Operating Instructions

DULCOMETER® D1C

Part 2: Adjustment and Operation,
Measured variable chlorine dioxide

D1C2-ClO2-001-GB

type D

type W

D1C A ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

Please enter the identity code of your device here!

Please completely read through operating instructions! · Do not discard!
The warranty shall be invalidated by damage caused by operating errors!

1 Device Identification / Identity Code

D1C A	DULCOMETER® Controller Series D1C / Version A
	Type of mounting
D	Control panel installation 96 x 96 mm
W	Wall mounting
	Operating voltage
0	230 V 50/60 Hz
1	115 V 50/60 Hz
2	200 V 50/60 Hz (only with control panel installation)
3	100 V 50/60 Hz (only with control panel installation)
4	24 V AC/DC
	Measured variable
D	Chlorine dioxide (0...0.5 ppm; 0...2 ppm; 0...10 ppm; 0...20 ppm)
	Connection of measured variable
1	Terminal, standard signal 0/4-20 mA
	Correction variable
0	None
2	Temperature (Pt 100) terminal for connection with sensor type CDP
3	Temperature standard signal 0/4-20 mA in connection with sensor type CDP
4	Automatic
	Feed forward control
0	None
1	As standard signal 0/4-20 mA
2	As frequency 0-500 Hz
3	As frequency 0-10 Hz
	Control input
0	None
1	Pause
	Signal output
0	None
1	standard signal 0/4-20 mA measured value
2	standard signal 0/4-20 mA control variable
3	standard signal 0/4-20 mA correction variable
4	2 standard signal outputs 0/4-20 mA, free programmable
	Power control
G	Alarm and 2 limit value relays
M	Alarm and 2 solenoid valve relays
R	Alarm relay and servomotor with feedback
	Pump control
0	None
2	Two pumps
	Control characteristic
0	None
1	Proportional control
2	PID control
	Log output
0	None
	Language
D	German
E	English
F	French
I	Italian
N	Dutch
S	Spanish
P	Polish
A	Swedish
B	Portuguese
G	Czech
H	Hungarian

D1C A	_ _ _ _ _ _ _ _ _ _ _ _ _

Please enter the identity code of your device here!

2 General User Information

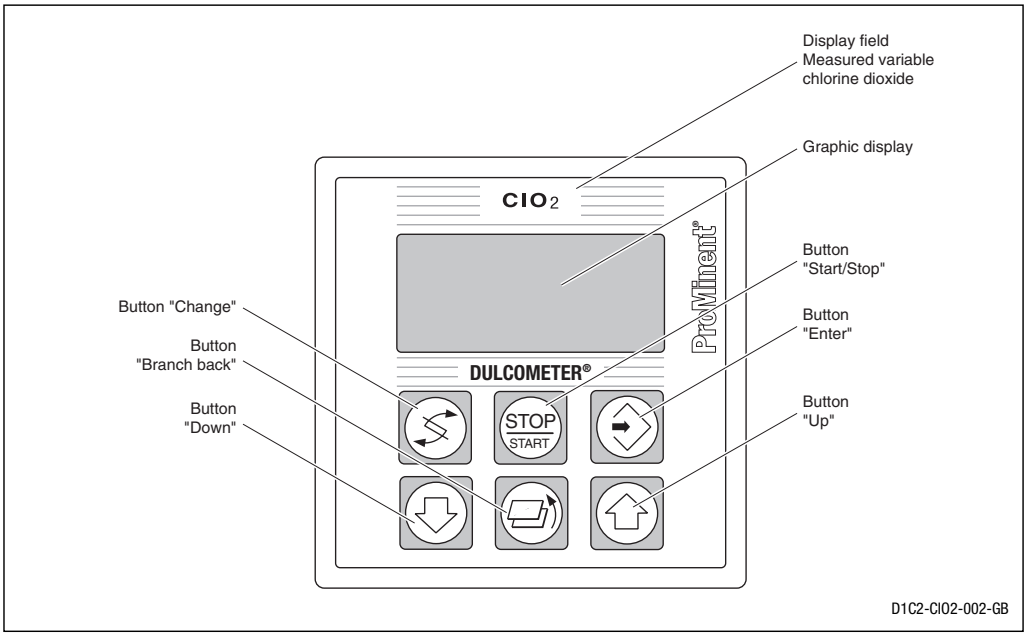
General User Information

These operating instructions describe the technical data and function of the series DULCOMETER® D1C controller, provide detailed safety information and are divided into clear steps.

IMPORTANT

- ***Please observe the parts of these operating instructions applicable to your particular version! This is indicated in the Section "Device Identification / Identity Code"!***
- ***Correct measuring and dosing is only possible in the case of impeccable operation of the probe. The probe has to be calibrated / checked regularly!***

3 Device Overview / Controls



	CHANGE Button To change over within a menu level and to change from one variable to another within a menu point.
	START/STOP Button Start/stop of control and metering function.
	ENTER Button To accept, confirm or save a displayed value or status. For alarm acknowledgement.

	UP Button To increase a displayed numerical value and to change variables (flashing display).
	BRANCH BACK Button Back to permanent display or to start of relevant setting menu.
	DOWN Button To decrease a displayed numerical value and to change variables (flashing display).

4 Functional Description

NOTE

Please refer to the description of the complete operating menu in Section 8 for a detailed description of the individual characteristics of the DULCOMETER® D1C controller!

4.1 Operating Menu

The D1C controller permits settings to be made in two different menus. All values are preset and can be changed in the **complete operating menu**.

The controller is delivered with a **restricted operating menu** so that the D1C controller can be used effectively in many applications from the very onset. If adaptations prove to be necessary, all relevant parameters can then be accessed by switching over to the complete operating menu (see “General Settings”).

4.2 Access Code

Access to the setting menu can be prevented by setting up an access code. The D1C controller is supplied with the access code 5000 which permits free access to the setting menu. The calibration menu remains freely accessible even when access to the setting menu is blocked by the code.

4.3 Control

The D1C can operate as a proportional controller or as a PID controller - dependent on the device version (see identity code) and the setting.

The controlled variable is recalculated once a second. Control procedures which require rapid correction of setpoint deviations (less than approx. 30 seconds) cannot be processed with this controller. The cycle times must be taken into consideration when activating solenoid valves (pulse length) in the same way as their running times when activating servomotors (3-point).

Via the control input pause, the control function (selection of controlled variable) can be switched off. The calculation of the controlled variable starts again after cessation of "pause".

4.4 Feed Forward Control

The D1C controller can process a signal of a feed forward control. Depending on the device version (see identity code) and the setting, this signal can be obtained in any form of a 0–20 mA or 4–20 mA signal or as a digital contact signal with the maximum frequencies 10 Hz or 500 Hz.

During start-up, the zero point has to be checked. The multiplicative feed forward control is not designed for switching off permanently the actuating variable (signal ≈ 0).

