COUNTER MODULES TC700

COUNTER MODULES TC700

3rd Edition - January 2005

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History of editions

Edition	Date	Description
1.	May 2004	1st version
2.	June 2004	The items OUT0 and OUT1 in the data structure Cont were renamed to DO0 and DO1 to correspond with Mosaic development environment version 1.4.1 and higher.
3.	January 2005	Adaptation needed for Mosaic Help performed

1. INTRODUCTION

Counter modules (Table 1.1) serve for interconnection of pulse signals from different sources or signals from incremental encoders from an object being controlled to a programmable logic controller TECOMAT (PLC). The modules ensure the conversion of the input level to the level of internal logic signals of the PLC and filtering off of faults and vice versa, conversion of logic signals of the PLC to output digital signals.

The information on module type and their basic parameters can be found on the front plate and module sides. The assignment of signals on the terminals of the module connectors is illustrated on the inside of the door. The module in the PLC are unequivocally identified by its position in the rack and by the rack address. Counter modules can be fitted at any arbitrary position of both the main and expansion racks.

Table 1.1 List of modules with order numbers

Module type	Modification	Order number
IC-7702	2 counters with 5 inputs, or 4 counters with 3 inputs (24 V DC)	TXN 177 02

2. MECHANICAL DESIGN

Each module has a plastic protective case 30 mm wide. After opening the door you can access the connectors for signal connection. At the bottom of the unit there is a hole for cables connected to the technology being controlled.

The modules are fitted with connectors. The removable connectors have screw-type or screwless (spring) terminals. Taking out of each connector is facilitated by means of locking levers. By moving the locking lever round a slight amount, the terminal becomes loose. When fitting the connector on, the locking lever has to be moved round a slight amount in reverse direction and, for connectors, the locking levers serve also to secure the connector against disconnecting. The connector for connection of the input and output signals with 20 terminals is delivered separately (it is not part of the module delivery). The following variants are available:

- with spring terminals TXN 102 30 (mounting in the line of the conductor)
- with screw terminals TXN 102 31 (screw in the line of the conductor)
- with screw terminals TXN 102 32 (screw perpendicularly to the conductor)

The connectors are described in the documentation TXV 102 30 or in the Manual for designing of systems TECOMAT and TECOREG TXV 001 08.01.

2.1. Connectors - features

Table 2.1 Connector parameters

		Order number of connector set			
		TXN 102 30	**TXN 102 31**	**TXN 102 32**	
No. of connectors in set		1	1	1	
No. of connector terminals		1x20	1x20	1x20	
Terminal spacing	mm	5,08	5,08	5,08	
Type of terminal		screwless (spring)	screw-type, straight	screw-type, perpendicular	
Length of stripping of conductor	mm	10	13	7	
Conductor dimensions					
Clamping range	mm^2	0.08 ÷ 2.5	0.08 ÷ 1.5	0.08 ÷ 2.5	
Wire [1)]	mm^2	0.5 ÷ 2.5	0.5 ÷ 1.5	0.5 ÷ 2.5	
Cable [2)]	mm^2	0.5 ÷ 2.5	0.5 ÷ 1.5	0.5 ÷ 2.5	
Cable with female header [3)]	mm^2	0.5 ÷ 2.5	0.5 ÷ 1.5	0.5 ÷ 2.5	
Cable with female header with plastic collar [4)]	mm^2	0.5 ÷ 1.5	0.5 ÷ 1.5	0.5 ÷ 1.5	
Electrical parameters					
Nominal voltage	V	250	250	250	
Nominal current	A	10	10	9	

[1)] Wire, e.g. harmonized type H05(07) V-U
[2)] Cable, e.g. harmonized type H05(07) V-K
[3)] Cable, with copper cable female header according to DIN 46228/1
[4)] Cable, with cable female header with plastic collar according to DIN 46228/4

The connectors are ordered separately and are ready for mechanical encoding. For each module type, a different code is used, so that it is ensured that the user does not interchange the cables by mistake with another connections and does not possibly destroy the module by a higher voltage.

Encoding is carried out by means of plastic pins into the connector (according to the instructions for use, which are part of each connector set). The modules are supplied with male connectors already encoded according to Fig. 2.1.

Fixation of the module on the rack is easy and done by means of a screw located at the top part of the case.

When fixing the module on the rack, the module has to be put with its two lugs at the rear bottom part of the case into the holes at the bottom edge of the metal frame in required position and by swinging movement press the module down onto the connector of the bus and secure it by the screw located at the top side of the case. When you want to take the module out off the rack, loose the screw at the top part of the case and by swinging movement towards you and down, tilt the module from the rack and take it carefully out of the rack.

ATTENTION! The modules contain parts sensitive to static charge, therefore, it is necessary to follow the safety rules when working with these circuits! Any handling must be done on the module taken out from the rack!

Table 2.2 Module dimensions and weight

Dimensions	- height	198 mm
	- width	30 mm
	- depth	137 mm
Weight		0.3 to 0.4 kg (acc. to type)

2.2. Connectors - encoding

The connectors are supplied without encoding, the encoding elements are part of the packaging of each connector. The connectors can get a code to avoid the connector to be plugged in another type of connector. The male connector in the module has already a code from the manufacturer, its counterpart (connector) is encoded by the customer. The code of each module is given in the basic documentation supplied with the module (the position of the coding element is illustrated by a black rectangle on the figure).

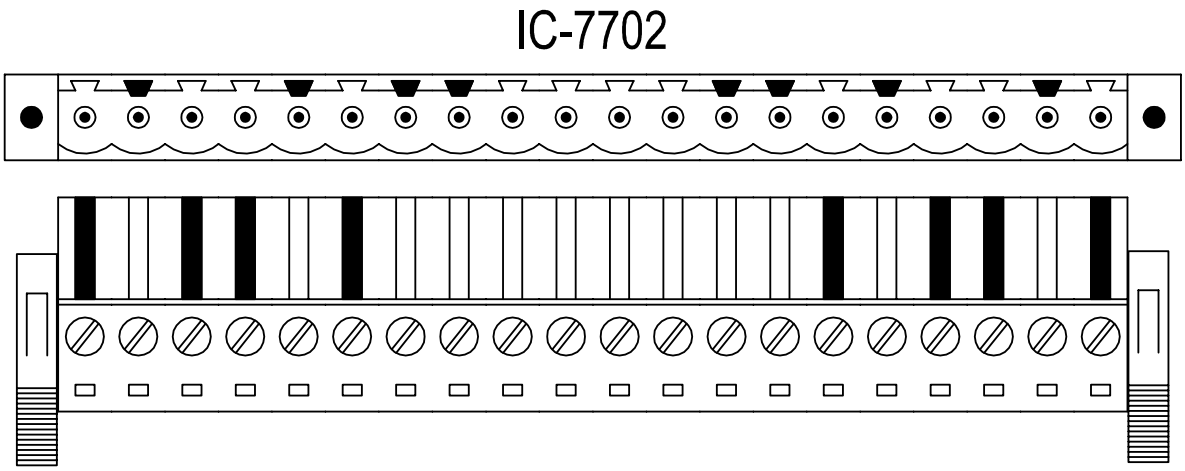


Fig. 2.1 Encoding of connectors of modules IC-7702 (view of the male connectors from the pins, i.e. from the door side)

The encoding elements supplied with the connector are designed to be pushed in the grooves in the connector (see Fig. 2.2).

***Encoding procedure*:**

The encoding element is pushed in the direction of arrows ➢ **BL** ➢ into the groove of the connector (the elements are different for connectors TXN 102 3x and for connectors TXN 102 40 – two-line elements with raster 3.5 mm). After pushing in the stop position, the rest of the element is broken off (see Fig. 2.2). The same procedure is used for the second side of the encoding element.

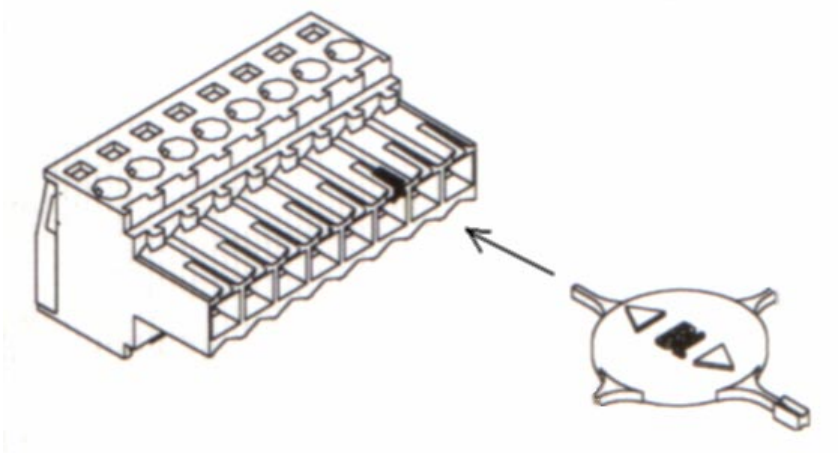


Fig. 2.2 Plugging in of the encoding element into connector body

ATTENTION!	**Taking out or pushing in of the connector from / to the module has to be carried out with power supplies of the circuits being controlled switched OFF! The contacts are not designed to extinct possible electric arcs, the contacts might burn off!**

3. REQUIREMENTS FOR FEEDING OF MODULES

The internal circuits of the module are fed from a power source that is part of the TC700 system assembly and the power source is led through the PLC rack.

3.1 Feeding of input and output circuits of PLC

The direct input and output circuits are fed from a direct voltage source (e.g. PS series power supplies). No other appliances must be connected to the source that could cause the increase of interference or overvoltage level. A permissible tolerance of direct supply voltage including ripple effect for the input and output circuit is 20 per cent from the voltage nominal value. Detailed information can be found in the Manual for designing of systems TECOMAT and TECOREG TXV 001 08.01.

3.1.1 Power sources PS-25/24, PS-50/24 and PS-100/24

For feeding of 24 V circuits, power sources PS-25/24 (order nr. TXN 070 22), PS-50/24 (order nr. TXN 070 10) or PS-100/24 (order nr. TXN 070 15) can be employed, which serve for feeding of direct current circuits 24 V with the input power of 25 W, 50 W or 100 W, respectively. The power sources are fed from the 230 V AC network. The sources are designed to be installed on the bar.

Table 3.1 Output loss on one input

Module type	Nominal voltage	Output loss for 1 input
IC-7702	24 V DC	0.12 W

Table 3.2 Output loss on one output

Module type	Nominal voltage	Output current	Output loss for 1 output
IC-7702	24 V DC	2 A	1.2 W

3.2 Preventative protection against interference

To reduce the level of interference in the distributing frame with the installed PLC, all the inductive loads have to be treated with interference suppressor devices. For this purpose, interference suppressor sets are delivered (Table 3.3, Table 3.4).

3.2.1 Using the interference suppressor set

The interference suppressor set serves for protecting of the digital direct as well as alternating output units of the PLC against voltage peaks that occur especially when controlling inductive load. Though some units have this protection on the board, we recommend to do this protection straight on the load. This is due to maximum avoidance of interference spreading as a source of possible faults.

As protective element we deliver varistors or RC-elements, the highest efficiency can be reached by combination of both protection types. The set can be used anywhere in controlled technologies to protect contacts or against interferences arising during control processes.

Table 3.3 Interference elimination units

Interference elimination unit content	For load	Unit order number
8x varistor 24 V	24 V DC/AC	TXF 680 00
8x varistor 48 V	48 V DC/AC	TXF 680 01
8x varistor 115 V	115 V AC	TXF 680 02
8x varistor 230 V	230 V AC	TXF 680 03
8x RC element - R = 10Ω, C = 0.47µF	24 - 48 V DC/AC	TXF 680 04
8x RC element - R = 47Ω, C = 0.1µF	115 - 230 V AC	TXF 680 05

Table 3.4 Parameters of varistors used in interference suppressor sets

Energy that can be captured by the varistor I^2t (t is for duration of the blanking pulse - in ms)	< 80 J
Current through varistor I	< 25 A
Mean value of output power loss P	< 0.6 W

Protection element connection

An example of connection is given on Fig. 3.1. The principles of interference suppression in the position of its source as close as possible have to be taken in account.

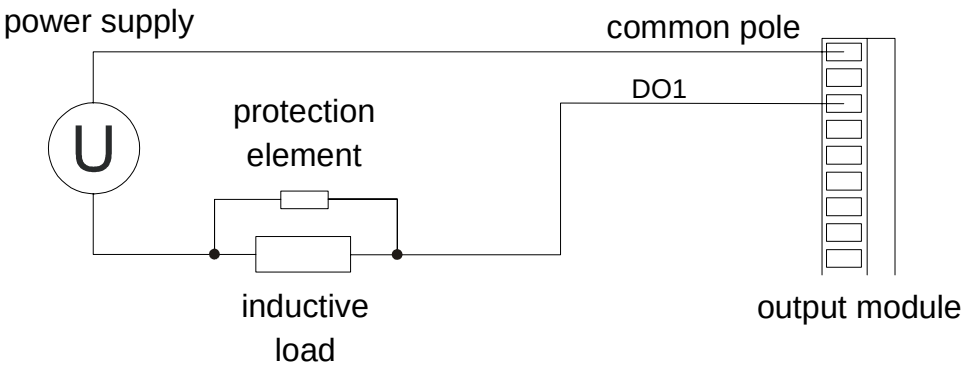


Fig. 3.1 Protective element connection parallel to the load

Further information on interference elimination can be found in the Manual for designing of systems TECOMAT and TECOREG TXV 001 08.01, section 7.3.

4. COUNTER MODULE IC-7702

The IC-7702 module can have optionally 2 counters of 32 bits with 5 inputs, or 4 counters of 32 bits with 3 inputs, for connection of pulse signals or signals from incremental encoders. Further optional function are timers, conditionally switched counters and optionally the signal period measurement function. The input signals are bipolar with levels of 24 V DC with minus or plus common terminal, direct outputs with quick response, for levels of 24 V DC, 2 A with plus common terminal. The outputs are realized by semiconducting switches equipped with overcurrent and thermal protection. The equipment of these protections is part of the module diagnostics. The function of the outputs allow controlling of two-status drives for the purpose of setting of the position of movement axes of machinery also with a possibility of slowdown points, optionally also outputs in time functions. The setup and reading of values are carried out from the user program.

4.1 Basic parameters

Product standard	IEC EN 61131-2
Protection class of electrical object ČSN 33 0600	III
Connection	Removable connector, max. 2.5 mm^2 conductor per terminal
Type of equipment	built-in
Coverage (after installation into rack)	IP20 IEC EN 60529
Dimensions	137 x 30 x 198 mm

4.2 Operational conditions

Class of ambient influence – ČSN 33 2000-3	Normal
Operating temperatures range	0 °C to + 55 °C
Permissible temperatures during transport	-25 °C to +70 °C
Relative humidity	10 % to 95 % without condensation
Atmospheric pressure	min. 70 kPa (< 3000 above see level)
Degree of pollution - IEC EN 61131-2	2
Overvoltage category of installation - ČSN 33 0420-1	II
Working position	Vertical
Type of operation	Continuous
Electromagnetic compatibility	
Emissions - IEC EN 55022*	Class A
Immunity	Table 16, IEC EN 61131-2
Vibration resistance (sinusoidal vibrations) Fc according to IEC EN 60068-2-6	10 Hz to 57 Hz amplitude 0.075 mm, 57 Hz to 150 Hz acceleration 1G

* This is a product of Class A. In indoor conditions (i.e. such conditions, where using of radio and TV sets can be supposed in a distance of 10 m from the mentioned equipment), the product can cause radio disturbances. It might be required in such cases that the user takes necessary measures to avoid this.

