TEKEL S.R.L. INSTRUMENTS

TKM60P

Programmable multi-turn absolute encoder

User's manual

Edition 1.0

INDEX

0. Preliminary information

0.1. SYMBOLS AND CONVENTIONS USED IN THIS MANUAL

In this manual we have used the following symbols to call the reader's attention or to provide any information that can be needed,

The Caution Symbol indicates that the paragraph to which it is referred is fundamental for the use of some function or for the global comprehension of the context in which the paragraph is inserted.

The Information Symbol indicates that the paragraph to which it is referred contains useful pieces of advice for the user so that he can carry out some definite operations in an easier way.

0.2. INDEX OF REVISIONS

Index of revisions			
Rev. no	Rev. date	Description of the revision	Approval
0	20/03/2004	First issue	Technical Dept.

1. Introduction

1.1. Incremental and absolute encoders

The encoder is an electro-mechanical transducer that is used to transform a mechanical movement into an output which is always a voltage or a current signal according to the output interface integrated in the encoder itself.

Fundamentally an encoder is an angular or a linear position transducer of electromechanical type that is able to provide a digital or an analogue electrical signal as an output.

In case the position is located by using an angular measurement system (which is to say the device coupling on the shaft) we refer to a rotative encoder. On the contrary, if the position is located through the linear system (for example in an optical bar or by means of a proper gear-rack/edge coupling) we refer to a linear encoder.

The ENCODING is the transformation of the mechanical movement, that operates the encoder shaft rotation, into an electrical or an optical signal which indicates the numerical or analogue data supplied by its outputs.

This coding process is of discrete type (quantized) which is to say that the encoder shaft position is located according to discrete steps which are determined by the RESOLUTION of the encoder itself. According to the encoder model we can have resolutions starting from a minimum of 1 pulse/turn up to over 10000 pulse/turn.

The resolution of the encoder determines the maximum precision that can be obtained on the measurement of the round angle.

The encoders are generally divided into two big series:

- incremental encoders
- absolute encoders (single turn / multi turn, programmable)

The operation principle on which each series is based is the same but the position information is given to the user in two different ways. In case of incremental encoders we have a pulse train (rectangular or sinusoidal) which represents the transition from one position of the shaft to the next one according to the resolution of the encoder itself. In case of absolute encoders we have a bit string (output code) which represents, in an univocal way, the encoder shaft position. Moreover this position is maintained even when the device is off (memory) and this is the main characteristic between the two encoders series.

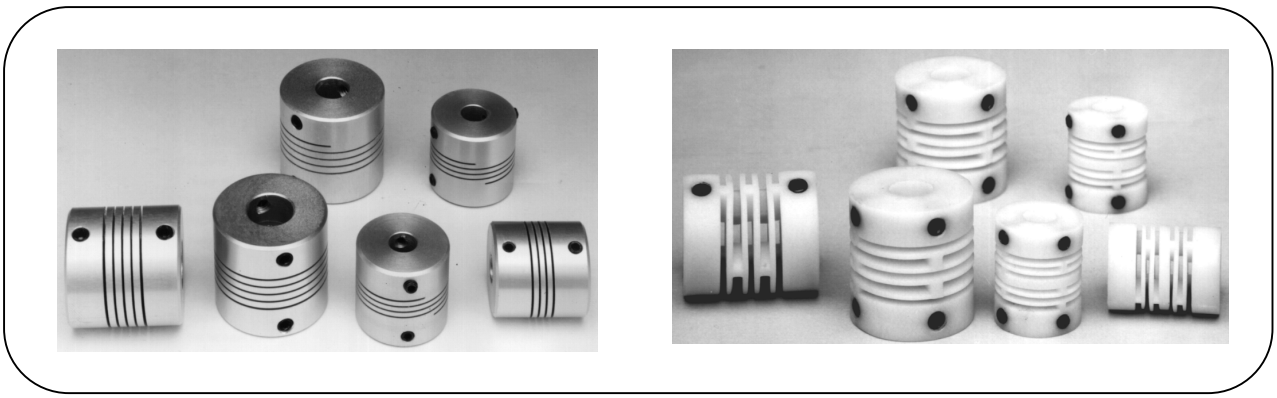
In particular an absolute encoder maintains always the shaft position both if it is on or if it is off. In other words instead of having on the disk a simple reticule corresponding to each channel we have a series of windows that form a digital or analogue code that is univocal according to the shaft rotation angle.

1.2. Mechanical assembly

The encoder operates in various environments for example in machines for the stone cutting, in the automatic looms or in the movement control of bridge cranes. The encoder must be assembled and fixed to the part of which we need to check the rotation and operates in conditions that can be very different. For this reason we have developed many different assembling and fixing systems and the most common ones, which are used for the shaft encoders, are the following:

- Servo flange (servo holes on the shaft side).
- Clip flange (it enables the encoder orientation).
- Servo-clip assembly (combination of the previous types of assembly).

Concerning the shaft encoders we suggest the use of flexible couplings, see picture no.1, in the following cases: in case the encoder shaft must stand intense stresses and it is necessary to compensate the materials thermal expansions (this is important in case of glass disks) or in case a coupling between shafts with a different diameter is requested. Anyway the assembling system must not be considered as a rigid ensemble consisting only of the encoder and of the device that has to be measured.



Picture 1 Models of metal and plastic flexible couplings.

Concerning the hollow shaft encoders the problem of a rigid assembling is less important since this type of encoder is sustained directly by the measuring shaft. In order to prevent the encoder rotation caused by the measuring shaft we usually position an insert in a proper slot obtained on the case. This insert is assembled on the device and avoids the rotation of the encoder itself. .

1.3. The TKM60P absolute encoder

On the market there are two big series of absolute encoders:

- Single turn
- Multi turn

The single turn absolute encoders consist of one single disk called ***main disk*** that gives all the necessary information for the code development for the requested resolution. Therefore if you order a single turn encoder with 8192 steps/turn this will have one single glass disk with a 13-bit Gray code recorded on it.
The multi turn encoders, among which there is the TKM60P, consist of the main disk and of a series of disks which are generally smaller than the main one and which are called ***satellite disks***. For each turn of the main disk, by means of a system of gear wheels, we obtain the side disks rotation for an angle fraction function of the gear wheels mechanism. Since the TKM60P has a maximum resolution, in terms of turns, of 4096 codes, we use three side disks and each of them is able to generate 16 codes on the whole.
The main disk of the TKM60P has 8192 codes and plus it has the side disks which are able to generate 16*16*16 = 4096 codes; therefore the total code that can be generated in output by the TKM60P is equal to 8192 x 4096 = 33554432 codes. This means a development of 25 bit (13 bit of the main disk + 12 bit of the side disks).
Any type of mechanical error existing in the system, due for example to the coupling backlash between the side disks gears or due to the optical system alignment of the main disk, is eliminated by using proper devices called *ASIC* (*Application Specific Integrated Circuit*). These devices operate on the signals generated by the reading system and align in an automatic way the code, this is necessary for all applications characterized by intense mechanical vibrations.

2. The TKM60P encoder

2.1. Technical characteristics

CHARACTERISTICS	VALUE	MEASUREMENT UNIT AND NOTES
Standard resolution	8192	Codes generated each turn
No. of turns	4096	No. of turns
Type of code generated	Gray, Binary, BCD Excess 3 Gray code	
Output electronics	Synchronous serial Parallel Asynchronous serial	SSI (13 bit / 21 bit / 25 bit) NPN, PNP, Push Pull, TTL RS232, RS422/485
No. of parallel outputs	16 + 16	(4 groups of 8 channels each)
No. optional outputs	2	Choice between optional output signals and available alarms.
No. otpoisolated inputs	6	Choice between inputs and hardware controls
SSI available protocols	13 bits 21 bits 25 bits	Aligned on the right Aligned on the centre or on the right Aligned on the centre or on the right
Program memory	EEPROM	Non volatile - with no need of buffer battery
Max rotation speed possible	700	RPM
Optional output signals (*)	FAIL ERROR ZERO SIGNAL PARITY	Optoisolated: open=damaged; closed = normal operation HI=normal condition LO=anomaly HI=normal; LO=indicates that the present code is "0" Bit added to the output code - Program. Even/Odd
Alarms available as state bit (*)	Stopping shaft Max rotation speed Rotation direction 4 limit switches + 4 optional switches	0= rotating shaft; 1= stopping shaft 0=speed <=700 RPM; 1=speed >700 RPM 1= CW; 0= CCW 0=any alarm; 1=alarm - Programmable 0=any alarm; 1=alarm - Programmable
Control selection	SW / HW	SW=serial; HW = logic level applied on input
HW inputs and SW controls HW+SW HW+SW HW+SW HW+SW SW SW SW HW+SW HW+SW HW+SW	 Up/Down Zero set Enable Latch Normal/Reverse Prefix Preset Stopping shaft Speed alarm Alarm threshold	 Increases/decreases count for shaft CW rotation Sets to "0" the present code value Enables the outputs in high impedance state. Freezes the output code at the current value. Output code normal or complemented. Intermediate zero and counts -/+ Gives a new value to the present shaft position Time constant for stopping shaft status Max. speed exceeded Alarm threshold exceeded
Setting functions	From Host through serial interface	- reading of code present value - reading of encoder present status - reading of present rotation speed - reading of alarm thresholds values
Encoder address	00÷99	Programmable

(*) HW = input (control) or output physically available with electrical connections.
SW = input available as software control or output available as state bit both sent through an asynchronous serial line by Host computer.
HW+SW = input or output available in both ways above described.

2.2. Electrical characteristics

CHARACTERISTICS	VALUE	MEASUREMENT UNIT AND NOTES
Device operating voltage	11÷30	V (c.c. residual ripple ± 1 V_{PP})
Power	2 (max)	W
Delivered current for each output	30	Max mA with protection against short circuit
Output voltage	11÷30	V (c.c.)
Protection	Yes	Against inversion of polarity

2.3. Mechanical characteristics

CHARACTERISTICS	VALUE	MEASUREMENT UNIT AND NOTES
Dimensions	ø 60x80	mm
Assembling with shaft	"S" / "SG"/ "F"	"S"=servo (standard) "SG"=Servo-clip (optional) "F"=square flange
Assembling with hollow shaft	"N"	"N"=normal (standard) with anti rotation slot
Weight	0,5	Kg (ax.)
Diameter shaft encoder	10 o 6	mm tolerance h6
Diameters hollow shafts	6, 8, 9.52, 10, 11	Hole tolerance : H7 Max depth : 20 mm
Proof shaft	Yes	Optional (only for shaft encoders)
Bearings life	> 10^9	Revolutions

2.4. Environmental characteristics

CHARACTERISTICS	VALUE	MEASUREMENT UNIT AND NOTES
Operating temperature	0÷70	C°
Storage temperature	-30÷+85	C°
Protection	IP 64	EN 60529 standard
Relative humidity	98 % RH	Without condensation
Vibrations	10 g	In the range 10÷2000 Hz
Shock	20 g	for 11 ms

2.5. Overall dimensions

For further information concerning the types of assembling refer to the catalogue in the section ***programmable multi-turn absolute encoders TKM60P, TKMW60P, TIAEEX70P, TIAEEX70WP***.

If you can connect to the Internet it is possible to check the data sheets at the address:

http://www.tekel.it/

then it is possible to proceed with the selection basing on the needed encoder type and by using one of links proposed in the Tekel home page, in the specific case:

http://www.tekel.it/EncAss.htm or http://www.tekel.it/EExEncoder.htm

then it is possible to proceed with the display of the data sheet in pdf format by selecting the following *links*:

http://www.tekel.it/pdf/Tkm60p.pdf or http://www.tekel.it/PDF/TIAEEX70P.pdf or

http://www.tekel.it/PDF/TKMW60P.pdf or http://www.tekel.it/PDF/TIAEEX70WP.pdf

in the data sheet there are the references to generate the ordering code.

If you need to download the data sheet, to check it in the future, select the *link* by pressing the right button of the mouse, then select the option *Save object with name* and press the left button of the mouse. In this way a *download* window will be opened and it will be possible to download the file.

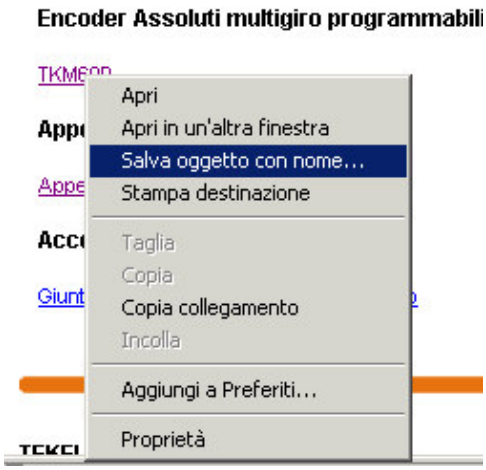


Fig. 2 Right button mouse menu

3. The TK_PROG programming software

3.1. Where to find TK_PROG programming software

The TK_PROG programming software is distributed free of charge by Tekel Instruments and it is on the CD containing our catalogue.
In alternative it is possible to download the software from Internet to following *link*:

http://www.tekel.it/Download.htm

It is possible to select the software version, according to the operating system in use, by utilizing the connections indicated in picture 2A:

Picture 2A Software download window from Tekel site

Before the installation it is necessary to explode the content of the downloaded compressed file (*.zip) in one temporary folder (example: "C:\TEMP\"), then select the temporary folder and follow the indications of point 3.2.

In the CD select the folder relevant to the software version according to the operating system in use (w2k or w9x), and then follow the indications of point 3.2.

