EDCi

User Manual

(original manual)

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1 Safety

1.1 General Safety Hints

Read this manual carefully before starting with the installation and operation of the EDC. False handling of the instrument can cause severe damage to persons and property. It is essential to adhere to the technical directions and connection conditions from the name plate and documentations.

1.1.1 Warning Signs

The manual contains warning signs adverting to possibly dangerous situations. These warning signs may be found on the instrument, too. It is essential to adhere to the warning signs and the related hints:

Table 1: Symbols and their meanings

Symbol	Meaning
	**Safety Instructions:** In order to avoid interruptions in the workflow as well as damages to man and machine, follow the safety instructions at all cost.
	**Safety Instructions: Danger by electricity and its effects** In order to avoid interruptions in the workflow as well as damages to man and machine, follow the safety instructions at all cost.
	**Note:** Important note for the operation, the function or for the working procedures.
	**Tip:** Gives tips for easy handling of the EDCs or the testing instrument.

1.1.2 Demands on personnel

 **Attention! Only qualified personnel are allowed to perform transport, mounting, installation, start-up, operation or maintenance.**

Qualified personnel are people being well acquainted with transport, mounting, installation, start-up, operation or maintenance. These people must be adequately qualified for their occupations. In detail:

- Transport: Personnel skilled in treating components being susceptible to electrical discharge, only!
- Installation: Personnel with electro-technical apprenticeship, only!
- Start-up: Personnel with wide-ranged skills in the fields of electrotechnics and/or drive engineering, only!
- The qualified personnel must know and adhere to the following standards and directions:
  HD 60364 respectively CENELEC HD 384 or DIN VDE 0100
  National accident prevention directives or DGUV V3**,** DGUV V4.

 **Attention! The devices do contain components being susceptible to electrical discharge. These components may be damaged by incorrect treatment. Always wear an earth strap to dissipate any electrostatic body charge before handling any instrumentation. Avoid the contact with highly insulating material (synthetic fibres, synthetic foils etc.). Place all units on a conductive base mat.**

 **Attention! Do not open the devices! Keep all coverings closed during operation. There is danger of dead or severe damage to persons or property.**

 **Attention! Draw the mains plug before opening the covering of the devices. There is danger of dead or severe damage to persons or property.**

Attention! Never disconnect any electrical connection while the device is still energized. In bad cases, electric arcs may emerge and damage persons or property.

Attention! Mount and place the EDC in a manner, that the emergency-off can be reached and activated easily and that the mains plug can be reached and drawn easily.

Attention! After having drawn the mains plug, wait at least two minutes before touching potentially live components (e.g. contacts, thread bolts) or disconnecting any electrical connection. After disconnection of the supply voltage, capacitors may bear dangerous voltages for up to two minutes. For your safety, it is recommended to measure the voltage in the link and wait, until it has fallen below 40V.

1.2 Legal use of the EDC

The EDC is designed for use with testing instrument systems and must only be operated as an integrated component. The EDC must only be used with a 230/115V, 50/60Hz. single-phase mains supply and in accordance with the environmental conditions defined in this manual. Adhere to the instructions given in this manual.

Attention! Inappropriate handling of the device may affect its functionality or cause severe damage to persons or property.

1.3 CE Conformity, Directives and Standards

DOLI EDC appliances and components meet the requirements of the following directives:

- EMC Directive 2014/30/EC
- Low Voltage Directive 2014/35/EC
- EC RoHS Directive 2011/65/EC and Delegated Directive (EU) 2015/863

If these appliances are used as integrated control for testers, they will be considered as electronic component supporting Machinery Directive 2006/42/EC, e.g. E-Stop button.

Standards for the adherence of the Machinery Directive 2006/42/EC
EN ISO 12100
DIN EN ISO 13849-1:2008
DIN EN ISO 13850:2008

Standards for the adherence of the EMC Directive 2014/30/EC
IEC 61326-1:2012

Standards for the adherence of the Low Voltage Directive 2014/35/EC
IEC 61010-1:2010
IEC 61010-2-x

2 EDCi Overview

The **EDCi** electronics from DOLI are powerful and cost effective systems especially designed for data acquisition and closed-loop control of testing instruments. The **EDCi** systems technically succeed the well-established EDC family, starting with EDC5/25/100 and EDC60/120 up to EDC220V/222V/580V.

You can find further technical information in the EDCi Installation Manual.

2.1 RMCi Overview

2.1.1 RMCi Types

Fig. 1: RMCi1

Fig. 2: RMCi6, RMCi7, RMCi8

2.1.2 RMCi Address Select

Attention! If you connect two or more RMCs of the same type (e.g. 2 x RMC7) to the EDC, the addresses of these RMCs must be different. Follow the next steps to change the RMC address.

- Switch off the EDC.
- Hold the LINK key  pressed and switch on the EDC.
- Now you see a headline with the current RMC address.
- Press the LINK key several times to change the RMC address (0...3).
- Switch off and on the EDC again.

2.1.3 RMCi Brightness Select

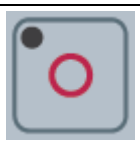
Attention! The life time of the yellow OLED of the RMCi6 and RMCi7 display is limited and depends on the brightness setting and the ambient temperature. Lower brightness values and lower ambient temperature lead to a longer life time. For systems running 24h a day or at higher temperatures we recommend setting the brightness to the lowest value at which the display is still readable.

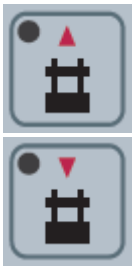
- Switch off the EDCi.
- Hold the LINK key  pressed and switch on the EDCi.
- Now you see a headline with the current RMCi address.
- Press the DigiPoti key to toggle between RMCi address and brightness adjustment.
- Now you see a headline with the current brightness setting.
- Press the LINK key several times to change the brightness (10%...100%).
- Switch off and on the EDCi again.

Starting from EdcApp 9149.004 we provide a screen saver that extends the display life time a lot. The screen saver sets the display to the lowest brightness (10%) if there is no key or DigiPoti input for more than one hour. Any keyboard or DigiPoti input stops the screen saver and the display returns to normal operation mode.

2.1.4 RMCi Key Functions

Table 2: RMCi Key functions

Key	Comment	Function
	ON	Switch drive on. LED is flashing. After drive amplifier is on, LED is also on.
 + 	OFF	Press Digipoti and ON key to switch drive off. LED is off.
	UP	Moves crosshead up. LED is on during movement in this direction.
	HALT	Halts movement of crosshead. In standalone mode the key stops the running test. Test results are shown.
	DOWN	Moves crosshead down. LED is on during movement in this direction.
	POS MODE	Change operational mode of Digipoti from speed to position control mode. Both direction LEDs are on.
	Turn	In speed control mode: increase / decrease speed. In position control mode: increase / decrease position.
 + 	High / Low Pressure	Press Digipoti and POS MODE key to activate / deactivate high pressure. This function must be enabled and configured in the EDC setup. LED is on if high pressure is active.

	Close / Open Grips	These four keys operate hydraulic / pneumatic grips. This function must be enabled and configured in the EDC setup. LEDs are controlled by an external device.
	Close / Open Extensometer	These two keys operate automatic extensometer arms. This function must be enabled and configured in the EDC setup. LEDs are controlled by an external device.
	Move Fixed XHead	These two keys operate adjustment of a fixed crosshead. This function must be enabled and configured in the EDC setup. LEDs are on if crosshead is moving.
	START HALT CONTINUE	Start test (LED on). Halt running test (LED flashing). Continue test (LED on). Function depends on the standalone or PC application.
	RETURN	Return to start position. Function depends on the standalone or PC application.
	LINK	Link key. Function depends on the EDC general data setup parameter **RMC Active Mode.** If two or more RMC are connected, you can set the behavior of the active RMC. *MULTI* - All connected RMCs are active. All link LEDs are on. *SINGLE* - Only one active RMC is allowed. One link LED is on. - All other RMC keys are disabled (Estop is always active). - Press link key of the active RMC to switch to another RMC. - Now all RMC link LEDs are blinking. - Press the RMC link key of the new RMC.

	F1…F3	Function keys are only used in PC Control. Function depends on the PC application. Build in EDCi standalone tests don't use these keys.

2.1.5 RMCi1/RMCi8 Key and Touch Functions

If you want to use the EDCi build in standalone tests, you have to use an RMCi1/RMCi8 with touch display. With the RMCi1/RMCi8 you can edit the test parameters and you get the test results on the display.

An additional RMCi6 or RMCi7 shows only the current load and position readings.

The following tables on the next pages show the touch display handling.

