**CC 16
Cam Controller**

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1. General

The CC16 ... is a modern programmable cam controller for linear or rotary (0 – 360°) position feedback.
The unit is packaged in a compact, standard housing for easy panel mount.

A large LED display and numeric keyboard provide for quick and simple operation. Passwords and an input for a key switch assure protection against use by unauthorized personnel.

The CC16 is available for the following measurement systems:
- Incremental encoder
- Absolute encoder with SSI-interface
- Absolute transsonar encoder (magnetostrictive transducer) (P-interface)

The CC16 can be used as:
- rotary programmable cam controller (0 – 360°)
- linear programmable cam controller (displacement)

Cam functions:
- Static and dynamic switch-points with dead time compensation
- Direction-dependent switch-points
- Multiple switch-points for each cam
- 300 switch-points can be split into 15 programs
- Tool/zero point correction separate for each program
- 8 outputs / cams
– additional cams possible by using parallel versions of the CC16

Additional functions (using keyboard):
- Display program number
- Select program number
- Test mode

Additional functions (using external 24 V inputs):
- Program select
- Teach-In (program current position as switch-point)
- Lock outputs
- Keyboard enable
- Zero set

The CC16 is ideal for fast running machines due to its fast cycle time (see technical data at chapter 8).

Follow the instructions in this manual for safe and proper use of the product.

Keep this manual throughout the lifespan of this product.

Wiring and startup of this device may be done by trained personnel only.

Read this manual carefully. Follow the installation instruction and the initial startup guidelines. Neglecting the instructions will result in loss of warranty and liability on part of the manufacturer.

This unit monitors internal operation conditions as well as on the equipment side. However, malfunctions caused by defective elements cannot be prevented in any case.

Personal danger has to be avoided at system side by interrupting the operating voltage through an emergency stop chain.

2. Front Panel / Keyboard
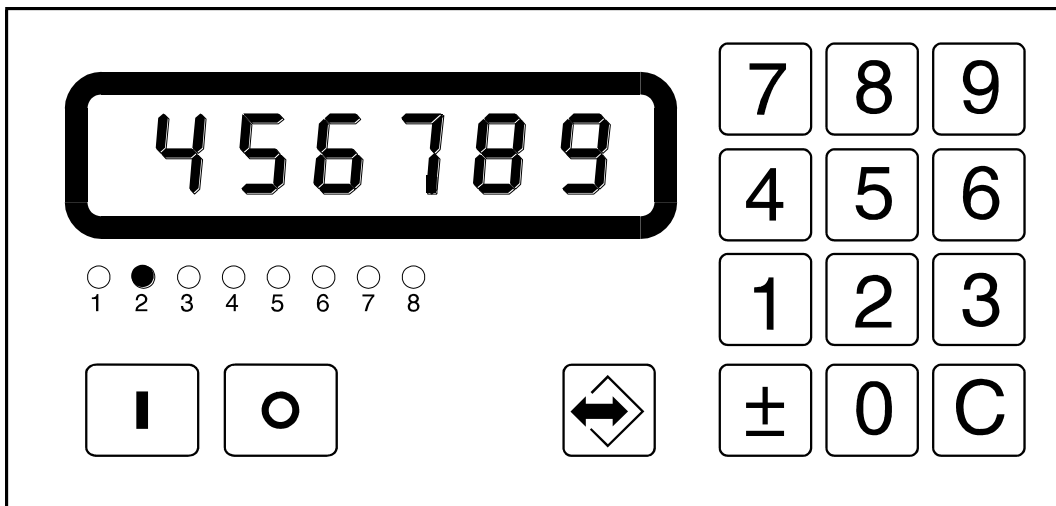
|	
	Numeric LED display for programming and displaying the actual position. LEDs show the state off individual outputs (e.g. output 2 is active)
789 456 123	Numeric keyboard.
C	Clear key for deleting input values.
⬦	Store key for confirmation values.
I	Cam programming: switch-point position or direction dependant "ON". (See chapter 3.3.2)
O	Cam programming: switch-point position or direction dependant "OFF". (See chapter 3.3.2)
O ⬦	Press both at the same time: Call up program or parameter input, or end programming sequence.
±	Toggle LEDs between showing outputs 1-8 and 9-16.

☞ The display flashes if during a programming sequence no key has been pressed within 60 seconds.

Pressing any key will stop the display from flashing.
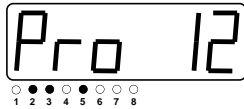
3. Specification of Operation Modes

3.1 Position and Program Number

In normal operation, the actual position of the system is displayed, and the LEDs indicate which outputs are switched on.
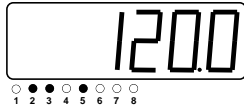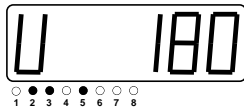
Current position, e.g. 120.0 mm / inch / °

Outputs 2, 3, 5 are on, the other outputs are switched off.

