Operating Manual

BY340 / BY641

High performance low cost synchronous controllers for one slave axis

Product Features:

- Precision angular synchronization and speed ratio control
- High accuracy due to high feedback frequency range
  (300 kHz with TTL encoders and 200 kHz with HTL encoders)
- Full remote phase control by Index pulse operation, Trim functions etc.
- Four programmable alert outputs
- Most compact unit including operator panel for direct
  access and RS232 interface for remote access
- PROFIBUS DP interface available (option)
- Analog output, configurable for voltage or current operation
- 24 VAC / 17 … 40 VDC power supply

Available Devices:

- BY340: Synchronizer with speed ratio setting by keypad,
  14 bit analog output and 4 power transistor outputs for alerts
- BY641: Synchronizer with features like BY340, but additional front
  thumbwheel switches for speed ratio and 4 relay outputs for alerts

Version:	Description:
BY34002a/April 07/mb/hk	First edition
BY34002b/July 07/mb/hk	Small corrections and supplements
BY34002c/Nov 11/sm	Changing relay output BY641
BY34002d/Feb 12/pp	Small corrections and supplements
BY34003a / Jun 12 / TJ	New parameter F08.071; new actual display value Index Correction
BY34004a / March 15 / TJ	New parameter F03.029 … 031, new master speed display
By340_04b_oi/Dez-15/ag	Notice for analog output supplemented „only V or mA (not both together)” „Safety Instructions and Responsibility“ and „Legal notices“ added „Technical specifications“ and manual-design updated

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Table of Contents

1. Safety Instructions and Responsibility

1.1 General Safety Instructions

This operation manual is a significant component of the unit and includes important rules and hints about the installation, function and usage. Non-observance can result in damage and/or impairment of the functions to the unit or the machine or even in injury to persons using the equipment!

Please read the following instructions carefully before operating the device and observe all safety and warning instructions! Keep the manual for later use.

A pertinent qualification of the respective staff is a fundamental requirement in order to use these manual. The unit must be installed, connected and put into operation by a qualified electrician.

Liability exclusion: The manufacturer is not liable for personal injury and/or damage to property and for consequential damage, due to incorrect handling, installation and operation. Further claims, due to errors in the operation manual as well as misinterpretations are excluded from liability.

In addition the manufacturer reserve the right to modify the hardware, software or operation manual at any time and without prior notice. Therefore, there might be minor differences between the unit and the descriptions in operation manual.

The raiser respectively positioner is exclusively responsible for the safety of the system and equipment where the unit will be integrated.

During installation or maintenance all general and also all country- and application-specific safety rules and standards must be observed.

If the device is used in processes, where a failure or faulty operation could damage the system or injure persons, appropriate precautions to avoid such consequences must be taken.

1.2 Use according to the intended purpose

The unit is intended exclusively for use in industrial machines, constructions and systems. Non-conforming usage does not correspond to the provisions and lies within the sole responsibility of the user. The manufacturer is not liable for damages which has arisen through unsuitable and improper use.

Please note that device may only be installed in proper form and used in a technically perfect condition - in accordance to the Technical Specifications (see chapter 12). The device is not suitable for operation in explosion-proof areas or areas which are excluded by the EN 61010-1 standard.

1.3 Installation

The device is only allowed to be installed and operated within the permissible temperature range. Please ensure an adequate ventilation and avoid all direct contact between the device and hot or aggressive gases and liquids.

Before installation or maintenance, the unit must be disconnected from all voltage-sources. Further it must be ensured that no danger can arise by touching the disconnected voltage-sources.

Devices which are supplied by AC-voltages, must be connected exclusively by switches, respectively circuit-breakers with the low voltage network. The switch or circuit-breaker must be placed as near as possible to the device and further indicated as separator.

Incoming as well as outgoing wires and wires for extra low voltages (ELV) must be separated from dangerous electrical cables (SELV circuits) by using a double resp. increased isolation.

All selected wires and isolations must be conform to the provided voltage- and temperature-ranges. Further all country- and application-specific standards, which are relevant for structure, form and quality of the wires, must be ensured. Indications about the permissible wire cross-sections for wiring are described in the Technical Specifications (see chapter 12).

Before first start-up it must be ensured that all connections and wires are firmly seated and secured in the screw terminals. All (inclusively unused) terminals must be fastened by turning the relevant screws clockwise up to the stop.

Overvoltages at the connections must be limited to values in accordance to the overvoltage category II.

For placement, wiring, environmental conditions as well as shielding and earthing/grounding of the supply lines the general standards of industrial automation industry and the specific shielding instructions of the manufacturer are valid. Please find all respective hints and rules on www.motrona.com/download.html --> “[General EMC Rules for Wiring, Screening and Earthing]”.

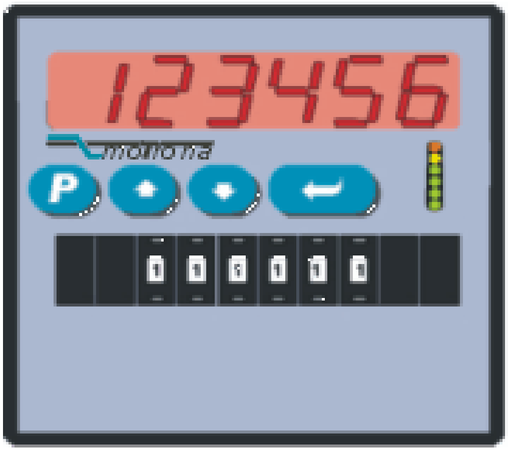
1.4 Cleaning, Maintenance and Service Notes

To clean the front of the unit please use only a slightly damp (not wet!), soft cloth. For the rear no cleaning is necessary. For an unscheduled, individual cleaning of the rear the maintenance staff or assembler is self-responsible.

During normal operation no maintenance is necessary. In case of unexpected problems, failures or malfunctions the device must be shipped for back to the manufacturer for checking, adjustment and reparation (if necessary). Unauthorized opening and repairing can have negative effects or failures to the protection-measures of the unit.

2. Available Models

The two models as shown below are available. Both models are fully similar in terms of function and performance; however there is some difference with the size, the alert outputs and the speed ratio setting.

	BY340: ▪ Front size 96 x 48 mm (3.780’’ x 1.890’’) ▪ Speed ratio setting by keypad ▪ Analog output 14 bits ▪ 4 power transistor outputs (alert)
	BY641: ▪ Front size 96 x 96 mm (3.780’’ x 3.780’’) ▪ Speed ratio setting by keypad or by front thumbwheel switches ▪ Analog output 14 bits ▪ 4 power transistor outputs (alert) and 4 relay outputs (alert)

Both models are suitable for front panel or operator desk mounting, by means of the included mounting clamps.

Where you desire to mount the units on DIN rails inside a cabinet, please refer to the mounting brackets type SM 300 and SM 600 available as accessories.

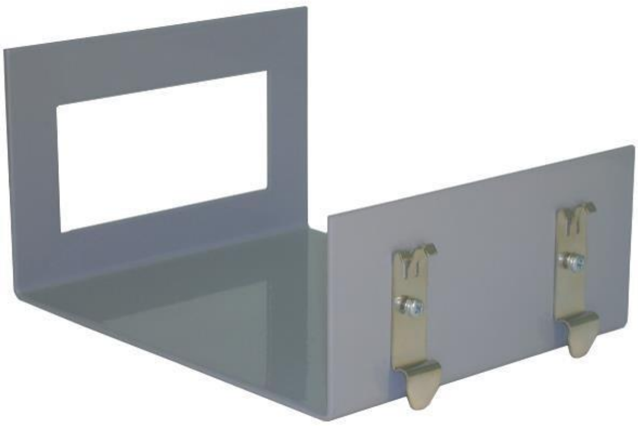


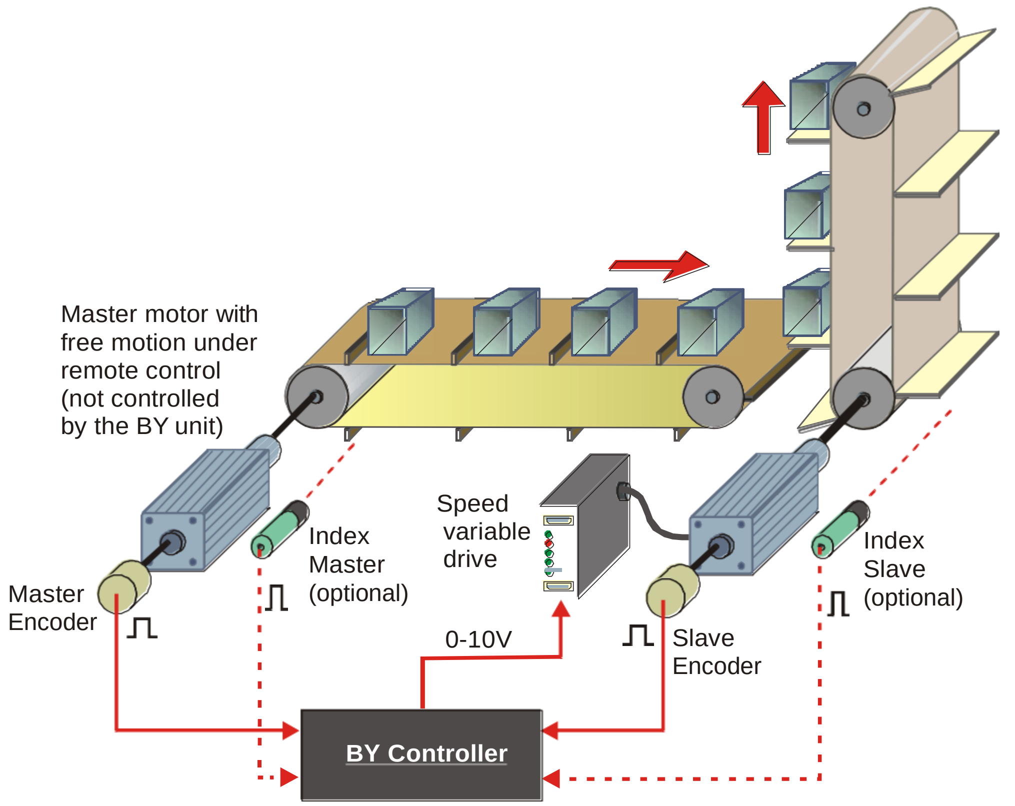
Figure: SM300 mounting bracket for DIN rail mounting of BY340 units

3. Introduction

The BY340 / BY641 units are suitable to operate as electronic synchronous controllers with speed-variable drives of any kind and any size, provided they dispose of an analog input to set the speed. The operation is based on a Master / Slave principle.

