla:
 - i. Salvando il file EDS --> importarlo in CODESYS
 - ii. Salvando nel Coupler CANopen la configurazione appena fatta



Note

Scegliere una delle due vie: salvataggio dei parametri nel nodo oppure importazione tramite file EDS.

2. Tramite SDO:

alla fine della fase di inizializzazione del modulo è possibile, in CODESYS, scaricare nel nodo tramite SDO una lista di parametri. Grazie a questa procedura si può modificare l'impostazione della scheda SSI.

15	16#3001:16#01	Module Slot 1 Parameter 1	1	8	
16	16#3001:16#02	Module Slot 1 Parameter 2	13	8	
17	16#3001:16#03	Module Slot 1 Parameter 3	8192	32	
18	16#3001:16#04	Module Slot 1 Parameter 4	0	8	
19	16#3001:16#05	Module Slot 1 Parameter 5	1	8	
20	16#3001:16#06	Module Slot 1 Parameter 6	17	8	
21	16#3001:16#07	Module Slot 1 Parameter 7	129	8	

Per come comporre i vari parametri di configurazione, riferirsi alla seguente tabella:

Byte	7	6	5	4	3	2	1	0	
0	Operating mode								16#3001.1
1	Encoder value coding	Encoder value bit width							16#3001.2
2-5	Total number of encoder steps								16#3001.3
6	Multiple transmission		Parity		Number of appended bits				16#3001.4
7	Baud rate				Monostable multivibrator time period				16#3001.5
8	Comparator 2 mode				Comparator 1 mode				16#3001.6
9	Diagnosis alarm	Reserved	Reserved	Reserved	Normalization	Direction reversal	Latch		16#3001.7

Operating mode

1 = Operating mode 1

Encoder value coding

0 = Gray code; 1 = Natural binary code

Encoder value bit width

0 = No encoder

8 = 8 bits / 9 = 9 bits / ... / 15 = 15 bits / ... / 31 = 31 bits (with no parity bit)

Total number of encoder steps (16 - 2³¹); (16, ..., 32768, ..., 2147483648)

Multiple transmission

0 = No multiple transmission

1-3 = Multiple transmission with 1-3 idle cycles

Parity bit

0 = None; 1 = Odd; 2 = Even

Number of appended bits

0 bits-15 bits

Baud rate/Clock frequency

0 = 125 kHz; 1 = 250 kHz; 2 = 500 kHz; 3 = 1 MHz;

4 = 1.5 MHz; 5 = 2 MHz

Monostable multivibrator time period 0 = 16 µs; 1 = 32 µs; 2 = 48 µs; 3 = 64 µs

Comparator 1/2 mode

0 = Disabled; 1 = Forward direction; 2 = Reverse direction; 3 = Both directions

Diagnosis alarm

0 = Disabled; 1 = Enabled

Normalization

0 = Disabled; 1 = Enabled

Direction reversal

0 = Disabled; 1 = Enabled

Latch

0 = Disabled; 1 = Rising edge at DI;

2 = Falling edge at DI; 3 = Both edges at DI

1.7. Risoluzione dei problemi

1. Non viene inviato il TPDO della quota:
 - a. Verificare che il PDO mapping sia impostato a 255
 - b. Ristabilire la configurazione di default del Nodo TB20 Coupler tramite ToolBox

2. Non funziona il latch della quota e/o non si attiva il comparatore di quota:
 - a. Verificare/modificare le impostazioni di default del Modulo

3. L'encoder SSI dell'Eltra prevede un ingresso per resettare la quota. Quando si esegue il reset tramite questo ingresso dell'encoder, il modulo di acquisizione SSI va in errore (probabilmente a fronte di un "salto" di quota). Lo stato di errore del modulo si resetta tramite il bit7 della cella CAN 16#2201.2.