After pressing ⬌, the currently active program number is displayed.

For rotary applications, the display switches from degrees to rpm at rpm > 10. This is indicated with the letter U on the left. For lower speeds, the display shows the position in degrees with no initial letter.

Current speed in rpm

3.2 Selecting Programs from the Keyboard

Program selection from keyboard is only possible with input signal "keyboard enable" set to 24V DC.
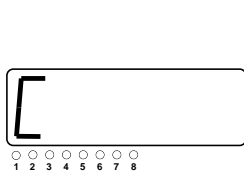
Call up password input.

Confirm without password.

Input program number and confirm.

Exit program mode. New program is activated.

☞ This function is only possible, if all four input signals for external program selection are at "0 Volt" level or not connected (see chapter 4.1 for additional information).

3.3 Switch-point Programming

300 switch-points can be split into 15 programs.

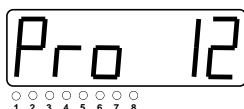If many switch-points are required in one program, the number of programs must be reduced.

Example: 4   programs = 75 switch-points per program
15   programs = 20 switch-points per program

☞   Before programming, set the control parameter P6 "number of programs" (see 3.5.1).

Programming Example:

Program No: Pro 12	Switch-point	Output No.	Position	Function
	SP 1	Out 3	50,0	ON
	SP 2	Out 3	115,5	OFF
	SP 3	Out 1	70,0	ON
	SP 4	Out 1	130,0	OFF
	SP 5	Out 1	210,0	ON
	SP 6	Out 1	320,0	OFF
	|	|	|	|
	SP 20	Out 7	275,0	OFF

Example:


```
Out 1


Out 3

           50    70      115,5              210
                          130
```
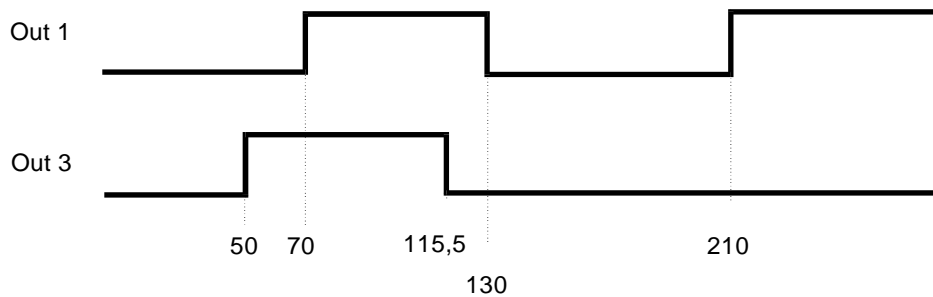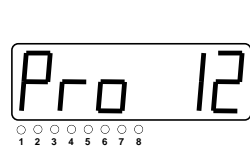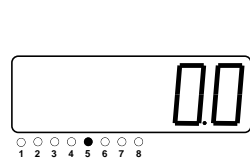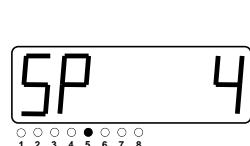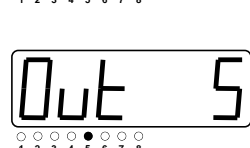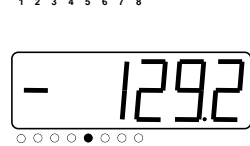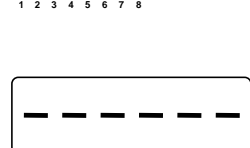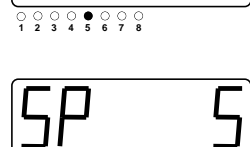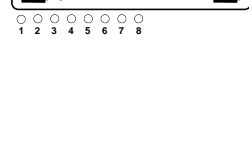
☞   After changing the travel direction, the switch-points will switch after leaving the hysteresis.
(Parameter P90, see chapter 3.5.3).

3.3.1 Programming Sequence

Programming from keyboard is only possible with input signal "keyboard enable" set to 24V DC.

Call up password input.

$\boxed{C}$

Confirm without password.

Pro   12

Enter program number and confirm.

The LEDs indicate those outputs of the first 8 which are already programmed with at least one cam.

The state of outputs 9 – 16 is not shown.

0.0

If desired, enter the zero-point offset of the selected program and confirm.

SP   4

Enter switch-point and confirm or confirm the indicated switch-point.

Out   5

Enter output number (1 - 16) and confirm.
0 = switch-point turned off.

LED of the selected output flashes.

− 129.2

Enter or teach-in switch-point position and confirm. (see also chapter 4.5)

LED of the selected output flashes slowly for outputs 1 – 8 and fast for outputs 9 – 16. LED 1 flashes slowly for output 1 and fast for output 9 etc.

