Inline terminal for pulse width modulation and frequency modulation

R911170576
Edition 02

Data sheet R-IB IL PWM/2-PAC

2 independent channels
5 V or 24 V output signals

11 / 2018

1 Description

The terminal is designed for use within an Inline station.
Two channels that operate independently of one another offer the option of pulse width modulation (PWM) for the output signals.
The terminal block supports the following operating modes: PWM (pulse width modulation), frequency generator, single shot (single pulse generator), and pulse direction signal.

Features

- 2 independent channels
- Output of 5 V or 24 V signals
- Maximum frequency of 50 kHz
- Pulse direction signal output without integrated ramp function for controlling step motor power supply units
- Single pulse output (pulse length of 10 µs to 25.5 s can be set)
- Pulse width modulation (period length can be set in increments from 100 µs to 10 s, duty factor in 0.39% increments)
- Frequency output (frequency can be set between 0 Hz and 50 kHz)

☞ This data sheet is only valid in association with the “Automation terminals of the Inline product range” application description (DOK-CONTRL-ILSYSINS***-AW..-EN-P, MNR R911317021).

☞ Make sure you always use the latest documentation.
It can be downloaded under www.boschrexroth.com/electrics.

2 Table of contents

3 Ordering data

Description	Type	MNR	Pcs./Pkt.
Inline terminal for pulse width modulation and frequency modulation, complete with accessories (connectors and labeling fields)	R-IB IL PWM/2-PAC	R911170444	1

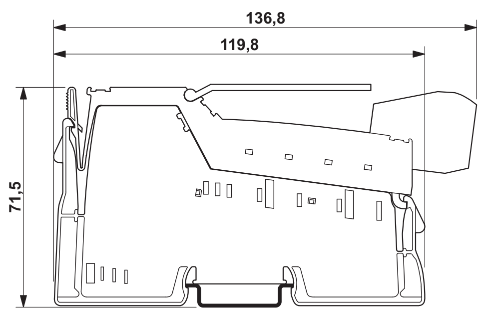
Documentation	Type	MNR	Pcs./Pkt.
Application description Automation terminals of the Inline product range	DOK-CONTRL-ILSYSINS***-AW..-EN-P	R911317021	1

Additional ordering data

For additional ordering data (accessories), please refer to the product catalog at www.boschrexroth.com/electrics.

4 Technical data

Dimensions (nominal sizes in mm)



Width	24.4 mm
Height	136.8 mm
Depth	71.5 mm

General data	
Weight	130 g (with connectors)
Operating mode	Process data operation with 2 words
Ambient temperature (operation)	-25 °C ... 55 °C
Ambient temperature (storage/transport)	-25 °C ... 85 °C
Permissible humidity (operation)	10 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	10 % ... 95 % (non-condensing)
Air pressure (operation)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Air pressure (storage/transport)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20
Protection class	III, IEC 61140, EN 61140, VDE 0140-1

Connection data: Inline connector	
Connection method	Spring-cage connection
Conductor cross section solid / stranded	0.2 mm^2 ... 1.5 mm^2 / 0.2 mm^2 ... 1.5 mm^2
Conductor cross section [AWG]	24 ... 16
Stripping length	8 mm

Interface: Inline local bus	
Number	2
Connection method	Inline data jumper
Transmission speed	500 kbps

Communications power (U_L)	
Supply voltage	7.5 V DC (via voltage jumper)
Current draw	max. 130 mA
Power consumption	max. 0.98 W

Segment circuit supply (U_S)	
Supply voltage	24 V DC (via voltage jumper)
Current draw	max. 1 A