2. English

2.1. Introduction

The purpose of this application note is to help the user to configure a TB20 SSI module with a FCT640 controller, showing an application example. It is recommended to save this product with the product. For more complete information about the module or the controller, please refer to the documents that are available in the <http://www.cmz.it> website or contact CMZ SISTEMI ELETTRONICI S.r.l..

The example that is reported in this document consist of the connection of an Encoder SSI of Eltra with 13bit Gray code (8192 pulses in primary wave) to the 640-320-7AA01 Module and try the various functionalities, that are provided by the module, on:

1. HBUS of FCT640
2. Coupler EtherCAT
3. Coupler CANopen

2.2. Setting of "Encoder Type" and "Total Steps of Absolute Encoder"

The setting of the encoder type seems not to work because the only admissible configuration is SSI 15 bit (Default configuration).

If the SSI 13 bit is set, the red led of the module blinks Red "parameter assignment error".

Cause: the not coherence between the Encoder "SSI 13 bits" setting and the "Total steps of Absolute Encoder" parameter

FCT640:

General			
Diagnostic alarm	BOOL	TRUE	FALSE
Gray-/Dual Converter	Enumeration of USINT	Gray	Gray
Encoder type	Enumeration of USINT	SSI 13 Bits	SSI 15 Bits
Total steps of absolut encoder	UDINT(16..2147483648)	SSI 8 Bits	32768
Number of trailing bits	USINT(0..15)	SSI 9 Bits	0
Parity	Enumeration of USINT	SSI 10 Bits	None
Repetition	Enumeration of USINT	SSI 11 Bits	Inactive
Baud rate	Enumeration of USINT	SSI 12 Bits	125 kHz
Monoflop time	Enumeration of USINT	SSI 13 Bits	32 µs
Comparator 1	Enumeration of USINT	SSI 14 Bits	Inactive
Comparator 2	Enumeration of USINT	SSI 15 Bits	Inactive
Scaling	BOOL	SSI 16 Bits	FALSE
Reversal of rotational direction	BOOL	SSI 17 Bits	FALSE
Latch	Enumeration of USINT	SSI 18 Bits	Inactive

- Correct configuration:

CHZ-HBUS Parameters							CHZ-HBUS I/O Mapping							CHZ-HBUS IEC 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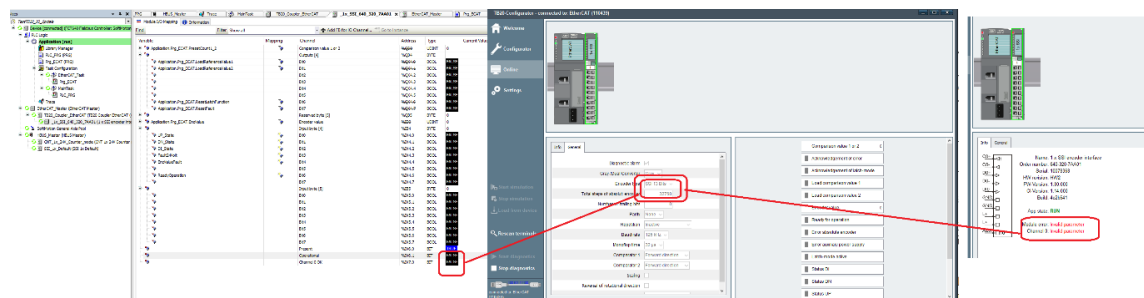
- Wrong configuration, the module doesn't work, the red led is on and at IEC level no info is reported:

