Configuration of the Profibus DP - Multiturn Encoder 5860/9080

This document is for training purposes to get familiar with the Kübler Profibus Encoder operating modes and scaling functions. It shows also examples with the configuration tool Ezturn DP. It complements the EzturnDP.htm helpfile.

1. Overview

The Kübler Profibus Encoders 5860 and 9080 series can be programmed according the PROFIBUS-Profile for Encoders in 2 classes and 5 different modes. The following matrix shows all modes and its characteristics.

Device Class	1		2		
Mode	Singleturn	Multiturn	Scaling of Measuring Units per Revolution (MUR)	Scaling of Total Measuring Range (TMR)	Scaling of MUR & TMR
Module	Class 1 Singleturn 0xD0	Class 1 Multiturn 0xD1	Class 2 Multiturn UP13 0xF1	Class 2 Multiturn UP17 0xF1	Class2 Singleturn 0xF0
Code sequence programmable	**yes**				
Scaling possible	**no**		**yes** (1, (2		
Preset possible	**no**		**yes** (1		
Diagnostic Function	**Standard**		**Extended** (1		
Scaling function	**none**		***Measuring Units per Revolution (MUR) 1...8192***	***Total Measuring Range (TMR) 1...33.554.432 units***	***Measuring Units per Revolution (MUR) 1...8192 units & Total Measuring Range (TMR) 1...8192 units***
Single Turn Resolution (# of units per revolution)	**13 bit (8.192 units)**		**1...8.192 units, MUR**	**(TMR / 4.096) units**	**1...8.192 units, MUR**
Multiturn Count (# of distinguishable revolutions)	**1 (no revolution counting)**	**12 bit (4.096 revolutions)**	**12 bit (4.096 revolutions)**	**12 bit (4.096 revolutions)**	**(TMR / MUR) revolutions**
Total Measuring Range (# of total units)	**13 bit (8192 units)**	**25 bit (33.554.432 units)**	**4096...33.554.432 units, (4096 x MUR)**	**1...33.554.432 units (TMR)**	**1...8.192 units, depending on scaling**

1) - if class 2 enabled
2) - if scaling enabled

In **class 1** the encoder operates either as a Standard Singleturn or Multiturn Encoder at full resolution, no scaling or preset is possible, only the code sequence (counting direction clockwise or counter-clockwise) can be chosen. Diagnostic Function is standard.

In **class 2** three different scaling modes and a preset value can be set. Extended Diagnostic Functions are enabled.

