

Wallace & Tiernan[®]

an eVOQUA brand

MFC ANALYZER / CONTROLLER

BOOK NO. WT.050.580.001.UA.IM.0814

W3T109633

MFC
ANALYZER / CONTROLLER

BOOK NO. WT.050.580.001.UA.IM.0814

MFC ANALYZER / CONTROLLER

EQUIPMENT SERIAL NO. _____

DATE OF START-UP _____

START-UP BY _____

Prompt service available from nationwide authorized service contractors.

ORDERING INFORMATION

In order for us to fill your order immediately and correctly, please order material by description and part number, as shown in this book. Also, please specify the serial number of the equipment on which the parts will be installed.

WARRANTY

Seller warrants for a period of one year after shipment that the equipment or material of its manufacture is free from defects in workmanship and materials. Corrosion or other decomposition by chemical action is specifically excluded as a defect covered hereunder, except this exclusion shall not apply to chlorination equipment. Seller does not warrant (a) damage caused by use of the items for purposes other than those for which they were designed, (b) damage caused by unauthorized attachments or modifications, (c) products subject to any abuse, misuse, negligence or accident, (d) products where parts not made, supplied, or approved by Seller are used and in the sole judgment of the Seller such use affects the products' performance, stability or reliability, and (e) products that have been altered or repaired in a manner in which, in the sole judgment of Seller, affects the products' performance, stability or reliability. **SELLER MAKES NO OTHER WARRANTY OF ANY KIND, AND THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS OF THE MATERIAL OR EQUIPMENT FOR ANY PARTICULAR PURPOSE EVEN IF THAT PURPOSE IS KNOWN TO SELLER.** If Buyer discovers a defect in material or workmanship, it must promptly notify Seller in writing; Seller reserves the right to require the return of such defective parts to Seller, transportation charges prepaid, to verify such defect before this warranty is applicable. In no event shall such notification be received by Seller later than 13 months after the date of shipment. No action for breach of warranty shall be brought more than 15 months after the date of shipment of the equipment or material.

LIMITATION OF BUYER'S REMEDIES. The **EXCLUSIVE REMEDY** for any breach of warranty is the replacement f.o.b. shipping point of the defective part or parts of the material or equipment. Any equipment or material repaired or replaced under warranty shall carry the balance of the original warranty period, or a minimum of three months. Seller shall not be liable for any liquidated, special, incidental or consequential damages, including without limitation, loss of profits, loss of savings or revenue, loss of use of the material or equipment or any associated material or equipment, the cost of substitute material or equipment, claims of third parties, damage to property, or goodwill, whether based upon breach of warranty, breach of contract, negligence, strict tort, or any other legal theory; provided, however, that such limitation shall not apply to claims for personal injury.

Statements and instructions set forth herein are based upon the best information and practices known to Evoqua Water Technologies, but it should not be assumed that every acceptable safety procedure is contained herein. Of necessity this company cannot guarantee that actions in accordance with such statements and instructions will result in the complete elimination of hazards and it assumes no liability for accidents that may occur.



725 Wooten Road
Colorado Springs, Co 80915

INTRODUCTION

The MFC analyzer/controller offers a broad combination of water analysis and disinfection/chemical control in a single unit.

The control function offers an easy, software selectable range of control modes; flow proportional, residual control only, compound loop, and set point trim enabling precise control of a gas feeder or metering pump to maintain the desired level of disinfection and water quality. Two independent control loops are available. There are 8 separate relays that can be assigned a number of functions, such as alarms or control outputs. There are also 4 separate mA output signals for measurement indication or control output.

Up to 4 water quality parameters, such as free and total chlorine, chlorine dioxide, ozone, fluoride, conductivity, redox, pH and temperature can be measured by single or multiple flow cells. A variety of flow cells are available, including the Depolox® 5, bare-electrode measuring cell for free chlorine, potassium permanganate, chlorine dioxide and ozone and the VariaSens™ flow block for utilizing internally buffered oxidant sensors. This flexibility provides for an almost limitless combination of continuous measurement technologies for the same sample or different samples from the entire treatment process.

The following water quality parameters can be measured by the MFC analyzer flow cells:

- Free Chlorine
- Total Chlorine
- Combined Chlorine (When free and total probes are used)
- Ozone
- Potassium Permanganate
- Conductivity
- Fluoride
- pH
- Chlorine Dioxide
- ORP (redox)
- Temperature
- Sulfur Dioxide (Deox/2000® Unit Only)
- Sodium Bisulfite (Deox/2000® Unit Only)

The Depolox® 5 flow cell, in addition to the integral bare-electrode sensor, can be fitted with 1 membrane-type sensor and/or up to 3 other additional sensors such as pH, fluoride, ORP, etc. The maximum number of sensors or measurands is 4 for each MFC electronic package. The VariaSens™ flow cell can accommodate 1 or 2 membrane-type sensors and/or up to 3 other additional sensors as noted above. The maximum number of sensors here is also limited to 4 for each MFC electronic package.

The electronic module can be upgraded in the field to accept additional measurement inputs, up to the maximum number of 4. Measurement packages consisting of a sensor that is mounted in the appropriate flow cell and a plug-in circuit module that is inserted into the electronic module are available. Utilizing “plug and play” technology allows the controller to automatically recognize the sensor and provide the correct display information.

The Micro/2000® system is designed to measure chlorine, chlorine dioxide, potassium permanganate, and ozone residual in water. The system consists of two sections: the “wet side” containing the electrochemical cell and the reagent feed system, and the MFC with a Micro/2000® input card. This equipment continuously analyzes a water sample stream, displaying the measured residual in mg/L; and provides various status indicating relay outputs. Setup procedures enable configuring for various requirements and self diagnostic features that aid in troubleshooting.

A Deox/2000® system is designed to measure chlorine and sulfur dioxide or sodium bisulfite residual in water. The system consists of two sections: the “wet side” containing the electrochemical cell and the reagent feed system, and the MFC with a Deox/2000® input card. This equipment continuously analyzes a water sample stream, displaying the measured residual in mg/L; outputs a zero-centered (12mA) 4-20mA output signal proportional to the measured residual signal; and provides various status indicating relay outputs. Setup procedures enable configuring for various requirements and self-diagnostic features aid in troubleshooting.

To facilitate operation in water prone to biological growth, a relay output is provided to control periodic “dosing” of the sample line with a cleaning agent (e.g., chlorine) to eliminate growth in the line.

Intended Use

The MFC (Multi Function Controller) is exclusively designed for measurement and control purposes for the treatment of potable water, waste water and industrial water.

The MFC may only be used in buildings and under the operating conditions described in this manual. The device is not designed for any application other than that described in this manual. Compliance with the intended use of this device also includes reading this operating manual and observance of all instructions which it contains, particularly the safety instructions. Furthermore, all inspection and maintenance work must be performed at the prescribed intervals. If the device is not employed in accordance with its intended use, safe and reliable operation cannot be guaranteed.

The operator is solely responsible for any personal injury or damage to property resulting from employment of the device which is contrary to its intended use. The operator is obligated to keep the device in proper working order.



WARNING: TO AVOID INJURY TO PERSONS CAUSED BY ELECTRICITY ONLY AUTHORIZED AND QUALIFIED ELECTRICIANS MAY INSTALL THE DEVICE AND OPEN THE HOUSING. THE DEVICE MAY ONLY BE OPERATED WHEN THE HOUSING IS CLOSED AND MUST BE CONNECTED TO THE PROTECTIVE CONDUCTOR. MODIFICATIONS TO THE DEVICE WHICH EXCEED THOSE DESCRIBED IN THIS MANUAL ARE NOT PERMISSIBLE.

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VERY IMPORTANT SAFETY PRECAUTIONS

This page provides very important safety information related to safety in installation, operation, and maintenance of this equipment.

WARNING

TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, OBSERVE THE FOLLOWING:

ALL USERS OF THIS EQUIPMENT SHOULD BE MADE AWARE OF THE PROBLEMS ASSOCIATED WITH HANDLING HAZARDOUS MATERIALS IN EITHER LIQUID OR GASEOUS FORM AND OF THE EFFECTS OF EXPOSURE TO THEIR FUMES. REFERENCE SHOULD BE MADE TO THE LITERATURE AVAILABLE FROM THE SUPPLIERS OF THESE CHEMICALS, PARTICULAR ATTENTION BEING PAID TO THE INFORMATION AND ADVICE ON PROTECTIVE CLOTHING.

THIS EQUIPMENT IS CONNECTED TO LINE VOLTAGE. IT IS ESSENTIAL THAT THE UTMOST CARE IS TAKEN WHEN WORK IS CARRIED OUT ON EQUIPMENT WHERE LINE VOLTAGES ARE PRESENT. IT IS RECOMMENDED THAT ALL POWER SUPPLIES ARE SWITCHED OFF WHENEVER POSSIBLE.

WHEN DEALING WITH HAZARDOUS MATERIAL, IT IS THE RESPONSIBILITY OF THE EQUIPMENT USER TO OBTAIN AND FOLLOW ALL SAFETY PRECAUTIONS RECOMMENDED BY THE MATERIAL MANUFACTURER.

DO NOT DISCARD THIS INSTRUCTION BOOK UPON COMPLETION OF INSTALLATION. INFORMATION PROVIDED IS ESSENTIAL TO PROPER AND SAFE OPERATION AND MAINTENANCE.

ADDITIONAL OR REPLACEMENT COPIES OF THIS INSTRUCTION BOOK ARE AVAILABLE FROM:

Evoqua Water Technologies
725 Wooten Road
Colorado Springs, CO 80915
Phone: (800) 524-6324

NOTE

Minor part number changes may be incorporated into Evoqua Water Technologies products from time to time that are not immediately reflected in the instruction book. If such a change apparently has been made in your equipment and does not appear to be reflected in your instruction book, contact your local Evoqua Water Technologies sales office for information.

Please include the equipment serial number in all correspondence. It is essential for effective communication and proper equipment identification.

REGIONAL OFFICES**INSTALLATION, OPERATION, MAINTENANCE, AND SERVICE INFORMATION**

Direct any questions concerning this equipment that are not answered in the instruction book to the Reseller from whom the equipment was purchased. If the equipment was purchased directly from Evoqua Water Technologies, Colorado Springs, CO contact the office indicated below.

UNITED STATES

725 Wooten Road
Colorado Springs, CO 80915
TEL: (800) 524-6324

CANADA

If the equipment was purchased directly from Evoqua Water Technologies, Canada, contact the nearest office indicated below.

ONTARIO

Evoqua Water Technologies Ltd.
2045 Drew Road
Mississauga, Ontario
L5S 1S4
(905) 944-2800

QUEBEC

Evoqua Technologies des Eaux Itée
505 Levy Street
St. Laurent, Quebec
H4R 2N9
(450) 582-4266

MFC ANALYZER / CONTROLLER

SECTION 1 - TECHNICAL DATA

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1.1 MFC Electronic Module

Dimensions (W x H x D)	12.6" x 10.6" x 6.9" (320mm x 270mm x 175mm)
Weight	approx. 11 Lbs (5 kg)
Protection category	NEMA 4X (IP 66)
Power supply	240 V AC \pm 10%, 50 - 60 Hz, 30 VA Fuse 1A (T) Type: TR5 or 120 V AC \pm 10%, 50 - 60 Hz, 30 VA Fuse 1A (T) Type: TR5 or 24 V DC \pm 20%, 30 W Fuse 2.5A (T) Type: TR5
Operating conditions	Ambient temperature: 32 - 122°F Environment: No direct sunlight Humidity: Non-condensing Storage temperature: 50 - 90°F Electrical Noise emission: <45 dB
Digital inputs	3 x for floating contact (< 100 Ohm) Power supply through MFC D1: Sample water monitoring (freely selectable) D2: Freely selectable in menu D3: Freely selectable in menu

Measurement inputs

- 1 x temperature input PT 1000 (32 - 122°F) with sensor error display
- 1 x feedback input
 - Positioner position feedback
 - Potentiometer 1 kOhm or 5 kOhm
- 5 x Measured value inputs (electronically isolated up to 50 V to ground)
 - 3 bare electrode cells for free chlorine, chlorine dioxide, potassium permanganate, ozone
 - Membrane sensors for total chlorine (TC1), free chlorine (FC1), chlorine dioxide (CD7), ozone (OD7)
 - Micro/2000® 3 bare electrode cells for free or total chlorine, chlorine dioxide, potassium permanganate with reagent feed
 - Deox/2000® 3 bare electrode cells for chlorine and sulfur dioxide or sodium bisulfite with reagent feed
 - pH value
 - Redox potential
 - Fluoride
 - Conductivity
 - mA/V input

Interfaces

- 1 x RS232 for direct printer control or for configuration download or firmware upload (not electronically isolated).
- 1 x RS485 for connection to programmable controller or central instrumentation and control systems via RS485 Evoqua Water Technologies protocol. The RS485 interface is electronically isolated up to 50 V to ground. (Refer to separate instruction manual for details.)

Display and operating unit

- 1 x Operating panel with 9 keys
- 8 x Red LEDs for indication of operating conditions
- 1 x Green LEDs for indication of the power supply
- 1 x Graphics display - Resolution 240 x 64 pixels and Green background illumination

Relay plug-in card (outputs)	Switching values - 8 x
	5 A, 250 V AC, 1250 VA max.
	5 A, 220 V DC, 150 W max.
	UL/CSA-rating -
	5 A, 1/6 HP 125, 250 V AC
Analog outputs plug-in card	Outputs 0-5mA/0-10mA/0-20mA/ 4-20mA
	Accuracy < 0.5 % FS
	Load max. can be switched over 1000 Ohm / 400 Ohm
	Temperature drift max. 0.2 % / 10 °C
	Load monitoring
	Electrically isolated up to 50 V to ground

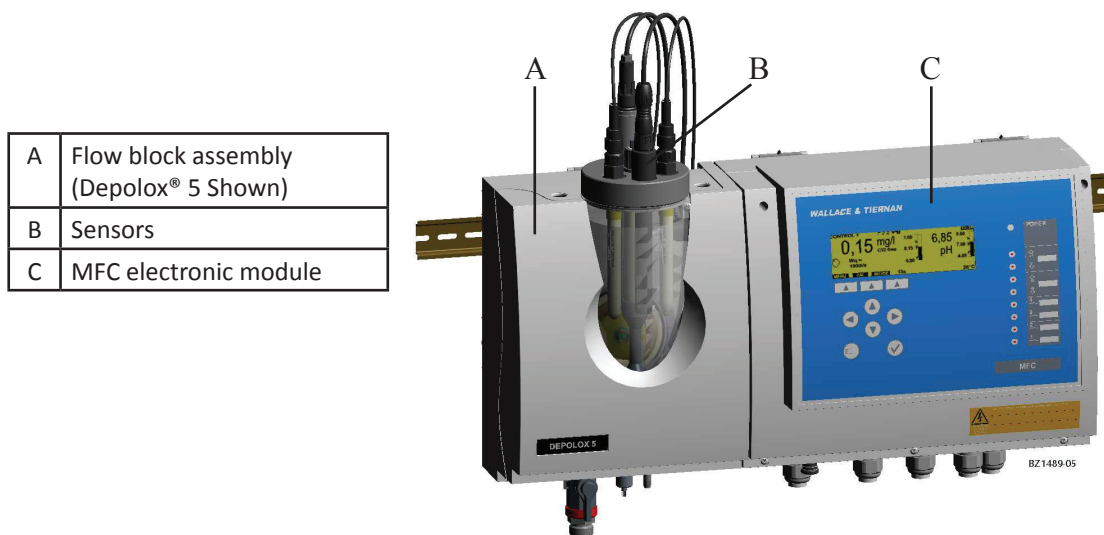
NOTE: All sensor measuring modules are electrically isolated to 50 V to ground.

For technical information on individual measurement inputs, see instruction manual provided with the measurement module kit.

1.2 Design

1.2.1 Overall Design

The MFC unit is a modular design and can be equipped with up to four sensor measuring modules. The modules can be different or the same. This component arrangement determines the version and number of flow block assemblies. It is also possible to install several different versions of flow block assemblies.



1.2.2 MFC Electronic Module

The MFC electronic module consists of a plastic housing with a removable cover.

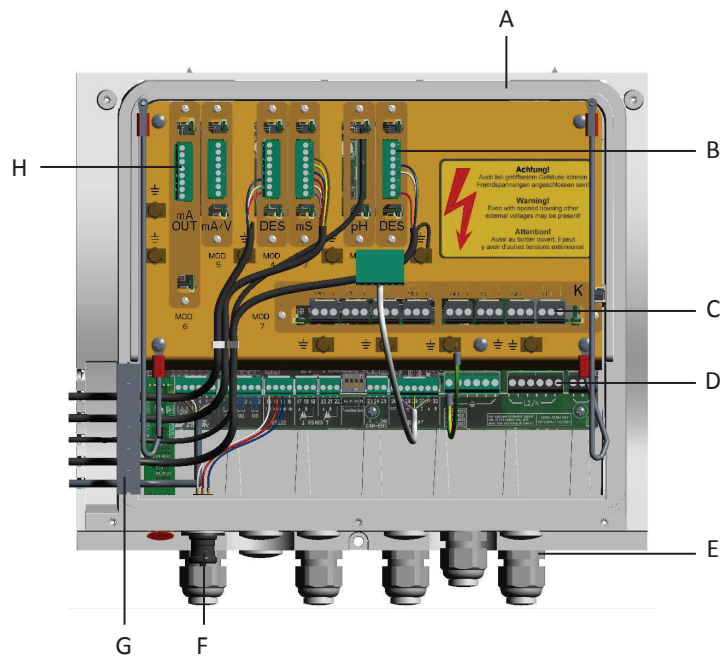
The housing contains:

- Motherboard with power unit and five slots for the sensor measuring module cards
- Relay card
- Plug-in card with analog outputs
- Terminal strip
- Glands for the cables of the sensor measuring modules

The following are incorporated into the base of the housing:

- RS232 interface
- Cable unions

A	Plastic housing
B	Slots
C	Relay card
D	Terminal strip
E	Cable union
F	RS232 interface
G	Sensor measuring module housing duct and glands
H	Analog outputs



The following are integrated into the cover:

- Graphic display
- Operator controls
- A green LED to indicate the power supply
- Eight red LEDs to indicate the operating conditions

MFC ANALYZER / CONTROLLER

A	Cover
B	Green LED (Power)
C	Red LED (operating and control indicator)
D	Operator controls (keys)
E	Graphic display



SECTION 2

SECTION 2 - INSTALLATION

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2.1 Module Mounting

The device must be protected against rain, frost and direct sunlight and may not be installed outdoors. It must be mounted horizontally on a flat wall with an ambient temperature of 32 to 122°F. The air in the room should be non-condensing.

Opening the housing:

1. Remove the housing cover of the flow block assembly by lightly pressing the two buttons on the top of the housing.
2. Loosen the five screws on the cover of the MFC electronic module.



CAUTION: The indication and operator controls on the cover of the MFC electronic module are connected to the housing with strain relief cables.

NOTE: The device switches off automatically when the cover is removed.

3. Carefully remove the cover of the MFC electronic module and leave to hang on the strain relief cables.

Installation with mounting rail (see drawing 50.580.100.010):

1. Fasten the mounting rail to the wall, using screws and inserts compatible with wall material and mounting rail.
2. Hook the electronic module onto the mounting rail so that it is flush to the right and fasten to the wall with a screw, to prevent the unit from sliding or moving on the mounting rail.
3. Hook the flow block assembly onto the mounting rail to the left of the MFC electronic module and fasten to the wall with two screws.

NOTE: The flow block assembly does not need to be mounted directly next to the MFC electronics, it can be mounted on separate mounting rail. The exact location limited by available probe cable lengths.

Installation without mounting rails (see drawing 50.580.100.020):

If the electronic module and the flow block assembly are to be mounted in different places, the modules can be hooked onto suitable tallow-drop screws by the top holding fixtures instead of onto the mounting rail. Proceed with the installation as described above.

NOTE: If the electronic module and the flow block assembly are mounted at separate locations, the Evoqua Water Technologies sensor cable extensions with a maximum length of 50m must be used. An impedance converter for the Redox, fluoride and pH sensors is also required. Depolox® 5 flow block cable is a maximum of 1.5 meters. The Micro/2000® and Deox/2000® probe cable is a maximum of 1 meter.

2.2 Electrical Connections

1. The MFC electronics and Micro/2000® and Deox/2000® flow block are protected by internal line fuses. Refer to Section 5 - Service for fuse ratings.



WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, THE UNIT SHOULD BE POWERED WITH GROUND FAULT INTERRUPT PROTECTION. THE UNIT IS FUSED INTERNALLY FOR THE PROTECTION OF ELECTRICAL/ELECTRONIC COMPONENTS ONLY - THESE FUSES WILL NOT PROTECT THE USER FROM INJURY CAUSED BY ELECTRICAL SHOCK. WHILE ELECTRICAL COMPONENTS ARE SUITABLY ISOLATED FOR NORMAL OPERATION, THE PRESENCE OF WATER OR OTHER POSSIBLY CONDUCTIVE FLUIDS IN COMBINATION WITH DANGEROUS OPERATING VOLTAGE, PRESENTS A SHOCK HAZARD THAT IS BEST MINIMIZED BY THE USE OF GROUND FAULT INTERRUPT PROTECTION ON THE MAIN POWER SUPPLY.

2. Connect main power supply to MFC electronic module per drawing 50.580.155.010 in Section 5 - Service. Power to the Micro/2000® and Deox/2000® flow block can be jumped from the MFC electronics module or directly from line power.
3. An external power disconnect must be provided to isolate the Micro/2000® and Deox/2000® flow block from the MFC mains power when servicing the flow block. No power switch is provided within the MFC or the flow block.



CAUTION: Only authorized and qualified electricians are permitted to install the device and open the housing. The device may only be taken into operation when the housing is closed, and must be connected to protection earth. Modifications to the device which go beyond those described in this manual are not permissible.

The device is not equipped with a mains switch and is in operation as soon as the supply voltage is applied. An external switch or circuit breaker is necessary.

Provide a mains fuse locally (6 A). The conductor cross section of the mains cable must be at least 0.75 mm (AWG 18).

When connecting system components (e.g. devices, motors, pumps) as well as when entering operating data, the system components must be switched off in order to prevent uncontrolled activation or any incorrect function.

To ensure safe and correct commissioning, knowledge of the operation, connected electrical load, measurement signals, cable assignment and fuse protection of the connected devices and machines and the relevant safety regulations is required.

Therefore, the device may only be commissioned by qualified and authorized electricians.

Incorrectly connected devices can be damaged, possibly irreparably, or cause faults in other equipment when they are switched on or in operation. Ensure that the measuring and control cables are not confused or make contact with one another. Never connect or disconnect any cables to which voltage is applied!

A 6 A fuse in the main supply line is necessary when connecting to 230 V or 115 V.

Recommendation: Provide an on/off switch for the device at the installation site.

4. Checking the mains voltage:

The device is available in three voltage variations:

24 V DC

200–240 V AC, 50–60 Hz (switchable)

100–120 V AC, 50–60 Hz

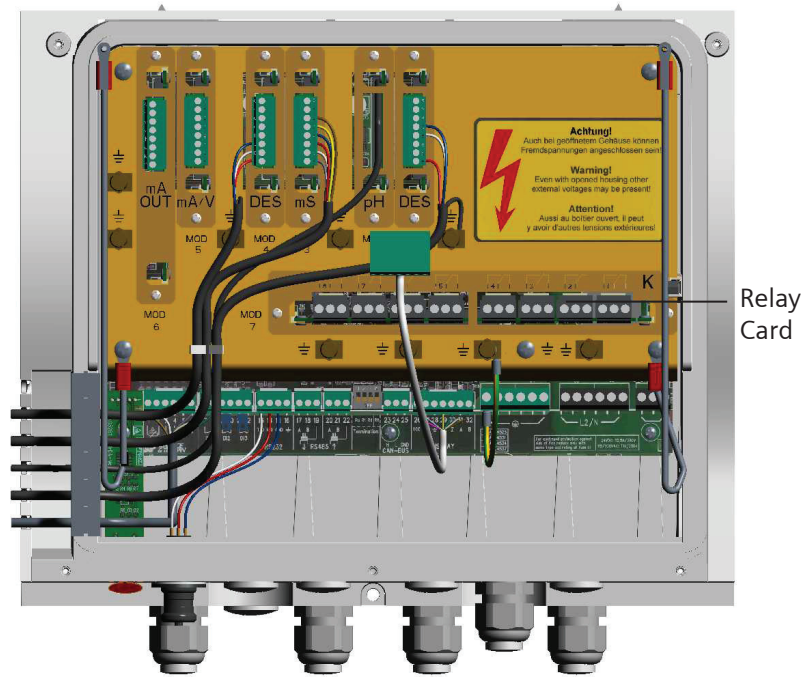
Switching the mains voltage:

The mains voltage is switched over from 230 V AC to 115 V AC as follows:

- a. Disconnect the device from the power supply.
- b. Remove the cover of the MFC electronic module.
- c. Remove the relay card.
- d. Through the empty slot of the relay card, switch the mains switch on the motherboard (e.g. with a screwdriver).

It is not necessary to replace the fuses.

- e. Reassemble the device.



5. Mounting the Labeling Field:

- Select the supplied labeling field in accordance with the specified application.
- Supplement the labeling field, if necessary.
- Insert the labeling field for the LEDs on the inside of the housing cover of the MFC electronic module in accordance with the selected application.