This signal can be used, for example, for flow-proportional metering (multiplicative effect) or feed forward-dependent basic load metering (additive effect). The result of control variable calculation from the proportional or PID control is multiplied by or added to the feed forward signal. A multiplicative feed forward variable at the level of the set rated value carries over the calculated control variable unchanged into the controlled variable:

Controlled variable = Feed forward variable/rated value x calculated control variable

An additive feed forward variable at the level of the rated value results in maximum controlled variable:

Controlled variable (max. 100 %) = (Feed forward variable/rated value x max. controlled variable) + calculated control variable

4.5 Error Messages

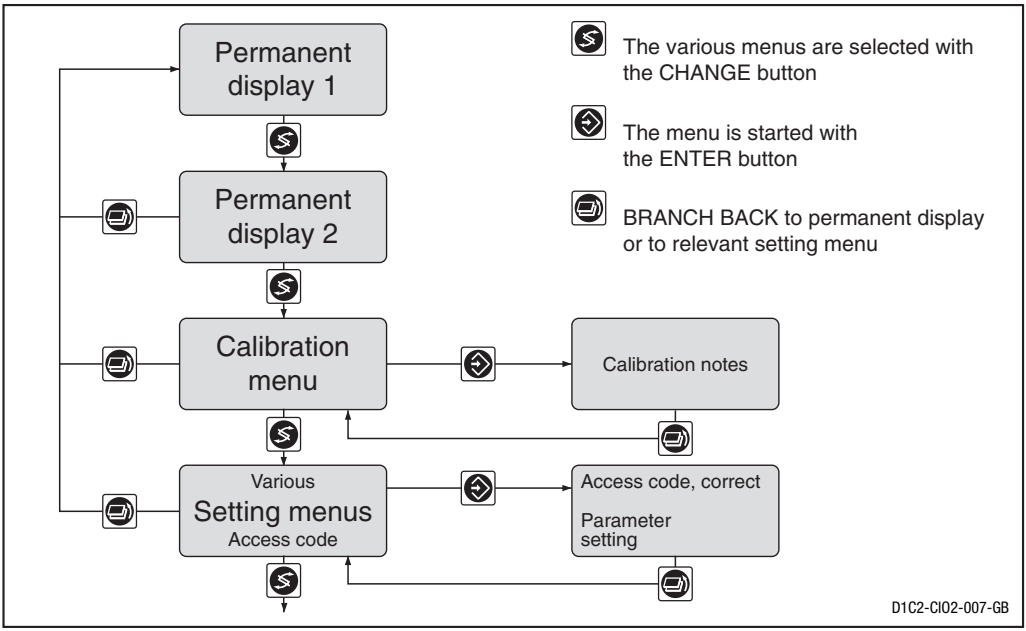
Error messages and information are indicated on the bottom line in the permanent display 1. Errors to be acknowledged (acknowledgement switches off the alarm relay) are indicated by the "Ɛ". Errors/notes which still apply after acknowledgement are indicated alternately. During correction variable processing (temperature for correction of pH-value), the value is indicated in the same line as the error/note. Faults which are rectified of their own accord due to changed operating situations are removed from the permanent display without the need for acknowledgement.

5 Display Symbols

The display of the DULCOMETER® D1C controller uses the following symbols:

Description	Comment	Symbol
Limit value transgression Relay 1, upper	Symbol left	
Relay 1, lower	Symbol left	
Relay 2, upper	Symbol right	
Relay 2, lower	Symbol right	
Metering pump 1 (chlorine dioxide) Control OFF	Symbol left	
Control ON	Symbol left	
Metering pump 2 (De-ClO_2) Control OFF	Symbol right	
Controll ON	Symbol right	
Solenoid valve 1 (chlorine dioxide) Controll OFF	Symbol left	
Controll ON	Symbol left	
Solenoid valve 2 (De-ClO_2) Controll OFF	Symbol right	
Control ON	Symbol right	
Servomotor Control, open relay		
Control, close relay		
Without control		
Position feedback	Thickness of bar increases from left to right during opening	
Stop button pressed		
Manual metering		
Fault		

6 Operation



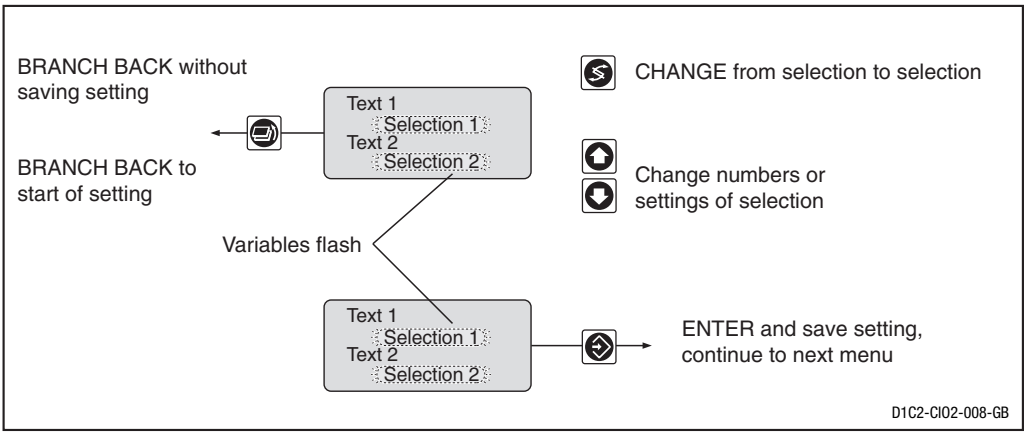
NOTE

Access to the setting menus can be barred with the access code!

The number and scope of setting menus is dependent on the device version!

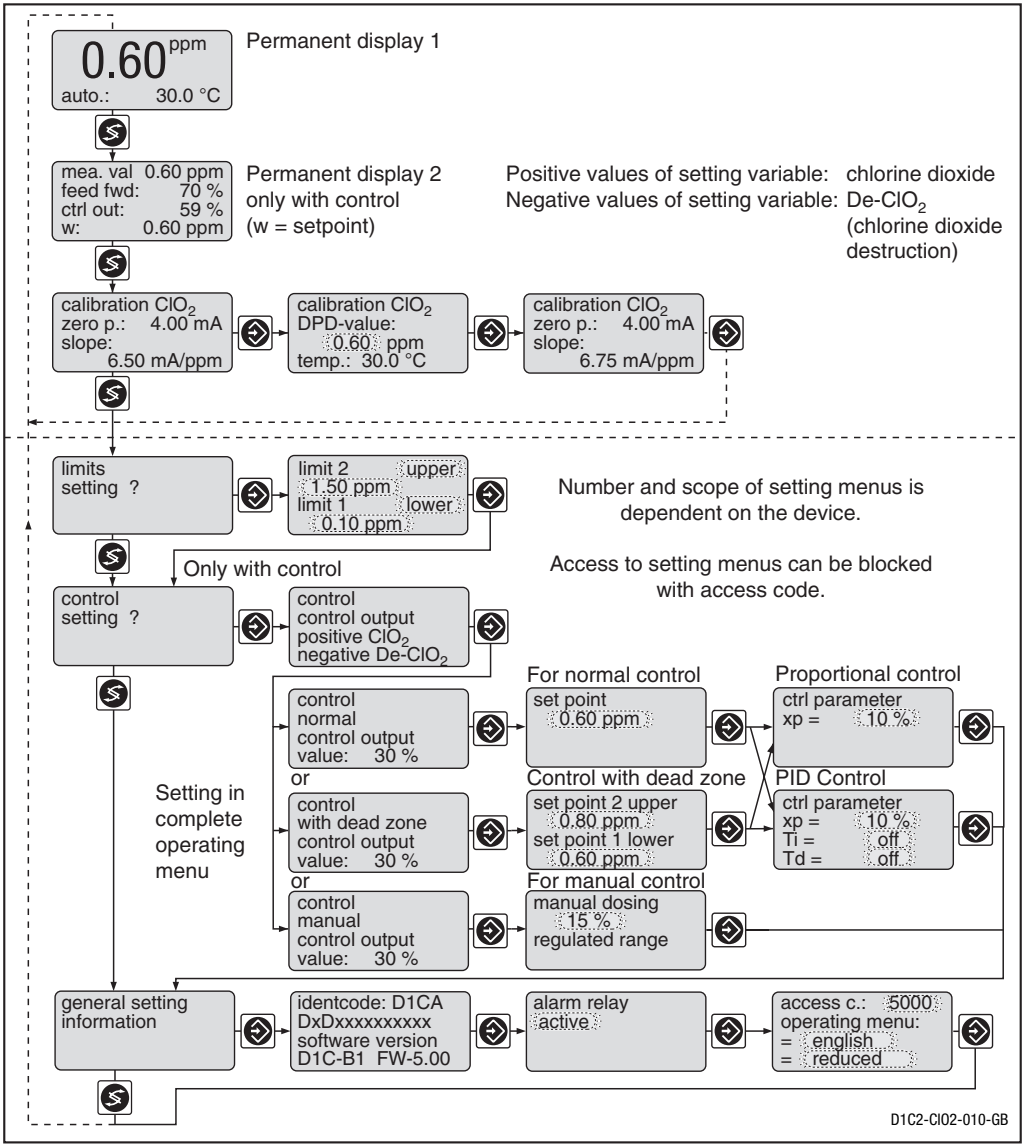
If the access code is selected correctly in a setting menu, then the following setting menus are also accessible!