CHZ-HBUS Parameters						CHZ-HBUS I/O Mapping						CHZ-HBUS IEC Objects																	
Status						Information						Status						Information											
Find						Filter						Show all						Add FB for IO Channel...						Go to Instance					
Parameter	Type	Current Value	Prepared Value	Value	Default Value	Unit	Variable	Mapping	Channel	Address	Type	Current Value																	
General																													
Diagnostic alarm	BOOL	TRUE	TRUE	TRUE	FALSE		Application_PLC_Counter	Encoder value	%QW4	UDINT	0	FALSE																	
Gray-/Dual Converter	Enumeration of USINT	Gray	Gray	Gray	Gray			Ready for operation	%QW0.0	BOOL	FALSE	FALSE																	
Encoder type	Enumeration of USINT	SSI 13 Bits	SSI 13 Bits	SSI 13 Bits	SSI 15 Bits			Error absolute encoder	%QW0.1	BOOL	FALSE	FALSE																	
Total steps of absolut encoder	UDINT(16..2147483648)	32768	32768	32768	32768			Error auxiliary power supply	%QW0.2	BOOL	FALSE	FALSE																	
Number of trailing bits	USINT(0..15)	0	0	0	0			Latch-mode active	%QW0.3	BOOL	FALSE	FALSE																	
Parity	Enumeration of USINT	None	None	None	None			Status DI	%QW0.4	BOOL	FALSE	FALSE																	
Repetition	Enumeration of USINT	Inactive	Inactive	Inactive	Inactive			Status DN	%QW0.5	BOOL	FALSE	FALSE																	
Baud rate	Enumeration of USINT	125 kHz	125 kHz	125 kHz	125 kHz			Status LP	%QW0.6	BOOL	FALSE	FALSE																	
Monoflop time	Enumeration of USINT	32 µs	32 µs	32 µs	32 µs			Comparison value 1 reached	%QW0.7	BOOL	FALSE	FALSE																	
Comparator 1	Enumeration of USINT	Forward direction	Forward direction	Forward direction	Inactive			Comparison value 2 reached	%QW0.8	BOOL	FALSE	FALSE																	
Comparator 2	Enumeration of USINT	Forward direction	Forward direction	Forward direction	Inactive			Load function error	%QW1.0	BOOL	FALSE	FALSE																	
Scaling	BOOL	FALSE	FALSE	FALSE	FALSE			Load function running	%QW1.1	BOOL	FALSE	FALSE																	
Reversal of rotational direction	BOOL	FALSE	FALSE	FALSE	FALSE			Comparison value 1 or 2	%QW1.2	UDINT	0	FALSE																	
Latch	Enumeration of USINT	With rising edge DI	With rising edge DI	With rising edge DI	Inactive			Acknowledgement of error	%QW2.0	BOOL	FALSE	FALSE																	
								Acknowledgement of latch-mode	%QW2.1	BOOL	FALSE	FALSE																	
								Load comparison value 1	%QW2.2	BOOL	FALSE	FALSE																	
								Load comparison value 2	%QW2.3	BOOL	FALSE	FALSE																	

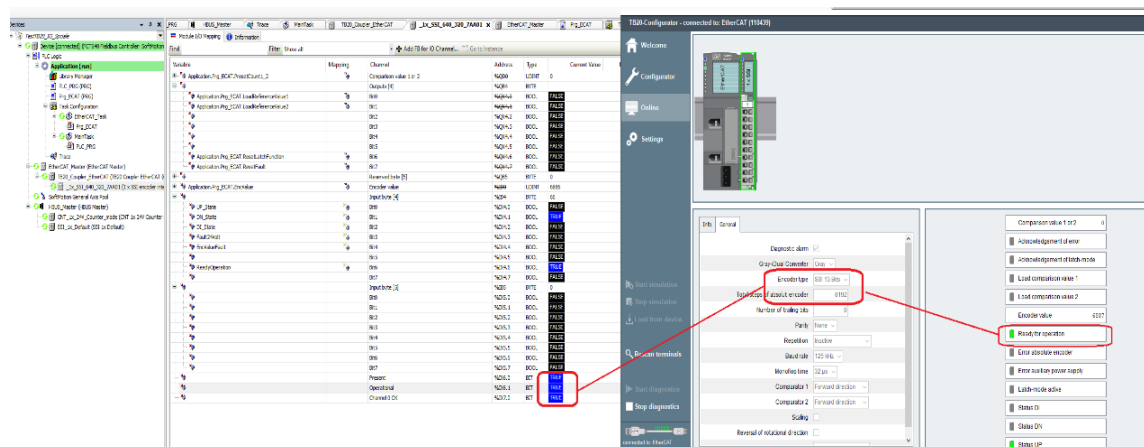
Coupler EtherCAT:

To follow a correct configuration the “Encoder Type” value must be coherent with the “Total steps of absolute encoder”; in other words, the value of the “total step absolute encoder” parameter must be lower or equal to the maximum number that can be encoded by the Encoder Type. Example: 13bit -> max encoding 8192 and not 32768.