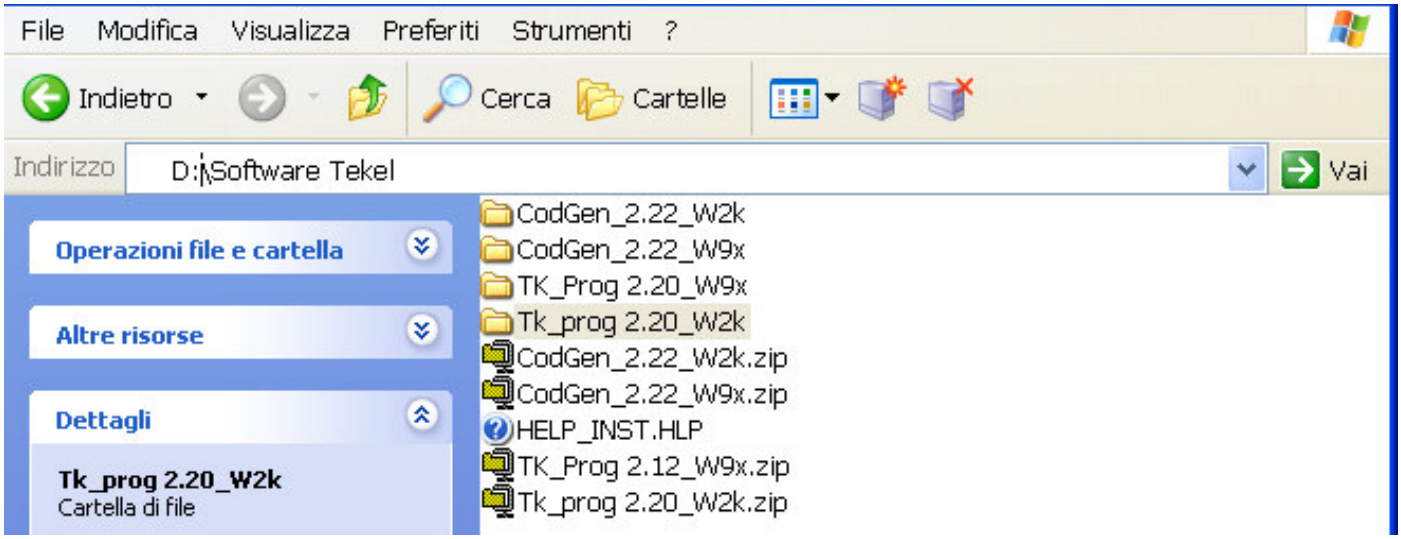


Fig. 2B Software installation Window from Tekel CD

3.2. Installation of the programming software

In order to avoid malfunctions before installing the TKPROG software It is necessary to remove all the versions previously installed. To uninstall the programme use the Control panel at the option Installation of Applications from the Start menu.

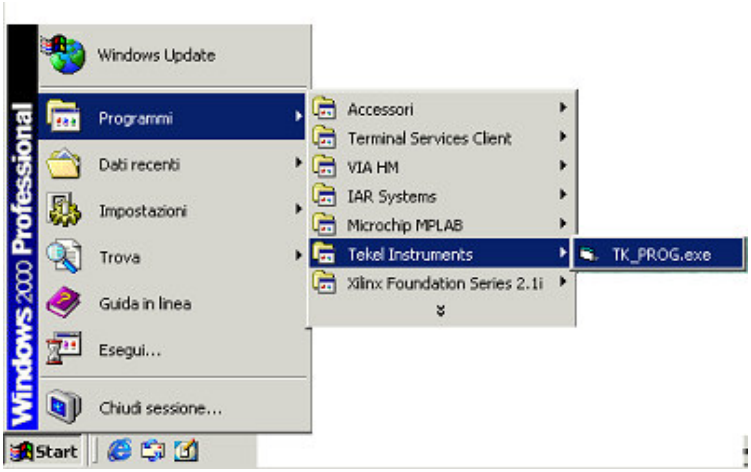
In order to install the programme select the programme version, according to the operating system used, then press *Enter* or *Return*.
To locate the required version refer to picture no. 2 and to table 1 ("n.nn" is the software version number).

Before the installation it is necessary to explode the compressed file in a temporary directory (example "C:|\TEMP\"), then execute "Setup.exe" to run the installation programme. Afterwards follow the instructions on video confirming the proposed options.

During the installation the computer rebooting may be requested; in this case reboot the system and run the program.

When the installation is completed the programme can be started by pressing *Start* from the applications bar and looking in the group *Programmes/Tekel Instruments/TK_PROG*, see picture 3.

From the selected job folder as indicated in point 3.1. execute the installation program SETUP.EXE and always confirm the options proposed on video.

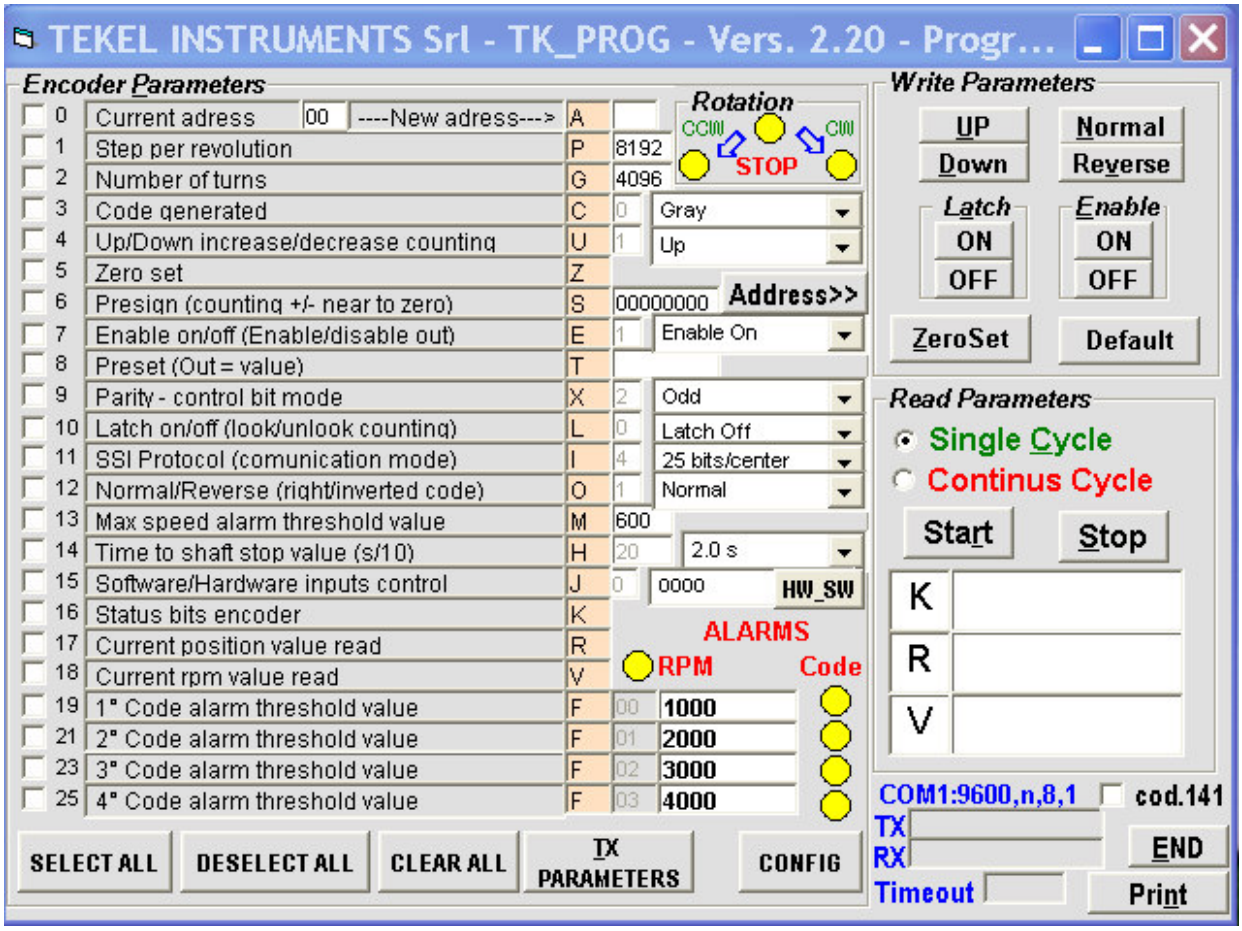


Picture 3 Path for installed programme

Once the programming software has been started it is possible to choose the language, see picture 4; at this point , to start the program, select by using the mouse the flag corresponding to the requested language version.

Picture 4 Window for the language selection

After the language selection you enter the real programming panel of the TKM60P encoder



Picture 5 Programming panel for the TKM60P encoder.

3.3. Use of the TKPROG programming software

The programming panel is divided into five distinct sections:

- Encoder parameters
- Rotation
- Write Parameters
- Read Parameters
- Serial interface monitor

The first section, concerning the *Encoder parameters,* enables the user to set all the functions foreseen for the TKM60P multi turn absolute encoder at the date of this document. For example it will be possible to program the resolution, the type of code generated in output, or the alarm thresholds and other functions that will be described in detail in the continuation of this manual.

For the first time you use this programming software you had better select and then program one single function at a time to avoid to program the non-requested parameters with consequent cancellation of the current settings. When you will have acquired a higher control of the system it will be possible to set different parameters at the same time by carrying out a multiple programming.

Any function, both in reading or in writing mode, has to be carried out when the encoder is not Working (stopping shaft).

Remind that a function is selected, namely enabled in reading or writing mode, only if there is a tick sign in the first column.

A generic function is considered in reading mode when in the subject field no value is indicated (you must select and press the CANCEL key). In this way, by operating the TX PARAMETERS button the function is transmitted

without the parameter, the encoder reads the command as a request in its internal setting and it replies with the value which is now given to the function under examination.

The function is considered in writing mode when, in the subject field, there is indicated a value comprised in the interval of validity established from the function in examination. By indicating a valid value and pressing the TX PARAMETERS button you will modify in a definitive way the encoder programming for the considered function.

To select one single function at a time you can proceed in two different ways:

1. by using the mouse deselect all the options that are not needed;
2. by using the DESELECT ALL button eliminate the tick sign from all the functions, then select with the mouse the needed function.

3.3.1. Encoder current configuration retrieving

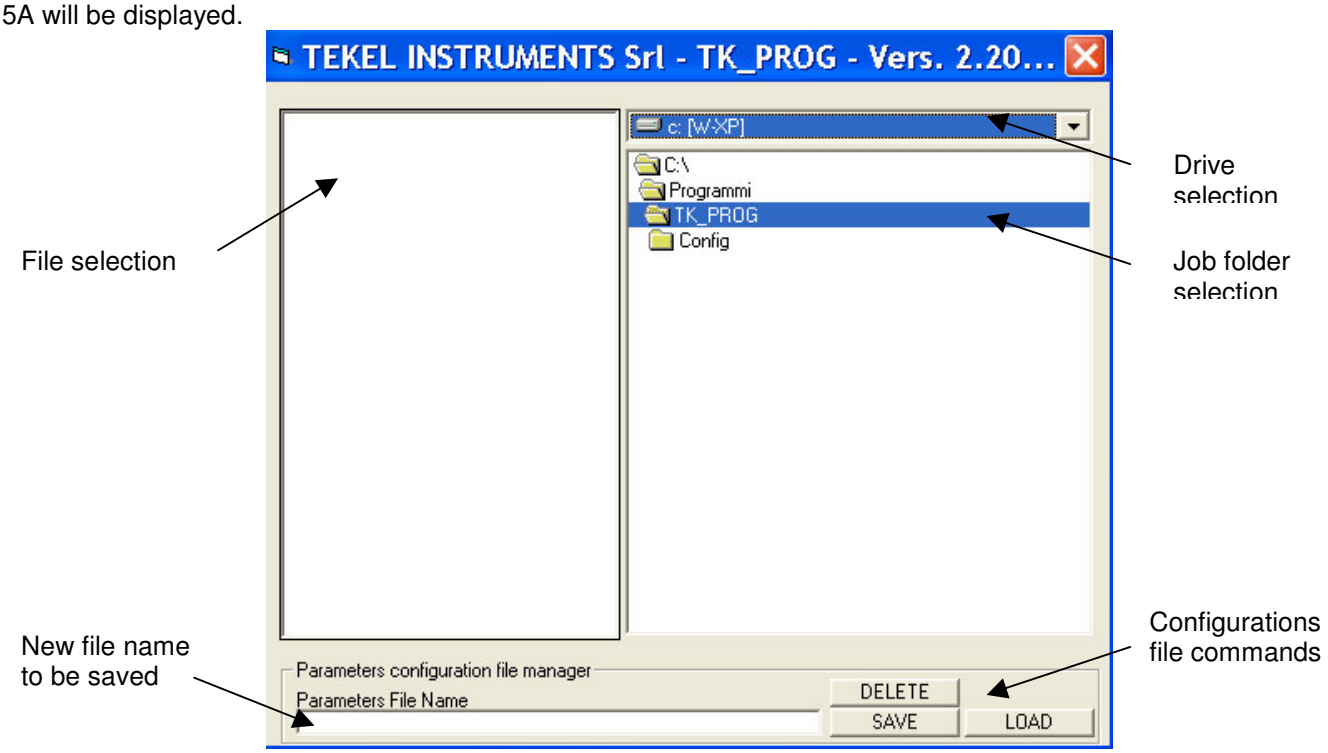
Press the Stop button in the window *Parameters Reading*.
In order to verify the current encoder configuration, once you know the current address, you just have to press in sequence the CLEAR ALL and the SELECT ALL buttons; afterwards press the TX PARAMETERS button which enables the parameters transmission.
After few seconds the panel relevant to the *Encoder Parameters* will be completed with the configuration of the interrogated encoder.