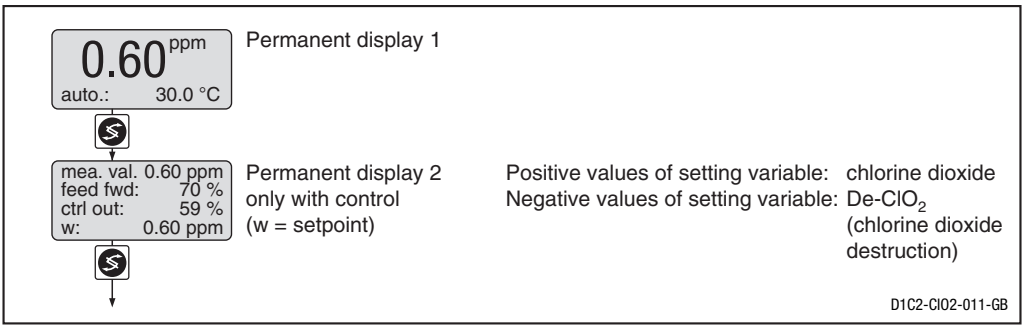
If within a period of 10 minutes no button is pushed, the unit automatically branches back from the calibrating menu or a setting menu to the permanent display 1.



7 Restricted Operating Menu / Layout

The restricted operating menu permits simple operation of the most important parameters. The following overview shows the settings which can be selected:



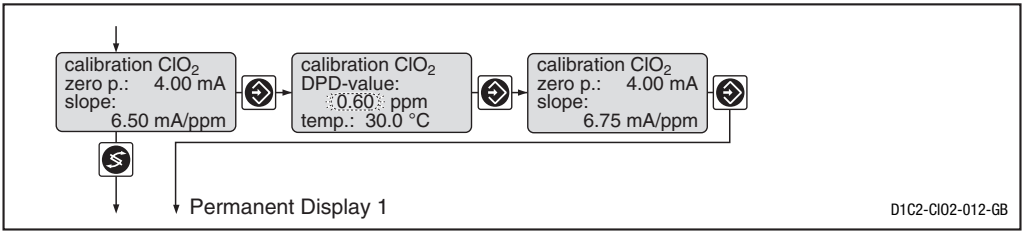


Calibration the Chlorine dioxide Probe

During calibration, the control function persists. The standard signal of the output (measured value) remains unchanged. The measured value registered during the start of the calibration is proposed as the DPD value; this value is adjustable (arrow keys!). Calibration is only possible if the DPD value is ≥2 % of the measuring range. On successful completion of calibration, all error checks which refer to the measured value are restarted.

ATTENTION

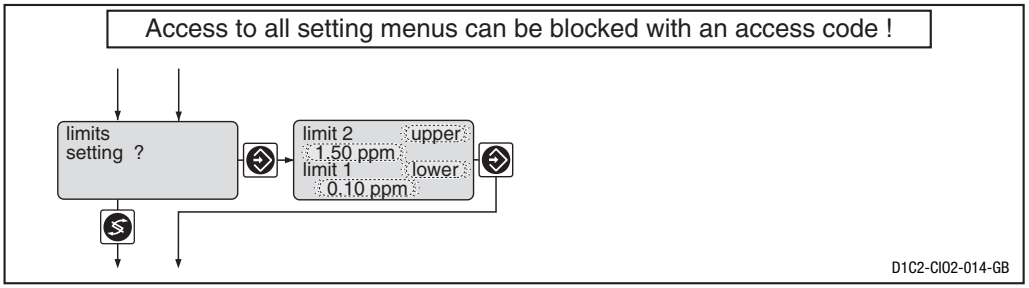
The measuring range of the probe must agree with the set measuring range (factory setting: 0–2 ppm). The measuring range must be reset prior to calibration (refer to page 15).



	Initial value	Possible values Increment	Lower value	Upper value
	Measured value	0.01 ppm	0 ppm	20 ppm

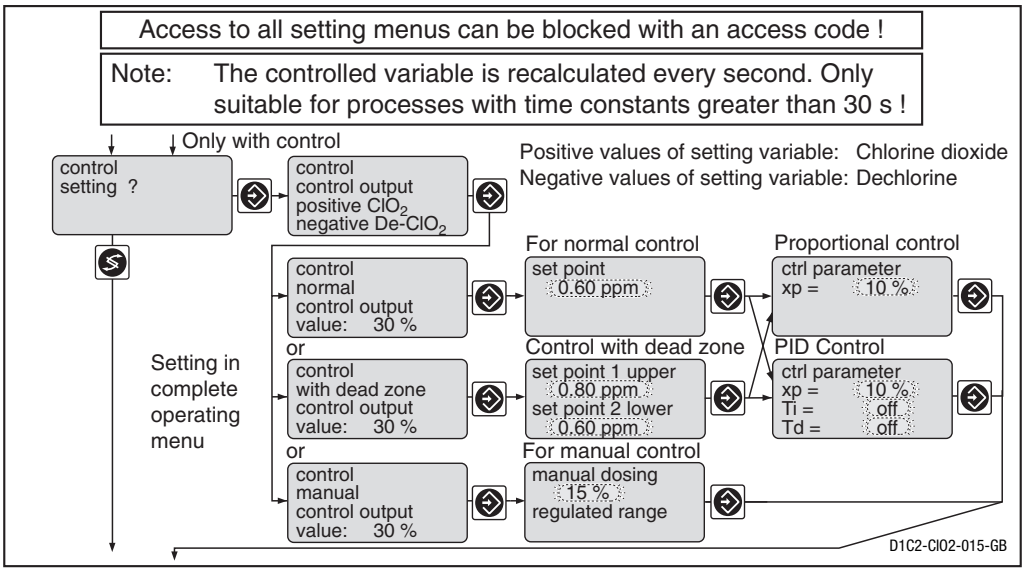
Error message	Condition	Effect
Calibration ClO_2 not possible! Probe slope too low	ClO_2 slope too low (<25 % of norm slope)	Calibrate again
Calibration ClO_2 not possible! Probe slope too high	ClO_2 slope too high (>300 % of norm slope)	Calibrate again
DPD value too low DPD > x.xx ppm	DPD <2 % measuring range	Calibrate again after adding chorine dioxide

Limits



		Initial value	Possible values: Increment	Lower value	Upper value	Remarks
Type of limit transgression	Limit 1:	lower	upper lower			Limit transgression when exceeding or dropping below value *) only with limit relays
	Limit 2:	upper	off *)			
Limit value	Limit 1:	0.1 ppm	0.01 ppm	0.00 ppm	20.00 ppm	
	Limit 2:	1.5 ppm	0.01 ppm	0.00 ppm	20.00 ppm	