Digital output: 24 V DC	
Number of outputs	2
Connection technology	2-wire (shielded)
Nominal output voltage	24 V DC
Voltage difference with nominal current	max. -1 V
Nominal current per channel	typ. 500 mA
Nominal load, ohmic	12 W
Nominal load, inductive	12 VA (1.2 H, 24 Ω)
Nominal load, lamp	12 W
Signal delay when switching on an ohmic nominal load	typ. 80 µs
Signal delay when switching on an inductive nominal load	typ. 50 ms (1.2 H, 24 Ω)
Signal delay when switching on a lamp nominal load	typ. 30 ms
Signal delay when switching off an ohmic nominal load	typ. 80 µs
Signal delay when switching off an inductive nominal load	typ. 150 ms (1.2 H, 24 Ω)
Signal delay when switching off a lamp nominal load	typ. 100 µs
Maximum operating frequency with ohmic nominal load	500 Hz
Maximum operating frequency with inductive nominal load	0.3 Hz (1.2 H, 24 Ω)
Maximum operating frequency with lamp nominal load	500 Hz
Reaction time with short-circuit	ca. 400 ms
Behavior at voltage switch-off	The output follows the power supply without delay
Output data validity	typ. 1 ms (after switching the 24 V voltage supply (power up))
One-time unsolicited energy	max. 200 mJ
Limitation of the voltage induced on circuit interruption	approx. -25 V
Behavior with overload	Auto restart
Reverse voltage resistance to short pulses	Reverse voltage proof
Resistance to permanent reverse voltage	to 2 A (Reverse voltage protection within the scope of the permissible supply voltage)
Resistance to permanently applied surge voltage	no
Overcurrent shut-down	as of 0.7 A
Short-circuit protection, overload protection of the outputs	integrated damping diode for each channel

Digital output: 5 V DC	
Number of outputs	2
Connection technology	2-wire (shielded)
Nominal output voltage	5 V DC
Voltage difference with nominal current	max. 0.5 V
Nominal current per channel	typ. 10 mA
Signal delay when switching on an ohmic nominal load	typ. 2 µs
Signal delay when switching off an ohmic nominal load	typ. 2 µs
Maximum operating frequency with ohmic nominal load	50 kHz
Short-circuit protection, overload protection of the outputs	integrated damping diode for each channel

Programming data (INTERBUS, local bus)	
ID code (hex)	BF
ID code (dec.)	191
Length code (hex)	02
Length code (dec.)	02
Process data channel	32 Bit
Input address area	4 Byte
Output address area	4 Byte
Parameter channel (PCP)	0 Byte
Register length (bus)	4 Byte

For the programming data/configuration data of other bus systems, please refer to the corresponding electronic device data sheet (e.g., GSD, EDS).

Configuration and parameter data in a PROFIBUS system	
Required parameter data	1 Byte
Required configuration data	5 Byte

Error messages to the higher level control or computer system	
Short circuit or overload of a 24 V output	Yes

Electrical isolation/isolation of the voltage areas	
Test section	**Test voltage**
7.5 V supply (bus logics)/24 V supply (I/O)	500 V AC, 50 Hz, 1 min.
7.5 V supply (bus logic) / 5 V supply (I/O)	500 V AC, 50 Hz, 1 min.
24 V supply (I/O) / functional earth ground	500 V AC, 50 Hz, 1 min.
5 V supply (I/O)/functional earth ground	500 V AC, 50 Hz, 1 min.

Approvals

For the latest approvals, please visit www.boschrexroth.com/electrics.

5 Additional tables

Formula for calculating the power dissipation of the electronics

$$P_{EL} = P_{BUS} + P_{Out5V} + P_{Out24V}$$

$$P_{EL} = 1\ W + \sum_{i=1}^{n} (I_{Li}^{2} \times 0,4\ \Omega)$$

Where:

P_{EL}	Total power dissipation in the terminal
P_{BUS}	Power dissipation in the terminal without set output
P_{Out5V}	Power dissipation in the terminal due to set 5 V outputs; This value is negligible, which is why it is not included in the calculation.
P_{Out24V}	Power dissipation in the terminal due to set 24 V outputs
i	Continuous index
n	Number of set 24 V outputs (n = 1 ... 2)
I_{Li}	Load current of output i