Table 3: RMCi1/RMCi8 general handling in menus

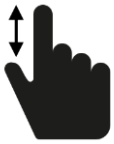
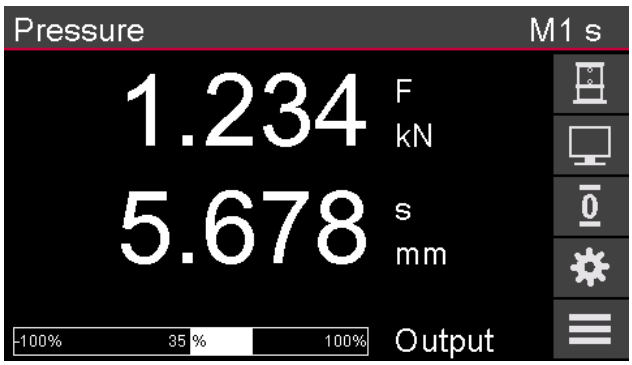
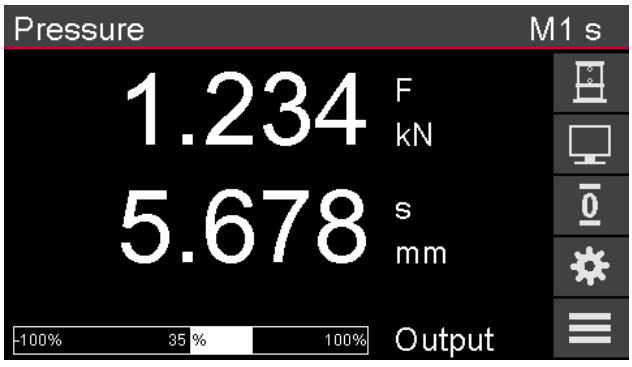
Key	Comment	Function
	Touch	ENTER function in menus or selects a menu item.
	Swipe	Moves cursor up/down or selects a choice in parameter menus.
	Turn	Moves cursor up/down or selects a choice in parameter menus.
	Press	ENTER function in menus or selects a menu item.

Table 4: RMCi1/RMCi8 Main display and menus

Display	Function
	Main Display Buttons ◄ Machine menu. ◄ Display mode (for future use). ◄ Tare menu. ◄ Test settings. ◄ Main menu.
	Main Display Readings The headline shows the test name, machine number and current control sensor. Depending on the selected test you see the sensor readings and additional info like the output.

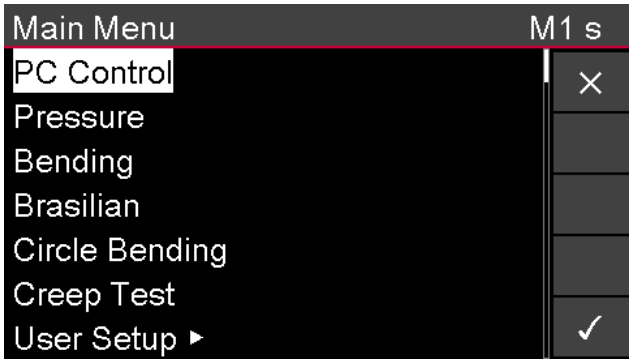
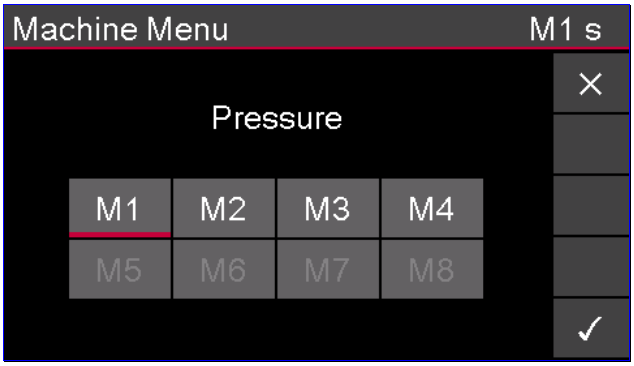
	Main Menu ◄ CANCEL: return to previous menu. Select PC Control for USB/LAN communication. Select a standalone test. Edit user setup parameter. Show EDC info menu. ◄ ENTER: confirm selection.
	Machine Menu ◄ CANCEL: return to previous menu. Select machine. ◄ ENTER: initialize selected machine.
	Tare Menu ◄ CANCEL: return to previous menu. Set/Reset sensor tare. ◄ ENTER: confirm new sensor tare.

Table 5: RMCi1/RMCi8 PC Control menu

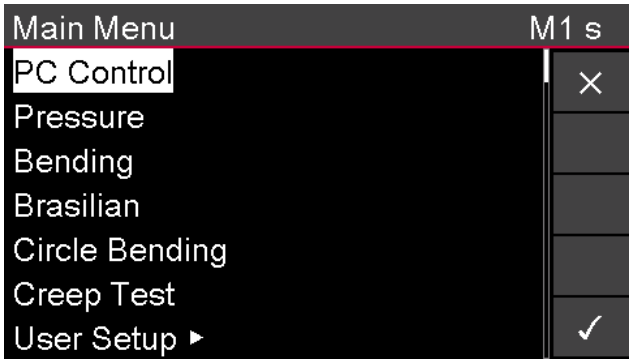
Display	Function
	Main Menu ◄ CANCEL: return to previous menu. Select PC Control for USB/LAN communication. ◄ ENTER: confirm selection.
	PC Control Offline ◄ PC Control settings. ◄ Main menu.
	PC Control Online ◄ Function keys for PC application.

Table 6: RMCi1/RMCi8 test settings menu

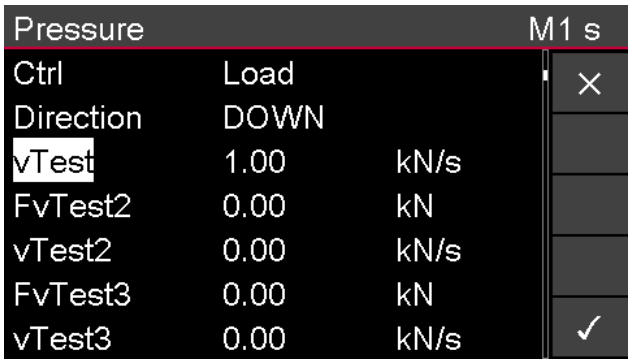
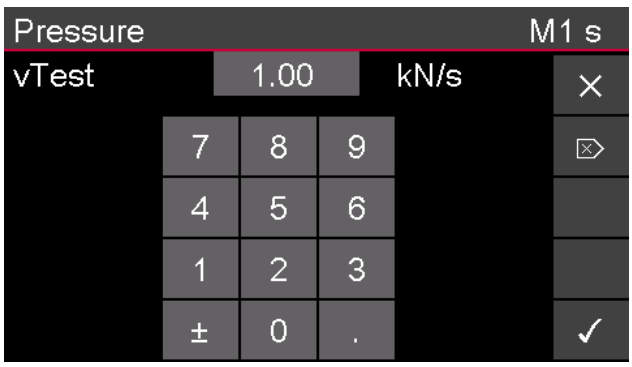
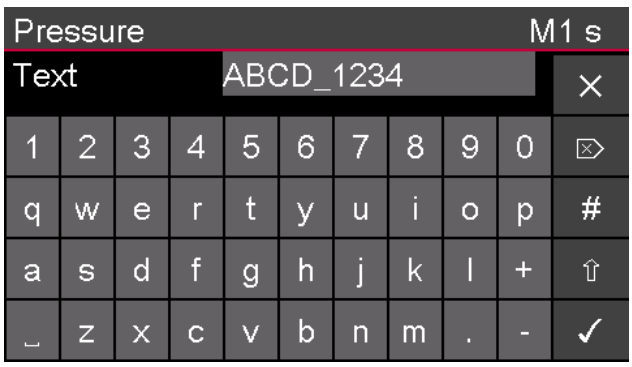
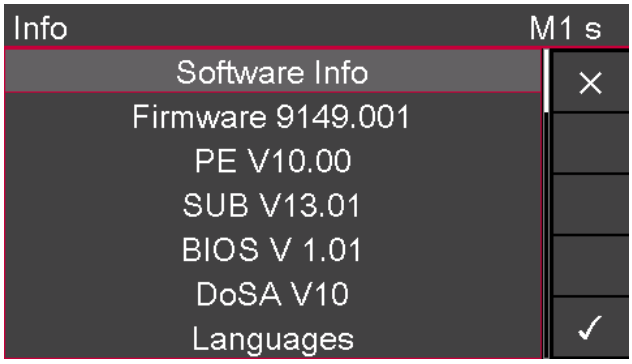
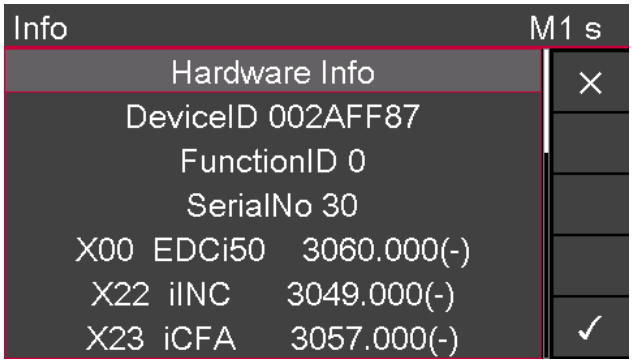
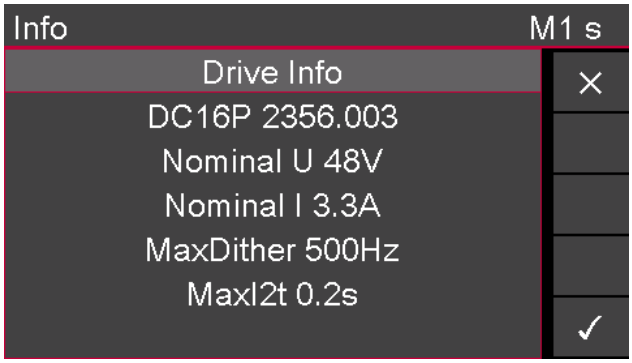
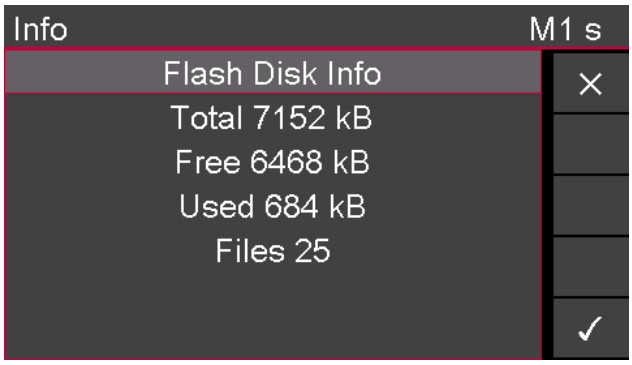
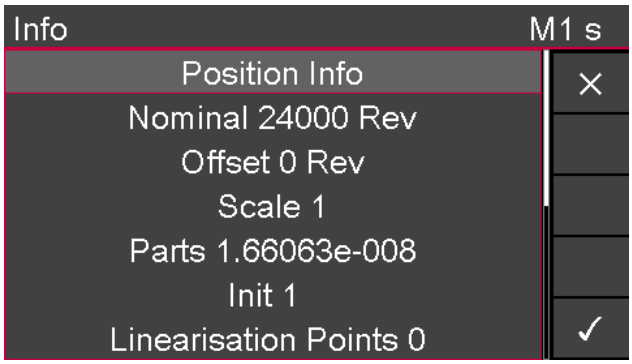
	Test Settings Menu ◄ CANCEL: return to previous menu. ◄ ENTER: edit parameter.
	Edit Value ◄ CANCEL: return to previous menu. ◄ DELETE: delete input. ◄ ENTER: confirm changed parameter.
	Edit Text ◄ CANCEL: return to previous menu. ◄ DELETE: delete input. ◄ SYMBOLS: show special symbols. ◄ SHIFT: change lower/capital characters. ◄ ENTER: confirm changed parameter.