3.3.2. Management of the parameters configurations file for encoder programming

It is possible to save the encoder current configuration parameters and, through the relative function, to create the file of the configurations relevant to different encoders, with the possibility of:

- saving in a file the configuration parameters;
- copying, renaming or cancelling an existing configuration files;
- reloading the encoder parameters values from a configuration file;
- programming an encoder with parameters values reloaded from a configuration file

In order to activate the configuration management press the CONFIG push-button, the window shown in picture 5A will be displayed.



Picture 5A Parameters Configuration Management Panel

It is possible to use the panel windows to:
- Select a drive different from the predefined one (C:);
- Select a different folder job (the folder "Config" contains an example file configuration called "Sample.tkp";
- Select one of the files contained in the relative window (on the left side of panel).

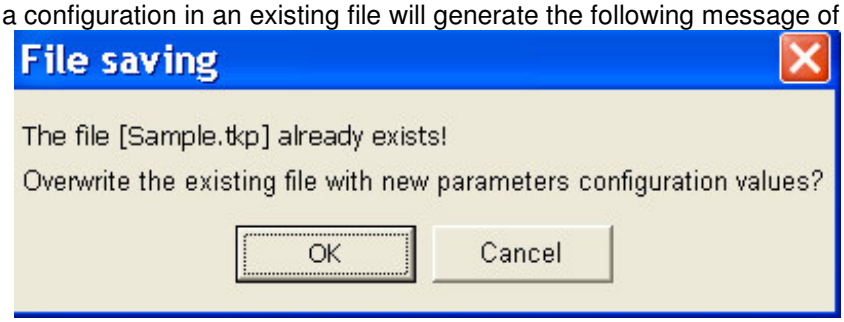
The functions described at the points 3.3.2.1., 3.3.2.2., 3.3.2.3. must be activated from Configuration Parameters Management Panel.
With the mouse select to return to the programming panel from the Parameters Configuration Management Panel.

3.3.2.1. Saving the current configuration in a file

In order to save the current configuration, shown in the TK_PROG programming panel in a new file it is necessary to write the file name in the relative text box, then press the SAVE push-button.
To confirm the successful recording the "Parameters File Name" box becomes green and the file name, with ".tkp" extension, is added to the window correspondent to the selected job folder.

In the file a configuration is saved containing only the values of the parameters that appear in the relative boxes of the programming panel. In order to avoid the reloading of null values it is better, before saving a configuration, to always verify that all the parameters are present in the relative boxes.

The attempt to save a configuration in an existing file will generate the following message of error:

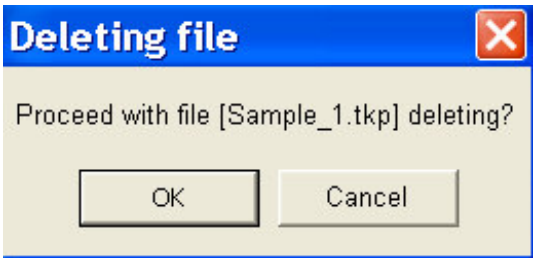


Picture 5B Confirmation of configuration file overwriting

By pressing the OK pushbutton the overwriting of the existing file with the new configuration values will be confirmed. Pressing the Cancel pushbutton the file writing operation will be cancelled and the current configuration values will not be saved.

3.3.2.2. Deleting a configuration file from the job folder

In order to delete a configuration file from the job folder it is necessary to select the file name (with "tkp" extension) from the relative window on the left side of configuration panel, then press the DELETE pushbutton, the confirmation window of picture 5C will be displayed.



Picture 5C Confirmation of configuration file overwriting

By pressing OK the selected file will be deleted, by pressing Cancel the file deleting operation will be cancelled.

3.3.2.3. Reloading of a parameters configuration file from job folder

To reload a parameters configuration file from job folder select the file name (with "tkp" extension) from the relative window on the left side of the configuration panel, then press the LOAD pushbutton.
The confirmation window of picture 5D will be displayed.

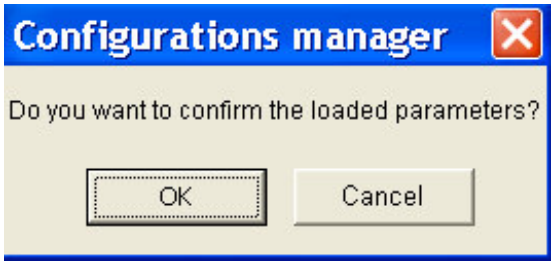


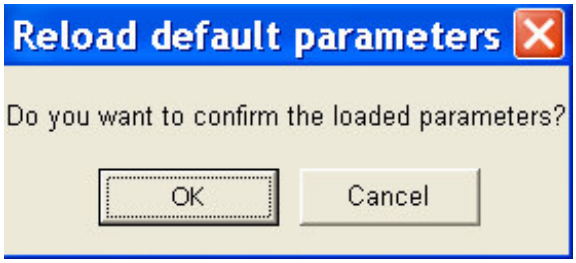
Fig. 5D Confirmation of configuration loading from file

By pressing OK the parameters relevant to the configuration recorded on file will be reloaded and overwritten on those already present on programming panel. By pressing Cancel the operation will be cancelled and on the control panel the parameters, present before the request of configuration reloading from file, will be maintained.

3.3.3. Retrieving of predefined values

It is possible, whichever is the value of the parameters stored in an encoder, to reload a default configuration that is surely working (this can be useful, for example, to restore a tested condition on encoders that apparently have a fixed output when the shaft is rotating, or a value always "000000" or always "FFFFFFF").

To activate this function press the **Default** pushbutton on the W*rite Parameters window*.
The program reloads the values predefined from the factory (default configuration); these are displayed on video and then a confirmation of the loaded values is requested (see picture 5A).



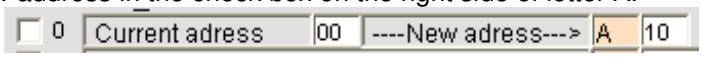
Picture 5A – Confirmation of predefined values restoring

By pressing OK the loaded parameters are confirmed, while by pressing Cancel the values present before the activation of the **Default** pushbutton are restored.

With the restoring of the predefined values also the eventual values of "Preset", "Presign" and "Automatic Zero" will be replaced. For this reason it is necessary to repeat eventual adjustment of the machine set point.

3.3.4. Function Current Address

Each encoder can be identified in an univocal way by assigning a numeric address that can vary from 00 to 99. The encoder gives a feedback only if it has been addressed in accordance with the assigned address.
For each encoder type TKM60P TEKEL usually assigns as default address the value 00.
Afterwards indicate the new address in the check box on the right side of letter *A*.

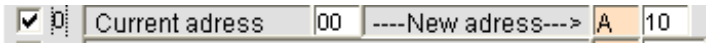


Picture 6 Example of setting a new address with value equal to 10 for an encoder with an old address equal to 0.

Before up-dating the address it is necessary to indicate in the check box *current address* the current address of the encoder that has to be programmed.

You had better put on the encoder case a label with the new address. Remind that once you have modified the address the encoder will give a feedback only to the new address. If you should forget the programmed address you will have to search the correct address with the **Address>>** function.

In the end use the mouse to activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

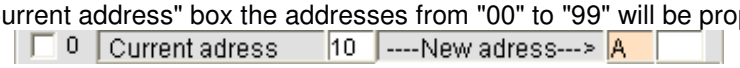


Picture 7 Example of new address selection: Old address = 00, New address = 10

Now it is possible to proceed with the encoder programming by pressing the TX PARAMETERS button.

3.3.5. Automatic address search

Press the Address>> pushbutton in order to begin the search of the unknown address. The pushbutton will become red and in the "Current address" box the addresses from "00" to "99" will be proposed in sequence.



Picture 7A

The sequence will be interrupted when an answer from the connected encoder will be found. The encoder address will be visible in the "Current Address" box.
In case no encoder is found, the addresses sequence will continue up to "99"; afterwards the starting address will be proposed again and the search will be interrupted.

WARNING: this condition indicates an anomalous operation which Is probably due to:

- Wrong or missing electrical connections between encoder and PC (it is typical the reversal between TX and RX signals, or the missing connection of the GND signal coming from the PC to the "0 V" signal of the encoder power supply);
- Interruption of the connection (cable interrupted, missing contact, inappropriate clips tightening);
- Encoder power supply lacking or outside from the specified field;
- Presence of two or more encoders connected in parallel on the same serial line;
- Failure of the PC serial interface or of the encoder.

Once started it is possible to interrupt the search in any time by pressing the Stop pushbutton.

3.3.6. Function number of steps for single revolution

This function enables to set the encoder resolution for each shaft revolution. The admitted value range goes from a minimum of 1 to a maximum of 8192.

In order to program the no. of steps for each revolution indicate the requested resolution in the check box on the right side of the letter *P*.

Picture 8 Example of setting of a 3600 resolution for each single revolution.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 9 Selection of the function no. of steps for single rev.

Now it is possible to proceed with the encoder programming by pressing the TX PARAMETERS button.

3.3.7. Function Number of revolutions

This function enables to set the max. number of revolutions referred to the encoder output code. The admitted value range goes from a minimum of 1 (the TKM60P becomes as a programmable single turn absolute encoder) up to maximum of 4096 revolutions.

In order to program the no. of steps for each revolution indicate the requested resolution in the check box on the right side of the letter *G*.

Picture 10 Example for 1024 turn selected.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 11 Example for 1024 turn selected.

Now it is possible to proceed with the encoder programming by pressing the TX PARAMETERS button.

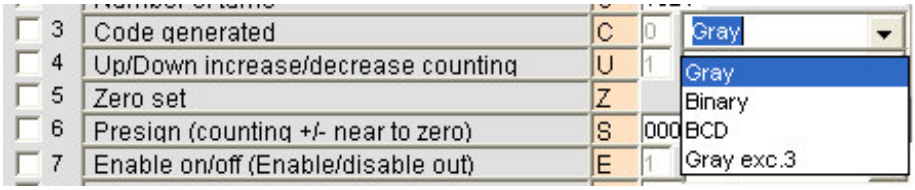
3.3.8. Function Type of code

This function enables to set the type of code that has to be generated in output by the encoder (but not the type of output electronics). This function can be set, at the present time, according to the options indicated in table 2.

Code	Type of code generated in output
0	Gray
1	Binary
2	BCD
3	Excess 3 Gray code

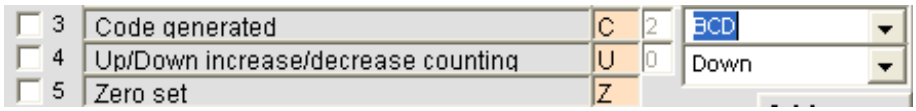
Table 2 Codes that can be generated in output by the TKM60P encoder.

In order to choose the requested code select with the mouse the menu relevant to the function under examination, then choose the possible options:



Picture 12 Selection of the code type in output

By using the mouse scroll the menu options until you find the requested option. Then press the mouse left button to select the type of code. At this point the choice window is closed and the code previously chosen is displayed. If for example you need the BCD code in output, after having pressed the mouse left button, you will have the following situation:



Picture 13 Example of BCD code selection.

After the selection of the code type, in order to see the up-dating of the identification code, you just have to select one of the other cells.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

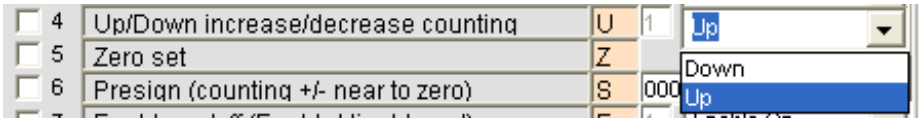
Picture 14 Selection of the function relevant to the type of code in output.

Now it is possible to proceed with the encoder programming by pressing the TX PARAMETERS button.

3.3.9. Function Up/Down Increases/Decreases the output counting

This function (available both software and hardware) enables to set the encoder counting direction. Usually the code increases with the shaft clockwise rotation; through this function it is possible to reverse the counting direction thus obtaining a code that decreases with the shaft clockwise rotation.

If you need to set an increasing counting with the shaft clockwise rotation (UP mode) select with the mouse the menu relevant to the function under examination. At this point a menu with the following options will be displayed:



Picture 15 Selection of the UP counting mode.

By pressing the mouse left button you select the underlined option which, in the example of picture 15, is referred to the UP counting direction.

At this point the menu closes and in the check box appears the chosen direction.

Picture 16 Look of the UP/DOWN text box with Up option selected.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 17 Selection of UP/DOWN function.

Now it is possible to proceed with the encoder programming by pressing the TX PARAMETERS button.

3.3.10. Function zero set

This function (available both software and hardware) enables to set to "0" value the encoder output code independently from the value acquired by the code itself.

Once the code has been set to "0" value it will be no longer possible to recover the code value present before the setting.

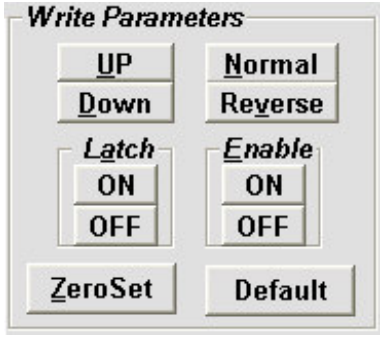
This function can be activated in two different ways: following the common procedure already explained for the other functions or using the proper button which makes the different operations quicker. In the second way the software itself will select the function and will send the zero set command.