Power dissipation of the housing

1.2 W, maximum (within the permissible operating temperature)

6 Internal circuit diagram

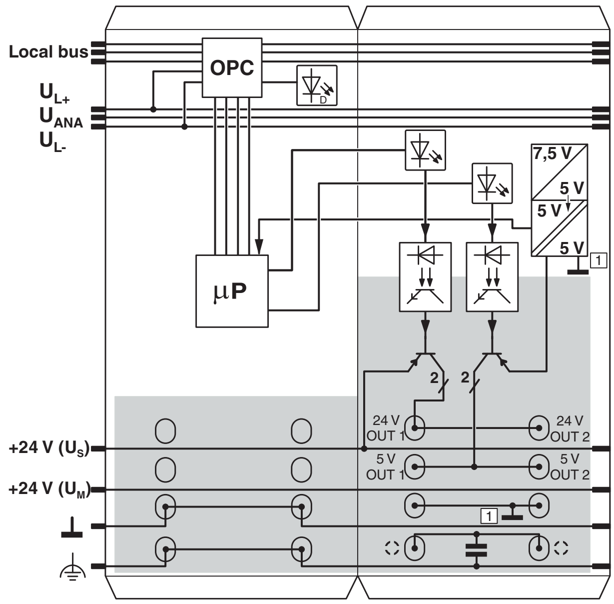
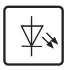


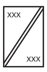
Fig. 1 Internal wiring of the terminal points

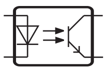
Key:

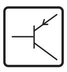
Protocol chip

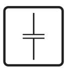

Diagnostic and status indicators (LEDs)

Microprocessor

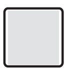

DC/DC converter with electrical isolation


Optocoupler


Transistor


Capacitor


Ground for 5 V outputs, electrically isolated from ground of communications power U_L


Electrically isolated area

For an explanation of the other symbols used, please refer to the “Automation terminals of the Inline product range” application description (DOK-CONTRL-ILSYSINS***-AW..-EN-P, MNR R911317021).

7 Abbreviations and term used

PWM	Pulse width modulation
Duty cycle	High phase of the period
Period	Duration of the signal to be generated
Single shot	Single pulse
LSB	Least significant bit (LSB)

8 Terminal point assignment

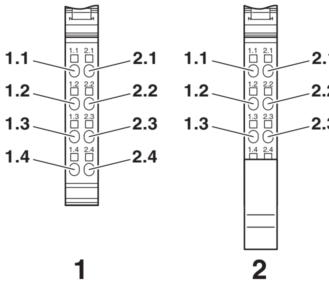


Fig. 2 Terminal point assignment

Terminal point	Assignment	
Connector 1		
1.1, 2.1, 1.2, 2.2	-	Not used
1.3, 2.3	GND_24V	GND for **24 V outputs**
1.4, 2.4	FE	Functional earth ground (FE)
Connector 2		
1.1	DO1	24 V output 1
2.1	DO2	24 V output 2
1.2	DO1'	5 V output 1
2.2	DO2'	5 V output 2
1.3, 2.3	GND_5V	GND for **5 V outputs**
1.4, 2.4	FE	Functional earth ground (FE)

Connect the 24 V outputs and the 5 V outputs to the corresponding ground respectively.

9 Connection example

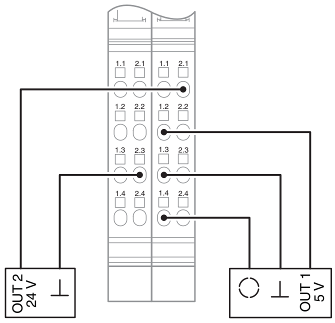


Fig. 3 Example contact of a 24 V and a 5 V actuator (not with the pulse direction signal operating mode)

Use a connector with shield connection when installing the actuator.

Use the connector with shield connection to connect the I/O device. The image shows the connection schematically (without shield connection).

10 Operating modes

The terminal supports four operating modes.

10.1 PWM (pulse width modulation) with variable duty cycle

You can use this operating mode to control semiconductor relays, for example.

It is suitable for temperature control and specifying the speed for drives.

In this operating mode, you can work with a frequency of up to 10 kHz.

10.2 Frequency generator with constant duty cycle

You can use this operating mode to specify the speed for drives, for example.

In this operating mode, you can work with a frequency of up to 50 kHz.

In this operating mode, you can work with a frequency of up to 50 kHz.

10.3 Single shot (single pulse generator)

In this operating mode, you can generate single pulses with a variable duration of between 10 µs and 25.5 s.

