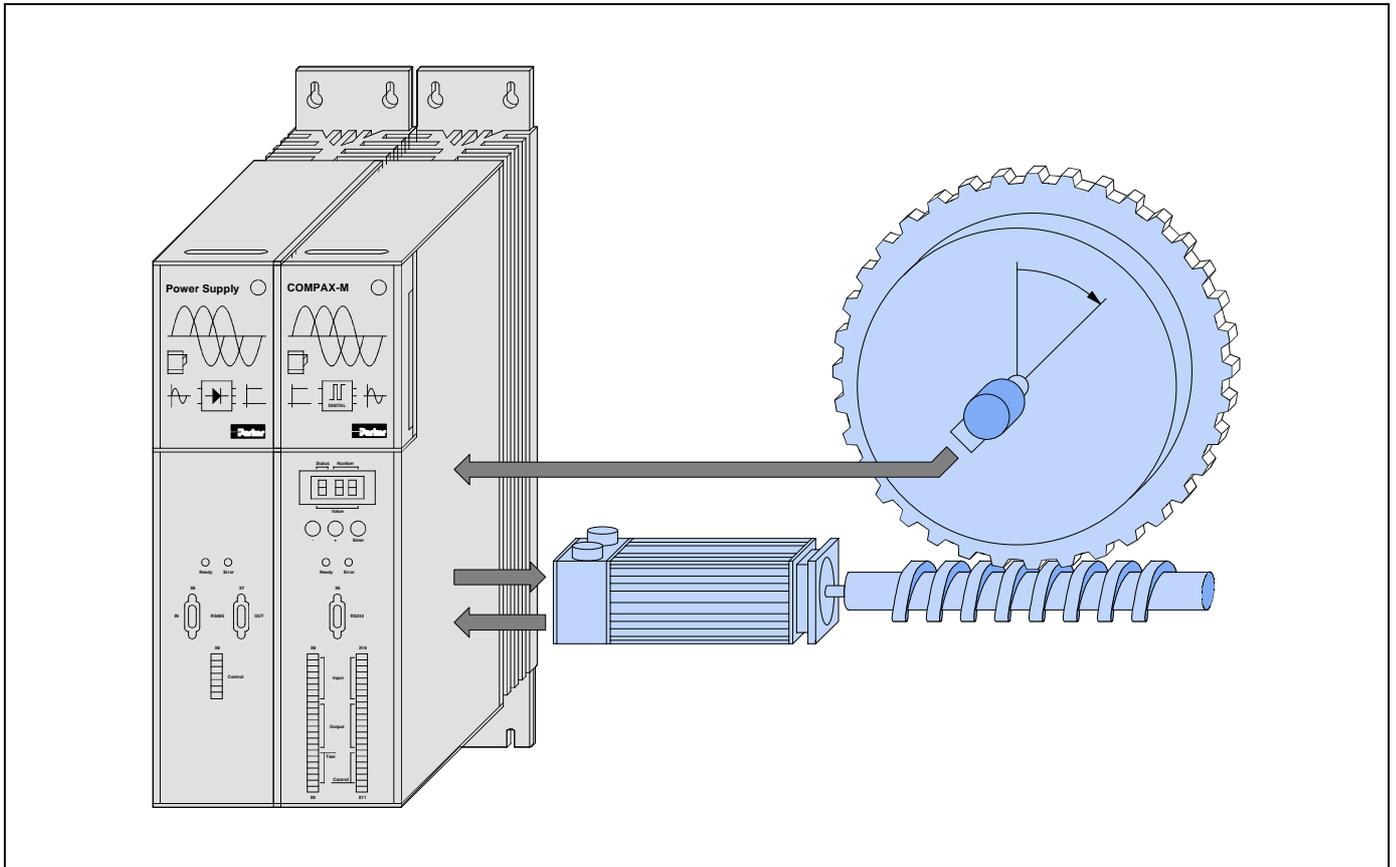# Operating Instructions

Indexing Table Control

- Supplement to User Guide COMPAX-M/S -

From software version V3.64

October 98

COMPAX XX30

Inhalt

This manual applies to the following devices:

- ◆ COMPAX 2530S
- ◆ COMPAX 4530S
- ◆ COMPAX 8530S
- ◆ COMPAX P130M
- ◆ COMPAX 0230M
- ◆ COMPAX 0530M
- ◆ COMPAX 1530M
- ◆ COMPAX 3530M

Code of device designation

e.g.: COMPAX 0260M:

COMPAX: Name
02:    Power class
60:    Variant   e.g. "00": Standard device
M: Device type; M: Multi axis device E: Single axis device

HAUSER-nameplate

The nameplate is on the top of the device and has the following structure:

```
HAUSER
|||||||||||||||||||||||||||||||||
038106 0001 951-160101 Compax 0260M
E2
```

option name ─┘
serial number ─────┘   equipment
                               name
                               part number

1 Overview

With COMPAX XX30 indexing tables, endless or batch quantity assembly chains can be position controlled with high precision.

The positions are programmed in degrees. The direction of rotation can be positive or negative.

Apart from the standard-command set of the COMPAX standard which is not described here in detail (see user guide COMPAX M/S) a special command is used for the indexing calculator. Tha table can be subdivided in the same angle segments with the indexing command.

The standard position measurement follows the resolver in the motor. An external position measuring device to increase the positioning precision is supported.

The indexing table control differs from the COMPAX M standard device in the following features:

Required options:	no; Option E2 or E4 for external position measuring
Possible Operation Modes	As in the standard device extended to the reset mode
Acceptable Drive Types:	Indexing table control; Universal drive
Additional Commands:	WAIT POSR n indexing calculator Positioning to arc segments, without rounding errors.
Locked Commands:	SPEED SYNC GOSUB EXT and GOTO EXT restricted to I9...I11 Label related positioning
Modified Configuration	◆ Range of the gear ratio: 1,000000...1000,000000 ◆ The moments of inertia are given without moment of inertia of the motor. ◆ Distances are given in angles (360°)
Modified Commands	-
Modified I/O Functions:	I12: Switch currentless I13: Compensation of measurement error via external position sensor I14: Release brake O14: No measurement error O16: Output stage currentless
Special Parameters:	P1: Real zero -360...360 degree P11: +4000000 fixed P12: -4000000 fixed P98: Distance per table rotation P75: Maximum measuring error P214: Measurement direction of the external measurement
Modified Status:	S41: Encoder speed S42: Encoder position S46: Sign encoder speed S47: Measurement error S48: Actual value S49: Target position after division calculation
Miscellaneous:	Absolute encoder function not possible!

2 Configuration

➡ Before configuration the drive has to be currentless!
Instead of the configuration course with the standard operation instruction, you must note the following at the indexing table control:

New operation mode	P93	"Reset mode" (P93="3"). P93="3" is the standard adjustment for indexing table control **Caution!** In the reset mode „inch" and „increments" units are not possible!
New unit for distances	P90	Unit degree P90="3": 0-360°

For the configuration of the **motor type**, the **ramp profile** and the **direction** the details used in the standard operation instruction of COMPAX M are valid.

Drive type choose	P80	**P80="64": Indexing table control**
	P81 P82 P85	**indexing table control**
		P81: Minimum moment of inertia Moment of inertia converted to the motor side. Range: 0...**P82**
		P82: Maximum moment of inertia Moment of inertia converted for the motor side. Range: 0...200000kgmm²
		P85: Gear ratio Range: 1,000000...1000,000000 ➡ See chapter 2.1 u. 2.2.
Drive type choose	P80	**P80="16": Universal drive**
	P81 P82 P83 P85	**P81: Minimum moment of inertia** Moment of inertia converted to the motor side. Range: 0...**P82**
		P82: Maximum moment of inertia Moment of inertia converted for the motor side. Range: 0...200000kgmm²
		P83: Travel per motor revolution in milli degree

Configuring the direct position measurement

➡ See chapter 2.3 und 3

Resolution	P143	Resolution per table rotation Range: 500...2 000 000 $\leq 2^{14}$* gear ratio
Distance per rotation	P98	Distance per table rotation Fixed adjustment: P98 = 360
Measurement direction of the external measurement	P214	"0": positive direction when the table goes right. "1": positive direction when the table goes left.