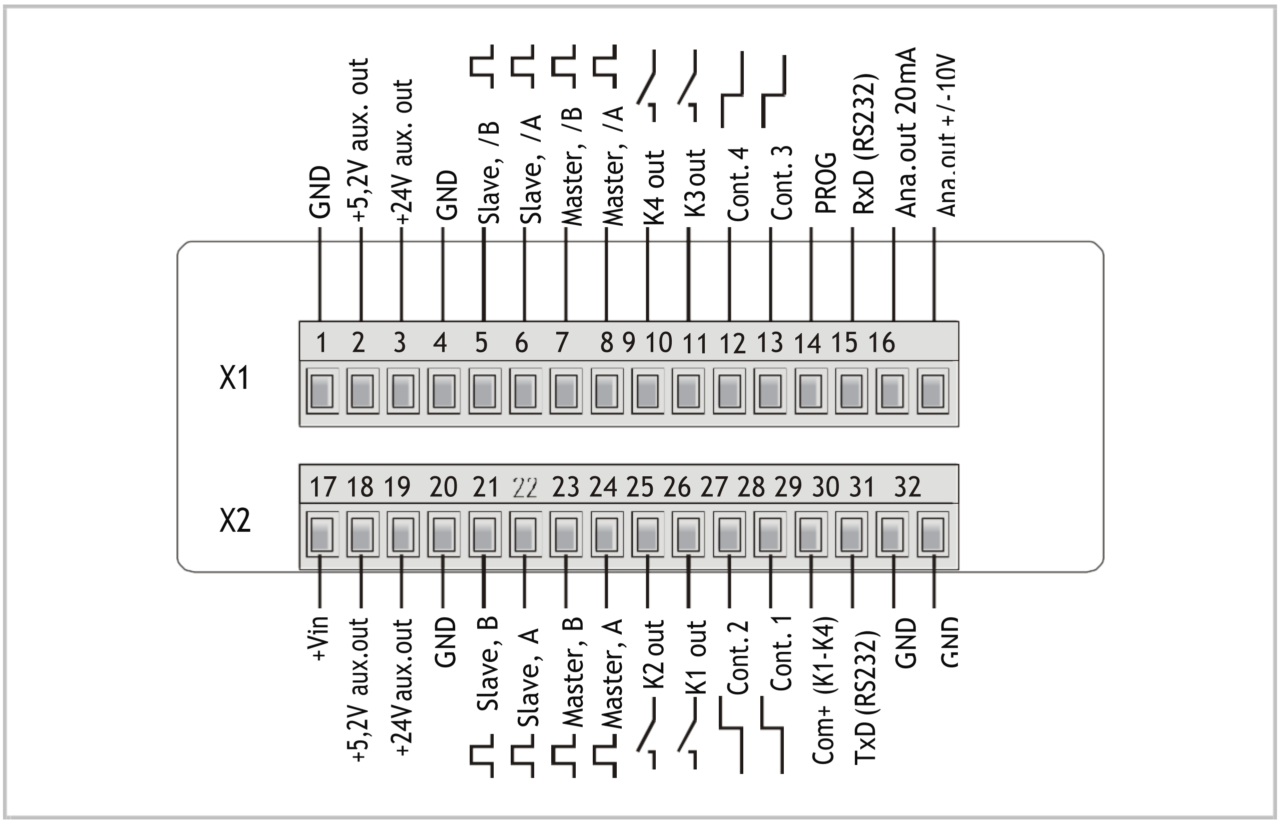
The Master could basically be any moving part of a machine, provided there is a quadrature incremental encoder signal available from the Master motion. The Slave would typically be a speed-variable drive like an Inverter Drive or Servo Drive or DC Drive, but could also be a hydraulic system with a servo valve or similar. In any case a quadrature feedback signal is also necessary from the Slave.

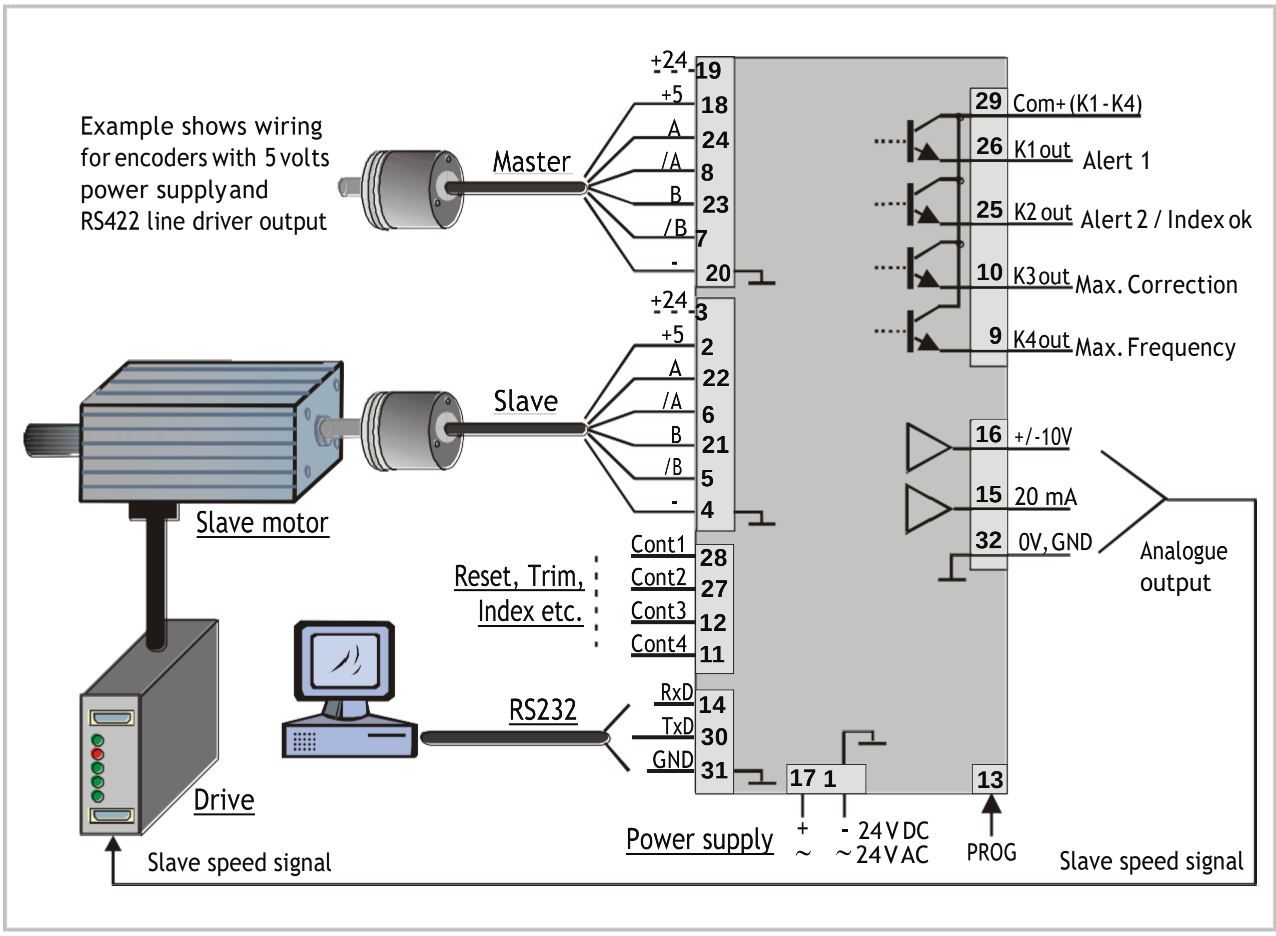
The subsequent drawing shows an example of speed synchronization between two belts, including automatic position adjustment by means of index sensors (optional).



- This manual first provides all basic instructions for operation of model BY340
- For operation of relays and thumbwheels with model BY641 see appendix
- For PC setup our "OS32" software is available on the CD included to delivery, or on our homepage www.motrona.com
- For communication by PLC, IPC or by a remote operator terminal, please observe the serial protocol details described in our separate SERPRO manual.
- PROFIBUS communication is possible with use of our gateway PB251.

4. Electrical Connections





Terminal	Name	Function
01	GND	Common Ground Potential (0 V)
02	+5,2V out	Aux. output 5.2 V/150 mA* for encoder supply
03	+24V out	Aux. output 24 V/120 mA* for encoder supply
04	GND	Common Ground Potential (0 V)
05	Slave, /B	Slave encoder, channel /B (inverted track)
06	Slave, /A	Slave encoder, channel /A (inverted track)
07	Master, /B	Master encoder, channel /B (inverted track)
08	Master, /A	Master encoder, channel /A (inverted track)
09	K4 out	Digital output K4, transistor PNP 30 V, 350 mA
10	K3 out	Digital output K3, transistor PNP 30 V, 350 mA
11	Cont.4	Programmable control input
12	Cont.3	Programmable control input
13	(PROG)	(for download of new firmware only, not for general use)
14	RxD	Serial RS232 interface, input (Receive Data)
15	Ana.out 20 mA	Analog output 0…20 mA (Slave speed reference) **
16	Ana.out +/-10V	Analog output -10 V…0…+10 V (Slave speed reference) **
17	+Vin	Power supply input, +17 ... 40 VDC or 24 VAC
18	+5,2V out	Aux. output 5.2 V/150 mA for encoder supply
19	+24V out	Aux. output 24 V/120 mA for encoder supply
20	GND	Common Ground Potential (0 V)
21	Slave, B	Slave encoder, channel B (non-inverted)
22	Slave, A	Slave encoder, channel A (non-inverted)
23	Master, B	Master encoder, channel B (non-inverted)
24	Master, A	Master encoder, channel A (non-inverted)
25	K2 out	Digital output K2, transistor PNP 30 V, 350 mA
26	K1 out	Digital output K1, transistor PNP 30 V, 350 mA
27	Cont.2	Programmable control input
28	Cont.1	Programmable control input
29	Com+ (K1-K4)	Common positive input for transistor outputs K1-K4
30	TxD	Serial RS232 interface, output (Transmit Data)
31	GND	Common Ground Potential (0 V)
32	GND	Common Ground Potential (0 V) for DC or AC power supply

*) 120 mA and 150 mA are per encoder, i.e. total maximum currents are 240 mA and 300 mA

**) In general, the voltage output terminal 16 should be used for the slave speed signal

4.1. Power Supply

The BY340 synchronizer accepts both, a 17…40 VDC power or a 24 VAC power for supply via terminals 17 and 1. The current consumption depends on the level of the input voltage and some internal conditions; therefore it can vary in a range from 100 … 200 mA (auxiliary currents taken from the unit for encoder supply not included).

4.2. Auxiliary Outputs for Encoder Supply

Terminals 2 and 18 provide an auxiliary output with approx. +5.2 VDC (300 mA totally).
Terminals 3 and 19 provide an auxiliary output with approx. +24 VDC (240 mA totally)

4.3. Impulse Inputs for Incremental Encoders

All input characteristics of the impulse inputs can be set by the parameter menu, for each of the encoders separately. The unit works with quadrature information (A / B, 90°) only. In theory, any of the following encoder characteristics would be applicable:

- Symmetric differential signals according to RS422 standard, however 1 V min. as differential voltage.
- TTL inputs at a level of 3.0 to 5 V (differential, with inverted signal)
- TTL inputs at a level of 3.0 to 5 V (single-ended) *)
- HTL signals at a 10 … 30 V level (alternatively differential A, /A, B, /B, or single-ended A, B only)
- Pulses from photocells or proximity switches etc. providing a HTL level (10…30 V)
- Proximity switches according to NAMUR (2-wire) standard (may need additional remote resistor)

*) requires special settings of the threshold parameters, see 8.2.9 "Special parameters F08"

- For trouble-free angular synchronization it is mandatory to use quadrature encoders with channels A and B or with channels A, /A, and B, /B (90° phase displacement).
- Where the impulse level is HTL (10 … 30 V) you can use either single-ended signals (A and B only) or differential signals (A, /A, B, /B).
- Where the impulse level is TTL or RS422, it is strictly recommended to use symmetric differential signals (with inverted channels /A and /B). Under industrial environment conditions, single-ended TTL signals may cause serious problems due to insufficient EMC immunity of the signal lines.
- All encoder input lines are internally terminated by pull-down resistors (8.5 kΩ). Where encoders with pure NPN outputs are used, corresponding pull-up resistors must be available inside the encoder or externally to ensure proper function (1 kΩ…3.3 kΩ).