Table 7: RMCi1/RMCi8 info menu

Display	Function
	Main Menu ◄ CANCEL: return to previous menu. ◄ ENTER: show info sub menu.
	Info Menu ◄ CANCEL: return to previous menu. ◄ ENTER: show info.
	Software Info ◄ CANCEL: return to previous menu. ◄ ENTER: confirm.
	Hardware Info ◄ CANCEL: return to previous menu. ◄ ENTER: confirm.

	Drive Info ◄ CANCEL: return to previous menu. ◄ ENTER: confirm.
	Flash Disk Info ◄ CANCEL: return to previous menu. ◄ ENTER: confirm.
	Sensor Info ◄ CANCEL: return to previous menu. ◄ ENTER: confirm.

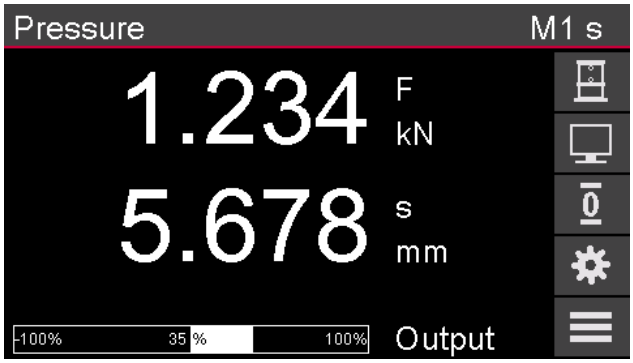
3 General Operation

3.1 Switch On the EDC

Switch-on the EDC. The system check runs automatically.

Note: The correct contents of the sensor EEPROMs and the EDC setup are preconditions for the accurate running of the system check. If an initialisation error occurs, the EDC will show the error number and a short description on the display of the RMC1 (see chapter 5).

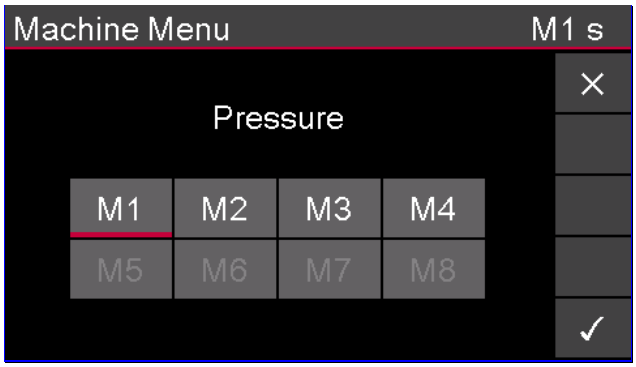
The active machine number and the current closed loop control mode are always displayed at the upper right display corner.



Fig, 3: EDC display: main readings

3.2 Select Machine

Press the key to select the right machine, if the EDC controls more than one machine or has different machine settings in the setup. Press the OK button to initialize the selected machine.



Fig, 4: EDC display: machine menu

3.3 Tare Sensors

Press the key to tare a sensor. Press the OK button to confirm the new tare.

Fig, 5: EDC display: tare menu

3.4 Switch On the Drive

Press the ON key in order to switch on the drive. The illuminated ON LED signalises the condition Drive On.

Note: If there is an error, it will be shown on the display of the RMCi1/RMCi8. In this case the drive cannot be started and the ON LED will not illuminate.

If the drive was started successfully, the EDC software shows the last test, in which the machine has been shut off. The testing parameters are still available, but not the testing results or the statistics of the testing series before the disconnection. Now, the machine is in the positioning mode, explained in chapter 3.5.

3.5 Positioning the Crosshead

To move the crosshead or the hydraulic piston with the direction keys, three conditions must be fulfilled:

1. The display must show the readings.
2. The drive must have been switched on (ON LED is on).
3. There must not be a test running (TEST LED is off).

Press the  key to choose between two Digipoti modes, speed control or position control.
You can set the sensitivity of the Digipoti with a parameter in the EDC setup.

3.5.1 Digipoti in Speed Control

The Digipoti controls the speed of the crosshead. You can adjust the driving direction with the direction keys. A LED in the direction key shows the chosen direction.

Attention! If the Digipoti start speed 'RMC Speed Slow' was set to a non-zero value in the EDC setup, the machine starts moving immediately with this speed. If the start speed is set to zero, the machine will start moving only after the Digipoti has been turned.

To change the direction of the machine, press the appropriate direction key and after that turn the Digipoti. You can stop the machine by pressing the **STOP** key.

If the push mode is activated in the EDC setup, the crosshead moves while you press the direction key. If you release the key, the machine stops immediately.

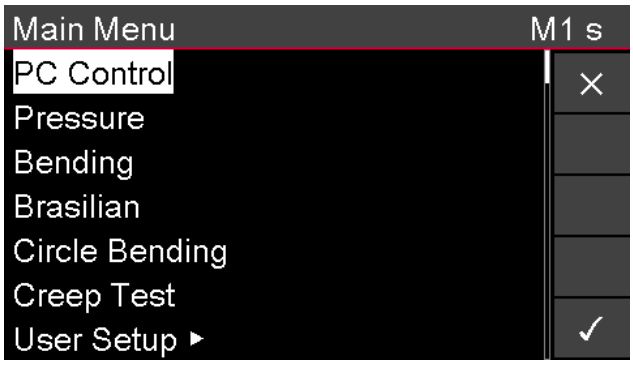
3.5.2 Digipoti in Position Control

The Digipoti controls the position of the crosshead. The **UP** and **DOWN** LEDs are on. Turning the Digipoti right or left moves the crosshead up or down. You can stop the machine by pressing the **STOP** key.

This mode can be useful when clamping samples.

3.6 Main Menu

Press the  key to enter the main menu. Here you can select the build in standalone tests, PC Control, user setup and some other information. Press the OK button to select your choice.



Fig, 6: EDC display: main menu

3.6.1 User setup

In this menu you can set the following parameters:

Table 8: Parameters for user setup

Parameter	Choice	Unit	Remark
SPos		mm	Crosshead position.
SMax SMin		mm mm	Position soft ends.
FUnit	mN, N, kN		Minimum displayed load unit.
Bypass		s	The bypass valve is opened for this time at the return move after test end. If a crosshead travel transducer is available, the defined time will be ignored and the bypass valve is closed, when reaching the return position.
Bypass	closed opened		The bypass valve is closed. The bypass valve is opened manually, as long as the Digipoti key is pressed.
Language	English German User1 User2		Select the EDC display language. User1 and User2 language can be load from the PC with the DOLI Installation Center.
Date	dd.mm.yyyy		The date for the EDC real time clock can be set.
Time	hh:mm:ss		The time for the EDC real time clock can be set
Protocol Setup			Select protocol setup menu (see chapter 3.6.2)

3.6.2 Protocol Setup

This menu shows, how to adjust the protocol interface settings for standalone test results.

If the receiver is set to **PC**, you can set the communication parameters for the **DoSA** Interface. With **DoSA** you can control the build-in EDC creep test from your PC application. You can get the measured values and results of the tests.

The EDC headline shows some further information, if **DoSA** mode is active:

- If the EDC keyboard was locked by the **DoSA** interface, a # charter is displayed.
- A beam shows the fill level of the buffered data in the EDC.

Table 9: Protocol setup for the PC interface (DoSA)

Parameter	Choice	Unit	Remark
Receiver	PC		Activate **DoSA** protocol to PC
Time		s	Time base for the transfer of readings to the PC
Decimal	Point Comma		Decimal sign
Results	No/Yes		Send results to PC
Data	No/Yes		Send measured data results to PC
Buffer	No/Yes		Buffers measured data in the EDC, while the PC is offline.

If the receiver is set to **USB Disk**, the results of the standalone tests are saved as CVS (Comma Separated Values) file on a connected USB stick. If no USB stick is connected, you are not able to start the test.