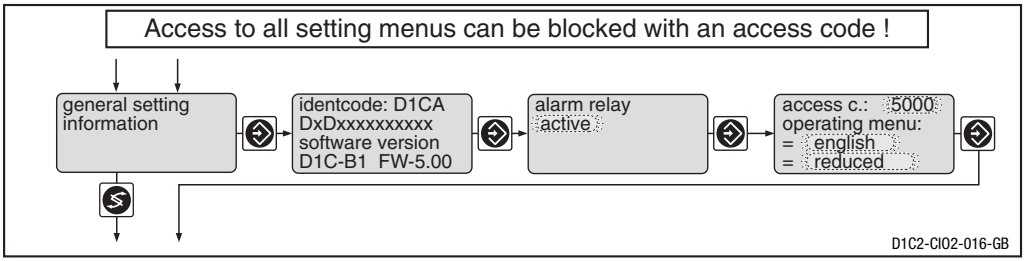
Control



Restricted Operating Menu / Description

	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Setpoint	0.60 ppm	0.01 ppm	lower limit measuring range	upper limit measuring range	2 setpoints necessary for control with dead zone. Setpoint 1 > setpoint 2
Control parameter xp	10 %	1 %	1 %	500 %	xp referred to measuring range
Control parameter Ti	off	1 s	1 s	9999 s	Function off = 0 s
Control parameter Td	off	1 s	1 s	2500 s	Function off = 0 s
Manual metering	0 %	1 %	-100 %	+100 %	

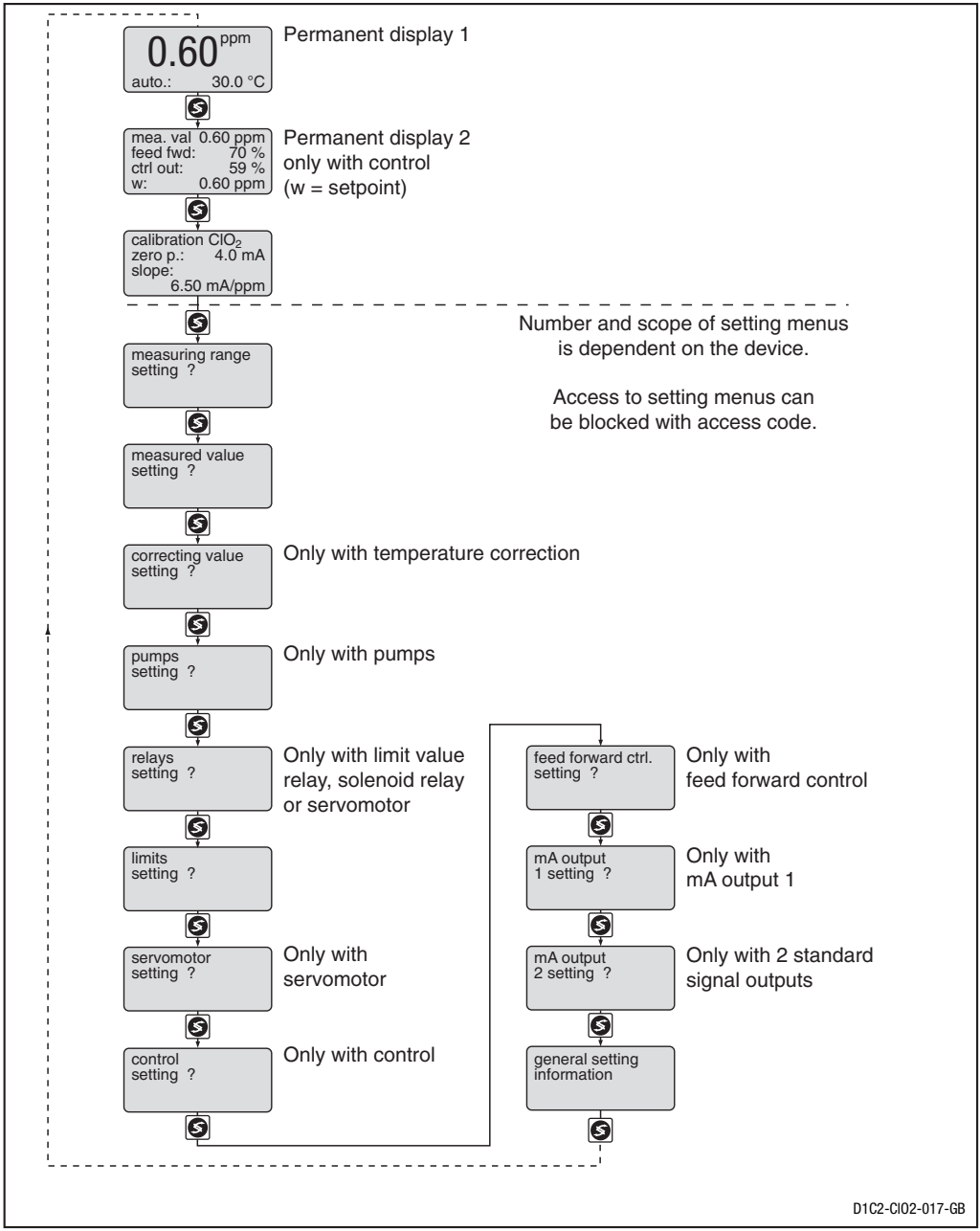
General Settings

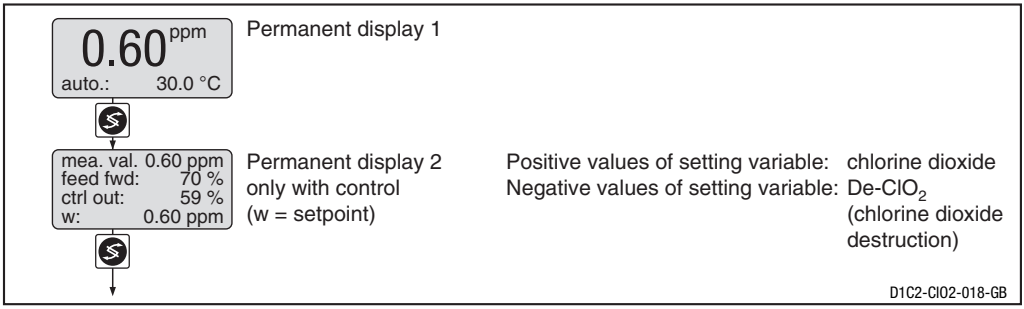


	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Alarm relay	active	active not active			
Access code	5000	1	1	9999	
Language	as per identity code	German English French Italian Dutch Spanish Polish Swedish Portuguese Czech Hungarian (as per identity code)			
Operating menu	restricted	restricted complete			

8 Complete Operating Menu / Overview

All parameters of the controller can be set in the complete operating menu (access see previous page). The following overview shows the settings which can be selected:





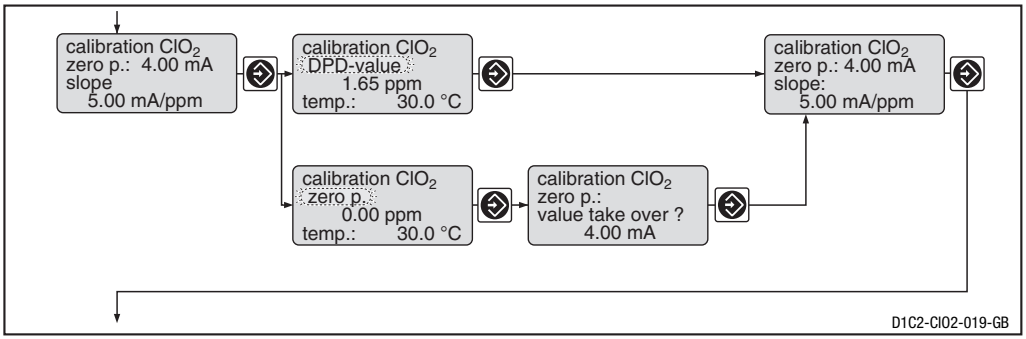
Calibration the chlorine dioxid probe (zero point and slope)

The control function is retained during the calibration procedure. The standard signal of the output (measured value) is not changed. The measured value frozen at the start of calibration is offered as the DPD value; this value is adjustable (arrow keys!). Calibration is only possible when the DPD value is ≥2 % of the measurement range. Once calibration has been successfully completed, all fault tracing procedures which refer to the measured value are restarted.