We will show the standard procedure and then we will explain the alternative procedure.

The zero set function does not need any parameter then you must only select it and press the transmission button to program the encoder with output code equal to 0.

3.3.11. Alternative procedure to reset the output code (zero set)

In order to quicken the set to "0" operation, press the ZeroSet button in the panel *Parameters writing* and the output code is reset. This button is equivalent to all the operations that have to be carried out with the standard procedure namely the function selection and consequently the parameters transmission.



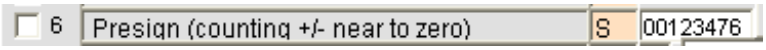
Picture 18 - Write *Parameters* window.

3.3.12. Function Presign (counts +/- around the zero position)

The Presign function enables to define a code origin and to distinguish between positive and negative codes according to their origin.

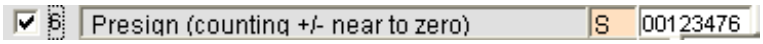
It is possible to set a code between 0 and 33554431 (which means 8192x4096 codes that can be generated).
The state of the bit corresponding to the sign is present as a hardware output on a pin of the connector or of the cable according to the chosen output type.
In order to set a zero as a starting data you must write the code value that has to be considered as the origin and to do this operation stroke the code in the text check box on the right side of letter *S*.

For example, if you need to set as origin 123476 you will have to stroke:



Picture 19 Example of setting the origin for the presign function.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.



Picture 20 Selection of the presign function set at the value 00123476.

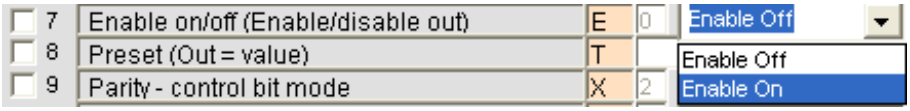
Now it is possible to proceed with the presign programming by pressing the PARAMETERS button.

3.3.13. Function Enable on/off (output enabled/disabled)

Through the *Enable* function (available both software and hardware) it is possible to enable or disable the encoder outputs; in other words if this function is disabled the output drivers go into high impedance state and the other lines of the system are insulated.

1. In case of standard PP electronics (with internal pull-down load between the output and the 0 Volt reference) the outputs will go to zero.
2. In case of PNP OP electronics (without internal pull-down load) the output will go into high impedance state.
3. In case of standard NPN electronics (with internal pull-up load connected between the output line and the +Vin input potential) the outputs will acquire the value of the input voltage supplied by the encoder.
4. In case of NPN OC electronics (without internal pull-up load) the output will go into high impedance state.
5. In case of SSI electronics the output driver will go into high impedance state.

In order to disable the *Enable* function select with the mouse the menu corresponding to the function under examination and at this point a menu will open with the following choices:



Picture 21 Example of disabling of the *Enable* function.

By pressing the mouse left button select the underlined option that in the example shown in picture 22 is referred to the Enable disabling.

At this point the menu closes and in the text box appears the chosen option.

Picture 22 Example of disabling of the *Enable* function.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 23 Example of selection to disable the *Enable* function.

At this point by pressing the PARAMETERS button you can proceed with the disabling of the output *Enable* function and the output will go into high impedance state.

Before contacting the TEKEL after-sales service, the user should check the state of this function. If the function is disabled (both software or hardware), the encoder output is in high impedance state, this may confuse the user which could consider it as an encoder malfunction.

3.3.14. Function Preset (sets the output equal to a defined value)

Through this function it is possible to programme the current value of the output code with any value ranging from 0 to 33554431. This is an extension of the zero set command; in fact the zero set enables to reset only the output code while, through the *Preset* function, it is possible to set the output at an arbitrary value included in the admitted range previously indicated.

Once the code value has been re-programmed it will be no longer possible to restore the value acquired by the code before the new programming.

In order to set the output code with a different value from the present one write the requested value in the text check box on the right side of letter *T*.

For example, if you need to set as origin 1453276, stroke the following:

Picture 24 Programming of the output code through Preset function.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 25 Example of selection referred to the *Preset* function.

At this point, pressing the TX PARAMETERS button, you will set the output code at the chosen value, in the case of the example you will have 1453276.

3.3.15. Function Parity – control bit mode

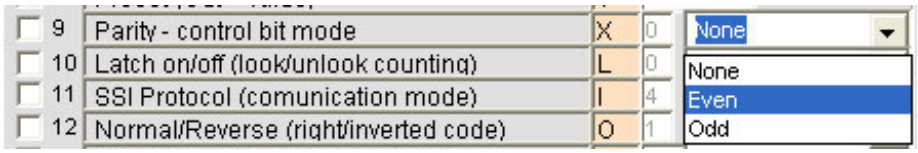
Through this function it is possible to disable the parity or, in case this is enabled, to establish if this must be even or odd.

We can have two different types of parity:

1. ***even parity*** the parity output is equal to 1 only in case the number of "1" contained <u>just in the output code</u> is even.
2. ***odd parity*** the parity output is equal to 1 only in case the number of "1" contained <u>just in the output code</u> is odd.

In order to set the parity type or to disable the parity, open the menu referred to this function on the right side of letter *X*, in the example we suppose to select the even parity.

As default configuration TEKEL does not select the parity output then the starting parameter of this function will have the value *none*.



Picture 26 Menu referred to the *Parity* function.

By pressing the mouse left button select the underlined option that, in the example shown in picture 26, corresponds to the even parity.
At this point the menu closes and in the check box it appears the chosen option.

Picture 27 Selection of the option corresponding to the even parity.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 28 Selection of the function for the parity programming.

At this point, pressing the TX PARAMETERS button, you can set the chosen parity type.

3.3.16. Function Latch on/off (Freeze the output code)

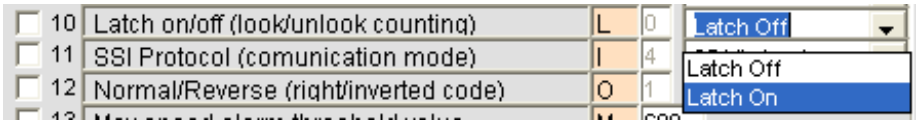
Through the LATCH function (available both software and hardware) it is possible to freeze the encoder output code. The encoder, considering the serial interface, keeps on operating.

As default setting TEKEL sets the disabled LATCH; in this way the output code does not result locked.

Before contacting the TEKEL after-sales service always verify the state of this function. If the function is enabled (software or hardware), the outputs are locked at a fix value and this may confuse the user which could consider it as an encoder malfunction.

In order to set the latch type or to disable the latch, open the menu corresponding to this function on the right side of letter *L*.

In the example we suppose to freeze the output code and to enable again the LATCH function.



Picture 29 Selection of the function for the LATCH programming.

By pressing the mouse left button select the underlined option that, in the example shown in picture 29, corresponds to the enabled Latch signal.

At this point the menu closes and in the check box it appears the chosen option.

Picture 30 Latch function after the selection.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 31 Selection of the function relevant to the LATCH.

At this point, by pressing the TX PARAMETERS button, you can configure the LATCH function, that in the shown example, freezes the encoder output value.

3.3.17. Function SSI Protocol (mode and format)

In addition to the parallel outputs (NPN, PNP or Push-Pull types) there is another extremely common type of output for the absolute encoders (both single- and multi turn) which is the SSI type (Serial Synchronous Interface). For any information regarding the operation of this type of output please refer to Chapter 4.

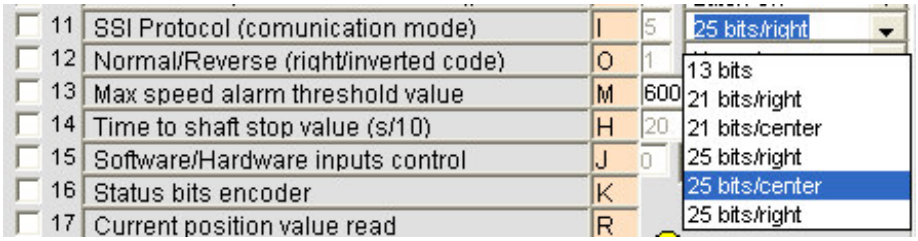
The SSI interface supports different standards that are described in the table 3.

Number of bit	Alignment
13	Not applicable
21	Right
21	Centre
25	Right
25	Centre

Table 3 SSI possible protocols

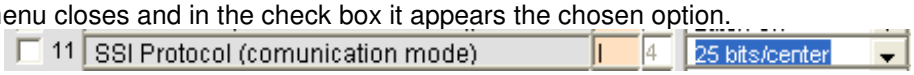
In order to select one among the possible protocols you have to go to the menu at the right side of letter *I*.

In the example it is shown how to select the SSI protocol with 25 bit aligned on the centre.



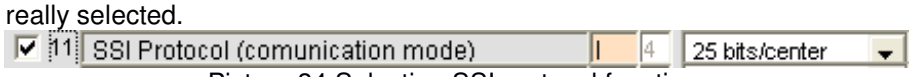
Picture 32 Selection of the SSI protocol with 25 bit aligned on the centre.

By using the mouse left button select the underlined option that, in the example shown in picture no.32, corresponds to the SSI protocol with 25 bit aligned on the centre.
At this point the menu closes and in the check box it appears the chosen option.



Picture 33 Selection of SSI protocol for option 25 bit aligned on the centre.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.



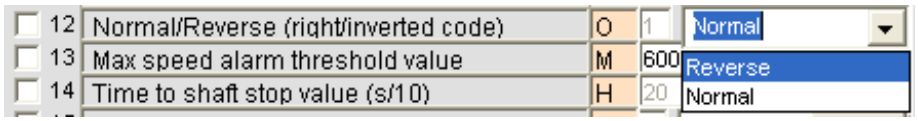
Picture 34 Selection SSI protocol function.

At this point, by pressing the TX PARAMETERS button you can configure the SSI protocol.

3.3.18. Function Normal/Reverse (code normal/reverse)

This function executes the negation of the output code, carrying out the complement to 1of the single bit.
As default configuration TEKEL sets this function in Normal mode, namely the output code is not inverted.
In order to set the *Normal* or the *Reverse* mode open the menu related to this type of function at the right side of letter *L*.

In the example it is shown how to enable the complemented code option namely the *Reverse* mode.

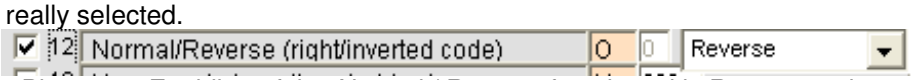


Picture 35 Selection Normal / Reverse option.

By pressing the mouse left button select the underlined option that, in the example shown in picture 35, corresponds to the enabling of *Reverse* option.
At this point the menu closes and in the check box it appears the chosen option.

Picture 36 Selection Normal / Reverse option.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

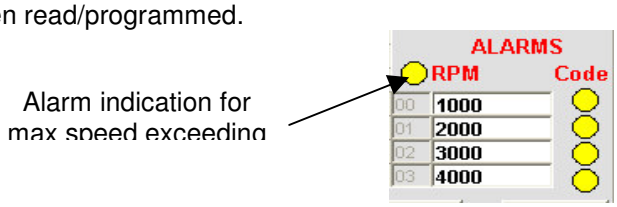


Picture 37 Enabling of the *Normal / Reverse* function with *Reverse* option.

At this point, by pressing the TX PARAMETERS button you can configure the SSI protocol.

3.3.19. Function Threshold Value for max. speed alarm

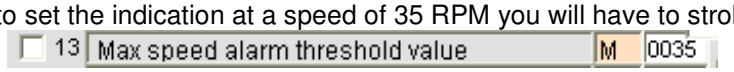
The a.m. function enables to set a threshold relevant to the exceeding of a speed ranging from 0 RPM (alarm always on) to 700 RPM (revolutions per minute). The exceeding of the max speed is indicated through a dedicated pin on the output connector or through a wire on the cable output. Besides the physical signal the speed alarm is also displayed on the TKPROG panel (from yellow to red) in the alarm section, picture 38.
The threshold on the alert goes from the green colour to the red one. The indication is yellow when the parameter has never been read/programmed.



Picture 38 Alarm window (max speed exceeding and thresholds).

You can set the threshold speed value indicating the speed value in the text check box at the right side of letter *M*.

For example, if you need to set the indication at a speed of 35 RPM you will have to stroke the following:



Picture 39 Example of speed threshold programming.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 40 Selection of the max. speed exceeding function.

At this point, by pressing the 

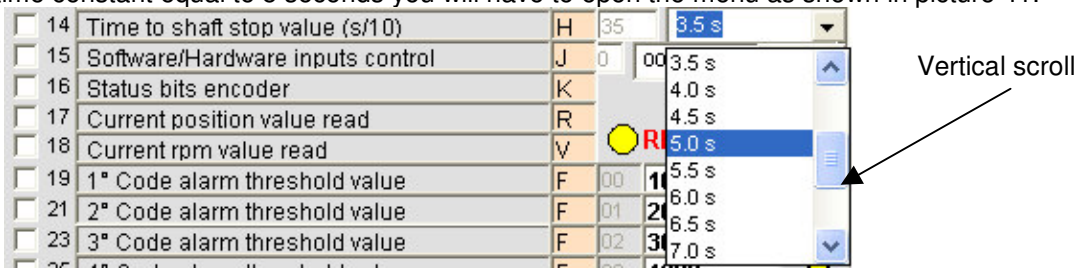
button you can set the speed limit beyond which the alarm threshold will be enabled.

3.3.20. Function Time Constant for stopped shaft status

This function gives a signal when the encoder shaft is not operating for a period of time that is higher than the fixed one (between 0 and 9,5 s). The period of time is quantified in seconds and can be selected in the table with steps of 0,5 s.