You can use these pulses to control the opening time of a valve, for example.

10.4 Pulse direction signal

You can use this operating mode to control stepper motors, for example.

Here you can specify a frequency of up to 25 kHz and a target position.

10.5 Selecting the operating mode

Select the operating mode by sending the output words. You do not need to parameterize the operating mode separately.

You can select a separate operating mode for each channel, except in pulse direction signal mode.
If the terminal is already operating in pulse direction signal mode, both outputs will be required for this operating mode.

10.6 Changing the operating mode

If you want to change the operating mode, proceed as follows:

1. Disable the operating mode used up to that point.
2. Select the new operating mode.

The following parameters stop the relevant operating mode:

Operating mode	Parameter	Value
PWM	Duty cycle	0
Frequency generator	Frequency	0
Single shot	Factor	0
Pulse direction signal	Frequency	0
	“Set to zero” bit	0

> The selected operating mode remains in the state with voltage applied until you specify another valid operating mode.
>
> In the delivery state, the operating mode is initialized with 000_{bin}. As soon as you select a valid operating mode for the first time, this code is no longer permissible as an operating mode.
>
> The terminal rejects this code as invalid and does not change the current state.

11 Special features of the terminal

Both of the output signals are available for a 5 V output and a 24 V output.
The 5 V outputs support all frequencies.
You can only operate the 24 V outputs up to 500 Hz. For higher frequencies or pulses that are shorter than 100 µs, the 24 V outputs go to 0.

All outputs are reset after a bus reset. All output activities are stopped.

12 Local diagnostic and status indicators

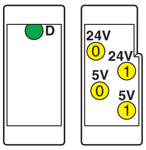


Fig. 4 Local diagnostic and status indicators

Designation	Color	Meaning
D	Green	Diagnostics (bus and logic voltage)
24V (0)	Yellow	24 V channel 1 active
24V (1)	Yellow	24 V channel 2 active
5V (0)	Yellow	5 V channel 1 active
5V (1)	Yellow	5 V channel 2 active

Function identification

Orange

13 Process data

The terminal uses two words of IN process data and two words of OUT process data.

The assignment of the process data depends on the operating mode.

PWM modes, frequency generator, and single shot mode

In these operating modes, each channel occupies one word and operates independently of the other channel.

Process data word	0	1
OUT	Channel 1	Channel 2
IN	Channel 1 mirrored	Channel 2 mirrored

The word for one channel is valid for both the 24 V output and the 5 V output of the channel.

If the output data is valid, it will be mirrored to the input data.

If the output data contains reserved codes and is therefore invalid, it will not be mirrored. In this case, the input data contains the last valid values.

Pulse direction signal

Both outputs are controlled jointly and the terminal operates on a single channel.

14 General output word

The operating mode is specified in bit 15 to 13 of the output word for each channel. The assignment of further bits depend on the operating mode.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Operating mode															

Code (bin)	Code (hex) (for bit 12 = 0)	Operating mode
000	0	Reserved
001	2	Reserved
010	4	PWM
011	6	Frequency generator
100	8	Single shot
101	A	Pulse direction signal
110	C	Reserved
111	E	Reserved

15 Read firmware version and module ID

Only output word 0 is used to read the firmware version and module ID of the terminal.

Output word 0																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0
hex	3				C				0				0			

Input word 0: acknowledgment of the output word																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0
hex	3				C				0				0			

Input word 1: firmware version (example: Version 1.23) and module ID (5 for PWM/2)																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	1
hex	1				2				3				5			

16 PWM (pulse width modulation) mode

This operating mode is used to specify the pulse-pause ratio in a period. To do this, specify the variable duty cycle for a fixed frequency (by specifying the period length). The terminal generates continuous pulses.

You can specify a period length between 100 µs and 10 s. This covers a frequency range from 10 kHz to 0.1 Hz. You can choose a duty cycle between 0.39% and 99.45%.

You can use PWM mode to control semiconductor relays, for example. It is suitable for temperature control and specifying the speed for drives.