Zero point calibration must be carried out under real conditions in water free of chlorine dioxide. Calibration is normally only necessary for the measuring range 0 – 0.5 ppm when measuring at the lower limit of the measuring range.

ATTENTION

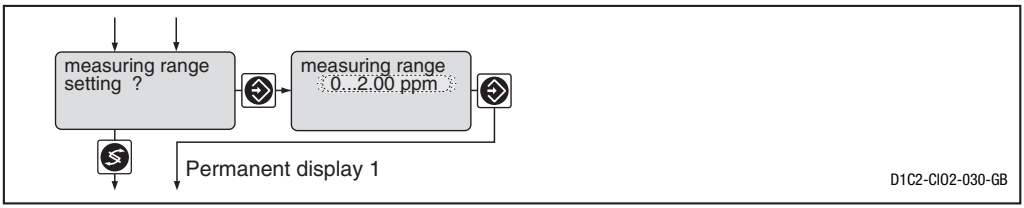
The measuring range of the probe must agree with the set measuring range (factory setting: 0–2 ppm). The measuring range must be reset prior to calibration (refer to page 15).



		Possible values		
	Initial value	Increment	Lower value	Upper value
	Measured value	0.01 ppm	0 ppm	20 ppm

Error message	Condition	Effect
Calibration ClO_2 not possible! Probe slope too low	ClO_2 slope too low (<25 % of norm slope)	Calibrate again
Calibration ClO_2 not possible! Probe slope too high	ClO_2 slope too high (>300 % of norm slope)	Calibrate again
DPD value too low DPD > x.xx ppm	DPD <2 % measuring range	Calibrate again after adding chorine dioxide
Zero point too low Zero point too high	< 3 mA > 5 mA	Check probe/cable Repeat calibration in chlorine-free water

Measuring Range

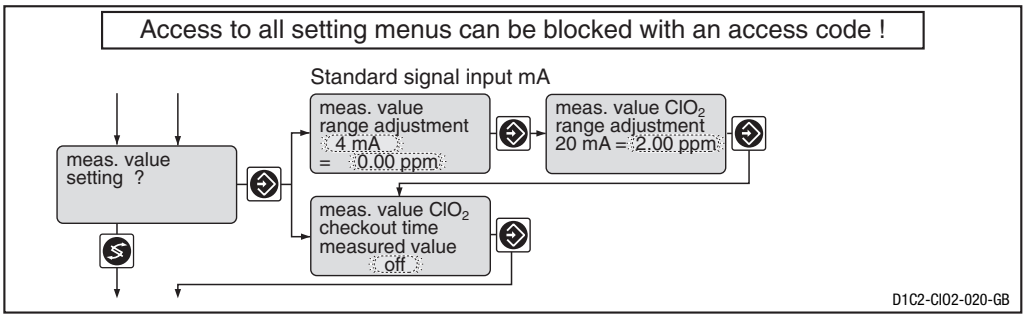


	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Measured range	0...2 ppm	0...0.5 ppm 0...2 ppm 0...10 ppm 0...20 ppm			

ATTENTION

If the area allocation is changed, the chlorine-dioxide must be re-calibrated and all the menu settings must be checked!

Measured Value

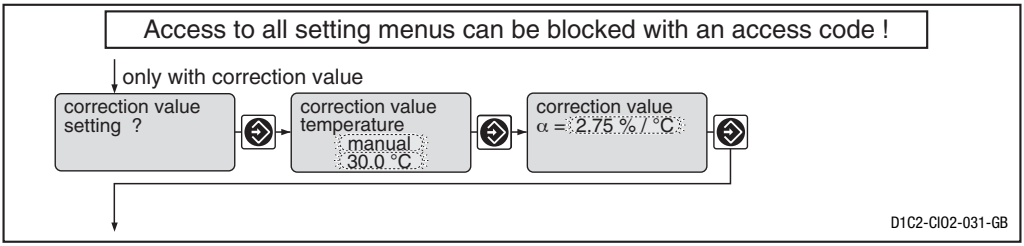


ATTENTION

If the area allocation is changed, the chlorine-dioxide must be re-calibrated and all the menu settings must be checked!

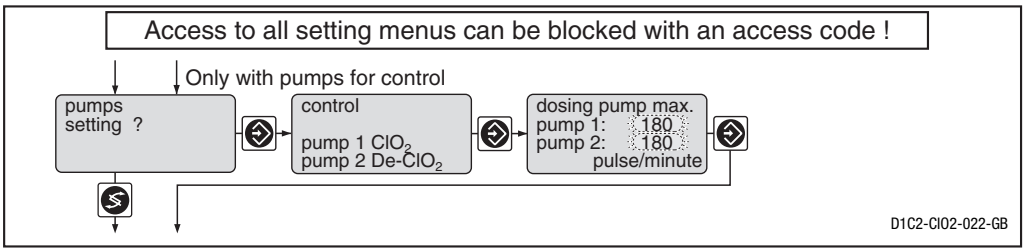
	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Standard signal input lower signal limit	4 mA	0 mA 4 mA			
Allocated measured value lower	0 ppm				
upper	2 ppm	0.01 ppm	0.00 ppm	20.00 ppm	
Checkout time	off	1 s	1 s	9999 s	Constant measurement signal results in message and alarm. Function off = 0 s

Correction value



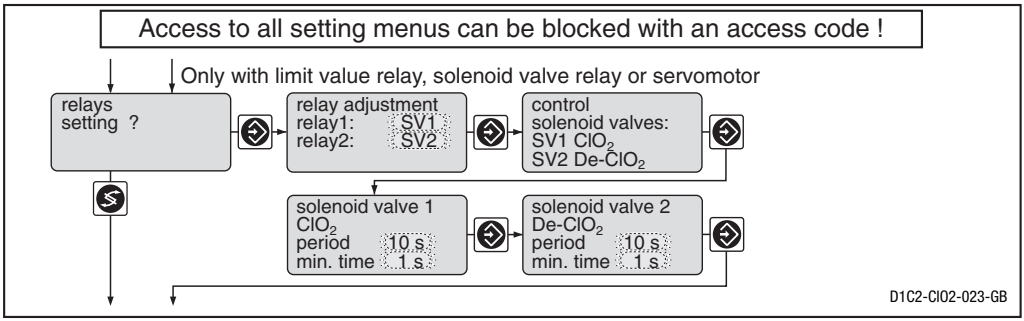
	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Type of temperature compensation	as per identity code	manual automatic off			Switching only when identity code shows = automatic
Manual temperature compensation	25 °C	0.1 °C	0 °C	100 °C	
Correction value α	2.75 %/°C	0.01 %/°C	0.00 %/°C	10.00 %/°C	

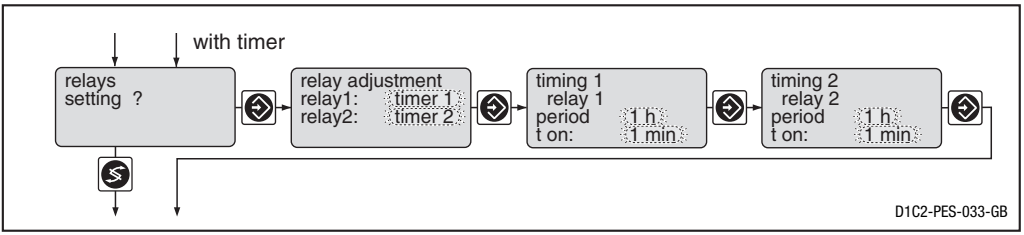
Pumps



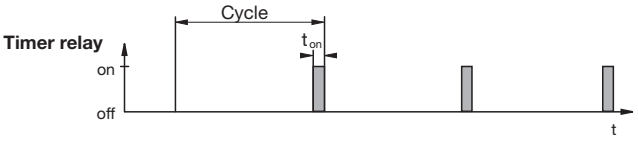
	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Max. stroke/minute of pumps 1 and 2	180	1	1	500	off = 0 strokes/min