4.4. Control Inputs Cont.1 – Cont.4

These inputs can be configured for remote functions like Reset, Phase trimming, Index evaluation or display selection purpose. All control inputs require HTL level. They can be individually set to either NPN (switch to -) or PNP (switch to +) characteristics. For applications where edge-triggered action is needed, the menu allows to set the active edge (rising or falling). The Control inputs will also accept signals with Namur (2-wire) standard.

For reliable operation of the Control Inputs a minimum impulse duration of 50 µs. must be ensured. Especially when using the Z marker pulse of a HTL encoder for index tracking, please verify that this minimum duration can be kept even with maximum speed of the machine.

4.5. Switching Outputs K1 – K4

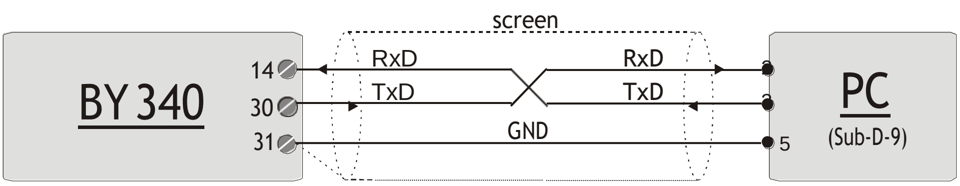
BY340 provides four digital outputs to signal control states like “out of synchronization” or “Index o.k.”. K1 – K4 are fast-switching and short-circuit-proof transistor outputs with a switching capability of 5 – 30 volts / 350 mA each. The switching voltage of the outputs must be applied remotely to the Com+ input (terminal 29).

4.6. Serial Interface

The serial RS232 interface can be used for the following purposes:

- Set-up of the unit by PC with use of the OS32 PC software
- Remote change of parameters during operation
- Remote readout of actual values by PLC or PC

The figure below explains the connection between the BY340 unit and a PC using the standard Sub-D-9 serial connector



For details of the serial communication protocol, please refer to the special SERPRO manual.

4.7. Analog Output

The unit provides a voltage output of +/- 10 volts (load = 3 mA) <u>or</u> a current output of 0 … 20 mA (load = 0 … 270 Ohms), both at a resolution of 14 bits (13 bits + sign). With most standard applications the voltage output is used as a speed reference signal, connected to the speed input of the Slave drive.

- Important note: “voltage out” and “current out” <u>must not be used together</u>. Please do never connect mA and V simultaneously!
- Continuous serial communication may temporary increase response times.

5. Principle of Operation

5.1. Synchronization

The Synchro controller receives full positional information about the master axis by means of the Master encoder. This incremental information can be scaled by means of the Master Scaling Factor (subsequently named Factor1). From this information the unit can calculate an analog speed output signal which is necessary to make the Slave axis exactly follow to the Master.

The feedback of the actual position of the Slave axis is given by the Slave encoder. This information uses a separate impulse scaling by means of the Slave Scaling Factor (subsequently named Factor2).

Master position and Slave position are compared continuously, and the analog output is updated correspondingly within very short cycle times of only about 100 µs. As a result, both positions can be kept inside an error window of typically +/- 5 encoder increments (e.g. the Slave may lead or lag the Master by a few encoder increments, but will never loose position)

It is easy to understand, that this kind of positional and angular synchronization includes at the same time error-free speed synchronization of Master and Slave.

When we move the Master forward or reverse by a distance “d_{Master}”, at the same time the Slave will move forward or reverse by a distance “d_{Slave}”, under consideration of the impulse scaling factors Factor1 and Factor2. In general Factor1 is the parameter to change the speed ratio, and Factor2 is considered as a machine constant.

With most of the applications it is desirable to have proportional characteristics of Factor1, i.e. we like to increase the Slave speed when we increase Factor1.

Some application however may require reciprocal characteristics (e.g. when we use the unit for a rotary cutter application where Factor1 is used to set the cutting length. In this case, higher setting requires lower Slave speed, i.e. Factor1 has to operate reciprocally.

Both, proportional and reciprocal characteristics can be selected by parameter. Depending on these settings, the distances (and also the speeds) follow to one of the formulae below:

Proportional Operation:	$d_{Slave} = d_{Master} \times \dfrac{Factor1}{Factor2}$
Reciprocal Operation:	$d_{Slave} = d_{Master} \times \dfrac{1}{Factor1} \times \dfrac{1}{Factor2}$

5.2. Mechanical Phase and Position Considerations

Normally the synchronizer would always keep the angular phase or relative position between Master and Slave, which has existed while the unit has been powered up, or which has been defined manually while the unit was kept in the Reset state.

However it may be desirable to adjust the relative position in standstill or on the fly, by means of manual or remote commands, or even to set a certain position automatically, triggered by external events. For this reason, phase trimming functions and index functions have been designed, which can be assigned to either the front keys or the control inputs. Once the desired phase adjust commands have been assigned, the final function can be specified by setting of the appropriate Operating Mode of the unit (see chapter 6)

5.2.1. Phase Trimming under Timer Control (Modes 1 – 4 and 7 – 8)

Activating one of the +/-Trim commands allows to temporary run the Slave at a speed which is slightly higher (Trim+) or slightly lower (Trim-) than the correct synchronous speed, which results in a displacement of phase between Master and Slave (Slave leads or lags the Master). The differential speed to displace the phase is parameter adjustable. The system returns to closed-loop synchronous operation in a new relative position, as soon as the Trim command is released again.

5.2.2. Phase Trimming under Impulse Stepper Control (Modes 5 and 6)

With this mode of operation the +/-Trim commands must be assigned to two of the Control Inputs, which then operate as impulse inputs from a remote source (push button or PLC or else). Every impulse applied to the Trim+ input will advance the Slave by one differential increment*) and every impulse applied to the Trim- input will retard the Slave with respect to the Master. This method allows adjusting the relative position step by step

5.2.3. Lead or Lag by a programmable distance (Mode 3)

With this mode, every impulse detected on the Index Master or Index Slave input will jump the Slave forward or reverse by a fixed distance, as set to the Offset register. This method of phase displacement allows toggling the relative phase between two or more scheduled operating positions (e.g. 0°, 90°, 180° and back to 0°).

5.2.4. Position Definition by Index Inputs (Modes 2, 6 and 8)

Index signals may be used do define and to automatically adjust mechanical positions or events between the drives (for an example see the figure under section 3). Index signals can be generated by proximity switches, photo cells or by use of the marker pulse of a HTL encoder. Where you intend to use marker pulses from TTL encoders, you have to translate the Z and /Z information to HTL level before applying it to the controller.

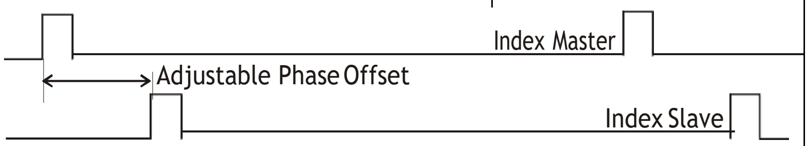
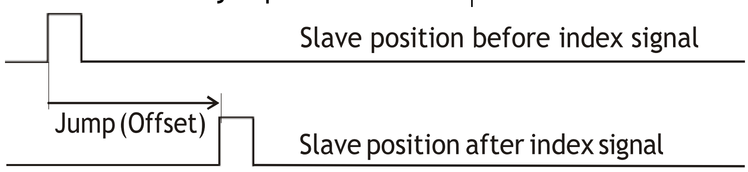
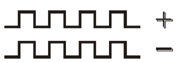
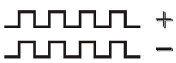
While modes 2 and 6 are designed for immediate and tough correction of index errors, mode 8 provides a soft way of making corrections. The Trim register is used to approach a new position by means of an adjustable differential speed.

*) Mechanically, one differential increment equals to one Slave encoder increment divided by Factor2

- Please observe the minimum duration of 50 µs. for index pulses
- Every index pulse must clearly mark one explicit and repeatable event within one machine cycle

6. Operating Modes

The operating mode (parameter F02.004) sets the functions of Trim and Index inputs, provided that these functions have been assigned to some Control Inputs or front keys.

Mode F02.004	Trim Input Function	Index Input Function	Impulse scaling (Slave : Master)
1	+/- Phase trim by internal timer. Temporary change of Slave speed while one of the Trim commands is on.	No Function	Fact 1 : Fact 2
2	Similar to Mode 1	Index control with adjustable phase 	Fact 1 : 1.00000
3	Similar to Mode 1	Index Master: Slave jumps forward Index Slave: Slave jumps reverse 	Fact 1 : Fact 2
4	Similar to Mode 1	<u>Motor Potentiometer Function</u>: Index Master: Increment Factor1 (+++) Index Slave: Decrement Factor1 (---)	Fact 1 : Fact 2
5	Phase trim by external pulse source 	No Function	Fact 1 : Fact 2
6	Phase trim by external pulse source 	Similar to Mode 2	Fact 1 : 1.00000
7	Similar to Mode 1	Similar to Mode 1	Fact 1 : Fact 2
8	Similar to Mode 1	Unlocked index operation with soft correction, for use with special applications like gantry cranes or precision register control.	Fact 1 : 1.00000

7. Keypad Operation

An overview of all parameters and explanations can be found under section 8.

The menu of the unit uses four keys, hereinafter named as follows:

P			
PROG	UP	DOWN	ENTER

Key functions depend on the actual operating state of the unit. Essentially we have to describe three basic states:

- Normal operation
- General setup procedure
- Direct fast access to scaling factors

7.1. Normal Operation

In this mode the unit operates as a synchronous controller according to the settings defined upon setup. All front keys may have customer-defined functions according to the specifications met in the keypad definition menu F06 (e.g. Reset or Trim or else)

7.2. General Setup Procedure

The unit changes over from normal operation to setup level when keeping the P key down for <u>at least 2 seconds</u>. Thereafter you can select one of the parameter groups F01 to F09.

Inside the group you can now select the desired parameter and set the value according to need. After this you can either set more parameters or return to the normal operation.

See example on the next page…

The adjoining sequence of key operations explains how to change
Parameter number 052 of group F06 from the original value of 0 to a new value of 8:

Step	State	Key action		Display	Comment
00	Normal operation			Actual Error	
01		P	> 2 sec.	F01	Display of the Parameter group
02	Level: Parameter group		5 x	F02 ... F06	Select group # F06
03				F06.050	Confirmation of F06. The first parameter of this group is F06.050
04	Level: Parameter numbers		2 x	F06.051... F06.052	Select parameter 052
05				0	Parameter 052 appears in display, actual setting is 0
06	Level: Parameter values		8 x	1 8	Setting has been modified from 0 to 8
07		P		F06.052	Save the new setting (8)
08	Level: Parameter numbers	P		F06	Return to level parameter groups
09	Level: Parameter groups	P		Actual Error	Return to normal operation
10	Normal operation				

During the general setup procedure all control activities remain disabled.
New parameter settings become active after return to normal operation only.