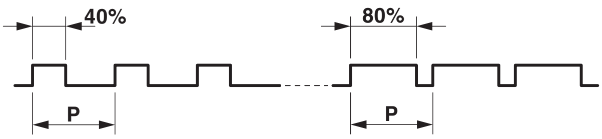


Fig. 5 PWM with constant period (P) and variable duty cycle of 40 % or 80 %

You can select PWM mode for one channel or both channels.

The corresponding output word has the following structure:

Output word																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	**0**	**1**	**0**	Period length (5 bits)					Duty cycle in 0.39% per LSB (8 bits)							
	High byte (HB)															

The corresponding input word contains the mirrored values of the output word.

The following table contains all possible values for the period length. To facilitate use, the high byte (HB) is shown. It consists of the operating mode and period length.

High byte (HB), period length (P), and frequency (f)											
HB	**P**	**f**	**HB**	**P**	**f**	**HB**	**P**	**f**	**HB**	**P**	**f**
hex	**µs**	**kHz**	**hex**	**ms**	**Hz**	**hex**	**ms**	**Hz**	**hex**	**s**	**Hz**
40	100	10	45	1	1000	4D	60	16.7	54	1	1
41	200	5	46	2	500	4E	80	12.5	55	2	0.5
42	400	2.5	47	4	250	4F	100	10	56	4	0.25
43	600	1.67	48	6	167	50	200	5	57	6	0.167
44	800	1.25	49	8	125	51	400	2.5	58	8	0.125
			4A	10	100	52	600	1.67	59	10	0.1
			4B	20	50	53	800	1.25			
			4C	40	25						

Duty cycle

The duty cycle covers a value range from 0 (0_{hex}) to 255 (FF_{hex}) with a resolution or 0.39% per LSB.

The value 0 stops the PWM function.
The values 1 to 255 correspond to 0.39% to 99.45% of the period.

> The minimum duty cycle (high phase of the period) must be at least 40 µs.
> The minimum low phase of the period must be at least 60 µs.

The minimum low phase of the period at the 24 V output depends on the load.

Load resistance R_L	Minimum low phase of the period
kΩ	µs
< 1	80
< 10	200
> 10	250

Example

A signal with the following properties should be generated:

- Period length = 200 ms
  (Frequency = 1/period length = 1/200 ms = 5 Hz)
- Duty cycle = 40%

As per the “High byte (HB), period length (P), and frequency (f)” table, the code for the operating mode and period length of 200 ms equals 50_{hex}.

You must calculate the code for the duty cycle:

Code = 40% / 0.39% = 102.564; 103 = 1100111_{bin} = 67_{hex}

The exact value of 40% cannot be mapped. Either 40.17% (67_{hex}) or 39.78% (66_{hex}) can be mapped.

Output word for the example																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	0	1	0	Period length (5 bits)					Duty cycle in 0.39% per LSB (8 bits)							
bin	0	1	0	1	0	0	0	0	0	1	1	0	0	1	1	1
hex	5				0				6				7			

Further examples

Period length	HB	Duty cycle			Output word
As per “High byte (HB), period length (P), and frequency (f)” table		%	Code (dec)	Code (hex)	hex
400 µs	42	0.39	01	01	4201
10 ms	4A	5.07	13	0D	4A0D
60 ms	4D	10.14	26	1A	4D1A
600 ms	52	19.89	51	33	5233
1 s	54	24.96	64	40	5440
10 s	59	49.92	128	80	5980
200 µs	41	74.88	192	C0	41C0
100 ms	4F	99.45	255	FF	4FFF

17 Frequency generator mode

The operating mode is used to specify a variable frequency for a constant duty cycle of 50%. The terminal generates continuous pulses.

You can specify the frequency in a range from 12.21 Hz to 50 kHz with a resolution of 12.21 Hz per LSB.

At a frequency > 500 Hz, the 24 V output switches to 0.

You can use this operating mode to specify the speed for drives, for example.

Fig. 6 Frequency generator

You can select frequency generator mode for one channel or both channels.

The corresponding output word has the following structure:

Output word																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	**0**	**1**	**1**	Res.	Frequency in 12.21 Hz per LSB (12 bits)											

Res. Reserved (= 0)

The corresponding input word contains the mirrored values of the output word.

Example

A signal with a frequency of 10 kHz should be generated.