2. General remarks

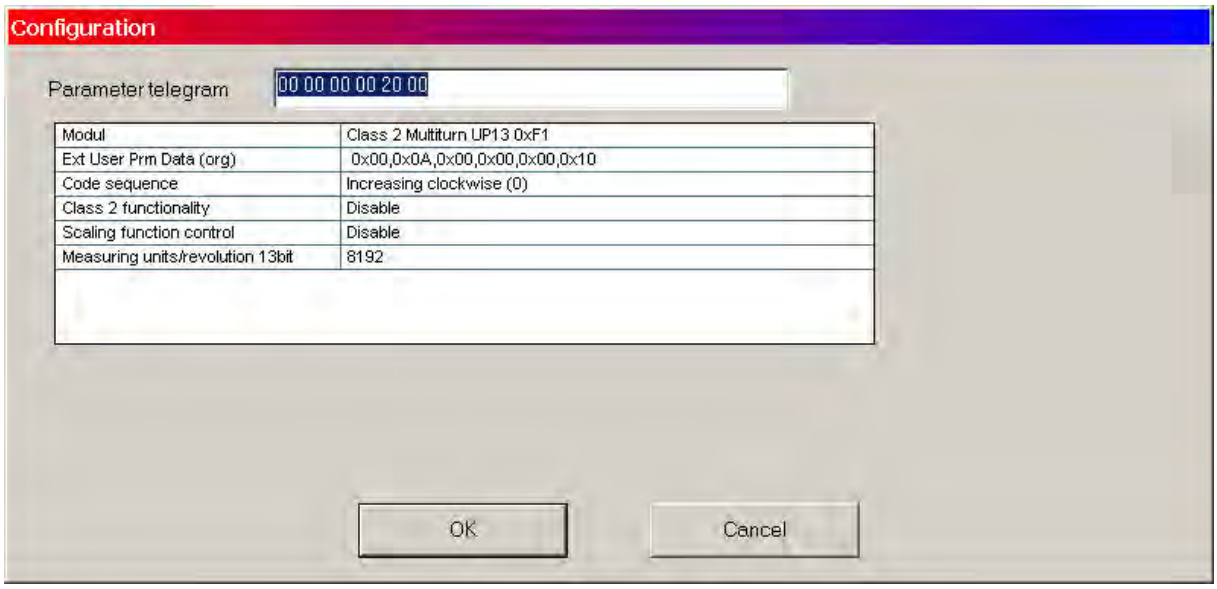
a) Factory default settings

The factory default loaded module of Ezturn DP is:

- Class 2 Multiturn uP 13
  (Scaling of Measuring Units / Revolution, Number of revolutions fixed to 4096=12 bit)
- Direction of rotation: increasing clockwise
- Class 2 functionality: disable
- Scaling: disable

=> Resolution 8192 steps per revolution (13 bit)
=> Total measuring range 8192 * 4096 = 33554432 (25 bit)

Thus the encoder operates as a standard 25 bit Multiturn Encoder



(The factory default settings of the encoder are corresponding to this:

- Class2 Multiturn uP13
- Class2 disabled,
- Scaling disabled
- 25 Bit Resolution)

b) Reset of the encoder after changing to a new mode

If there was a change in the module configuration the new module must be transmitted to the encoder twice in Ezturn because of the scaling procedure.

c) Preset function

With the preset function a preset value can be set to an actual position of the encoder. This function enables the adjustment of the encoder zero point or of a specific value to a physical position of the encoder shaft (which is for example corresponding to a mechanical reference point of the system).

NOTE! The preset function should only be used during encoder standstill.

(The preset value is written to the encoder as output data in the Data_Exchange function.
Normal operating mode MSB = 0 (bit 31, optionally bit 15)
Preset mode MSB = 1 (bit 31, optionally bit 15)
With the MSB = 1 the Encoder accepts the transferred value (bit 0-30) or (bit –15) as a preset value in binary code. Then the encoder reads the current position value and calculates an offset value to the preset value. After a successful preset the MSB can be set to zero by the Master.)

3. The Class 2 Scaling Modes

a) Scaling of Measuring Units per Revolution (MUR)

(Class 2 Multiturn UP 13 0xF1)

This mode is used to assign a required number of steps to 1 revolution of the shaft. The value must not exceed 8.192 (max. singleturn resolution of the encoder), minimum is 1.

In this mode the Total Measuring Range (TMR) will be reached after 4.096 turns and is calculated as:

TMR = MUR (required Measuring Units per revolution) x 4096 (max. countable number of revolutions)