4.3 Electrical parameters

Number of inputs		10 (in two groups)	
Number of inputs in group		5	
Galvanic isolation from internal circuits		Yes, groups and mutually	
Diagnostics		Yes, signalization of energized input on module panel	
Type of inputs		Type 1	
Common pole		Minus	Plus
Input voltage for log. 0 (UL)	Max.	5 V DC	- 5 V DC
	Min.	- 5 V DC	5 V DC
Input voltage for log. 1 (UH)	Min.	15 V DC	-15 V DC
	Typ.	24 V DC	-24 V DC
	Max.	30 V DC	-30 V DC
Output current at log. 1	Typ.	5 mA	
Frequency of symmetrical signal (e.g. V, G)	Max.	100 kHz	
Width of isolated pulse on input (e.g. NI)	Min.	5 µs	
Optional filtering of input signals		no filter; 0.18 ms; 1.5 ms; 12 ms	

Number of outputs		4
Number of outputs in group		2
Galvanic isolation from internal circuits		Yes
Diagnostics		Yes, signalization of closed output on the module panel, signalization of output protection equipment in module status
Common pole		Plus
Type of outputs		Semiconducting switch, overcurrent and thermal protection
Switching voltage	Max.	30 V DC
	Typ.	24 V DC
	Min.	9.6 V DC
Switching current	Max.	1 A (2 A only for one output)
	Min.	2.5 mA
Common pole current	Max.	4 A
Leakage current (log. 0)	Typ.	300 µA
Switch on period of output	Typ.	100 µs
Switch off period of output	Typ.	100 µs
Limit values for switching load:		
- for resistance load	Max.	2 A at 24 V DC
- for inductive load DC13	Max.	2 A at 24 V DC
Voltage drop at max. load on closed output	Max.	0.6 V
Switching rate without load	Max.	2.5 kHz
Switching rate with nominal load	Max.	2.5 kHz
Polarity inversion protection [1)]		Yes

Short-circuit protection		Internal
- limitation of initial peak current	Typ.	7.5 A
- disconnecting period of initial peak current	Typ.	4 ms
- limitation of short-circuit current	Typ.	6.5 A
Overload protection		Yes
- current limitation	Typ.	6.5 A
Inductive load treatment		External RC element, varistor, diode
External supply voltage of module output circuits		24 V DC
Max. consumption from external source (module internal circuits)		30 mA

[1] The circuit will be put in inactive status, the loads will be closed and the current will flow through the protection diode of the circuit.

Insulation voltage among inputs and internal circuits		500 V DC
Insulation voltage among groups of inputs among each other		500 V DC
Module output loss	Max.	4 W
Module input power taken from system source	Max.	1 W

4.4 Power supply

The internal circuits of the module are fed from a power supply source, which is part of the TC700 system assembly and the power supply is led through the PLC rack.

4.5 Connection

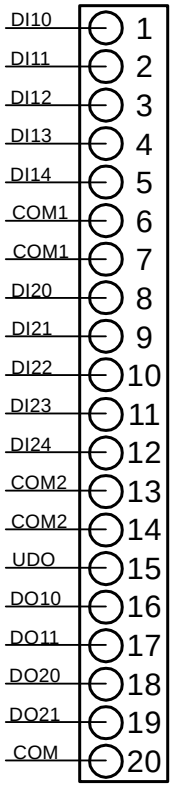
The module is fitted with a connector (order number of the connector TXN 102 30, ..31, ..32, acc. to customer's specification). The connection of the connector is on Fig. 4.1. Detailed information on connection, proper installation procedure, examples of module connection and principles for increasing resistance and reliability can be found in the Handbook for designing TXV 001 08.01.

Table 4.1 Meanings of outputs of counters 0 and 2 of module IC-7702

Input configuration	DI14, DI24	DI13, DI23	DI12, DI22	DI11, DI21	DI10, DI20
IRC (5)	REF	NI	MD	G	V
IRC (3)	-	-	MD	G	V
DIR(5)	REF	NI	MD	Dir	Pulz
DIR(3)	-	-	MD	Dir	Pulz
UP/DN(5)	REF	NI	MD	Dn	Up
UP/DN(3)	-	-	MD	Dn	Up
CNT	-	-	-	En	Clk
TIM	-	-	-	Tim	-

Table 4.2 Meanings of counters of outputs 1 and 3 of module IC-7702

Input configuration	DI14, DI24	DI13, DI23	DI12, DI22
IRC	G	V	MD
DIR	Dir	Pulz	MD
UP/DN	Dn	Up	MD
PER	Per	-	MD



DIxy Terminal of digital input y (from group x).

COMx Common pole of group x of input circuits of the module

UDO Common pole of output circuits of the module (+ 24 V DC)

COM Common pole of output circuits of the module

DOxy Output terminal of output y (from group x)

Note: Identically marked terminals are interconnected inside the module

Fig. 4.1 Terminal connection of module IC-7702

4.6 Operation

4.6.1 Module HW configuration

The module is operated, set and diagnosed from the MOSAIC development environment.

4.6.2 Putting in operation

After putting the module into the rack and switching power supply on, the module is fully ready for operation and does not require any other settings of its elements.

4.7 Diagnostics

The basic diagnostic system of the module is part of the standard module software. The diagnostic system becomes active after module power supply is on, and works independently from the user.

4.8 Indication

On the front panel of the module each input digital signal is assigned one green indication LED. If this LED is on, it indicates the presence of the input signal on the corresponding terminal. Further, there are a green RUN LED, a red ERR LED and a yellow OFF LED on the front panel. If the RUN LED is on, the module is in the HALT mode, if the RUN LED is flashing, the module is in the RUN mode and communicates with the central unit.

If the ERR LED is permanently on, the module is in the error condition, its initialization was not successful, and a service intervention is required. If the ERR LED is flashing, some of the counters indicates a failure of the phase of V and G traces (bit ERRVG in the status). Most likely the incremental sensor will need replacing, or the input frequency of the signals V and G was exceeded. By program, this signalization can be reset by the RES bit in the Cont byte. The OFF LED indicates blocking of the outputs, for example in the HALT mode.

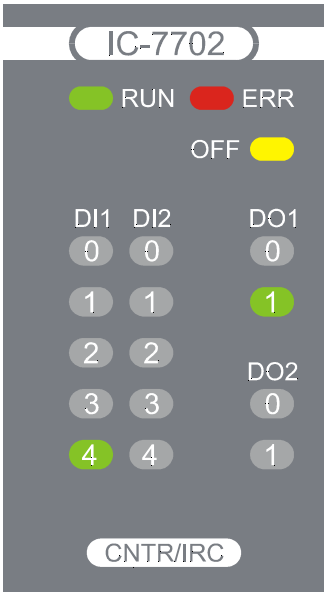


Fig. 4.2 Indication panel of module IC-7702

4.9 Module setup

The module is operated, set and diagnosed from the MOSAIC development environment (*Project | Project manager | HW configuration)* | click on the line at the selected position in the column *Module type | Other modules | IC-7702 | OK*, or also the icon on the line of the module selected).

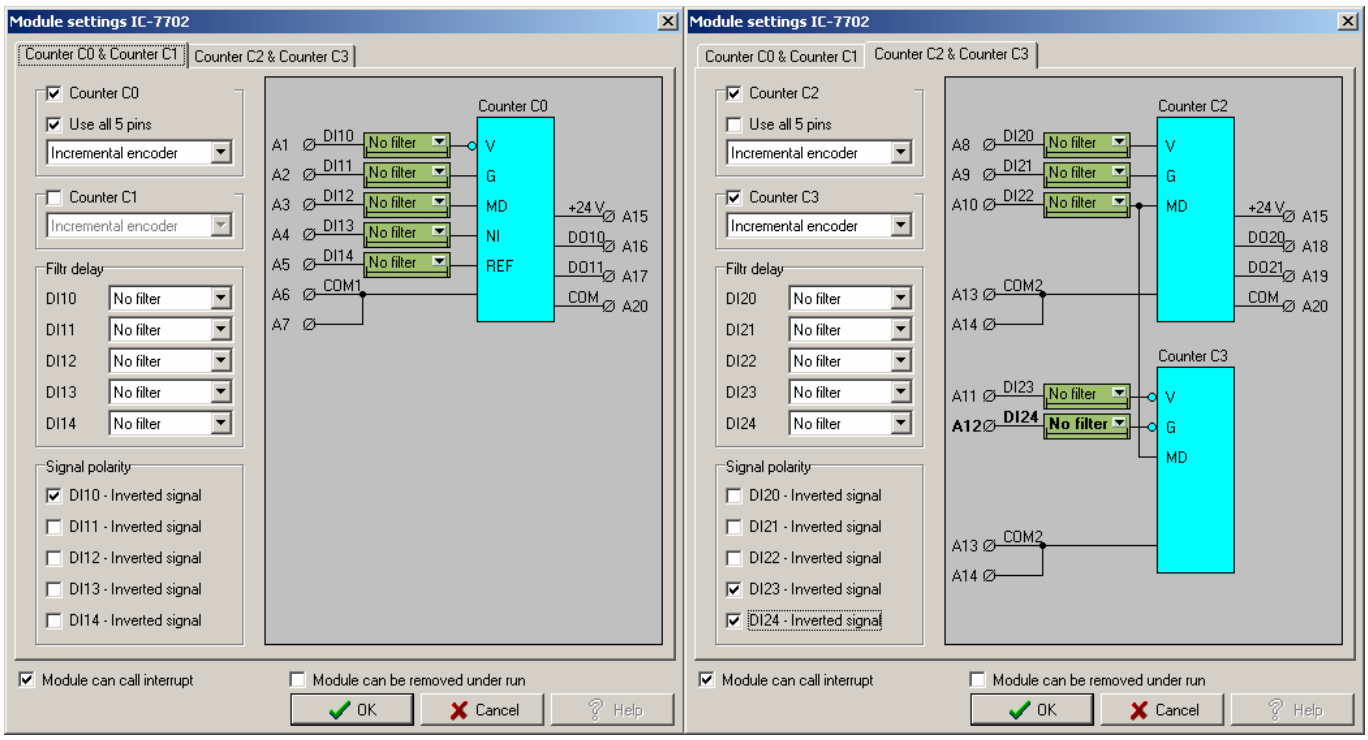


Fig. 4.3 Examples of dialogue for selection and configuration of counters in the IC-7702 module

Optional configurations of function of inputs of counters 0 and 2:

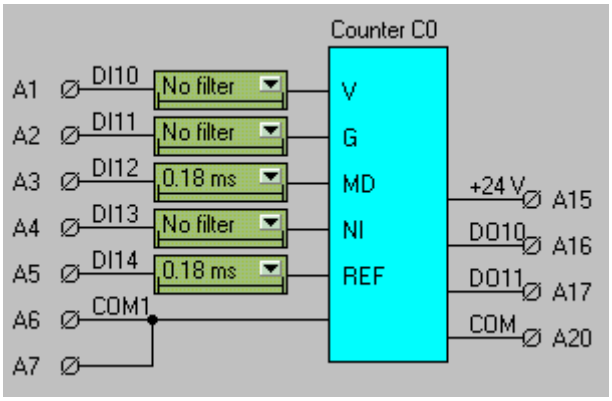
- incremental encoder (tracks shifted by 90°) with 5 or 3 inputs
- pulses and direction with 5 or 3 inputs
- UP and DOWN with 5 or 3 inputs
- timer
- conditionally switched counter

Optional configurations of function of inputs of counters 1 and 3:

- incremental encoder (tracks shifted by 90°) with 3 inputs
- pulses and direction with 3 inputs
- UP and DOWN with 3 inputs
- period measurement

For individual input signals time filters and polarity can be set.

4.9.1 Incremental encoder with 5 inputs



In installation with high accuracy and reliability of position measurement, incremental encoders are employed (encoders, further as IRC). These can be either rotational or linear ones. Typically, they work on the principle of photoelectric reading of the mutual position of two glass rasters on the rotor and the stator. The output signals, also called track V and G, are oblong symmetrical signals by 90 °C mutually out of phase, so that it is possible to evaluate the motion direction. The counter module counts each edge of both tracks and if, for example the IRC has a division of 2 500 divisions per a revolution, then the

counter counts 10 000 increments per a revolution. The counters in the module IC-7702 have the range of 32 bits. The track measured is in the range of –2 147 483 648 to +2 147 483 647 increments.

The IRCs are standardly supplied with a division of 100 to 6000 divisions and one null impulse NI per a revolution. Similarly, linear incremental sensors send the NI null impulses in a regular period. The null impulse allows repeated setting so called reference point with the accuracy of one increment, for example the origin of coordinates for a movement axis. For this, so called reference sensor REF is used for a rough marking of the revolution, in which the reference point with the null impulse NI will be declared. To ensure that the clearances in the mechanism, in the gears, etc. are also taken up, it approaches to the NI null impulse always from the same direction and the reference point is the first NI null impulse after setting if the input REF to log "1". An example of this function is on Fig. 4.4.

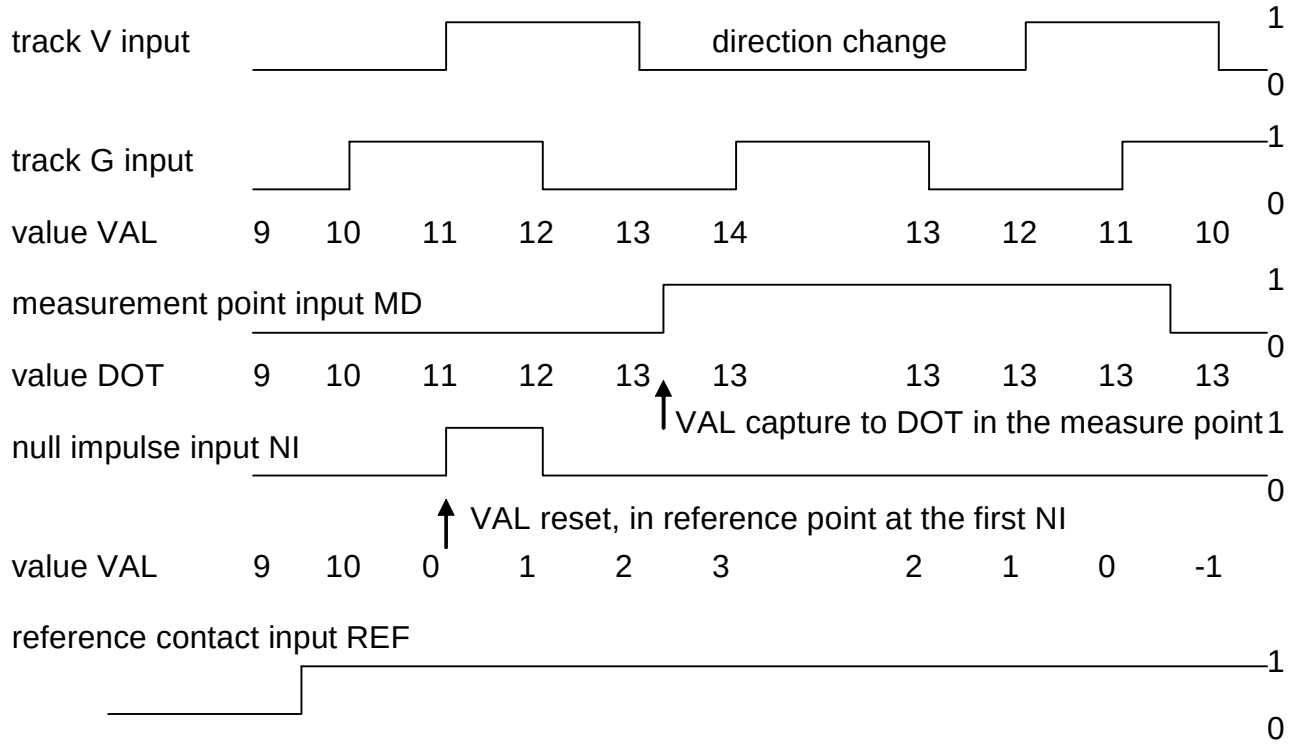


Fig. 4.4 Function on the mode of incremental sensor with 5 inputs

Notes:

1) To capture a value given by MD to DOT, bit EMD has to be set to "1" in the Cont byte and for repeating of this function, this bit has to be returned to "0" first. The indication of the activity of MD is through the IMD bit in the Status.
2) For the function of referencing, the MODE bits have to be set in the Cont byte. The indication of the reference point setup is through the IREF bit in the Status.