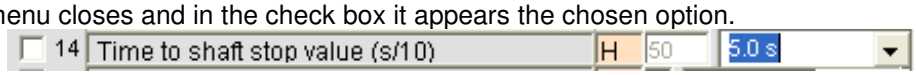
In the window *Rotation*, the enabling of the non operating shaft function is signalled through the STOP indicator. The two lateral indicators (CCW and CW) indicate the rotation direction, counter clockwise and clockwise respectively.

If you need to set a time constant equal to 5 seconds you will have to open the menu as shown in picture 41.



Picture 41 Selection menu for non operating shaft constant.

By pressing the mouse left button select the underlined time constant; if the requested time constant does not appear in the menu use the vertical scroll bar to scroll the remaining options (to use the scroll bar position the mouse cursor on the bar, press the left button and move the mouse upwards or downwards).
At this point the menu closes and in the check box it appears the chosen option.



Picture 42 Selection menu for non operating shaft constant.

By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 43 Selection menu for non operating shaft constant.

At this point, by pressing the 

button you can set the speed limit beyond which the alarm threshold will be enabled.

3.3.21. Function for Software/Hardware options control

With this function it is possible to choose if a certain command has to be managed only software or if it can also be of hardware type. In any case the software setting has always a priority, in other words it is never possible to disable a certain command in a definitive way (SW+HW).
The commands that can be managed according to the SW and HW mode are the following:

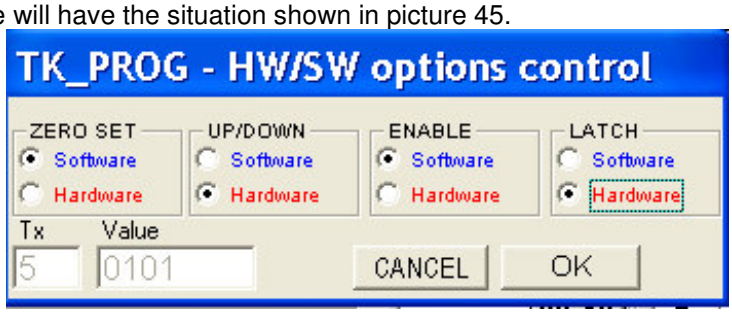
1. LATCH (freezes the output code)
2. ENABLE (enables the output or this goes into high impedance state)
3. UP/DOWN (defines the direction of code counting increase/decrease)
4. ZERO SET (sets to "0" value the output code)

In order to define a valid combination of the above indicated commands press the 

button; at this point the selection window shown in picture 44 will appear.

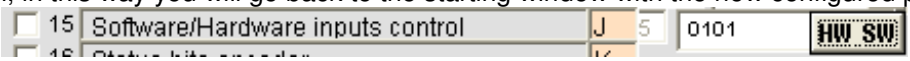
Picture 44 Selection menu HW and SW commands.

Press the mouse left button for the requested selection. If for example you need to enable the UP/DOWN and LATCH commands in Hardware mode (namely operate the lines which are physically present on the connector or on the cable and which are dedicated to these inputs) and you need to manage the ZERO-SET and the ENABLE input only by software, we will have the situation shown in picture 45.



Picture 45 Selection of the UP/DOWN and LATCH inputs of Hardware type.

If you are not sure of the chosen selection press the CANCEL button, in this way you will go back to the main window without altering the existing configuration. If the chosen selection is correct proceed pressing the OK button, in this way you will go back to the starting window with the new configured parameters.



Picture 46 Selection of the UP/DOWN and LATCH options of Hardware type.

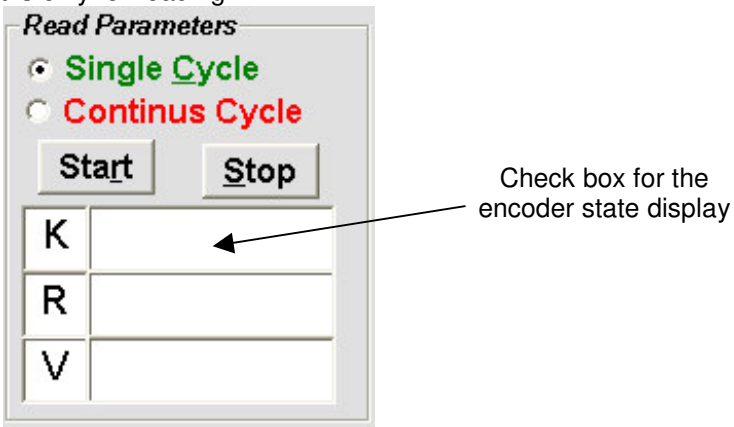
By using the mouse activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 47 Selection of the function for the HW and SW settings.

To transmit the new parameters you will just have to press the TX PARAMETERS button.

3.3.22. Function for encoder state signals

This function enables the displaying of the encoder state word in the window *Read Parameters*. Since this parameter does not have any argument it is only for reading.



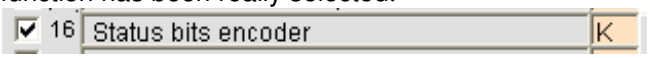
Picture 48 Window *Read Parameter*

No. 8 state bit are available for the reading; these are organized to form 4 hexadecimal numbers which are able to represent 4 conditions each. The operation range goes from "0000" and "FFFF", with the possibility of representing 4*4 = 16 bit.

The development of the single bit starts from the right (bit 0÷3) towards the left (bit 12÷15) in conformity with the following correspondence:

bit 0 : Stopped Shaft (0=moving, 1= stopped)
bit 1 : Max. speed exceeded (0=max speed not exceeded, 1=max speed exceeded)
bit 2 : Encoder direction (1 = CW, 0 = CCW)
bit 3 : for future usages
bit 4 ÷7 : temporary data
bit 8÷11 : limit stop alarms 0, 1, 2, 3 (0=OFF, 1=ON)
bit 12÷15 : limit stop alarms 4, 5, 6, 7 (0=OFF, 1=ON)

To read the encoder state, by using the mouse, activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

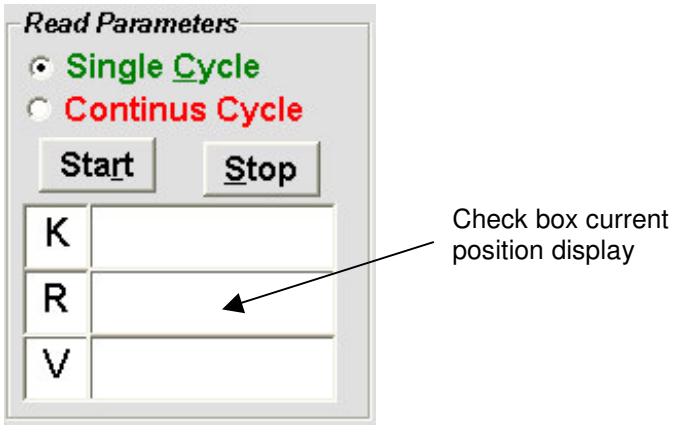


Picture 49 Selection of the function for the encoder state signaling.

For the reception of the state word you just have to press the PARAMETERS button; the updated state word will appear in the window *Read Parameters* in the line identified with letter *K*.

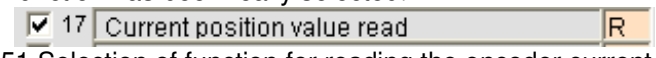
3.3.23. Function for the reading of the current position value

Similar to the previous function, also this one does not have any argument and it is only for reading. This function enables the reading of the encoder current position. The information concerning the position is displayed in the window *Read Parameters* in the line identified with letter *R*.



Picture 50 Window *Read Parameters*.

To read the encoder position, by using the mouse, activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

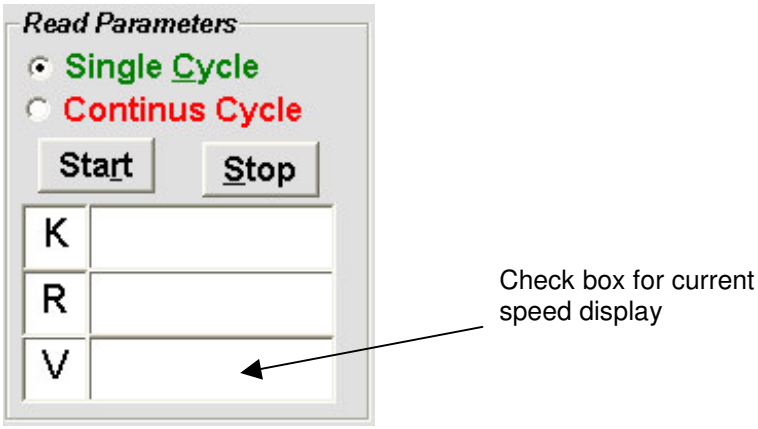


Picture 51 Selection of function for reading the encoder current position.

For the reception of the value relevant to the encoder current position you just have to press the PARAMETERS button; the updated value will appear in the window *Read Parameters* in the line identified with letter *R*.

3.3.24. Function for the current speed value reading

Also this function belongs to the ensemble of the read only functions and it enables to acquire the encoder current speed. The information concerning the speed is displayed in the window *Read Parameters* in the line identified with letter *V*.



Picture 52 Window *Read Parameters*.

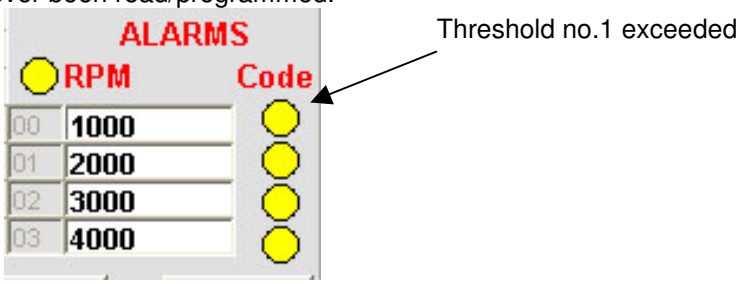
To read the encoder speed, by using the mouse, activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.

Picture 53 Selection of the function for the encoder current speed reading.

For the reception of the speed you just have to press the TX PARAMETERS button; the encoder current speed is displayed in the window *Read Parameters* in the line identified with letter *V*.

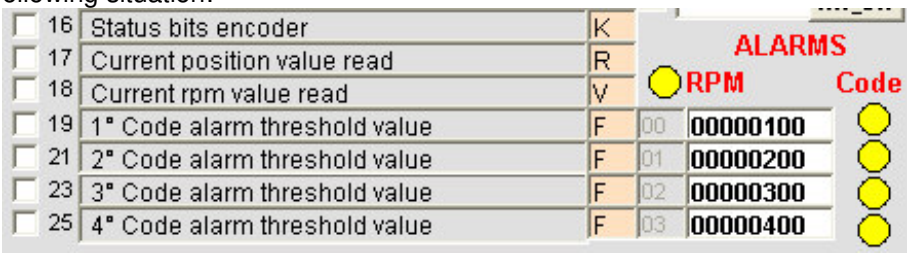
3.3.25. Function code alarm threshold value

We have grouped in one single section the last four functions that are available on the programming panel since they are substantially used in the same way.
Each function enables to set a signal when the encoder code exceeds a default threshold that can be set at any value going from 0 to 33554431.
The signal indicating that the threshold has been really exceeded is displayed on the programming panel in the alarm window shown in picture 54. The threshold on the alert goes from the green color to the red one. The signal is yellow when the parameter has never been read/programmed.



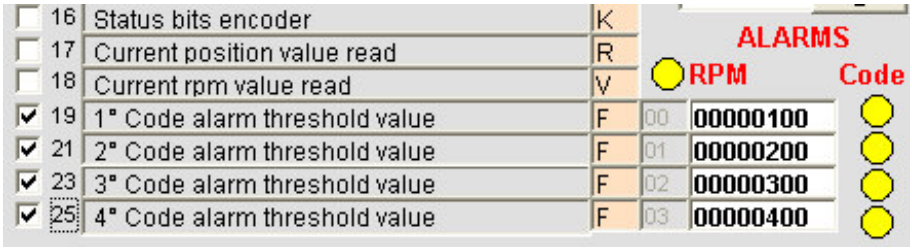
Picture 54 Alarm window (exceeding of max. speed and thresholds).

To program one of the four thresholds write the requested value in the field immediately on the right of the number that identifies the threshold. For example you need to set the four thresholds to 100, 200, 300 and 400. You will have the following situation:



Picture 55 Example of setting the alarm thresholds on the code.

By using the mouse, activate the square check box in the first column; a tick sign is displayed to indicate that the function has been really selected.



Picture 56 Example of setting the alarm thresholds on the code.

To transmit the new parameters press the TX PARAMETERS button.

3.3.26. RS422 protocol activation - Mode 1 (code 141)

The "Mode 1" transmission protocol for RS422 (code 141) serial interface electronic is activate by clicking on the cod.141 box. The message of picture 56C will be displayed.

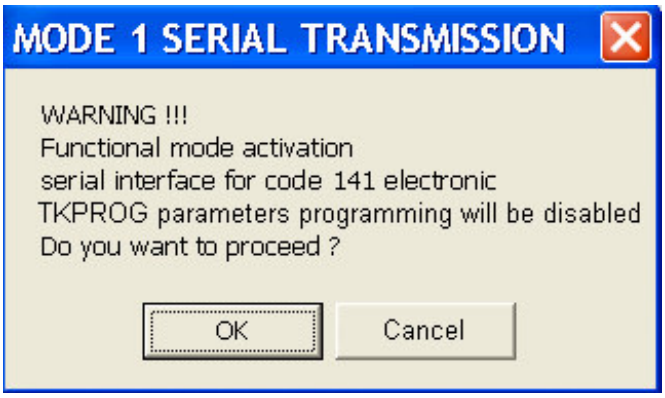


Fig. 56C Confirmation of MODE1 serial protocol activation

This modality does not allow any parameters programming, but it only reads the value of the encoder shaft current position.