Table 10: Protocol setup for USB Disk

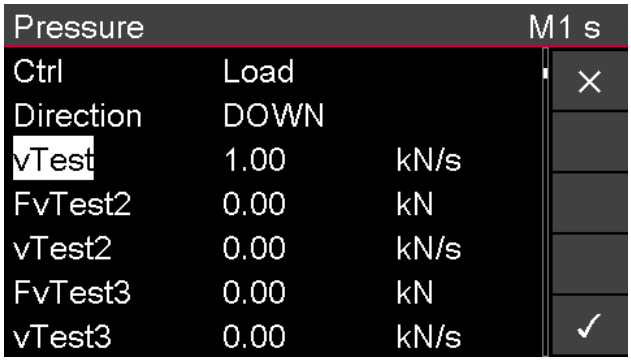
Parameter	Choice	Unit	Remark
Receiver	USB Disk		Activate USB disk
Decimal	Point Comma		Decimal sign
Separator	TAB CSV		Separator for values is TAB Separator for values is CVS compliant
Info result files			Show info about result files
Erase result files			Erase all result files on USB disk

ATTENTION:

If you use Microsoft Excel to open the CSV file, you should set the separator to TAB. The reason is a well-known bug in Excel (import of a UTF16 CSV file).

3.7 Test Settings

Press the  key to enter the current test settings menu. Each test has its own settings menu, in which the variable test parameters are to be set. A detailed description of the test settings can be found in the respective test chapters (see chapter 4). Press the OK button to edit the parameters, press CANCEL to leave the menu.



Fig, 7: EDC display: test settings

3.8 PC Control

In main menu you can switch from EDC standalone to PC Control mode. This is the default mode, if no RMCi1/RMCi8 is connected to the EDC.

All standalone tests are disabled and a PC application can control the EDC. No process hardware is needed by the PC, because the electronics of the EDC is used. All commands can be transferred directly from the PC to the EDC and vice versa, the measured values will directly go to the PC.

In order to use this operation mode, you have to connect the USB or LAN interface of the PC with the X17 USB or the X16 LAN connector of the EDC. For LAN communication, you have to use a 'crossover LAN cable', if you do not use a LAN switch between your PC and the EDC. You have to install a USB or LAN driver provided by DOLI.

Tip: For more information about the drivers, install the DOLI Installation Center and read the document: CommuncationDrivers\CommuncationDrivers.pdf

Use the button to choose the following settings for the PC Control.

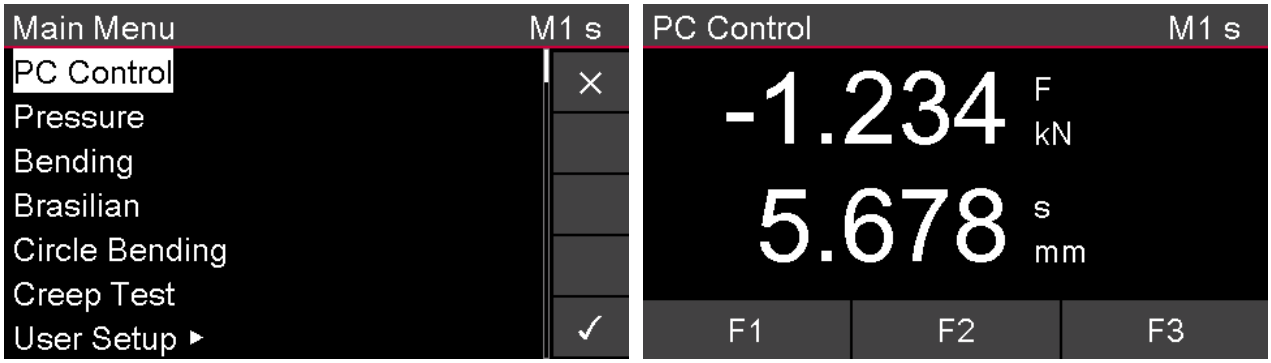
Table 11: Settings for PC Control

Parameter	Choice	Unit	Remark
Connector	AUTO X17 USB X16 LAN		Automatically detect the active interface (USB or LAN) Use only USB Use only LAN

As soon as the communication is online, the function keys F1, F2 and F3 will appear. All keys are transmitted to the PC. As a result, all reactions are determined by the PC program. The PC can control the whole EDC display including the function key texts.

To leave PC Control you must exit your PC application or switch off and on the EDC. If the PC does not communicate with the EDC, you can go back to the main menu and select any other test.

If the PC turns OFFLINE, the EDC will switch to the EMERGENCY STOP state. If the PC goes ONLINE again, the EDC will turn to normal state and you are able to switch on the drive amplifier again by pressing the ON key.



Fig, 8: EDC display: PC Control

4 Tests

The following chapters describe all different standalone tests, which are available on the EDC. Depending on the EDCs licence file, some tests may not be active.

4.1 General test control

The test control, the handling of the test results and the structure of the printouts are equal for all tests and described in this chapter. Possible variations and the specific test parameters are described in the different tests.

4.1.1 Test mode „Control“ and „No Control“

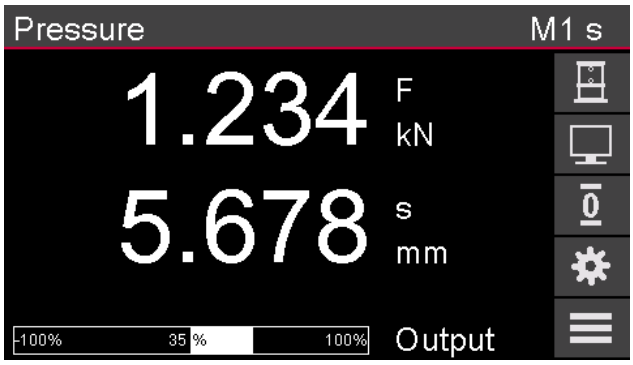
Generally, all tests can be carried out in the mode „Control“ as well as in the mode „NO Control“. You can adjust the desired mode in the EDC machine setup with the parameter Testmode (see documentation “DOLI Installation Manual”). The difference between the test modes is as follows:

Table 12: Test mode „Control“ and „No Control“

Test mode	Characteristic
Control	The machine respectively the test run is controlled by the EDC. It is possible to react to critical errors (e.g. with Emergency Stop). Additionally, the EDC records the measuring data and calculates them.
No Control	The EDC records the measuring data and does the calculations only. There is no possibility to control the machine. The movement keys have no effect. The **START** key starts the calculations only. The test has to be started at the machine control panel. If the load limit is exceeded, the digital output signal for the brake is set (low active).

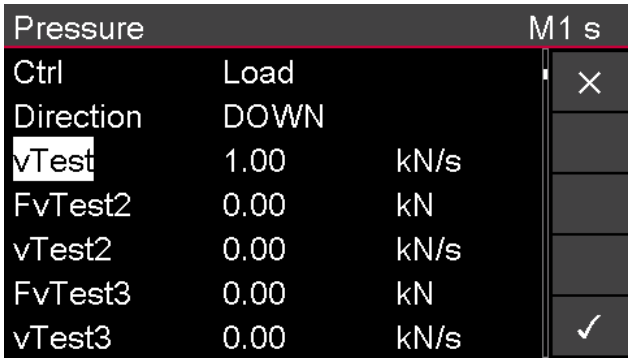
4.1.2 Test Start

In the headline you see the selected test, below you can see the measuring values which are normally load and position. See chapter 2.1 for a general description of the RMCi.



Fig, 9: EDC test display

Use the  button to enter the test settings menu.



Fig, 10: EDC test settings

If you want to start a new testing series, enter the series menu here before starting the test. After leaving the series menu, a new testing series is started. If there are any statistic results from previous testing series, they will be finished.

Fig, 11: EDC test series

Table 13: Function keys for test start

Key	Comment	Function
	START	Start test.
	STOP	Halts movement of crosshead. Stops the running test. Test results are shown.
	RETURN	Return to LE start position.

4.1.3 Test Results

The test results appear at the regular test end or if the  key is pressed.

Fig, 12: EDC test results

Table 14: Function keys for test result

Key	Comment	Function
	CANCEL	Discard the test results. The results are not saved and the statistics is not updated.
	OK	Accept the test results. The results are saved and the statistics is updated (see chapter 3.6.2).

After your choice the measuring values are shown again and you can start the next test with the  key.

4.2 Tension/Compression Test

This is a tension/compression test for plastics and springs. The following figure shows the diagram of this test.

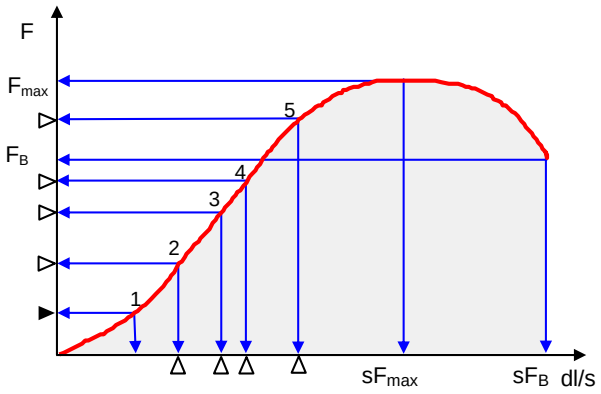


Fig. 13: Graph of the tension/compression test

The specimen will be charged with a constant speed until test end. The results of the test are the position at preload, the maximum load (Fmax), the break load (Fb) and the equivalent position. Besides that, you have the possibility to mark up to five points (P1..P5) in the diagram and the software will determine the corresponding values. The test results will be put out numerically on the display.