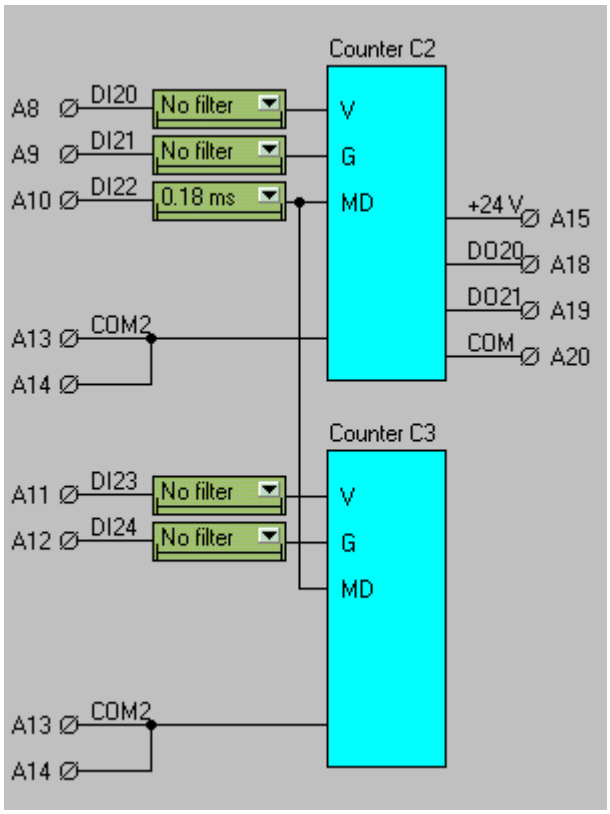
For signals **V, G** and **NI, filtering has to be OFF,** the other signals are filtered off as required. It is necessary to follow the maximum dynamic parameters of the input signals during the application. For example, an IRC with the division of 2 500 divisions per a revolution connected by tracks V, G and NI can rotate at a speed of 2 400 rpm at maximum to measure the track. But for capturing of the NI im

pulse, it can rotate at a maximum speed of 1 200 rpm.

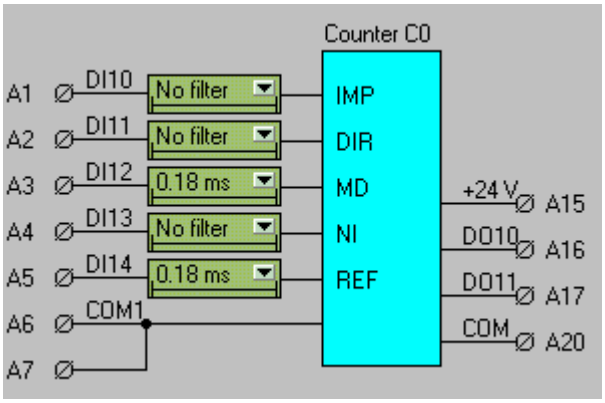
100 kHz / 2500 * 60 = 2400 rpm 1/(**5 µs** * 4) / 2500 *60 = 1200 rpm

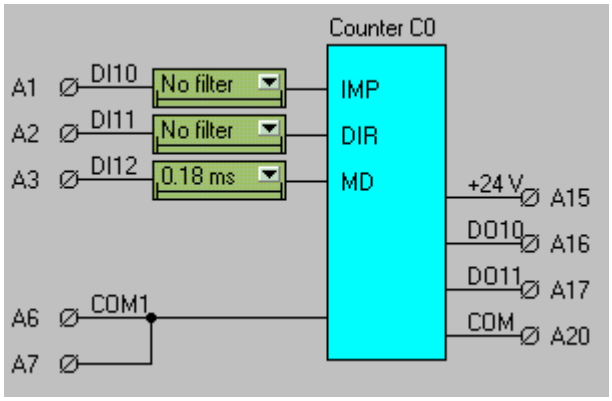
4.9.2 Incremental encoder with 3 inputs

In the configuration with 3 inputs, the NI and REF inputs are not employed, otherwise the function of the counter is identical. To set the reference point, it is possible to use the MD signal, when we set the EMR bit to "1" in the Cont byte, then with the activation of the MD signal, the current value of the counter will be set to zero. Of course, the accuracy of the setup is significantly lower and depends on the speed of the movement, MD sensor scatter characteristics, its reaction time and input filter setup. Under idle conditions, the zero point can be set up also from the program in the Cont byte, bit RES. In the configuration with 3 inputs, the MD input is common for counters 0 and 1 (2 and 3). If the MD input is used for setting of the counters to zero or for capturing of the current measured position, switching of measurement contacts has to be realized outside the IC-7702 module.



4.9.3 Pulses and direction with 5 or 3 inputs





In the configuration Pulses and direction, the first input gives the change in the value of the counter to the leading edge and the second input determines the direction of counting. The other functions are identical as it is for the IRC configuration.

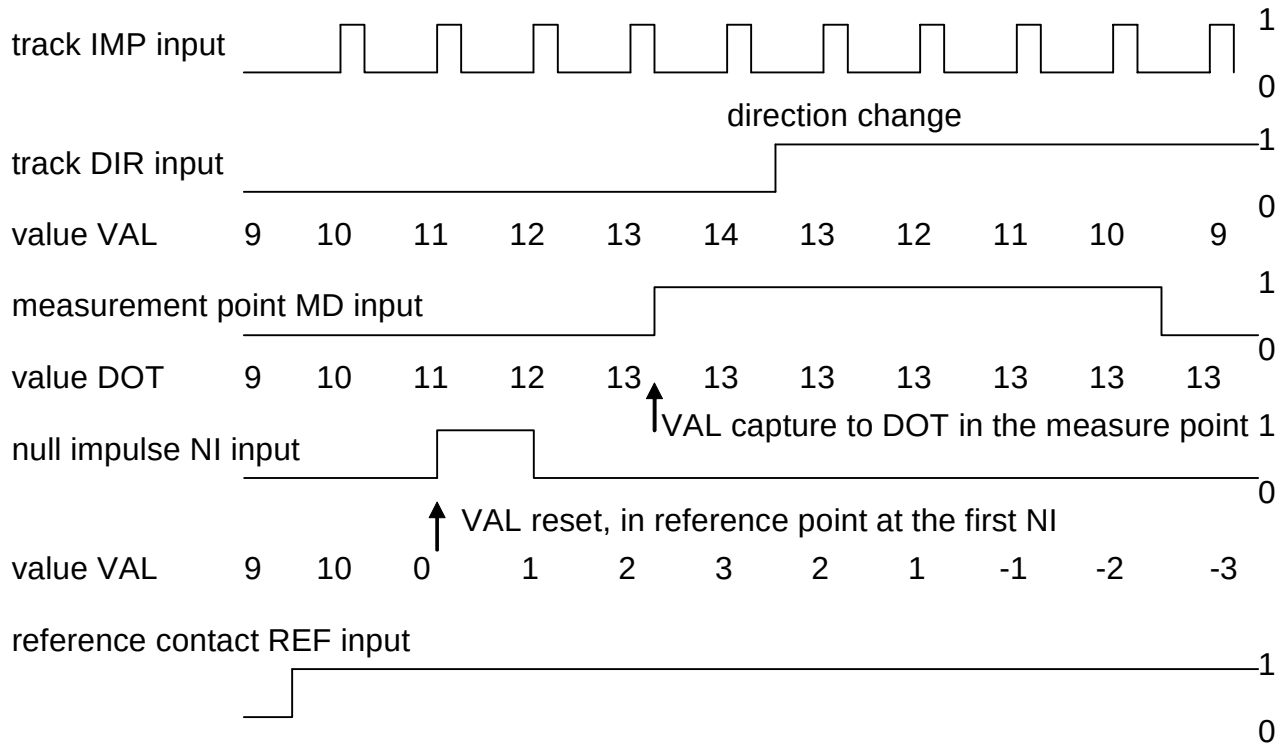
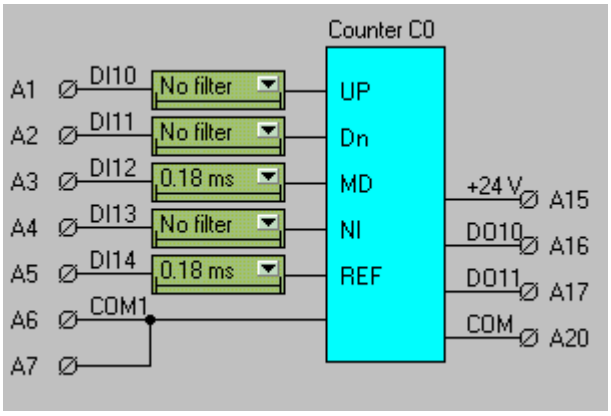
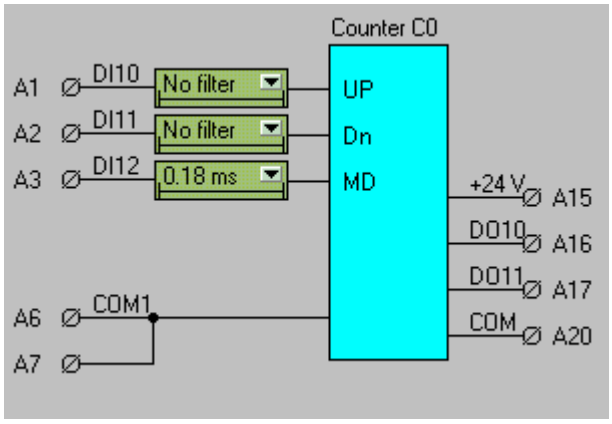


Fig. 4.5 Function in mode Pulses and direction with 5 inputs

Notes:
1) To capture a value given by MD to DOT, bit EMD has to be set to "1" in the Cont byte and for repeating of this function, this bit has to be returned to "0" first. The indication of the activity of MD is through the IMD bit in the Status.
2) For the function of referencing, the MODE bits have to be set in the Cont byte. The indication of the reference point setup is through the IREF bit in the Status.

4.9.4 Up and Down with 5 or 3 inputs





In the configuration UP and DOWN, the first input at the leading edge increments the value of the counter and the second input at the leading edge decrements the value of the counter. The other functions are identical as it is for the IRC configuration.

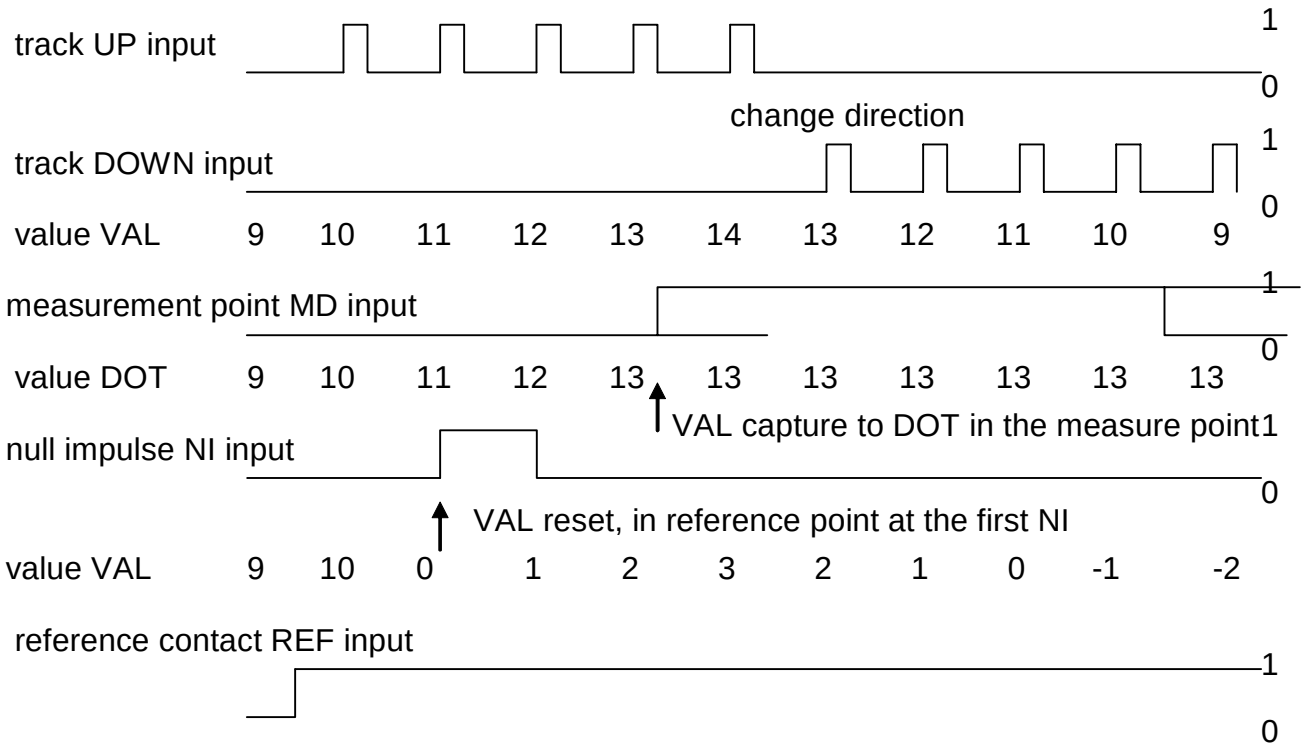
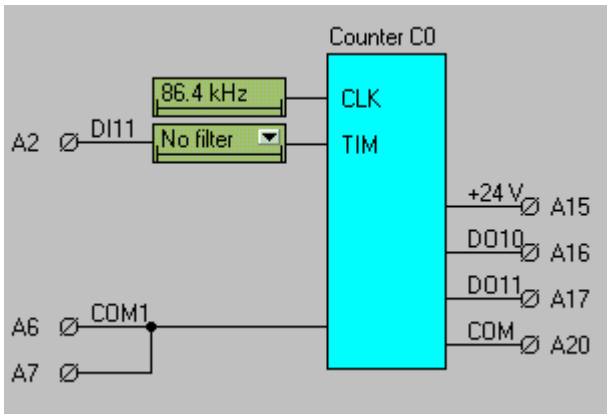


Fig. 4.6 Functions in mode UP and DOWN with 5 inputs

Notes:
1) To capture a value given by MD to DOT, bit EMD has to be set to "1" in the Cont byte and for repeating of this function, this bit has to be returned to "0" first. The indication of the activity of MD is through the IMD bit in the Status.
2) For the function of referencing, the MODE bits have to be set in the Cont byte. The indication of the reference point setup is through the IREF bit in the Status.

4.9.5 Timer



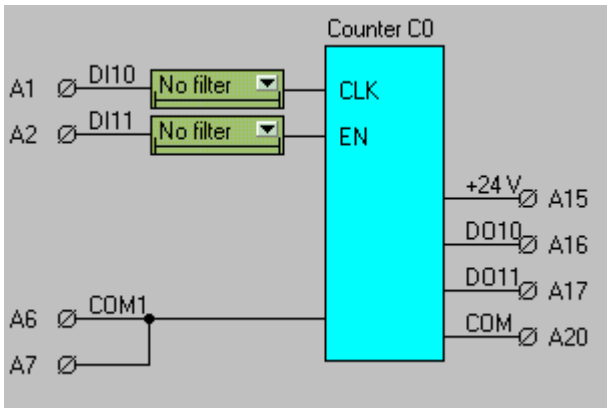
In the configuration of the timer, the counter measures the length of the pulse or allows generating of a pulse. The length of the pulse is measured at input **DI1**. The value **POS1** has to be set to maximum, i.e. +2 147 483 647. The length of the pulses can be in the range from 11.574 ms to 24 855 s. The length is calculated as follows:

T = Val / 86400 [s].