2.3 Start-Up

Switching the Device On

The device is not equipped with a mains switch and is in operation as soon as the supply voltage is applied. When entering operating data it must be taken into account that these could directly influence the connected system components.

- Activate the power supply to the device.
- The green “POWER” indicator lights up.

The following appear in succession on the graphic display:

- Version
- MFC
- Analog scan
- Wallace & Tiernan GmbH

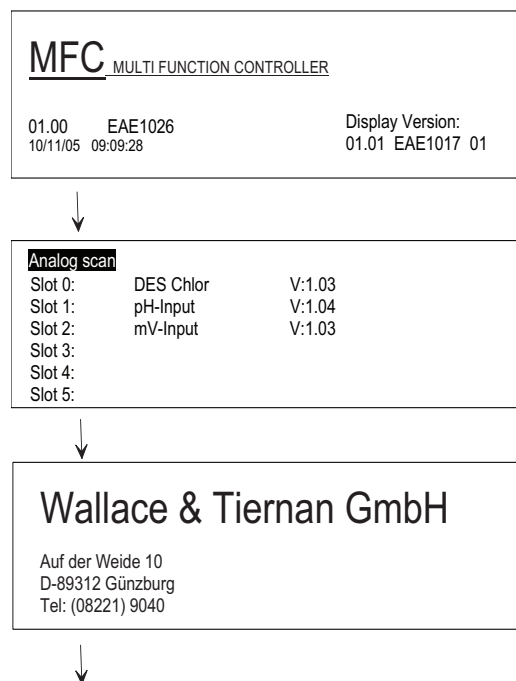
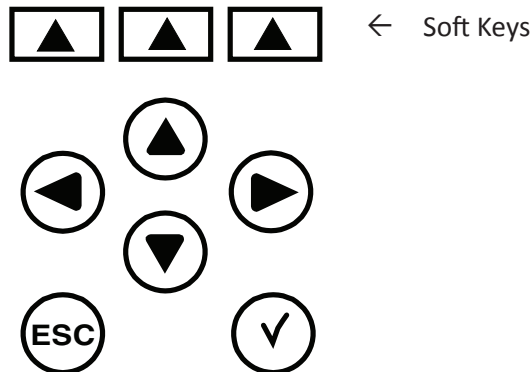
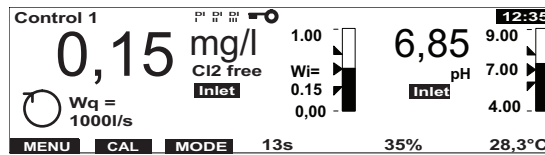


Figure 2.1 - Basic display in main menu

2.4 System Setup

2.4.1 Setting Language



- 1 Press left soft key (Menu)
- 2 Press ▲ ▼ arrow to (SYSTEM)
- 3 Press right soft key (EINGABE)
- 4 Press ▲ ▼ arrow to (ALLGEMEIN)
- 5 Press right soft key (EINGABE)
- 6 Press ▲ ▼ arrow to (SPRACHE)
- 7 Press right soft key (EINGABE)
- 8 Press ▲ ▼ arrow to (ENGLISCH)
- 9 Press right soft key (EINGABE)
- 10 Press ESC key as required back to main display

2.4.2 Common Setup

- 1 Press left soft key (Menu)
- 2 Press ▲ ▼ arrow to (SYSTEM)
- 3 Press right soft key (ENTER)
- 4 Press ▲ ▼ arrow to (COMMON)
- 5 Press right soft key (ENTER)
- 6 Upon setup completion press ESC key as required back to main display.

From the Common Menu, set the current time, date, language and system name. To activate any selection press the ▲ ▼ arrows to move cursor to desired selection and press the right softkey (ENTER). A second cursor ► will appear before the current parameter value, and an underbar — will appear below the active value. Press the ▲ ▼ arrows to change the value, press ◀ ▶ arrows to move underbar — to next digit. When desired values have been set, press right soft key (ENTER) to accept value.

Measurement filter can be set from the common menu, to Off/Low/High. This provides a dampening effect to the measured values in the event of erratic or unstable processes.

Hold function can be set from the common menu to On/Off. The hold function freezes the mA outputs during calibration.

The system name can be set from the common menu. Up to (12) letters/numbers/symbols can be entered.

2.4.3 Safety

The feed delay feature delays the dosing start when the unit is switched on and when the operating mode has changed.

The sample water delay determines the time to dosing deactivation in the event of failure, for example loss of sample water flow.

A four digit system password can be entered into the unit to limit access. Once a system password is entered an additional menu item will appear allowing a calibration password to be set.

NOTE: After the passwords are entered, you must return to the "Menu Select" screen and press the center soft key (Lock) to lock the system. Once locked the system cannot be changed without the password. All menu options are still available for viewing only. If not manually locked, the system will automatically lock one hour after password is set.

2.4.4 Trend Graph

The trend graph menu allows setup of the trend display and outputs. The graphs can be set to any of the measurements installed in slots 1-4, as well as other parameters depending on the selected control applications, such as temperature, flow, external setpoint, etc.

2.4.5 Module Designation

Each installed measurement module can be assigned up to a six letter/digit/symbol designation.

2.4.6 Reset

The MFC can be reset in several different ways.

- System Restart - Initializes system but saves user entered values.
- Delete Graph - Deletes stored trend graph data.
- Standard Values - Initializes system to factory default (except for application).
- Deleting Dosing AVG - Deletes stored dosing data and resets to zero.
- Dosing Factors - Resets dosing factor table to selected value and dosing AVG to zero.

2.5 Start-Up Task Checklist

Sequence	Task	Section	Completed
1	Module mounts	2.1	<input type="checkbox"/>
2	Connect electrical power	2.2	<input type="checkbox"/>
	Check the set mains voltage and adjust if necessary		
3	Wire the device acc. to the application (refer to wiring diagrams)	2.2	<input type="checkbox"/>
4	Insert the labeling field into the housing cover acc. to the application	2.2	<input type="checkbox"/>
5	Close the housing cover	2.2	<input type="checkbox"/>
6	Select the language	2.4.1	<input type="checkbox"/>
7	Common data setup	2.4.2	<input type="checkbox"/>
8	Set safety	2.4.3	<input type="checkbox"/>
9	Set the graph assignment	2.4.4	<input type="checkbox"/>
10	Set module descriptions	2.4.5	<input type="checkbox"/>
11	Set the application	2.6	<input type="checkbox"/>
	If module 1-4 is available:		
1	Refer to manual supplied with the measurement module.		<input type="checkbox"/>
	Input and output settings:		
1	Check flow rate signal settings, including unit, factor, format, measuring range start and end value, adjust if necessary	4.3.6	<input type="checkbox"/>
2	Check flow rate limit values, adjust if necessary	4.3.6	<input type="checkbox"/>
3	Check external set point/dosing factor setting including signal and factor, adjust if necessary (only if using an external set point/dosing factor)	4.3.6	<input type="checkbox"/>
4	Check limit values for external set point/dosing factor, adjust if necessary (only if using an external set point/dosing factor)	4.3.6	<input type="checkbox"/>
5	Check mA signal 1–4, adjust if necessary (only if using the mA outputs)	4.3.6	<input type="checkbox"/>
6	Check mA 1–4 assignment, adjust if necessary (only if using the mA outputs)	4.3.6	<input type="checkbox"/>

Sequence	Task	Section	Completed
7	Check settings for digital inputs 1 - 3, adjust if necessary	4.3.6	<input type="checkbox"/>
8	Configure RS232 interfaces as required	4.3.6	<input type="checkbox"/>
9	Configure RS485 interfaces as required	4.3.6	<input type="checkbox"/>
10	Check function of alarms 1–8, adjust if necessary	4.3.7	<input type="checkbox"/>
11	Configure alarm 1–8 assignment as required	4.3.7	<input type="checkbox"/>
12	Via MODE - MAN.DOS, check all connected actuators and dosing pumps for proper function	4.3.11	<input type="checkbox"/>
13	Calibrate the fitted sensors after approximately one hour running-in time	4.3.10	<input type="checkbox"/>
14	Set to the “AUTO” operating mode	4.3.11	<input type="checkbox"/>
15	Repeat calibration after 24 hours running time	4.3.10	<input type="checkbox"/>

2.6 Setting the Applications

- Starting from the basic display, restart the system by selecting “Reset” under the “Select” and “System” menus, and then selecting “System Restart” ... “Yes”.
“RESET CPU” and then “MFC” appears.

In the following display “Analog Scan”, press both the “left” and the “right” arrow at the same time for at least two seconds.
“Wallace & Tiernan GmbH” then appears.

Wallace & Tiernan GmbH

Auf der Weide 10
D-89312 Günzburg
Tel: (08221) 9040

INIT
APPLIC
FAC.CAL

Select the “APPLIC” function.
The “Application Select” menu appears.

Select the set application with the “ENTER” function.

Another application can now be set with the “Up” or “Down” keys (See 3.4 “Applications”).

Select “ENTER” to program the set application. Select “BACK” to return to the basic display.

2. Make the desired settings in the menu.
3. Calibrate the sensors. Re-calibrate the next day, as new sensors can change within the first 24 hours.

2.7 Decommissioning



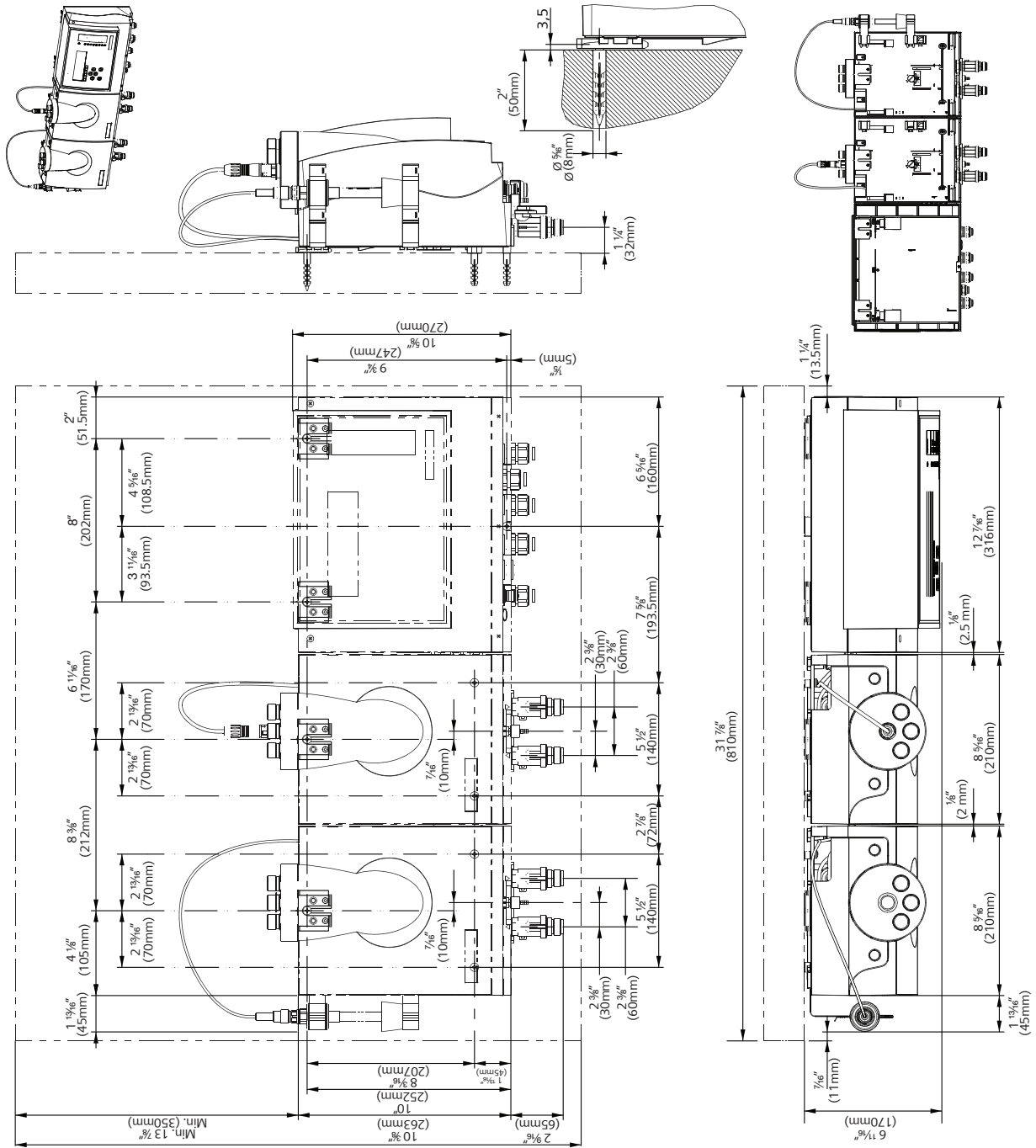
CAUTION: Danger of uncontrolled dosing of chlorine or pH correction medium: Shut down dosing system, close positioner!

NOTE: If the installation site of the flow block assembly is not frost-free, the system must be shut down prior to any possible frost formation.

1. Switch off the power supply.
2. Drain the sample water supply line and drainage line (hold container underneath)
3. Empty cell bodies and remove grit (see section 5.2, Maintaining Depolox® 5 Flow Block Assembly).
4. Dismantle the filter housing and the check valve housing.
5. When the remaining water has drained from the flow control valve, refit the filter housing and the check valve housing.
6. Remove the sensors from the cell body cover and disconnect from the cable (see section 3.2.6, Membrane sensors).
7. Apply a KCl solution to the protection caps of the pH and Redox electrodes and fit onto the electrodes.

A "KCl tank to store the sensors" may be used instead of the protection cap for pH and Redox electrodes (see section 7, Complete Devices, Retrofit Kits and Spare Parts).

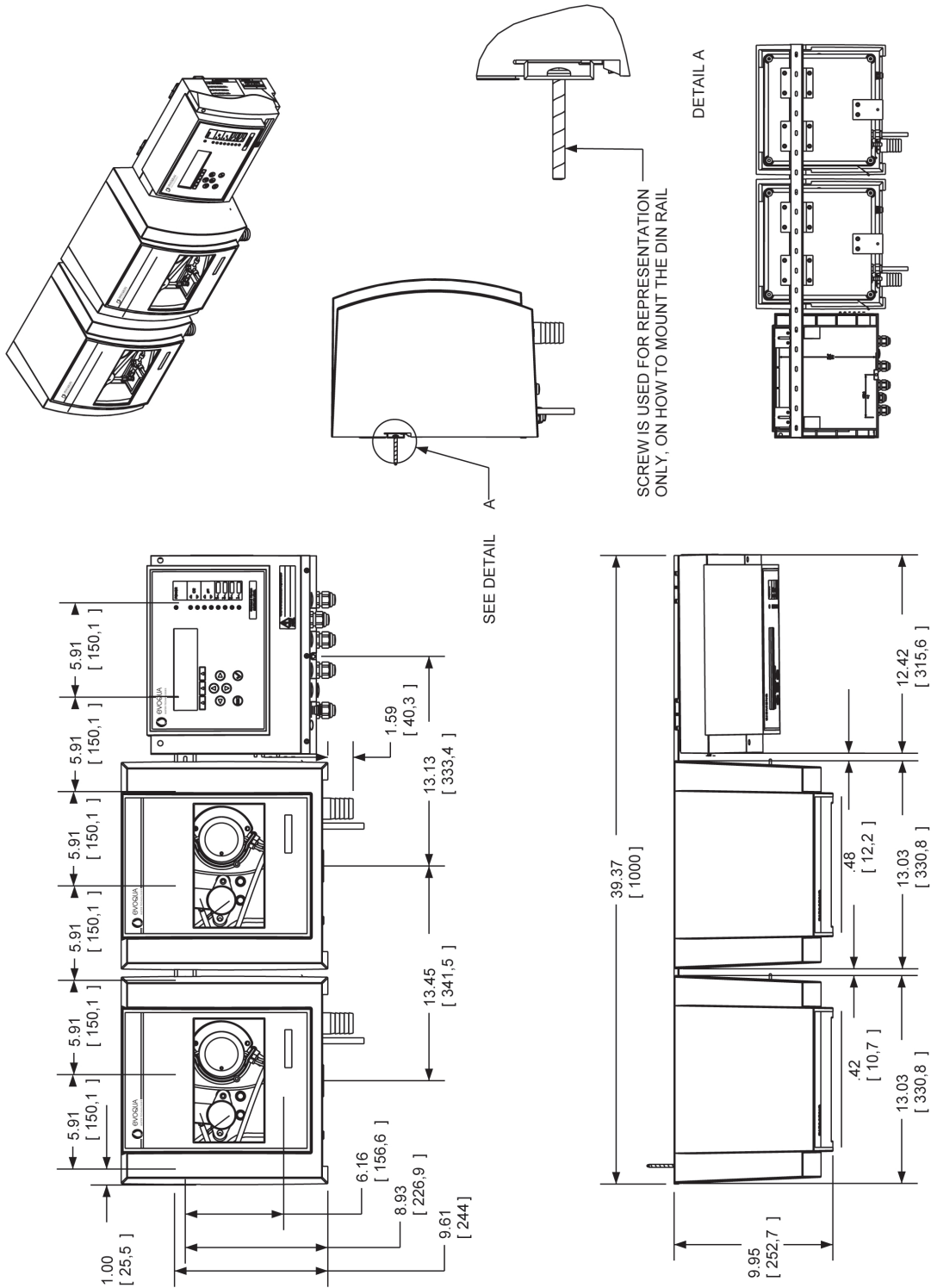
MFC ANALYZER / CONTROLLER



WALL MOUNT ASSEMBLY - DIMENSIONS

50.580.100.020

ISSUE 1 6-08

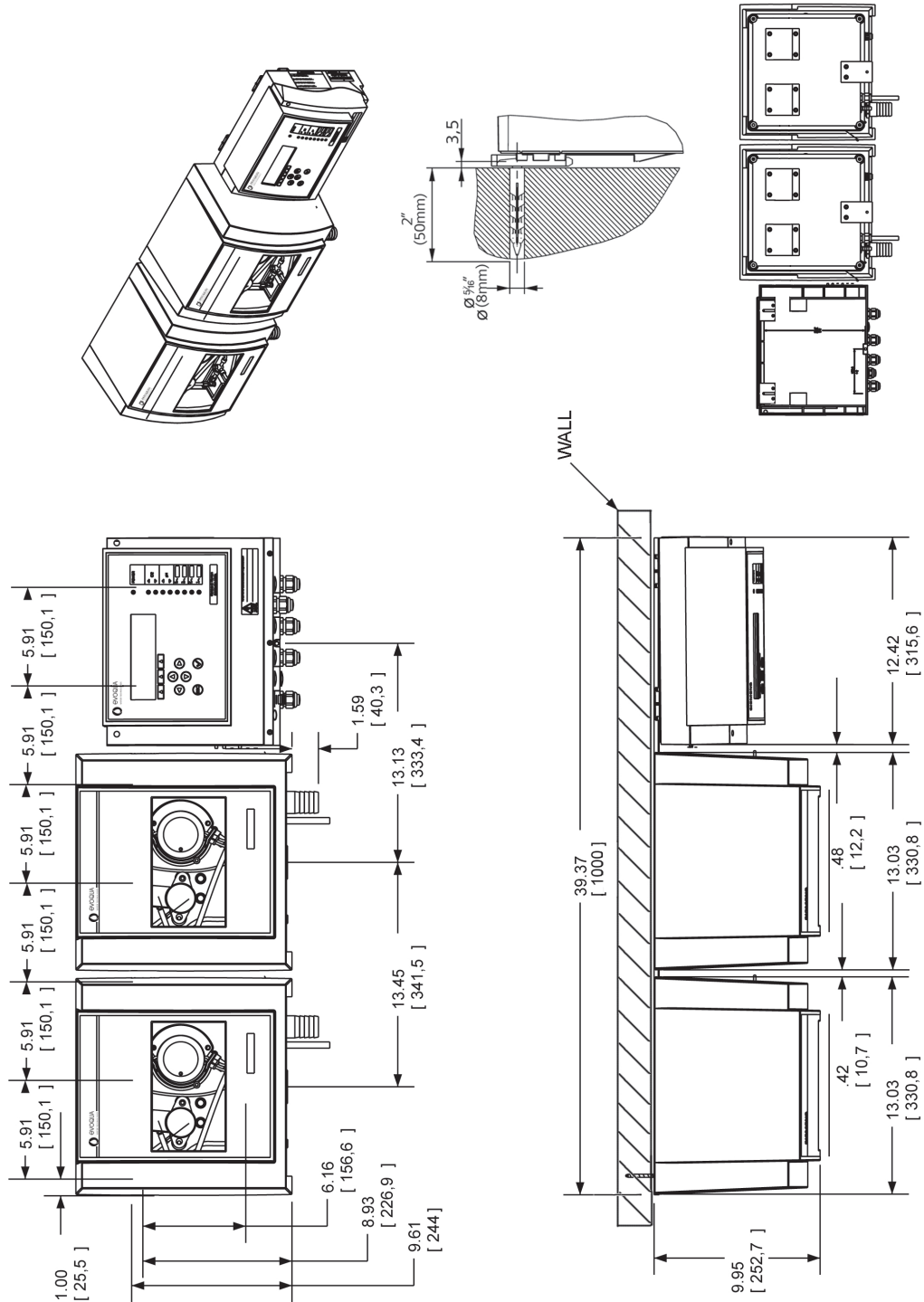


Dimensions in inches [mm]

TOP HAT RAIL ASSEMBLY - DIMENSIONS

50.580.100.030

ISSUE 1 8-14

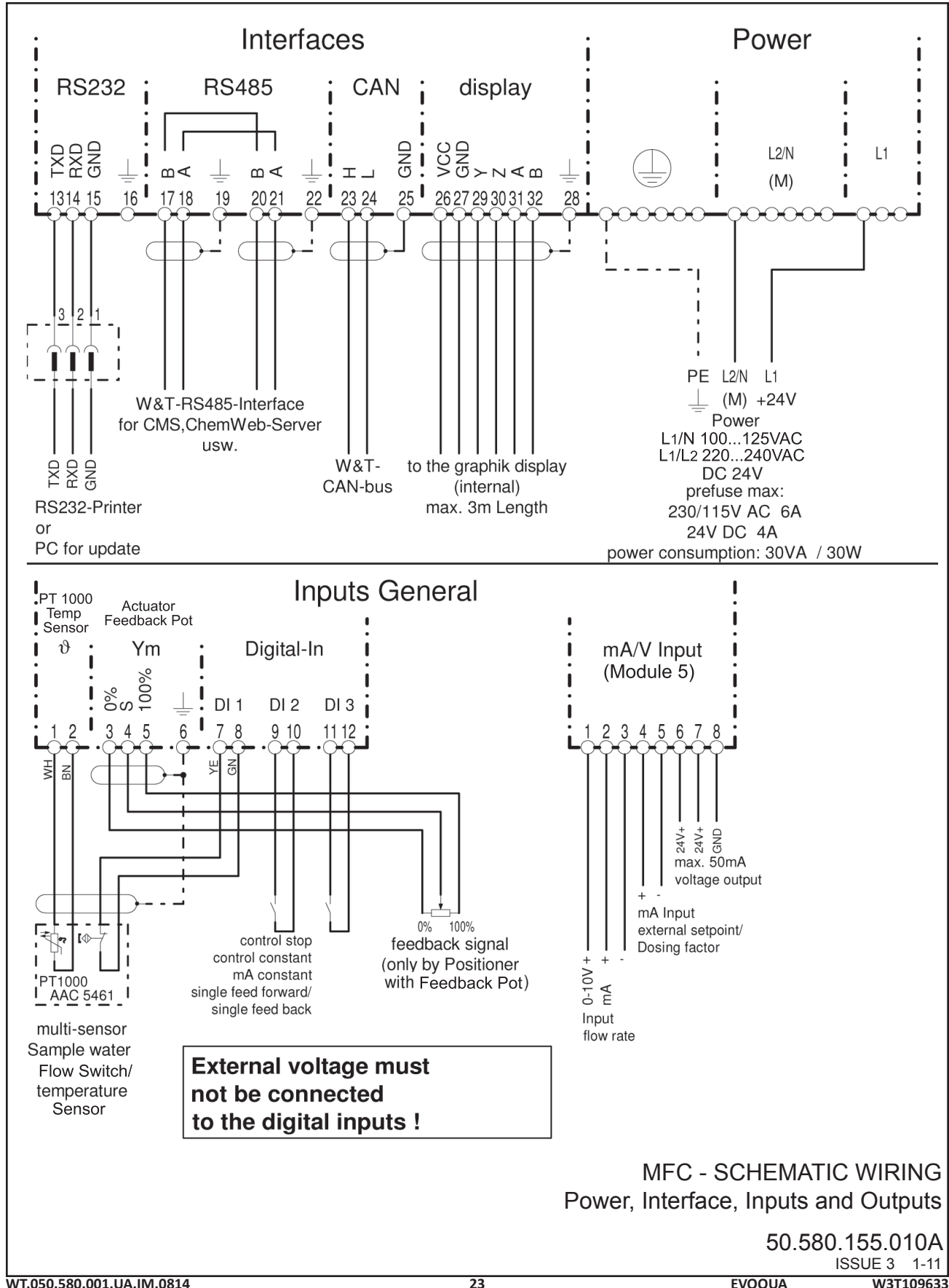


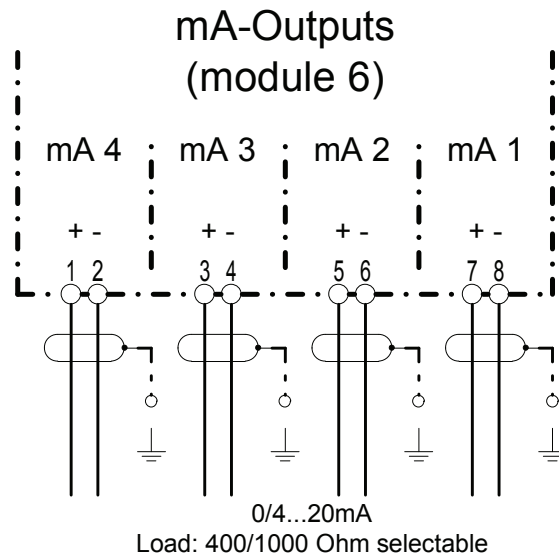
Dimensions in inches [mm]