⚠ **Caution!**
Notice the following section when adjusting the measurement direction.

At first start up of the external position measuring system it is possible that, due to a direction change through the gear, the rotating direction of the encoder is opposed to the resolver. Therefore the [I13=1] position correction will operate in the opposite direction. This results in an increase of the measurement error and the device will be disabled via the error message "error 15".
The following start up sequence therefore has to be followed:
1. External measurement not active: I13 = 0
2. Configure resolution external measurement system
3. Set parameter P75 to small value (typical 1°)
4. Connect external measurement: I13 = 1
5. No error: → o.k.
6. Error 15: Parameter P214 change measurement direction from 0 to 1 and acknowledge error

The counting direction of the external encoder will be inverted through the change of the measurement direction.

Machine zero	P213	You can select with P213, at the indexing table control, the side of the machine zero initiator which will be evaluated as machine zero. Value: "0" / "1"
Software end limits	P11, P12	Fixed adjustment: P11=+4000000 P12=-4000000
Real zero point	P1	Range: -360...360 degree

2.1 Moment of Inertia

The data of minimum and maximum moment of inertia refer to the moment of inertia of the gear and indexing table, the units are given in kgmm². They have to be calculated as seen on the motor shaft, therefore the gear ratio has to be considered.
Normally large gear ratios will be used, so that the additional moment of inertia of the pay load can be neglected and set to 0.
COMPAX takes the moment of inertia of the motor from the internal motor table.

2.2 Gear Ratio i

Range: i = 1,000000...1000,000000
For a whole number gearing the reference point can be defined via the logical AND-connection of machine zero initiator with the resolver zero impulse (COMPAX standard application). No external position measuring system is required. With a gear ratio which is not a whole number the resolver zero impulse shifts at every table movement, the calculation of the resolver information becomes inaccurate. In this case an external position measuring system is required.

2.3 Position Measuring

For the inner control loop COMPAX always needs a resolver, regardless whether an external measurement system exists. The position accuracy is 15', related to the motor shaft. This accuracy results from the tolerance of the resolver. The repeatability is in the order of 1,3' (corresponds to 2^{14} counts per motor rotation).

If the accuracy of the resolver is not sufficient or the gear ratio is not a whole number, an external position measuring system is required. For control of the servo loops, the actual value from the resolver is still used. This value will be corrected with the value of the external position measuring system. This has the following advantages:

◆ The dynamic response is not dependant on the external position measurement system.

◆ Start up is possible without an external measurement system.

◆ Filtering of the external measuring signal is possible without a loss of dynamics.

Activation of external position measuring:

To increase the accuracy of positioning, the measurement error compensation can be activated via input I13. First, the resolution has to be configured (via the configuration menu or with P143).

I13 will be polled before every positioning. So you can decide at any time to position by resolver or external encoder. If no resolution is configured (P143=0), input I13 will not be polled and the measurement error compensation will not be activated.

If the difference between resolver position and the position which is measured externally is larger than the maximum measurement error P75, an error message "E15 measurement error" will be displayed and output O14 "no measurement error" will be reset to 0. The drive will then be disabled. The error message can be acknowledged with function key "Enter".

3 Reference Drive

Usually the reference (home) position is determinated by the external machine zero initiator and resolver zero impulse. The rotation direction hereby is negative, related to the motor (for direction P215 ="0").

For direct position measurement and whole number gear ratio the home position can be determined by the zero impulse of the position measurement system. A MN-Initiator is not needed, the position measurement system is mounted directly at the table.

For applications with a 2-step gear and the mounting of the position measurement system after the first step, a MN initiator is needed at the table.

With P212 you can adjust several reference modes (see User Guide COMPAX-M/S).

➡️ The operation with end-initiators is not possible.