7.3. Direct Fast Access to Speed Ratio Setting

To get to the fast access routine, please press both

P and at the same time

This will access the parameter group F01 right away. To change the settings follow the same procedure as already described above. Besides the advantage of direct access, the fundamental difference to general setup is the following:

During the fast access procedure all control functions remain fully active.
Access is limited to Factor settings; no other parameters can be changed.

7.4. Change of Parameter Values on the Numeric Level

The numeric range of the parameters is up to 6 digits. Some of the parameters may also include a sign. For fast and easy setting or these values the menu uses an algorithm as shown subsequently. During this operation the front keys have the following functions:

P			
PROG	UP	DOWN	ENTER
Saves the actual value shown in the display and returns to the parameter selection level	Increments the highlighted (blinking) digit	Decrements the highlighted (blinking) digit	Shifts the cursor (blinking digit) one position to the left, or from utmost left to right

With signed parameters the left digit scrolls from 0 to 9 and then shows "-„ (negative) and "-1" (minus one). The example below shows how to change a parameter from the actual setting of 1024 to the new setting of 250 000.

This example assumes that you have already selected the parameter group and the parameter number, and that you actually read the parameter value in the display.
Highlighted digits appear on colored background.

Step	Display	Key action		Comment
00	001024			Display of actual parameter setting, last digit is highlighted
01			4 x	Scroll last digit down to 0
02	001020			Shift cursor toleft
03	001020		2 x	Scroll highlighted digit down to 0
04	001000		2 x	Shift curser 2 positions left
05	001000			Scroll highlighted digit down to 0
06	000000			Shift cursor left
07	000000		5 x	Scroll highlighted digit up to 5
08	050000			Shift cursor left
09	050000		2 x	Scroll highlighted digit up to 2
10	250000	P		Save new setting and return to the parameter number level

7.5. Code Protection against Unauthorized Keypad Access

Parameter group F09 allows to define an own locking code for each of the parameter menus. This permits to limit access to certain parameter groups to specific persons only.

When accessing a protected parameter group, the display will first show "CODE" and wait for your entry. To continue keypad operations you must now enter the code which you have stored before, otherwise the unit will return to normal operation again.

After entering your code, press the ENTER key and keep it down until the unit responds. When your code was correct, the response will be "YES" and the menu will work normally. With incorrect code the response will be "NO" and the menu remains locked.

7.6. Return from the Programming Levels and Time-Out Function

At any time the PROG key sets the menu one level up and finally returns to normal operation. The same step occurs automatically via the time-out function, when during a period of 10 seconds no key has been touched.

Termination of the menu by automatic time-out will not store new settings, unless they have already been stored by the PROG key after editing.

7.7. Reset all Parameters to Factory Default Values

Upon special need it may be desirable to set all parameters back to their original factory settings (e.g. because you have forgotten your access code, or by too many change of settings you have achieved a complex parameter state). Default values are indicated in the parameter tables shown later.

To reset the unit to default, please take the following steps:

- Switch power off
- Press and simultaneously
- Switch power on while you keep down both keys

Where you decide to take this action, please note that all parameters and settings will be lost, and that you will need to run a new setup procedure again.

8. Menu Structure and Description of Parameters

All parameters are arranged in a reasonable order of functional groups (F01 to F09) You must only set those parameters which are really relevant for your specific application. Unused parameters can remain as they actually are.

8.1. Summary of the Menu

This section shows a summary of the parameter groups, with an assignment to the functional parts of the unit.

Gruppe	Funktion
F01	Impulse Scaling
000	Factor 1 (Master)
001	Factor 2 (Slave)
002	Reserve
003	Reserve
F02	Operational Settings
004	Mode (Betriebsart)
005	Trim Time
006	Integration Time
007	Correction Divider
008	Factor 1 Scaling
009	Factor 1 Minimum
010	Factor 1 Maximum
011	Sampling Time
012	Wait Time
013	Max. Master Frequency
014	Ramp Time
015	Stop-Ramp Time
016	Alert 1
017	Alert 2
018	Phase Offset*
019	Slave Pulses Index*
020	Phase Adjust*
021	Master Index Divider
022	Index Window
023	Max. Index Correction
024	Reserve
025	Reserve

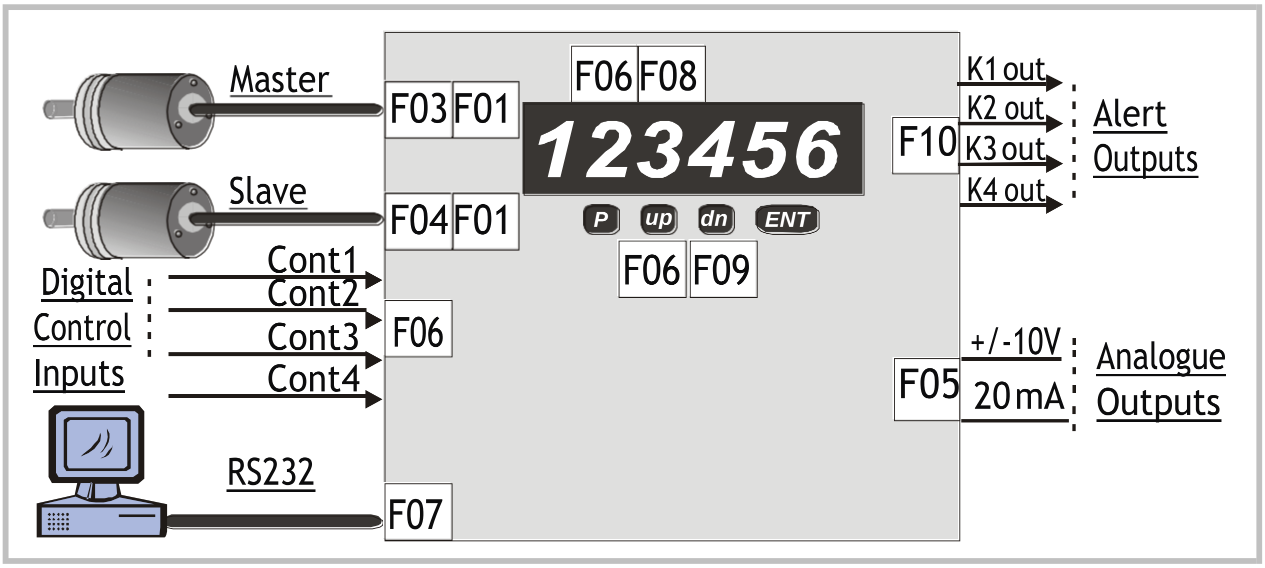
Gruppe	Funktion
F03	Definitions for the Master Encoder
026	Encoder Properties
027	Edge Counting
028	Counting Direction
029	Speed Display Factor
030	Speed Display Divider
031	Speed Display Dec.Point
F04	Definitions for the Slave Encoder
032	Encoder Properties
033	Edge Counting
034	Counting Direction
035	Reserve
036	Reserve
037	Reserve
F05	Analog Output Settings
038	Analog Format
039	Offset Correction
040	Gain Correction
041	Max. Correction
042	Offset Total
043	Gain Total
044	Reserve
045	Reserve

*) Parameters for Index Modes are only available with Software version BY34002 and higher

F06	Command Assignment
046	Key Up Function
047	Key Down Function
048	Key Enter Function
049	Input 1 Configuration
050	Input 1 Function
051	Input 2 Configuration
052	Input 2 Function
053	Input 3 Configuration
054	Input 3 Function
055	Input 4 Configuration
056	Input 4 Function
057	Reserve
F07	**Serial Communication**
058	Unit Number
059	Serial Baud Rate
060	Serial Format
061	Reserve
062	Reserve
063	Reserve
F08	**Special Functions**
064	Input Filter
065	Trigger Threshold 1
066	Trigger Threshold 2
067	Brightness
068	Frequency Control
069	Factor Store Configuration
070	Display Time
071	Reserve

F09	Keypad Protection Codes
072	Protect Group F01
073	Protect Group F02
074	Protect Group F03
075	Protect Group F04
076	Protect Group F05
077	Protect Group F06
078	Protect Group F07
079	Protect Group F08
080	Protect Group F09
081	Reserve
082	Reserve
083	Reserve
084	Reserve
085	Reserve
086	Reserve
087	Reserve

The following schematics shows how in principle the parameter blocks are assigned to the various elements and functions of the controller.



8.2. Description of the Parameters

8.2.1. Impulse Scaling

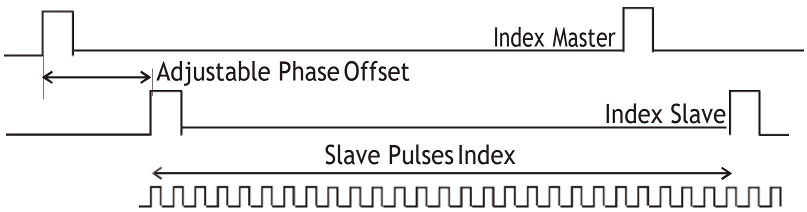
F01		Range	Default
F01.000	Factor 1: Impulse scaling factor for Master encoder.	0.00001 … 9.99999	1.00000
F01.001	Factor 2: Impulse scaling factor for Slave encoder.	0.00001 … 9.99999	1.00000

8.2.2. Operational Settings

F02		Range	Default
F02.004	Operation mode (see table under section 6)	1 …8	1
F02.005	Trim Time: Rate of change, to be entered as a number of cycles (1 cycle = 250 µs), for phase trimming, when the +/- Trim command are activated	0…9999 0000 = Trim off 0001 = fast change 9999 = slow change	10
F02.006	Integration Time: Time constant for the phase integrator, which avoids positional errors, also to be entered as a number of cycles (1 cycle = 250 µs)	0 …9999 0000 = Integrator off 0001 = fast speed 9999 = slow speed	0

F02		Range	Default
F02.007	Correction Divider: Function to provide a digital attenuation of the phase correction signal that is produced, when the drive on mechanical grounds (dead band or backlash) cannot respond. In such a case, it is not desirable to make corrections immediately. The "Correction Divider" provides a window for the drive "backlash", within which the controller produces no correction and a division of the differential error count. 0 = No window, Reaction to 1 increment, no division 1 = Window +/- 1 increments, error division by 2 2 = Window +/- 2 increments, error division by 4 3 = Window +/- 4 increments, error division by 8 etc.	0 ... 9	0
F02.008	Factor 1 Scaling: This factor allows scaling of the remote Factor 1 entry to "user units" or to adapt the numeric value of Factor 1 to the application.	0.00001 ... 9.99999	1.00000
	It is essential, for all steps of set-up, to program F1-Scaling Factor to 1.00000 first in order to avoid confusions with factor calculations. This ensures that the Factor setting corresponds to the real operative Factor 1. Once the set-up procedure is terminated, set F1-Scaling Factor to the numeric value that later should correspond to an operative value of 1.0000 for Factor 1. <u>Example</u>: If the operator desires to set 3.50000 instead of 1.00000, set F1-Scaling Factor to 3.50000. For all factor calculations, please be aware if you operate with a proportional or a reciprocal characteristic of Factor1!		
F02.009 F02.010	Factor 1 Minimum: Factor 1 Maximum: These are limitations of the setting range of Factor 1 and out of range settings will be overwritten by the appropriate min or max value. With Factor 1 Minimum set to 0.95000 and Factor 1 Maximum set to 1.05000, the operator is limited to a +/- 5% variation of the speed ratio.	0.00001 ... 9.99999	0.00001 9.99999