WALL MOUNT ASSEMBLY - DIMENSIONS
Micro/2000® and Deox/2000® Flow Block

50.580.100.040

ISSUE 1 8-14



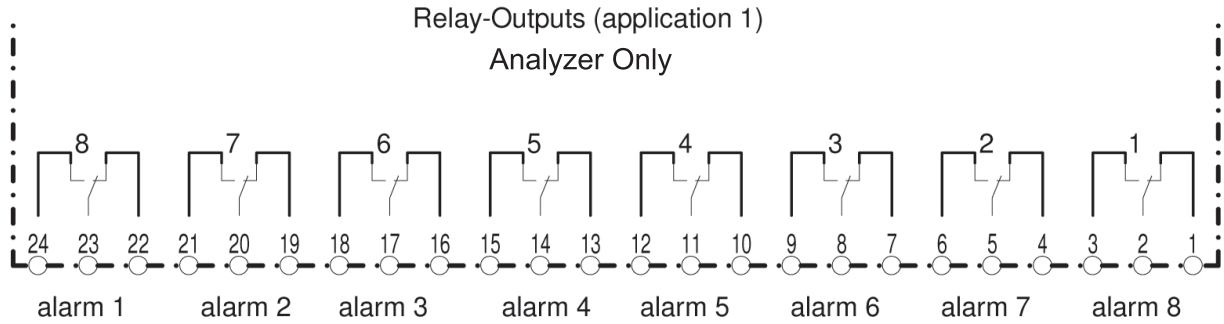


All mA-outputs are freely selectable:
 -to sensor measurement module 1-4
 -temperature
 -Ym/Yout
 -Ypi
 -flow rate
 -ext. Setpoint/Dosing factor

MFC - SCHEMATIC WIRING
 Power, Interface, Inputs and Outputs

50.580.155.010B

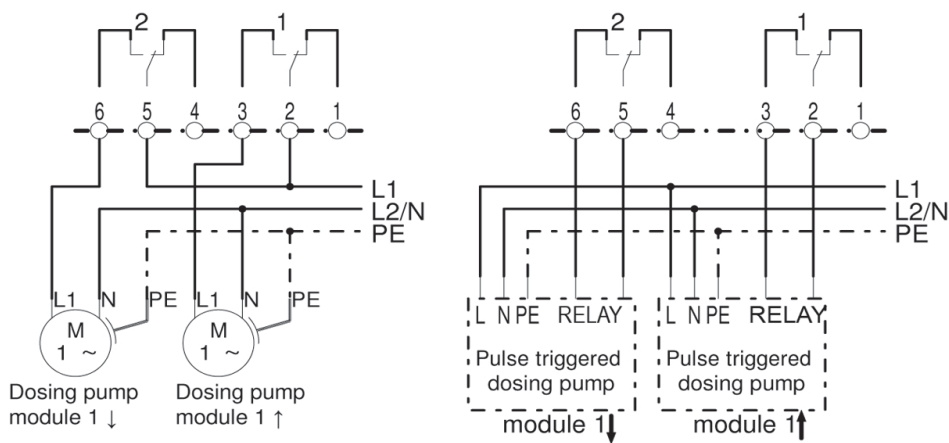
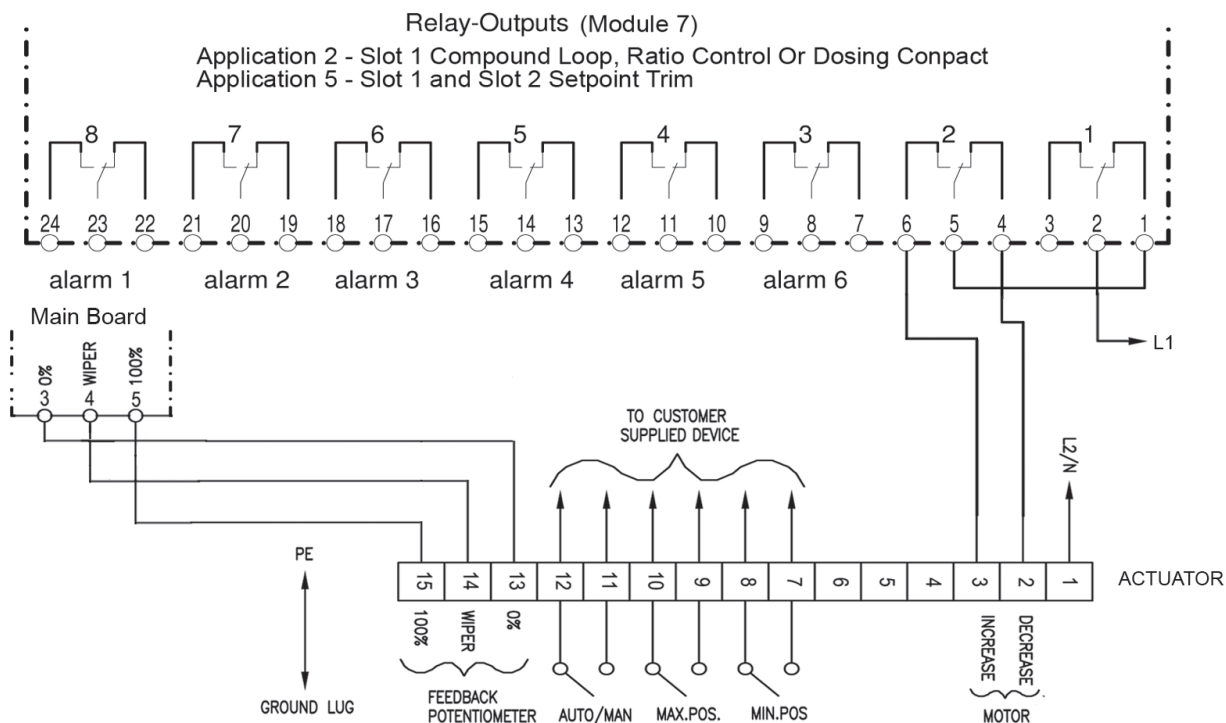
ISSUE 1 5-09



MFC APPLICATION 1 - INSTALLATION WIRING
Relay Output Wiring

50.580.155.050A

ISSUE 0 5-09

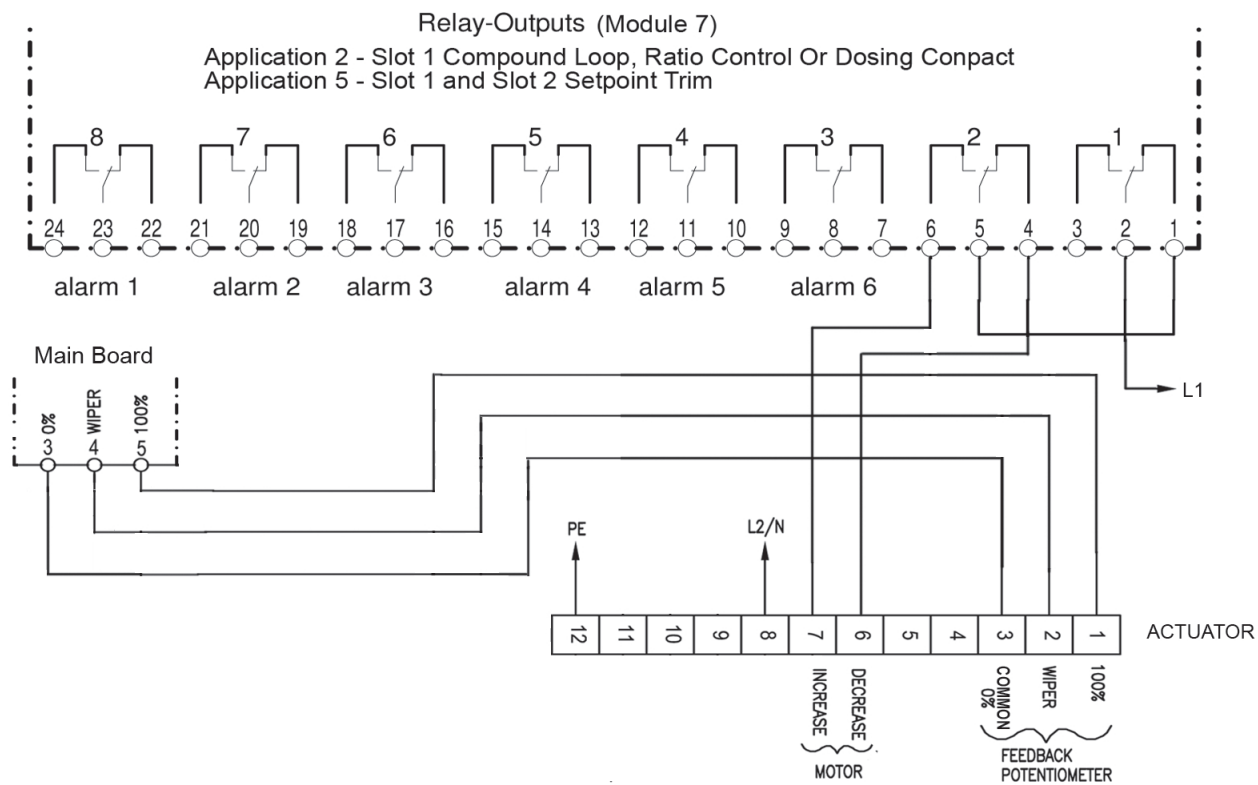


MFC APPLICATIONS 2 AND 5 CONNECTING MFC TO MOTOR CONTROLLED ACTUATORS - INSTALLATION WIRING

Used with V10K and S10K Gas Feeders; Encore® 700 Series Metering Pumps;
 and LVN-2000 Liquid Chemical Feed System
 V-Notch - W2T11479 (115VAC); UXA96285 (230VAC)
 Pump - W3T108074 (115VAC); W3T108075 (230VAC)

50.580.155.050B

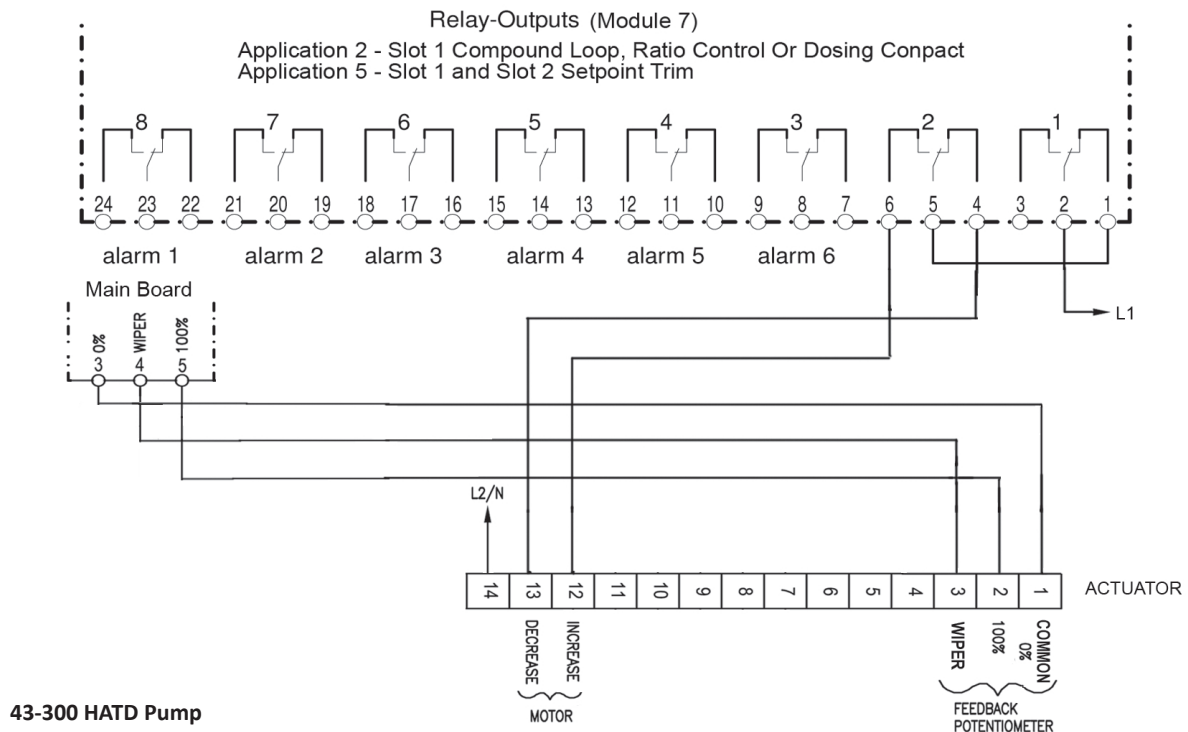
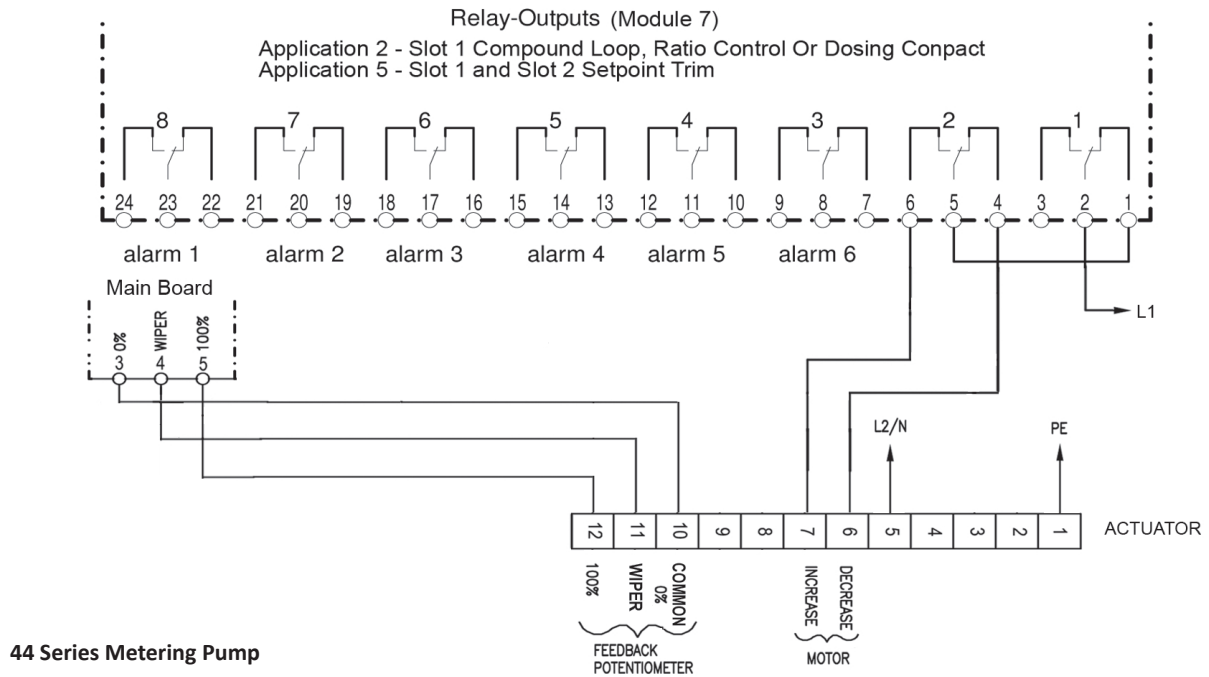
ISSUE 1 2-11



MFC APPLICATIONS 2 AND 5
CONNECTING MFC TO MOTOR CONTROLLED ACTUATORS - INSTALLATION WIRING
Used with V-75, V-100, V-500 and V-2000 Gas Feeders
V-Notch - U27959; V-Notch - U29202

50.580.155.050C

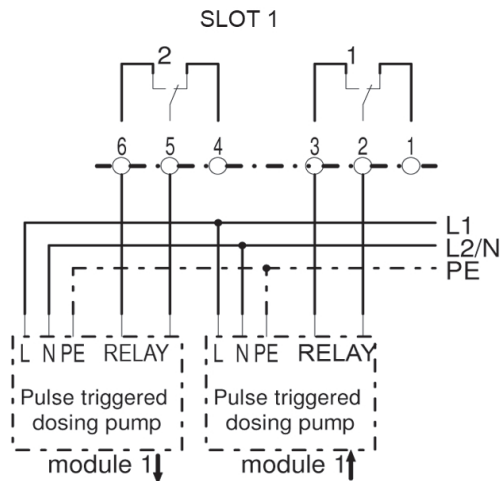
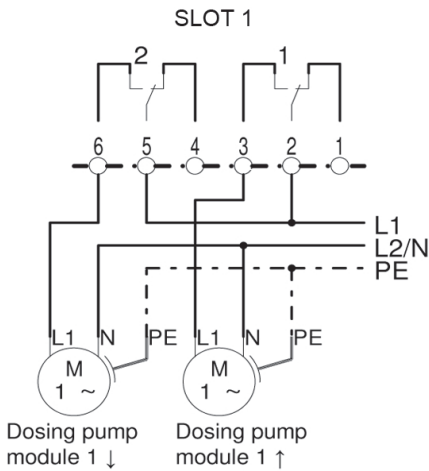
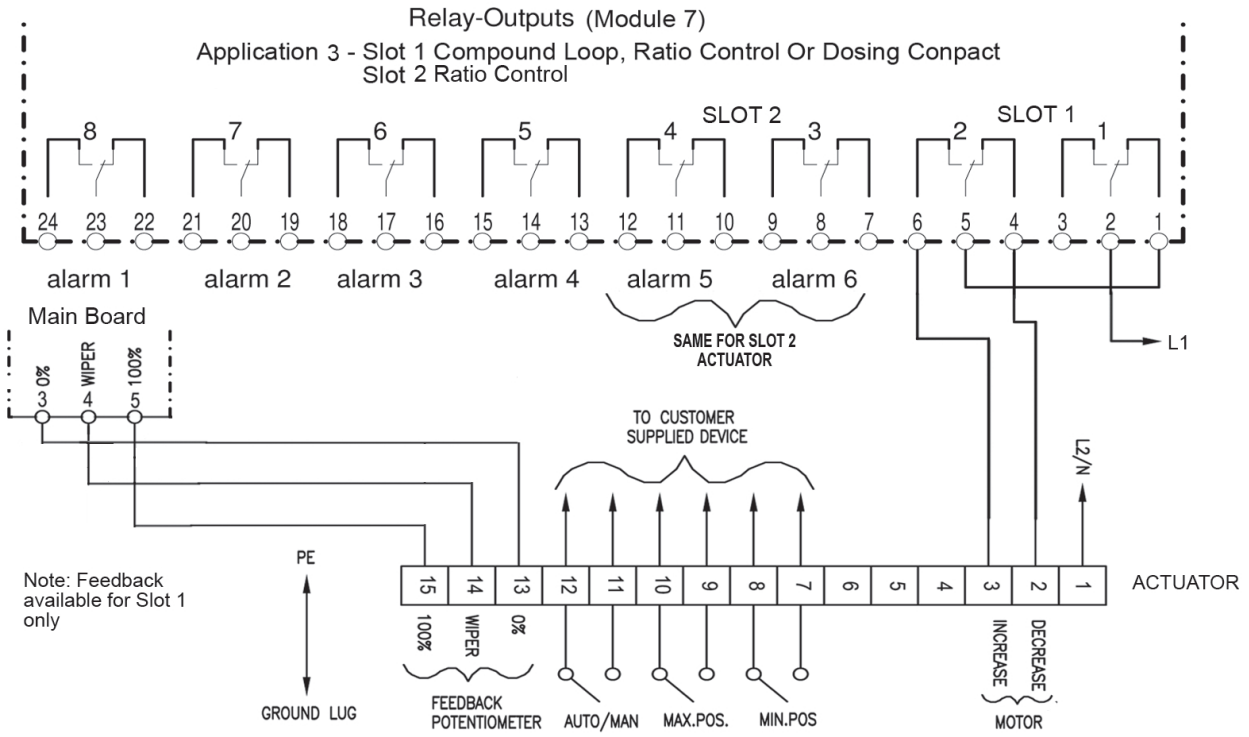
ISSUE 0 5-09



MFC APPLICATIONS 2 AND 5
CONNECTING MFC TO MOTOR CONTROLLED ACTUATORS - INSTALLATION WIRING
Used with 43-300 HATD Pumps and 44 Series Metering Pumps
43-300 Pump - U28342; 44 Series Pump - U27960

50.580.155.050D

ISSUE 0 5-09



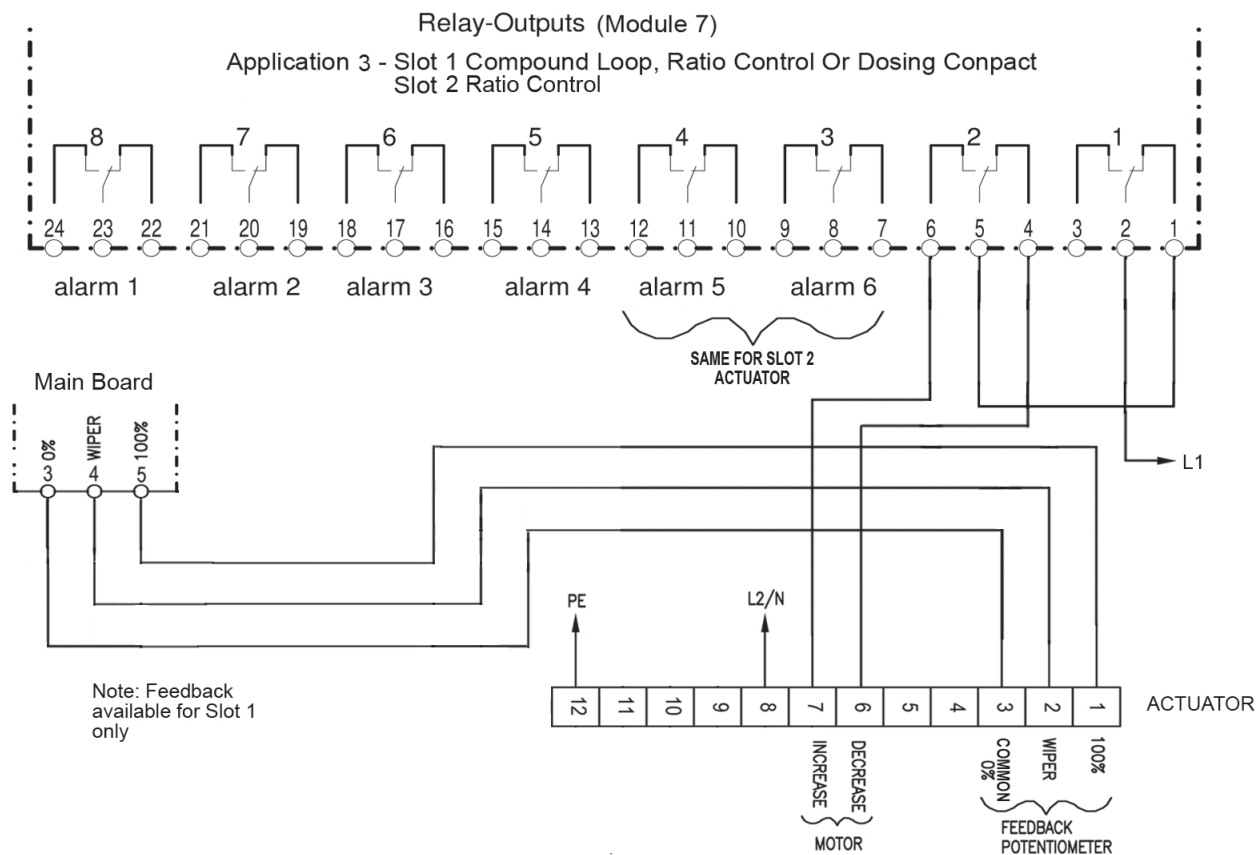
Note: Relays 3 & 4 wired the same for slot 2 control.