This frequency can only be implemented with a 5 V output.

You must calculate the code for the frequency:

Code = 10 kHz / 12.21 Hz = 819 = $0011\ 0011\ 0011_{bin}$ = 333_{hex}

Output word for the example																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	0	1	1	Res.	Frequency in 12.21 Hz per LSB (12 bits)											
bin	0	1	1	0	0	0	1	1	0	0	1	1	0	0	1	1
hex	6				3				3				3			

Further examples

Frequency		Output word		Frequency		Output word
Hz	Code (dec)	hex		kHz	Code (dec)	hex
12.21	01	6001		1	82	6052
24.42	02	6002		10	819	6333
48.84	04	6004		20	1638	6666
97.68	08	6008		30	2457	6999
244.20	20	6014		40	3276	6CCC
500.61	41	6029		50	4095	6FFF

18 Single shot (single pulse generator) mode

In this operating mode, the terminal outputs a single pulse at the output for the specified duration. You can specify a pulse length between 10 µs and 25.5 s.

You can use these pulses to control the opening time of a valve, for example.

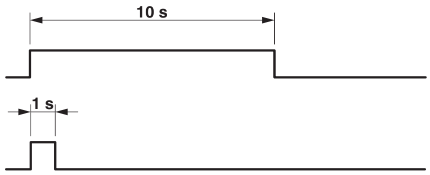


Fig. 7 Two single shots with different lengths

Pulse length

To set the pulse length, specify a time base and factor.

Pulse length = time base x factor

You can select single shot mode for one channel or both channels.

The corresponding output word has the following structure:

Output word																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	**1**	**0**	**0**	Res.		Time base			Factor (8 bits)							

Res. Reserved (= 0)

The corresponding input word has the following structure:

Input word																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	**1**	**0**	**0**	Ready	Res.	Time base			Factor (8 bits)							

Time base

The time base defines the value range for the pulse length.

Code (bin)	Code (hex)	Time base	Maximum time	Note
000	0	10 µs	2.5 ms	For 5 V outputs only
001	1	100 µs	25.5 ms	
010	2	1 ms	255 ms	
011	3	10 ms	2.5 s	
100	4	100 ms	25.5 s	
Other	Reserved			

A time base of 10 µs is only permitted for 5 V outputs. It is disabled for 24 V outputs.

If a value can be displayed in different time bases, you should select the time base in which the value can be displayed more precisely. See “Further examples” table for single shot mode.

Factor

The factor covers a value range from 0_{dec} to 255_{dec}. The value 0 stops the single shot function.

Ready (input word)

Value	Meaning
0	Pulse generator has started
1	High phase finished

Single shot sequence

Start single shot mode by writing the time base and/or factor. In the input word, Ready bit = 0 indicates the start.

When the high phase is finished, the Ready bit = 1.

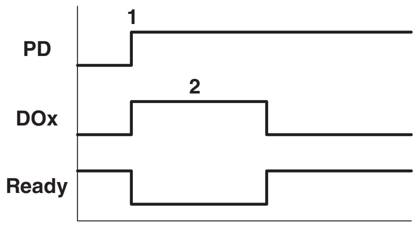


Fig. 8 Pulse generation sequence following specification of a time basis and/or factor

PD	Process data
1	Time of the time base and/or factor change
2	High phase

To generate another pulse, change the time base and/or factor.

> Active pulse output is extended by the newly specified period of time in the event of the following actions:
> - If you change the pulse length during active pulse output.
> - If you start the pulse generator at the same time that Ready = 0 (i.e., before the previously started single shot has elapsed).
> - First change the time base and/or factor if Ready = 1.

If you want to repeatedly generate the same pulses several times over, proceed as follows after each pulse generation:

- Wait until Ready = 1. This means that the high phase of the pulse is finished.
- Set factor = 0.
- Wait for confirmation by reading the input word (factor = 0).
- Set the factor to the desired value.

> Each pulse at the 5 V output has a constant error of 5 µs.
>
> Each pulse at the 24 V output has a constant error of 100 µs.

Example

A single shot with a duration of 12 s should be generated.