<table>
<tr><th>F02</th><th></th><th>Range</th><th>Default</th></tr>
<tr><td>F02.011</td><td>Sampling Time:
Sets the internal digital feed forward control with respect to dynamics and resolution.
Lower set values result in faster response, but less accuracy of the feed forward signal. Higher set values result in better accuracy, but slower response with sudden speed changes.
Feed forward signals with lower accuracy do not at all affect speed accuracy of the synchronizing process, but only might cause slight angular errors. Depending of the maximum Master encoder frequency, the subsequent setting can be recommended:
<table>
<tr><th>fmax</th><th>Sampling -Time</th></tr>
<tr><td>1 kHz</td><td>100 ms</td></tr>
<tr><td>3 kHz</td><td>33 ms</td></tr>
<tr><td>10 kHz</td><td>10 ms</td></tr>
<tr><td>30 kHz</td><td>3 ms</td></tr>
<tr><td>≥ 100 kHz</td><td>1 ms</td></tr>
</table></td><td>0.001…9.980
(seconds)</td><td>0.001</td></tr>
<tr><td>F02.012</td><td>Wait Time:
Not used, please leave at default setting.</td><td>0.01…9.99</td><td>9.99</td></tr>
<tr><td>F02.013</td><td>Max. Master Frequency:
Sets the expected maximum input frequency on the Master encoder input. You should add a 10% reserve to the real maximum frequency. The unit will not process frequencies higher than this setting</td><td>0.1 …300000.0
(Hz)</td><td>30000.0</td></tr>
<tr><td>F02.014</td><td>Ramp Time:
Ramp time for changes of the Slave speed after Factor1 has been changed.</td><td>0 …999
(sec.)</td><td>0</td></tr>
<tr><td>F02.015</td><td>Stop-Ramp Time:
Deceleration and acceleration ramp when the “Stop Slave” command is used.</td><td>0 …999
(sec.)</td><td>0</td></tr>
<tr><td></td><td colspan="3">Ramp time settings refer to one full transition of the analog output from 0 volts to 10 volts.</td></tr>
<tr><td>F02.016
F02.017</td><td>Alert 1:
Alert 2:
Set tolerance window for errors between Master and Slave. Affects outputs 1 or 2 when out of window.</td><td>5 …9999
(Increments)</td><td>256</td></tr>
<tr><td></td><td colspan="3">The alarm count considers the error bits after the correction divider (see register “Correction Divider”). With Index modes the Alert 2 output is overwritten by the “Index ok” function.</td></tr>
</table>

F02		Range	Default
F02.018	Phase Offset * Allows setting a position offset between the Master index and the Slave Index. When set to zero, the controller will align the active edges of both index signals. Setting is in Slave encoder increments. 	-199999 - 199999	0
F02.019	Slave Pulses Index * Number of Slave encoder pulses between two slave index signals	1 – 999999	5000
F02.020	Phase Adjust * <u>With index operation only (Mode 2 and 6):</u> Digital attenuation of the response upon marker pulse errors. 1: full correction with each index check, i.e. 100% 2: correction by several steps with 50 % of the residual error 3: correction by several steps with 25 % of the residual error 4: correction by several steps with 12,5 % of the residual error 5: correction by several steps with 6,25 % of the residual error etc. The setting depends on the dynamics of the drive and the maximum speed. <u>Example</u>: If a marker pulse arrives every 20 ms but the drive cannot correct the largest error in 20ms, it will lead to instability if the next correction is executed before the previous is completed. In such a case the phase correction percentage must be reduced.	1 - 9	1
F02.021	Master Index Divider * This is a programmable index divider for the master marker pulses. It permits different numbers of marker pulses from the master and the slave. For the same reason as clarified above, we also recommend to use the divider with very short sequences of marker pulses, to allow the drive to stabilize before the next index correction starts.	1 - 99	1

*) Parameters for Index Modes are only available with Software version BY34002 and higher

F02		Range	Default
F02.022	Index Window * Sets a window (encoder increments) where the slave index pulse should be within with regard to the actual master index position. The output is ON when the Slave index is inside the tolerance window	1 - 9999	10
F02.023	Max. Index Correction * The response to registered marker pulse errors is limited to the value set here (encoder increments). Works similar to parameter "Phase Adjust" but allows absolute limitation of the amount of index correction to a level that can be handled by the drive.	1 - 32000	32000

*) Parameters for Index Modes are only available with Software version BY34002 and higher

<u>Important Hints for Index Operation only:</u>

- When using the +/-Trim function with one of the index modes, the Trim impulses will automatically take along the Phase Offset setting, i.e. the Trim function can also be used to manually adjust the desired Phase Offset.
- Phase Offset settings adjusted with use of the +/-Trim function will be active until to next power-down only, unless you apply a "Store EEProm" command before switching power off
- With operating modes 2 and 6 it is most important to set the <u>correct number of encoder pulses between two Slave index pulses</u> to parameter F02.019.
  Bad settings may cause severe instability!
- With mode 8, when the accurate encoder impulse number between two Slave index pulses is unknown or can vary, it is also acceptable to set parameter F02.019 to an estimated number of impulses. However, the setting must be lower or equal but not higher than the real number of encoder pulses between two index pulses. Index errors higher than half of the F02.019 register setting will not be corrected with mode 8
- As soon as one of the index modes is used, output K2 will operate as "Index ok" output and the setting of Alert 2 is inactive

8.2.3. Definitions for the Master Encoder

F03			Range	Default
F03.026	Encoder properties		0 ...3	1
	0=	Differential Impulses A, /A, B, /B (2 x 90°) incl. inv.		
	1=	Single-ended Impulses A, B (2 x 90°) without inv.		
F03.027	Edge counting		0 ...2	0
	0=	Simple edge evaluation (x1)		
	1=	Double edge evaluation (x2)		
	2=	Full quadrature edge evaluation (x4)		
F03.028	Counting direction		0 ...1	0
	0=	Up when A leads B		
	1=	Down when A leads B		
F03.029	Speed Display Factor Multiplication factor to calculate the speed display value from the master frequency (see chapter 9.3)		1 ... 999999	1
F03.030	Speed Display Divider Divider to calculate the speed display value from the master frequency (see chapter 9.3)		1 ... 999999	1
F03.031	Speed Display Dec.Point Position of decimal point for the speed display value (see chapter 9.3)		0 ...5	0

8.2.4. Definitions for the Slave Encoder

F04			Range	Default
F04.032	Encoder properties		0 ...3	1
	0=	Impulses A, /A, B, /B (2 x 90°) incl. inv.		
	1=	Impulses A, B (2 x 90°) without inv.		
F04.033	Edge counting		0 ...2	0
	0=	Simple (x1)		
	1=	Double (x2)		
	2=	Full quadrature (x4)		
F04.034	Counting direction		0 ...1	0
	0=	Up when A leads B		
	1=	Down when A leads B		
F04.035	n. a.			

n. a. = not applicable

8.2.5. Analog output definitions

F05			Range	Default
F05.038	Control characteristics and analog format		0 ... 3	0
	0=	The slave speed changes proportionally to the Factor 1 setting, i.e. doubles motor speed when changing Factor 1 from 1.00000 to 2.00000. (suitable for most of all applications) Output scaled for a -10 volts ... +10 volts signal		
	1=	The slave speed is reciprocal to the Factor 1 setting, i.e. halves the motor speed when changing Factor 1 from 1.00000 to 2.00000. (suitable for rotating cutter applications when Factor 1 represents the length preset) Output scaled for a -10 volts ... +10 volts signal		
	2=	Similar to setting 0, but Output scaled for a -20 mA ... +20 mA signal		
	3=	Similar to setting 1, but Output scaled for a -20 mA ... +20 mA signal		
F05.039	Offset Correction: Digital setting of analog offset on correction signal.		-10.000 ...+10.000 (volts)	0.000
F05.040	Gain Correction: Digital setting of the proportional gain of the control loop. Setting to 2.048 results in a response of 1 mV per error bit. Recommended setting: 0.500...5.000 (Gain Correction / 2048 = x.xxx volts per error bit).		0 ...51.200	2.000
F05.041	Max. Correction: Limitation of the output voltage of the correction signal (correction will not exceed this setting)		0 ...10.000 (volts)	2.000
F05.042	Offset Total: Digital setting of analog offset of the overall analog output signal.		-10.000 ...+10.000 (volts)	0.000
F05.043	Gain Total: Sets the full-scale output voltage at maximum master frequency.		0 ... 99.999	10.000

n. a. = not applicable

Calculation of analog output voltage:

$$U_A[V] = \underbrace{GainTotal \cdot Factor1 \cdot \frac{master\ frequency}{Max.MasterFrequency} + OffsetTotal}_{\text{Feed forward signal}} + \underbrace{\frac{Differential\ counter \cdot GainCorrection}{2048} + OffsetCorrection}_{\text{correction signal}}$$

8.2.6. Key command assignments

F06			Range	Default
F06.046	Function assignment to key „UP“		0 ... 16	0
	0=	No function		
	1=	Reset		
	2=	Trim -		
	3=	Trim +		
	4=	n. a.		
	5=	n. a.		
	6=	Integrator off	For more details about these functions see section 9.1	
	7=	Store EEProm		
	8=	Scroll Display		
	9=	n. a.		
	10=	Clear Min. & Max.		
	11=	n. a.		
	12=	n. a.		
	13=	n. a.		
	14=	Read front thumbwheels (model BY641 only)		
	15=	Stop Slave		
	16=	n. a.		
F06.047	Function assignment to key „DOWN“		0 ... 16	0
	See key „UP“			
F06.048	Function assignment to key „ENTER“		0 ... 16	0
	See key „UP“			

n. a. = not applicable

8.2.7. Characteristics and functions of the Control Inputs

F06			Range	Default
F06.049	Switching characteristics of input „Cont.1“		0 ...7	0
	0=	NPN (switch to -), function active LOW		
	1=	NPN (switch to -), function active HIGH		
	2=	NPN (switch to -), rising edge		
	3=	NPN (switch to -), falling edge		
	4=	PNP (switch to +), function active LOW		
	5=	PNP (switch to +), function active HIGH		
	6=	PNP (switch to +), rising edge		
	7=	PNP (switch to +), falling edge		
F06.050	Function assignment to input „Cont.1“		0 ...16	6
	0=	No function		
	1=	Reset		
	2=	Trim -		
	3=	Trim +		
	4=	n. a.		
	5=	n. a.		
	6=	Integrator off		
	7=	Store EEProm	For more details about these functions see section 9.1	
	8=	Scroll Display		
	9=	Parameter Disable		
	10=	Clear Min. & Max.		
	11=	Index Slave		
	12=	Index Master		
	13=	n. a.		
	14=	Read front thumbwheels (model 641 only)		
	15=	Stop Slave		
	16=	n. a.		
F06.051	Switching characteristics of input „Cont.2“		See „Cont.1“ (F06.049)	
F06.052	Function assignment to input „Cont.2“		See „Cont.1“ (F06.050)	
F06.053	Switching characteristics of input „Cont.3“		See „Cont.1“ (F06.049)	
F06.054	Function assignment to input „Cont.3“		See „Cont.1“ (F06.050)	
F06.055	Switching characteristics of input „Cont.4“		0 – 3	
	0=	NPN (switch to -) function active LOW		
	1=	NPN (switch to -) function active HIGH		
	2=	PNP (switch to +), function active LOW		
	3=	PNP (switch to +), function active HIGH	no edge-triggered functions are possible with Cont.4	
F06.056	Function assignment to input „Cont.4“		See „Cont.1“ (F06.050)	

n. a. = not applicable

- Unconnected NPN inputs are always HIGH (internal pull-up resistor)
  Unconnected PNP inputs are always LOW (internal pull-down resistor)
- When you use Index operation, it is mandatory to use
  Control Input 1 as Master Index (F06.050 = 12) and
  Control Input 2 as Slave Index (F06.052 = 11).
  These two inputs are no more available for other purpose.
- Index inputs must always be edge-triggered, i.e. parameters F06.049 and F06.051 must be either 2 or 3 or 6 or 7 when you use index operation.
- Where you like visualize Index Signals on your PC screen by means of the OS32 Operator Software, you must temporary set the inputs to static operation. The corresponding light boxes on the screen are not suitable to display dynamic signals. Please return to edge- triggered operation after the test.