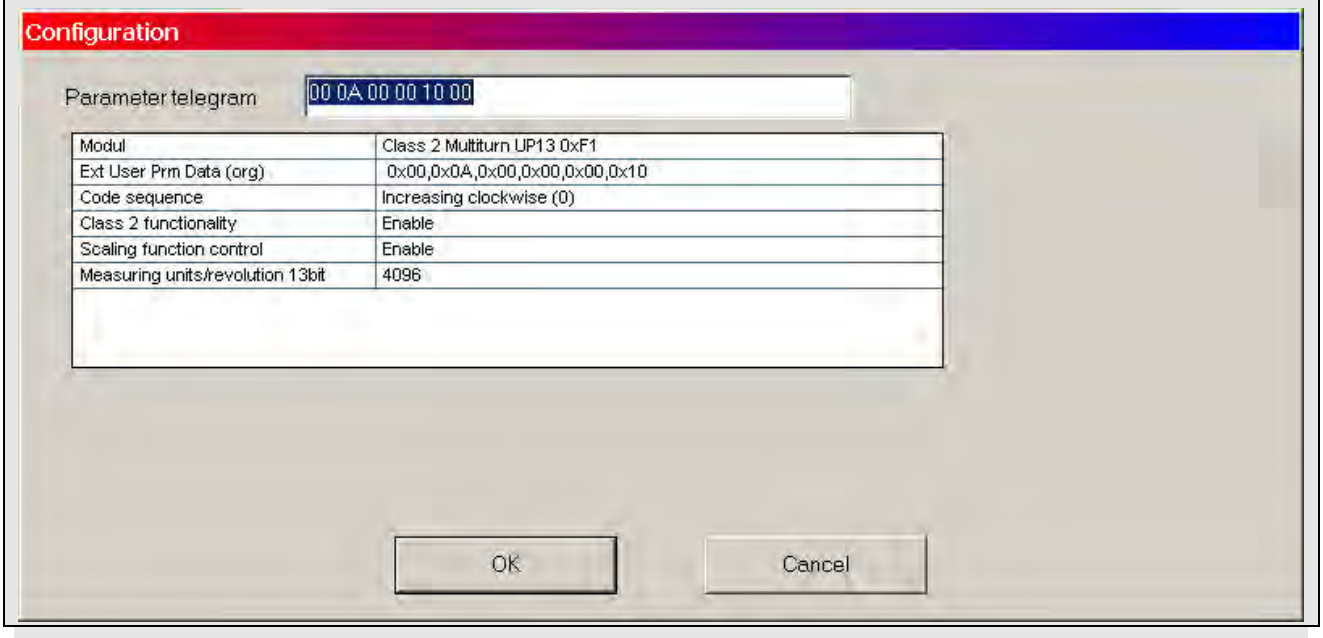
After reaching the TMR (after 4096 turns) the encoder starts counting at 0 again.

This mode can be used if e.g. a gearbox factor shall be programmed. The number of steps per revolution must be whole-numbered, only integer numbers can be programmed. If a not whole-numbered quantity of steps per revolution shall be programmed, the mode “Scaling of Total Measuring Range” is required to use.

e.g.:

Programming as a multiturn encoder with 12 bit Resolution and 12 bit multiturn counting, increasing at clockwise rotation.

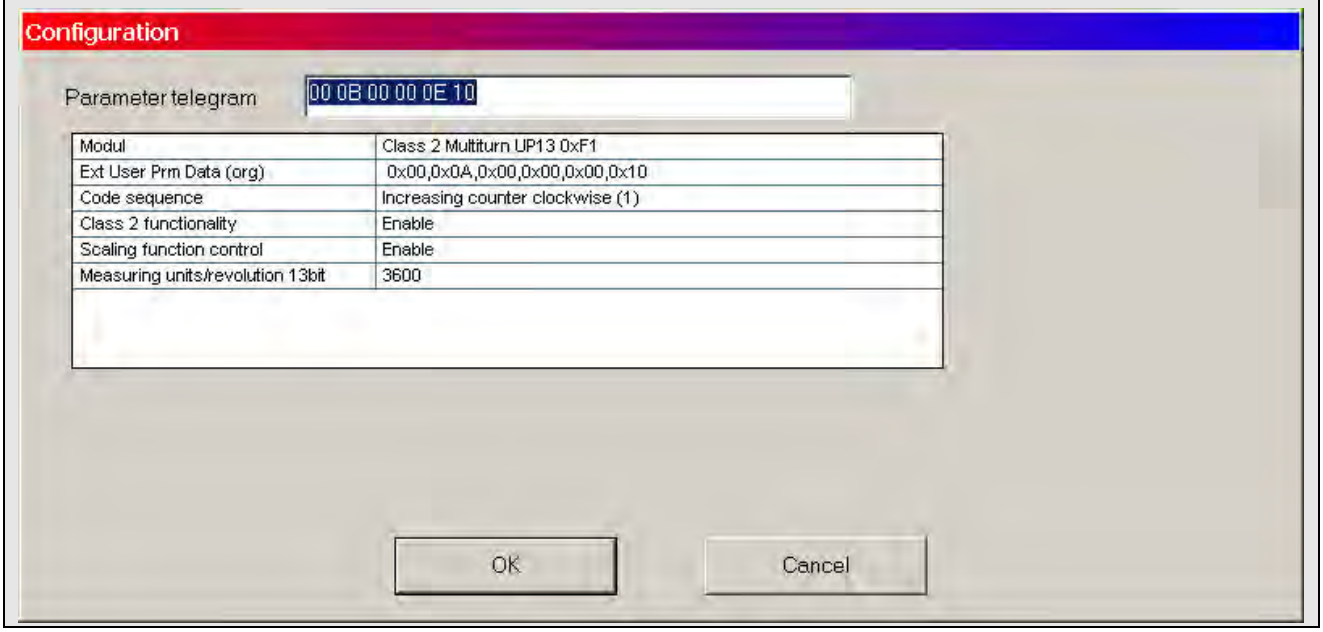
MUR = 12 bit = 4.096, => TMR = 4.096 x 4.096 = 16.777.216