At output **DO0** it is possible to generate the pulse of the length **T = POS1 / 86400 [s]**. In this case, input **DI1** has to still be „1”, since it conditions the input of the clock pulses to the counter. Output **DO0** is „1”, if the value of the counter is **Val** < **POS1**. Output **DO1** is inverted to output **DO0**. The counting is stopped, as long as the value of **Val** reaches the value of **POS1**.

4.9.6 Conditionally switched counter

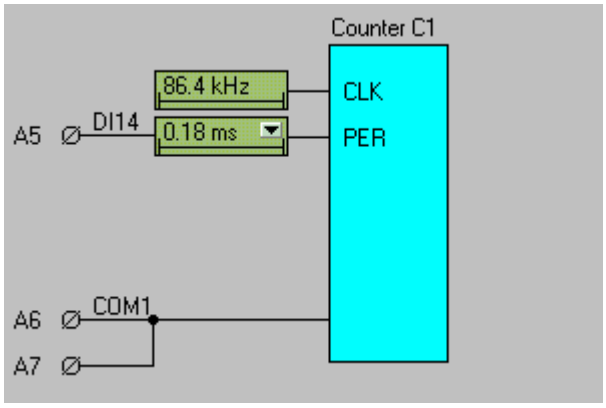
In the configuration of the conditionally switched counter, it counts the leading edges of the pulses at input **DI0**, if "1" is at input **DI1**. Output **DO0** is „1“, if the value of **Val** < **POS1**. Output **DO1** is inverted to output **DO0**. The counting is stopped, as long as the value of **Val** reaches the value of **POS1**.



4.9.7 Period measurement

In the configuration of period measurement, the counter measures the period from the leading edge to the next leading edge at input **DI1**. The measured period of the pulses can range from 11.574 ms to 24 855 s. The period is calculated according to the following formula:

T = Val / 86400 [s].



4.10 Program-selectable modes of function of outputs for counter 0 and 2:

- Manual control of outputs through bits DO0, DO1
- Digital mark mode (output switched in an interval of two specified points)
- Positioning by outputs UP and DOWN (DO0 - UP, DO1 - DOWN)
- Moving to reference by outputs UP and DOWN (DO0 - UP, DO1 - DOWN)
- UP positioning, with 2 speeds (DO0 - FAST, DO1 - SLOW)
- DOWN positioning, with 2 speeds (DO0 - FAST, DO1 - SLOW)
- Moving to reference with 2 speeds (DO0 - FAST, DO1 - SLOW)

The functions of outputs behaviour are optional under run from the user program and are incorporated only with counters 0 and 2. The mode of outputs behaviour is controlled by the status of bits MODE0, MODE1 and MODE2 in the Cont byte of the structure of the corresponding counter.

4.10.1 Manual control of outputs through bits DO0, DO1

MODE0 = 0; MODE1 = 0; MODE2 = 0;

In this mode, the status of outputs **DO0** and **DO1** is given by the value of bits **DO0** and **DO1** in the Cont byte.

4.10.2 Digital mark mode

MODE0 = 1; MODE1 = 0; MODE2 = 0;

In this mode, the status of outputs **DO0** and **DO1** is given by comparison of the value of the counter **Val** with values **POS1** and **POS2**. Output **DO0** is closed, if **Val >= POS1 and Val <= POS2**. Output **DO1** is inverted to output **DO0**.

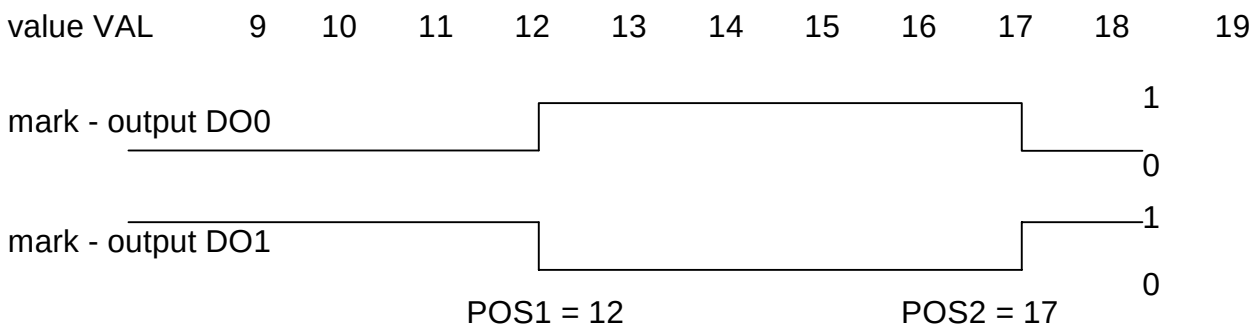


Fig. 4.7 Digital mark mode

4.10.3 Positioning by outputs UP and DOWN

MODE0 = 0; MODE1 = 1; MODE2 = 0;

In this mode, output **DO0** has the function of starting the movement up (**UP**) and output **DO1** has the function of starting the movement down (**DN**). Possible changes of the speed during the movement has to be solved by means of another digital or analog outputs by means of the program. The function of outputs **UP** and **DN** is given by the following expressions:

Output **UP** is on, if **Val < POS1**.

Output **DN** is on, if **Val > POS1**.

After the target value of **POS1** is reached, the **DST** bit in the Status is set to "1" and both outputs are off, until a new different value of **POS1** is written, or the **MODE** is changed.

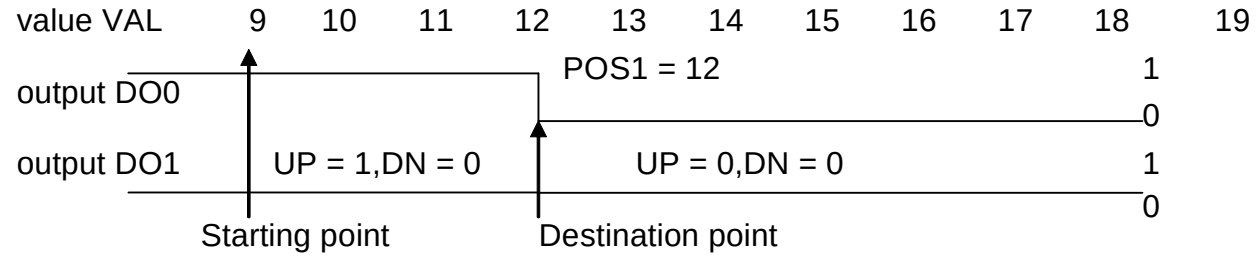


Fig. 4.8 Positioning by outputs UP

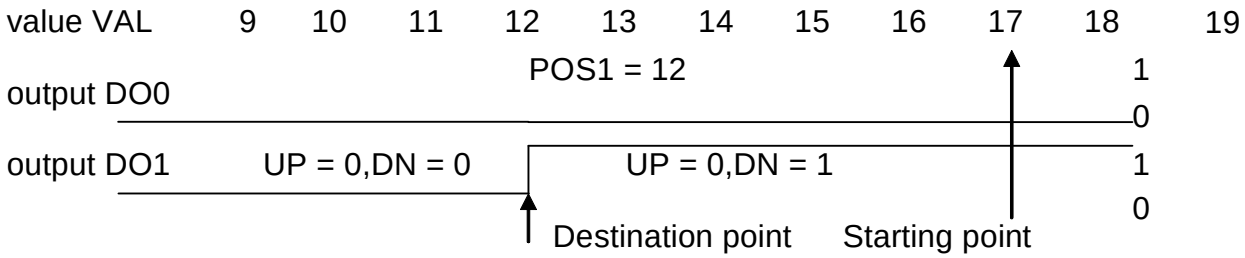


Fig. 4.9 Positioning by outputs DOWN

4.10.4 Moving to reference by outputs Up and Down (UP/DN)

To move to a reference point in the mode UP/DN, the following bits have to be set in Cont of the counter:

MODE0 = 1; MODE1 = 1; MODE2 = 0;

The function is clear from the following figures for the cases, when the start point is above or under the position of the **REF** switch. The **REF** switch has to be always closed from one side of the entire track and always open from the second side, by which the direction for reference searching is determined. If the start point is when the **REF** switch is closed, then the **DN** output closes to move to the position where the **REF** switch will be open. Subsequently the **UP** output closes and the first closing of the **NI** (Null index) signal is searched. If the start point is when the **REF** switch is open, than the **UP** output closes, and after closing of the **REF** switch, the first closing of the **NI** signal is searched. At this point, the content of the counter is reset, by which the origin of coordinates for measuring is set. Searching for **NI** is carried out always from the same direction to eliminate the effect of clearances in the drive to improve the repeatability of the origin setup.

After reaching the **NI** and resetting of the counter, the bit **IREF** in the Status is set to "1". Both outputs will be off, until **MODE** is changed. The **IREF** bit is set to zero by switching on the mode of moving to reference again. Possible changes of the speed during the movement has to be solved by means of another digital or analog outputs by means of the program.

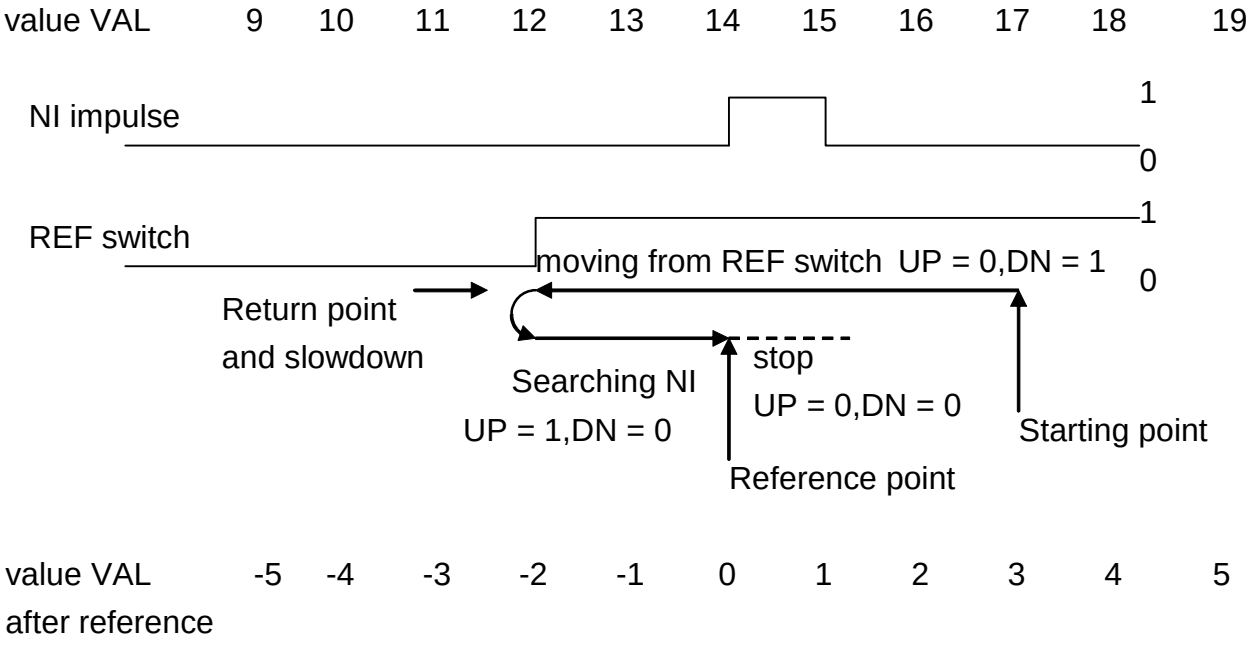


Fig. 4.10 Moving to reference DOWN

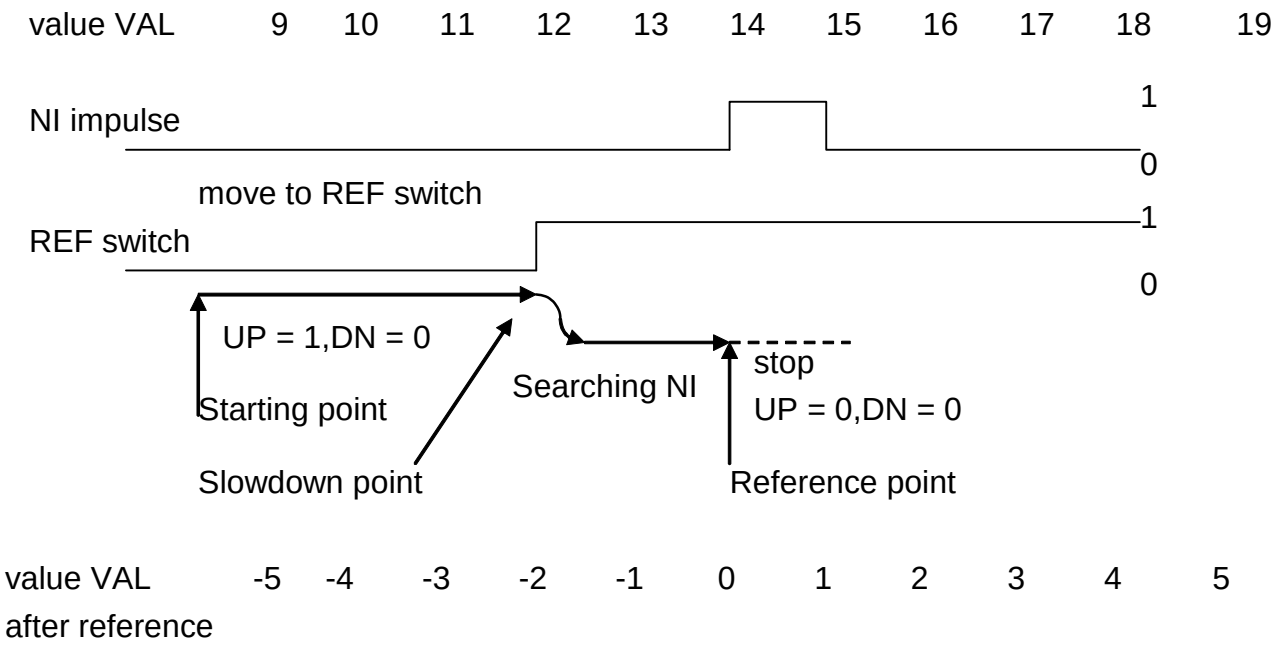


Fig. 4.11 Moving to reference UP

4.10.5 Up positioning with two speeds

MODE0 = 0; MODE1 = 0; MODE2 = 1;

In this mode, output **DO0** has the function to switch on the movement fast (**Fast**) and output **DO1** has the function to switch on the movement slow (**Slow**). The function of outputs **Fast** and **Slow** is given by the following expressions:

Output **Fast** is on, if **Val < POS2**.

Output **Slow** is on, if **Val ≥ POS2 and Val < POS1** .

After reaching of the target value **POS1**, the **DST** bit is set to „1“ in the Status and both outputs are off, until a new different value of **POS1** is written, or the **MODE** is changed.

Note: The direction of the movement UP for two-speed control has to be preset from the program by means of common digital outputs.