- Correct configuration:



- Wrong configuration:



Coupler CANopen:

See [Section 2.6, “Configuration via CANopen”](#)

2.3. Encoder Position Reset

Through an input it can be activated the Encoder Position Reset function, after this action the module returns an error (the Blue led becomes Red ON fixed), the encoder position resets and remains “frozen” until the error is reset through the bit Acknowledgement of Error (see [Section 2.5, “Variables for the fault Reset”](#)).

FCT640:

Variable	Mapping	Channel	Address	Type	Current
Application.PLC_PRG.Counter		Encoder value	%N20.1	UDINT	0
		Ready for operation	%N20.0	BOOL	FALSE
		Error absolute encoder	%N20.1	BOOL	TRUE
		Error auxiliary power supply	%N20.2	BOOL	FALSE
		Latch-mode active	%N20.3	BOOL	FALSE
		Status DI	%N20.4	BOOL	FALSE
		Status DI	%N20.5	BOOL	FALSE
		Status UP	%N20.6	BOOL	FALSE
		Comparison value 1 reached	%N20.7	BOOL	FALSE
		Comparison value 2 reached	%N21.0	BOOL	FALSE
		Load function error	%N21.1	BOOL	FALSE
		Load function running	%N21.2	BOOL	FALSE
		Comparison value 1 or 2	%N21.3	UDINT	0
		Acknowledgement of error	%N20.0	BOOL	FALSE
		Acknowledgement of latch-mode	%N20.1	BOOL	FALSE
		Load comparison value 1	%N20.2	BOOL	FALSE
		Load comparison value 2	%N20.3	BOOL	FALSE

Coupler EtherCAT:

Variable	Mapping	Channel	Address	Type	Current
Application.PLC_PRG.Counter		Encoder value	%N20.1	UDINT	0
		Ready for operation	%N20.0	BOOL	FALSE
		Error absolute encoder	%N20.1	BOOL	TRUE
		Error auxiliary power supply	%N20.2	BOOL	FALSE
		Latch-mode active	%N20.3	BOOL	FALSE
		Status DI	%N20.4	BOOL	FALSE
		Status DI	%N20.5	BOOL	FALSE
		Status UP	%N20.6	BOOL	FALSE
		Comparison value 1 reached	%N20.7	BOOL	FALSE
		Comparison value 2 reached	%N21.0	BOOL	FALSE
		Load function error	%N21.1	BOOL	FALSE
		Load function running	%N21.2	BOOL	FALSE
		Comparison value 1 or 2	%N21.3	UDINT	0
		Acknowledgement of error	%N20.0	BOOL	FALSE
		Acknowledgement of latch-mode	%N20.1	BOOL	FALSE
		Load comparison value 1	%N20.2	BOOL	FALSE
		Load comparison value 2	%N20.3	BOOL	FALSE

2.4. Position Capture

After a signal edge on the position capture input:

FCT640:

The capture happening is reported by the bit "Latch-mode Active" bit, furthermore the bit 31 of the Encoder Value is set to TRUE ("dirtying" the Encoder position).