e.g.:

Programming as a multiturn encoder with 3.600 Measuring Units per Revolution, increasing at counter-clockwise rotation.

MUR = 3.600, => TMR = 3.600 x 4.096 = 14.745.600



b) Scaling of Total Measuring Range (TMR)
(Class 2 Multiturn UP 17 0xF1)

In this mode the user can assign a required number of steps to the total physical measuring range, this means to the 4096 revolutions in total. It is not needed that the required number of steps is a whole-numbered multiple of 4096. So this mode is the only one where it is possible to set the scaling to a non integer (not whole-numbered) number of measuring units per revolution (MUR).

TMR = 4096 x desired number of steps / desired number of revolutions

e.g.: 9 revolutions shall equal 10.000 steps => 1 revolution equals 1.111,111… steps.

=> TMR = 4096 x 10.000 / 9 = 4.551.111

After reaching the TMR (after 4096 turns) the encoder starts again counting at 0.

Max TMR value is 33.554.432 (25 bit = 13 bit singleturn and 12 bit Multiturn)

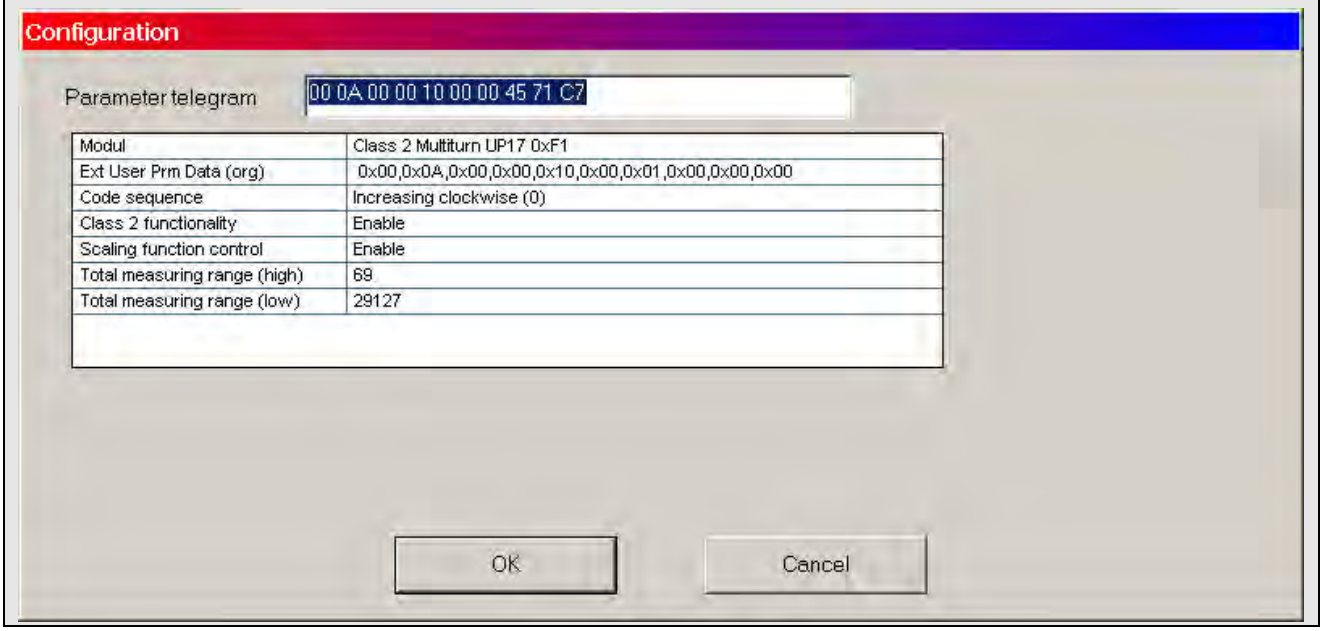
Due to the fact that several controller-software like Siemens STEP 7 (Siematic) require that 32-bit-parameters must be separated in 2 16bit-words (High and Low) also Ezturn DP requires a setting of TMR as a High-data-word and a Low-data-word. This can be done as follows:

1. If TMR < 65.536: $TMR_{(high)}$ = 0
   $TMR_{(low)}$ = TMR
2. If TMR >= 65.536: $TMR_{(high)}$ = INTEGER(TMR / 65536) (integer value of the division)
   $TMR_{(low)}$ = TMR - ($TMR_{(high)}$ x 65536) (remaining part)

or
- convert TMR from decimal into hexadecimal => hex data
- cut the lower significant 4 digits of the hex data, convert these into dec and use this value as total measuring range (low)
- convert the remaining upper 1...4 digits of the hex data, convert these into dec and use this value as total measuring range (high)

e.g.: - calculation of high data word: 4.551.111 / 65.536 = **69**,44….
=> $TMR_{(high)}$ = 69

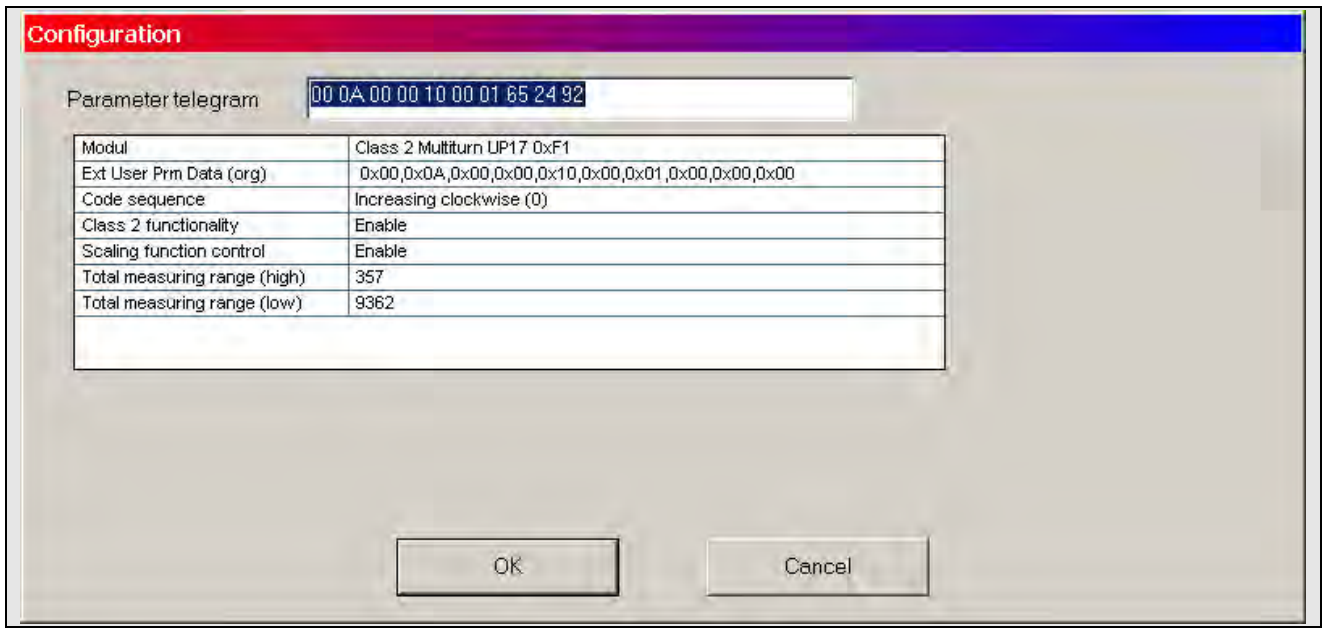
- calculation of low data word: 69 x 65536 = 4521984;
4.551.111 – 4521984 = **29127**
=> $TMR_{(low)}$ = 29127



e.g.