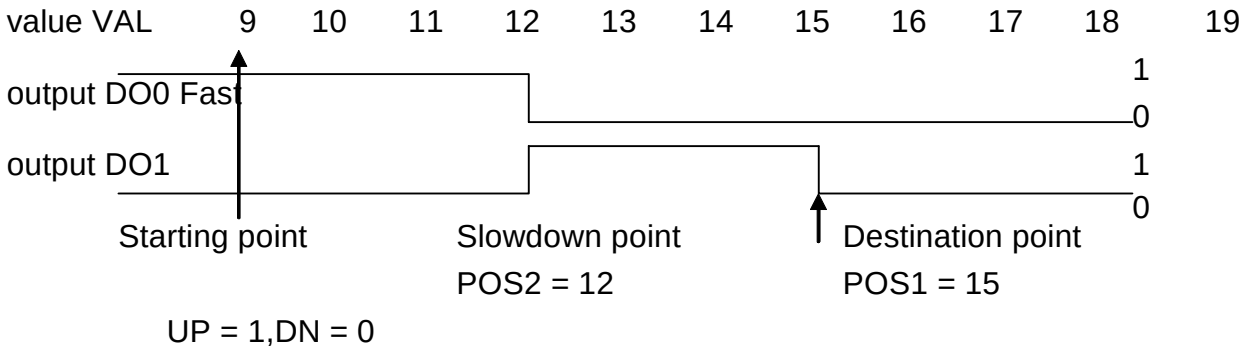


Fig. 4.12 Positioning UP by two speeds

4.10.6 Positioning DOWN by two speeds

MODE0 = 1; MODE1 = 0; MODE2 = 1;

In this mode, output **DO0** has the function to switch on the movement fast (**Fast**) and output **DO1** has the function to switch on the movement slow (**Slow**). The function of outputs **Fast** and **Slow** is given by the following expressions:

Output **Fast** is on, if **Val > POS2**.

Output **Slow** is on, if **Val ≤ POS2 and Val > POS1** .

After reaching of the target value **POS1**, the **DST** bit is set to „1“ in the Status and both outputs are off, until a new different value of **POS1** is written, or the **MODE** is changed.

Note: The direction of the movement UP for two-speed control has to be preset from the program by means of common digital outputs.

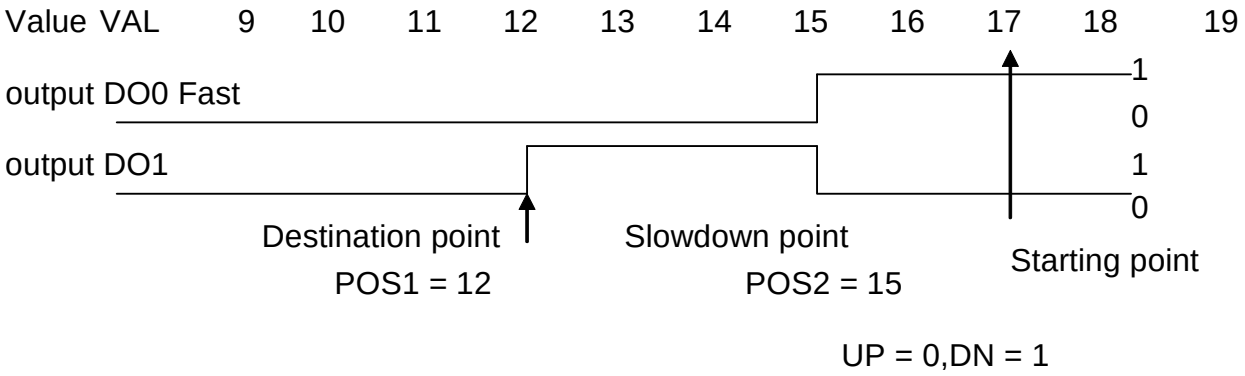


Fig. 4.13 Positioning DOWN by two speeds

4.10.7 Moving to reference by two speeds

MODE0 = 0; MODE1 = 1; MODE2 = 1;

In this mode, output **DO0** has the function to switch on the movement fast (**Fast**) and output **DO1** has the function to switch on the movement slow (**Slow**). The function of outputs **Fast** and **Slow** is given by the following expressions:

Output **Fast** is on, if **REF** is „0“.

Output **Slow** is on, if **REF** is „1“ and **NI** is not „1“ yet.

If the start point is when the **REF** switch is closed, than it is necessary to move down by the program from the **REF** switch to open it. After that, it is necessary to set the movement up by the program and to set the mode of the movement to reference by two speeds. If the start point is when the **REF** switch is open, than the output **Fast** closes, after closing of the **REF** switch, the output **Slow** closes and the output **Fast** opens. The first closing of the **NI** (Null index) signal is searched. At this point, the content of the counter is reset, by which the origin of coordinates for measuring is set. Searching for **NI** is carried out always from the same direction to eliminate the effect of clearances in the drive to improve the repeatability of the origin setup.

After reaching the **NI** and resetting of the counter, the bit **IREF** in the Status is set to "1". Both outputs will be off, until **MODE** is changed. The **IREF** bit is set to zero by switching on the mode of moving to reference again.

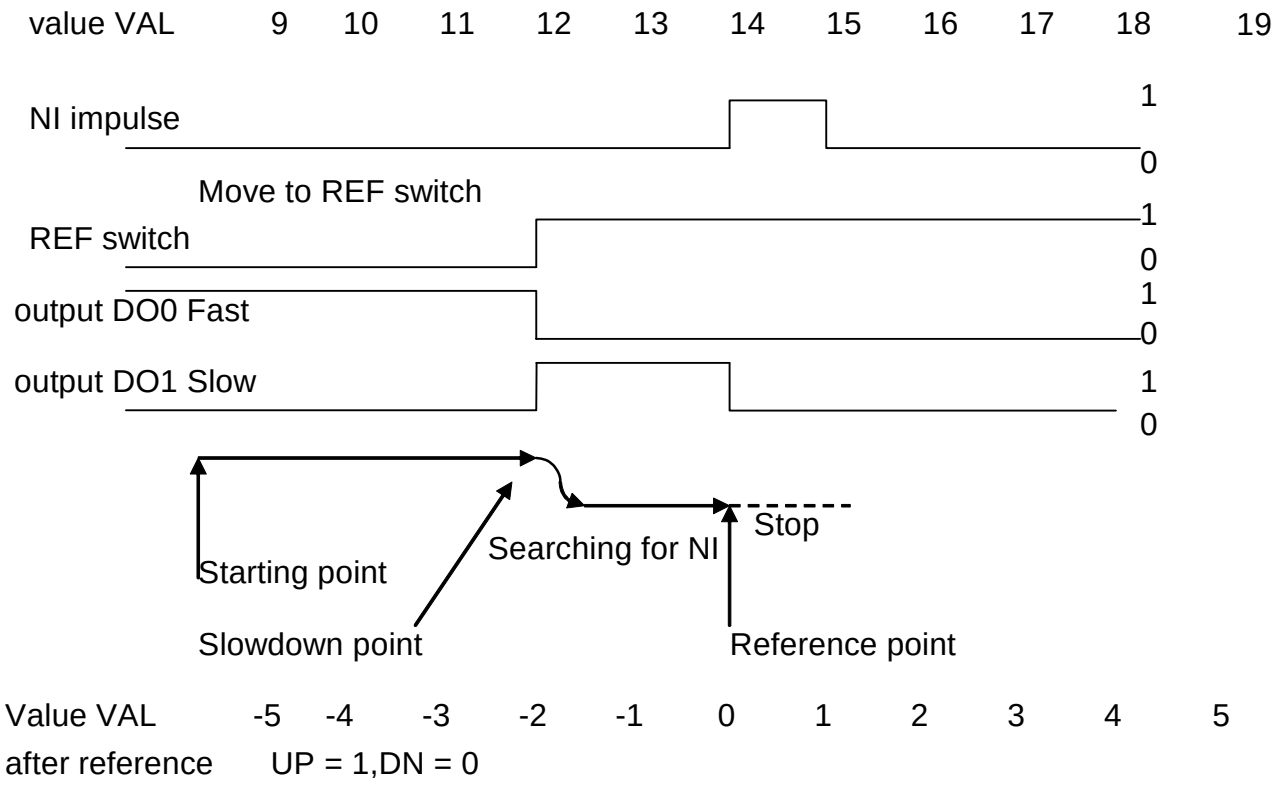


Fig. 4.14 Moving to reference by two speeds

4.11 Scratchpad memory data structure

The IC-7702 counter module operates 4 counters of the width of 32 bits. Counters 0 and 2 have more functions than counters 1 and 3 and therefore they have a different structure of the data read and written.

The items of the structure of the counter module have assigned symbolic names, , beginning with the rack number and position number in the rack. In the column *Full notation*, concrete symbolic name is specified for the given item. If you want to use the data in the user program, you will use either this symbolic name or you will write your symbolic name in the column *Alias* that can be used later. We do not recommend to use absolute operands, since they can change by adding another modules to the PLC assembly after a new compilation of the user program. The structure of passed data is obvious from the panel *I/O Setting* in the MOSAIC development environment (icon IO).

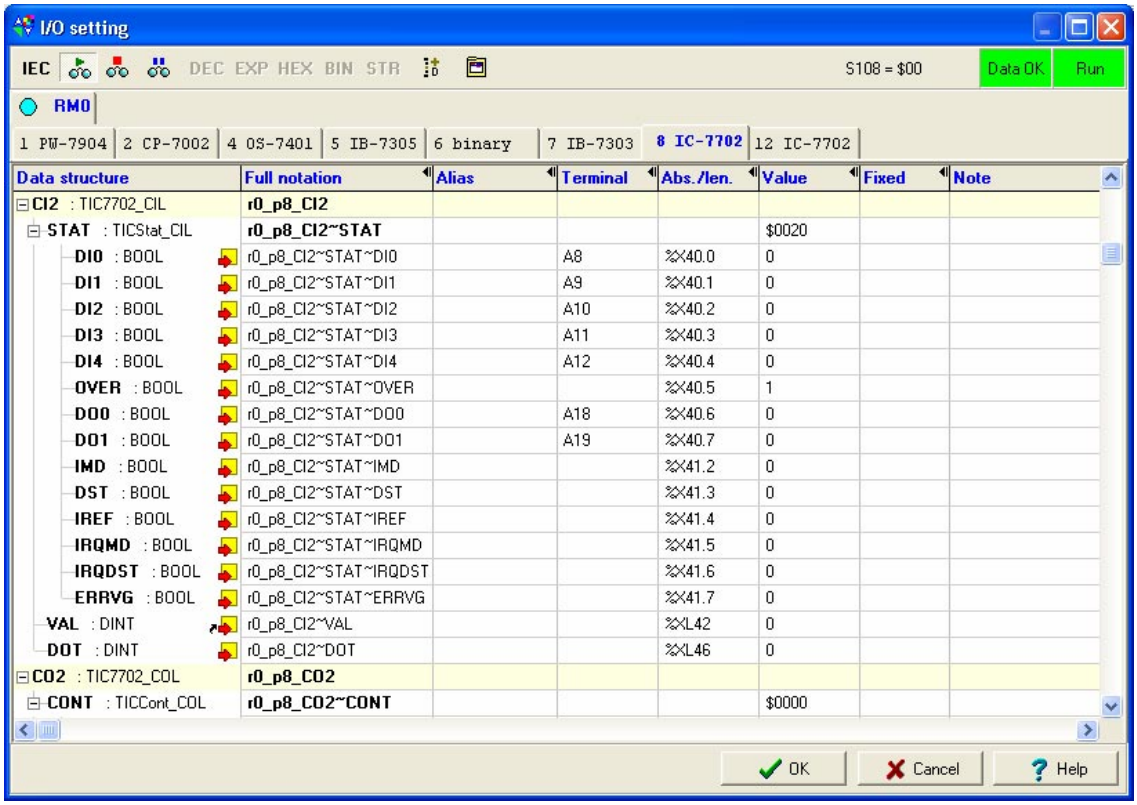


Fig. 4.15 Example of structure of input data of counter 2 of the IC-7702 module

In this dialogue, it is possible to monitor the items of the data structures or to fix them at a selected value.

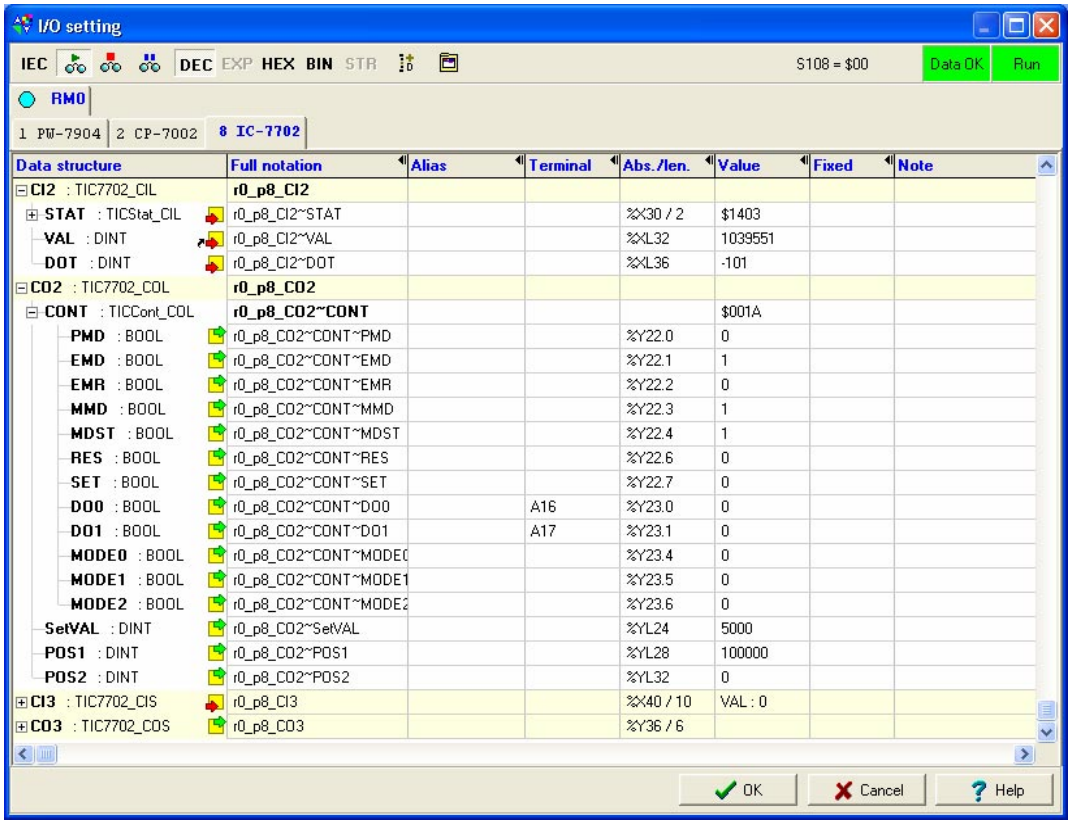


Fig. 4.16 Example of structure of output data of counter 2 of the IC-7702 module

The data structure of the module is **generated automatically** by Mosaic (according to the setup in the dialogue for selection and configuration of counters) to the file HWconfig.ST and is as follows:

STAT - status of counter 0 and 2

DO1	DO0	OVER	DI4	DI3	DI2	DI1	DI0
.7	.6	.5	.4	.3	.2	.1	.0
ERRVG	IRQDST	IRQMD	IREF	DST	IMD	0	0
.15	.14	.13	.12	.11	.10	.9	.8

```
TICStat_CIL : STRUCT           // status of counter 0 and 2
  DI0     : BOOL;   // status of input DI0
  DI1     : BOOL;   // status of input DI1
  DI2     : BOOL;   // status of input DI2
  DI3     : BOOL;   // status of input DI3
  DI4     : BOOL;   // status of input DI4
  OVER    : BOOL;   // output overload signalization status
  DO0     : BOOL;   // status of output DO0
  DO1     : BOOL;   // status of output DO1
  dummy8  : BOOL;
  dummy9  : BOOL;
  IMD     : BOOL;   // status of initialization of measurement point MD
  DST     : BOOL;   // status of reaching the destination during
                ;   // positioning
  IREF    : BOOL;   // reference point setup status
  IRQMD   : BOOL;   // request for interrupt from MD
  IRQDST  : BOOL;   // request for interrupt from reaching of destination
  ERRVG   : BOOL;   // error,consecution of tracks from incremental counter
END_STRUCT;
```