Relay for power activation





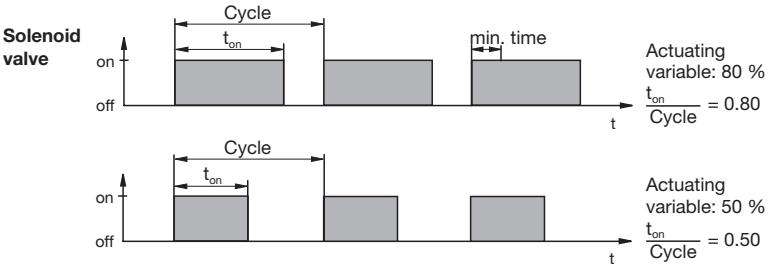
	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Relay adjustment	as per identity code				
Relay 1		Solenoid valve 1 Limit value 1* Actuator 1 Timer 1 Motor off			*For “limit value”, the relays remain active, even in the event of a fault.
Relay 2		Solenoid valve 2 Limit value 2* Actuator 2 Timer 2 off			
Cycle	10 s	1 s	10 s	9999 s	for solenoid valve
min. time	1 s	1 s	1 s	Cycle/2	for solenoid valve
Period (Cycle)	off	1 h	1 h / off	240 h	for timer
t on	1 min	1 min	1 min	60 min	for timer



IMPORTANT

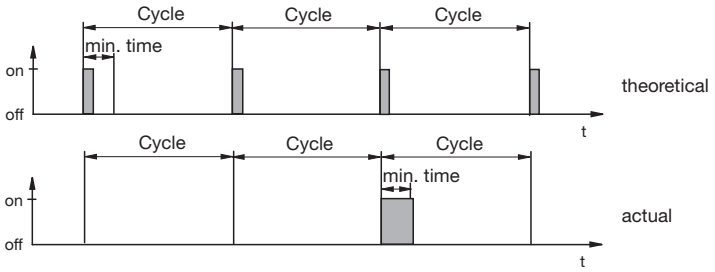
The timer will reset in the event of a power failure.

At the end of the (timer) cycle time the DULCOMETER® D1C closes the assigned relay for the duration of "t on" (timer). "Pause" interrupts the timer.
When the clock is shown in the LC display the timer can be reset to the start of the cycle at precisely this point using the enter button.
The % figure in the LC display indicates the progress of the current cycle.
Timer relays may be used, e.g. for shock metering or sensor cleaning.



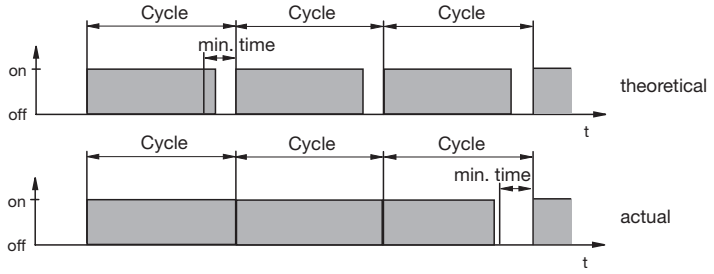
The switching time of the DULCOMETER® D1C (solenoid valve) depend on the actuating variable and the "min. time" (smallest permitted operating factor of the connected device).
The actuating variable determines the ratio t_{on}/cycle and thus the switching times (see fig. above).
The "min. time" influences the switching times in two situations:

a) theoretical switching time < min. time:



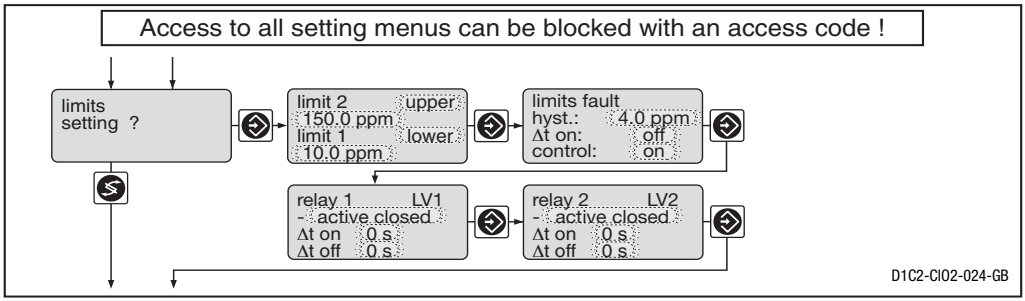
The DULCOMETER® D1C does not switch for a certain number of cycles until the sum of the theoretical switching times exceeds the "min. time". Then the DULCOMETER® D1C switches for the duration of this total time.

b) theoretical switching time > (cycle - min. time) and calculated switching time < cycle



The DULCOMETER® D1C does not deactivate for a certain number of cycles until the differences between cycle and theoretical switching time exceed the “min. time”.

Limit values



	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Type of limit transgression		upper			Limit transgression when exceeding or dropping below value
Limit 1:	lower	lower			
Limit 2:	upper	off *)			*) only with limit relay
Limit value Limit 1:	0.1 ppm	0.01 ppm	0.00 ppm	20.00 ppm	
Limit 2:	1.5 ppm	0.01 ppm	0.00 ppm	20.00 ppm	
Hysteresis limits	0.04 ppm	0.01 ppm	0.02 ppm	20.00 ppm	Effective in direction of cancelling limit transgression
Checkout time limits Δt on	off	1 s	1 s	9999 s	Results in message and alarm. off = 0 s: Function switched off, no message, no alarm
Control	on	on off			

	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Switching direction Limit value 1; Limit value 2	active closed	active closed active open			Acts as N/O Acts as N/C
Switch-on delay Δt on Switch-off delay Δt off	0 s 0 s	1 s 1 s	0 s 0 s	9999 s 9999 s	

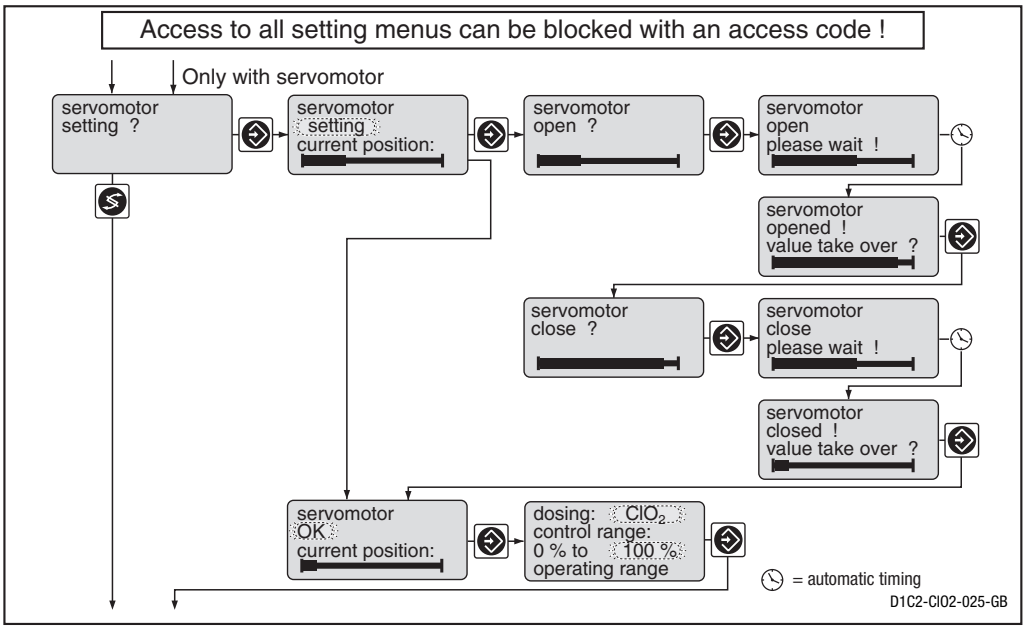
If the limit is exceeded for longer than the “Delay time - limit values” an error message is given, which must be acknowledged, and the alarm relay circuit is broken. If “Controller” is also set to “off” the control process stops.