4 Commands

As a comparison with the standard commands of **COMPAX** the following modifications apply:

4.1 Positions Commands

The positioning default values are related to the angle of the table. They are measured in degrees and have to be in the range of -360,000 ... 360,000 degrees.
After every table rotation the position set points and actual values are reset, so that the actual values are in the range of 0 ... 360 degree.
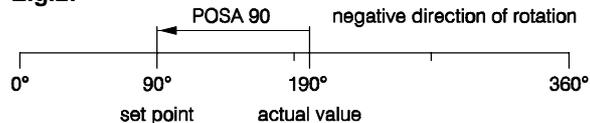
Absolute Positioning

The absolute target position value with POSA lies in the range of 0...360 °. This is within one table rotation. The direction of rotation is dependent on the travel difference (new target point - old target point).

E.g.1:
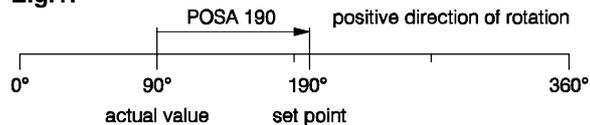
E.g.2:

Relative Positioning

At a relative target reference positive and negative values are allowed: POSR -360...360. The direction of rotation is selected with the sign.
With parameter P215 the polarity of all position values can be changed.
With a suitable combination of absolute and relative positioning commands an optimum indexing operation is possible.

E.g.:

N001: REPEAT 10	number of repetitions
N002: POSR 33	move forward for 33° 10 times
N003: WAIT START	wait for start at position 330Deg from zero position
N004: END	
N005: POSA 0	back to zero position (-330°)
oder	
N005: POSR 30	optimum distance to zero position
oder	
N005: POSA 360	

4.2 Indexing Calculator

With the indexing calculator you can position to arc segments, without adding the rounding error.
Command: **WAIT POSR n**   n: +/-1...999
         The sign of n gives the direction of rotation.
A circle is divided into "n" segments. With every processing of the command "WAIT POSR n" it is moved forward by one segment. To avoid rounding errors the specific target position is determined with the following rule:

$$\text{Target position} = \frac{360 \text{ degree}}{n} * \text{indexing step} + \text{basic position}$$

n: indexing factor
Teilungsschritt: internal step counter
Basisposition: start position of the indexing calculator.
                  It will be actualised before the first indexing step.

Example: n = 7
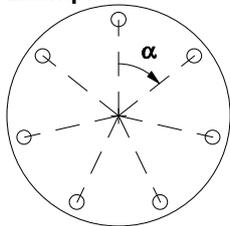
$$\alpha = \frac{360°}{7} = 51,428...°$$

To calculate the target position the indexing calculator does not use the angle α, which is full of rounding errors, but the target position related to the whole circle. This ensures that after the positioning movements 360° is reached exactly.

Example for a fixed number o f part steps:
N001: REPEAT m   repeat factor m < 65536
N002: WAIT POSR n   next indexing step
N003: WAIT START   wait until start at I5
N004: END
The REPEAT loop gives the total number of the indexing steps to be executed. The table will wait at every position for a new start signal at I5.

Example for a variable number of part steps:
N001: IF I7=0 GOTO 1   start of the move cycle with I7
N002: WAIT POSR n   next indexing step
N003: OUTPUT O7 = 1   activate processing
N004: WAIT 100   processing
N005: OUTPUT O7 = 0   switch off processing
N006: IF I8 = 0 GOTO 1   switch further
N007: WAIT POSR 0   delete indexing counter
This case is similar with the REPEAT loop, the indexing counter will be raised by 1 with every partition. The loop can be left at any time with I8 = 1 and the present segmentation will be lost.

Additional function: WAIT POSR 0
With this command the internal indexing counter (counter of the indexing steps) will be reset to one. By so doing the actual indexing calculation is deleted.

Interruption of the indexing calculator

◆ Through a new indexing calculator with other indexing factors or through the command „search machine zero point" the pedometer will be set to one and the basic position set to the current position.

◆ With the commands POSA, POSR the indexing calculation will not be influenced.