MFC APPLICATION 3 CONNECTING MFC TO MOTOR CONTROLLED ACTUATORS - INSTALLATION WIRING

Used with V10K and S10K Gas Feeders; Encore® 700 Series Metering Pumps;
and LVN-2000 Liquid Chemical Feed System
V-Notch - W2T11479 (115VAC); UXA96285 (230VAC)
Pump - W3T108074 (115VAC); W3T108075 (230VAC)

50.580.155.050E

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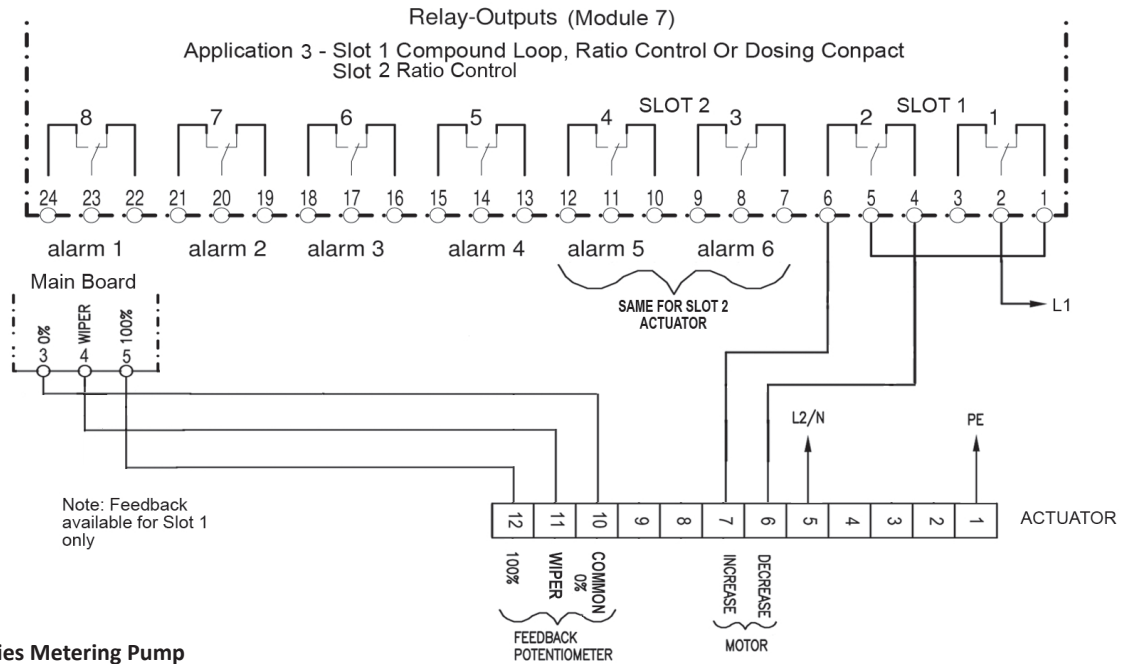
MFC APPLICATION 3

CONNECTING MFC TO MOTOR CONTROLLED ACTUATORS - INSTALLATION WIRING

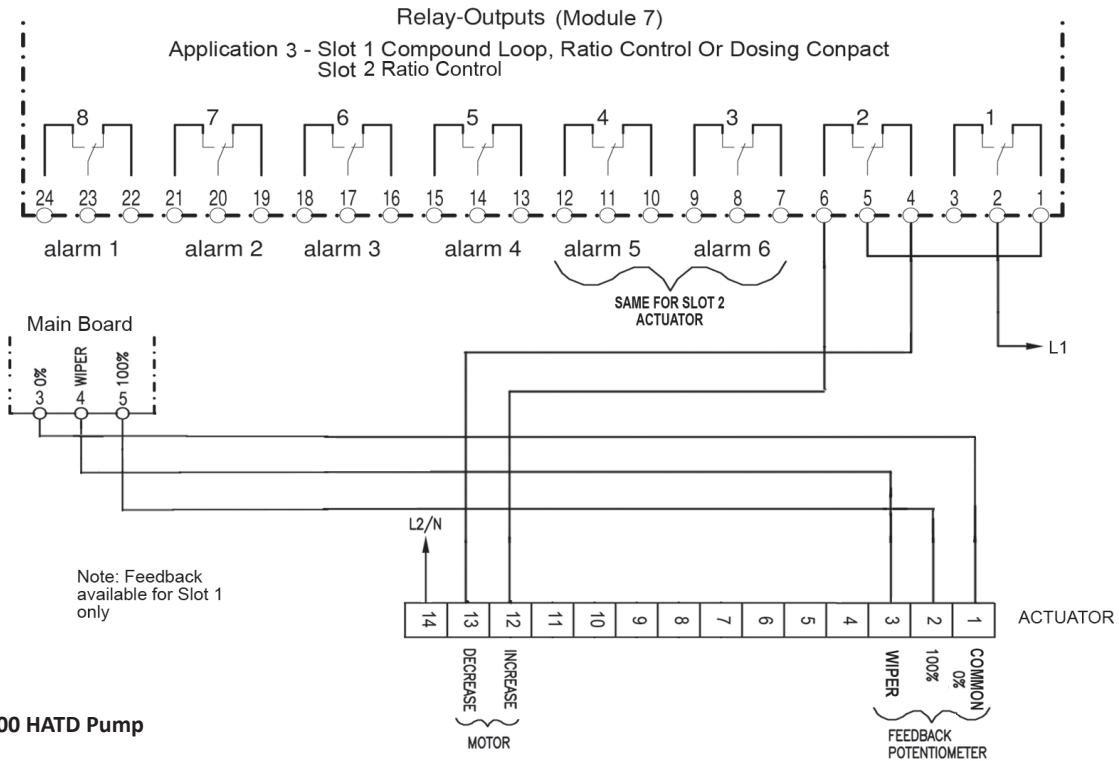
Used with V-75, V-100, V-500 and V-2000 Gas Feeders
V-Notch - U27959; V-Notch - U29202

50.580.155.050F

ISSUE 0 5-09



44 Series Metering Pump



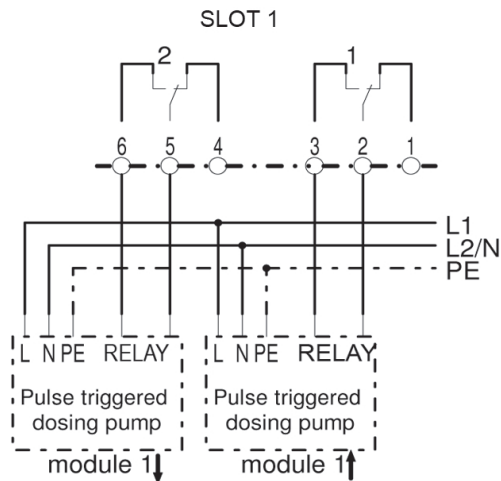
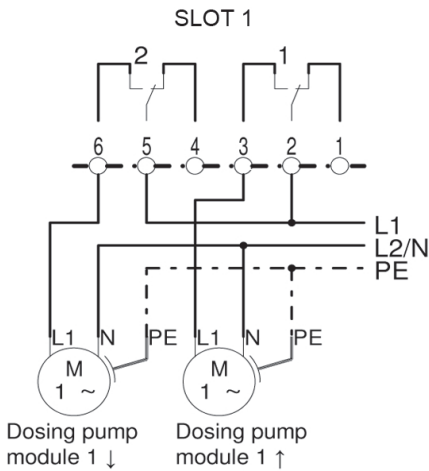
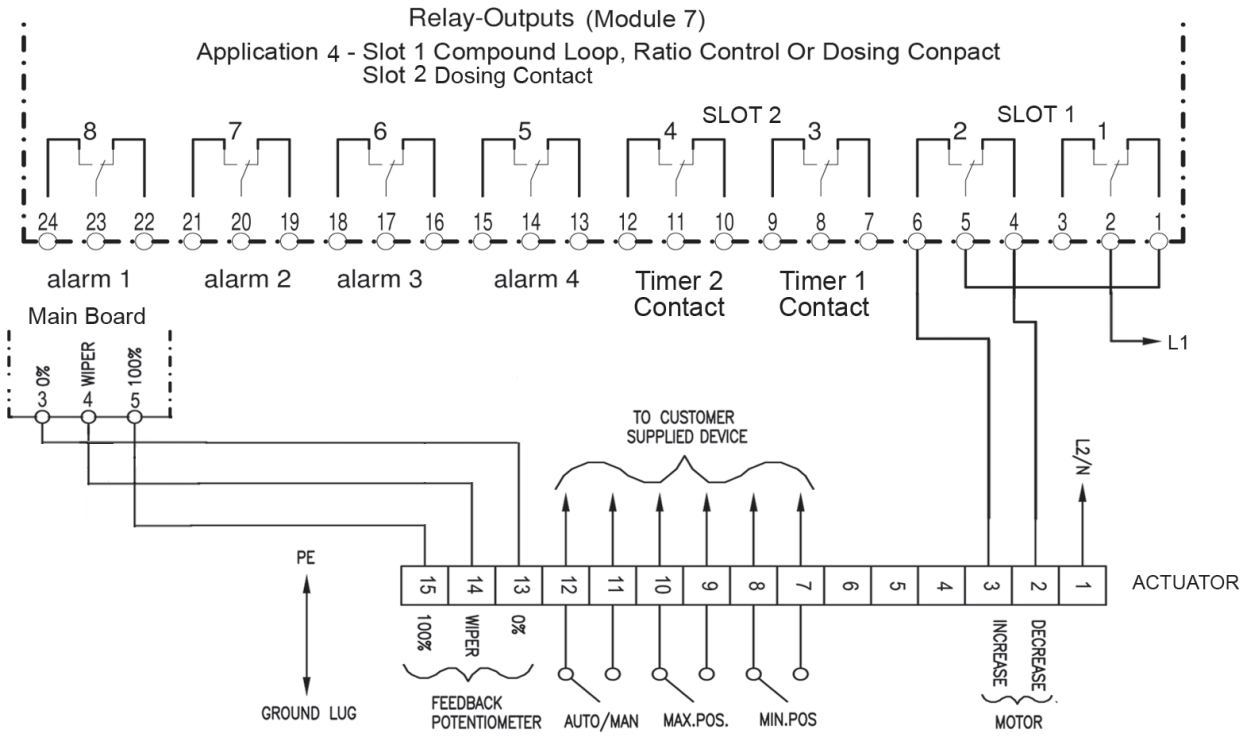
43-300 HATD Pump

MFC APPLICATION 3 CONNECTING MFC TO MOTOR CONTROLLED ACTUATORS - INSTALLATION WIRING

Used with 43-300 HATD Pumps and 44 Series Metering Pumps
43-300 Pump - U28342; 44 Series Pump - U27960

50.580.155.050G

ISSUE 0 5-09



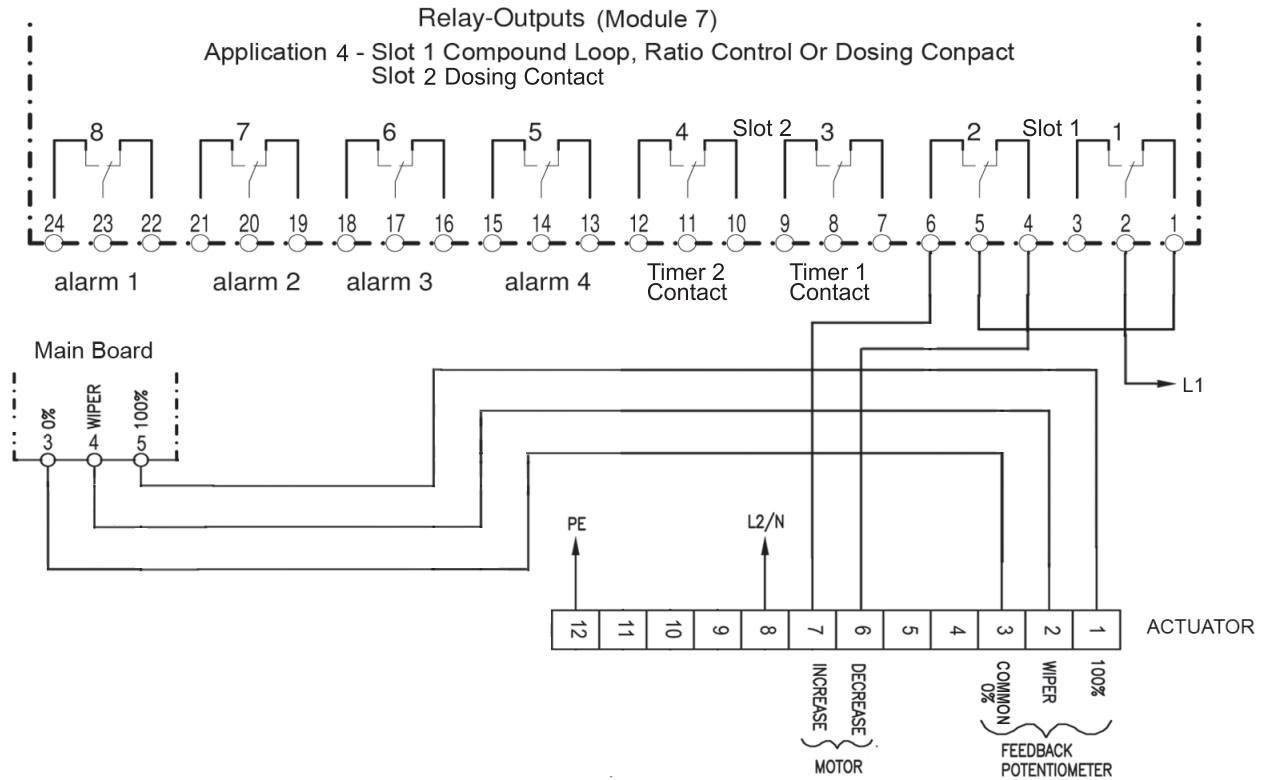
Note: Relays 3 & 4 wired the same for slot 2 control.

MFC APPLICATION 4 CONNECTING MFC TO MOTOR CONTROLLED ACTUATORS - INSTALLATION WIRING

Used with V10K and S10K Gas Feeders; Encore® 700 Series Metering Pumps;
and LVN-2000 Liquid Chemical Feed System
V-Notch - W2T11479 (115VAC); UXA96285 (230VAC)
Pump - W3T108074 (115VAC); W3T108075 (230VAC)

50.580.155.050H

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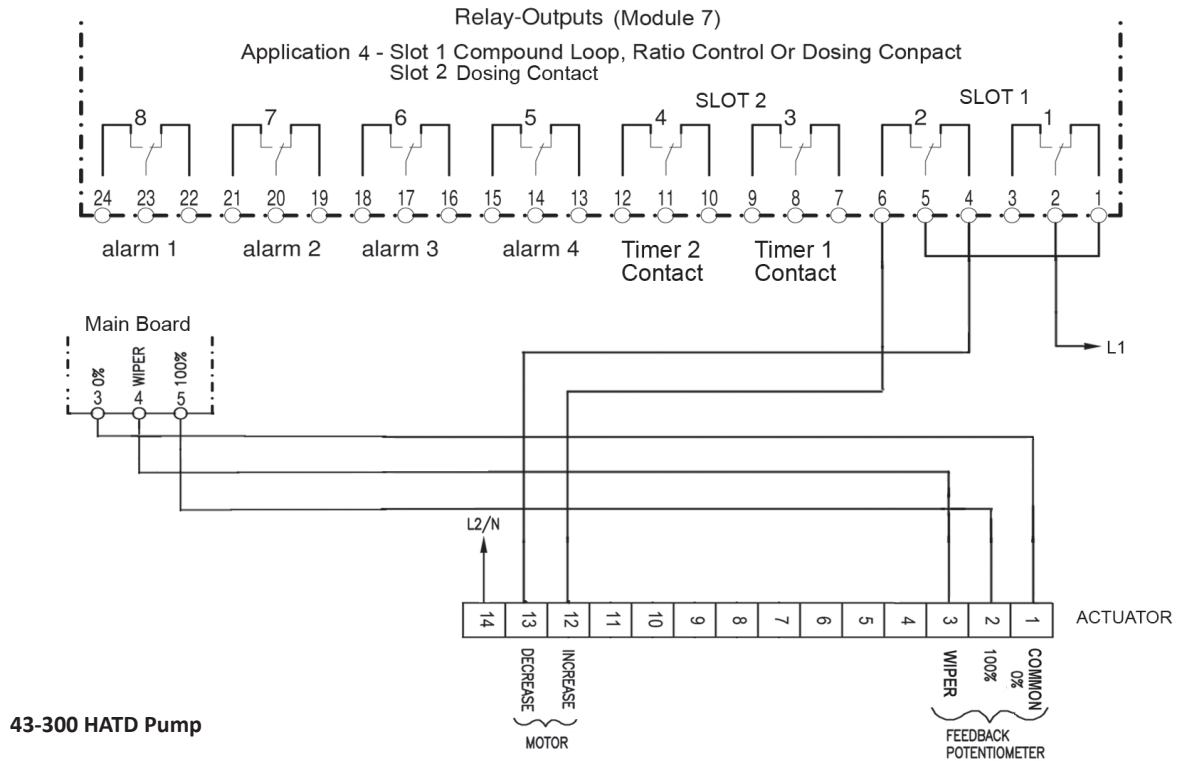
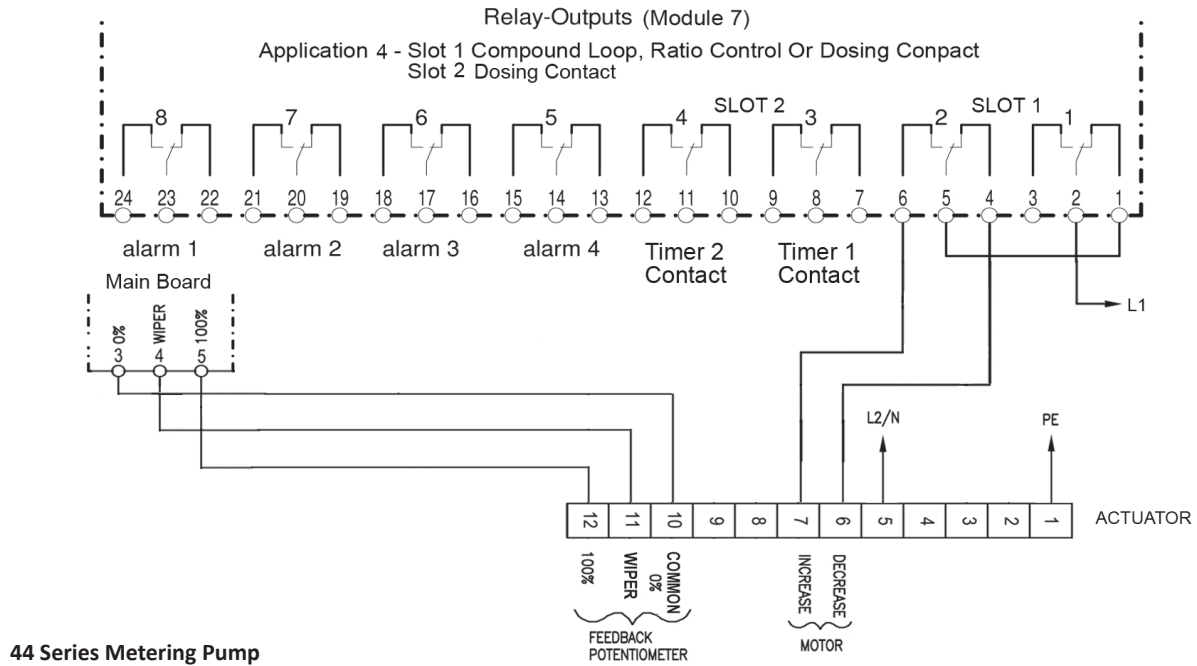
MFC APPLICATION 4

CONNECTING MFC TO MOTOR CONTROLLED ACTUATORS - INSTALLATION WIRING

Used with V-75, V-100, V-500 and V-2000 Gas Feeders
V-Notch - U27959; V-Notch - U29202

50.580.155.050J

ISSUE 0 5-09



MFC APPLICATION 4
CONNECTING MFC TO MOTOR CONTROLLED ACTUATORS - INSTALLATION WIRING
 Used with 43-300 HATD Pumps and 44 Series Metering Pumps
 43-300 Pump - U28342; 44 Series Pump - U27960

50.580.155.050K

ISSUE 0 5-09

SECTION 3

SECTION 3 - FUNCTIONS

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PARA./DWG. NO.

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3.1 General Information

The MFC is a special measuring and control device for use on potable quality water when used with the Depolox® 5 and VariaSens™ flow block, and any municipal, waste, industrial or process water, when used with the Micro/2000® and Deox/2000® flow block.

Typical applications:

- Measurement and registration of water parameters
- Flow-controlled potable water chlorination (combi-control)
- Flow-controlled fluoride dosing (combi-control)
- pH single feedback closed-loop control
- Chlorine single feedback closed-loop control
- Quantity-proportional dosing of disinfectants (ratio control)
- Wastewater chlorination, dechlorination dosing and control
- Industrial process water monitoring
- Raw water pre-chlorination dosing and control

The device processes up to four process parameters simultaneously, which are recorded with special sensor measuring modules and sensors.

The integrated graphic display displays system parameters:

- Measured value
- Mode
- Bar graph with limit values
- Set point and measuring range
- Description of customized measuring points

The menus are easy to use, displayed in plain text and are selected using soft keys.

A 7-day trend display enables you to view past measured values for up to four selectable process variables.

Four mA outputs and an RS485 bus interface including Evoqua Water Technologies protocol are available to connect visualization systems. Five different process control applications are integrated into the MFC to simplify commissioning.

3.1.1 Overall Function

Up to four measured values can be indicated by specific process components.
Possible measured values:

- Free chlorine*/Cl₂⁺⁺*, potassium permanganate*, chlorine dioxide*, ozone* (Depolox® 5 and Micro/2000® flow block)
- Total chlorine*/Combined chlorine* (membrane sensor and Micro/2000® flow block)
- pH value*
- Redox potential
- Conductivity*
- Ozone* (membrane sensor)
- Chlorine dioxide* (membrane sensor)
- Free chlorine* (membrane sensor)
- Fluoride
- External mA/V inputs
- Temperature measurement
- Actuator feedback
- Sulfur dioxide*, sodium bisulfite* (Deox/2000® flow block)

The value of the combined chlorine is calculated from the difference between the total chlorine and the free chlorine (optional). This requires a free chlorine and total chlorine measurement in the same sample water.

The Cl₂⁺⁺ value is a pH-compensated chlorine measurement (optional for Depolox® 5 flow block only). This requires a pH-measurement in the same sample water as the Depolox® 5 flow block.

The graphic display shows the measured data, limit values and set points as numeric values, diagrams or a trend line.

All measured values can be displayed at the same time.

* These measurements are automatically temperature-compensated.

The possible control functions are determined on the MFC by assigning the sensor measuring module to the module slot. The type of sensor measuring module installed in slot 1 and/or 2 determines which measured variables will be controlled.

Sensor measuring module 1	Ratio control, single feedback closed-loop control or combi-control Additional alarms and limit switches
Sensor measuring module 2	Single feedback closed-loop control or ratio control Additional alarms and limit switches Measured variables for set point trim for Control module 1 2x timer contact
Sensor measuring module 3	Alarms and limit switches
Sensor measuring module 4	Alarms and limit switches
Sensor measuring module 5	Inputs for two control variables for: <ul style="list-style-type: none"> • Current flow rate measurement for the combi-control/ratio control of module 1 as well as for the ratio control of module 2 • Signal input for external set point/dosing factor for the module 1 controller

NOTE: Not all the same controller functions are available in all applications (see 3.4, Applications).

3.1.2 Controller Outputs

Controller outputs for positioners, dosing pumps, pulse pumps, continuous mA output as well as a sample line dosing contact.

3.1.3 Adaption Program

The adaption programme automatically determines the control parameters for measuring module 1 and 2 when commissioning the single feedback closed loop control (chlorine, chlorine dioxide, ozone and potassium permanganate, sulfur dioxide and sodium bisulfite modules only).

3.1.4 Safety Functions

The following safety functions are integrated into the control if configured accordingly:

- Safety cut-off if dosing tank signals empty and also if the sample water supply fails (flow switch integral to Depolox® 5 and VariaSens™ flow block, external switch required for Micro/2000® and Deox/2000® flow block)
- Dosing time delay
- Alarms
- External stop for all controllers with digital input
- “Positioner closed” function in the event of a power failure (only if positioner has external power supply)
- Password protection on two levels

3.1.5 Applications 1 to 5

The MFC provides the option to customise the system to the desired on-site controller functions and systems using up to 5 integrated applications (see section 3.4, Applications).

3.1.6 Links

The MFC supports the following links:

- CMS 3.0:
Visualisation software for archiving and display of measured values on PCs with Windows operating systems
- SECO-S7:
PLC driver for data links to Evoqua PLC, Type S7-300
- OPC-Server Data Access V2.0:
Server software for Windows operating systems for data links to visualisation system with OPC client capability
- ChemWeb-Server:
Measured value archiving and display, remote diagnosis, remote access with standard browser with Internet and e-mail capability
- Process control systems of different manufacturers
(refer to the manual “RS485 Bus Interface for MFC” WT.050.580.002.UA.IM for description, specification and protocol)

3.2 Measurement Inputs

In principle, the following sensor measuring module types or retrofit kits can be installed at module slots 1 to 4:

DES	-	for Depolox® 5, Micro/2000® and Deox/2000® flow block assemblies
DES	-	for membrane sensors: free chlorine (FCI), chlorine dioxide (CD7), ozone (OZ7), total chlorine (TC1)
pH	-	pH value
mV	-	Redox value
R	-	Fluoride value
mS	-	Conductivity
mA/V	-	Input module

When the device is switched on, the menus are initialized according to the installed sensor modules. If the sensor modules are changed at a later date, the user menus are automatically initialized when the device is switched on.