STAT - status of counter 1 and 3

0	0	0	0	0	0	DI4	DI3
.7	.6	.5	.4	.3	.2	.1	.0
ERRVG	0	0	0	0	IMD	0	0
.15	.14	.13	.12	.11	.10	.9	.8

```
TICStat_CIS : STRUCT       // status of counter 1 and 3
  DI3     : BOOL;   // status of input DI3
  DI4     : BOOL;   // status of input DI4
  dummy2  : BOOL;
  dummy3  : BOOL;
  dummy4  : BOOL;
  dummy5  : BOOL;
  dummy6  : BOOL;
  dummy7  : BOOL;
  dummy8  : BOOL;
  dummy9  : BOOL;
  IMD     : BOOL;   // status of initialization of measurement point MD
  dummy11 : BOOL;
  dummy12 : BOOL;
  dummy13 : BOOL;
  dummy14 : BOOL;
  ERRVG   : BOOL;   // error, consecution of tracks from incremental
                ;   // counter
END_STRUCT;
```

CONT – control byte of counter 0 and 2

SET	RES	0	MDST	MMD	EMR	EMD	PMD
.7	.6	.5	.4	.3	.2	.1	.0
0	MODE2	MODE1	MODE0	0	0	DO1	DO0
.15	.14	.13	.12	.11	.10	.9	.8

```
TICCont_COL : STRUCT      // control of counter 0 and 2
  PMD     : BOOL;   // polarity of input of measurement point MD
  EMD     : BOOL;   // enabling of activity of input of
                    ;  // measurement point MD
  EMR     : BOOL;   // enabling of resetting from the input of measurement
                    ;  // point MD
  MMD     : BOOL;   // mask of interrupt from input of measurement point MD
  MDST    : BOOL;   // mask of interrupt from reaching of destination
                    ;  // during positioning
  dummy5  : BOOL;
  RES     : BOOL;   // program resetting of value
  SET     : BOOL;   // program setup of value
  DO0     : BOOL;   // required status of output DO0 in manual mode
  DO1     : BOOL;   // required status of output DO1 in manual mode
  dummy10 : BOOL;
  dummy11 : BOOL;
  MODE0   : BOOL;   // mode of function of outputs 0
  MODE1   : BOOL;   // mode of function of outputs 1
  MODE2   : BOOL;   // mode of function of outputs 2
  dummy15 : BOOL;
END_STRUCT;
```

CONT – control byte of counter 1 and 3

SET	RES	0	0	0	EMR	EMD	PMD
.7	.6	.5	.4	.3	.2	.1	.0
0	0	0	0	0	0	0	0
.15	.14	.13	.12	.11	.10	.9	.8

```
TICCont_COS : STRUCT // control of counter 1 and 3
  PMD     : BOOL;   // polarity of input of measurement point MD
  EMD     : BOOL;   // enabling of activity of input of measur. point MD
  EMR     : BOOL;   // enabling of resetting from the input of measur.
                    ;  // point MD
  dummy3  : BOOL;
  dummy4  : BOOL;
  dummy5  : BOOL;
  RES     : BOOL;   // program resetting of value
  SET     : BOOL;   // program setup of value
  dummy8  : BOOL;
  dummy9  : BOOL;
  dummy10 : BOOL;
  dummy11 : BOOL;
  dummy12 : BOOL;
  dummy13 : BOOL;
  dummy14 : BOOL;
  dummy15 : BOOL;
END_STRUCT;
```

```
  TIC7702_CIL : STRUCT
    STAT : TICStat_CIL; // status of counter 0 and 2
    VAL : DINT;         // current value of counter
    DOT : DINT;         // captured value of counter from MD
  END_STRUCT;

  TIC7702_COL : STRUCT
    CONT : TICCont_COL; // control of counter 0 and 2
    SetVAL : DINT;      // set value
    POS1 : DINT;        // value of pos. 1 (destination point, start of mark)
    POS2 : DINT;        // value of pos. 2 (slowdown point, end of mark)
  END_STRUCT;

  TIC7702_CIS : STRUCT
    STAT : TICStat_CIS; // status of counter 1 and 3
    VAL : DINT;         // current value of counter
    DOT : DINT;         // captured value of counter from MD
  END_STRUCT;

  TIC7702_COS : STRUCT
    CONT : TICCont_COS; // control of counter 0 and 2
    SetVAL : DINT;      // set value
  END_STRUCT;

(* IC-7702 *)         // definition of variables ( instances )
VAR_GLOBAL
  r0_p8_CI0            AT %X20  : TIC7702_CIL;
  r0_p8_CO0            AT %Y4   : TIC7702_COL;
  r0_p8_CI1            AT %X30  : TIC7702_CIS;
  r0_p8_CO1            AT %Y18  : TIC7702_COS;
  r0_p8_CI2            AT %X40  : TIC7702_CIL;
  r0_p8_CO2            AT %Y24  : TIC7702_COL;
  r0_p8_CI3            AT %X50  : TIC7702_CIS;
  r0_p8_CO3            AT %Y38  : TIC7702_COS;
END_VAR
```

4.12 Programming in mnemocode

When programming in the language of mnemonic code, we proceed according to manuals "PLC Tecomat Programmer's manual" TXV 001 09.02, "Examples of programming - Model 32 bits" TXV 004 04.01, "PLC Instruction set - Model 32 bits" TXV 004 01.02.

The following example demonstrates the use of the IC-7702 module in the function of the positioning module. An incremental counter, a measurement contact MD and a reference sensor are connected to the first counter C0. The outputs from IC-7702 control by means of two values (UP and DOWN) the drive motor, the revolutions are controlled stepwise by digital outputs Fast and Slow (e.g. by module OS-74xx). The module allows finding of a reference point, manual moving by buttons or moving to a position as required by the program.

```
; // global definition of variables
; // in reality buttons SB_ will be from an input module, e.g. IB-7...
#reg bit
     SB_home,
     SB_ManUp,
     SB_ManDn,
     SB_Start,
```

```
      SB_Stop,
      SB_Int_EN,
      SB_MD_EN,
      SB_Set,
      SB_Res,
      IRef,
      Done,
      IMd,
      UP,DN,
      Fast, Slow,
      ERRVG
#reg long
      Pos1,
      Pos2,
      Val,
      Dot,
      SetVal
#reg bit
      memStart,
      memHome,memHome1,memHome2,memHome3,memHome4,memHome5,
      memDone,pomBit

;Example of operation of positioning of axis in mnemonic code
;
P 0
;
  LD   SB_ManUp             ;manual UP
  WR   r0_p8_CO0~Cont~DO0
  LD   SB_ManDn             ;manual DOWN
  WR   r0_p8_CO0~Cont~DO1
;
  LD   SB_Start             ;start of movement
  SET  memStart
  LD   r0_p8_CI0~Stat~DST
  OR   SB_Stop              ;stop
  RES  memStart
;
  LD   Pos1
  WR   r0_p8_CO0~Pos1       ;entered destination position of movement
  LD   Pos2                 ;offset for movement slowdown
; WR   r0_p8_CO0~Pos2
;
  LD   r0_p8_CI0~Stat~IREF
; ANC  memHome5
  OR   SB_Stop
  RES  memHome

  LDC  memHome1
  LET  memHome3
  LET  memHome5             ;shift by one cycle
  SET  memHome              ;to reference slowly again

  LD   r0_p8_CI0~Stat~DI4   ;REF
  BET  memHome2             ;both edges REF
  OR   SB_Stop
  RES  memHome1

  LD   SB_Home              ;moving to REF point
```

```
  LET  memHome4
  SET  memHome1            ;fast to reference
;
  LD   r0_p8_CI0~Stat~DST
  SET  memDone
  LD   SB_Start
  RES   memDone
;
; LD    0
; WR   r0_p8_CO0~ContMD_pol;polarity of signal MD(0..direct,1..inverted)
  LD   SB_MD_EN
  WR   r0_p8_CO0~Cont~EMD ;enable capture of MD
                          ;(0..do not capture,1..capture)
; LD    0
; WR   AXX~MD_RES          ;enable reset from MD (0..do not reset, 1..reset)
  LD   SB_Set
  WR   r0_p8_CO0~Cont~Set ;value setup(0..do not setup,0/1..setup)
  LD   SB_Res
  WR   r0_p8_CO0~Cont~Res ;counter reset(0..do not reset,0/1..reset)
  LD   SetVal
  WR   r0_p8_CO0~SetVal   ;set point
;
  LD   SB_Int_EN
  WR   r0_p8_CO0~Cont~MMD ;enable interrupt from MD(0..disabled,1..enabled)
  WR   r0_p8_CO0~Cont~MDST;enable interrupt from destination
                          ;(0..disabled,1..enabled)
;
;IF ( Pos1 - Pos2 > ircIn.Val or Pos1 + Pos2 < ircIn.Val)  THEN  pomBit:=1;
  LD   Pos1                ;destination
  LD   Pos2                ;slowdown point offset
  SUB
  LD   r0_p8_CI0~Val
  GTS
  LD   Pos1                ;destination
  LD   Pos2                ;slowdown point offset
  ADD
  LD   r0_p8_CI0~Val
  LTS
  OR
  WR   pomBit
;
  LD   memStart            ;movement
  AND  pomBit
  RES  Slow
  SET  Fast
;
  LD   memStart            ;movement
  ANC  pomBit
  SET  Slow
  RES  Fast
;
  LD   memHome             ;to reference slowly again
  OR   memHome1            ;fast to reference
  SET  r0_p8_CO0~Cont~MODE0
  SET  r0_p8_CO0~Cont~MODE1
  RES  r0_p8_CO0~Cont~MODE2
;
  LD   memHome
```

```
  OR   memHome1            ;to reference
  AND  r0_p8_CI0~Stat~DO0  ;up
  AND  r0_p8_CI0~Stat~DI4  ;REF
;
  LD   memHome1            ;fast to reference
  RES  Slow
  SET  Fast
  LD   memHome             ;to reference slowly again
  SET  Slow
  RES  Fast
;
  LDC  memHome
  ANC  memHome1
  AND  memStart            ;movement
  RES  r0_p8_CO0~Cont~MODE0
  SET  r0_p8_CO0~Cont~MODE1
  RES  r0_p8_CO0~Cont~MODE2
;
  LDC  memHome
  ANC  memHome1
  ANC  memStart           ;manually
  RES  r0_p8_CO0~Cont~MODE0
  RES  r0_p8_CO0~Cont~MODE1
  RES  r0_p8_CO0~Cont~MODE2
  RES  Slow
  SET  Fast
;
  LD   r0_p8_CI0~Stat~IREF
  WR   IRef                ;reference point was set
  LD   memDone             ;
  WR   Done                ;movement is finished
  LD   r0_p8_CI0~Val
  WR   Val                 ;current position
  LD   r0_p8_CI0~Stat~IMD  ;
  WR   IMd                 ;indic. of capture of coordinate of meas. point
  LD   r0_p8_CI0~DOT       ;
  WR   Dot                 ;position of captured coordinate of meas. point
  LD   r0_p8_CI0~Stat~DO0  ;
  WR   UP                  ;indication of outputs
  LD   r0_p8_CI0~Stat~DO1  ;
  WR   DN                  ;indication of outputs
  LD   r0_p8_CI0~Stat~ERRVG;
  WR   ERRVG               ;failure of phase of track V and G
;
;-------------------------------------------------------------------
; for my trials, otherwise it will be  OS-7....
  LD   Fast
  WR   r0_p8_CO2~Cont~DO0  ; outputs 2 counter as Fast and Slow
  LD   Slow
  WR   r0_p8_CO2~Cont~DO1  ;
E 0
```