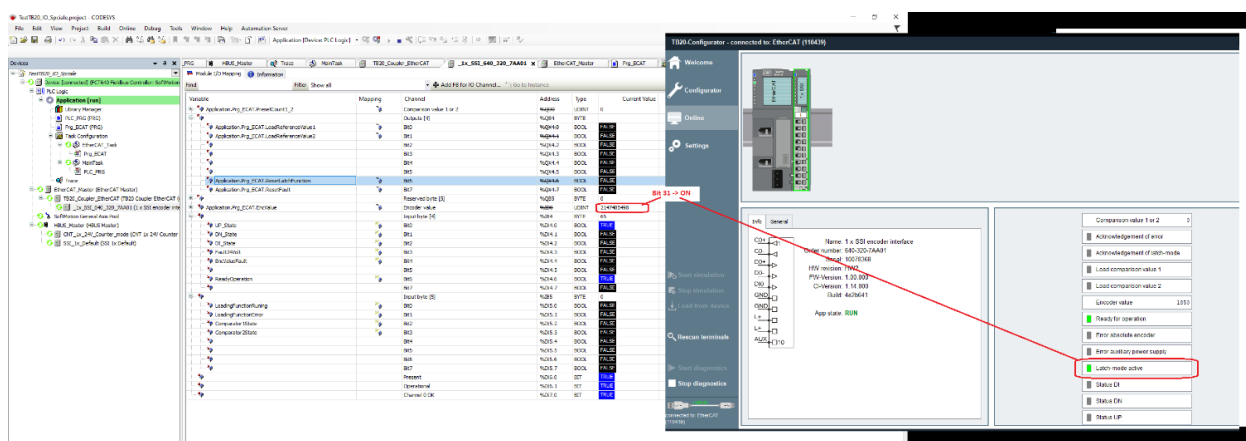
The Encoder position remains "frozen" until the bit "Acknowledgement of latch-mode bit" is set (see [Section 2.5, "Variables for the fault Reset"](#)).

Variable	Mapping	Channel	Address	Type	Current Value
Application.PLC_PRG.Counter		Encoder value	%ID2	UDINT	2147483648
		Ready for operation	%IX12.0	BOOL	TRUE
		Error absolute encoder	%IX12.1	BOOL	FALSE
		Error auxiliary power supply	%IX12.2	BOOL	FALSE
		Latch-mode active	%IX12.3	BOOL	TRUE
		Status DI	%IX12.4	BOOL	FALSE
		Status DN	%IX12.5	BOOL	TRUE
		Status UP	%IX12.6	BOOL	FALSE
		Comparison value 1 reached	%IX12.7	BOOL	FALSE
		Comparison value 2 reached	%IX13.0	BOOL	FALSE
		Load function error	%IX13.1	BOOL	FALSE
		Load function running	%IX13.2	BOOL	FALSE
		Comparison value 1 or 2	%QD2	UDINT	0
		Acknowledgement of error	%QX12.0	BOOL	FALSE
		Acknowledgement of latch-mode	%QX12.1	BOOL	FALSE
		Load comparison value 1	%QX12.2	BOOL	FALSE
		Load comparison value 2	%QX12.3	BOOL	FALSE

Coupler EtherCAT:

The Encoder position remains "frozen" until the bit "Acknowledgement of latch-mode bit" is set (see [Section 2.5, "Variables for the fault Reset"](#)).

It is not present the "Latch-mode Active" bit, but only the bit 31 of the Encoder Value.



2.5. Variables for the fault Reset

FCT640 and Coupler EtherCAT

The variables structure is pre-compiled. It is important to notice that the fault reset variables in the pre-compiled data structures have different names compared to the names reported in the modules manuals.

The latter are called "Reset fault" and "Reset latch function", while in the pre-compiled structure in the FCT640 and in the Coupler EtherCAT that are called respectively "Acknowledgment of error" and "Acknowledgment of latch-mode".

Status UP	%IX12.5	BOOL	TRUE
Comparison value 1 reached	%IX12.6	BOOL	FALSE
Comparison value 2 reached	%IX13.0	BOOL	FALSE
Load function error	%IX13.1	BOOL	FALSE
Load function running	%IX13.2	BOOL	FALSE
Comparison value 1 or 2	%QD2	UDINT	0
Acknowledgement of error	%QX12.0	BOOL	FALSE
Acknowledgement of latch-mode	%QX12.1	BOOL	FALSE
Load comparison value 1	%QX12.2	BOOL	FALSE
Load comparison value 2	%QX12.3	BOOL	FALSE

Reset fault

This bit is used to reset the aforementioned faults/errors.