− − − − − − −

Select "ON" or "OFF" function (I, O, L-H I, L-H O, H-L I, H-L O) and confirm. For detailed description of functions see chapter 3.3.2.

LEDs of programmed outputs flashes.

SP   5

Enter next switch-point.....

Leave programming mode.

⚠ **After quitting the programming mode, the switch-points will be recalculated in the unit. During this short time, the outputs and the run "ready" signal are off.**

3.3.2 Switch-point Types

Position dependent switch-points:

`------`	Switch-point is turned off.	*no effect*
`---    I`	Start of cam: Output is "on" at higher positions, otherwise "off".	
`---    0`	End of cam: Output is "off" at higher positions, otherwise "on".	
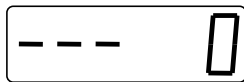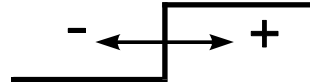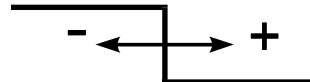
Direction dependent switch-points:
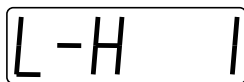
`L-H    I`	Output switches "ON" only with positive travel (Low -> High) (No change of output status with movement in negative direction.)	
`L-H    0`	Output switches "OFF" only with positive travel (Low -> High) (No change of output status with movement in negative direction.)	
`H-L    I`	Output switches "ON" only with negative travel (High -> Low) (No change of output status with movement in positive direction.)	
`H-L    0`	Output switches "OFF" only with negative travel (High -> Low) (No change of output status with movement in positive direction.)	
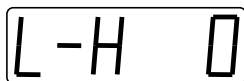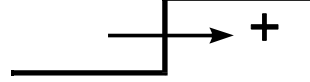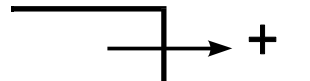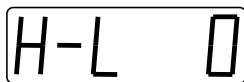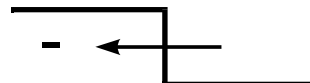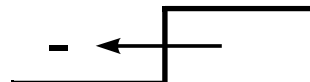
Selection of desired type:

"ON" – switch-point:
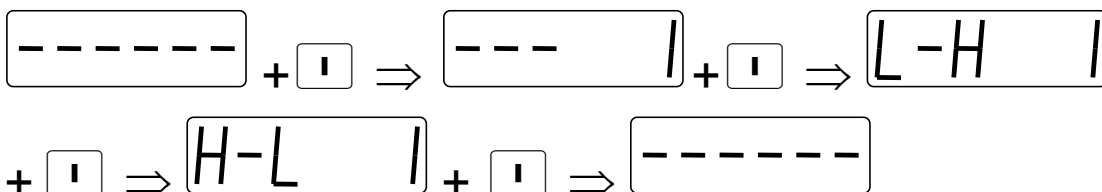
"OFF" – switch-point:
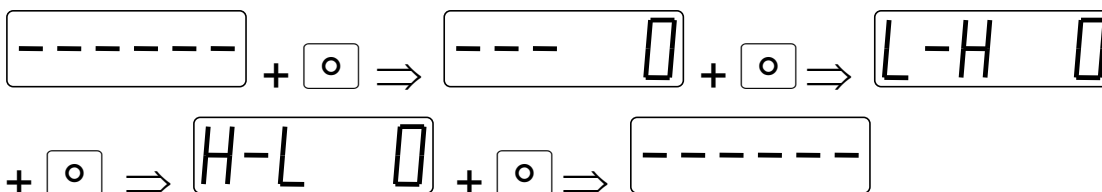
3.3.3 Clearing Program

Clearing programs from keyboard is only possible with input signal "keyboard enable" set to 24V DC.

	⃝ ⬌	Call up password input.
`C` (1 2 3 4 5 6 7 8)	⬌	Confirm without password.
`Pro 12` (1 2 3 4 5 6 7 8)	789 456 123	Enter program number.
	`C`	Press Clear key for at least 3 seconds, until "CLr" is displayed.
`CLr` (1 2 3 4 5 6 7 8)		Selected program is cleared.
`Pro 12` (1 2 3 4 5 6 7 8)		Clear function is ended (still in program mode).

3.3.4 Delete Switch-points

Activate input "keyboard enable"!

	⃝ ⬌	Call up password input.
`C` (1 2 3 4 5 6 7 8)	⬌	Confirm without password.
`Pro 12` (1 2 3 4 5 6 7 8)	789 456 123 ⬌	Enter program number and confirm.
`0.0` (1 2 3 4 ● 6 7 8)	⬌	Confirm zero point offset.
`SP 4` (1 2 3 4 5 6 7 8)	789 456 123	Enter switch-point number.
	`C`	Press Clear key for at least 3 seconds, until "CLr" is displayed.
`CLr` (1 2 3 4 5 6 7 8)		Selected switch-point is deleted.

```
SP      4
○ ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8
```
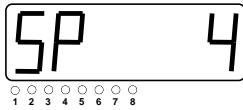
Clear function ended (still in program mode).