Table 15: Test parameters of the tension/compression test

Parameter	Choice	Unit	Comment
Direction	Tension Compression Spring Tension Spring Compr.		Test direction In the spring test mode, the position is not set to zero when reaching the preload.
vFpl		mm/min	Speed to preload
Fpl		N, kN	Preload
tFpl		s	Waiting time after preload is reached. During the waiting time, the preload is controlled in position closed loop control mode. 0 means no waiting time, the test is continued immediately.
vTest		mm/min	Testing speed
P1 P2 P3 P4 P5		N, kN, mm	Measuring points (position or load). If the input is position in [mm] the result will be the corresponding load. If the input is load in [N, kN] the result will be the corresponding position.
End		 mm N, kN N dF, kN dF N/s, kN/s %	Test end: - exceeding of position in (mm) - values below a minimum load in (N, kN) - absolute drop of load of Fmax in (N, kN) - load drop per second in (N/s, kN/s) - relative drop of load of Fmax in (%) (70% = 300N with Fmax = 1000N)
Return	yes no		Carry out return run Do not carry out return run
vReturn		mm/min	Speed for return run
   PrSFpl PrP1 PrP2 PrP3 PrP4 PrP5 PrFm PrSm PrFb PrSb	yes no	 mm Fdim, mm Fdim, mm Fdim, mm Fdim, mm Fdim, mm Fdim mm Fdim mm	Record the results in the protocol Do not record the results in the protocol - Position when preload reached - Load or position at measuring point 1 - Load or position at measuring point 2 - Load or position at measuring point 3 - Load or position at measuring point 4 - Load or position at measuring point 5 - Maximum load - Maximum position - Load when break of specimen - Position when break of specimen
Fdim	N, kN		Dimension of load in protocol
IOTare	yes no		Enable IOTare Disable IOTare BitIn0 Bit7: basic tare position BitIn0 Bit6: basic tare load
New Series			Sub menu to change series settings (see 4.1.2).

4.3 Building Material Tests

You have four different building material tests at your disposal:

- Pressure test (DIN 1048 part 5)
- Bending tensile strength test (DIN 1048 part 5)
- Brasilian test (DIN 1048 part 5)
- Circle bending test (DIN 4032)

The load and crosshead travel position (if available) can be seen in the display for measured values. Fig. 14 shows the diagram of these tests.

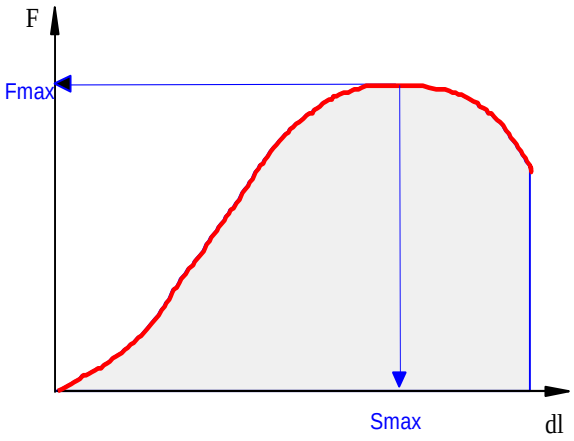


Fig. 14: Graph of the building material tests

4.3.1 Test mode „Control“

In all four tests, the specimen will be loaded up to break with a constant speed of increase of tension or position (only with crosshead travel transducer). The respective resistance (ß) can be calculated out of the arising maximum load (Fmax). The test results (Fmax, Smax, ß) will be put out on the display. Smax is only calculated, if a cross head travel transducer is connected to the EDC.

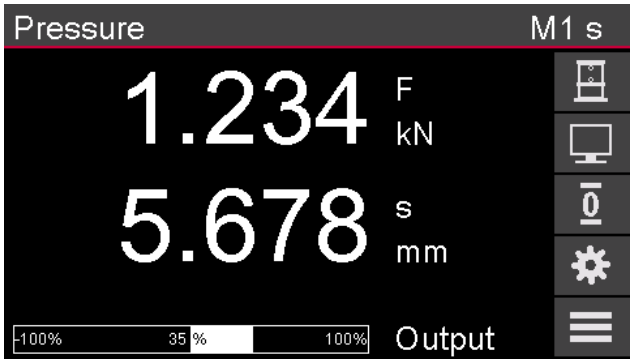


Fig. 15: EDC display: Building material test with mode “Control

- Display with crosshead travel transducer:
  The display shows the load and position. The beam shows the command output.
- Display without crosshead travel transducer:
  The display shows the load. The beam shows the command output.

4.3.2 Test mode „No Control“

In all four tests, the EDC measures the load. The respective resistance (ß) can be calculated out of the arising maximum load (Fmax). The test results (Fmax, Smax, ß) will be put out on the display numerically. Smax is calculated, if a cross head travel transducer is connected to the EDC, only.

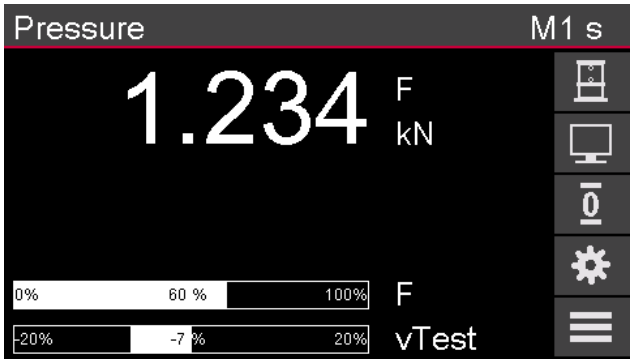


Fig. 16: EDC display: Building material test with mode “No Control”

- Display without crosshead travel transducer:
  The display shows the load.
  The upper beam shows the load in comparison to the nominal load of the machine (F100% in setup).
  The lower beam shows vTest, the real speed of tension increase in comparison to the theoretical speed, set in the test settings.
- Display with crosshead travel transducer:
  The display shows the load and position.
  The lower beam shows vTest, the real speed of tension increase in comparison to the theoretical speed, set in the test settings.

4.3.3 Pressure test

Table 16: Test parameters of the pressure test

Parameter	Choice	Unit	Comment
Test	Load Position		Control mode: Load control Control mode: Position control (only with XHead sensor)
Direction	UP DOWN		Test direction
vTest1		MPa/s, N/mm²s N/s, kN/s, mm/min	First test speed
FvTest2		N, kN	Load trigger level to switch to second test speed vTest2.
vTest2		MPa/s, N/mm²s N/s, kN/s, mm/min	Second test speed, when load level FvTest2 triggers. To switch off the trigger level FvTest2, set vTest2 = 0.
FvTest3		N, kN	Load trigger level to switch to third test speed vTest3.
vTest3		MPa/s, N/mm²s N/s, kN/s, mm/min	Third test speed, when load level FvTest3 triggers. To switch off the trigger level FvTest3, set vTest3 = 0.
Preload		N, kN	Preload (only required, if there is no closed load loop when test starts)
vPreload		mm/min, %	Preload speed. [mm/min] only with cross head travel transducer. [%] are percent of the maximum command, when there is no crosshead travel transducer.
Shape	Cube Cylinder		Specimen shape is a cube Specimen shape is a cylinder
Specimen			Menu for specimen parameters (see chapter 4.3.7)
Area	 No Input Input		When test starts: do not input specimen parameters input specimen parameters
Break		 % N dF,kN dF N, kN N/s, kN/s	Break recognition via: - relative load decay of Fmax in [%] (70% = 300N with Fmax = 1000N) - absolute load decay of Fmax in [N, kN] - underflow of a minimum load in [N, kN] - load decay per second in [N/s, kN/s]
vReturn		mm/min	Speed for return run
Return	Yes No		Activate return run Deactivate return run
 Prß PrFm PrSm PrA PrScale	Yes No		Activate result parameter Deactivate result parameter - Pressure resistance - Maximum load - Position at Fmax (only with XHead sensor) - Specimen area - Scale
New Series			Sub menu to change series settings (see 4.1.2).

The pressure resistance is calculated via the following formula:

For cuboids: $$ß = \frac{Load_{max}}{Width * Depth} * Scale$$

For cylinders: $$ß = \frac{Load_{max}}{Radius^2 * \pi} * Scale$$

4.3.4 Bending tensile strength test

Table 17: Test parameters of the bending tensile strength test

Parameter	Choice	Unit	Comment
Test	Load Position		Control mode: Load control Control mode: Position control (only with XHead sensor)
Direction	UP DOWN		Test direction
vTest1		MPa/s, N/mm²s N/s, kN/s, mm/min	First test speed
FvTest2		N, kN	Load trigger level to switch to second test speed vTest2.
vTest2		MPa/s, N/mm²s N/s, kN/s, mm/min	Second test speed, when load level FvTest2 triggers. To switch off the trigger level FvTest2, set vTest2 = 0.
FvTest3		N, kN	Load trigger level to switch to third test speed vTest3.
vTest3		MPa/s, N/mm²s N/s, kN/s, mm/min	Third test speed, when load level FvTest3 triggers. To switch off the trigger level FvTest3, set vTest3 = 0.
Span		mm	Span of specimen
Charge	Double Single		Charge
Preload		N, kN	Preload (only required, if there is no closed load loop when test starts)
vPreload		 mm/min %	Preload speed. [mm/min] only with XHead sensor [%] command, if no XHead sensor active.
Specimen			Menu for specimen parameters (see chapter 4.3.7)
Area		 No Input Input	When test starts: do not input specimen parameters input specimen parameters
Break		 % N dF,kN dF N, kN N/s, kN/s	Break recognition via: - relative load decay of Fmax in [%] (70% = 300N with Fmax = 1000N) - absolute load decay of Fmax in [N, kN] - underflow of a minimum load in [N, kN] - load decay per second in [N/s, kN/s]
vReturn		mm/min	Speed for return run
Return	Yes No		Activate return run Deactivate return run
  Prß PrFm PrSm PrA	Yes No		Activate result parameter Deactivate result parameter - Bending tensile strength - Maximum load - Position at Fmax (only with XHead sensor) - Specimen area
New Series			Sub menu to change series settings (see 4.1.2).