In a given application 35 revolutions of the encoder shaft are corresponding to a measuring length of 2 m. Required output of the encoder is 1 step per 1/100 mm.

a) calculate the number of required steps per required number of revolutions
=> number of required steps per 35 revolutions = 200.000
b) calculate the number of required steps per total physical range of the encoder revolutions
=> TMR = 4.096 x 200.000 / 35 = 23.405.714
c) calculate the $TMR_{(high)}$ data word
=> 23.405.714 / 65.536 = ***357***,14…
d) calculate the $TMR_{(low)}$ data word
=> 357 x 65.536 = 23.396.352, => 23.405.714 - 23.396.352 = ***9.362***
e) program the encoder
=> $TMR_{(high)}$ = 357, $TMR_{(low)}$ = 9362



c) Scaling of Measuring Units per Revolution (MUR) & Total Measuring Range (TMR)
(Class 2 Singleturn 0xF0)

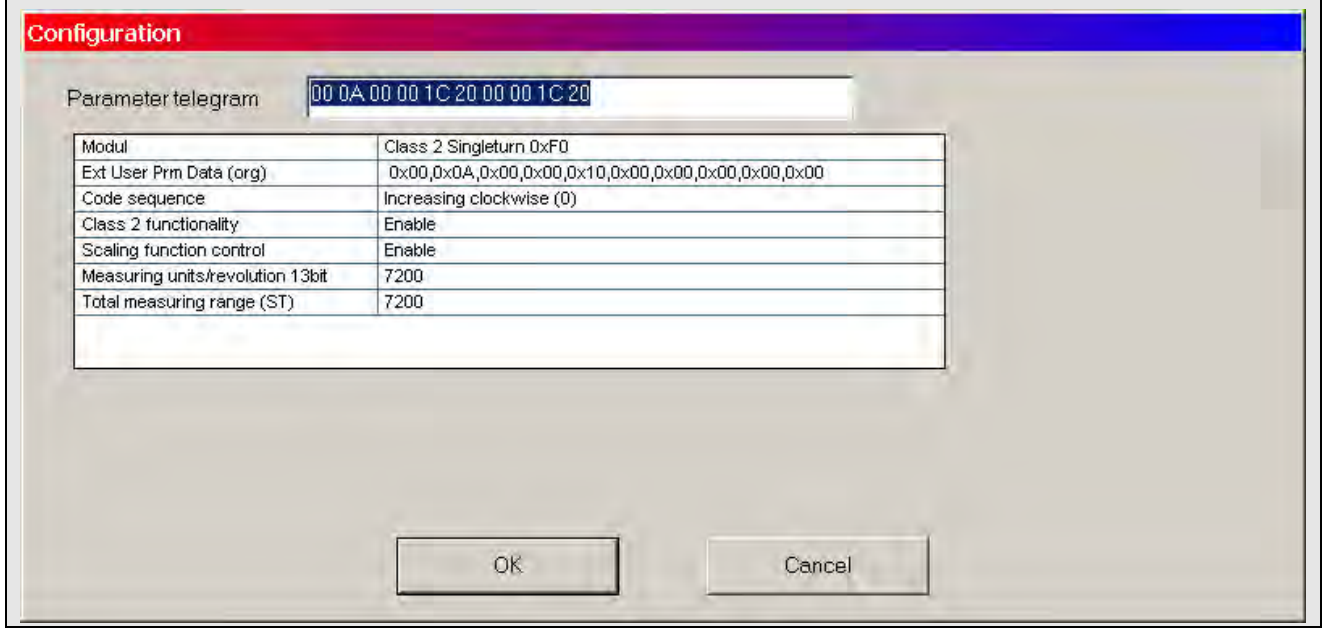
In this mode both, MUR and TMR, can be set at the same time. The value range for both factors is from 1 to 8.192. Mostly this mode is used to operate the encoder as a **singleturn encoder with a programmable resolution**. (> Class 2 **Singleturn**)

e.g:

the encoder shall operate as a singleturn encoder with a resolution of 7200 units per revolution.