3.4 Deadtime Compensation (dynamic switch-points)

A separate deadtime can be assigned to each output signal. The corresponding password is required to change the deadtime compensation value. (See chapter 11)

Activate input "keyboard enable" !

Call up password input.

```
C
○ ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8
```
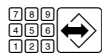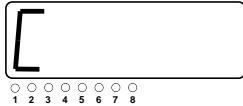
Enter code for parameter "deadtime compensation" and confirm.

```
t1    140
● ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8
```
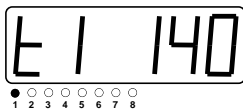
Enter deadtime for output 1 and confirm. Input range (0-250 ms)

```
t2    50
○ ● ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8
```
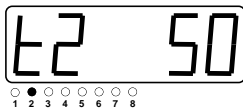
Enter deadtime for output 2 and confirm. Input range (0-250 ms)

```
t3     0
○ ○ ● ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8
```
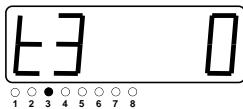
Enter deadtime for output 3...

...

Terminate parameter setting.

3.5 Entering Parameter

In the programming mode with additional code input, the unit can be set up for a specific application. Control parameters and sensor parameters can be directly selected using the corresponding password (see chapter 11).

Activate "keyboard enable" input!

Call up password input

```
C
○ ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8
```
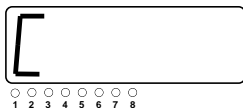
Input password (see chapter 11) and confirm.

Adjust the parameters to your needs.

Save changes and switches to next parameter.

Leave parameter input function.

⚠ **After quitting parameter mode, the switch-points are recalculated. During this short time the outputs and the run "ready" - signal are briefly switched off.**

3.5.1 Control Parameters

No.	Description	Default	Your setting
P0	Rotary / Linear 0: Rotary (units in degrees) 1: Linear	1	
P1	Digits after decimal point for P2 scaling (only for linear feedback systems) Range: 0-5	3	
P2	Scaling (for display) Rotary: steps per 360 degrees, degree display Range: 1-999999 Linear: Steps per required unit (e.g. mm, inch,...) Range (depends on P1): 0.000001-999999 Incremental feedback system (internal 4x interpolation): SSI feedbacksystem: Transsonar feedback system (P-interface):	1 1 21	
P3	Setting decimal point *) Displayed digits after decimal point (0-3)	0	
P4	Feedback direction (or direction of rotation) 0: normal 1: inverted	0	

P5	Power-up condition of directional cams:
	(before a movement takes place)
	0: Start condition "Off"
	1: All "L-H" switch-points under the turn-on position
	     are switched on.
	2: All "H-L" switch-points over the turn-on position are
	     switched on.
		0	

P6	Number of programs (1 -15) *) The number of programs determines the distribution of the 300 switch-points. e.g. 4 Programs = 75 switch-points per program 15 Programs = 20 switch-points per program	4	

*) ⚠ **Check the program again after changing parameters P3 or P6.**

3.5.1.1 Calculation of the Scale Factor (Parameter P2)

Rotary applications

Scaling is entered in steps / 360 degree rotation

Linear application with encoder

Example: Spindle drive with (rotary) encoder resolution 4096 steps/revolution. The position of the carriage needs to be displayed.

a: Display in "inches", spindle with 0.5 inch pitch
4096 steps (1 spindle revolution) corresponds to 0.5 inches travel
P2 = 4096 steps / 0.5 inch = 8192 steps/inch.

b: Display in "millimetres", spindle with 10 mm pitch
4096 steps (1 spindle revolution) corresponds to 10 mm travel
P2 = 4096 steps / 10 mm = 409.6 steps/mm

☞ By using incremental encoder, the given steps / revolution must be entered fourfold

e.g. encoder with 1024 steps / revolution: Enter 1024 steps / revolution * 4 = 4096 steps / revolution

Linear application with magnetostrictive transducer

a: Display in "inch":
P2 = (60000 / waveguide gradient [m/s]) x 25.4
(Check: P2 = approx. 533.4 steps/inch)

b: Display in "millimeter":
P2 = 60000 / waveguide gradient [m/s] (see transducer label)
(Check: P2 = approx. 21.000 steps/mm)

3.5.2 Encoder Parameters

For incremental systems only

No.	Description	Default	Your setting
P11	Preset value (Enter value in desired units, e.g. mm) Range: -9999.99 - +9999.99	0.00	

For absolute SSI feedback systems only

No.	Description	Default	Your setting
P21	Setting zero point (zero offset) (Enter value in required units, e.g. mm) Range: -9999.99 - +9999.99	0.00	
P22	Mode: 0: Standard (CC16 as master module) 1: Parallel (CC16 as salve module)	0	
P23	SSI-device: number of revolutions "4096" for linear feedback systems Range: 1 (Single-Turn) – 8192	4096	
P24	SSI-devices: number of steps per revolution "4096" for linear systems: Range: 4 – 524288	4096	
P25	SSI-device data format 0: Gray code 1: Binary code	0	