Servomotor

The operating range is defined by the total resistance range of the feedback potentiometer. The maximum limit of the range actually used is set by defining the control range.

CAUTION

- ***Activation of the servomotor must be carried out with the same meticulous care as taken when calibrating a measuring probe.***
- ***To ensure correct operation, the activation time of the actuator used should not be less than 25 seconds for the control range from 0...100 %!***

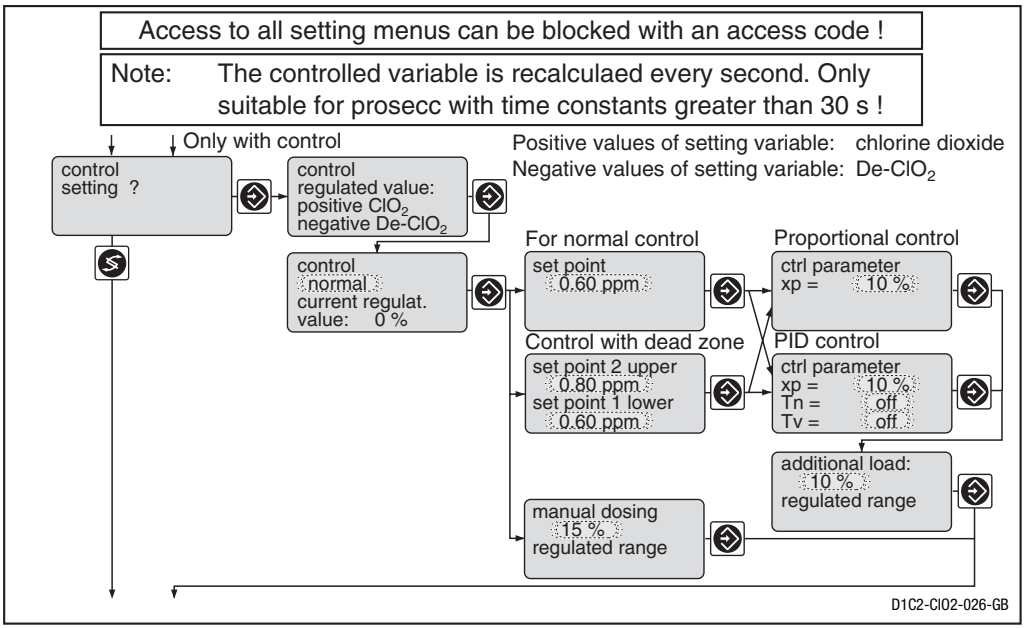


	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Servomotor	Setting	Setting ok off			
Control direction	ClO_2	ClO_2 De-ClO_2			
Control range	100 %	1 %	10 %	100 %	in % of operating range

NOTE

- ***If the broad bar is to the far right, the stroke adjustment motor is fully open.***
- ***The continuous display shows the degree (in %) to which it is open (the greater the percentage, the more open the stroke adjustment motor).***

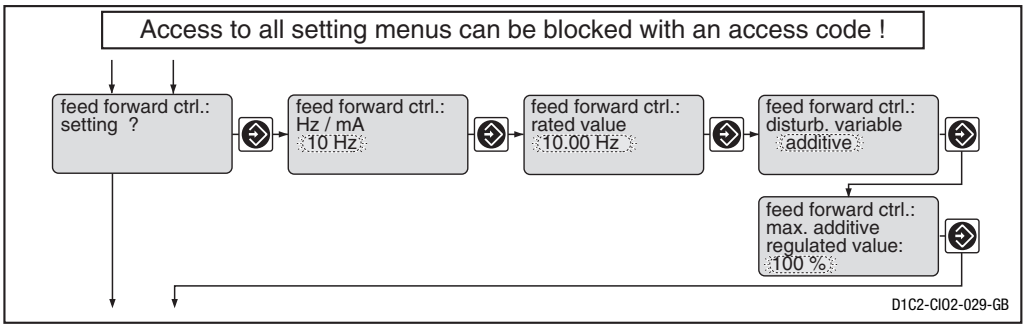
Control



	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Control	normal	normal with dead zone manual			When controlling with dead zone, the feed forward control is not used for measured values within the dead zone.
Setpoint	0.60 ppm	0.01 ppm	Lower measuring range	Upper measuring range	2 setpoints necessary for control with dead zone. setpoint 1 > setpoint 2
Control parameter xp	10 %	1 %	1 %	500 %	xp referred to measuring range
Control parameter Ti	off	1 s	1 s	9999 s	Function off = 0 s
Control parameter Td	off	1 s	1 s	2500 s	Function off = 0 s
Additional load	0 %	1 %	-100 %	+100 %	
Manual metering	0 %	1 %	-100 %	+100 %	

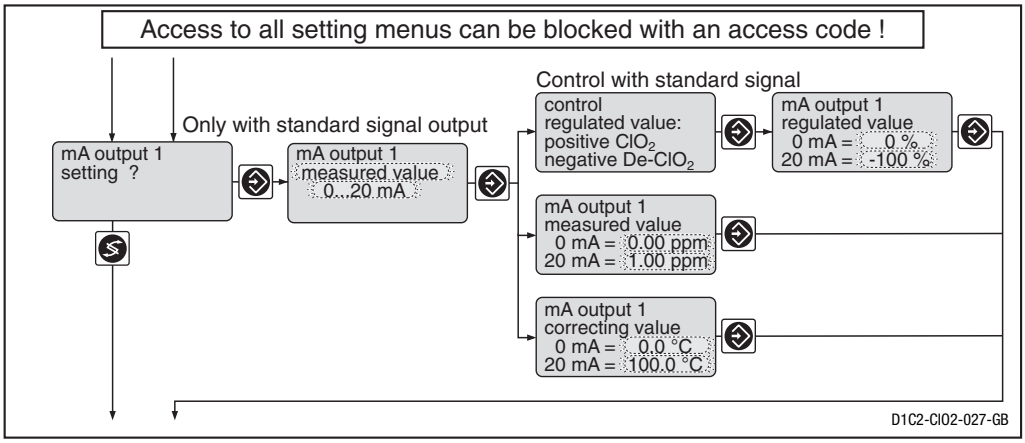
Abbreviations for control variables:
x_p = 100 %/K_p (inverse proportional co-efficient)
T_i = I controller integration time [s]
T_d = D controller differential time [s]

Feed forward control

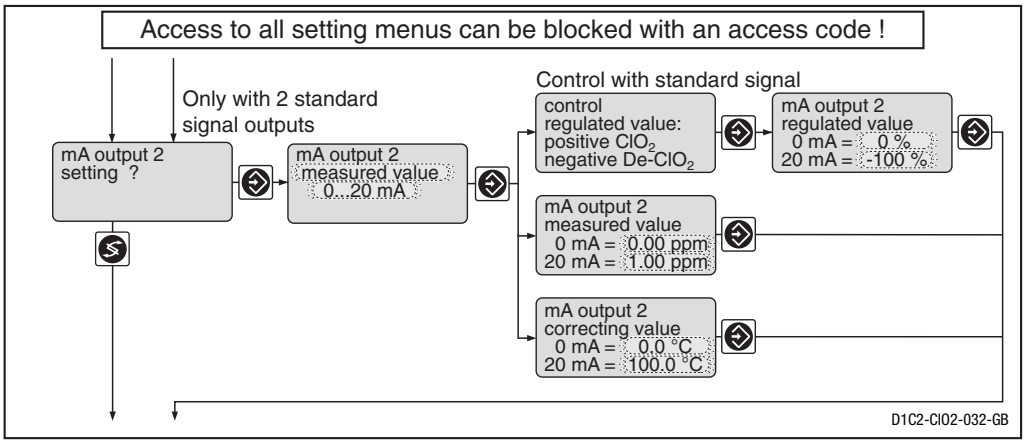


	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Feed forward control (Flow)	as per identity code Standard signal 4–20 mA	None 10 Hz 500 Hz 0…20 mA 4…20 mA			Signal processing: Signal <0.02 Hz = No flow Signal <0.2 Hz = No flow Signal <0.2 mA = No flow Signal <4.2 mA = No flow
Feed forward control rated value	10 Hz 500 Hz 20 mA	0.01 Hz 1 Hz 0.1 mA	0.1 Hz 1 Hz 0/4 mA	10 Hz 500 Hz 20 mA	Depended on signal type. Maximum limitation of range used.
Feed forward control effect	multiplicative	multiplicative additive			
Max. add. regulated value	100 %	1 %	-500 %	+500 %	only with add. feed forward control