Sensor Measuring Module 1 (MOD 1)

Sensor measuring module 1 is regarded as the main measurement and therefore has the most controller functions (ratio control, single feedback close-loop control or combi-control). No controller output is available for application 1.

Sensor Measuring Module 2 (MOD 2)

The sensor measuring module 2 has various functions depending on the application. Ratio control or single feedback closed loop control (application 3), two time switch contacts (application 4) or it can be used to optimise the controller set point in sensor measuring module 1 (application 5).

Module Slots 3 and 4 (MOD 3 and MOD 4)

Module slots 3 and 4 can be equipped with any sensor measuring module desired per the specific application. The measurands in module slots 3 and 4 can be locally monitored and/or output to a separate controller. They are not used by the MFC internal control functions for controlling system parameters.

Module Slot 5 (MOD 5)

Module slot 5 can only be equipped with a mA/V sensor measuring module, which is used to record further process parameters such as flow rate or external set point/dosing factor.

Module Slot 6 (MOD 6)

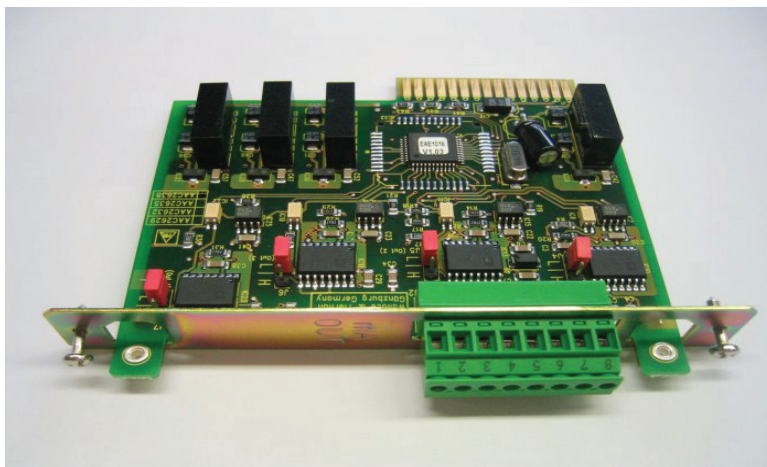
As an option, module slot 6 can be equipped with a four-way mA output card. Each mA output can be optionally assigned with a measured value or also with a controller control signal (Ym feedback / Yout).

3.3 Output Modules

3.3.1 mA Output Module

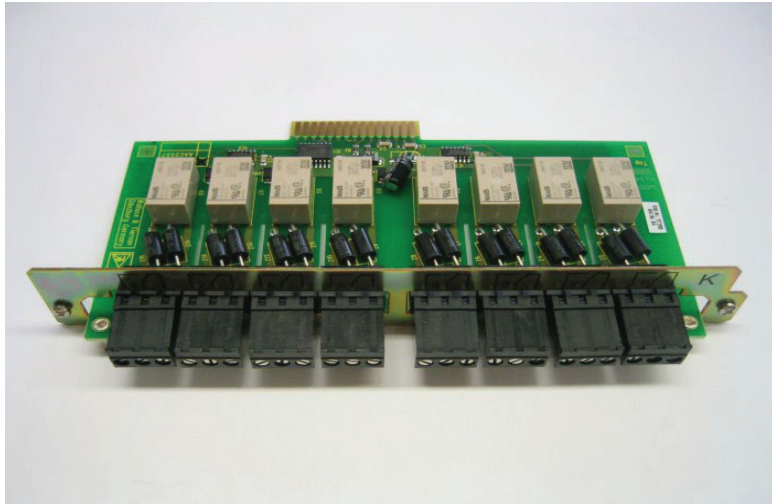
The mA output module has four potential-separated mA outputs. Each output can be configured in the menu to 0–5 mA, 0–10 mA, 0–20 mA or 4–20 mA. Any measured value, actuator output (Yout) or temperature can be assigned to the mA outputs.

NOTE: If less than 400 Ohm load is connected, the corresponding mA output's jumper should be attached to L (load < 400 Ohm). At higher loads, (max. 1000 Ohm), the jumper must be attached to H (load up to 1000 Ohm).



3.3.2 Relay Module (Eight-Way)

The relay module has eight relays, each with a two-way switch. These switches are assigned various switching tasks depending on the selected application (see section 3.4, Applications). The corresponding diagrams for the five applications are in the appendix under section 5, MFC Schematic Wiring. The switches are wired with suppressor diodes to protect from spikes. In order to switch larger inductive load, we recommend installing an additional contact such as a contactor or load relay.



3.4 Applications

The configuration of the system is determined by:

- The required measurement and control parameters
- The installed components
- The selection of the suitable application

The MFC provides the option to customize the analyzer/controller functions to suit the on-site systems using five integrated applications.

The available analyzer/controller functions are determined by selecting the applications 1, 2, 3, 4 or 5. Factory settings are always set for the respective application, if specified when ordered. However, these can be customized to the respective system at any time in the field.

NOTE: The defined application 1, 2, 3, 4 or 5 must be entered the first time the device is switched on (see section 2.10 “Switching the device on”). If the application is subsequently changed, all functions and control parameters return to factory defaults and must be reset.

The five applications 1, 2, 3, 4 and 5 are shown below. The illustrations show the options for wiring the inputs and outputs. Each application offers different control functions for input slots 1 and 2.

NOTE: Only the measurands installed in slots 1 and 2 are used for control functions. Slots 3-5 have no control functions.

NOTE: The mV/mA input module must be installed in slot 5 if flow input will be used in the selected application. This flow input signal will be used for all control functions selected for both slot 1 and 2.

3.4.1 Application 1 - Analyzer Only, No Control Functions

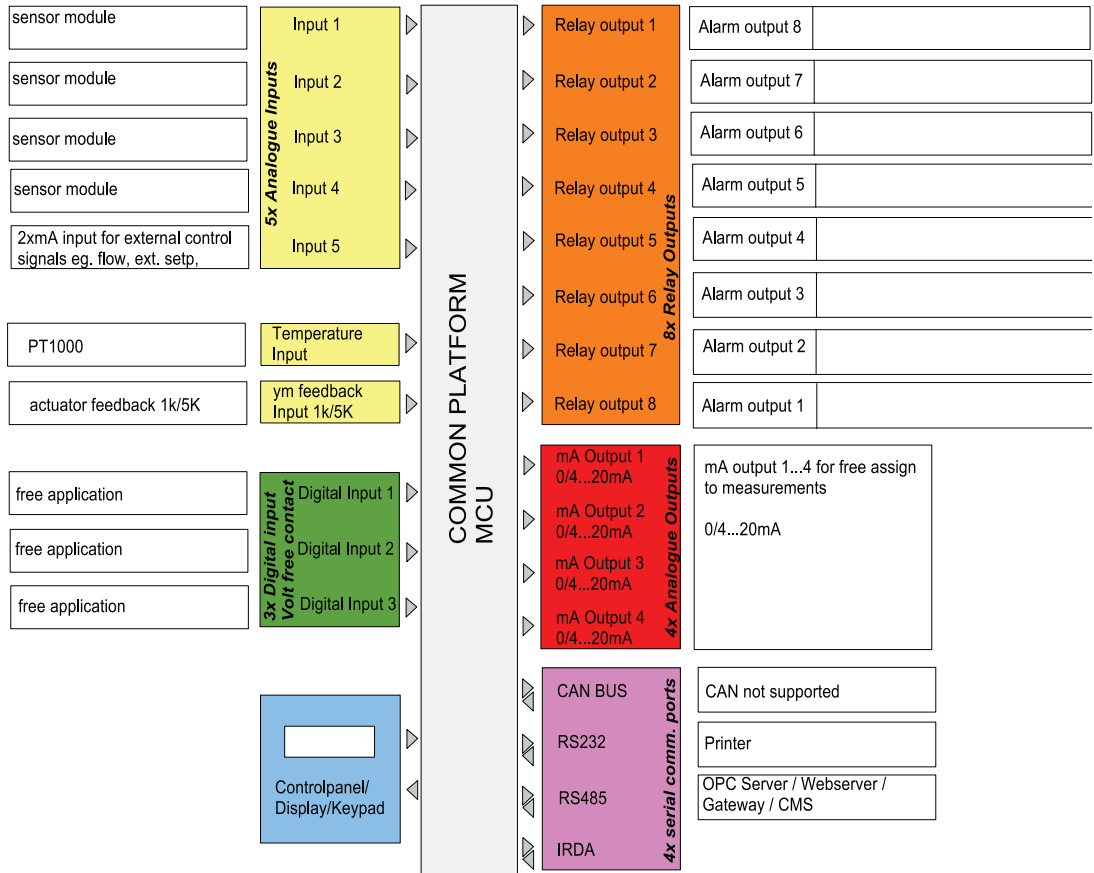


- Up to four sensor modules
- No controller functions
- mA output can be assigned
- 8 alarm contacts
- Switching functions configurable on digital inputs and limit values

NOTE: Alarms 1 and/or 2 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 1. Alarms 3 and/or 4 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 2.

In this configuration no control functions are available. Outputs (mA, relays) are assignable for transmitting signals to a separate control device.

Application 1



3.4.2 Application 2 - Compound Loop Control, Slot 1 Only

AAC4561
Application
2 / 5

POWER

↑

↓

6

5

4

3

2

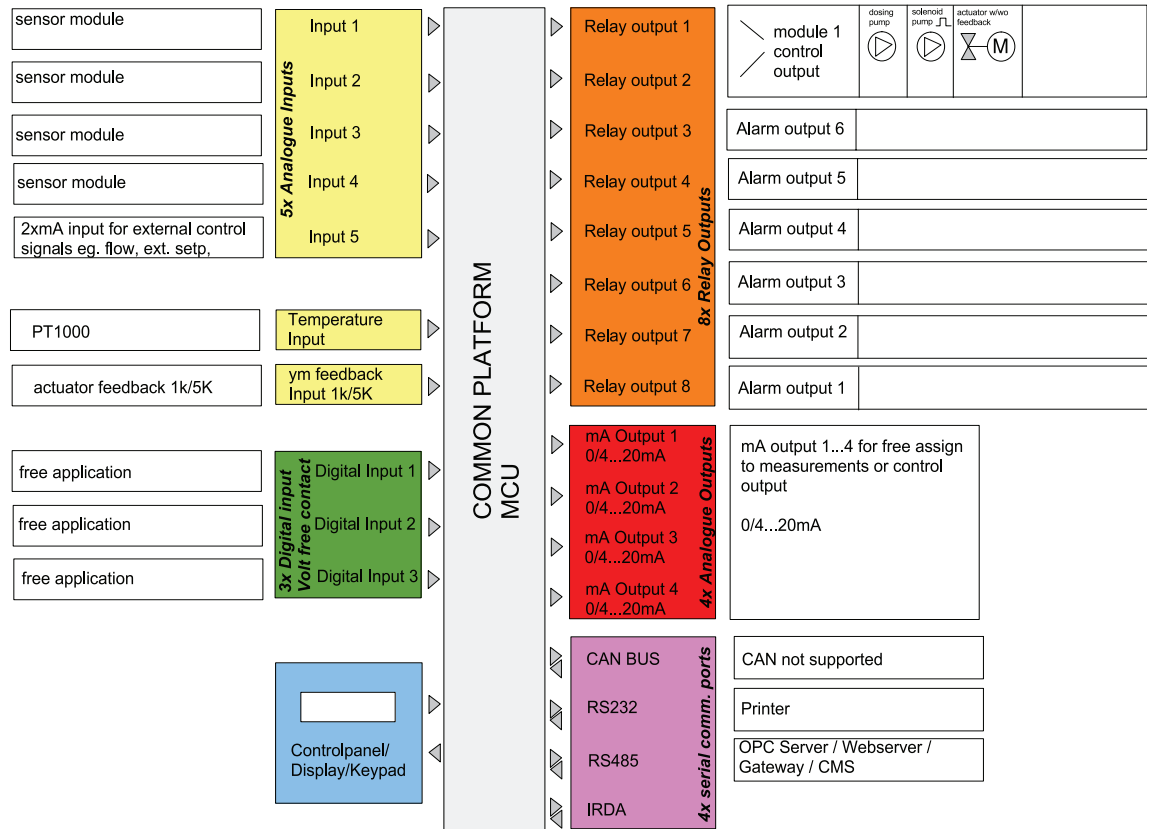
1

- Up to four sensor modules
- Sensor measuring module 1 has controller outputs for ratio control, single feedback closed-loop control or compound loop control.
- mA output can be assigned
- 6 alarm contacts
- Switching functions configurable on digital inputs and limit values

NOTE: Alarms 1 and/or 2 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 1. Alarms 3 and/or 4 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 2.

In this configuration no control functions are only available for measurand installed in slot 1.

Application 2



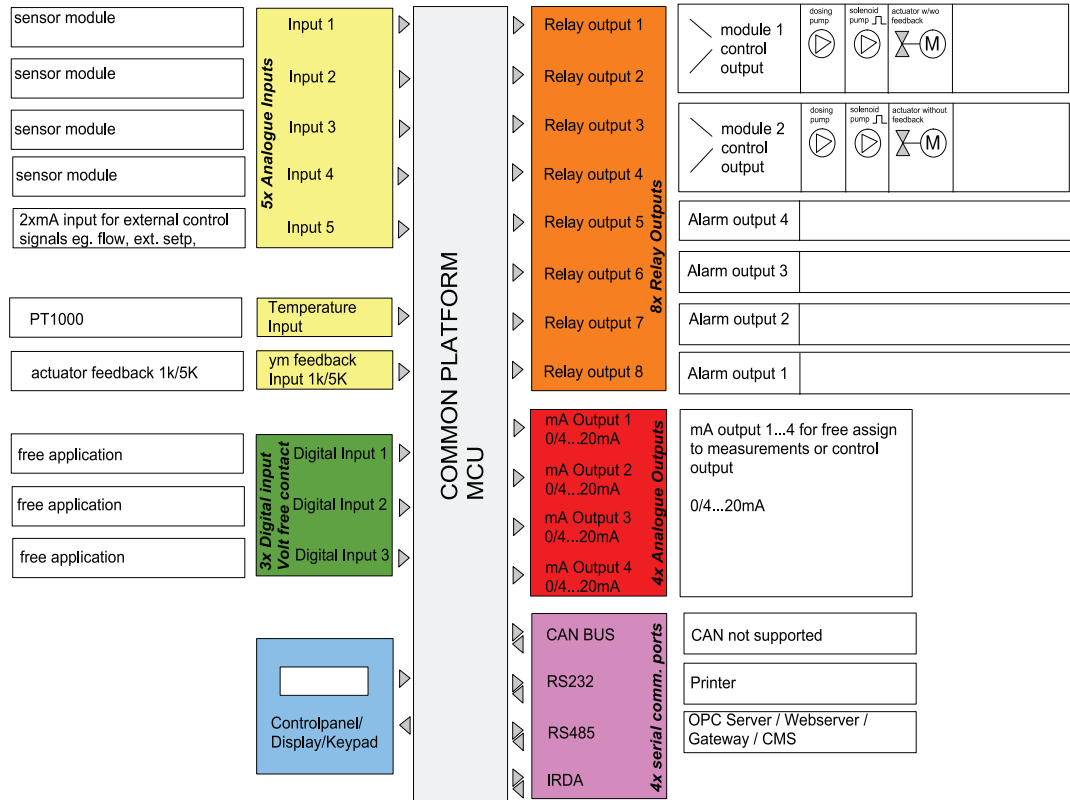
3.4.3 Application 3 - Compound Loop Control Slot 1, Ratio Control Slot 2.



- Factory setting
- Up to four sensor modules
- Sensor measuring module 1 has controller outputs for ratio control, single feedback closed-loop control or compound loop control.
- Sensor measuring module 2 has controller outputs as single feedback closed loop control or ratio control (same flowrate signal as MOD 1)
- mA output can be assigned
- 4 alarm contacts
- Switching functions configurable on digital inputs and limit values

NOTE: Alarms 1 and/or 2 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 1. Alarms 3 and/or 4 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 2.

Application 3



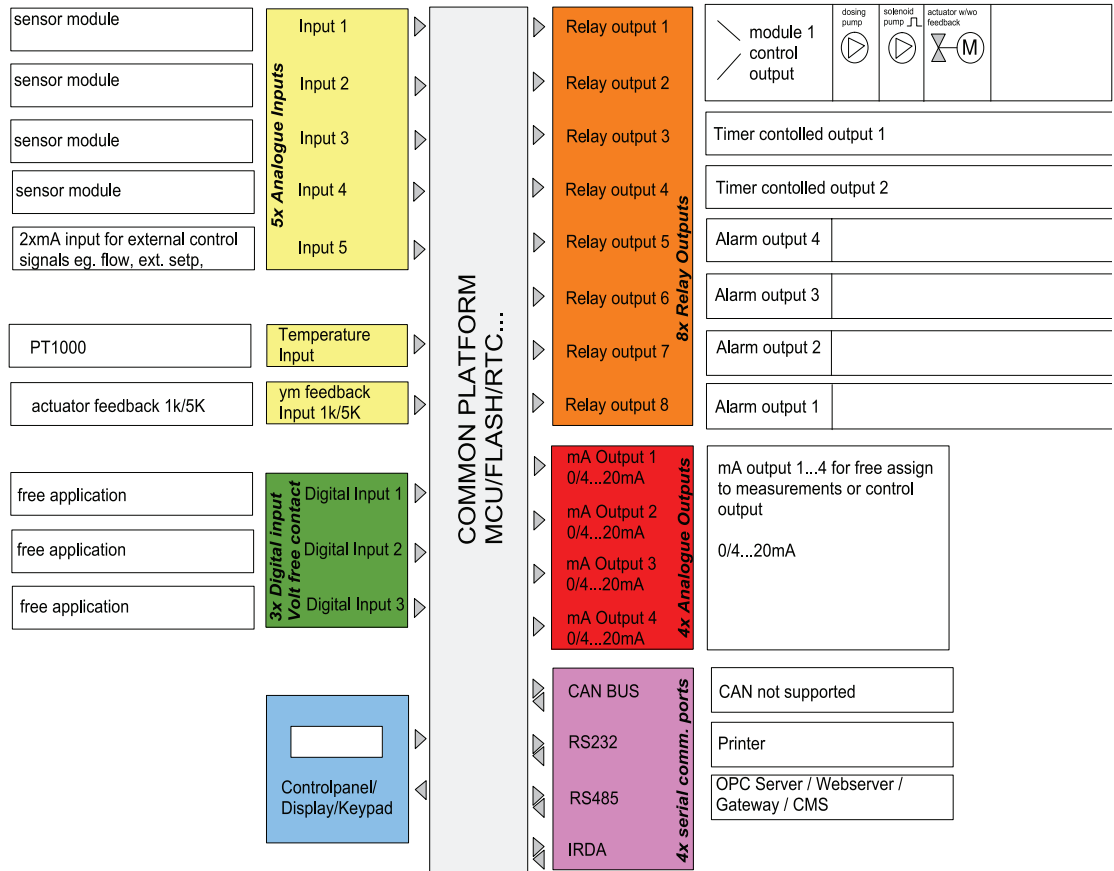
3.4.4 Application 4 - Compound Loop Control Slot 1, Dosing Contacts Slot 2.



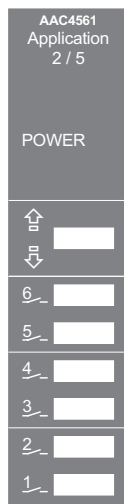
- Up to four sensor modules
- Sensor measuring module 1 has controller outputs for ratio control, single feedback closed-loop control or compound loop control
- Sensor measuring module 2 has two separately configurable switch contacts
- mA output can be assigned
- 4 alarm contacts
- Switching functions configurable on digital inputs and limit values

NOTE: Alarms1 and/or 2 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 1. Alarms 3 and/or 4 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 2.

Application 4



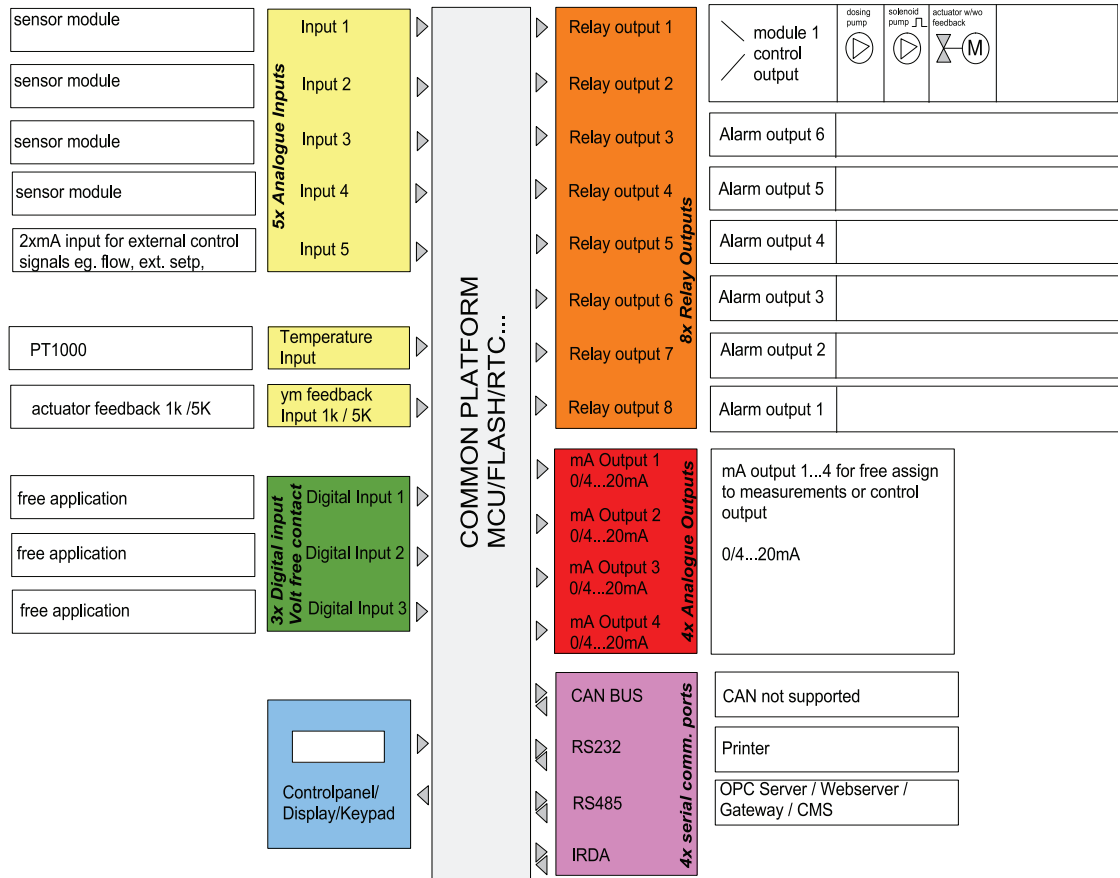
3.4.5 Application 5 - Setpoint Trim Control Using Both Slots 1 and 2



- Up to four sensor modules
- Sensor measuring module 1 has a controller output for compound loop control
- In conjunction with sensor measuring module 1, sensor measuring module 2 has automatic set point optimization (setpoint trim)
- mA output can be assigned
- 6 alarm contacts
- Switching functions configurable on digital inputs and limit values

NOTE: Alarms1 and/or 2 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 1. Alarms 3 and/or 4 automatically assigned as power switching relays if Micro/2000® or Deox/2000® modules are installed in slot 2.

Application 5



3.5 Controller Function

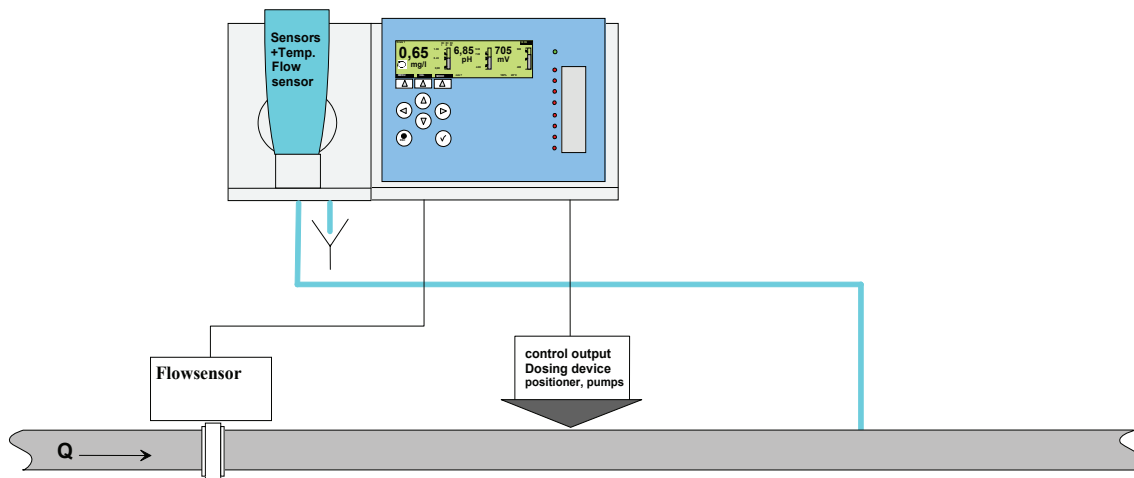
The following integrated control modes are available for selection:

- Flow proportional control
- Ratio control
- Direct residual control
- Compound loop control
- Setpoint trim control

Online measurement can be transmitted directly from the MFC and external measuring system via mA input signal. External control signals such as flow rate and external setpoint can be input using the mA/V input module. The MFC system can accept up to four main measurements and two external control signals. In addition, measuring inputs for temperature, actuator feedback and three digital inputs are available.