For magnetostrictive systems only (P-interface)

No.	Description	Default	Your setting
P41	Setting zero point (zero offset) (value in desired units, e.g. mm) Range: -9999.99 - +9999.99	0.00	
P42	Mode 0: Standard (CC16 as master module) 1: Parallel (CC16 as slave module)	0	

3.5.3 Hysteresis after change in direction

No.	Description	Default	Your setting
P90	Hysteresis (Enter value in desired units, e.g. mm) Range: 0 - +999.999	1.000	

4. External Function Selection

4.1 Function " Select Program "

The 4 input signals (Terminals X1.1 - X1.4) can be used externally recall a stored program. The following table applies (0=0 V, 1=24 V):

Prog. - Select 1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
Prog. - Select 2	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
Prog. - Select 4	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
Prog. - Select 8	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Program-No	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

☞ If all these input signals are at "0", program selection may be done manually using the keyboard.

⚠ **The switch-points are recalculated when changing programs. The outputs and the "ready" - signal are off during this short time.**

The program change has priority in all operation modes.

4.2 Function "Lock Outputs"

A +24 V signal on input signal "lock outputs" (pin X1.6) switches all outputs and the run "ready" signal "OFF".

4.3 Function "Keyboard Enable"

A +24 V signal on input signal "keyboard enable" (pin X1.7) allows to enter program or parameters from keyboard.

However, error clearing and displaying program number is always feasible from keyboard, even when locked.

Example application: Locking out with a key switch.

4.4 Function "Zero Set" respectively "Preset"

For absolute position encoders a +24 V pulse (positive edge) on input pin X1.8 sets the actual displayed position to zero. The internal calculated zero offset is saved in P21 resp. P41.

For incremental position encoders a +24 V pulse (positive edge) on input pin X1.8 sets the actual position to the display value saved in P11.

4.5 Function "Teach-In"

With a +24 V pulse (positive edge) on input pin X1.5 it is feasible to set the switch-point positions or the zero point offset by the actual position.

Example application: Moving the machine to the desired switch-point, and set the switch point directly.

5. Test Mode

For initial start-up or trouble shooting the inputs can be displayed and the outputs individually set or cleared by pressing the according button. The run "ready" signal output can likewise be switched.

☞ In test mode the normal functions are switched off.

⚠ **During the test mode the outputs are switched off. This or manual switching of outputs or the run "ready" - signal could cause the machine to move. It is therefore strongly recommended to lock out, power down or otherwise disable the machine during test mode.**
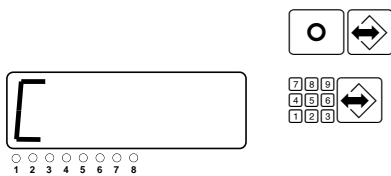
[O] [⬌]	Call up password input.
[789][456][123] [⬌]	Enter password for "Test Mode" (see chapter 11) and confirm.

C

○ ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8

|nPuE

○ ○ ● ○ ● ● ○ ○
1 2 3 4 5 6 7 8

[⬌] — Toggle between input and output displaying function.

OuEPuE

● ○ ● ○ ○ ○ ○ ●
1 2 3 4 5 6 7 8

The corresponding LEDs display the input signals which are at "high" level. (See technical data)

[789][456][123] — Pressing a numeral key switches the corresponding output "ON" or "OFF".

Pressing the +/- key selects outputs 9 – 16. Pressing the keys 1 – 8 than switches outputs 9 – 16 "ON" or "OFF".

The LEDs indicate the respective output state.

[O] [I] — Turn on/off the run ready output.

[O] [⬌] — Exit test mode.

6. Initial Start-Up Guidelines

The setting-up operation for the first time is performed as follows:

1. Connect power supply (but do not turn it on yet).
    Connect transducer or encoder.
    Apply +24 V to input signal "keyboard enable" (Pin X1.7).

2. Check all connections carefully.
    Turn on power supply.
    After turning on, the device version number will be displayed for several seconds. Then the device switches over to normal working mode and displays the actual position.

3. Call up the sensor parameters input function. Set the sensor parameters as required for the sensor, but leave P11, P21 and P41 at "0.000".

4. Set zero offset of the current program to "0.0".

5. Move sensor and check count direction.
    In the case of magnetostrictive devices, the factory setting for display of the position will be in millimeters. For SSI or incremental encoders, the display will show the actual <u>number</u> of counts, with each count corresponding to the sensor resolution.

6. Set control parameters P1 - P5 as required for the application.

7. Set the number of programs using Parameter P6.

8. Set zero point:
    Position the system at the desired zero point. Set "Zero" input (Pin X1.8) using a +24 V signal.
    Alternative: Enter desired zero-point position in Parameter P11, P21, P41.