8.2.8. Serial communication parameters

F07			Range	Default
F07.058	Serial device address (unit number)		11 ...99	11
F07.059	Serial baud rate		0 ...6	0
	0=	9600 Baud		
	1=	4800 Baud		
	2=	2400 Baud		
	3=	1200 Baud		
	4=	600 Baud		
	5=	19200 Baud		
	6=	38400 Baud		
F07.060	Serial data format		0 ...9	0
	0=	7 Data, Parity even, 1 Stop		
	1=	7 Data, Parity even, 2 Stop		
	2=	7 Data, Parity odd, 1 Stop		
	3=	7 Data, Parity odd, 2 Stop		
	4=	7 Data, no Parity, 1 Stop		
	5=	7 Data, no Parity, 2 Stop		
	6=	8 Data, Parity even, 1 Stop		
	7=	8 Data, Parity odd, 1 Stop		
	8=	8 Data, no Parity, 1 Stop		
	9=	8 Data, no Parity, 2 Stop		

8.2.9. Special functions

F08		Range	Default
F08.064	Digital input filter: must be set to “0”.	0 ... 3	0
F08.065	Trigger threshold for encoder1 inputs *)	30 ...250	166
F08.066	Trigger threshold for encoder2 inputs *)	30 ...250	166
F08.067	Brightness of the 7-segment LED display	0 ... 4	0
	0= 100% of maximum brightness		
	1= 80% of maximum brightness		
	2= 60% of maximum brightness		
	3= 40% of maximum brightness		
	4= 20% of maximum brightness		
F08.068	Frequency Control: must be set to “0”	0 ... 1	0
F08.069	Factor Storage	0 ... 1	0
	0= Factor temporary active until next power-down **)		
	1= Factor stored to EEProm for enduring use **)		
F08.070	Display Time: Update time (sec.) for display only	0.005...9.999	0.050
F08.071	Default Display: Number of actual value displayed by the unit after power up (see table in chapter 9.1 at description of Scroll Display command)	0 ... 8	0

*) Must be set to the default value (166) for any kind of input signals, except for single-ended TTL signals which require a setting of 35.

**) Refers only to those changes of the speed ratio settings where either the “Direct Fast Access” menu (see chapter 7.3) or the motor potentiometer function (operation mode 4, see chapter 6) have been used.

8.2.10. Keypad protection codes

F09		Range	Default
F09.071	Protected group F01		
F09.072	Protected group F02		0
F09.073	Protected group F03	0 = no protection	
F09.074	Protected group F04		
F09.075	Protected group F05	1 – 999 999 =	
F09.076	Protected group F06	Protection code	
F09.077	Protected group F07	for the actual	
F09.078	Protected group F08	parameter group	
F09.079	Protected group F09		

9. Description of Commands and Outputs

9.1. Commands

No.	Command	Description	Assignment to Keypad	Input
1	Reset	Sets the internal differential counter and the analog correction signal to zero. Both drives run solely in analog synchronization (open loop) whilst activated	yes	yes
2	Trim-	Provides a temporary lower or higher slave speed which results in a phase displacement between the motor shafts. When releasing the trim command, the drives will synchronize again in their new relative position. In Modes 5 and 6 impulses are required to change the position step by step	yes	yes
3	Trim+			
4	n. a.			
5	n. a.			
6	Integrator off	This command sets the phase integrator to 0. This prevents the integrator from building up error when the drives are stopped, but not in a perfect synchronous position. This prevents any leap in speed on restart	yes	yes
7	Store EEProm	Stores actual operational settings to the EEProm, so they remain available also after power down.	yes	yes
8	Scroll Display	Selects the source of the digital display. See chapter 9.3 "Display of Actual Values" for details.	yes	yes
9	Parameter Disable	Disables the keypad for any parameter access. Only commands assigned to the keypads will be accessible	no	yes
10	Clear Min. & Max	Sets the internal minimum and maximum error registers to the actual differential error.	yes	yes
11	Index Slave	Assigns the index pick-up function to the input (respectively Factor1 inc./dec. with Mode 4)	yes	yes
12	Index Master			
13	n. a.			
14	Read Thumbwheels	Reads and activates the Factor 1 setting from the front thumbwheel switches (model BY641 only)	yes	yes
15	Stop Slave	Ramps the Slave drive down to standstill using the "Stop Ramp". When released, the Slave ramps up again and locks into synchronization	yes	yes
16	n. a.			

n. a. = not applicable

9.2. Outputs

No.	Output	Terminal
K1	Alert 1 This output indicates that the position error has exceeded the preset tolerance band as specified by parameter F02.16 “Alert 1”	X2 / 26
K2	Alert 2 / Index ok When operating without index pulses, this output also works as alert signal. It then indicates that the position error has exceeded the preset tolerance band as specified by parameter F02.17 “Alert 2”. With index operation (Parameter F02.004 „Operation Mode“ = 2, 6 or 8), K2 works as “Index ok” output. It then indicates that the slave index is within the preset tolerance band as defined by parameter F02.022 “Index Window”.	X2 / 25
K3	Max. Correction Indicates that the limitation of the correction voltage has been activated to keep the correction inside “Max. Correction”	X1 / 10
K4	Max. Frequency Indicates that the actual master frequency is higher than the limit set by parameter F02.013 “Max. Master Frequency”	X1 / 9

9.3. Display of Actual Values

During normal operation it is possible to display an actual value. Two LEDs at the front panel indicate the actual value displayed. You can scroll the actual value on the display by Scroll Display command, which can be assigned either to a key or to an input. Parameter F08.071 “Default Display” selects the actual value to be displayed after power up of the unit.

No.	Display	L1 (red)	L2 (yellow)
0	Display OFF (only two decimal points are lit to indicate operation state)	OFF	OFF
1	Position error (differential counter)	OFF	OFF
2	Position error (bar graph display, see diagram below)	OFF	OFF
3	Actual Master speed The speed display can be scaled by the two parameters F03.029 Speed Display Factor and F03.030 Speed: $Display\ value = \frac{Master\ frequency\ [Hz] \cdot F\ 03.029}{F\ 03.030}$ If you want to display a decimal point with the speed value you can select the position of the decimal point by parameter F03.031 Speed Display Dec.Point.	ON	OFF
4	Recorded Minimum Error since last “Clear min-max” command	OFF	ON
5	Recorded Maximum Error since last “Clear min-max” command	ON	ON
6	Pulse count between two Master index pulses	Flashing	OFF
7	Pulse count between two Slave index pulses	OFF	Flashing
8	Index position error (	Flashing	Flashing

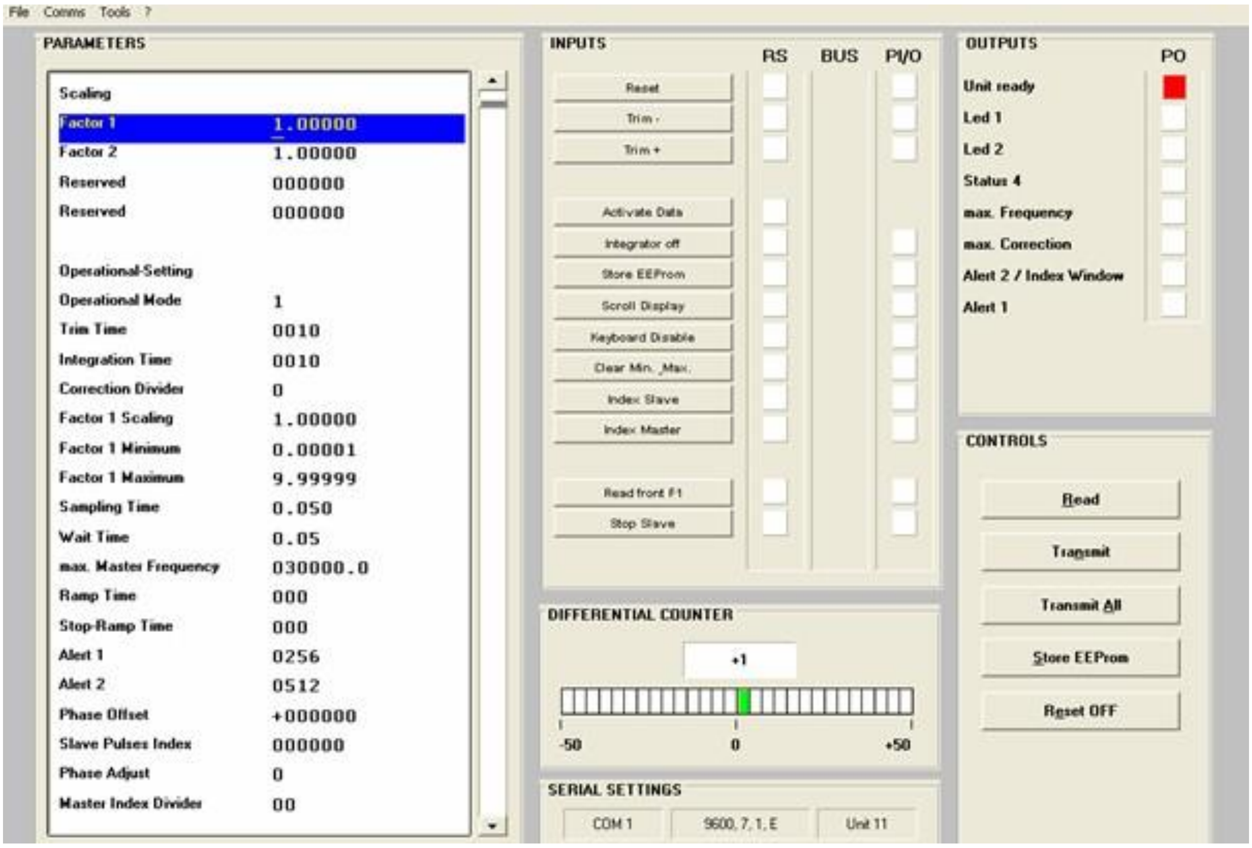
Bar graph display with reference to the actual synchronization error

The diagram shows positive errors only (Slave lags Master). Negative errors are mirror-inverted.