4.13 Programming according to IEC 61 131- 3

4.13.1 Example of function block in graphical form according to IEC 61 131- 3

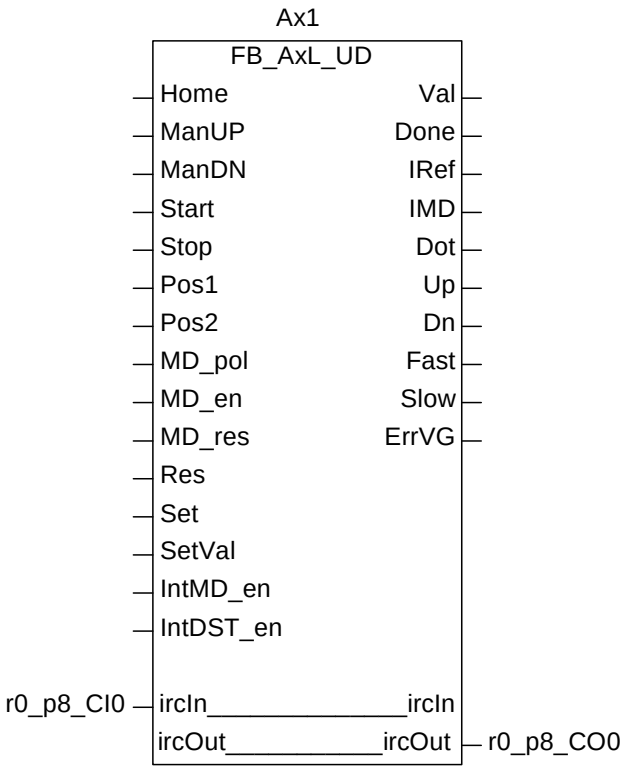


Fig. 4.17 Function block for counter in module IC-7702

4.13.2 Example of function block in structured text language ST according to IEC 61 131-3

When programming in the ST language, we proceed according to manual "Programming of PLC Tecomat in ST language" TXV 003 21. The following example demonstrates the use of the IC-7702 module in the function of the positioning module. An incremental counter, a measurement contact MD and a reference sensor are connected to the first counter C0. The outputs from IC-7702 control by means of two values (UP and DOWN) the drive motor, the revolutions are controlled stepwise by digital outputs Fast and Slow (e.g. by module OS-74xx). The module allows finding of a reference point, manual moving by buttons or moving to a position as required by the program. The example also demonstrates the possibility to use the interrupt from events on module IC-7702.

```
// FB for long counter C0 and C2 of module IC-7702
FUNCTION_BLOCK fb_AxL_UD // in mode Up/Down
  VAR_INPUT
    Home   : BOOL; // moving to reference point
    ManUp  : BOOL; // manual UP
    ManDn  : BOOL; // manual DOWN
    Start  : BOOL; // start of movement
    Stop   : BOOL; // movement stop
    Pos1   : DINT; // movement target position
    Pos2   : DINT; // offset for movement slowdown
    MD_pol : BOOL; // polarity of signal of MD (0..direct, 1..inverted)
```

```
   MD_EN  : BOOL; // enable capture of MD (0..do not capture, 1..capture)
   MD_RES : BOOL; // enable reset from MD (0..do not reset, 1..reset)
   RES    : BOOL; // counter reset  (0..do not reset, 0/1..reset)
   SET    : BOOL; // value setup (0..do not setup, 0/1..setup)
   SetVal : DINT; // set point
   IntMD_EN : BOOL;// enable interrupt from MD (0..disabled, 1..enabled)
   IntDST_EN: BOOL;// enable interrupt from destination(0..disabled,
                   //1..enabled)
END_VAR

 VAR
   memHome : SR;   // flip-flop circuit for moving to reference
   memStart: RS;   // flip-flop circuit for movement Up/Dn
   memDone : SR;   // flip-flop circuit for Done
 END_VAR
 VAR_OUTPUT
   Val     : DINT; // current position
   Done    : BOOL; // movement is finished
   IRef    : BOOL; // reference point was set
   IMd     : BOOL; // indication of capture of coordinate of meas. point
   Dot     : DINT; // position of captured coordinate of measur. point
   UP,DN   : BOOL; // indication of outputs
   Fast,Slow: BOOL;// outputs to digital module
   ERRVG   : BOOL; // indication of error of phase of track V and G
                   //of sensor IRC
 END_VAR
 VAR_IN_OUT
   ircIn  : TIC7702_CIL;
   ircOut : TIC7702_COL;
 END_VAR

 memHome( S1 := Home, R := ircIn.Stat.IREF or Stop);
 memDone( S1 := ircIn.Stat.DST, R := Start );
 memStart( S := Start, R1 := ircIn.Stat.DST or Stop );

 ircOut.Cont.MMD := IntMD_EN;        // enable interrupt
 ircOut.Cont.MDST := IntDST_EN;
 ircOut.Cont.EMD := MD_EN;
 ircOut.Cont.Set := Set;
 ircOut.Cont.Res := Res;

 ircOut.Cont.DO0 := ManUp;
 ircOut.Cont.DO1 := ManDn;
 ircOut.SetVal := SetVal;
 ircOut.Pos1 := Pos1;

IF ( Pos1 - Pos2 > ircIn.Val or Pos1 + Pos2 < ircIn.Val)  THEN
  Fast:=TRUE; Slow:=FALSE;
ELSE
  Slow:=TRUE; Fast:=FALSE;
END_IF;

IF ( memHome.Q1) THEN              // to reference
   ircOut.Cont.MODE0:=TRUE;ircOut.Cont.MODE1:=TRUE;ircOut.Cont.MODE2:=FALSE;
   IF (ircIn.Stat.DO0 and ircIn.Stat.DI4 ) THEN
     Slow:=TRUE; Fast:=FALSE;
   ELSE
     Fast:=TRUE; Slow:=FALSE;
```

```
    END_IF;
 ELSIF ( memStart.Q1) THEN        // movement
   ircOut.Cont.MODE0:=FALSE;ircOut.Cont.MODE1:=TRUE;ircOut.Cont.MODE2:=FALSE;
 ELSE                             // manually
  ircOut.Cont.MODE0:=FALSE;ircOut.Cont.MODE1:=FALSE;ircOut.Cont.MODE2:=FALSE;
 END_IF;

  IRef  := ircIn.Stat.IREF;
  Done := memDone.Q1;
  Val  := ircIn.Val;
  IMd  := ircIn.Stat.IMD;
  Dot  := ircIn.DOT;
  UP   := ircIn.Stat.DO0;
  DN   := ircIn.Stat.DO1;
  ERRVG:= ircIn.Stat.ERRVG;
END_FUNCTION_BLOCK

VAR_GLOBAL // global definition of variables ( instances )
// in reality buttons SB_ will be from an input module, e.g. IB-7xxx
  SB_home        : BOOL;     SB_home2        : BOOL; // inputs
  SB_up          : BOOL;     SB_up2          : BOOL;
  SB_down        : BOOL;     SB_down2        : BOOL;
  SB_start       : BOOL;     SB_start2       : BOOL;
  SB_stop        : BOOL;     SB_stop2        : BOOL;
  SB_Int_EN      : BOOL;     SB_Int_EN2      : BOOL;
  SB_MD_EN       : BOOL;     SB_MD_EN2       : BOOL;
  SB_Set         : BOOL;     SB_Set2         : BOOL;
  SB_Res         : BOOL;     SB_Res2         : BOOL;
    Pos1         : DINT;       Pos12         : DINT; // outputs
    Pos2         : DINT;       Pos22         : DINT;
    IRef         : BOOL;       IRef2         : BOOL;
    Done         : BOOL;       Done2         : BOOL;
    Val          : DINT;       Val2          : DINT;
    IMd          : BOOL;       IMd2          : BOOL;
    Dot          : DINT;       Dot2          : DINT;
    SetVal       : DINT;       SetVal2       : DINT;
    UP,DN        : BOOL;       UP2,DN2       : BOOL;
    Fast, Slow   : BOOL;    Fast2, Slow2     : BOOL;
    EFI          : BOOL;       EFI2          : BOOL;
    ERR          : BOOL;       ERR2          : BOOL;
    pomcitac     : int;    pomcitac2         : int; // test variables
    pomcitac3    : int;
END_VAR


PROGRAM TestIRC_UD          // master program
  VAR
    Ax1    :  FB_AxL_UD; // instance of 1st counter
    Ax2    :  FB_AxL_UD; // instance of 2nd counter
  END_VAR

  Ax1 ( Home := SB_home, ManUp := SB_up, ManDn := SB_down,
      // inputs interconnection-not assigned parameters assume default values
        Start := SB_start, Stop := SB_stop, Pos1 := Pos1, Pos2 := Pos2,
         MD_EN := SB_MD_EN,
        Res := SB_Res, Set := SB_Set, SetVal := SetVal,
        IntMD_EN :=SB_Int_EN, IntDST_EN :=SB_Int_EN,
        // outputs interconnection - it is not necessary to use all declared
```

```
        Val =>Val, Done =>Done, IRef =>IRef,
         IMd =>IMD, Dot =>DOT,
        UP =>UP, DN =>DN,
        Fast =>Fast, Slow =>Slow,
         ERRVG =>ERR,
        // variables IN_OUT - interconnection to 1st counter
        ircIn := r0_p8_CI0, ircOut := r0_p8_CO0
        );

  Ax2 ( Home := SB_home2, ManUp := SB_up2, ManDn := SB_down2,
      // inputs interconnection-not assigned parameters assume default values
        Start := SB_start2, Stop := SB_stop2, Pos1 := Pos12, Pos2 := Pos22,
         MD_EN := SB_MD_EN2,
        Res := SB_Res2, Set := SB_Set2, SetVal := SetVal2,
        IntMD_EN :=SB_Int_EN2, IntDST_EN :=SB_Int_EN2,
        // outputs interconnection - it is not necessary to use all declared
        Val =>Val2, Done =>Done2, IRef =>IRef2,
         IMd =>IMD2, Dot =>DOT2,
        UP =>UP2, DN =>DN2,
        Fast =>Fast2, Slow =>Slow2,
         ERRVG =>ERR2,
        // variables IN_OUT - interconnection to 2nd counter
        ircIn := r0_p8_CI2, ircOut := r0_p8_CO2
        );
END_PROGRAM

PROGRAM PInteruptIO   // program of interrupt operation from peripheries
BEGIN
   IF( r0_p8_CI2.Stat.IRQMD ) THEN pomcitac2  :=pomcitac2 + 1; END_IF;
   IF( r0_p8_CI2.Stat.IRQDST ) THEN pomcitac3 :=pomcitac3 + 1; END_IF;
END_PROGRAM
```

4.13.3 Configuration in structured text language ST according to IEC 61 131- 3

For configuration, we will use the IEC configurator, see Fig. 4.18. By right click, we will select adding of instance of the program to the task, for example FreeWheeling(Number := 0), by this, the program is incorporated into the P0 process being executed in cycles. The configurator automatically generates commands to the file *.MCF and compilation can be started by means of the key F9.

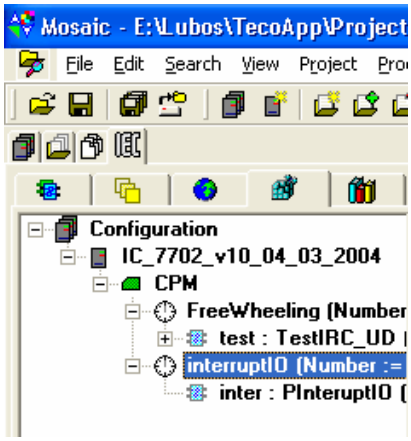


Fig. 4.18 IEC Configurator

```
CONFIGURATION IC_7702_v10_04_03_2004
  RESOURCE CPM
    TASK FreeWheeling(Number := 0);
    TASK InteruptIO(Number := 42);
    PROGRAM IntIO WITH InteruptIO : PInteruptIO ();
    PROGRAM iTest WITH FreeWheeling : TestIRC_UD ();
  END_RESOURCE
END_CONFIGURATION
```

4.14 Appendix for advanced users

4.14.1 Interrupt

WARNING: The use of interrupt should be considered only in well-founded cases, if this is necessary! The utility program in **P42** has to contain only the essential activities to avoid long runtimes. When a period of approx. 5 ms is exceeded, the system will report error 80 31 pcpc (pcpc is the address of the instruction, on which the error was reported)!

The IC-7702 module can initiate interrupt from the measurement contact **MD** or from reaching of the destination of the movement and so start the **P42** process. The interrupt has to be enabled in the Cont byte of counter 0 or 2 by the corresponding bits.

```
EMD     : BOOL; // enabling of activity of input of measurement point MD
MMD     : BOOL; // mask of interrupt from input of measurement point MD
MDST    : BOOL; // mask of interrupt from reaching destination during
                // positioning
```

The central unit interrupts the cyclic execution of the program after it finishes the instruction being just executed, it updates the data from the IC-7702 module and starts executing the program written in the **P42** process. It is necessary to find out at the beginning of this process, which event just happened. The requests for interrupt are tested in the Status of the counter, if they are set to "1".

```
IRQMD   : BOOL;   // request for interrupt from MD
IRQDST  : BOOL;   // request for interrupt from reaching of destination
```

see the example in chapter 4.8.2 and decides on further activity. After all instructions of the **P42** process are finished, the central unit continues in its normal activity. Further information on interrupt processes can be found in the Programmer's manual TXV 001 09.02.

4.14.2 Initialization data structure

The structures given below are typically automatically generated by the MOSAIC development environment (into file *.hwc) and it is not recommended to alter them. If the programmer does not use automatic configuration generation, the description below serves as a sample for manual module configuration.

The module requires an initialization table, this is represented in the declaration file of the MOSAIC development environment (*.HWC) by the following description:

```
#struct _TTS_Head                ;module heading structure
        UINT  ModulID,           ;module type identification code
        USINT Stat0,             ;data exchange status
        USINT Stat1              ;data exchange status

#struct _TTS_IC7702
        _TTS_Head  Head,
        USINT ESTAT0,   USINT EVAL0,   USINT EDOT0,
        USINT ESTAT1,   USINT EVAL1,   USINT EDOT1,
        USINT ESTAT2,   USINT EVAL2,   USINT EDOT2,
        USINT ESTAT3,   USINT EVAL3,   USINT EDOT3,
        USINT ECONT0,   USINT ESET0,   USINT EPOS10,   USINT EPOS20,
        USINT ECONT1,   USINT ESET1,
        USINT ECONT2,   USINT ESET2,   USINT EPOS12,   USINT EPOS22,
        USINT ECONT3,   USINT ESET3,
        UINT  CFG,
        UINT  MODEI,
        UDINT FLT
```

Example of initialization table declaration :

```
#table _TTS_IC7702 _r0_p8_Table = 7702,$01,$00,

$80,$80,$80,$00,$00,$00,$80,$80,$80,$00,$00,$00,$80,$80,$80,$80,$00,$00,$80,
$80,$80,$80,$00,$00,$1000,$0808,$00000000
```

Meaning of the items of the initialization table:

ModulID - module type identification code (order lower, top byte) - 7702

STATD0 - data exchange status

0	0	0	0	0	0	0	INT
.7	.6	.5	.4	.3	.2	.1	.0

INT - 1 - module can initiate interrupt, 0 - module cannot initiate interrupt

STATD1 - data exchange status

0	0	0	0	0	0	0	0
.7	.6	.5	.4	.3	.2	.1	.0

ESTATn, EVALn, EDOTn, ECONTn,ESETn,EPOS1n,EPOS2n – enable of value transmission

EN	0	0	0	0	0	0	0
.7	.6	.5	.4	.3	.2	.1	.0

EN - transmission of value is on

CFG - counter configuration

0	0	0	PDI1.4	PDI1.3	PDI1.2	PDI1.1	PDI1.0
.7	.6	.5	.4	.3	.2	.1	.0
0	0	0	PDI2.4	PDI2.3	PDI2.2	PDI2.1	PDI2.0
.15	.14	.13	.12	.11	.10	.9	.8

PDI1.0 polarity of signal DI1.0 0 - direct, 1 - inverted
PDI1.1 polarity of signal DI1.1 0 - direct, 1 - inverted
PDI1.2 polarity of signal DI1.2 0 - direct, 1 - inverted
PDI1.3 polarity of signal DI1.3 0 - direct, 1 - inverted
PDI1.4 polarity of signal DI1.4 0 - direct, 1 - inverted
PDI2.0 polarity of signal DI2.0 0 - direct, 1 - inverted
PDI2.1 polarity of signal DI2.1 0 - direct, 1 - inverted
PDI2.2 polarity of signal DI2.2 0 - direct, 1 - inverted
PDI2.3 polarity of signal DI2.3 0 - direct, 1 - inverted
PDI2.4 polarity of signal DI2.4 0 - direct, 1 - inverted

MODEI - counter configuration

0	MODEI1			C0full	MODEI0		
.7	.6	.5	.4	.3	.2	.1	.0
0	MODEI3			C2full	MODEI2		
.15	.14	.13	.12	.11	.10	.9	.8

MODEI0 mode of inputs:
000 - irc V, G, MD, (NI), (Ref)
001 - dir Imp, Dir, (MD)
010 - up/dn Up, Dn, (MD)
100 - tim 86,4 kHz, Tim
110 - cnt clk, En
C0full mode of counter 0: 0 - 3 input, 1 - 5 output

MODEI1 mode of inputs:
000 - irc V, G, (MD)
001 - dir Imp, Dir, (MD)
010 - up/dn Up, Dn, (MD)
101 - per 86,4 kHz, Per

MODEI2 mode of inputs:
000 - irc V, G, MD, (NI), (Ref)
001 - dir Imp, Dir, (MD)
010 - up/dn Up, Dn, (MD)
100 - tim 86,4 kHz, Tim
110 - cnt clk, En
C2full mode of counter 3: 0 - 3 input, 1 - 5 output

MODEI3 mode of inputs:
000 - irc V, G, (MD)
001 - dir Imp, Dir, (MD)
010 - up/dn Up, Dn, (MD)
101 - per 86,4 kHz, Per

FLT - filters at inputs

FL3		FL2		FL1		FL0	
.7	.6	.5	.4	.3	.2	.1	.0
FL7		FL6		FL5		FL4	
.15	.14	.13	.12	.11	.10	.9	.8
FL11		FL10		FL9		FL8	
.23	.22	.21	.20	.19	.18	.17	.16
FL15		FL14		FL13		FL12	
.31	.30	.29	.28	.27	.26	.25	.24

FLn - filter setup at input n

00 - OFF
01 - filter 0.18 ms
10 - filter 1.5 ms
11 - filter 12 ms

Example of module declaration :

```
#struct TModulE1                ;module declaration structure
        USINT version,          ;description version
        USINT rack,             ;rack address
        USINT address,          ;module address in the rack
        UINT  LogAddress,       ;logic address
        UINT  LenInputs,        ;length of input data zone
        UINT  LenOutputs,       ;length of output data zone
        DINT  OffsetInputs,     ;position of input data zone
        DINT  OffsetOutputs,    ;position of output data zone
        UINT  InitTable         ;initialization table index

#module TModulE1 1, 0, 8, 0, 40, 40, __offset(r0_p8_CI0),
__offset(r0_p8_CO0), __indx (_r0_p8_Table)
```

4.15 Module connection examples

Example 1: The use of the IC-7702 module in the function of the positioning module. An incremental counter, a measurement contact MD and a reference sensor are connected to the first counter C0. The outputs from IC-7702 control by means of two values (UP and DOWN) the drive motor, the revolutions are controlled stepwise by digital outputs Fast and Slow from module OS-7402.