9. Call up program input function.
    Program the switch-points.

☞   In case of problems with input or output signals, the test mode
    (see 5.) can be used as a diagnostic tool.

    After exiting the program input function, the outputs are set for their corresponding program. The input "Lock Outputs" must be unconnected or set to "0 V" to enable the outputs.

6.1 Mounting of SSI-encoders (linear applications)

SSI-encoders have to be mounted in a way the overflow is outside the traversing range.

Example: Single-Turn encoder with 4096 increments/revolution.

	Admissable traversing range		
4096	0	4096	0

7. Error Messages and Error Elimination

Basic method of confirming an error message:

➡️   Confirm/clear an error message.

or

           Set signal "Lock Outputs" to 24 V.

The following error conditions can arise:

E 1 to E 3 internal device fault

E 4 Contact bounce at input zero-set

     Check the switch at input zero-set

E 5 Checksum Error in Data Memory

     Device was switched off during program or parameter input. Check program and parameters.

E 6 Parameter Error

     Parameter outside the permitted limits. Device was switched off during parameter input. Check parameters.

E 7 Output Overload

     Check outputs for short circuit, improper connection, or exceeding max. output current.

E 8 Program Select Error

     Selected program number is greater than the number of available programs.

E11, E21, E41 Feedback Error

     Connection to feedback system is interrupted / improper connected. For magnetostrictive sensor: magnet may not be present / out of range.
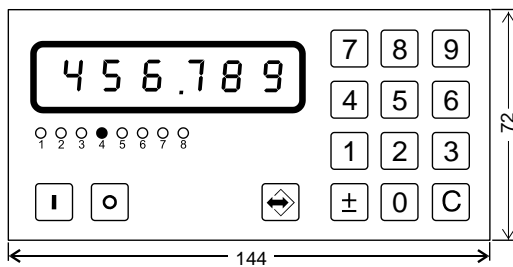
E---- Display Overflow

     Check Parameter P2 resolution / scaling

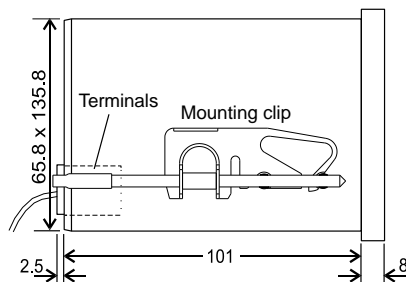The ready contact will be disable when the errors E1 – 41 arise.

8. Technical Data

Input	Numeric keyboard with membrane keys
Display	LED 7-Segment display, 6 red digits, height 14 mm
Outputs (cams)	Cycle time 2 ms
Position acquisition	Incremental: to 250 kHz (internal 4x interpolation) SSI: from 8 to 32-bit data, selectable Transsonar: P-interface, resolution: 50 µm
Encoder supply	5 V or 24 V, max. 300 mA
Program memory	Maintenance-free EEPROM 300 switch-points distributed over 15 programs
Supply voltage	18-32 V DC, ca. 0.3 A (no load on outputs)
Signal inputs	8 inputs 24 V / 7 mA Input impedance : R_i = 3,5 kOhm Logic "High"-Level >= 12 V Logic "Low"-Level <= 3 V
Outputs (cams)	16 digital transistor outputs 24 V / 1 A, short circuit protected and current limited
Ready signal	Floating relay contact (normally open). Contact load capacity 24 V / 1 A.
Operating temperature	0 ... 50° C (32 ... 122° F)
Storage temperature	-20 ... +70° C (-4 ... 158° F)
Humidity	max. 90 %, non-condensing
Protection class at front side	IP 64 (if front panel is vertical)
Emission: Interference:	EN 50081-2 EN 50082-2
Dimensions	Cutout: $68^{+0.7}$ x $138^{+1.0}$ mm