The bending tensile strength is calculated via the following formula:

For single loading: $$ß = \frac{Load_{max} * Span * 1.5}{Width * Height^2}$$

For double loading: $$ß = \frac{Load_{max} * Span}{Width * Height^2}$$

4.3.5 Brasilian test

Table 18: Test parameters of the Brasilian test

Parameter	Choice	Unit	Comment
Test	Load Position		Control mode: Load control Control mode: Position control (only with XHead sensor)
Direction	UP DOWN		Test direction
vTest1		MPa/s, N/mm²s N/s, kN/s, mm/min	First test speed
FvTest2		N, kN	Load trigger level to switch to second test speed vTest2.
vTest2		MPa/s, N/mm²s N/s, kN/s, mm/min	Second test speed, when load level FvTest2 triggers. To switch off the trigger level FvTest2, set vTest2 = 0.
FvTest3		N, kN	Load trigger level to switch to third test speed vTest3.
vTest3		MPa/s, N/mm²s N/s, kN/s, mm/min	Third test speed, when load level FvTest3 triggers. To switch off the trigger level FvTest3, set vTest3 = 0.
Length		mm	Length of specimen (only for cylinders)
Preload		N, kN	Preload (only required, if there is no closed load loop when test starts)
vPreload		 mm/min %	Preload speed. [mm/min] only with XHead sensor [%] command, when there is no XHead sensor
Shape		Cube Cylinder	Specimen shape is a cube Specimen shape is a cylinder
Specimen			Menu for specimen parameters (see chapter 4.3.7)
Area		 No Input Input	When test starts: do not input specimen parameters input specimen parameters
Break		 % N dF,kN dF N, kN N/s, kN/s	Break recognition via: - relative load decay of Fmax in [%] (70% = 300N with Fmax = 1000N) - absolute load decay of Fmax in [N, kN] - underflow of a minimum load in [N, kN] - load decay per second in [N/s, kN/s]
vReturn		mm/min	Speed for return run
Return	Yes No		Activate return run Deactivate return run
  Prß PrFm PrSm PrA	Yes No		Activate result parameter Deactivate result parameter - Resistance - Maximum load - Position at Fmax (only with XHead sensor) - Specimen area
New Series			Sub menu to change series settings (see 4.1.2).

The resistance is calculated via the following formula:

For cuboids: $$ß = \frac{Load_{max} * 2}{Width * Height * \pi}$$

For cylinders: $$ß = \frac{Load_{max} * 2}{Diameter * Length * \pi}$$

4.3.6 Circle bending test

Table 19: Test parameters of the Circle Bending test

Parameter	Choice	Unit	Comment
Test	Load Position		Control mode: Load control Control mode: Position control (only with XHead)
Direction	UP DOWN		Test direction
vTest1		MPa/s, N/mm²s N/s, kN/s, mm/min	First test speed
FvTest2		N, kN	Load trigger level to switch to second test speed vTest2.
vTest2		MPa/s, N/mm²s N/s, kN/s, mm/min	Second test speed, when load level FvTest2 triggers. To switch off the trigger level FvTest2, set vTest2 = 0.
FvTest3		N, kN	Load trigger level to switch to third test speed vTest3.
vTest3		MPa/s, N/mm²s N/s, kN/s, mm/min	Third test speed, when load level FvTest3 triggers. To switch off the trigger level FvTest3, set vTest3 = 0.
Length		mm	Length of the tube
G		N, kN	Load of the tube's weight
F'		N, kN	Load of the pressure bar
Preload		N, kN	Preload (only required, if there is no closed load loop when test starts)
vPreload		 mm/min %	Preload speed. [mm/min] only with XHead sensor. [%] command, when there is no XHead sensor
Shape	Circle Egg		The shape of the tube
Specimen			Menu for specimen parameters (see chapter 4.3.7)
Area	 No Input Input		When test starts: do not input specimen parameters input specimen parameters
Break		 % N dF,kN dF N, kN N/s, kN/s	Break recognition via: - relative load decay of Fmax in [%] (70% = 300N with Fmax = 1000N) - absolute load decay of Fmax in [N, kN] - underflow of a minimum load in [N, kN] - load decay per second in [N/s, kN/s]
vReturn		mm/min	Speed for return run
Return	Yes No		Activate return run Deactivate return run
 Prß PrFm PrSm PrA	Yes No		Activate result parameter Deactivate result parameter - Resistance - Maximum load - Position at Fmax (only with XHead sensor) - Specimen area
New Series			Sub menu to change series settings (see 4.1.2).

The resistance in [N/mm²] is calculated via the following formula:

$$\beta_{BZR} = \frac{1}{Length} \times F \times \frac{Diameter + Thickness}{2} \times \frac{6}{Thickness^2} \times \alpha_K$$

Shape is a circle: $F = 0.07 \times G + 0.30 \times (F_u + F')$

Shape is an ellipsoid: $F = 0.06 \times G + 0.35 \times (F_u + F')$

$$\alpha_K = \frac{3 \times Diameter + 5 \times Thickness}{3 \times Diameter + 3 \times Thickness}$$

F_u Load at break in [N]
F' Load of the pressure bar in [N]
G Load of the tubes weight in [N]
a_K Correction scale

4.3.7 Specimen parameters

Depending on the current test and the shape of the specimen, you can set one or more of the following specimen parameters:

Table 20: Specimen parameters for building material tests

Parameter	Choice	Unit	Comment
Width		mm	Width of the specimen (only for cubes) Pressure test Bending test Brasilian test
Height		mm	Height of the specimen (for cubes only) Bending test Brasilian test
Depth		mm	Depth of the specimen (for cubes, only) Pressure test
⌀		mm	Diameter of the specimen (for cylinders, only) Pressure test Brasilian test Circle bending test
Thick		mm	Thickness of the specimen (for cylinders, only) Circle bending test
Scale			Scale Pressure test

4.4 Creep Test

The EDC creep test is designed for static and cyclic creep tests. It controls the testing instrument in position, load or extension control and up to three temperatures controller may be connected via a serial line.

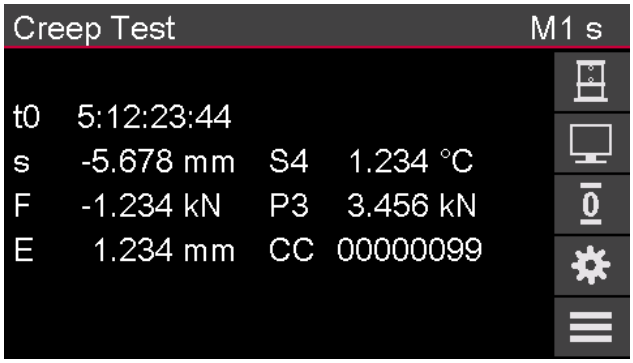


Fig. 17: Creep test

4.4.1 Test Structure

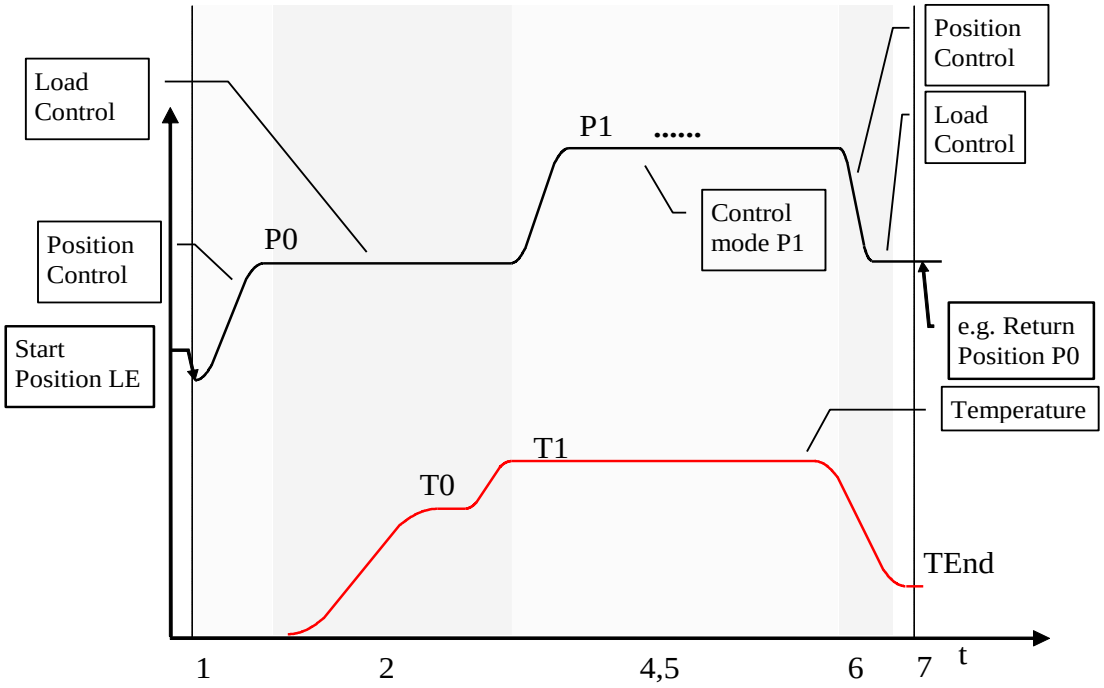


Fig. 18: Creep test structure

1. **Go to pre-load P0**
   - Start of total test time.
   - Move the machine in position control to pre-load P0.
   - Change to load control, and keep P0 constant.
   – If I/O-Control mode is Out/Input, wait here until input signal is active.
2. **Set Test Temperature**
   - Set temperature (Temp0)
   - wait THalt0.
   - set temperature (Temp)
   - wait THalt.