Reset latch function

This bit is used to reset the latch function.

Load reference value 2

This bit is used to start transmitting the preset count (from bytes 0 to 3) to comparator 2.

Load reference value 1

This bit is used to start transmitting the preset count (from bytes 0 to 3) to comparator 1.

Coupler CANopen

The structure of the variables is defined by the user, so even their name. An example is reported in [Section 2.6, "Configuration via CANopen"](#).

2.6. Configuration via CANopen

- For the encoder reading and the monitor of the peripheral status from CODESYS, the mapping on TPD must be done as shown in the following picture:

Name	Object	Bit length
<input checked="" type="checkbox"/> 16#1800: Transmit PDO Communication Parameter 1	16#181 (\$NODEID+16#180)	64
Digital Input 1	16#5000:16#01	8
Digital Input 2	16#5000:16#02	8
SSI_EncValue	16#2101:16#01	32
SSI_State1	16#2101:16#02	8
SSI_State2	16#2101:16#03	8

IEC variables mapping, as shown in the following picture:

+	EncSSI		SSI_EncValue	%ID4	DWORD
=			SSI_State1	%IB20	BYTE
	UpState		Bit0	%IX20.0	BOOL
	DnState		Bit1	%IX20.1	BOOL
	DiState		Bit2	%IX20.2	BOOL
	Fault24V		Bit3	%IX20.3	BOOL
	EncoderFault		Bit4	%IX20.4	BOOL
	ReadyXOp		Bit5	%IX20.5	BOOL
			Bit6	%IX20.6	BOOL
			Bit7	%IX20.7	BOOL
=			SSI_State2	%IB21	BYTE
	LoadRun		Bit0	%IX21.0	BOOL
	LoadError		Bit1	%IX21.1	BOOL
	Comp2State		Bit2	%IX21.2	BOOL
	Comp1State		Bit3	%IX21.3	BOOL
			Bit4	%IX21.4	BOOL
			Bit5	%IX21.5	BOOL
			Bit6	%IX21.6	BOOL
			Bit7	%IX21.7	BOOL

Input space length: 6 bytes

	7	6	5	4	3	2	1	0	
Bytes 0-3	Bits 0-30 = Encoder value; bit 31 = Latch active								16#2101.1
Byte 4	Reserved	Ready for operation	Reserved	Encoder value fault	24-V encoder supply fault	DI state	DN state	UP state	16#2101.2
Byte 5	Reserved	Reserved	Reserved	Reserved	Comparator 1 state	Comparator 2 state	Loading function error	Loading function running	16#2101.3

Encoder value

Bytes 0 to 3 contain the current encoder value and a bit indicating whether the latch function is active. More specifically, bits 0 to 30 contain the current encoder value and bit 31 indicates that the encoder value is a stored value / that the latch function is active.

Ready for operation

Byte 4, bit 6 is used to signal that the TB20 SSI module is ready for operation, i.e., that communications between the module and the connected encoder are OK.

Absolute encoder fault

Byte 4, bit 4 is used to signal faults such as wire breaks and parity errors detected when communicating with the absolute encoder. The corresponding fault needs to be reset before the module can be used.

24-V encoder supply fault

Byte 4, bit 3 is used to signal faults in the 24-V encoder supply.

The corresponding fault needs to be reset before the module can be used.

DI state

Byte 4, bit 2 is used to signal the state of the latch function's digital input.

DN state

Byte 4, bit 1 is used to signal a negative direction of movement.

UP state

Byte 4, bit 0 is used to signal a positive direction of movement.

Comparator 1 state

Byte 5, bit 3 is used to signal the state of comparator 1 (please refer to 8.1.6).