Front view   Side view

Mounting cut-out according to DIN: $68^{+0,7}$ x $138^{+1,0}$ mm

9. Connection diagram

9.1 General Wiring and Installation Requirements (shown with SSI-encoder)

See also safety precautions at chapter 10.
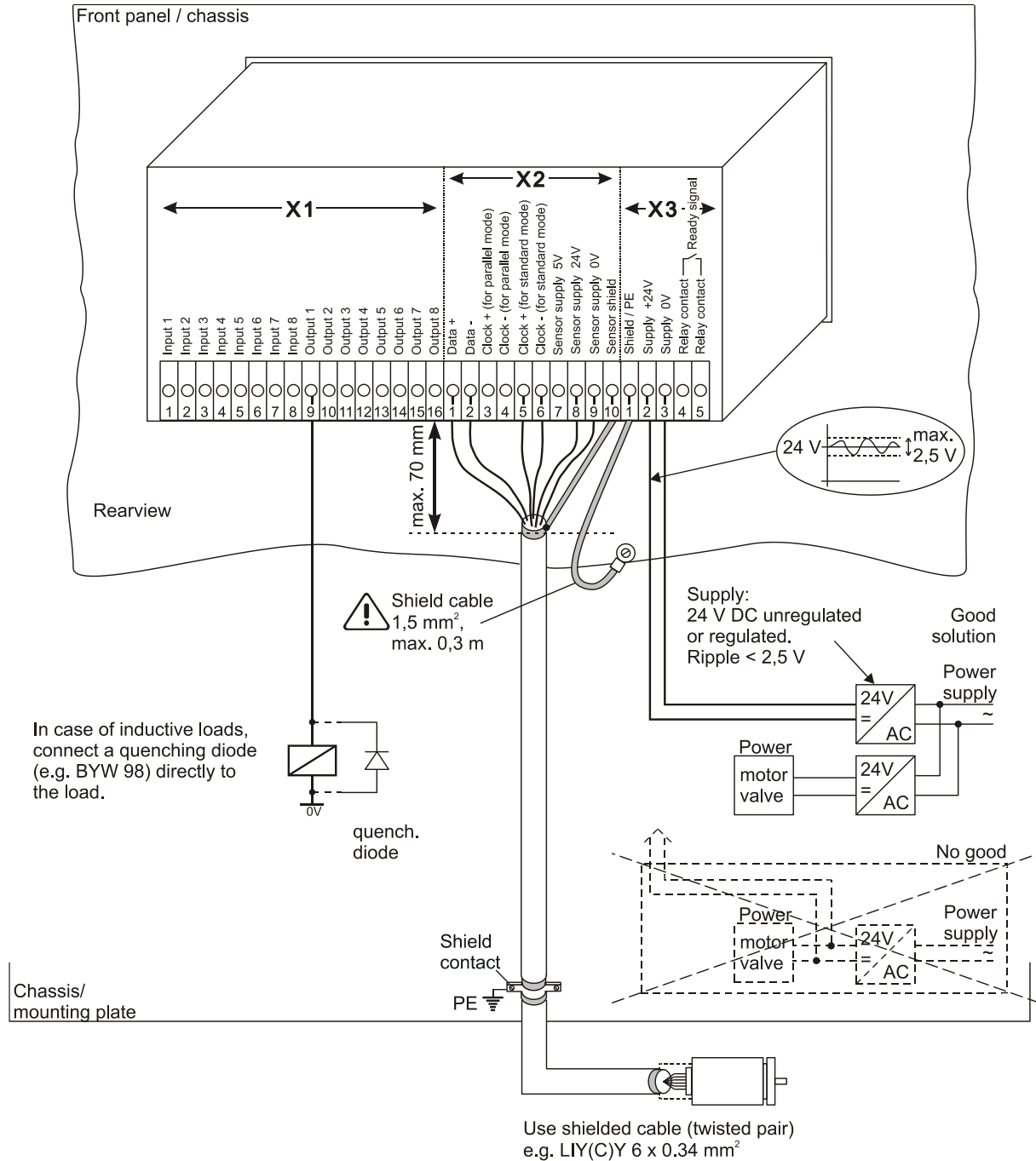
In case of inductive loads, connect a quenching diode (e.g. BYW 98) directly to the load.

quench. diode

Shield cable 1,5 mm², max. 0,3 m

Shield contact

PE

Chassis/ mounting plate

Supply: 24 V DC unregulated or regulated. Ripple < 2,5 V

Good solution

No good

Use shielded cable (twisted pair) e.g. LIY(C)Y 6 x 0.34 mm²

⚠ **In case of inductive loads, connect either a varistor (e.g. Murr-elektronik VG-A/24) or a quenching diode (e.g. Murrelektronik LG-A 01) directly to the load (see connection diagram example).**