   If more than one temperature controller is active, the temperature difference from starting temperature to Temp0 is divided into 10 steps. After each step, the system waits, until all temperatures have reached their destination. By this method, temperature is increased constantly.
   During temperature setting, pre-load P0 is kept constant.

3. **Tare Position and Extension.**
   - Start counting test time.
4. **Go to P1**
   – Change control mode to control mode of P1 and move the machine to P1. (e.g. in extension control to extension P1)
   - Wait halt time.
5. **Cycling**
   If more than one test steps are selected, move the machine to Pn, wait tn, until the last step is reached. Repeat this sequence (Starting at P1) for the number of cycles.
6. **Test end**
   The regular end of the creep-test is after the test time was elapsed.
   If the total number of cycles takes longer, or shorter than test time, the test always ends after the test time was elapsed.
   Test also stops, after test end condition was detected, or after exceeding a limit.
7. **Action after test end**
   After test-end was detected, one of the actions will be started:

S-Halt	Keep the current position in position control.
Return LE	Return to the position, where the test was started.
Return P0	Return to the pre-load P0, and stay there in load control.
F-Halt	Keep load at test end in load control.
E-Halt	Keep extension at test end in extension control.
Drive Off	Switch drive off.

If extensometer exceeds the limit, the alarm output is set. Besides of the extensometer limit, the alarm output will be set after test end and is reset with any key.

4.4.2 Readjusting of Extensometer

If the extension exceeds the extensometer range during the test, it can be readjusted. The alarm output is set and this message is shown:

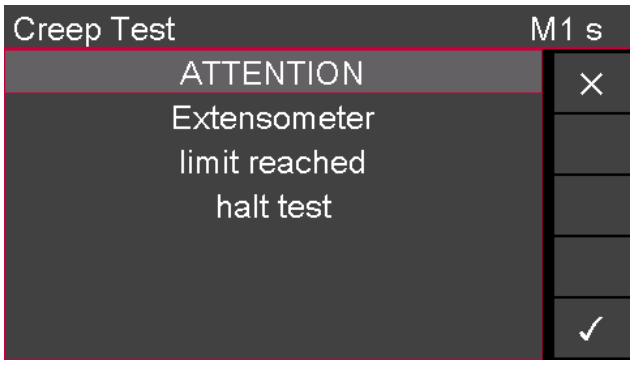


Fig. 19: Creep test extensometer limit reached

Test continues, until the operator presses the START key (LED flashing), to halt the test!

Now machine will be halted in position control and the alarm output is reset. The current extension reading is saved and this message is shown:

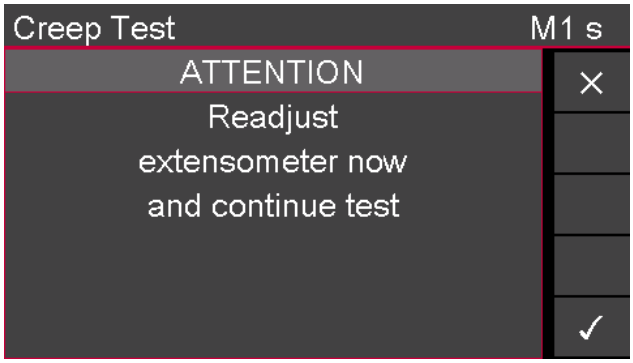


Fig. 20: Creep test extensometer readjust

Now, the extensometer must be readjusted. The operator can continue the test with the START key (LED on). Extension will be the “old” extension before readjustment plus the “new” extension.

4.4.3 Re-Calibration of Analogue Sensors

In order to reduce temperature influence, analogue sensors can be re-calibrated during the test. Re-calibrating is done by measuring the zero reference value.

Note:

- Only analogue sensors, not used for closed loop control, can be re-calibrated.
- The re-calibration is only activated, if the test is in a halt state, e.g. position, load or extension is kept constant!
- While measuring the reference, the sensors cannot be measured for approximately 0.5 seconds.

4.4.4 I/O Control

I/O-Control may be used to synchronise with an external hardware like furnace control. Two Modes are possible.

Output-Mode:

At end of test, the selected output bit at X2 is activated for the specified time. With this output pulse, a furnace may be switched off.

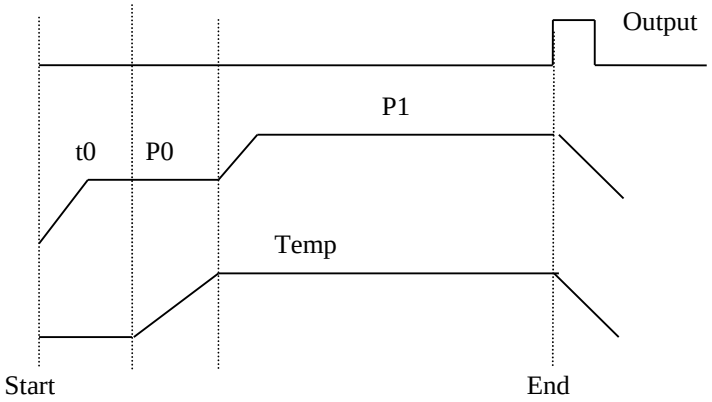
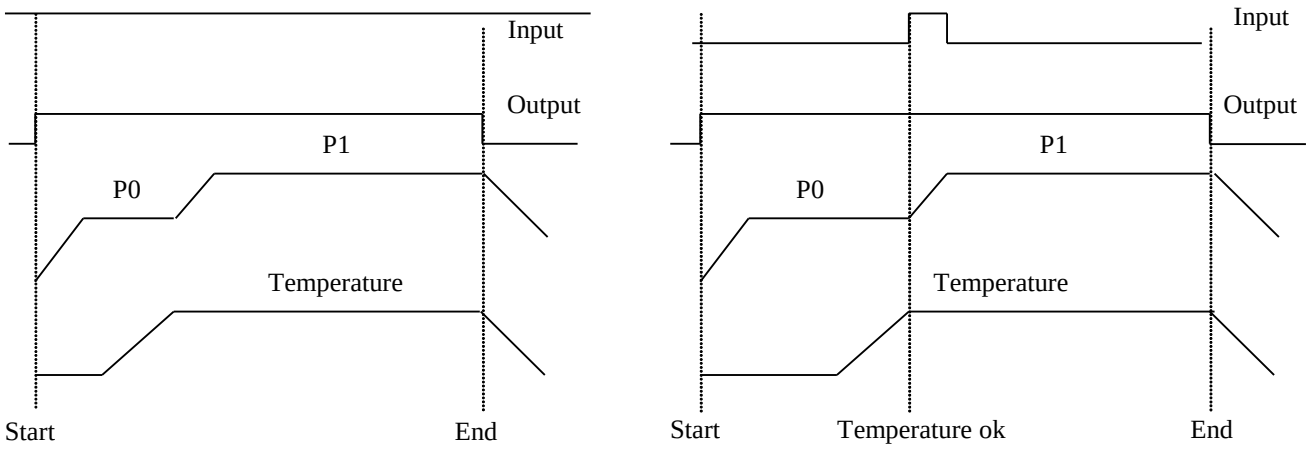


Fig. 21: Creep output mode

Output/Input-Mode:

Use this mode to switch a furnace on after test was started, and switch it off at end of test. If temperature is controlled by EDC, the input signal must always be active.

In case temperature is controlled by an external system, use the input signal to inform EDC temperature is ok. EDC will wait at P0 until the signal is active.