Time base	100 ms (code for time base = 4_{hex})
Factor	12 s / 100 ms = 120 = 1111000_{bin} = 78_{hex}

Output word for the example																
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
bin	1	0	0	Res.		Time base			Factor (8 bits)							
bin	1	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0
hex	8				4				7				8			

Further examples

Time base	10 µs (5 V only)		100 µs		1 ms		10 ms		100 ms	
Single shot length	Factor	OUT	Factor	OUT	Factor	OUT	Factor	OUT	Factor	OUT
	dec	hex	dec	hex	dec	hex	dec	hex	dec	hex
50 µs	5	8005								
100 µs	10	800A	1	8101						
250 µs	25	8019	--	--						
500 µs	50	8032	5	8105						
1 ms	100	8064	10	810A	1	8201				
2.5 ms	250	80FA	20	8114	2	8202				
2.55 ms	255	80FF	--	--	--	--				
5 ms			50	8132	5	8205				
10 ms			100	8164	10	820A	1	8301		
25.5 ms			255	81FF	--	--	--	--		
50 ms					50	8232	5	8305		
100 ms					100	8264	10	830A	1	8401
255 ms					255	82FF	--	--	--	--
500 ms							50	8332	50	8405
1 s							100	8364	10	840A
2 s							200	83C8	20	8414
2.5 s							250	83FA	25	8419
10 s									100	8464
25.5 s									255	84FF

OUT	Output word
Empty cell	The value cannot be displayed in this time base. Underrange or overrange of the permissible value range.
--	The value cannot be displayed precisely in this time base. Although the value is within the permissible value range for the time base, it could only be displayed as a rounded value. Select a different time base for precise display.

19 Pulse direction signal mode

In this operating mode, both outputs are used together so only one channel is available. Together with the freely controllable DO2 output, this operating mode simultaneously represents a pulse direction interface.

Pulse sequences (the frequency of which can be selected) are output as pulse direction signals. The connected stepper motor evaluates the frequency, converting each pulse into steps. As the frequency rises, the motor speed increases. You can thus influence the motor speed using the frequency. A position counter counts the completed steps, thereby enabling the position of the drive to be read.

You can set the operating mode for variable-speed drives without position setting (target position = FFFFhex). In this case, a higher-level controller evaluates the position and controls the motor.

You can also set the operating mode for variable-speed drives with position setting. In this case, the Inline terminal automatically stops the motor as soon as the specified target position is reached.

	Output word 0						**Output word 1**
Bit	15	14	13	12	11	10 ... 0	15 ... 0
bin	**1**	**0**	**1**	RD02	N	Frequency (11 bits)	Target position (16 bits)

RDO2	Direction and output DO2	R = 0 (DO2 = 0)	Down or left
		R = 1 (DO2 = 1)	Up or right
N	Set to zero	Rising edge	Position counter restarts at 0000000_{hex}

	Input word 0								**Input word 1**
Bit	15	14	13	12	11	10	9	8 ... 0	15 ... 0
bin	**1**	**0**	**1**	DO2	R	Res.		Position counter (25 bits)	

DO2	Image of output DO2		
R	Ready	= 0	Pulse output active
		= 1	Pulse output completed
Res.	Reserved		

RDO2 (direction and output DO2)

This bit controls output DO2 and, indirectly, the counting direction of the position counter.

RDO2 = 0:	Down or left
RDO2 = 1:	Up or right

N (set to zero)

On a rising edge of this bit to 1, the position counter restarts at 0000000_{hex}.

The values N = 1 **and** frequency = 0 stop the operating mode.

Frequency (11 bits)

The frequency code covers a range from 0 Hz to 25 kHz. This gives a resolution of 12.21 Hz per LSB.

The duty cycle is constantly maintained at 50%.

The value 0 aborts active pulse output.

The values N = 1 **and** frequency = 0 stop the operating mode.

A frequency change is applied immediately.

Target position (16 bits)

The target position covers a value range from 0_{hex} to $FFFE_{hex}$ (0_{dec} to 65534_{dec}).

The value $FFFF_{hex}$ (65535_{dec}) results in continuous pulse output.

For a value between 0_{hex} and $FFFE_{hex}$, pulse output ends when the low 16 bits of the position counter equal the target position.