Click OK to activate the "Mode1" transmission protocol for RS422 serial interface: all the other functions of the programming panel will be disabled and only the access to *"Reading Parameters"* panel is possible.

Click Cancel to return to the normal programming mode, with all the functions of the panel of control available.

To disable the "Mode 1", once activated, click in the cod.141 box, and the normal programming mode will be restored.

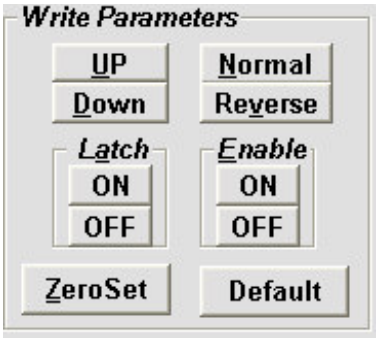
Pressing the Start pushbutton the ASHII "STX" character in transmitted to the encoder.
The transmission from the encoder starts immediately after the reception of the "STX" ASHII character, sending a eight characters HEX ASCII text, containing the current position value + the end text "CR" (carriage - return) character, which is stored in the box of "R" parameter of the Read Parameters panel.

The reading sequence is executed one single time, or in a cyclic mode, according to the operation modalities indicated at the points 3.2.27. and 3.2.28.

Activating the "Continuous Cycle" mode it is possible to interrupt the data reading by pressing the Stop push-button.

3.3.27. Window Write Parameters

The window Write Parameters, shown in picture 57, enables to set in a rapid way the main commands for the configuration of theTKM60P absolute encoder.



Picture 57 - Window Write Parameters.

As a matter of fact, through the buttons in this window, it is possible to execute in a direct way (without first selecting the function and then transmitting the parameter) the following functions:

- UP : to set the UP counting direction with clockwise shaft rotation
- DOWN : to set the DOWN counting direction with clockwise shaft rotation
- NORMAL : to set the standard output bit state
- REVERSE : to complement the output code bits compared with the standard code
- LATCH ON : to enable the LATCH function freezing the output code
- LATCH OFF : to disable the LATCH function, the output code is up-dated with the encoder shaft rotation.
- ENABLE ON : the encoder outputs are enabled.
- ENABLE OFF: the encoder outputs are in high impedance state.
- ZERO SET : to set to "0" value the output code.

By pressing the button relevant to the function under examination this is enabled or disabled and moreover the check box relevant to the function in the *Encoder Parameters* window is updated.

3.3.28. Window Read Parameters

The window under examination enables to set two enquiry modes of the encoder:

- single cycle;
- continuous cycle;

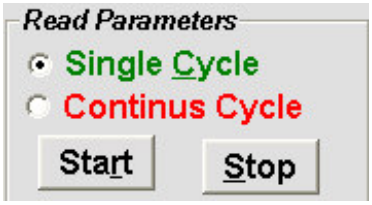
This window enables also the following operations: to check the *K* encoder state word; to display in the *R* window the output code indicated in BCD mode (this means that, for example, the Gray code is grouped in *nibble* and presented in hexadecimal format); to display the encoder shaft rotation speed expressed in RPM in window *V*.

For the meaning of the parameters contained in this window refer to the description at pages 22 and 23. Hereafter we will explain the two enquiry modes previously listed.

3.3.29. Single cycle operating mode

By selecting the *Single cycle* option and by pressing the 

button a single reading of the state word, of the encoder current position and speed are carried out. The received information is displayed in the *K*, *R* and *V* windows respectively in the *Read Parameters* window.

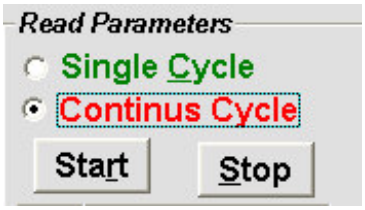


Picture 58 Setting for the encoder single cycle enquiry.

3.3.30. Continuous cycle operating mode

By selecting the *Continuous cycle* option and by pressing the 

button a continuous reading of the state word, of the encoder current position and speed are carried out. The received information is displayed in the *K*, *R* and *V* windows respectively in the *Read Parameters* window.



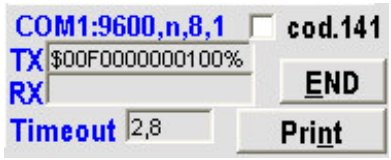
Picture 59 Setting for the encoder continuous cycle enquiry.

This mode is useful in particular when the user needs to learn how to use the device. As a matter of fact it enables to select and program the encoder options in a rapid and easy way, immediately verifying the correct operation of the encoder itself.

3.3.31. Monitor for the serial interface activity

The monitor relevant to the serial interface shown in detail in picture 60 enables to know if the encoder replies correctly and also to display the message that has been sent to the encoder to program or display a certain parameter.

In the TX field it appears the ASCII string sent by the TKPROG programming software to the TKM60P encoder in order to program the requested function. By operating on one single function at a time it is then possible to see which characters must be sent to the encoder to execute the chosen function. In case of multiple programming - namely if various functions have been selected with the tick sign - it will appear the programming string corresponding to the last function that has been sent.



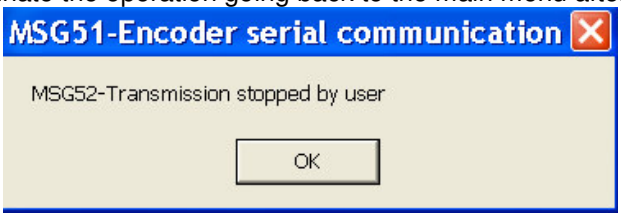
Picture 60 Serial interface monitor

In the RX field it appears the reply of the TKM60P encoder to a programming message sent by the TKPROG software; when the encoder understands the message it replies as last character with the "!" sign.

The last window, identified with Timeout, indicates the period of time that passes between the sending of the programming string from the TKPROG to the TKM60P encoder and the reception of the encoder reply to the programming software. The default max timeout is 10 s; if during this period of time no reply goes from the encoder to the TKPROG the error window shown in picture 61 will be displayed.

Picture 61 Timeout error window of serial interface

At this point the user can terminate the operation going back to the main menu after a brief confirmation message:



Picture 62 Closing confirmation message.

Otherwise it is possible to try again to transmit the last parameter by pressing the *Try again* or *Ignore* buttons.

4. *Serial program interface*

4.1. Encoder program interface type RS232/RS485

The main characteristic of the TKM60P is the possibility of modifying a series of parameters while in a conventional absolute encoder these are rigid and are decided when ordering the item.

This flexibility is enabled by using a special interconnection technique between devices of intelligent type (namely equipped with a microprocessor system) named *serial connection*.

This type of connection is rapid to do with every type of computer, both portable or desktop, currently produced and available on the home compute consumer market.

It is possible to manage in a simple and rapid way all the functions of the encoder by means of the serial interface and of a dedicated software (*TKPROG*) directly developed by TEKEL and supplied without costs added. This allows to obtain a system which is extremely flexible and utilizable even with applications which are very different one from the other.

The programming software is free and is available on CD-Rom, on 3,5 " floppy disk or visiting our web site www.tekel.it.

The programming software has been developed to work in Windows operating systems and is available for different platforms such as:

- ◊ Windows 9X (95/98)
- ◊ Windows ME
- ◊ Windows 2000 professional
- ◊ Windows XP

This software maintains its compatibility with the old versions and it is constantly innovated and improved to make it always easier to use and to increase its flexibility. Therefore we suggest that the user periodically checks if any up-dated versions have been issued.

In the following chapter we will describe in detail the programming software and afterwards we will give you all the information necessary for the carrying out of a serial cable to interconnect the encoder to the computer to explore the characteristics of this device.

4.2. Theory of the serial interface operation

This paragraph is addressed to the experienced users which need to implement on their PLC the serial protocol to carry out the software programming of the TKM60P multi-turn absolute encoder.

The serial interface of asynchronous type, concerning the data electrical transmission, can be RS232 or RS485; please note that the interface type must be indicated when ordering the encoder.

4.2.1. Setup of the asynchronous serial port

The data transmission and reception are carried out through the asynchronous serial port that can be configured with:

- Starting bit : 1 bit.
- Baud rate : 9600 baud.
- No. of bit : 8 bit + 1 stop bit (optional: 7 bit + 2 stop bit with or without parity), 8 bit + 1 stop bit with parity, 8 bit + 2 stop bit without parity).

4.2.2. Read Write Parameters

The encoder recognizes 25 parameters that can be used in reading mode (Rd), in writing mode (Wr), or in both modes. The writing involves a transmission from host (PC) towards the encoder; the reading involves a reception from host (PC) towards the encoder and takes place after the transmission of a command.
From the host it is possible to organize groups of functions by carrying out a sequence of consecutive writings/readings. In case of next transmissions towards encoder without handshake, the new command will be ignored (answer '?' [NAK]).

4.2.3. Transmission protocol towards the encoder

The transmission protocol towards the encoder has to be structured in the following way:

[$][Address][Name]<Value>[%]

in which:

$	start character that identifies the transmission start
Address	numerical value that identifies in an univocal way an encoder (2 ASCII decimal characters)
Name	letter that identifies the parameter that has to be read or written (1 ASCII character)

Value it contains the numerical value that has to be assigned to the parameter that must be programmed (writing). If it is omitted the value is requested to the encoder, except for the write only Names that do not have any value (n ASCII characters)
% stop character that identifies the transmission end

4.2.4. Reception protocol from the encoder

From the encoder the following answers will be obtained:

[?] or [!] or [$]<Value>[%]

in which:
? in case of non considered name or value incongruity or transmission timeout
! indicates the correct command execution
$ start character that identifies the transmission start
Value it contains the numerical value in reply to a data or a configured value request (n ASCII characters)
% stop character that identifies the transmission end

4.2.5. Encoder programming parameters

Note 1: All the transmitted and received data are in ASCII code; all the parameters are numerical and are expressed in decimal value, except for the state (16, 18) and the errors diagnostic parameters (21), which are expressed in hexadecimal (16 number system).

Note 2: The velocities (V and M) are expressed in RPM.

Note 3: The stopped shaft period of time (H) is expressed in decimate of second.

Note 4: The threshold setup (F) must be carried out when the encoder shaft is stopped, in order to avoid errors.

Note 5: Code type :
0 : Gray
1 : Binary
2 : BCD
3 : Excess 3 Gray

Note 6: SSI protocol:
0 : 13 bit
1 : 21 bit right alignment
2 : 21 bit center alignment
3 : 25 bit right alignment
4 : 25 bit center alignment

Note 7: Options control
bit 0 : LATCH (0 = SW, 1 = HW)
bit 1 : ENABLE (0 = SW, 1 = HW)
bit 2 : UP/DOWN (0 = SW, 1 = HW)

Note 8: Encoder state:
bit 0 : Encoder non operating
bit 1 : Programmed speed exceeded
bit 2 : Encoder direction (1 = CW, 0 = CCW)
bit 3 : of no value
bit 4÷7 : temporary data
bit 8 : Alarm threshold 0 ÷ 3
bit 12÷15 : Alarm threshold 4 ÷ 7 (expansion)

No.	Name	Value (Limits)	Rd	Wr	Byte	Characteristic	
1	A	00 ÷ 99	(x)	X	2	RS485 Address	
2	P	0002 ÷ 8192	x	x	4	Standard resolution	
3	G	0000 ÷ 4096	x	x	4	No. of turns	
4	C	0 ÷ 3	x	x	1	Code type	(ref. note 5)
5	U	1, 0	x	x	1	UP/DOWN	
6	Z			x	0	Zero set	
7	S	00000000 ÷ 33554431	x	x	8	Preset	
8	E	0, 1	x	x	1	Enable	
9	T	00000000 ÷ 33554431		x	8	Preset	
10	X	0, 1	x	x	1	Parity	
11	L	0, 1	x	x	1	Latch	

12	I	0 ÷ 4	x	x	1	SSI protocol	(ref. note 6)
13	O	0, 1	x	x	1	Code negation	
14	M	0000 ÷ 9999	x	x	4	Max. speed	
15	H	00 ÷ 99	x	x	4	Encoder non operating	(ref. note 3)
16	J	0 ÷ F	x	x	1	Options control	(ref. note 7)
17	F	00÷03 00000000÷33554431	x	x	2+8	Alarm threshold 0..3	
18	K	0000 ÷ FFFF	x		2	Encoder state	(ref. note 8)
19	R	00000000 ÷ 33554431	x		8	Current value reading	
20	V	0000 ÷ 9999	x		4	Rotation speed	
21	B	00 ÷ 99	x	x	2	Transmitted program no.	

Table 4 Commands summary

4.3. Wiring diagrams

In this paragraph we will explain the most common wiring diagrams to carry out a RS232 / RS485 serial connection between the PC *host* and the TKM60P absolute encoder.

In some PCs the serial interface is available with a 25 pin DB connector housing (DB25) but in the latest PCs this interface is almost only supplied with a 9 pin DB connector (DB9).