EDC controls temperature **External temperature control**

Fig. 22: Creep output/input mode

4.4.5 Test Parameters

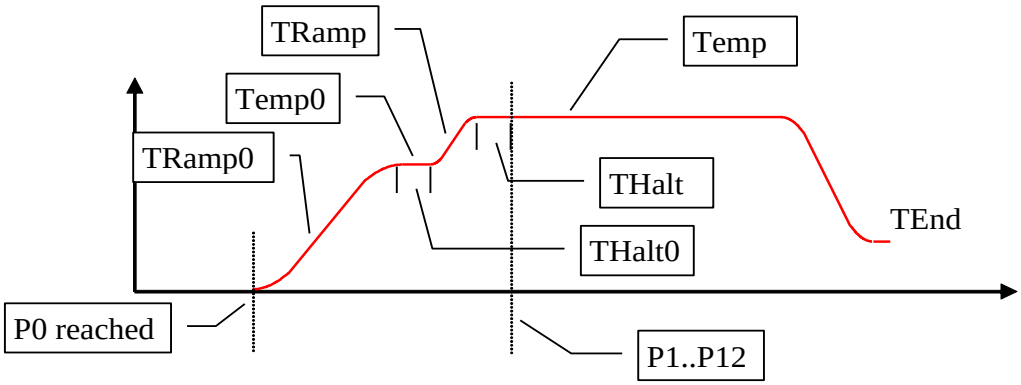


Fig. 23: Creep temperature control

Table 21: Creep temperature control parameters

Parameter	Choice	Unit	Comment
TSens	Not Active Sensors 4…15		Select Sensor for Temperature feedback If more than one temperature controller is connected; use here the calculated sensor for mean value.
dTemp		°C	Delta of temperature steps
Temp0		°C	First temperature step
TRamp0		°C/s °C/min °C/h	Temperature ramp to reach Temp0
THalt0		s, min	Halt time after Temp0 is reached
Temp		°C	Final Temperature
TRamp		°C/s °C/min °C/h	Temperature ramp to reach Temp
THalt		s, min	Halt time after Temp is reached
TEnd		°C	Temperature after test end

Table 22: Creep test parameters

Parameter	Choice	Unit	Comment
P0			**Enter sub menu for P0 parameter**
v		mm/min µm/min mm/s µm/s	Speed in position control to reach P0
P		N, kN	Value of P0
t		s, min	Halt time after P0 was reached
tareP0	Yes, No		Tare load when reaching P0
tareT	Yes, No		Reset test time
Steps			Number of steps from 1 to 12
P1 to P12			**Enter sub menu for P1 to P12 parameter**
Ctrl	Position Load Extension Temp		Select control for Pn. Move on position, load and extension control to Pn or change temperature.
Mode	Ramp Halt Cosine Triangle Rectangle		Select movement mode for Pn.
v			Speed to reach Pn.
P			Value of Pn.
t		s, min	Halt time after Pn was reached.
Loops			Number of loops P1 to Pn
Days			Duration of test in days, hours, minutes and seconds. **Attention:** Test end is always after time is elapsed, not number of loops!
Time	hh:mm:ss		
RetAct	 S-Halt Return LE Return P0 F-Halt E-Halt Drive off		Return action after test time is elapsed: Keep current XHead position in position control Go to position where test was started Go to P0, and keep this load in load control Keep current load in load control Keep current extension in extension control Switch drive off
vRetAct		mm/min µm/min mm/s µm/s	Return speed to LE or P0.
ELimit		mm, µm	Maximum extension for extensometer (see 4.4.2).
Alarm	Bit0 … Bit7		Definition of an output bit at X2 for alarm signal. The alarm output is activated after test end or ELimit is exceeded.
tRef		min	Time period for re-calibration of analogue sensors (see: 4.4.3)
Chan.1 to Chan.6	 not active Sensors		Definition of values for the display (max. 6 possible): Display off Active sensors

	Cycles Loops Step S-Min / S-Max F-Min / F-Max E-Min / E-Max Ctrl1 BlkLine		Command cycles Loop count Step Pn Position sensor min / max Load sensor min / max Extension sensor min / max Ctrl1 states Block command line
ModeT	 TestTime RemainingTime		Definition of time display on LCD: Time since P0 was reached (up count) Time until test ends (down count)
New Series			Sub menu to change series settings (see 4.1.2).

Table 23: Creep test end parameters

Parameter	Choice	Unit	Comment
ESens	**not active** **Sensor**		**Sensor for test end detection**
EMode	 above below delta of max Rate		Test ends if: Sensor > End Sensor < End SensorMax – Sensor > End SensorRate > End
End		Unit	Sensor value for test end check.
EndAct	 S-Halt Return LE Return P0 F-Halt E-Halt Drive off		Action after end condition was detected: Keep current X-head position in position control Go to position where test was started Go to P0, and keep this load in load control Keep current load in load control Keep current extension in extension control Switch drive off
vEndAct		mm/min µm/min mm/s µm/s	Return speed to LE or P0.
Limit	**not active** **Sensor**		**Sensor for limit detection**
Limit++		Unit	Upper limit
Limit--		Unit	Lower limit
LimAct	 S-Halt Return LE Return P0 F-Halt E-Halt Drive off		Action after limit condition was detected: Keep current X-head position in position control Go to position where test was started Go to P0, and keep this load in load control Keep current load in load control Keep current extension in extension control Switch drive off
vLimAct		mm/min µm/min mm/s µm/s	Return speed to LE or P0.

Table 24: Creep test results

Parameter	Choice	Unit	Comment
PrTime		s	Transmit data record every PrTime seconds
PrdS		mm, µm	Transmit data record if position has changed
PrdF		N, kN	Transmit data record if load has changed
PrdE		mm, µm	Transmit data record if extension has changed
Xmit0 …15	not active Sensor0…15 TotalTime TestTime Cycles Loops Step SensorMin SensorMax Ctrl1 BlkLine		Definition of data record. Up to 16 data can be defined. Sensor 0 to 15 Total time over all test since last time reset Testing time Cycles of Pn cycling command Loops over all steps P1 to P12 Step P1 to P12 Sensor 0…2 minimum Sensor 0…2 maximum Closed loop controller state 1 Internal block program line

Table 25: Creep IO control

Parameter	Choice	Unit	Comment
IOCtrl	 OFF Output Out/Input		IO control mode (see 4.4.4): No I/O's are active. After test end, a pulse will be generated. Input and output are used.
OutBit	Bit0…7		Definition of output bit number at connector X2.
OutPol	ACTIVE LOW ACTIVE HIGH		Polarity of output bit.
InBit	Bit0…7		Definition of input bit number at connector X2.
InPol	ACTIVE LOW ACTIVE HIGH		Polarity of input bit.
Time		s	Time for output pulse (only IOCtrl = Output).

Table 26: Creep closed loop parameters S, F, E

Parameter	Choice	Unit	Comment
PosP			Proportional gain position controller.
SpeedP			Proportional gain speed controller.
SpeedI		ms	Integration time for speed controller.
SpeedD		ms	Differential gain for speed controller
SpeedFFP		%	Feed forward for speed controller.
PosDelay		ms	Delay for position controller.
Read PID from Setup			Copy all closed loop parameter from setup.

Not all parameters may be available for position, load and extension closed loop controller, depending on the EDC setup.

4.4.6 PC Command interface (DoSA)

Each command follows the same syntax:

XXXX;Y;ZZZZ;D

XXXX	Command number like 500 (EXT_CMD_PARA_P0) for P0.
Y	0 = write parameter, 1 = read parameter
ZZZZ	Parameter value like 100.0 for P0 or parameter selection (see tables below).
D	Parameter unit (see tables below)

Example:	301;0;1;0	Set Controller Mode for P1 to Load
	401;0;0.1234;0	Set Speed to P1 to 0.1234 N/s
	501;0;555.5;0	Set P1 to 555.5 N

Example:	301;1;0;0	Read Controller Mode for P1
	401;1;0;0	Read Speed to P1
	501;1;0;0	Read P1

Table 27: Creep PC command interface units

Unit	0	1	2	3	4	5	6
Position	mm	µm					
Load	N	kN	MN				
Extension	mm	µm					
Temperature	°C						
Position Speed	mm/min	µm/min	mm/s	µm/s	mm/h	µm/h	m/s
Load Speed	N/s	kN/s	MN/s				
Extension Speed	mm/min	µm/min	mm/s	µm/s	mm/h	µm/h	m/s
Temperature Ramp	°C/s	°C/min	°C/h				

Table 28: Creep PC command interface parameters

Parameter	0	1	2	3	4	5	6 … 15	255
Sensor	Position	Load	Extens.	Digipoti	Sensor4	Sensor5	Sensor6 … Sensor15	Not active
Halt Time	s	min						
ReturnAct EndAct LimitAct	S-Halt	Return LE	ReturnP0	F-Halt	E-Halt	Drive Off		
ModeT	Test Time	Remaining Time						
EMode	above	below	DeltaMax	Rate				
I/O-Control	Off	Output	Out/Input					
OutBit	Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6 … 7	
InBit	Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6 … 7	
OutPol InPol	ActiveLow	ActiveHigh						
Xmit Channel	Total Time	Test Time	Position	Load	Extension	Digipoti	Sensor4 … Sensor15	Not active

5 Error handling and maintenance

5.1 General Errors

- Errors during the initialisation and the operation of the EDC will be shown as system message on the RMCi1/RMCi8 display. The display shows the first occurred error only.
- With the system message number, you can find further information on error causes and error clearing in the EDCi Installation Manual.

5.2 Maintenance

The EDC is maintenance-free. If cleaning becomes necessary, use a soft moist (not wet! Just clear water) towel for cleaning.

Attention! Wait for the EDC and the componentry to be dry again before switching it on (at least 10 min to be sure).

6 Versions

Version	Changes	Date	Name
1.0	First version for EDCi.	2017-10-12	PET
1.1	• System messages updated. • Creep parameters updated. • RMCi screen saver added.	2018-01-19	PET
1.2	• EDCi20/22/70/72 added. • Safety chapter updated.	2018-07-27	MOR/PET
1.3	• Creep DoSA units updated. • New DOLI logo.	2018-09-20	PET
1.4	• Chapter System messages moved to EDCi Installation Manual	2019-01-03	PET
1.5	• New DOLI address added. • RMCi Start/Halt/Continue function added. • RMCi8 added. • Creep extensometer readjustment added. • Creep re-calibration of analogue sensors added.	2019-07-24	PET
1.6	• EDCi technical overview removed. • RMCi8 picture added.	2019-10-17	PET
1.7	• Tension/Compression test added. • EDCi USB Stick added.	2020-06-24	PET
1.8	• Chapter 1. Safety updated.	2021-06-17	PET