3.5.1 Ratio Control and Flow Proportional - Available in Applications 2, 3 and 4

This operating mode controls the quantity-proportional dosing of disinfectants.



NOTE: The internal dosing factor and flow measurement from MOD 5 are used as control variables for both slots 1 and 2.

Required module configuration:

- MOD1 - To record the measured value (applications 2, 3, 4)
- MOD2 - To record the measured value (application 3)
- MOD5 - mA/V input module to record flow rates as well as the external dosing factor

Input signals:

- Flow measurement (0/4–20mA, 0–10V) scalable (module 5)
- Second control variable possible via sensor measuring module 1
- Internal or external dosing factor (0/4–20 mA module 5)

The following controller outputs are possible:

- Dosing pumps
- Solenoid pump
- Positioner with feedback 1kOhm/5kOhm
- mA analog output

3.5.1.1 Ratio Control Theory of Operation

The flow rate is recorded and the dosing rate adjusted proportionally to the flow rate using the flow rate sensor with linear mA/V output signal.

For the flow signal settings, see menu "Input/Output" – "Flow Wq".

The ratio between control variables and dosing output is determined by the internal dosing factor (control "Dos.Fact.Source" = internal), or it can also be set by an external mA/V input signal (Dos.Fact.Source = external).

You can switch between internal and external dosing factor (DF) via the digital input ("Dos.Fact.Source" = "external with DI3" or "internal with DI3").

It is possible that a second control variable "Measured Value X" (measured value from module 1) will proportionally or reverse proportionally influence the ratio control ("X-direction" = direct / inverse variable).

The second control variable X is activate if the parameter "Control Variable X" "Measured Value X" (second control variable deactivated by "Off" setting (factory setting).

The amplification factor for this parameter is defined by the X-factor input parameter.

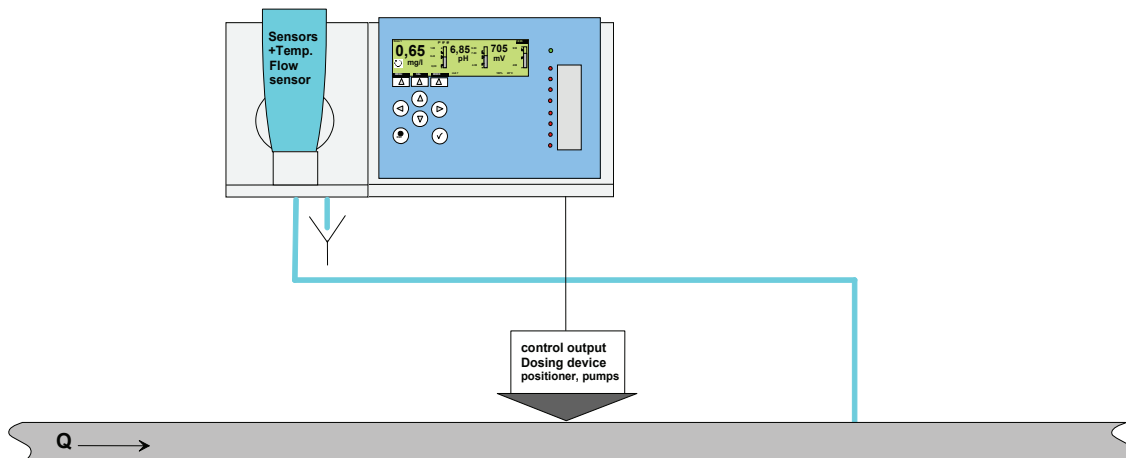
The controller output is calculated in this operating mode as follows:

$$Y_{out} = Wq \times DF \times (X\text{-measured value} \times X\text{-factor})$$

<i>Wq</i>	<i>Control variable 1 flow in %</i>
<i>DF</i>	<i>Set dosing factor in %</i>
<i>X-measured value</i>	<i>Control variable 2 measured value sensor measuring module 1 in %</i>
<i>Yout</i>	<i>Amplification factor for X measured value</i>
<i>Yout</i>	<i>Determined controller output value %</i>

3.5.2 Direct Residual Control - Available in Applications 2, 3 and 4

This operating mode controls the desired measured variable according to the provided set point.



Required module configuration:

- MOD1 - To record the measured value (applications 2, 3, 4)
- MOD2 - To record the measured value (application 3)
- MOD 5 - mA/V input module to record the external set point (optional)

NOTE: This control operating mode is also available for sensor measuring module 2 if application 3 is selected, however, only with internal set point input.

Input signals:

- Module 1 measured value recording
- Internal or external set point (module 5) (optional)

The following controller outputs are possible:

- Dosing pumps
- Solenoid pump
- Positioner with/without feedback (1kOhm/5kOhm)
- Continuous

3.5.2.1 Direct Residual (Single Feedback Closed-Loop) Control Theory of Operation

A PI controller is used to control the measured variables of sensor module 1 continuously and without control deviation from the desired set point. It continuously determines the required dosing output.

The set point can be set within the measuring range of module 1 (at "Set point Source" = internal).

Kp and Tn are control parameters to be set. They can also be automatically determined via the integrated adaption during a chlorine control.

An external set point from 0–100 % can be provided via the mA/V input signal ("Set point Source" = external) You can switch between internal and external set point via the digital input ("Set point Source" = "external with DI3" or "internal with DI3").

The control direction can be selected with the parameter "Control Direction" = direct or inverse (e.g. direct = chlorination, inverse = dechlorination).

The controller output is calculated in this operating mode as follows:

$$Y_{out} = Y_{pi} = e_k \times K_p \times (1 + t/t_n)$$

t Controller cycle time

t_n Integral action time

K_p Control amplification 100 / X_p

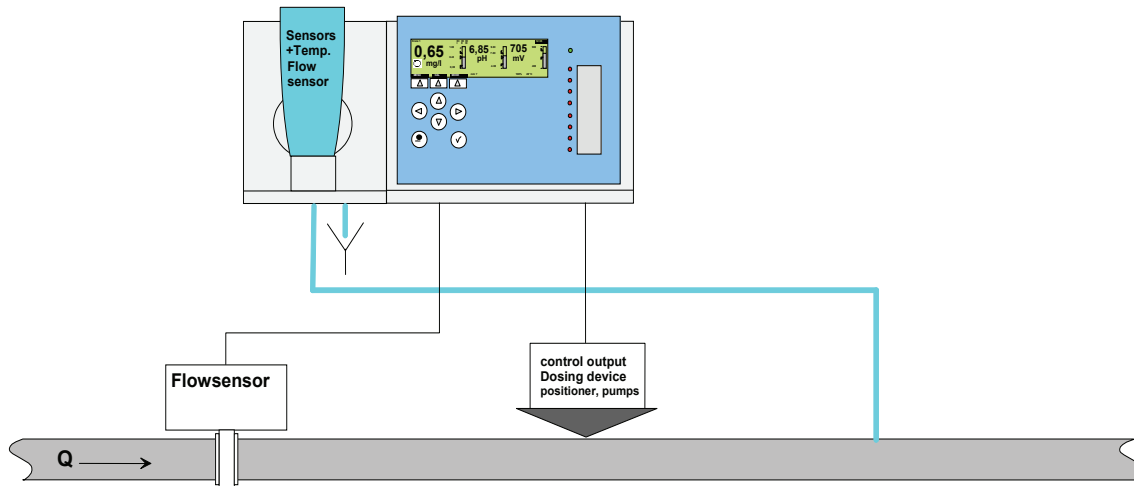
e_k Set point-actual value control deviation

Y_{pi} PI controller output variable

Y_{out} Determined controller output value %

3.5.3 Compound Loop - Available in Applications 2, 3 and 4 For Slot 1 Only

The compound loop control is a combination of the ratio control with additional single feedback closed-loop control to correct control deviations.



Required module configuration:

- MOD 1 - To record measured value (applications 2, 3, 4)
- MOD 5 - mA/V input module to record the flow as well as the external set point

Input signals:

- Flow rate measurement (0/4–20mA, 0–10V) scalable (module 5)
- Module 1 measured value recording
- Internal or external set point (module 5)

Output parameter:

- Dosing pumps
- Solenoid pump
- Positioner with/without feedback (1kOhm/5kOhm)
- Continuous
- 4-20mA out

3.5.3.1 Compound Loop Control Theory of Operation

The combi-controller outputs a dosing rate proportional to the flow rate, which does not have a fixed dosing factor proportional to the flow rate as in the ratio control, but varies depending on demand.

To detect control deviations, the sensor module 1 records the control variable and a set point is specified, which are compared with the integrated single feedback closed-loop control.

The internal set point can be set within the measuring range of sensor module 1. "Set point Source" must be set to "internal". An external set point from 0–100 % can be provided via the mA/V input signal. "Set point Source" must be set to "external". You can switch between internal and external set point via the digital input. The "Set point Source" must be set to "external with DI3" or "internal with DI3".

The Xp and Tn control parameters of this higher-level single feedback closed-loop control are automatically determined by the integrated fuzzy logic Tconst and Tvar process times to be entered at 100 % flow rate. Because the Tvar process time changes, Tvar, Xp and Tn are continuously updated by the integrated fuzzy logic.

The MFC operates internally with a dosing factor table for 0 – 105 % flow. In 5 % intervals, the device determines the required dosing factors automatically during operation based on the corresponding flow rate. The single feedback closed-loop control corrections are transferred into the dosing factor table during this process. Non-linearities in the control loop are learned this way. This quickly activates the set point if flow rate changes occur.

The control operating mode can be switched between ratio control and single feedback closed-loop control via digital input.

The control direction can be selected with the parameter "Control Direction" = direct or inverse (e.g. direct = chlorination, inverse = dechlorination)

3.5.3.2 Behavior in Operation

Operation after a flow rate change:

The single feedback closed-loop control remains switched off (Ypi stop function) during the disturbance variables (flow rate change, positioner running time, dead time from line lengths). This maintains a stable control, which means the control operates with the dosing factor from the dosing factor table applicable for the new flow rate. The time the single feedback closed-loop control is switched off is determined by the fuzzy module and is therefore variable ("PI" display in seconds).

A larger change in the set point deletes all learning meters, in order to reinitialise the dosing rate curve when the set point is reached. However, the learned dosing factors remain initially unchanged. Inactivated flow rate values are automatically preassigned a dosing factor. The single feedback closed-loop control is always active.

Control deviations that occur are quickly offset by the PI single feedback closed-loop control during continuous flow.

A positive jump in the flow rate causes a brief drop below the set point due to the running time of the positioner and the dosing delay. Therefore, the PI controller freezes for a brief period ("PI" display in seconds).

A negative jump in the flow rate causes the set point to be briefly exceeded due to the running time of the positioner and the dosing delay. Therefore, the PI controller freezes for a brief period ("PI" display in seconds).

The PI controller is not deactivated if the flow rate is continuously rising or falling if the dosing rate can quickly adjust to these changes. This is true of fast positioner running times and loops without dosing delay.

3.5.3.3 Special Functions

- The control direction can be switched.
- Automatic determination of the control parameter using the integrated fuzzy module. The fuzzy module determines the control parameter from the embedded Tconst and Tvar process times.
- The set point can be switched between internal and external
- Ypi stop function during a change in control variable
- Control variable Wq available optionally as proportional or indirect proportional as well as factor adjustment
- Smooth switch from compound loop control to ratio control or residual only control via digital input 1, 2 or 3 available

$$Y_{out} = W_q \times \underbrace{DF_{W_q}}_{\text{Ratio}} + \underbrace{e_k \times K_p \times (1 + t/tn)}_{\text{Feedback control}}$$

<i>t</i>	<i>Internal controller cycle time</i>
<i>tn</i>	<i>Integral action time</i>
<i>Kp</i>	<i>Control amplification 100 / Xp</i>
<i>ek</i>	<i>Set point-actual value control deviation</i>
<i>DF_{Wq}</i>	<i>Learned dosing factor for the current flow rate</i>
<i>Wq</i>	<i>Flow rate signal in %</i>
<i>Yout</i>	<i>Determined controller output value %</i>

3.5.3.4 Determining Compound Loop Control Process Times

To adjust the control for compound loop control, the Tconst and Tvar process times must be entered in the parameter menu path. These times refer to control loop dead times, which on the one hand are independent of the control variables, and on the other hand depend proportionally on the control variables.

The constant dead time < Tconst > (independent of control variable) consists of the control variable measurement dead time (measuring dead time) and possible dosing delays.

The variable dead time < Tvar > depends on the current control variable and is entered in the menu at a control variable of 100%.

The following calculation examples apply for the use of the MFC for chlorine dosing.

3.5.3.5 Determining the Control Variable Independent Dead Time Tconst

The control variable independent dead time Tconst consists of the measuring dead time and the dosing dead time.

Calculating the Measuring Dead Time

Calculation 1:

The sample water is extracted right after the mixture loop and fed to the measuring cell.

The sample water dead time depends on the nominal diameter and length of the sample water line and the flow rate to the measuring cell. A flow rate of 36 l/h is assumed for the Depolox® 5 measuring cell.

The following equation applies to the Depolox® 5:

$$t_{mw}(\text{Depolox}^{\circledR} 5) = (d_{mw} \times d_{mw} \times l_{mw}) : 7.65 \quad (\text{result in min})$$

In general, this equation applies:

$$t_{mw} = (4.71 \times d_{mw} \times d_{mw} \times l_{mw}) : Q_{mw} \quad (\text{result in min})$$

d_{mw} = Internal diameter of the sample water line in cm
 l_{mw} = Length of the sample water line in meter
 Q_{mw} = Flow rate to the measuring cell in l/h

Example

The sample water line is 10 m long and connected to a Depolox® 5 chlorine measuring cell.

$$t_{mW} = (0.6 \times 0.6 \times 10) : 7.65 \text{ min} = 0.47 \text{ min, (i.e. approx. 28 sec.)}$$

Calculation 2:

The sample comes from the sample water pump (bypass line).

Sample water dead time depends on the flow rate of the sample water pump, nominal diameter of the bypass line and its length up to the sample water branch pipe to the measuring cell.

$$T_{by} = (4.71 \times d_{by} \times d_{by} \times l_{by}) : Q_{by}$$

d_{by} = Internal diameter of the bypass line in cm

l_{by} = Length of the bypass line from the sample water extraction point to the sample water branch pipe to the cell in m

Q_{by} = Flow rate to the bypass pump in l/h (result in min)

Check whether the length of the sample water line to the measuring cell can be neglected. If so, establish the sum from calculation 1 and 2.

Calculation 3:

The sample water distraction is carried out as in calculation 1 and/or 2. To increase the exposure time, the sample water is also sent through a delay tank.

The exposure time in the delay tank must be added to the calculated time.

3.5.3.6 Determining the Dosing Dead Time (Dosing Delay)

Dosing dead times arise from long dosing lines and positioner running times.

Calculation 1:

Determining the dead time based on dosing line length

The dosing dead time can be determined as follows:

$$t_{dos} = (4.71 \times d_{dos} \times d_{dos} \times l_{dos}) : Q_{dos} \text{ (result in min)}$$

d_{dos} = Internal diameter of the dosing line in cm

l_{dos} = Length of the dosing line in m

Q_{dos} = Dosing line flow rate in l/h

Calculation 2:

If rapid control variable changes are expected in the system, which the dosing equipment cannot adjust to (e.g. positioner running times, dosing pump cycle times), the dosing delay time should be assumed under all circumstances to be half of the positioner running time t_y or the cycle time t_p .

At a positioner running time of 80 seconds, a value of approx. 40 s should be assumed as the constant dosing delay.

The sum of the measured dead time and the dosing delay is displayed in the < Tconst > menu in minutes.

3.5.3.7 Determining the Control Variable Dependent Tvar Dead Time

The control variable dependent Tvar dead time depends on the nominal flow rate, the internal diameter of the line and the distance between where the chlorine is added and the sample water extracted.

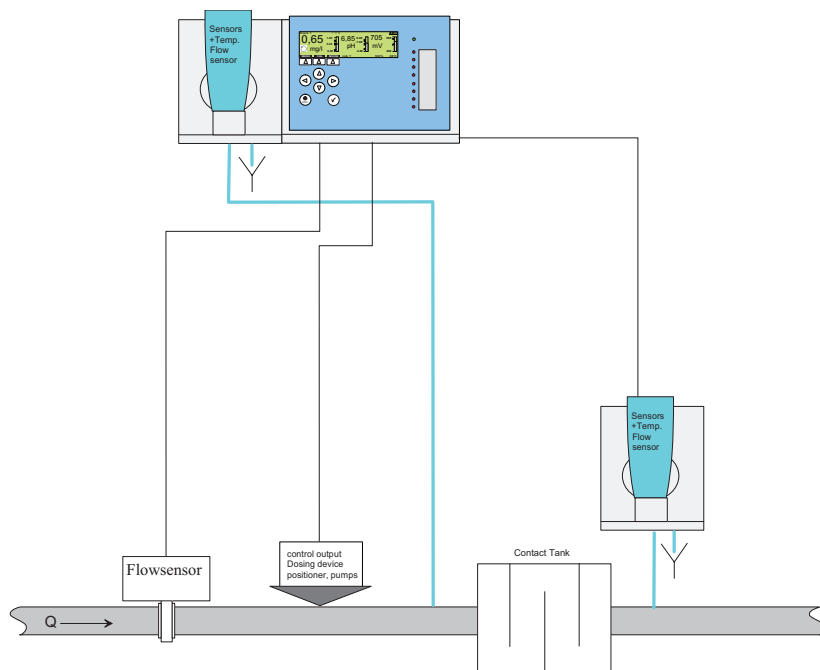
$$t_{var} = (d_{pipe} \times d_{pipe} \times l_{pipe}) : 212.3 \times Q_{nom} \quad (\text{result in min})$$

d_{pipe} = Internal diameter of the pipeline in cm
 l_{pipe} = Distance between where chlorine is added and sample water extracted in m
 Q_{nom} = Nominal flow rate in m³/h (reflects the flow rate, which is preset for the controller as 100% flow signal)

If there are special reaction tanks in the system, they must be treated separately.

3.5.4 Set point Trim Control - Available in Application 5 Only

This control type consists of a compound loop control with adaptive set point. A second measurement controls possible control deviations. The compound loop control's adaptive set point adjustment automatically equalizes control deviations that develop in the system.



Required module configuration:

- MOD1 - To record the measured value
- MOD2 - To record the measured value
- MOD5 - mA/V input module to record flow as well as the external set point.

Input signals:

- Flow measurement (0/4–20mA, 0–10V) scalable
- Measured variable 1 compound loop control (Sensor module 1 - Cl_2 , pH, –)
- Measured variable 2 control measurement (Sensor module 2 - Cl_2 , pH, –)

The following requirements must be met:

Measured variables 1 and 2 must be equal measurements with the same measuring range and unit.

Example: Module 1 = Cl_2 free with 1.00 mg/l measuring range
 Module 2 = Cl_2 free with 1.00 mg/l measuring range

Only internal set point possible.

Output parameter:

- Dosing pump
- Solenoid pump
- Positioner with/without feedback 1kOhm/5kOhm
- Continuous mA output

3.5.4.1 Set point Trim Control Theory of Operation

The control circuit 1 operates as the compound loop control (see section 3.5.3, Compound Loop). All settings for module 1 must also be made as described under compound loop control.

The actuator output is based on the same calculation as the compound loop control. In addition, the compound loop control set point may be optimized depending on the need.

$$Y_{out} = Wq \times \left(\frac{DF}{Ratio} + e_k \times Kp \times \left(1 + \frac{t}{tn} \right) \right)$$

Ratio Feedback control

<i>t</i>	-	<i>Internal controller cycle time</i>
<i>tn</i>	-	<i>Integral action time</i>
<i>Kp</i>	-	<i>Control amplification 100 / Xp</i>
<i>ek</i>	-	<i>Set point-actual value control deviation</i>
<i>DF</i>	-	<i>Learned dosing factor</i>
<i>Wq</i>	-	<i>Flow rate signal in %</i>
<i>Yout</i>	-	<i>Determined controller output value %</i>

A second measurement (sensor measuring module 2) is used to optimize the control and it detects possible control deviations. The compound loop control's adaptive set point adjustment then optimizes the set point, in order to eliminate existing control deviations.

The set point adjustment operates with a delay time that determines the set point trim function Tconst and Tvar as well as the flow rate using the process times. The flow must be constant during this delay, otherwise the time restarts.

The following parameters must be set for this operating mode in menu (2):

- Set point range
- Trim factor
- Xsh
- Tconst
- Tvar

3.5.4.3 Set point Range

This parameter describes the range within which the combi-control set point 1 can be adjusted by the set point trim.

The set point range corresponds to the measuring range in percent. The compound loop control set point may move within the range of set point2 + set point range or set point2 - set point range.

Example:

Measuring range	=	2.0 mg/l free chlorine
Set point 2	=	1.00 mg/l
Set point range	=	20%

The set point range of 20% defined here corresponds to the measuring range, (i.e. 20% of 2.00 mg/l = 0.40 mg/l). The set point may move in the range of 0.60 to 1.40 mg/l.

If the set point trim function records a value outside this range, the maximum or minimum value of the range is entered (in this example: 0.60 mg/l and 1.40 mg/l).

3.5.4.4 Trim Factor

This parameter describes the modification factor, by which the combi-control set point 1 should change in the event of a control deviation. The value corresponds to the control deviation in percent.

Example:

Measured value=	0.60 mg/l free chlorine
Set point	= 1.00 mg/l
Trim factor	= 50%
Error	= 0.40 mg/l

The set point is increased by 0.20 mg/l, which reflect 50% of the error.

3.5.4.5 Xsh

This parameter describes a neutral range for the measured value of module2 and is indicated in percent on the measuring range end value. If the measured value in module 2 is within this range around the set point, the set point trim function is inactive. If the measured value of module 2 is outside this neutral range, the set point trim function is active and optimises the set point of module1.

3.5.4.6 Determining the Set point Trim Function

To adjust the control for the set point trim function, the Tconst and Tvar process times must be entered in the set point trim menu. These times refer to control loop dead times, which are independent of the control variables, and depend proportionally on the control variables.

Tconst Menu 2

The constant dead time “Tconst” for the set point trim is the sum of the module 2 measurement dead time and possible dosing delays during the combi-control.

For the calculation, see “Determining combi-control process times”.

Tvar Menu 2

The variable dead time “Tvar” depends on the current flow rate control variable, the internal diameter of the line and the distance between where the chlorine is added and the sample water extracted. Tvar is entered in the menu for a control variable at 100% (flow rate = 100%).

3.5.4.7 Tvar Determination Procedure

Enter flow rate Wq between 50% and 100%.
Set manual dosing rate and start the dead time measurement at the same time.

Wait until the actual value2 adjusts to the dosing rate and remains constant.

Stop elapsed measuring time.

Calculate as follows:

$$\text{Tvar} = (\text{measuring time} - \text{Tkonst}) \times 100\% / \text{flow rate Wq\%}$$

3.6 Controller Outputs

3.6.1 Controller Types

Controller For	Type	Parameter Description	Action
Positioner with feed-back	3-point	Positioner with Ym	Dosing ↑ or ↓
Positioner without feedback	3-point	Positioner without Ym	Dosing ↑ or ↓
Motor dosing pump (pulse duration controller)	2-point	Dosing pump 2p	Dosing ↑ or ↓
2 Motor dosing pumps (pulse duration controller)	3-point	Dosing pump 3p	Dosing ↑ or ↓
Pulse pump (pulse frequency controller)	2-point	Pulse pump 2p	Dosing ↑ or ↓
2 Pulse pumps (pulse frequency controller)	3-point	Pulse pump 3p	Dosing ↑ or ↓
Dosing pump with mA-input	2-point	Analog output 2p	Dosing ↑ or ↓
2 Dosing pumps with mA-input	3-point	Analog output 3p	Dosing ↑ or ↓
Dosing contact	2-point	Enable contact	Dosing ↑

3.6.2 Positioner (With and Without Feedback)

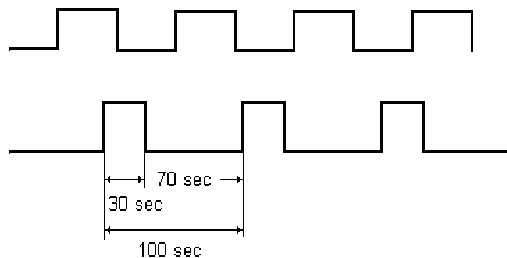
With the selection of the integrated controller for “positioner”, for example, it is possible to use chlorine overfeed control in connection with a positioner as dosing equipment in a chlorinator.

3.6.3 2-Point Pulse Duration Controller for Dosing Pumps

The dosing pump is switched on for the calculated time within an adjustable cycle period TP (relay contact). The cycle period is mainly determined by the reaction time of the connected system and entered as the cycle period TP.

Example:

Cycle period TP	=	100 s
Output value Yout	=	30%
Duty cycle	=	30 s
Off duty cycle	=	70 s



3.6.4 2-Point Pulse Frequency Controller For Pulse Pumps

Pulse pumps are controlled with 0 to 100 or 0 to 120 pulses per minute, depending on the specification of the connected pump.