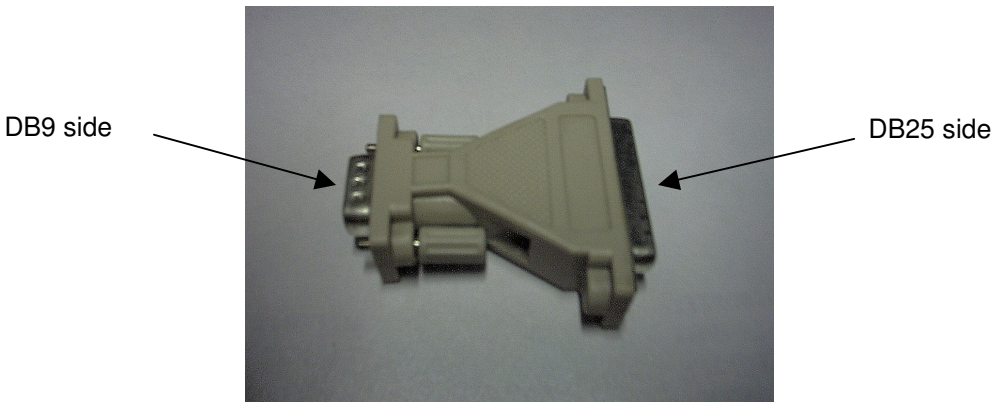
On the market you can easily find some adapters to transform the DB25 output in DB9 (ref. picture 63).

In black character are listed the signals that are essential in order to carry out a serial connection of minimum type (without handshake hardware). Through these signals it is possible to entirely program the TKM60P encoder.
In order to prepare the cable, even in case of 25 pin DB connector, refer to the following table for the connection diagram for this type of connector.

RS232 pin assignment (DB25 connector serial port on PC)			
Pin 1	**Shield**	Pin 6	-
Pin 2	**Transmit Data (TX)**	Pin 7	**Signal Ground (0 Volt)**
Pin 3	**Received Data (RX)**	Pin 8	-
Pin 4	-	Pin 20	-
Pin 5	-	Pin 22	-

Table 5

The connector on the PC is male, then you will have to assemble
a cable with a DB25 female connector at the end.



Picture 63 Example of DB25 - DB9 adapter

Hereafter you will find the connection diagram relevant to the 9 pin DB connector. As far as the pin numeration on the welding side is concerned refer to what it is indicated in picture 64:

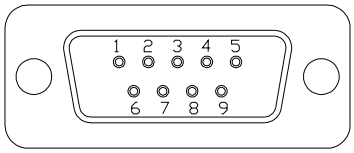
RS232 pin assignment (DB9 connector serial port on PC)			
Pin 1	-	Pin 6	-
Pin 2	**Received Data (RX)**	Pin 7	-
Pin 3	**Transmit Data (TX)**	Pin 8	-
Pin 4	-	Pin 9	-
Pin 5	**Signal Ground (0 Volt)**		

Table 6

The connector on the PC is male, then you will have to assemble a cable with a DB9 female connector at the end. At this point you will have a cable witch a connector on one end and is ready to be connected to the PC.
In order to complete the connection also on the encoder side it is necessary to remind the following:

- The TX cable coming from the PC must be connected to the RX cable or pin (in case the encoder has a connector output) relevant to the TKM60P encoder.
- The RX cable coming from the PC must be connected to the TX cable or pin (in case the encoder has a connector output) relevant to the TKM60P encoder.

This reversal between RX and TX signals existing between the connector on PC side and the connector/cable on encoder side is essential to make the PC communicate with the encoder in the correct way. If the RX and TX signals are not connected in the correct way this will cause a Timeout error.



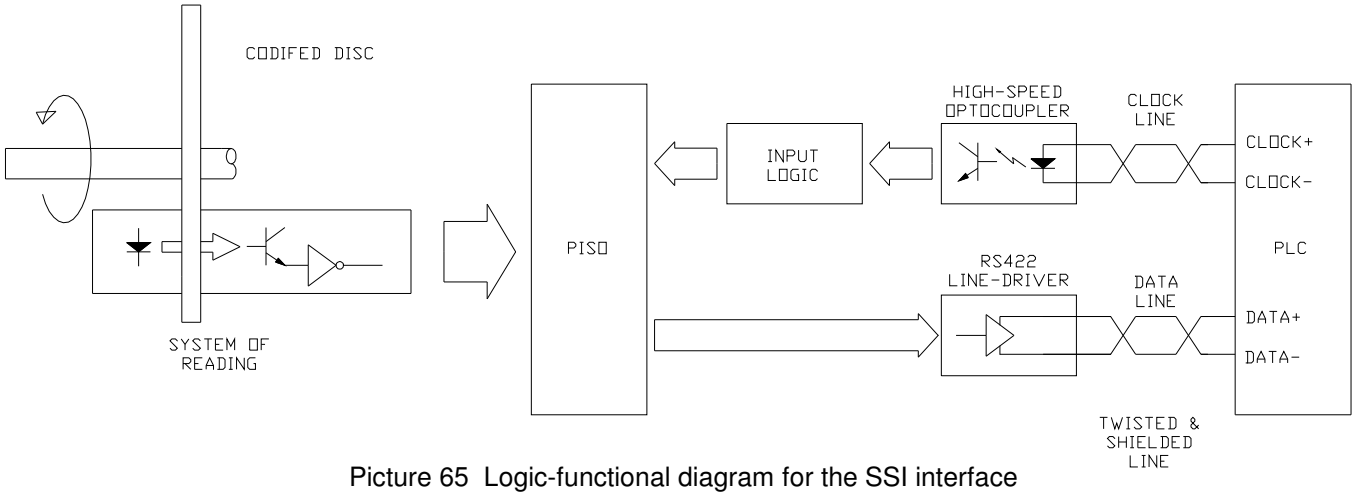
Picture 64 Pin numeration of DB9 female connector on welding side.

5. SSI interface

The SSI interface (*Synchronous Serial Interface*) enables to transfer through a bit sequence the encoder position information to a physical support, made of two data lines and of two clock signal lines that enables to synchronize the data transfer between the encoder and the requesting device (master).

Substantially the master acquires the word relevant to the encoder absolute position through a bit stream. The sending of bit from the encoder is subordinated to the request sent by the master and for this reason we talk of synchronous serial transmission.

From the circuit point of view the SSI interface can be explained as shown in picture 65.



Picture 65 Logic-functional diagram for the SSI interface

The transmission start is communicated from the master to the encoder by bringing the state of the clock line from high to low logic level.

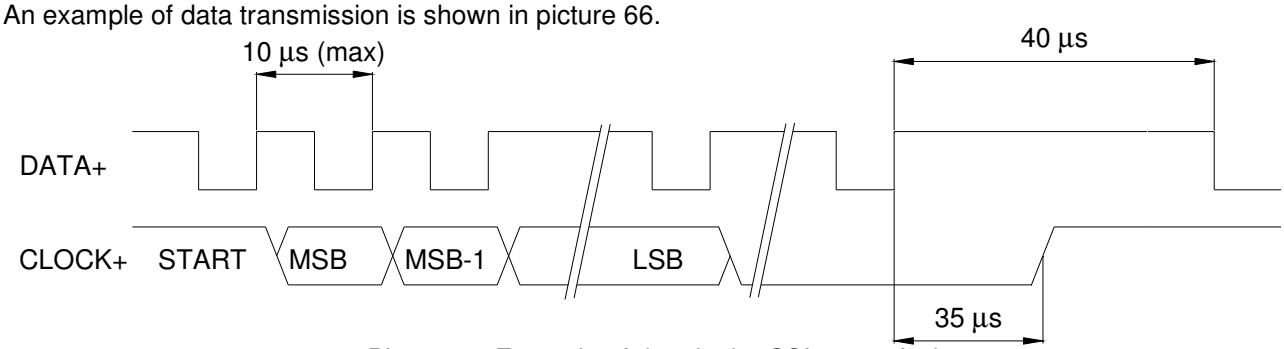
The reading system senses the code present on the main disk and on the satellite disks of the encoder by means of the modulation of a high efficiency light source. After a data request from the master device – that in picture 65 is identified as a programmable logic controller (*PLC*) – the data is stored in a register named PISO (*Parallel Input Serial Output*). After the signals sent on the clock line the PISO sends the code information, 1 bit at a time, through the line-driver on the data line.

This type of information transmission is very simple and enables to reach the transferring speeds (*transfer rate*) up to 2 Mbit/second.

When the transmission of the last bit is ended, the signal of the SSI interface data line remains at low logic level for a default period of time from the *monoflop time* which is generally considered between 30 µs and 40 µs.

After this period of time the data line is again in *idle mode*.

An example of data transmission is shown in picture 66.



Picture 66 Example of data in the SSI transmission.

5.1. Technical characteristics

5.1.1. CLOCK signal

Characteristics	Value
Input type	Differential
Min. frequency	100 kHz
Max. frequency	2 MHz
Minimum current @ 2 MHz	6.6 mA
Max. current	20 mA
Line state *idle*	1 logic (CLOCK+ = HIGH, CLOCK- = LOW)

Table 7

5.1.2. DATA signal

Characteristics	Value
Output type	Differential compatible with RS422
Line Driver type	26LS31 (5 VDC)
Line state *idle*	1 logic (DATA+ = HIGH, DATA- = LOW)
Output data format	Gray (standard), Binary

Table 8

5.1.3. External connections

Characteristics	Value
No. of conductors	4 signals + 2 power supply + 1 Ground (independently from the resolutions)
Characteristics of the connection cable	3 twisted pairs contained in one single shielded cable (min. shielding percentage 70 %)
Allowed transmission distance	≤ 50 m, ≤ 100 m, ≤ 200 m, ≤ 400 m
Baud rate (according to the transmission distance)	≤ 1.000 kHz, ≤ 500 kHz, ≤ 250 kHz, ≤ 100 kHz

Table 9

5.1.4. Transmission protocol

Characteristics	Value
Max. no. of transmitted bit	25
Max. resolution of transmitted data	8192 PPR x 4096 turns
Supported transmission formats	13, 21, 25 bits
Bit justification	Right or center (standard)
Monoflop time	35 µs

Table 10

For the structure of the bit with center alignment or right alignment refer to pictures 67 and 68 respectively.

MSB LSB

CKI	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
4096	N12	N11	N10	N9	N8	N7	N6	N5	N4	N3	N2	N1	P13	P12	P11	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1	8192
2048	0	N11	N10	N9	N8	N7	N6	N5	N4	N3	N2	N1	P12	P11	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1	0	4096
1024	0	0	N10	N9	N8	N7	N6	N5	N4	N3	N2	N1	P11	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1	0	0	2048
512	0	0	0	N9	N8	N7	N6	N5	N4	N3	N2	N1	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1	0	0	0	1024
256	0	0	0	0	N8	N7	N6	N5	N4	N3	N2	N1	P9	P8	P7	P6	P5	P4	P3	P2	P1	0	0	0	0	512
128	0	0	0	0	0	N7	N6	N5	N4	N3	N2	N1	P8	P7	P6	P5	P4	P3	P2	P1	0	0	0	0	0	256
64	0	0	0	0	0	0	N6	N5	N4	N3	N2	N1	P7	P6	P5	P4	P3	P2	P1	0	0	0	0	0	0	128
32	0	0	0	0	0	0	0	N5	N4	N3	N2	N1	P6	P5	P4	P3	P2	P1	0	0	0	0	0	0	0	64
16	0	0	0	0	0	0	0	0	N4	N3	N2	N1	P5	P4	P3	P2	P1	0	0	0	0	0	0	0	0	32
8	0	0	0	0	0	0	0	0	0	N3	N2	N1	P4	P3	P2	P1	0	0	0	0	0	0	0	0	0	16
4	0	0	0	0	0	0	0	0	0	0	N2	N1	P3	P2	P1	0	0	0	0	0	0	0	0	0	0	8
2	0	0	0	0	0	0	0	0	0	0	0	N1	P2	P1	0	0	0	0	0	0	0	0	0	0	0	4

N. GIRI ⇦ | ⇨ PASSI PER GIRO

Picture 67 25 bit SSI protocol with center alignment.

RIGHT

CKI	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
512 x 256	0	0	0	0	G^{16}	G^{15}	G^{14}	G^{13}	G^{12}	G^{11}	G^{10}	G^{9}	G^{8}	G^{7}	G^{6}	G^{5}	G^{4}	G^{3}	G^{2}	G^{1}	G^{0}

Picture 68 21 bit SSI protocol with right alignment

5.2. SSI interface connection

For the wiring diagrams refer to the catalogue in the section ***ABSOLUTE ENCODER – TKC - TKM series connections***.

If you can connect to the Internet it is possible to check the data sheets relevant to the SSI interface; the *on-line* documentation is available in pdf format at the address:

http://www.tekel.it/EncAss.htm

6. Parallel output interface

6.1. Introduction

Unlike the serial output interface (both the programming serial output and the SSI interface) in which the encoder absolute position is presented as a bit sequence, in case of parallel interfaces the position is presented in a parallel way. This means that theoretically all the bit of the code are available for the user contemporaneously on a number of output lines that is proportional to the bit of the resolution.

With the parallel outputs we have a quicker data transmission but a number of output lines to the encoder that is higher according to the encoder bit resolution. For example an encoder with a resolution equal to 8192 PPR x 4096 turns, with output code Gray or Binary, needs 25 bit in output, therefore 25 data lines while it needs 30 bit in case of BCD code.

The parallel interface is useful when, for example, the PLC has to process the data coming from different transducers in short periods of time; in this case a single reading cycle enables to directly acquire the encoder position. Other applications see the direct interfacing of the outputs of the encoder through some visual display unit with BCD input; in this way the position data found by the encoder is immediately available for the operator in a visual way.