10. Steps for Commissioning

For easy and uncomplicated commissioning of the BY340 / 641 controllers you need a PC with the actual operator software OS3.x. You can download this software and full instructions, free of charge, from our homepage www.motrona.com.

Connect your PC to the synchronizer as shown in section 3.6 and start the OS3.x software. The following screen will appear:



Where instead you find the mask blank with the indication „OFFLINE“ in the top bar, please click to the „Comms“ menu and check the serial settings of your PC.

Edge triggered events (e.g. Index Master / Index Slave) cannot be displayed in the OS3.x, due to the slow serial data transmission.

Set all parameters in the Edit filed according to your needs, following the hints given in this manual. The following parameters should initially be set to the values as shown:

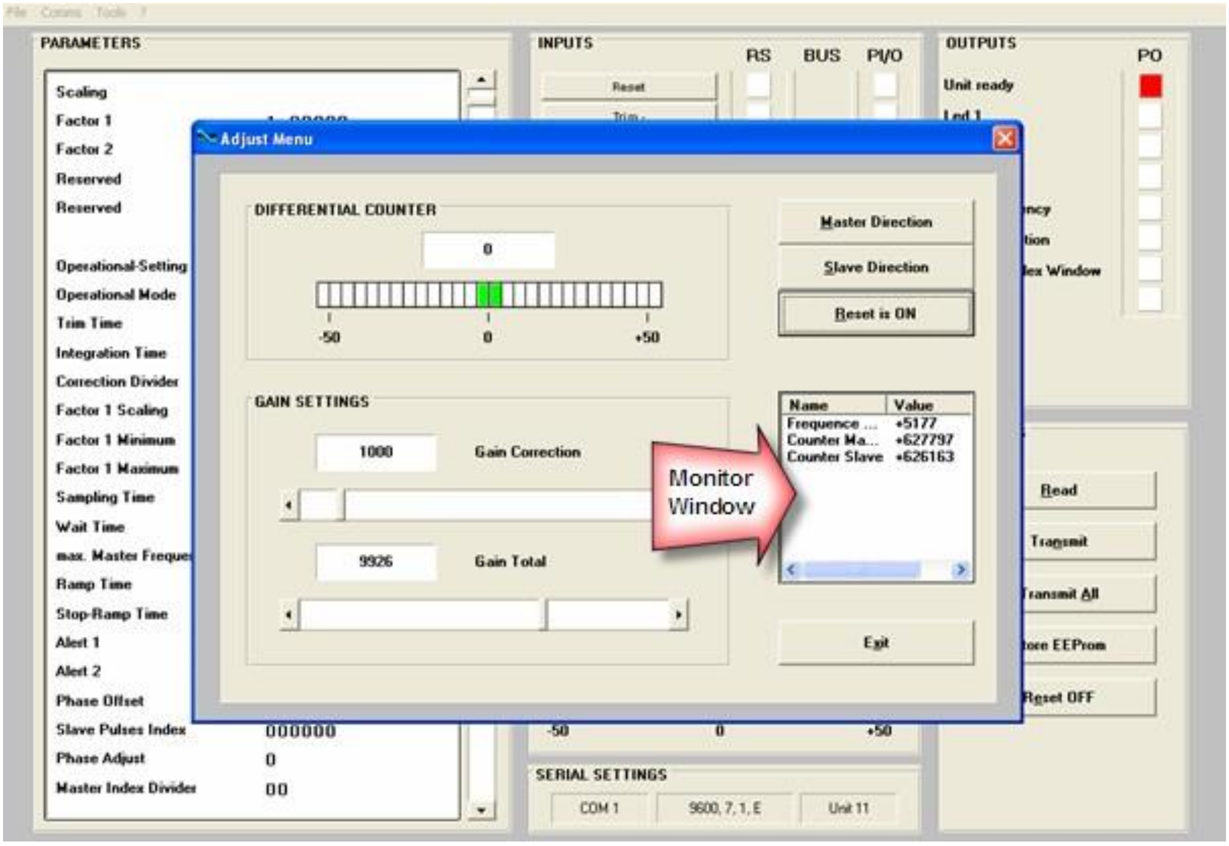
Number	Register	Initial Setting
F02.004	Operation mode	1
F02.006	Integration Time	0000
F02.007	Correction Divider	0
F05.040	Correction Gain	1.000
F05.041	Max. Correction	10.000

After entry of all parameters click to "Transmit All" followed by "Store EEProm" to store all parameters to the BY340 or BY641 controller.

At this time, both drives (Master and Slave) must be adjusted to proper and stable operation over the full speed range. Slave drive settings must provide a maximum of dynamics and response (set ramps to zero, switch of any integral or differential component of the internal speed control loop, operate the drive with proportional speed control only, with the proportional Gain set as high as possible).

10.1. Running the Adjust menu

For adjustments of directions and control gains of the slave drive, you need to open the „Adjust" menu available under „Tools" in the main menu of the screen. To start the Adjust menu the first time, the Slave drive should be disabled for reasons of safety.



10.2. Set Directions of Rotation

The direction of rotation must be defined for both, master and slave encoder. Make sure the Reset is switched on when you do this (the softkey must show "Reset is ON")

- Move the Master encoder into forward direction (manually or by means of a remote speed signal to the Master drive). Observe the "Counter Master" value shown in the monitor window on the right. It must count up to positive values. Where you find it counts down or to negative, please click to button "Master Direction" to change the counting direction.
- Move the Slave encoder into forward direction (manually or by enabling the Slave drive while the Master is moving forward). Observe the "Counter Slave" value. It must again count up to positive values. Where you find it counts down or to negative, please click to button "Slave Direction" to change the counting direction.

10.3. Tuning the Analog Output

- Switch Reset to ON by clicking to the corresponding softkey on the screen.
- Enable both, Master and Slave drive. Turn the speed signal for the Master to approximate 25% of the maximum speed. The Slave should now move, too. As a next step, switch the Reset to OFF by clicking to the Reset button (showing actually "Reset On"). This will activate the closed loop control.
- Observe the color bar and the value of the differential counter. There are the following two possibilities:

a. The bar graph moves to the right and the differential counter shows positive values. This indicates that the analog output is too low. Please increase the setting of "Gain Total" by scrolling up with the arrow key on the right, or by shifting the slider into a more right position.

b. The bar graph moves to the left and the differential counter shows negative values. This indicates that the analog output is too high. Please decrease the setting of "Gain Total" by scrolling down with the arrow key on the left, or by shifting the slider into a more left position.

"Gain Total" is set correctly when the bar graph remains in its center position and the differential counter swings around zero (e.g. +/-8 counts)

- Turn speed signal for the master to approximately 80% of maximum speed. Continue to observe the color bar and the value of the differential counter and adjust "Gain Total" again if necessary.

> You can reset the differential counter to zero at any time between, by cycling the "Reset" command.

10.4. Setting of the Proportional Gain

The register "Gain Correction" determines how strong the controller responds to position and speed errors of the drive. In principle, this setting therefore should be as high as possible. However, depending on dynamics and inertia of the whole system, too high gain values will produce stability problems.

Please try to increase the setting of Correction Gain from 0.500 to 1.000, 1500, 2.000, 2.500, 3.000 etc. However, as soon as you find unsteady operation, noise or oscillation, you must reduce the setting again correspondingly.

We also recommend to ramp up and down the master while checking the color bar and the differential counter for stable operation.

Once you have successfully concluded these steps, you can exit the Adjust menu.
Your synchronous application is ready to work now.

10.5. Hints for final operation

10.5.1. Using and Adjusting the Integrator

When, for stability reasons, you needed to keep your " Correction Gain" value low, any important non linearity in your drive system could cause changing phase errors with different speeds or loads (e.g. color bar deviates to right at low speed, stays in center at medium speed and deviates to left at maximum speed).

Please note that a deviation of the color bar does not indicate a speed error at all, unless the differential counter shows figures outside a +/- 1024 error increment range. Inside this range, the speed is always error-free and deviations only refer to a constant number of encoder increments that the Master leads or lags the Slave.

Where your differential counter remains in an acceptable range around zero (e.g. -8....0 ..+8), there is no need to use the integrator and you should leave "Integration Time" set to 0000.

Where you feel that, despite of maximum settings of the proportional gains, your phase accuracy must still become better, set "Integration Time" to 50....40....30 20 .. 10 or even lower. The Integrator will move the phase error always into a +/-6 increments error window. The lower the Integration Time setting, the faster it will catch up with the correct phase. Too low settings (= too high integration speeds) will however result in oscillation problems.

> Too high settings of Gain-Correction and too low settings of the Integration Time will cause stability problems like oscillation or hunting of the Slave

10.5.2. Adjusting the Correction Divider

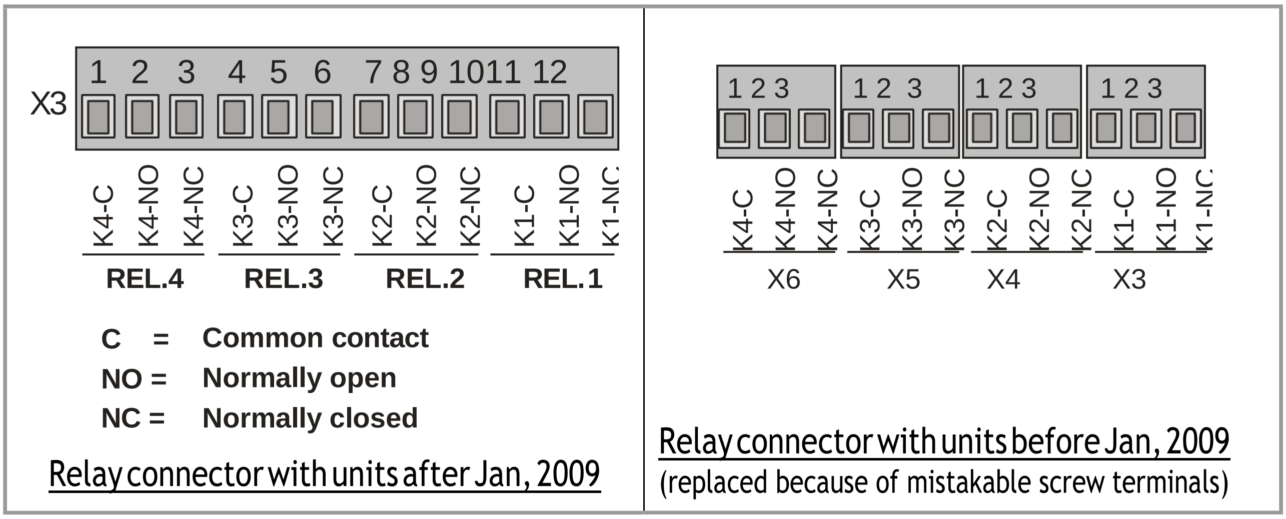
Where you find your color bar oscillates quickly around zero over several fields, this indicates your encoder resolution is too high with respect to mechanical clearance, backlash of tooth belts or other tolerances. To eliminate this, set Correction Divider to 1 or 2 or higher until you observe more stable operation.

11. Appendix for model BY 641

11.1. Relay Outputs

While model BY340 provides high-speed transistor outputs only, model BY641 provides four additional relay outputs, operating in parallel to the high-speed transistor outputs K1 - K4.

All electrical connections of BY641 are fully similar to BY340, except that with BY641 models the back plane is equipped with four additional terminal strips (3 positions each).