Standard Signal Output 1



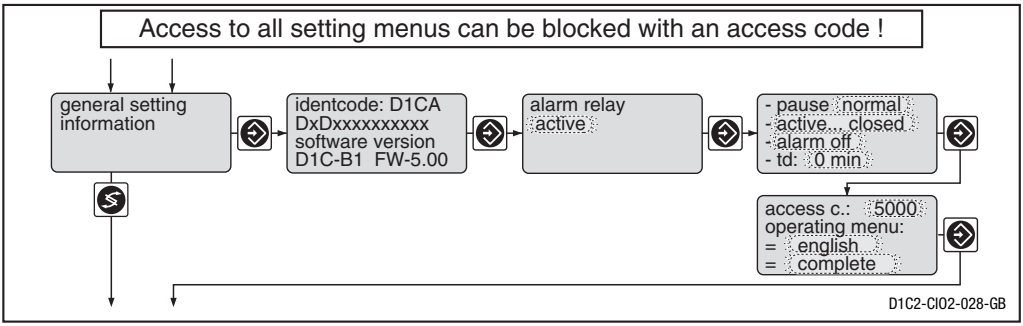
Standard Signal Output 2



	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Variable allocation	as per identity code	Measured value Controlled variable Correction value			If control is present, only with adjustment variable
Output range	0…20 mA	0…20 mA 4…20 mA			
Range measured value	0…1 ppm	0.01 ppm	0 ppm	20 ppm	Minimum range 0.1 ppm
Range controlled variable	-100 %...0 %	1 %	-100 %	+100 %	Minimum range 1 %
Range correction value	0...100 °C	0.1 °C	0 °C	100 °C	Minimum range 1 °C

Complete Operating Menu / Description

General setting



	Initial value	Possible values Increment	Lower value	Upper value	Remarks
Alarm relay	active	active not active			
Pause	normal	normal Hold			
Control input pause	active closed	active closed active open			
Pause alarm	alarm off	alarm off alarm on			Alarm relay can be triggered by pause contact.
td	0 min	1 min	0 min	60 min	
Access code	5000	1	1	9999	
Language	as per identity code	German English French Italian Dutch Spanish Polish Swedish Portuguese Czech Hungarian (as per identity code)			
Operating menu	complete	restricted complete			

Pause Normal

If the pause-switch is off, the DULCOMETER® D1C sets the operating outputs to “0” for as long as the pause-switch is off or for a set time-delay t_d (if t_d is set to > 0 min). Whilst the pause-switch is off, the D1C establishes the P-proportion in the background.
With PID-control (Identity code characteristics “control characteristic” = 2): the I-proportion is stored when the pause is switched off (I-proportion then usually only present if Tn > 0 has been selected in the “Control setting?” setting menu).
Exception: the standard signal outputs mA for the measured value or correction value are not affected by the pause.
After pause is activated the operating outputs remain at “0” for the length of the time-delay t_d. The time-delay t_d must be set up in such a way that, in this time e.g. sample water (process-specific current concentration) flows to the sensor.
With PID-control (Identity code characteristics “control characteristic” = 2): The control variable output resulting from the pause and the expiry of the time-delay t_d is reconciled jointly with the current P-component and (if Tn is set > 0) with the stored I-component.

Pause Hold

If the pause-switch is off, the DULCOMETER® D1C freezes the operating output at the most recent value for as long as the pause-switch is off or for a set time-delay t_d (if t_d is set to > 0 min). Whilst the pause-switch is off, the D1C establishes the P-proportion in the background.
With PID-control (Identity code characteristics “control characteristic” = 2):
Even the mA standard signal outputs for measured value or correction value are frozen.
After pause is activated the operating outputs remain frozen for the length of the time delay t_d. The time delay t_d must be set up in such a way that, in this time e.g. sample water (process-specific current concentration) flows to the sensor.
With PID-control (Identity code characteristics “control characteristic” = 2): The control variable output resulting from the pause and the expiry of the time-delay t_d is reconciled jointly with the current P-proportionand (if Tn is set > 0) with the newly established I-proportion.

Fault	Fault text	Symbol	Effect on metering	Effect on control	Alarm with acknowledgement	Remarks	Remedy
Measured value Checkout time measured value exceeded	Check ClO_2 probe	Ɛ	Basic load	Stop	Yes	Function defeatable	Check function of probe
Signal exceeded/drops below value	Check ClO_2 input	Ɛ	Basic load	Stop	Yes	Signal <3.8 ±0.2 mA or >23 ±0.2 mA	Check probe, transducer and cable connection
Calibration probe with error	Check ClO_2 calibration	Ɛ	Basic load	Stop	No	Metering continues in case of error with unsteady measured values	Check probe, replace if necessary, recalibrate if necessary
Adjustment measured variable Signal exceeds/ drops below value	Check Temp. input	Ɛ	Basic load	Stop	Yes	Pt100-signal >138.5 Ω signal <3.8 ±0.2 mA or >23 ±0.2 mA Last valid value is reused	Check probe, transducer and cable connection
Feed forward control Signal exceeded/ drops below value	Check feed forward input	Ɛ			Yes	Signal <3.0 ±0.2 mA or >23 ±0.2 mA Value last valid is used	Check probe, transducer and cable connection
Limit transgression after checkout time limit value	ClO_2 limit 1 ClO_2 limit 2	Ɛ			Yes	Function defeatable	Define cause, reset values if necessary
Servomotor Position not reached	Servomotor defective	Ɛ			Yes	Servomotor closes	Check servomotor
Electronics error	System error	Ɛ O	Stop	Stop	Yes	Elektronic data defective	Call in service

Operation	Note text	Symbol	Effect on metering	Effect on control	Alarm with acknowledgement	Remarks	Remedy
Pause contact	Pause	Ɛ O	Stop	Stop	No	No further fault check	–
	Pause/Hold	Ɛ		PI-part frozen			
Stop button	Stop	Ɛ O	Stop	Stop	No	Relay drops out	–
During calibration probe			Basic load	Stop	No	No error processing of measured variable	–
Probe slope too low Probe slope too high	Slope ClO_2 low Slope ClO_2 high	Ɛ	Basic load	Stop	No	25% > probe of slope > 300% norm slope	Check probe, replace if necessary
DPD-value <2 % measuring range	DPD too low						Recalibrate after adding ClO_2
Zero point	Zero point low Zero point high	Ɛ	Basic load	Stop	No	Signal < 3 mA Signal > 5 mA	Check probe/cable Repeat calibration in chlorine-free water
During servomotor setting Position feed back wrong Upper position <40 % max. value Lower position >30 % range	Direction check Final value small Final value big					Without correct adjustment the last valid values are still used	Check connection of relay, potentiometer Adjust the operation region of the servomotor correctly

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