The duty cycle during each dosing is 0.3 s. The break time is calculated between 0.2 and 60 s depending on the dosing rate.

Example for a solenoid pump with 120 pulses/min.:

Yout in %	100...	84...	72...	56	50...	33...	25...	10...	5...	10
Pulses/ min	120...	96...	85...	75	60...	40...	30...	12...	6...	10

3.6.5 3-Point Pulse Duration Controller for Dosing Pumps and 3-Point Pulse Frequency Controller for Solenoid Pump

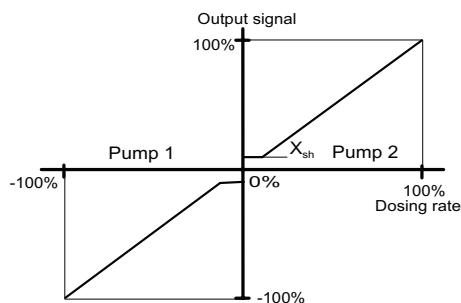
Pump 1 decreases the control value.

Pump 2 increases the control value.

The control range is between -100% (pump 1) and +100% (pump 2); this range can also be set in manual mode.

If the set point = actual value, no pump is activated (neutral zone Xsh).

Output signals as for 2-point pulse-duration controller and 2-point pulse-frequency controller.



3.6.6 Controller With mA Output

The MFC has up to four analog mA outputs. These can be assigned individually as registration or controller outputs.

If module 1 dosing “analog output 2p” or “analog output 3p” is selected, the mA output 1 is permanently assigned.

If module 2 dosing “analog output 2p” or “analog output 3p” is selected, the output 2 is permanently assigned.

3.6.7 Analog Output Controller 2-Point

With a controller output of 0%, the output current is 0 or 4mA; with a higher controller output, the output current reaches up to 20mA. Pumps with current input, thyristor controllers with DC or 3-phase pumps or analog control valves can be used as dosing equipment.

3.6.8 Analog Output Controller 3-Point

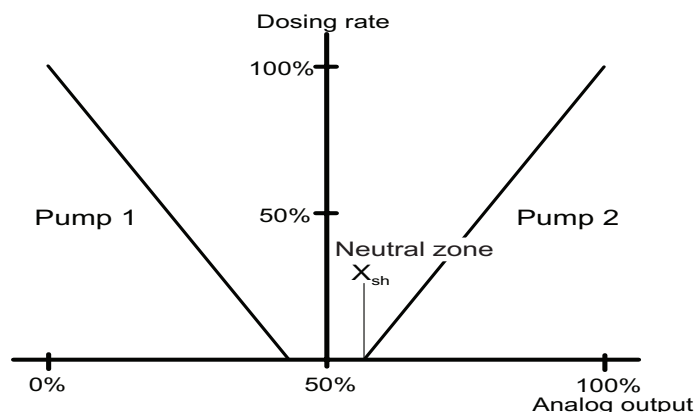
Pump 1 decreases the control value.

Pump 2 increases the control value.

Output behavior is similar to “analog output controller (2-point)”, but with 50% offset. This means that with a control deviation of 0% (set point = actual value) a current of 10 or 12 mA is output (pump is idle).

Setting	Signal	Pump	Signal	Pump
0–20 mA	0–20 mA	Pump 1	10–20 mA	Pump 2
4–20 mA	4–20 mA	Pump 1	12–20 mA	Pump 2

Therefore, 2 suitable pumps can be controlled with one mA current loop.



3.7 Control Parameters

Control parameters and setting values for determining the control functions of a controller. Different parameters apply for each controller type.

NOTE: The control parameters are listed alphabetically.

Pulses Max./Min

Meaning: Maximum number of pulses.

Explanation: The pulses max./min parameter only applies to solenoid pumps.

This parameter is used to set the maximum number of pulses per minute in accordance with the employed pump.

Setting range: The pulses max./min parameter can be set at either 100 or 120 pulses.

Set point

Specified value at which the control variable can be maintained by the controller. The setting range corresponds to the respective measuring range.

Tn

Meaning: Integral action time (I-element).

Display: Minutes (min).

Explanation: On the basis of the integral action time Tn, the dosing rate changes constantly until the set point is reached. The higher the value of Tn, the longer it takes until the controller increases the dosing rate.

Tn higher: Control response is slower.

Tn lower: Control response is faster.

Setting range: The parameter Tn can be set from 0–100 min (Tn = 0 means that the “I-element” is deactivated, i.e. a pure P-control response applies). It may not be possible to reach the set point value.

T

Sampling time T is the time after which a change control variable or set point is responded to. This value must be adjusted in the case of delayed feedback signals.

Tp

- Meaning: Cycle period.
- Display: Seconds.
- Explanation: The parameter Tp only applies to dosing pumps. The cycle period Tp defines a switching period, which must be coordinated with the respective pump type.
- Setting range: The parameter Tp can be set from 10–180 s.
- Example: Fast dosing pumps correspond to a low Tp; slow dosing pumps correspond to a high Tp.

The control parameter Tp must always be adjusted to suit the pump employed:

Dosing pump strokes/min	up to 20	20-40	40-80	80-125	125-200
Tp value	120	100	60	30	15

Ts

- Meaning: Loop rise time.
- Display: Minutes.
- Explanation: Time required to reach the measuring range end value with 100% dosing chemical supply (see section 3.9, Adaption).
- Setting range: The parameter Ts can be set from 1 s – 8 h.

NOTE: If the values Tu and Ts are manually modified, the control parameters Xp and Tn are re-calculated.

Tu

- Meaning: Loop dead time.
- Display: Seconds.
- Explanation: Time required between dosing start and clear recognition of the rise in the control variable.
- Setting range: The parameter Tu can be set from 1 s – 59 min 59s.

NOTE: If the values T_u and T_s are manually modified, the control parameters X_p and T_n are re-calculated.

T_y

Meaning: Running time of the positioner.

Display: Seconds.

Explanation: The parameter T_y only applies to positioners.

T_y is the time which the positioner requires to adjust from 0% to 100%.

Setting range: The parameter T_y can be set from 10–180 s.

Control Direction

Meaning: Direction of the control.

Display: Direct/inverse (e.g. for pH).

Explanation: Defines which medium is used to perform the correction.

Example:

pH: Control direction “inverse”: Lowering pH-value by adding acid.

pH: Control direction “direct”: Adding alkaline to raise the pH value.

X_p

Meaning: Proportional factor.

Display: Percentage (%) with factor.

Explanation: The control amplification is determined with the proportional factor.

The lower the proportional factor X_p is selected in %, the greater the deviation from the set point is amplified, and the more quickly the controller attempts to control the deviation from the set point.

The control amplification factors is calculated using the following formula:

$$\text{Factor} = (1/X_p) \times 100\%$$

Setting range: The parameter X_P can be set from 1% (factor 100) – 1000% (factor 0.1).

Xsh

Meaning:	Neutral zone.
Display:	Percentage (%).
Explanation:	The parameter Xsh only applies to 3-point controllers.

No controller output occurs in the neutral zone.

Setting range:	The parameter Xsh can be set from 1–5% (depending on the measuring range). The neutral zone is the defined range of set point + Xsh to set point Xsh.
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Ymax

Meaning:	Dosing rate limitation (single feedback control-loop control only).
Display:	Percentage (%).
Explanation:	The parameter Ymax only applies to:

- Positioner with feedback
- Dosing pumps
- Solenoid pump
- Controller with mA output

Ymax defines the maximum control output to the actuator

The control parameter corresponds to electronic dosing limitation of the actuator.

Setting range:	The parameter Ymax can be set from 0–100%.
----------------	--

Ymin

Meaning:	Dosing rate basic load (single feedback control-loop control only).
Display:	Percentage (%).
Explanation:	The parameter Ymin only applies to:

- Positioner with feedback
- Dosing pumps 2p
- Solenoid pumps 2p
- Controllers with mA output 2p

A basic dosing rate is output to the actuators with Ymin.

Setting range: The parameter Ymin can be set from 0–100%.

NOTE: Ymin and Ymax is only available for the single feedback closed-loop control. The control range is limited by the parameters Ymax and Ymin. Do not select a Ymax value lower than Ymin. At Ymin > 0 overdosing can occur.

Flow Rate Source

This parameter is only available during ratio control of module 1.

This parameter switches off the flow input (off) and activates the flow rate signal for the ratio control (factory setting = flow measurement) as control variable.

The parameter must be set to “Flow Measurement” for quantity-proportional dosing.

Flow Direction

This parameter determines the direction of the flow rate signal directly proportional to the actuator output:

Direct = flow rate input signal directly proportional to actuator output (factory setting).

Inverse = flow rate input signal inversely proportional to actuator input.

Example: 0–100% flow rate = 0–20 mA (direct).
0–100% flow rate = 20–0 mA (inverse).

Control Variable 2

This parameter activates and deactivates a second control variable during the ratio control.

If “Control Variable 2” = measured value X is selected, this influences the actuator output. The setting “Off” indicates this control variable is inactive (factory setting) (see section 3.5.1, Ratio Control and Flow Proportional).

X Direction

Determines the direction of the second control variable during the ratio control.

Direct = measured value directly proportional to the actuator output

inverse = actuator output indirectly proportional to measured value (factory setting = direct)

X Factor

This parameter is only available during ratio control, control variable 2 = measured value X.

Determines an adjustment factor, how strongly the measured value influences the actuator output (factory setting 1.0).

Tconst

Defines the constant dead time in the combi-controller loop. Consists of the sample water line dead time and the dosing delay time (for the calculation, see section 3.5.3, Compound Loop).

Tvar

Defines the variable dead time in the combi-controller loop. The time to be entered is based on 100% flow rate (for the calculation, see section 3.5.3, Compound Loop).

Max.lin.Corr

This parameter monitors changes to already learned dosing factors. If new dosing factor changes are learned, which are larger than the max. linearity correction, this dosing factor is used for all values in the dosing curve => initialisation of the curve.

Max.lin.Corr. = 0: No curve function; only one dosing factor for all flow rates.

Example:

Max.lin.Corr. = 50% (based on dosing factor):

Previous dosing factor: 30%

Newly learned dosing factor: 48%

max. permissible correction range: $30 \pm (50\% \text{ from } 30\%)$

$= 30\% \pm 15\%$

Change in this case: $48\% - 30\% = +18\%$

=> The new dosing factor is assumed for the entire curve because the new dosing factor (+ 48%) is greater than the max.lin.Correction (+18%).

Control Factor

Setting the ratio of control range and measuring range, in order to adjust the control amplification X_p to the process.

Control factor =
(End of measuring range - start of measuring range) : Control range

Example:

Start of measuring range: pH 4

End of measuring range: pH 9

Max. process control range: ± 1 pH ($\Rightarrow 2$ pH increments)

\Rightarrow Control factor =

$(9 - 4) : 2 = 2.5$

3.8 Actuator Calibration

Actuator Ym Calibration

Only with selection of "Electr.Pos. w. Ym".

Automatic calibration:

1. Starting with the basic display in the main menu, open the "Dosing" window from the "Module Type (1)" menu.
2. Select "Ym Calibration" and confirm the selection.
3. Select the "Auto" function and confirm the selection.

Feedback signal alignment starts automatically. The motor moves to the end positions $Y_m = 100\%$ and $Y_m = 0\%$. The message "End" indicates the end of the alignment. If an error occurs during automatic setting, "pos.-error" appears and the setting is terminated.

4. Determine the running time of the positioner from 0% to 100%.
5. Enter the determined running time in the "Dosing" window under T_y .

NOTE: If automatic alignment is not successful, perform alignment manually. For this purpose, manually move to YmCal 0% and YmCal 100% and save.

Manual calibration:

The feedback signal can be adjusted by no more than 30%.

1. Switch device to manual (Keys "Mode" ... "Change").
2. Manually close the positioner via MAN.DOS ... Module Type (1) key until the limit switch turns off.
3. Starting with the basic display in the main menu, open the "Dosing" window from the "Module Type (1)" menu.
4. Select "YmCal 0%" and confirm the selection.

5. Manually open the positioner via the MODE - MAN.DOS - Module Type (1) key until the limit switch turns off.
6. Starting with the basic display in the main menu, open the “Dosing” window from the “Module Type (1)” menu.
7. Select “YmCal 100%” and confirm the selection.

There must be a distance of at least 60% of the total path between the set 0% position and the 100% position.

8. Check the position in a second operation:
 - Select the “Manual” operating mode.
 - Move to various positions via the MAN.DOS key and check the dosing rate.
 - Repeat calibration at 0% and 100%, if necessary.
9. Determine the running time of the positioner from 0% to 100%.
10. Enter the determined running time in the “Cl₂ Dosing” window under Ty.

3.9 Alarms

The alarms are output via relay contacts and the red LED. The number of up to eight alarms is stipulated in the application.

Each alarm can be assigned the following functions:

Limit value = Min	All measured values individually selectable Cl ₂ , pH, mV, Cl-N, conductivity, etc.
Limit value = Max	All measured values individually selectable Cl ₂ , pH, mV, Cl-N, conductivity, etc.
Digital inputs	1 to 3 can be selected individually
Error	Software malfunction

If the Micro/2000® or Deox/2000® flow block is used one alarm relay output is assigned as output for the peristaltic pump/impeller of the Micro/2000® unit.

Sensor slot 1	Alarm relay 1
Sensor slot 2	Alarm relay 2

If the Micro/2000® or Deox/2000® flow block is used there is the possibility to activate an automatic sample line dosing function for each flow block separately. It is possible to switch the sample line dosing function on or off in the menu. Each sample line dosing function is assigned to a separate dosing relay output.

Sensor slot 1	Alarm relay 3
Sensor slot 2	Alarm relay 4

The Alarm 3 or 4 is no longer available if the sample line dosing of slot 1 or 2 is activated.

The type of alarm can be selected in the “Alarms” menu in the displays “Alarm ... Functions” (displays 1.6.1 and 1.6.2 “Alarm - Menu 1.6”, section 4.3) There are three types of alarms.

In all alarm types the response can be influenced by entering a delay (td) (refer to the diagrams in this chapter).

3.9.1 Unlatched Alarm Without Acknowledgement Option (N.O. Unlatched N.C. Unlatched)

The LED lights up in the event of an alarm and goes out automatically when the alarm conditions are eliminated. The same applies for the contact.

3.9.2 Latched Alarm With Reset Acknowledgement Option (N.O.Latched N.C.Latched)

The LED flashes in the event of an alarm until the alarm is acknowledged. The LED goes out, also if the set alarm conditions still apply when the alarm is acknowledged.

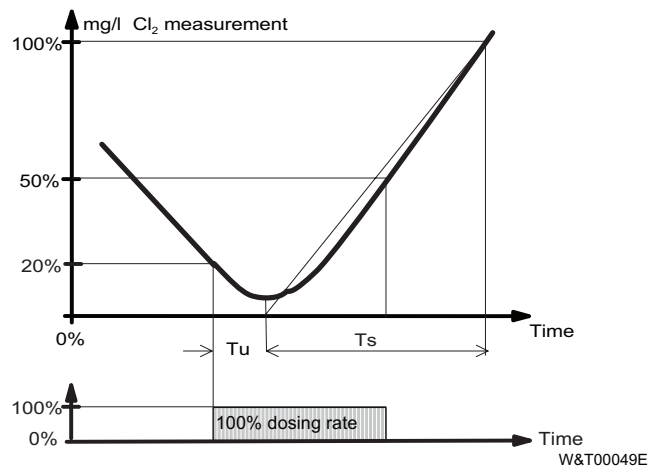
3.9.3 Latched Alarm With Confirmation (Acknowledgement Option) (N.O. Latched Ack.) (N.C. Latched Ack.)

The LED flashes in the event of an alarm until the alarm is acknowledged.

- If the alarm condition no longer applies when the alarm is acknowledged, the LED goes out.
- If the alarm condition still applies when the alarm is acknowledged, the LED resets from flashing to permanent illumination. The LED lights up until the alarm condition is eliminated (auto-reset).

3.10 Adaption

This only applies to Cl_2 single feedback closed-loop control module 1 and 2.



3.10.1 Use

Adaption is used for automatic determination of the reaction times of the control loop (loop dead time T_u and loop rise time T_s) or the resulting control parameters X_p and T_n .

NOTE: The control parameters X_p and T_n determined by adaption must be regarded as a recommendation for commissioning! The control parameters X_p and T_n can be manually optimised for maximum control quality.

3.10.2 Requirements

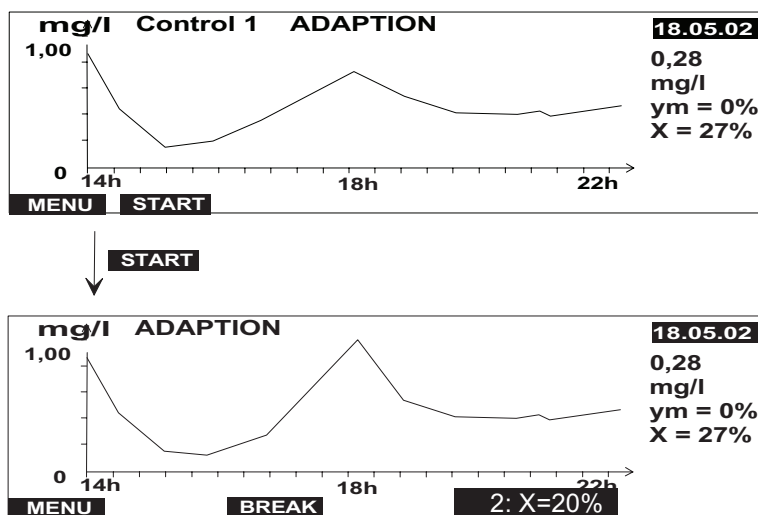
- Positioner set to automatic (manual wheel engaged) Dosing pump set to automatic
- Calibrated Cl_2 measurement (zero point and span value)
- Loop dead time < 60 min
- Loop rise time < 480 min (8 h) for 0–100% measuring range
- Decomposition time < 480 min (8 h) of the current value to 20% of the measuring range
- Correct menu setting of the end value, control direction (direct or inverse), actuator (e.g. positioner), positioner running time (T_y)

Adaption may not be started:

- If a large volume of fresh water is added
- If the chlorine sensor has not been run in
- During cleaning work
- During filter backwashing
- When the circulation changes
- If there are flow rate fluctuations

3.10.3 Starting Adaption

1. Starting from the basic display, select "Adaption" from the "Cl₂ free" menu. The Tu and Ts loop parameters are displayed.
2. In the "Cl₂ Adaption" menu, select the "ADAPT" soft key. This displays the diagram of the previous adaption.
3. Press "START" to start the adaption. Adaption starts.



3.10.4 Displays

The diagram shows the chlorine value curve during the adaption phases. The current phase of adaption (total of 13) is shown in the bottom line.

Successful adaption is confirmed by the "ADAPTION OK" message.

Press the "BACK" soft key to return to the basic display.

If adaption is not successful, the error message "ADAPTION?" is displayed.

3.10.5 Adaption Sequence

Each adaption phase is then displayed with a status message:

Display text	Explanation
"0: Init"	Start
"1: Ym = 0%"	Chlorinator to 0% or dosing pump off
"2: X = 20%"	Delay until actual value < 0.2 x end value
"3: Ym = 100%"	Chlorinator to 100% or dosing pump on
"4: Ym = 100%"	Wait until the chlorinator reaches 100%
"5: Tu! "	Start dead time measurement
"6: Tu! "	Measurement of the loop dead time Tu
"7: Tu Check"	Plausibility enquiry dead time
"8: Init Ts"	Start of rise time measurement
"9: Ts "	Measurement of the loop rise time Ts
"10: TS "	Calculate control parameters
"11: Y = 0%"	Chlorinator to 0% or dosing pump off
"12: Y = 0%"	Wait until the chlorinator reaches 0%
"13: Adaption OK"	End

Various status messages can be output, depending on the selection of the actuator. Different status messages also have different execution times. It is possible that several status messages are only displayed briefly or not at all if the execution time is very short.



CAUTION: Adaption can take up to 13 hours, depending on the control loop. During this time no errors should occur on the control loop (e.g. filter back-washing, changes in the circulation).

NOTE: The adaption procedure can be terminated at any time with "STOP". The previously set parameters remain unchanged.

3.10.6 Completing Adaption Without Errors

When the loop times (dead time Tu and rise time Ts) have been completed without errors, calculation of the control parameters Xp and Tn commences. This is indicated by the message "Adaption OK". The calculated parameters are entered into the menus. When adaption has been concluded, the measuring amplifier adjusts with the newly calculated control parameters and continues in the selected operating mode (e.g. automatic).

These are entered into the "Tu" and "Ts" menus to monitor the determined loop times.

If errors occur in the control loop during adaption, incorrect loop times and therefore incorrect control parameters can be determined.



CAUTION: The remaining control parameters Y_{min} , Y_{max} and T_p are not influenced when adaption is performed. The control parameters X_p and T_n are determined for $Y_{min} = 0\%$ (no basic load) and $Y_{max} = 100\%$ (no dosing rate limitation). If a basic load Y_{min} or dosing rate limitation Y_{max} are required for specific system requirements, it must be taken into account that the control loop is restricted as a result. There is then the risk of excessive chlorination (Y_{min} too high) or inadequate chlorination (Y_{max} limits excessively).

3.10.7 Completing Adaption With Error

If errors occur in the control loop during adaption (e.g. filter backwashing, changes in the circulation) or if the reaction times of the control loop are too long, adaption is interrupted.

Possible error conditions:

Initial value not reached (Display: “T = > 8h”)

When adaption has started and the dosing system has closed or the dosing pump has switched off, the measuring amplifier waits until the actual value has dropped below the initial value (0.2 x the measurement range value). This delay is indicated by the message “2: X = 20%” and the maximum permissible time is 8 hours.

Loop dead time too high (Display: “Tu = > 1h”)

The value determined by the time measurement between starting up the dosing, switching on the dosing pumps and the rise of the actual value may only take a maximum of 1 hour. This measured time is displayed by “6: Tu!”

Loop rise time too high (Display: “Ts = > 8h”)

The time is determined by a measurement, which the control loop requires at a 100% dosing rate of the dosing system or the dosing pump, to increase the actual value to 50% of the measuring range. This measurement is indicated by the message “9: Ts!” and may take up to 4 hours.

If any of the error conditions described above occur, adaption is interrupted. The measuring amplifier indicates an error message. The “old” parameters X_p and T_n are not changed.

3.10.8 Determination of the Control Parameters With Known Tu and Ts Times

If the loop times Tu and Ts are already known or if these cannot be determined automatically due to specific system conditions, the loop times can be entered into the “Tu” and “Ts” menus. When Tu or Ts are saved, the control parameters Xp and Tn are also calculated and entered into the menus.

3.11 Interfaces

Various interfaces are available to externally link the MFC.

3.11.1 RS232

The RS232 interface serves to connect:

- A laptop or PC for a Firmware update (Download the latest firmware version with an update program and update instruction from the Wallace & Tiernan homepage (www.wallace-tiernan.de). Matching RS232 connecting cable: Wallace & Tiernan Ref. AAC5890).
- A printer

Specification of the RS232 interface for printer operation:

- Data transfer 9600 baud
- Parity even
- Word length 8 bit

A log is printed for each day (see “Log printout”).

Daily Log

Each daily log consists of:

- Log header
- Line diagrams
- Release of daily min. and max. values

Log Header

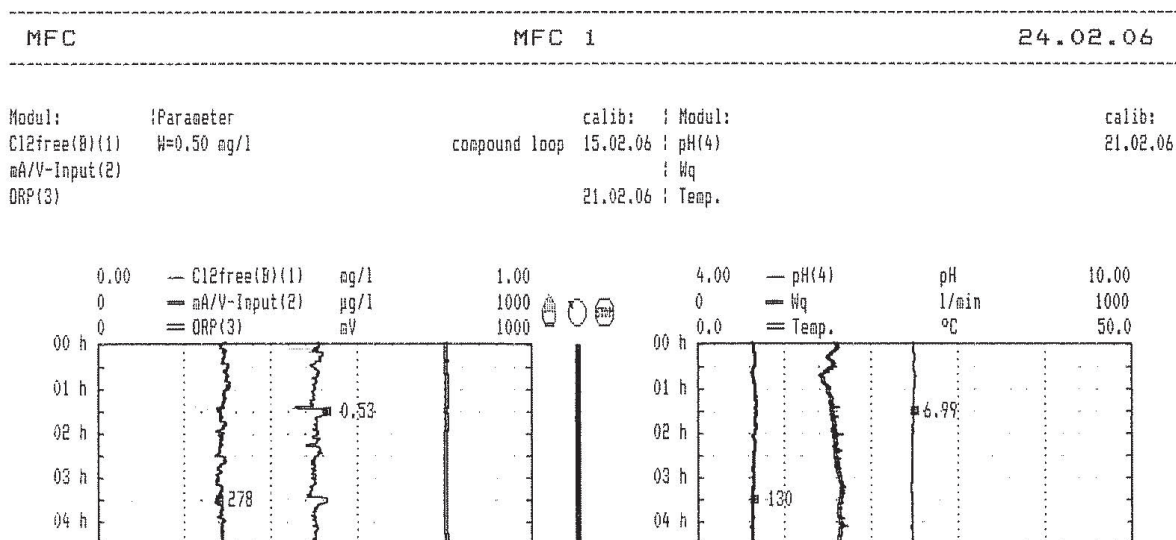
The supplied measurements and the corresponding parameters are printed in the log header. The date of the last calibration is also documented.