MUR = 7200
TMR = 7200

=> the encoder counts from 0 to 7200 over 1 revolution and starts then again with 0.



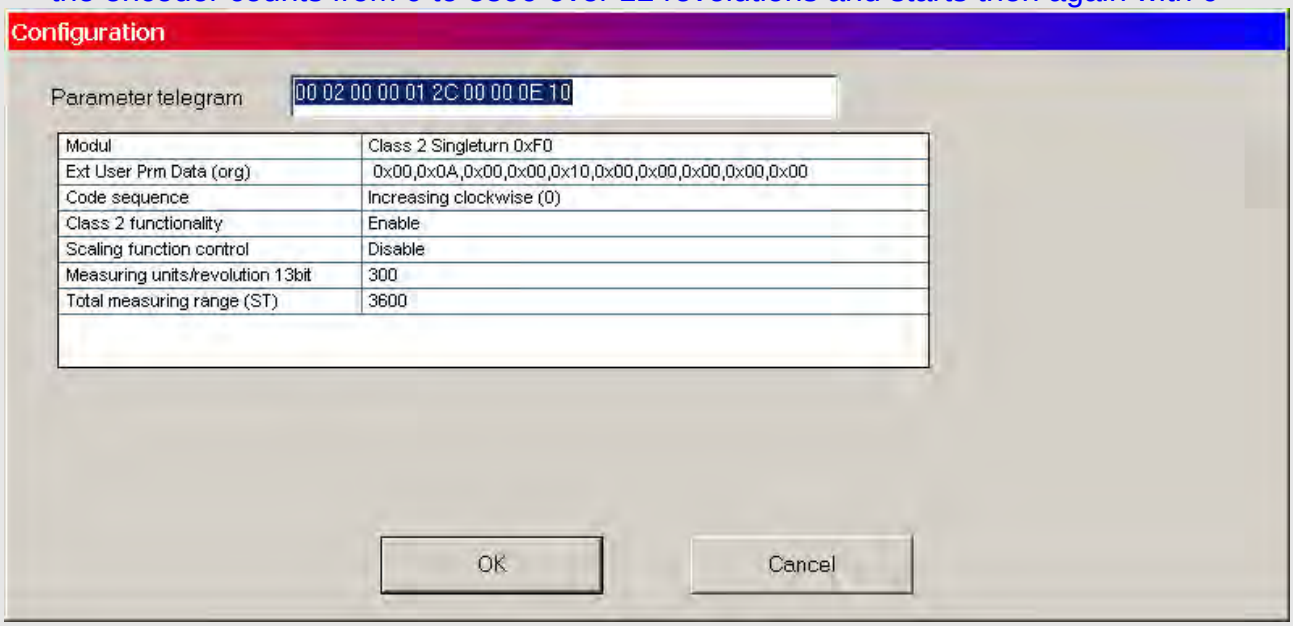
If TMR is set different than MUR it is also possible to define a wanted number of revolutions as a period after which the encoder starts counting at 0 again. This wanted number of revolutions is limited depending on the chosen MUR and is typically much less than 4096 physical revolutions.

Number of counted revolutions = TMR / MUR ($TMR_{max} = MUR_{max} = 8192$)

e.g.: after 12 revolutions the encoder shall start counting at 0. This physical range shall be devided into 3600 steps

TMR = 3600
MUR = 3600 / 12 = 300

=> the encoder counts from 0 to 3599 over 12 revolutions and starts then again with 0



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e.g.: The encoder shall devide 360° (physical) into 400 steps, every half revolution (180°) it shall start counting at 0 again.

MUR = 400
TMR = 0,5 x MUR = 200

=> the encoder counts from 0 to 199 over 1/2 revolution and starts then again with 0.