Relay connector with units after Jan, 2009

Relay connector with units before Jan, 2009
(replaced because of mistakable screw terminals)

11.2. Front Thumbwheel Switches

Moreover, the BY641 models provide thumbwheel switches on the front panel, for simple and easy setting of the speed ratio by means of Factor1.

This is how the front switches work:

- Upon power-up the unit will read the thumbwheel settings and overwrite the internal Factor 1 setting correspondingly, i.e. the synchronization will use the front thumbwheels.
- When during operation you change the thumbwheel setting, this will not affect the synchronization until you apply a "Read Thumbwheel" command to the unit. You can assign this command to either one of the front keys or to one of the Control Inputs, as shown under sections 8.2.6 and 8.2.7
- When the front thumbwheels are all set to zero, the controller will automatically use the internal Factor 1 as entered by menu.

12. Technical Specifications & Dimensions

Power supply:	Input voltage (AC):	24 VAC +/- 10 %
	Input voltage (DC):	17 … 40 VDC
	Protection circuit::	reverse polarity protection
	Consumption:	100 mA at 24 VDC (unloaded)
	Connections:	screw terminal, 1.5 mm² / AWG 16
Encoder supply:	Number of aux. voltages:	2 (each double-performed)
	Output voltage 1:	24 VDC
	Output current 1:	max. 120 mA each
	Output voltage 2:	5.2 VDC
	Output current 2:	max. 150 mA each
	Connections:	screw terminal, 1.5 mm² / AWG 16
Incremental input:	Signal levels:	HTL: LOW 0…2 V, HIGH 10…30 V
		TTL: LOW 0…0.8 V, HIGH 3…5 V
		RS422: Differential voltage > 1 V
	Channels:	symmetrical: A, /A, B, /B or asymmetrical: A, B
	Frequency:	RS422 / TTL symmetrical: 300 kHz
		HTL or TTL asymmetrical: 200 kHz
	Internal resistance:	Ri ≈ 8.5 kOhm
	Connections:	screw terminal, 1.5 mm² / AWG 16
Control inputs:	Number of inputs:	4 (configurable)
	Signal levels:	HTL: LOW 0 … 2.5 V, HIGH 10 … 30 V
	Characteristic:	NPN / PNP / Namur
	Internal resistance:	Ri ≈ 3.3 kOhm
	Min. pulse time:	50 µs
	Connections:	screw terminal, 1.5 mm² / AWG 16
Control outputs:	Number of outputs:	4 fast transistor outputs *
	Protection circuit:	short circuit proof
	Characteristic:	PNP, 5 … 30 V
	Output current:	350 mA each
	Reaction time:	< 1 ms **
	Connections:	screw terminal, 1.5 mm² / AWG 16
Relay outputs: (only with Version BY641)	Number of outputs:	4 potential-free changeovers *
	Switching capacity:	250 VAC / 1 A / 250 VA or 100 VDC / 1 A / 100 W
	Reaction time:	approx. 10 ms
	Connections:	screw terminal, 1.5 mm² / AWG 16
Analog output:	Voltage output:	+/- 10 V, max. 2 mA
	Current output:	0 / 4 … 20 mA (burden: max. 270 Ohm)
	Resolution:	14 bit (± 13 bit)
	Accuracy	0.1 %
	Reaction time:	< 1 ms **
	Connections:	screw terminal, 1.5 mm² / AWG 16
Serial interface:	Format:	RS232
	Baud rate (selectable):	600, 1200, 2400, 4800, 9600, 19200, 38400 Baud
	Connections:	screw terminal, 1.5 mm² / AWG 16

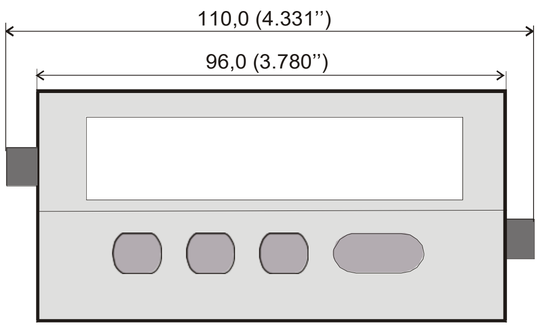
*) Diode or RC filtering is mandatory when switching inductive loads
**) Continuous serial communication may temporary increase response times

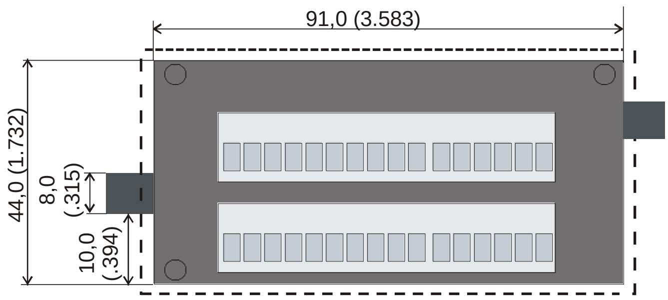
Continuation „Technical Specifications“

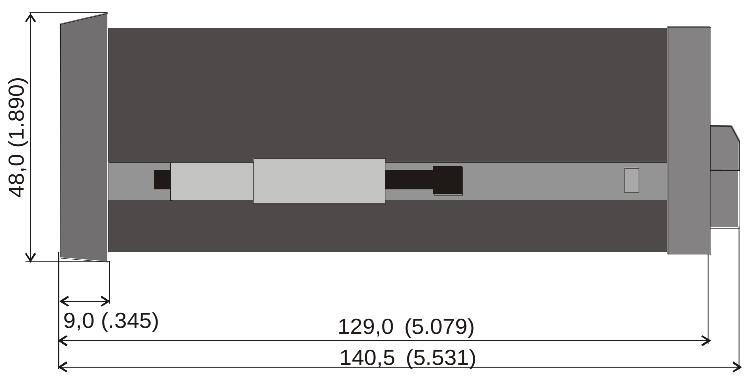
Housing:	Type / Material:	Norly UL94-V-0 / plastic
	Mounting:	panel
	Dimensions BY340:	cut out (w x h): 91 x 44 mm / 3.59 x 1.73 inch outer dimensions (w x h x d): 110 x 48 x 141 mm / 4.33 x 1.89 x 5.55 inch
	Dimensions BY641:	cut out (w x h): 89 x 91 mm / 3.50 x 3.59 inch outer dimensions (w x h x d): 110 x 96 x 141 mm / 4.33 x 3.78 x 5.55 inch
	Protection class BY340:	front: IP 65 / rear: IP20
	Protection class BY641:	front: IP 20 *** / rear: IP20
	Accessories:	SM300: mounting bracket for top hat rail mounting of BY340
	Weight:	BY340: approx. 250 g / BY641: approx. 370 g
Ambient temperature:	Operation: Storage:	0 °C … +45 °C / +32 … +113 °F (not condensing) -25 °C … +70 °C / -13 … +158 °F (not condensing)
Conformity & standards:	EMC 2004/108/EC: LV 2006/95/EC: Guideline 2011/65/EU:	EN 61000-6-2, EN 61000-6-3, EN 61000-6-4 EN 61010-1 RoHS-conform

***) IP65 is also achievable when using our optional plexiglass cover part # 64026

12.1. Dimensions of model BY340:

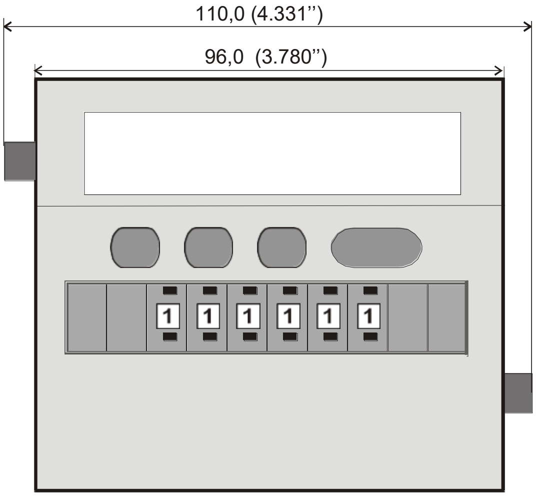


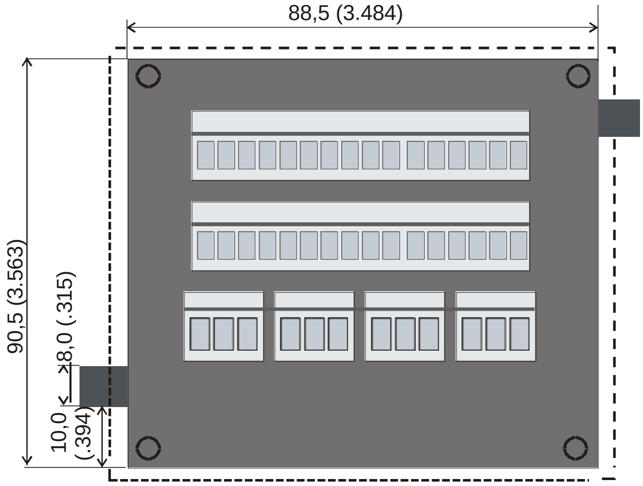




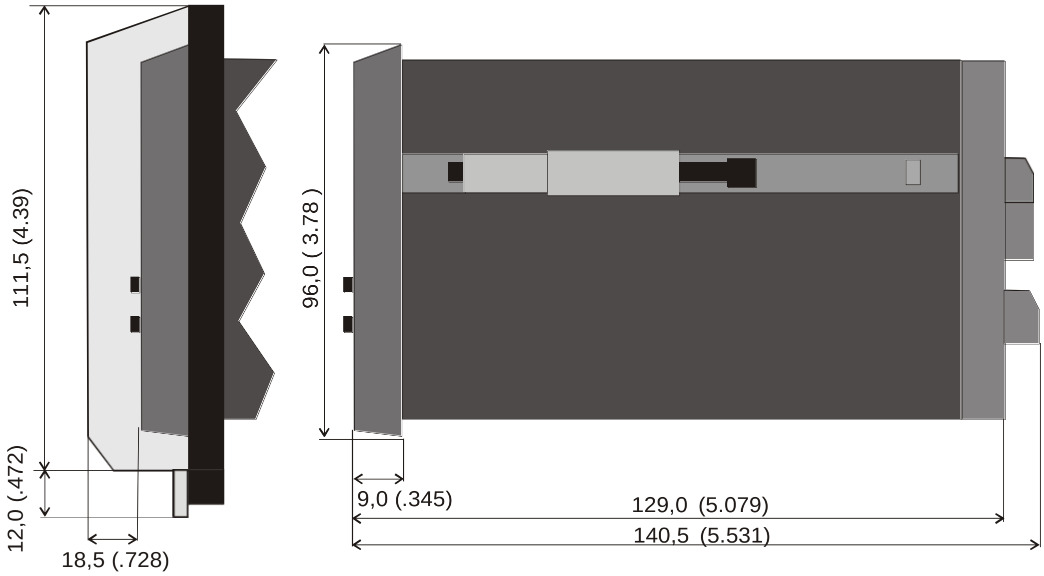
Panel cut out: w x h = 3.583 x 1.732'' (91 x 44 mm)

12.2. Dimensions of model BY641:





With optional plexi glass cover for protection class IP65 (motrona part # 64026)



Panel cut out: w x h = 3.504 x 3.583'' (89 x 91 mm)