9.2 Incremental Feedback System

9.2.1 Incremental encoder with +5 V supply voltage and RS422 line driver (Signals A, /A, B, /B, N, /N)

9.2.2 Incremental encoder with +24 V supply voltage and 12-24 V - Signals (A, B, N)

9.3 Absolute SSI Feedback System
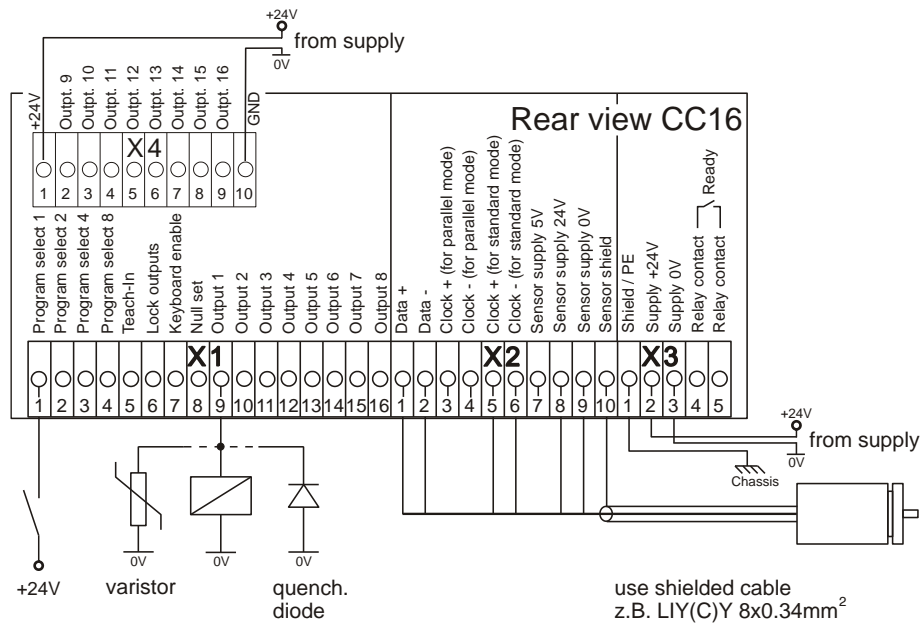
⚠ **In case of inductive loads, connect either a varistor (e.g. Murr-elektronik VG-A/24) or a quenching diode (e.g. Murrelektronik LG-A 01) directly to the load. (see connection diagram example).**

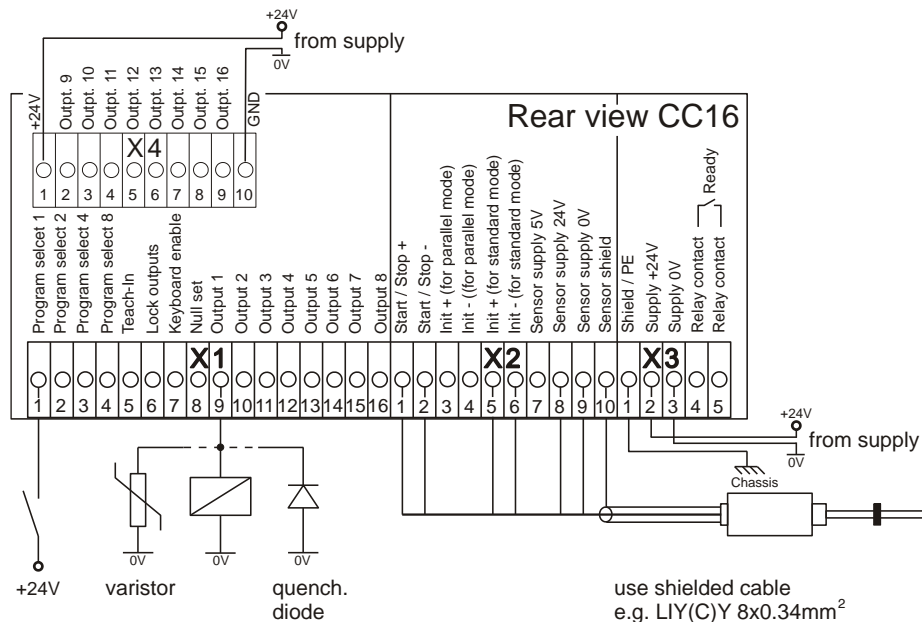## 9.4 Absolute Magnetostrictive Feedback System

⚠ **In case of inductive loads, connect either a varistor (e.g. Murr-elektronik VG-A/24) or a quenching diode (e.g. Murrelektronik LG-A 01) directly to the load. (see connection diagram example).**

10. Precautions

- The CC16.... is designed for industrial use.

- The unit must be installed in a metal enclosure (control cabinet, bench enclosure, etc.).

- The housing must be grounded properly.

- Wiring may be done by trained personnel only.

- Keep wire as close to housing or enclosure as possible.

- Route signal lines and power cables separately.

- The shield / PE connection on the CC16 must be a short cable (1,5 mm^2) and make full contact and conducts well to the housing or enclosure.

- Use a shielded cable between the transducer and the unit.

Read this manual carefully. Follow the installation instruction and the initial startup guidelines. Neglecting of the instructions will result in loss of warranty and liability on part of the manufacturer.

This unit monitors internal operation conditions as well as on the equipment side. However, malfunctions caused by defective elements cannot be prevented in any case.

Personal danger has to be avoided at system side by interrupting the operating voltage through an emergency stop chain.

Follow the instructions in this manual for safe and proper use of the product.

Keep this manual throughout the lifespan of this product.

11. Passwords for Parameter Adjustment

Control parameters adjustment	2401
Sensor parameters adjustment	2402
Hysteresis parameter adjustment	2403
Dead time Compensation adjustment	1201
Test Mode	8635

☞ These security codes are factory set and cannot be changed.

To avoid misuse, these codes should be given to authorized personnel only.

Consider removing this page before handing out this manual to operators.