Pulse output occurs at output DO1.

Direction bit RDO2 determines the counting direction.

DO2 (image of output DO2)

This bit indicates the state of output DO2.

R (Ready)

This bit is only active if continuous pulse output is desired (target position between 0_{hex} and $FFFE_{hex}$). The Ready bit then indicates whether or not pulse output has been completed.

Ready = 0	Pulse output is active
Ready = 1	Pulse output has been completed

As soon as pulse output starts again, the bit is reset.

Position counter (25 bits)

The position counter counts the pulses output so far up or down depending on the RDO2 signal.

Responses under specific conditions

Action	Response	
Frequency = 0	Pulse output stops	
Frequency change without changing the target position	Ready = 1	No response
	Ready = 0	The frequency is changed during active pulse output.
Frequency change and target position change	Ready = 1	Pulse output starts again.
	Ready = 0	The frequency is changed during active pulse output.
Target position change	Ready = 1	Pulse output starts again.
	Ready = 0	The old target position is discarded, pulse output is continued until the target position is reached.
Target position = 0	Normal target position	
Target position = $FFFF_{hex}$	Continuous pulse output	
Rising edge of set to zero bit	The position counter is cleared (independently of Ready).	
RDO2 bit	Output DO2 is controlled directly. The counting direction changes on the next pulse output. If the value of the RDO2 bit is changed, but the frequency and target position remain unchanged, there is no response at output DO2. The specified value is not applied. In the input word, the actual state of output DO2 is mirrored in the DO2 bit. In this case, it is not identical to the specified value in RDO2.	

Example 1

Target position 1B43$_{hex}$ should be reached from position 0.

It is approached in the positive direction (right), RDO2 = 1.

The frequency should be 1 kHz.

Frequency code: 1000 Hz / 12.21 kHz = 81.9; 82$_{dec}$ = 52$_{hex}$ = 000 0101 0010$_{bin}$

	Output word 0						**Output word 1**
Bit	15	14	13	12	11	10 ... 0	15 ... 0
bin	**1**	**0**	**1**	RD02	N	Frequency (11 bits)	Target position (16 bits)
bin	**1**	**0**	**1**	1	0	000 0101 0010	0001 1011 0100 0011
hex	B				052		1B43

When the value 1B43$_{hex}$ is reached in input word 1, pulse output is stopped. Up to that point, 1B43$_{hex}$ = 6979$_{dec}$ pulses were output with a frequency of 1 kHz.

Example 2

A target position should be reached where the code is greater than what can be displayed in 16 bits.

Target position = 215687_{hex}

RDO2 = 1

Frequency = 10 kHz; 10,000 Hz / 12.21 Hz = 819_{dec} = 333_{hex}

- Specify the value $FFFF_{hex}$ in output word 1. This means that you are selecting continuous pulse output.

	Output word 0						Output word 1
Bit	15	14	13	12	11	10 ... 0	15 ... 0
bin	**1**	**0**	**1**	RD02	N	Frequency (11 bits)	Target position (16 bits)
bin	**1**	**0**	**1**	1	0	011 0011 0011	1111 1111 1111 1111
hex	B				333		FFFF

- Monitor the position counter in the input words.
  As soon as the value $B021_{hex}$ appears in input word 0, specify the four low bytes of target position 5687_{hex} in output word 1.

	Input word 0								Input word 1
Bit	15	14	13	12	11	10	9	8 ... 0	15 ... 0
bin	**1**	**0**	**1**	DO2	R	Res.		Position counter (25 bits)	
bin	**1**	**0**	**1**	1	0	0	0	0 0010 0001	0000 0000 0000 0000
hex	B				021				0000

	Output word 0						Output word 1
Bit	15	14	13	12	11	10 ... 0	15 ... 0
bin	**1**	**0**	**1**	RD02	N	Frequency (11 bits)	Target position (16 bits)
bin	**1**	**0**	**1**	1	0	011 0011 0011	0101 0110 1000 0111
hex	B				333		5687

When the value in input word 1 corresponds to the specified target position, the terminal stops pulse output.

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2****-KB02-EN-P

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