Comparator 2 state

Byte 5, bit 2 is used to signal the state of comparator 2 (please refer to 8.1.6).

Loading function error

Byte 5, bit 1 is used to indicate that an error occurred when attempting to execute the loading function. To eliminate the error bits "load reference value 2" and "load reference value 1" (output byte 4, bits 0 and 1) are to be set to 0.

Loading function running

Byte 5, bit 0 is used to signal that the loading function is active.

- To manage the peripheral, the Fault Reset, the trigger activation and the Reset Latch of the position, it is necessary to map the RPD as shown in the following picture:

Receive PDOs (Master => Slave)		
<div> <div>+</div> Add PDO <div>+</div> Add Mapping <div></div> Edit <div></div> Delete <div></div> Move Up <div></div> Move Down </div>		
Name	Object	Bit length
<input checked="" type="checkbox"/> 16#1400: Receive PDO Communication Parameter 1	16#201 (\$NODEID+16#200)	64
Digital Output Bit 1	16#0200:16#01	8
Digital Output Bit 2	16#0200:16#02	8
Digital Output Bit 3	16#0200:16#03	8
SSI_PresetCount	16#2201:16#01	32
SSI_CtrlByte	16#2201:16#02	8

Assign the address to the IEC variables as shown in the following picture:

+	SSI_SetQuota		SSI_PresetCount	%QD3	DWORD
-			SSI_CtrlByte	%QB16	BYTE
	LoadRefValue1		Bit0	%QX16.0	BOOL
	LoadRefValue2		Bit1	%QX16.1	BOOL
			Bit2	%QX16.2	BOOL
			Bit3	%QX16.3	BOOL
			Bit4	%QX16.4	BOOL
			Bit5	%QX16.5	BOOL
	ResetLatch		Bit6	%QX16.6	BOOL
	ResetFault		Bit7	%QX16.7	BOOL

Output space length: 6 bytes

	7	6	5	4	3	2	1	0	
Bytes 0-3	Preset count for reference value 1 or 2								16#2201.1
Byte 4	Reset fault	Reset latch function	Reserved	Reserved	Reserved	Reserved	Load reference value 2	Load reference value 1	16#2201.2
Byte 5	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	

Preset count for reference value Used to specify the count that will be used as a reference value by the comparator.

Reset fault This bit is used to reset the aforementioned faults/errors.

Reset latch function This bit is used to reset the latch function.

Load reference value 2 This bit is used to start transmitting the preset count (from bytes 0 to 3) to comparator 2.

Load reference value 1 This bit is used to start transmitting the preset count (from bytes 0 to 3) to comparator 1.

- To change the configuration of the Encoder_SSI acquisition module it is possible to proceed in two different ways:

Info	Extended	General
Diagnostic alarm <input type="checkbox"/>		
Gray-/Dual Converter Gray ▾		
Encoder type SSI 15 Bits ▾		
Total steps of absolut encoder 32768		
Number of trailing bits 0		
Parity None ▾		
Repetition Inactive ▾		
Baud rate 125 kHz ▾		
Monoflop time 32 μ s ▾		
Comparator 1 Inactive ▾		
Comparator 2 Inactive ▾		
Scaling <input type="checkbox"/>		
Reversal of rotational direction <input type="checkbox"/>		
Latch Inactive ▾		

1. Through ToolBOX:

- a. Create a project with all the I/O modules that are present.
- b. Enter the configuration tab of the SSI module and customize it:
 - i. Saving the file EDS --> import it in CODESYS
 - ii. Saving in the CANopen coupler the configuration just done



Note

Choose one of the two ways: parameter saving in the node or import through EDS file.

2. Through SDO:

at the end of the module initialization phase it is possible, in CODESYS, to download a list of parameters in the node through SDO. Thanks to this procedure it is possible to modify the SSI board setting.