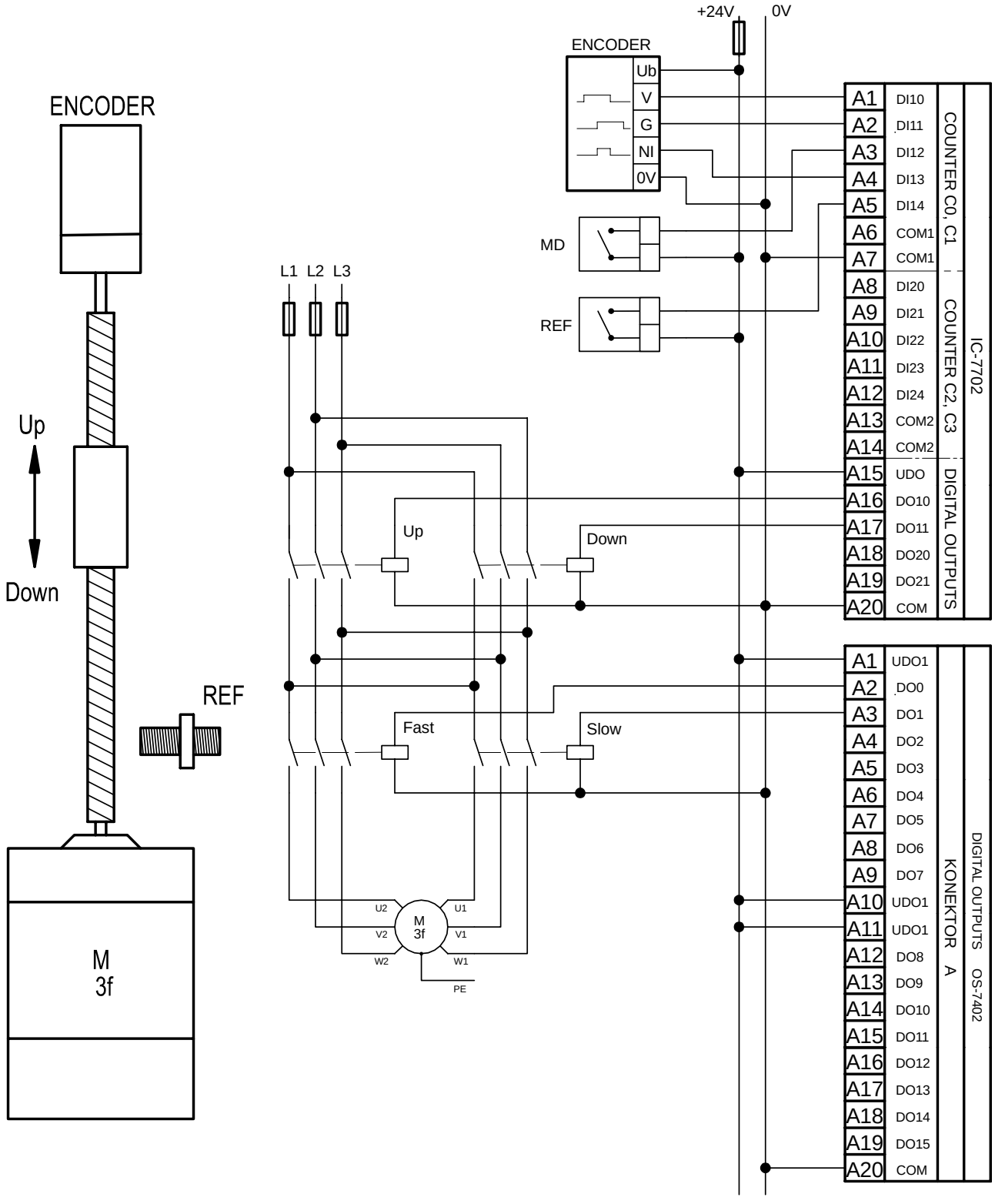


Fig. 4.19 Use of module IC-7702 for positioning (example of connection)

Example 2: - Connection of two incremental sensors including evaluation of null impulses
- Connection of contacts of the measurement contact (MD)

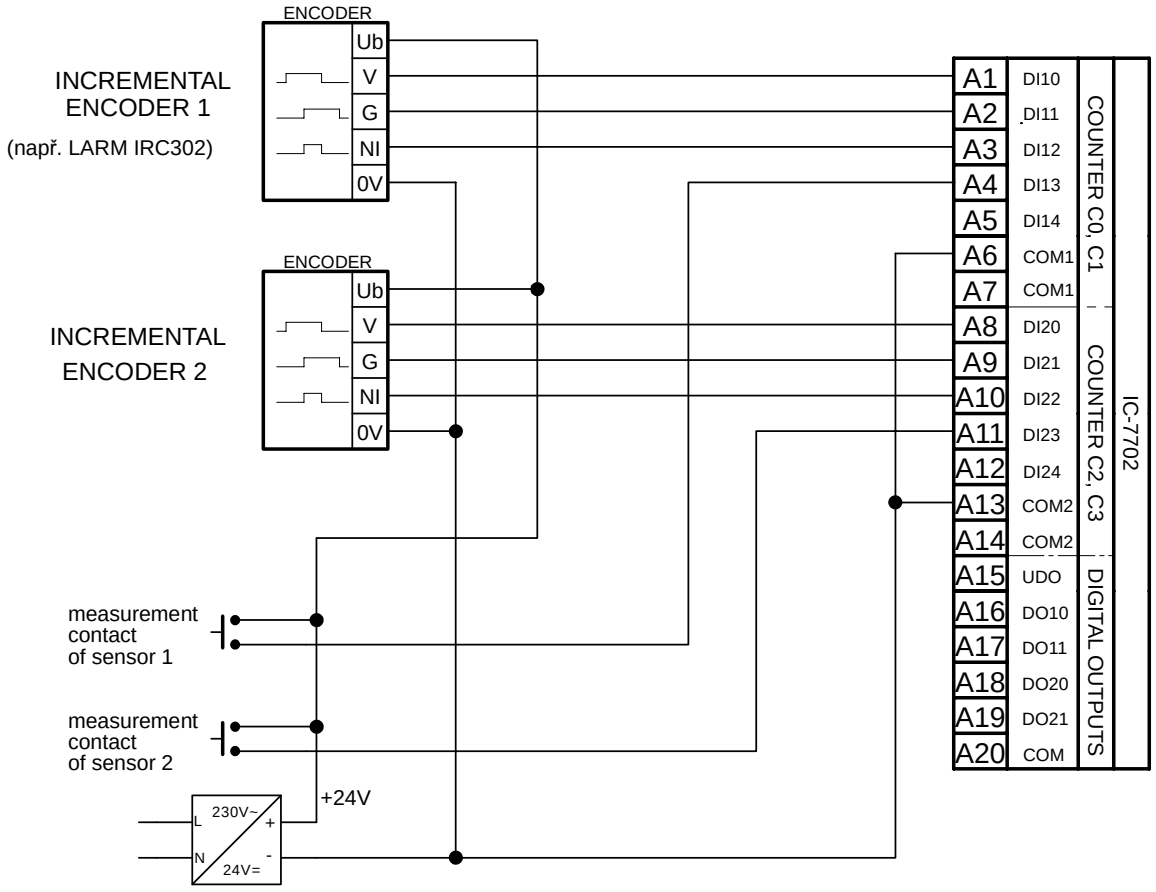


Fig. 4.20 Connection of module IC-7702 according to example 2

On Fig. 4.20 the basic use in the configuration for the evaluation of two incremental encoders is illustrated. The connection assumes a sensor fed from a source 24 V= with the employment of an external power supply source 24 V. The outputs of the counter are open PNP collectors (switches against positive terminal, power supply +24 V). The contact of the measurement contact is fed from a source 24 V= (as a standard digital input of the PLC).

Example 3: - Connection of 4 pulse outputs (e.g. water meters, gas meters, etc.), the IC-7702 module is used as 4 forward counters 32 bits.
- Control of 4 external relays by the outputs of the module

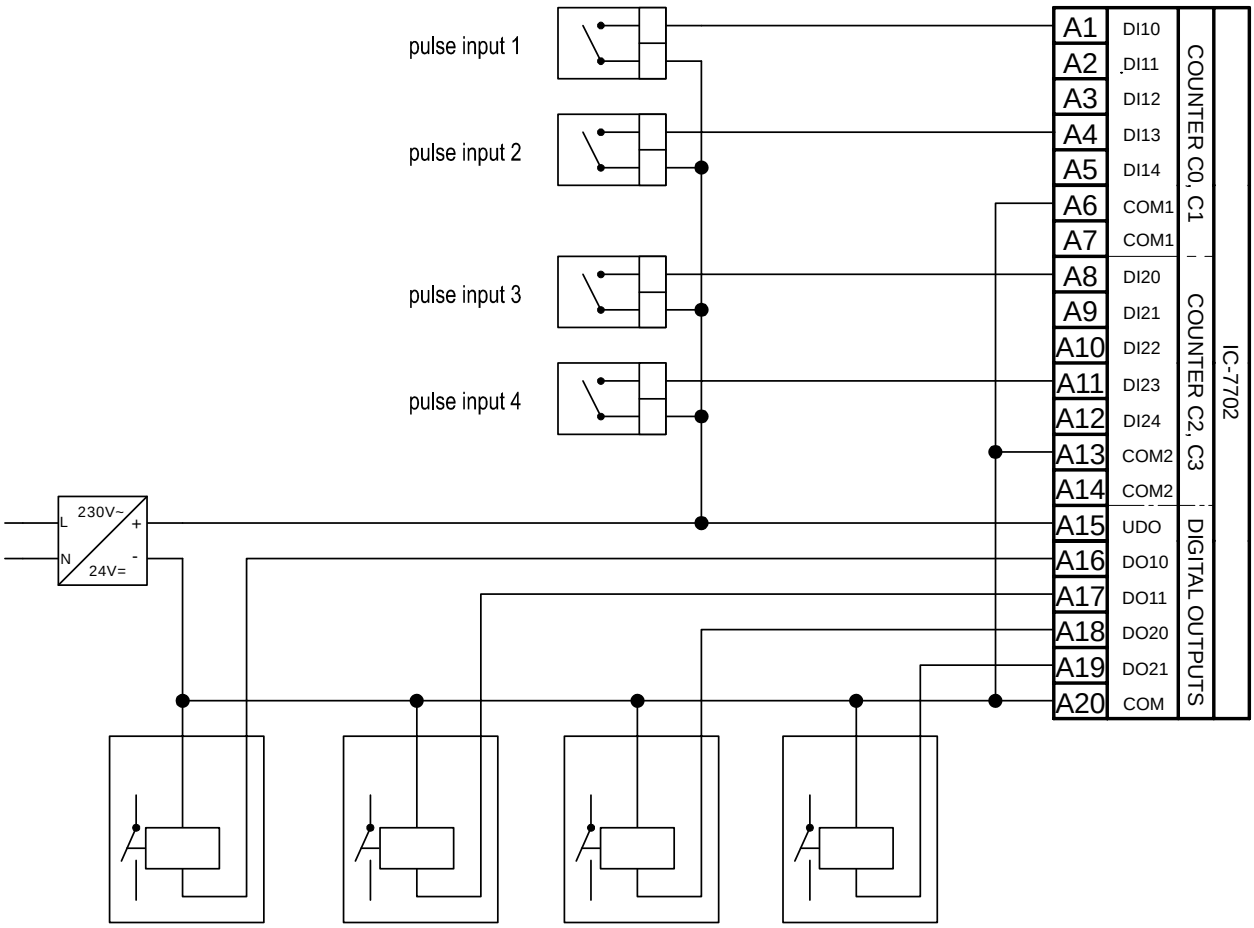


Fig. 4.21 Connection of module IC-7702 according to example 3

On Fig. 4.21, the basic use in the configuration of the module as 4 forward counters is illustrated. The connection assumes pulse outputs from the technology 24 V= as an open PNP collector and an equivalent solution (switches against positive terminal, power supply +24 V). Possible switch bounces can be treated by a digital adjustable filter on the module. All the outputs of the module are used as standard outputs of the PLC.

Example 4 - Connection of 4 incremental sensors without null impulses
- Connection of 4 contacts of the measurement contact (MD) with switching by means of module outputs.

The MD contacts can be used for external resetting of the counters. The resistances 2k2 ensure the minimum load of the outputs, the diodes separate particular switches connected the common input.

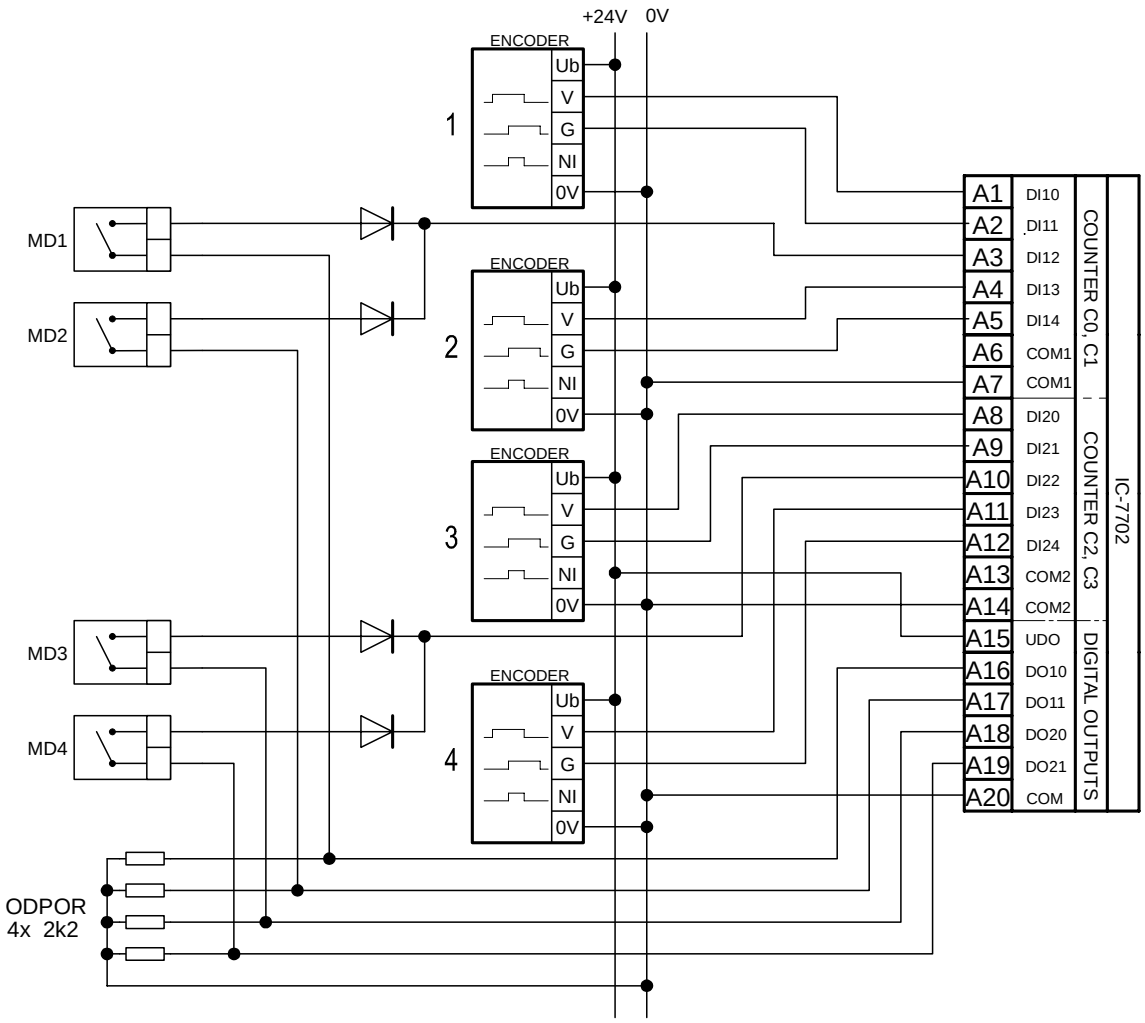
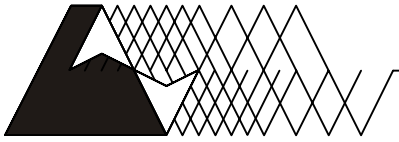


Fig. 4.22 Connection of module IC-7702 according to example 4

Notes

Notes



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