Example: With the program sequence drive to real zero (SHIFT I3)
N001: POSR 10   relative + 10 degree
N002: REPEAT 5   5 steps
N003: WAIT POSR -12   partion -360/12 = -30 degree
N004: END   end of the loop
N005: POSR 140   relative + 140 degree
the following angles will be driven to:

Position:	0	10	34	31	28	25	22	360
			0	0	0	0	0	
Direction:		**+**	**-**	**-**	**-**	**-**	**-**	**+**

With the following sequence
N006: WAIT POSR 0
N007: GOTO 2
the above program example will be repeated cyclically, the indexing calculation will be restarted each time.

4.3 Hand Operation

The hand operation is handled like a positioning move. An activated indexing calculation will not be influenced by hand operation. The indexing calculation refers to the last indexing step by continuing the process.

5 Special Inputs and Outputs

5.1 Functions of Inputs

Switch currentless   **I12** ⊓

- ◆ I12 will not be evaluated
  - ◆ during a positioning
  - ◆ and during the sentence processing, i.e. also in the Cam operation.
- ◆ With I12="1" the output stage is enabled.
- ◆ With I12="0" the output stage is currentless.

Measurement error compensation   **I13** ⊓

- ◆ I13 is only used in external position measurement operation.
- ◆ With I13="1" the actual value of the resolver will be compared and corrected with the external position measurement. If the error is larger than P75, error I15 will be generated and the drive will be disabled.

Release brake   **I14** ⊓

- ◆ With I14="1" the brake will be released by currentless output stage.

5.2 Functions of Outputs

No measurement error   **O14**

- ◆ O14="0" corresponds with error E15: measurement error
- ◆ O14="1" no measurement error

"Output stage currentless"   **O16**

- ◆ O16="0": Output stage active
- ◆ O16="1": Output stage currentless

6 Special Status Assignment

S12: Encoder position: in degree; referred to the table

S41: Encoder speed: motor speed diverted from the encoder in % of the motor nominal speed

S42: Encoder position: see S12

S46: Sign Encoder speed

S47: Measurement error: difference between encoder- and resolver position in degree

S48: Actual value: (corresponds S1)

S49: Target position of the division calculation: in degree

7 Additional Error Messages

Error 15: Measurement error

Measure: Check configuration (gear rate or resolution) and control wiring; check measuring wheel direction.

Recommendation by E15 error message:
After **Quit** of external position measurement, switch off for a short time with I13="0"!

8 Indexing Table Parameters

No.	Meaning	Unit	Minimum Value	Default Value	Maximum Value	Valid from...
Indexing Table Parameters						
P1	Real zero point	Degree	-360,000	0	360,000	1
P212	Reference procedure	"1": Resolver and machine zero "3": Encoder "4": Encoder and machine zero				VP
P75	Maximum measurement error	Degree	0,01	1,00	360,00	VP
P68	Measurement filter: <100%: leading >100% trailing (Filtering)	%	10	100	5000	VP
P80	Drive typ	="16": Universal drive ="64": Indexing table control				VC
P81	Minimum moment of inertia	kgmm^2	0	0	P82	VC
P82	Maximum moment of inertia	kgmm^2	0	0	200 000	VC
P83	Travel per motor revolution for drive type "universal drive"	$\frac{Degree}{1000}$	0	0	360 000	VC
P85	Gear ratio for drive type "indexing table control"	-	1,000000		1000,000000	VC
P90	Units for distance indication (extended)	"0": Increments "**1**": mm "2": Inch "3": Degree (Extension); by "Universal drive " in milli degree (1/1000 Degree)				VC
P93	Operation modes	"1": Normal operation "2": Endless operation "**3**": Reset mode (Extension) "4": Speed control operation				imme-diately
P98	Distance per encoder revolution	Degree	360	360	360	VC
P143	Resolution of the external position measurement system		0	0	2000000	VC
P144	Channel 1 = external encoder		= "6"			VC
P214	Measurement direction of the external measurement		"0", "1"			VP

▭⟩ All not indicated inputs, outputs and parameters are assigned like COMPAX-standard (see User Guide COMPAX-M/S).

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1 From the next positioning POSA or POSR.
   For activated indexing calculator a modified real zero will not be adopted. For a new indexing calculation a POSA or POSR command is first necessary.