15	16#3001:16#01	Module Slot 1 Parameter 1	1	8	
16	16#3001:16#02	Module Slot 1 Parameter 2	13	8	
17	16#3001:16#03	Module Slot 1 Parameter 3	8192	32	
18	16#3001:16#04	Module Slot 1 Parameter 4	0	8	
19	16#3001:16#05	Module Slot 1 Parameter 5	1	8	
20	16#3001:16#06	Module Slot 1 Parameter 6	17	8	
21	16#3001:16#07	Module Slot 1 Parameter 7	129	8	

To understand how to set the various configuration parameters, refer to the following table:

Byte	7	6	5	4	3	2	1	0	
0	Operating mode								16#3001.1
1	Encoder value coding	Encoder value bit width							16#3001.2
2-5	Total number of encoder steps								16#3001.3
6	Multiple transmission		Parity		Number of appended bits				16#3001.4
7	Baud rate				Monostable multivibrator time period				16#3001.5
8	Comparator 2 mode				Comparator 1 mode				16#3001.6
9	Diagnosis alarm	Reserved	Reserved	Reserved	Normalization	Direction reversal	Latch		16#3001.7

Operating mode

1 = Operating mode 1

Encoder value coding

0 = Gray code; 1 = Natural binary code

Encoder value bit width

0 = No encoder

8 = 8 bits / 9 = 9 bits / ... / 15 = 15 bits / ... / 31 = 31 bits (with no parity bit)

Total number of encoder steps (16 - 2³¹); (16, ..., 32768, ..., 2147483648)

Multiple transmission

0 = No multiple transmission

1-3 = Multiple transmission with 1-3 idle cycles

Parity bit

0 = None; 1 = Odd; 2 = Even

Number of appended bits

0 bits-15 bits

Baud rate/Clock frequency

0 = 125 kHz; 1 = 250 kHz; 2 = 500 kHz; 3 = 1 MHz;
4 = 1.5 MHz; 5 = 2 MHz

Monostable multivibrator time period 0 = 16 µs; 1 = 32 µs; 2 = 48 µs; 3 = 64 µs

Comparator 1/2 mode

0 = Disabled; 1 = Forward direction; 2 = Reverse direction; 3 = Both directions

Diagnosis alarm

0 = Disabled; 1 = Enabled

Normalization

0 = Disabled; 1 = Enabled

Direction reversal

0 = Disabled; 1 = Enabled

Latch

0 = Disabled; 1 = Rising edge at DI;
2 = Falling edge at DI; 3 = Both edges at DI

2.7. Troubleshooting

1. The position TPDO has not been sent:
 - a. Check that the PDO mapping is set to 255
 - b. Restore the default configuration of the TB20 Coupler Node through ToolBox

Info Settings

Name: CANopen coupler
 Order number: 640-160-1AA11
 Serial: 106296
 HW revision: HW2-1
 FW-Version: 1.10.002 ⚠
 CI-Version: 1.08.002

App state: **Operational**

Node-ID: 1
 CAN baud rate (Bit/s): 1000000
 Initialisation finished: Yes

Save diagnostic
 FW-Update
 Restart
Factory setting
 Operational
 Preoperational
 SDO

2. The latch of the position doesn't work and/or the position comparator doesn't activates:
 - a. Check/modify the Module default settings

Info Extended General

Diagnostic alarm ☐

Gray-/Dual Converter Gray ▾

Encoder type SSI 15 Bits ▾

Total steps of absolut encoder 32768

Number of trailing bits 0

Parity None ▾

Repetition Inactive ▾

Baud rate 125 kHz ▾

Monoflop time 32 µs ▾

Comparator 1 Inactive ▾

Comparator 2 Inactive ▾

Scaling ☐

Reversal of rotational direction ☐

Latch Inactive ▾

3. The encoder SSI of Eltra provides an input to reset the position. When the reset is made through this encoder input, the SSI acquiring module returns an error (probably due to a position "gap"). The error status of the module can be reset through the bit 7 of the CAN cell 16#2201.2.

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