6.2. Types of interface

Even though the way of transmitting the information is unique all the data are on a parallel bus that has as many lines as the max number of bit of the encoder resolution. The information can be transmitted to a data acquisition card or to a PLC in a different way. On the market there are various types of interfaces with different input structure of the interface itself.

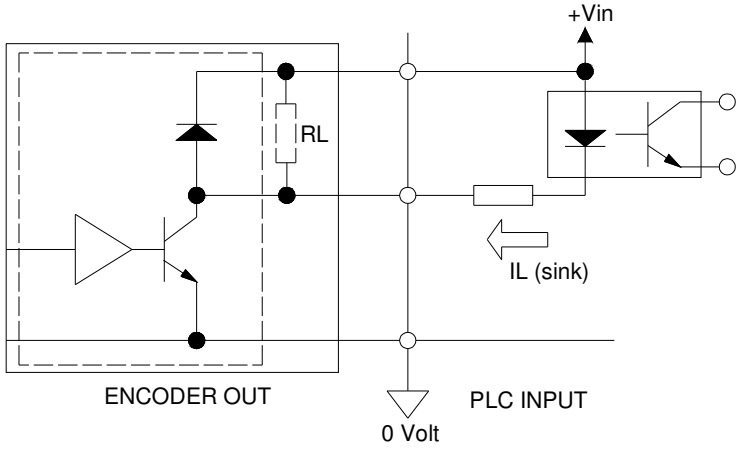
To this purpose there are different types of output electronics available for the TKM60P:

- NPN (negative logic) with internal load (pull-up) or open-collector
- PNP (positive logic) with internal load(pull-down) or open emitter.
- PUSH-PULL

For each type of interface we will explain hereafter the corresponding wiring diagram and the electrical characteristics.

6.2.1. NPN output

This is carried out by using some integrated drivers model TD62083AF; each output line is protected against over voltage through a 33 V zener diode and against short circuit through PTC. The outputs therefore are protected: against the short circuit towards the 0 Volt, against the short circuit towards the power supply and against the short circuit between channel and channel.
The output scheme, that has been drawn without the protections for simplicity, is shown in picture 69.



Picture 69 Output scheme for NPN electronics

In case of standard NPN electronics (ordering code 23) between each single data line and the voltage line, inside the encoder, there is a load resistor R_L with a value equal to 4.7 kΩ, the voltage is equal to 11-30 V. The output signal acquires a minimum voltage lower than 1,1 V while the maximum value is close to the voltage.

Parameter	Admitted values (V)	Test conditions
Output voltage at high logic level V_{OH}	V_{cc}	V_{cc}=11-30 V ; I_L=25 mA, T_a=25 °C
Output voltage at low logic level V_{OL}	≤ 1,1	V_{cc}=11-30 V ; I_L=25 mA, T_a=25 °C

Table 11 Electrical characteristics of standard NPN parallel output interface

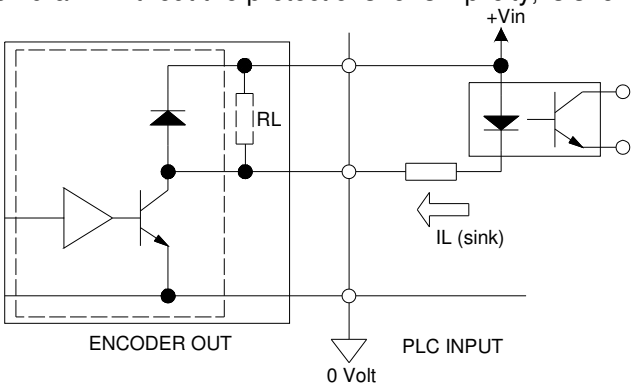
For the NPN electronics of type Open-Collector (ordering code 22), without the internal resistor R_L, the maximum level of the output voltage is equal to 30 V; for the minimum level refer to table 11.

For each channel we guarantee the respect of the values indicated in table 11 if the absorbed current is lower or equal to 25 mA.

6.2.2. PNP output

This is carried out by using some integrated drivers model TD62783AF; each output line is protected against over voltage through a 33 V zener diode and against short circuit through PTC. The outputs therefore are protected: against the short circuit towards the 0 Volt, against the short circuit towards the power supply and against the short circuit between channel and channel.

The output scheme, that has been drawn without the protections for simplicity, is shown in picture 70.



Picture 70 Output scheme for PNP electronics

In case of standard PNP electronics (ordering code 21) between each single data line and the 0 Volt line, inside the encoder, there is a load resistor R_L with a value equal to 4.7 kΩ, the voltage is equal to 11-30 V. The output signal acquires a minimum voltage close to 0 V while the maximum value is always higher or equal to (V_{cc}-2) V.

Parameter	Admitted values (V)	Test conditions
Output voltage at high logic level V_{OH}	≥ V_{cc}-2	V_{cc}=11-30 V ; I_L=25 mA, T_a=25 °C
Output voltage at low logic level V_{OL}	0	V_{cc}=11-30 V ; I_L=25 mA, T_a=25 °C

Table 12 - Electrical characteristics of standard PNP parallel output interface

For the PNP electronics of type Open-Emitter (ordering code 20), without the internal resistor R_L, the output voltage at high logic level acquires values according to those indicated in table 12.

For each channel we guarantee the respect of the values indicated in table 12 if the current absorbed by the output is lower or equal to 25 mA

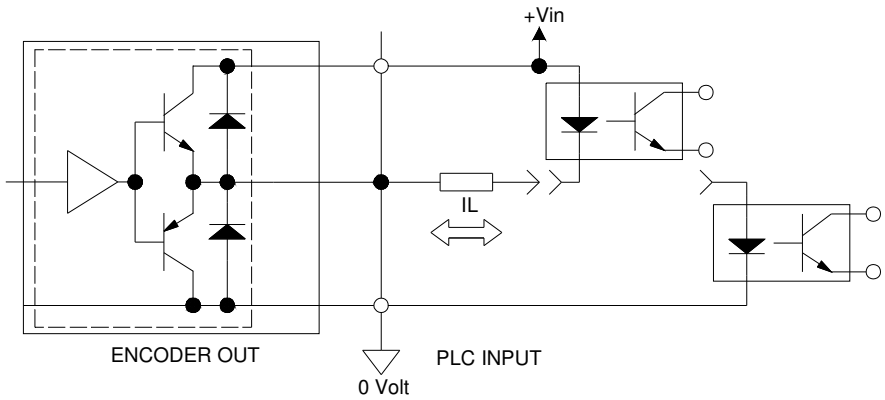
6.2.3. PUSH-PULL output

This is carried out by using some high speed drivers of integrated type model L6374. The main characteristic of this type of driver is the total protection (active) against any type of short circuit in output, therefore we have a complete and indefinite protection for each output line in the following conditions:

- short circuit towards 0 Volt;
- short circuit towards the voltage line;

- short circuit between the data lines.

The fundamental characteristic of the PUSH-PULL output, compared with the NPN or PNP outputs, is the low value of the output impedance both at a high logic level and at a low logic level. Thanks to this characteristic the PUSH-PULL output is immune from electromagnetic noise particularly on the data transmission lines having lengths of tens of meters[1].
The relevant simplified scheme of the output stage is shown in picture 71.



Picture 71 Scheme of the output stage of PUSH-PULL electronics

The electrical characteristics of the voltage levels present in output for a voltage of 11-30 V_{cc} are indicated in table 13.

Parameter	Admitted values (V)	Test conditions
Output voltage at high logic level V_{OH}	$\geq V_{cc}$-2	V_{cc}=11-30 V ; I_L=25 mA, T_a=25 °C
Output voltage at low logic level V_{OL}	$\leq$ 2	V_{cc}=11-30 V ; I_L=25 mA, T_a=25 °C

Tabella 13 caratteristiche elettriche interface di uscita parallela PUSH-PULL.

For each channel we guarantee the respect of the values indicated in table 13 if the current absorbed by the output is lower or equal to 25 mA

6.3. Wiring diagrams

For the wiring diagrams refer to the catalogue in the section ***ABSOLUTE ENCODER – TKC-TKM series connections*** or to the web site:

http://www.tekel.it/EncAss.htm

this *link* will directly open the file in pdf format.

[1] Obviously the max. immunity from any type of noise (both conducted or irradiated) is obtained by using shielded cables having electrical parameters (Ω/m, pF/m) in accordance with the characteristics of the data that has to be treated.

7. Terms of warranty

1. Our incremental and absolute encoders are guaranteed for a period of twenty four months from the date of the purchase invoice. Warranty does not mean exemption from payment obligations.

2. Warranty includes the replacement or the repair of the encoders free of charge in case of manufacturing faults or of defective material or components. The encoders will be checked and/or repaired exclusively at our premises at the following address:

   TEKEL Instruments S.r.l.
   Via Torino 13/1 - 10060 Roletto (TO)
   Tel. +39 0121 343 811 – Fax. +39 0121 343 888
   http: www.tekel.it e-mail: tekel@tekel.it

   The transport costs and risks to and from our company will be at customers' charge.

   We will reject any material sent with an unpaid shipment.

   The return of material must be previously agreed with our after-sales service: we will not accept material returned without the proper authorization number.

3. Warranty does not include the external case nor the damages caused by negligence, by incorrect or improper use and installation or by any other causes not depending on the normal operation of the transducer.

4. Furthermore warranty is no longer valid when:

   a) the encoder has been tampered or repaired by unauthorized personnel;
   b) the serial number has been altered or cancelled or the Tekel trademark eliminated;
   c) the encoder's identity label has been removed.

5. Transducer replacement and warranty extension in case of damage are excluded.

6. Compensation for direct or indirect damages occurred to people or things due to use or lack of use of the transducer is excluded.

FIVE YEARS EXTRA WARRANTY

Our encoders are equipped with solid state light sources. If within 5 years from delivery date, a failure should occur on these components, TEKEL engages to replace them free of charge, at our premises, if sent at customer's charge at the above indicated address.

The return of material must be always agreed with Tekel after-sales service.
We will not accept a returned material without the authorization number.

8. Inappropriate operations

The TKM60P absolute encoder is made of a series of electronic and mechanical components and for this reason the user must have some cares to avoid malfunctions or permanent damages to this device.

8.1. INAPPROPRIATE MECHANICAL OPERATIONS

1° Do not disassemble the encoder; in this case warranty and assistance are no longer valid. We accept to repair the material sent AT CUSTOMER'S CHARGE to the following address:

TEKEL Instruments S.r.l.
Via Torino 13/1 - 10060 Roletto (TO)
Tel. +39 0121 343 811 – Fax. +39 0121 343 888
http: www.tekel.it e-mail: tekel@tekel.it

2° Do not connect the encoder shaft to machine components in motion by using stiff couplings but only use flexible ones. An incorrect assembling drastically reduces the bearings life and causes the loss of warranty.

3° Do not subject the encoder to any shock: this may cause the breaking of the internal components and the loss of warranty.

4° Do not carry out any machining on the shaft nor on the case of the encoder. This causes the loss of warranty. For special executions refer to page 40.

5° Do not press, bend nor perform anomalous torsions on the encoder shaft. This may cause the breaking of the internal disk or the wearing of the bearings. This operation would cause the loss of warranty.

6° Do not install the encoder using any unauthorized assembly methods. This would cause the loss of warranty.

8.2. INAPPROPRIATE ELECTRICAL OPERATIONS

1° Once the encoder is on, wait at least 10s before starting the data acquisition or before carrying out any programming operations. This period of time is necessary for the configuration of the internal processing electronics.

2° Do not use supply sources which do not guarantee the galvanic insulation from the supply mains.

3° Do not position the output or the programming cables parallel to high-voltage lines or to lines of power feeding. Do not put the cables together in the same raceway. Remember to always observe this precaution in order to avoid problems of interference or of wrong reading of the encoder outputs.

4° Don't leave command lines open (for example UP/DOWN, LATCH, ENABLE, ZERO-SET). This may cause encoder configuration changes that are not foreseen. Basing on the type of chosen input NPN or PNP always finish the line (locally the closest possible to the encoder) with PULL-UP and PULL-DOWN resistors respectively with a value going from 4.7 kΩ to 10 kΩ for a voltage equal to 11-30 V_{cc}.

5° Do not use cables longer than necessary. It is fundamental to try to keep the cable as short as possible in order to avoid electrical interferences.

6° Do not carry out connections, if in doubt as to their arrangement see wiring diagrams printed on the encoder label or refer to the data sheets of the item. Wrong wirings may cause faults to the encoder internal circuits.

7° Do not connect the encoder shield line to the 0 Volt reference of power supply.

The shield must be always connected to GROUND. The shield connection point to ground can be located on the encoder side or on user's side. Anyway the best solution (minimum interference on user's side) has to be found basing on the type of installation and must be carried out by the final user.

8° Do not choose electronics of NPN or PNP type, or open collector or open emitter type with cable longer than 6 m. In this case the PUSH-PULL interface is suggested.

8.3. CUSTOM VERSIONS

TEKEL Instruments Srl is available to study and carry out any modification to our standard products according to customer needs (custom versions). This modifications can be made for mechanical assemblies that are not foreseen in the catalogue (for example different cases, adapting flanges, shafts with diameters on specification or that have to be machined with milling, keys or different holes) or can be electrical/electronic modifications (for example voltages with a different value, options on specification such as alarms and different indications etc …).

In case of need you can contact sales / technical dept. of

TEKEL INSTRUMENTS srl

at the following numbers:

tel. +39 0121 343 811 – fax. +39 0121 343 888

or using the e-mail service at the following address:

tekel@tekel.it

All the documents we receive are managed according to the existing rules concerning storage and usage of the personal data.