Trend Graphs

This prints the trend graphs including the measuring ranges and the current operating mode as a bar graph. Trend graphs are recorded in one minute intervals.

The daily min. and max. values per measurement are printed at the end of the log.

Log Printout



NOTE: The maximum cable length between the interface and the printer may not exceed 15 m.

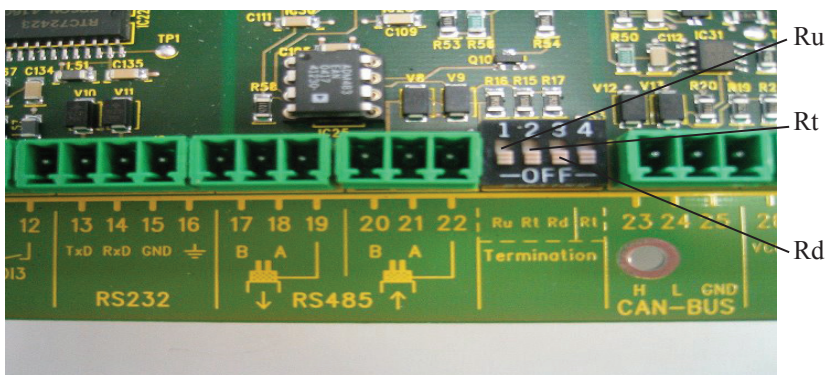
To print logs, Evoqua Water Technologies offers the RS232 log printer as an accessory as well as the 3m and 15m printer connecting cable. The printer includes setup instructions. Refer to section 7, Complete Devices, Retrofit Kits and Spare Parts.

3.11.2 RS485

The RS485 interface provides connectivity to:

- Web technology via Wallace & Tiernan® ChemWeb server
- Higher level visualisation systems through OPC Server Data Access V2.0
- Visualisation systems under Windows® TM via Wallace & Tiernan® CMS software 3.0
- SECO S7

The MFC RS485 interface is electrically isolated. To integrate into a Evoqua Water Technologies bus system, four terminal strips, a terminating resistor R_t and balancing resistor R_u and R_d are integrated into the MFC.



Information on the RS485 interface (WT.050.580.002.UA.IM) can be requested separately from Evoqua Water Technologies.

3.11.3 CAN Interface

The CAN interface of the MFC serves to control CAN actuators such as V10K with CAN interface or dosing pumps with CAN interface, for example.

Individual measured values can also be transmitted to other measuring and control systems using the CAN bus, e.g. SFC measuring system for Cl_2 tot./ Cl_2 free for displaying the combined chlorine or SFC- Cl_2 ++ with pH value input via CAN bus.

The second control measurement can also be imported with the CAN interface and the setpoint trim application.

The CAN interface of the MFC is electrically isolated. For connection to a Evoqua Water Technologies CAN bus system, three terminals and a terminating resistor R_t are integrated in the MFC.

The CAN bus is wired from station to station as a two-wire bus. The cable of type 1x 2x0.75 mm² (part. no. AAD8569) is used as the installation cable. Stub cables are not permitted.

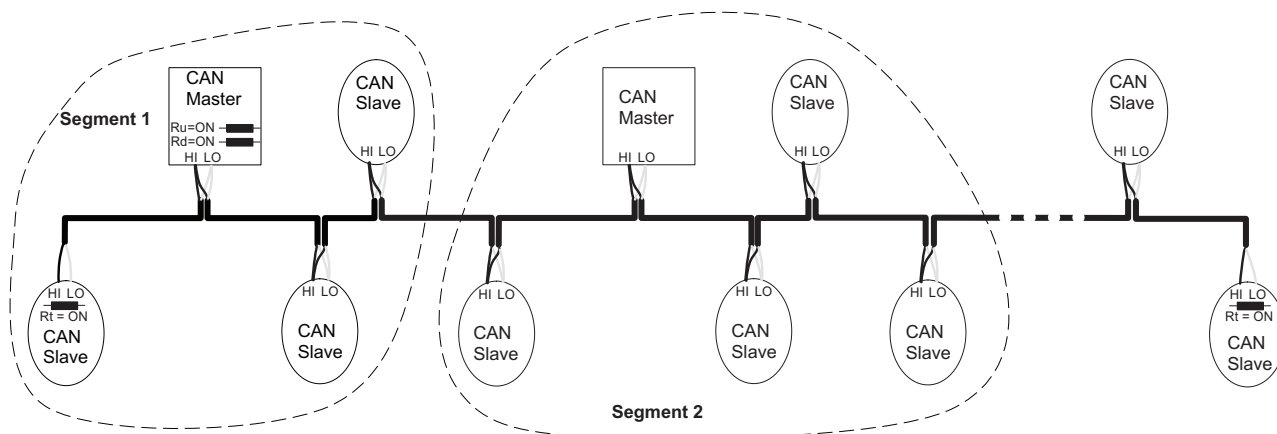
Do not exceed the maximum line length of 1000 m. The CAN bus is divided into max. 31 segments. In every segment, there can only be one CAN master. All devices communicating with one another must be operated in the same segment.

Setting parameters: Segment address 1...31
CAN address for actuator 0...31

The bus master in the segment is responsible for controlling the actuators. The bus master is, for example, MFC, SFC.

CAN slaves include, e.g., dosing pumps with CAN interface, V10K with CAN interface.

3.11.3.1 CAN Bus Structure



NOTE: This CAN interface is not compatible with CAN Open or other CAN systems. Only CAN nodes with a Evoqua Water Technologies-compatible software protocol may be integrated in this CAN system.

To illustrate the CAN functionality, two examples for CAN applications are listed below:

Example 1:

An MFC (master) is operated with a CAN actuator dosing pump in a CAN installation.

Both units must be operated in the same segment. In the following example, segment 1 is used, it could, however, be any segment from 1 - 31.

The following device settings are required:

MFC:	
Menu - Input/Output - Interface - "CAN segment":	1
Menu - Cl ₂ free - Dosing - "Dosing output":	CAN-Bus actuator
Menu - Cl ₂ free - Dosing - "CAN address":	2

CAN dosing pump:	
Menu - Configuration - CAN Bus	✓
Menu - Configuration - Segment address	1
Menu - Configuration - Slave address	2
Menu - Configuration - Bus termination	(only with the last and first units of the bus installation)

Example 2:

An MFC-Cl₂++ (master or slave) is installed with an MFC pH in order to compensate the chlorine measurement with the pH value. In this application, both units need not be operated in the same segment. In the following example, segment 1 is used and the following settings must be carried out.

SFC-Cl ₂ ++:	
Menu - Input/Output - Interface - "CAN segment"	1
Menu - Cl ₂ ++ - Measuring range - "CAN address pH"	2

MFC-pH:	
Menu - pH - Measuring range → "CAN seg. MW->"	1
Menu - pH - Measuring range → "CAN addr. MW->"	2

Example 3:

An SFC-Cl₂ is installed with an MFC setpoint trim. The Cl₂ measurement is transmitted from the SFC to the MFC via CAN. The following table lists possible settings for the MFC and SFC. The measurements are transmitted in segment 1 to address 2.

MFC-Cl ₂ :	
Menu - Input/Output - Interface - "CAN segment":	1
Menu - Mod 2 - Measuring range - "CAN address"	2

SFC-Cl ₂ :	
Menu - Input/Output - Interface - "CAN seg. MW->"	1
Menu - Input/Output - Interface - "CAN addr. MW->"	2

A bus end (bus termination Rt) must be installed at the first and last units in the bus. The MFC is equipped with a RT dip switch. Other units (dip switch number 4 on switch block between terminals 22 and 23) require a menu setting that activates the bus termination.

Balancing of the CAN bus must take place once in the CAN bus. However, the MFC does not offer this option.

3.12 Special Features

3.12.1 Temperature Measurement

If a temperature measurement is not integrated into the sensor measuring module (DES), the PT 1000 temperature measurement is automatically used from the mother board for temperature compensation. This can also be switched off in the "Temperature" calibration menu. This switches off the PT 1000 temperature compensation for all sensor measuring modules.

If a temperature measurement is integrated into a sensor measuring module for chlorine, it is automatically used for compensation.

You can select between options for manual, permanently set temperature value or temperature measurement with PT 1000 on the motherboard for compensation in the calibration menu for pH. If the PT 1000 measurement of the mother board is switched off, only a manual value may be set for compensation.

3.12.2 Calculated Measured Value Displays

Cl_2^{++} Measurement

The pH dependency of the chlorine measurement is compensated if the pH value fluctuates within the range of pH 6.5 to pH 8.75. This function is only guaranteed to a max. 10 mg/l free chlorine.

If free chlorine measurement is equipped with a Depolox® 5 measuring cell as well as a pH measurement, it is possible to select this measured value display as Cl_2^{++} measurement in the "Meas Range" - "Sensor Type" menu. The corresponding pH measurement can be selected for pH compensation of this Cl_2 .

This function is not available for mA/V sensor measuring modules.

Combined Chlorine Display

If a total chlorine measurement as well as free chlorine measurement installed, it is possible to display the combined chlorine value. To do this, set the display to "Cl-comb" in the total chlorine measurement "Meas Range" - "Sensor Type" menu. The corresponding free chlorine measure-

ment is then assigned in the “Cl₂ Free Ref” menu, in order to be able to determine the difference (Cl-combined) between the total chlorine and the free chlorine.

This function is not available for mA/V sensor measuring modules.

SECTION 4

SECTION 4 - OPERATION

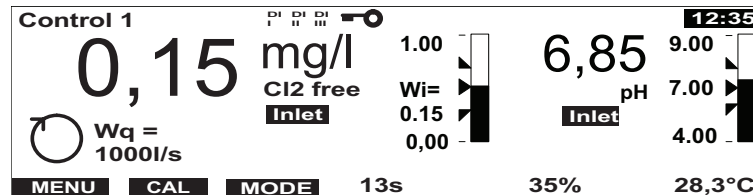
List of Contents

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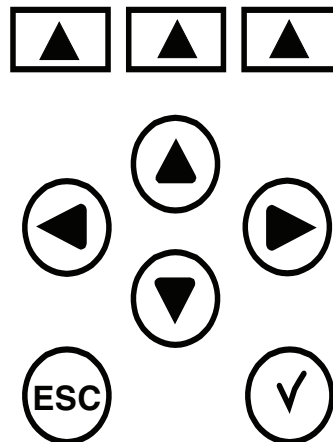
4.1 Display and Operator Controls

Graphic display and operating panel

All information is shown on the graphic display.



The MFC is operated with nine keys. The software function is controlled with the top three keys (soft keys).



The exact depiction of the individual parameters on the graphic display is described in chapter 4.3, Menu Structure.

Indicators

CONTROL 1

DI I DI II DI III



12:35



System name (Entered under "System" - "Common" - "System name")

Digital inputs 1, 2, and 3 active.

The symbols indicate that a function has been selected for the digital signal and that a signal is applied.

Password active

The defined password must be entered to permit modification of parameters and for calibrating the device.

Time

"AUTO" operating mode active

The control unit is running in automatic mode. Dosing is performed automatically.



“MANUAL” operating mode active
Dosing can be set manually.



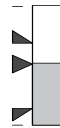
“System stopped” operating mode
Dosing is switched off.



“Adaption” operating mode is active during “Automatic” operation
Automatic determination of the control parameters for single feedback closed loop control is active.



“Adaption” operating mode is active during “Manual” operation
Automatic determination of the control parameters for single feedback closed loop control is active.



Bar graph
This indicates a measured value, the measuring range (column height), limit values (▲ and ▼) as well as the set point, W_i (internal set point), W_e (external set point), D_i (internal set point), D_e (external set point) (▶).

Soft keys

BREAK	Current soft key assignments Stop the adaption procedure.
SELECT	Select one or more options from the list provided.
CHANGE	Change the operating mode.
ENTER	Confirm your selection.
CAL	Select the "Calibration" menu.
LOCK	Activate password protection.
MENU	Select a menu.
MODE	Select the "Mode" menu.
UNLOCK	Start deactivation of password protection.
BACK	Move up one level.
--->	Open next diagnosis display.
13s	Feed delay The time until dosing resumes after interruption.
100%	Positioner feedback (Ym) If the display blinks, the positioner is in manual mode and cannot be activated.
28.4°C	Sample water temperature
mA?	1/5 Error indication active (display bottom right) The system has detected an error. The error can be specified with the table in section 4.5 "Errors". The number combination states the series number of the error message and the total number of error messages (in this case the first error of a total of five). Display number (display bottom right) This number enables allocation to a menu and stipulates the sequence within the menu.
PI 85 s	YPI stop time display. The time it takes after a spike in the flow rate for the single feedback closed loop control in the combi-control to reactivate.

INLET

MFC provides the option to assign a customer-specific name or designation to each measurement. In the menu “Module designat” of the “System” menu, you can name each measurement as desired up to six characters, such as “Inlet”, “Main”, “Tank”, etc. This name is displayed in the main display under the associated measurement. If blanks (default setting) are entered as a module name, it is deactivated and does not appear in the main displays.

Dosing and alarm indications

LED

The nine LEDs are another indicating element. The definition of the eight red LEDs depends on the selected application. This determines whether control output or alarm is selected. The definition is marked on the labeling strip to the right of the LED. The green LED lights up when the device is switched on (POWER).

General messages

Adaption is running!

This message appears if an attempt is made during adaption to automatically calibrate the positioner.

This function is possible in the MANUAL mode only!

This message appears, for example, if an attempt is made to calibrate the positioner during automatic operation. Acknowledge by pressing ENTER or the ESC key.

A module was removed!

Do you wish to accept this configuration?

This message appears when the device is switched on after removal of a module. Confirm with the yes/no key.

New hardware component found!

This message appears when the device is switched on after addition of a module.

NOTE: Information on the plug-in cards which are contained in the device are displayed in “Analog scan” when it is switched on or can be viewed statically in the “Diagnosis” menu under “Software Versions” (See 4.3 Menu Structure, “Diagnosis - Menu 1.8”).

Operator Controls



Soft key

- Activate the function shown on the graphic display with the keys.



Up

- Move up one level.
- Display the previous option.
- Increase the value.



Down

- Move down one level.
- Display the next option.
- Decrease the value.



Left/right

- Change the column in the menu.
- Change the position in the displayed value (cursor menu).
- Move forwards or backwards by seven hours in the trend graph.



Escape

- Cancel the entry without saving the new value.
- Move up one menu level.



Enter/Acknowledge

- Acknowledge alarm message.
- Set the running delays to zero.
- Delete adaption error.
- Acknowledge max. dosing time to reactivate dosing.
- Activate the function chosen on the graphic display to adjust values.

4.2 Notes On Operation

During operation observe the following points:

- Check your entry and modifications before exiting the menu.
- Only press the keys with your fingers, never with hard or pointed objects such as pencils, etc. This could damage the membrane keypad.

4.2.1 Operation

You have the following options starting from the basic display:

Switch between the basic displays and trend graphs	<ul style="list-style-type: none"> • Press the up or down key
Select menu	<ul style="list-style-type: none"> • Press the "MENU" soft key to select the menu • Press the "CAL" soft key to calibrate • Press the "MODE" soft key to set the operating mode
Select a menu item in the menu display	<ul style="list-style-type: none"> • Select the menu item with the arrow keys (arrow in front of menu item) • Confirm the selection with "ENTER"
Change/enter displayed parameters	<ul style="list-style-type: none"> • Select the parameter with the arrow keys (arrow in front of parameter) • Confirm the selection with "ENTER" • Change/enter the display with the up or down key • Confirm the entry with "ENTER"
Cancel entry	<ul style="list-style-type: none"> • Press the "ESC" key to exit the menu item. Entries which have not been confirmed are reset to their original settings.
Reactivate password protection	<p>This function is only active when a password has been programmed.</p> <ul style="list-style-type: none"> • Change/enter displayed parameters • Block the system entry with the "LOCK" soft key in the menu display
Exit the menu item	<ul style="list-style-type: none"> • Press the "ESC" key or • Press the "BACK" soft key

4.3 Menu Structure

The MFC has 11 different menus:

- Main menu
- Module type 1
- Module type 2
- Module type 3
- Module type 4
- Inputs/Outputs
- Alarms
- System
- Diagnosis
- Calibration
- Mode

Display of these depend on the number of sensor measuring modules installed.

The “Calibration” and “Mode” menus are opened with the corresponding soft keys directly from the basic display. All other menus can be accessed with the “MENU” soft key.

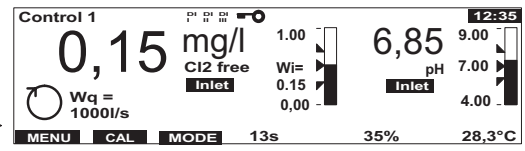
The following pages show the 11 individual menus. The displays contain the default settings. If options are available for individual parameter values, these are listed to the right of the illustration of the display information.

NOTE: The actual displays on your device can vary from those illustrated. The displays and menus depend on the number of sensor measuring modules installed and the selected settings. The display numbers are featured on the bottom right of the display. These numbers are frequently referred to in the following chapter.

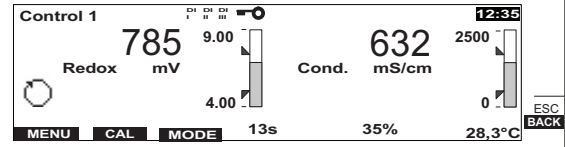
4.3.1 Main Menu

The main menu display can be selected by pressing the up or down arrows. There are three basic displays and four trend graph displays available. The last selected display will remain on the main menu screen until it is changed by the operator.

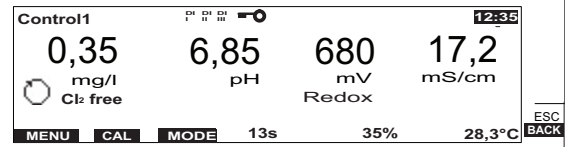
Basic display 1



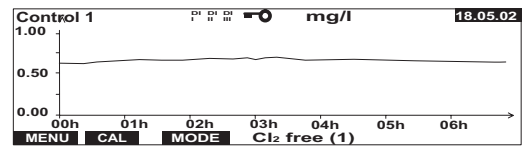
Basic display 2



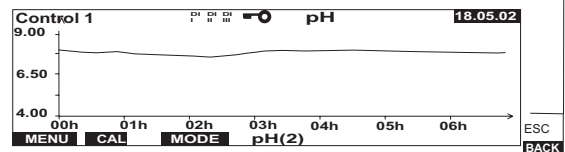
Basic display 3



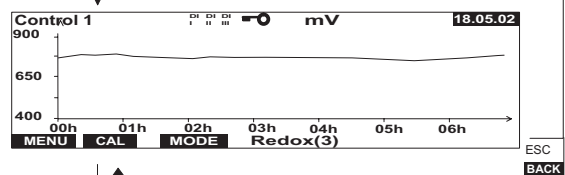
Trend Graph 1



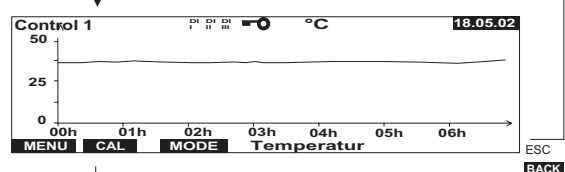
Trend Graph 2



Trend Graph 3

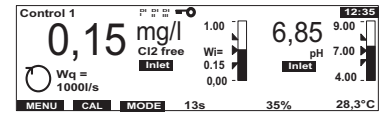


Trend Graph 4

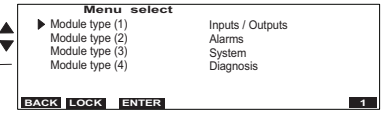


4.3.2 Module Type 1 - Menu 1.1

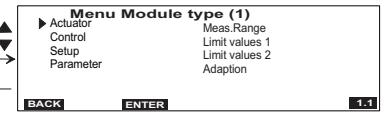
Basic Display



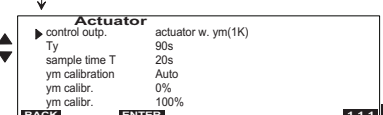
Menus Select



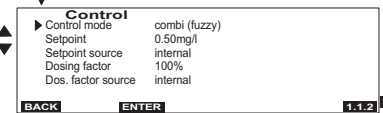
Module Type (1) Menu



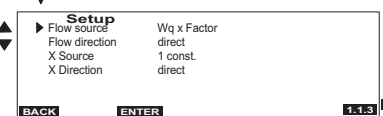
Dosing



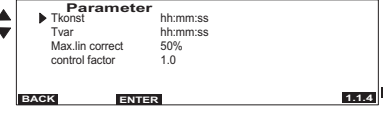
Control



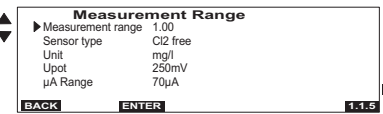
Setup



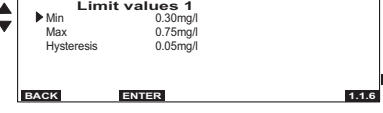
Parameter



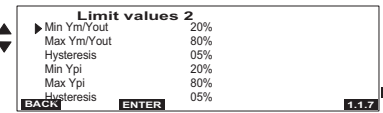
Measuring Range



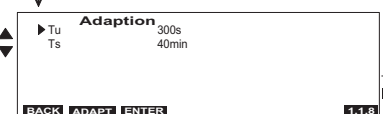
Limit Value 1



Limit Value 2



Adaption
(only for sensor type Cl₂ free)



Basic Display 1

Top status line

- System name (define in display 1.7.1)
- Digital inputs activated (select function in display 1.5.7)
- Password protection activated (set in display 1.7.2)
- Time (set in display 1.7.1)

Center display range

- Mode
- Measured value from module 1, e.g. free chlorine (mg/l) as a digital display and bar graph with module designation (optional)
- Measured value from module 2, e.g. pH value (pH) as a digital display and bar graph with module designation (optional)
- Flow rate display Wq

Bottom status line

- Soft key display
- Feed delay(s) (set in display 1.7.2) e.g. after sample water stop or change of mode from manual to automatic.
- Error message. The display alternates if there are several error messages.
- Sample water temperature (°C)

Basic Display 2

Top status line

- See basic display 1

Center display range

- Mode
- Measured value from module 3, e.g. Redox potential (mV) as a digital display and bar graph with module designation (optional)
- Measured value from module 4, e.g. conductivity (µS/cm) as digital display and bar graph with module designation (optional)

Bottom status line

- See basic display 1

Basic Display 3

Top status line

- See basic display 1

Center display range

- Mode
- Free chlorine (mg/l) - module 1 measured value display
- pH value (pH) - module 2 measured value display
- Redox potential (mV) - module 3 measured value display
- Conductivity (mS/cm) - module 4 measured value display

Bottom status line

- See basic display 1

Trend Graph (4 max.)

Top status line

- System name
- Digital inputs activated
- Password protection activated
- Selected measured parameter unit
- Date of the displayed diagram (set in display 1.7.1)
- Error message

Center display range

- 7-hour trend graph (can be scrolled back by up to seven days)

Bottom line

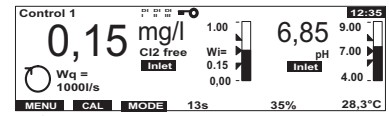
- Soft key display
- Measurement parameters (can be selected in display 1.7.3)

NOTE: When the trend graph is moved, the programmed values of the displayed period of time are also displayed when moving up or down one level in the displays. Return to the current display period by pressing “ESC”.

NOTE: The displayed menus and selection parameters depend on the number of sensor measuring modules installed and the selected application. All the parameters illustrated here are not displayed at the same time. Refer to manual provided with the measurement module for detailed menus.

4.3.3 Module Type 2 - Menu 1.2

Basic Display



Menu Select

Menu select

Module type (1)	Inputs / Outputs
Module type (2)	Alarms
Module type (3)	System
Module type (4)	Diagnosis

BACK LOCK ENTER 1

Module Type (2) Menu

Menu Module type (2)

Actuator	Setpoint Trim
Control	Meas. Range
Parameter	Limit values
Timer setting	Adaption

BACK ENTER 1.2

Dosing

actuator

Control outp.	actuator wo. ym
Ty	90s

BACK ENTER 1.2.1

Control

Control

Control Mode	single feed forw
Setpoint	7.00pH
Control direct.	direct
Dosing factor	100%

BACK ENTER 1.2.2

Parameter

Parameter

Xp	10%
Tn	20min
Xsh	2.0%
Ymin	0%
Ymax	100%

BACK ENTER 1.2.3

Time setting

Timer Setting

Timer Contact 1	1: 08.00 - 16.00 Mo
Timer Contact 2	1: 00.00 - 00.00 --

BACK ENTER 1.2.4

Trim Set point

Setpoint Trim

Setpoint trim	On
Change	10%
Band	20%
Xsh	2%
Tkonst	hh:mm:ss
Tvar	hh:mm:ss

BACK ENTER 1.2.5

Measuring Range

Meas. Range

Range Start	04.00
Range End	09.00

BACK ENTER 1.2.6

Limit Values

limit values

Min	6.30pH
Max	7.50pH
Hysteresis	0.05pH

BACK ADAPT ENTER 1.2.7

Adaption

Adaption

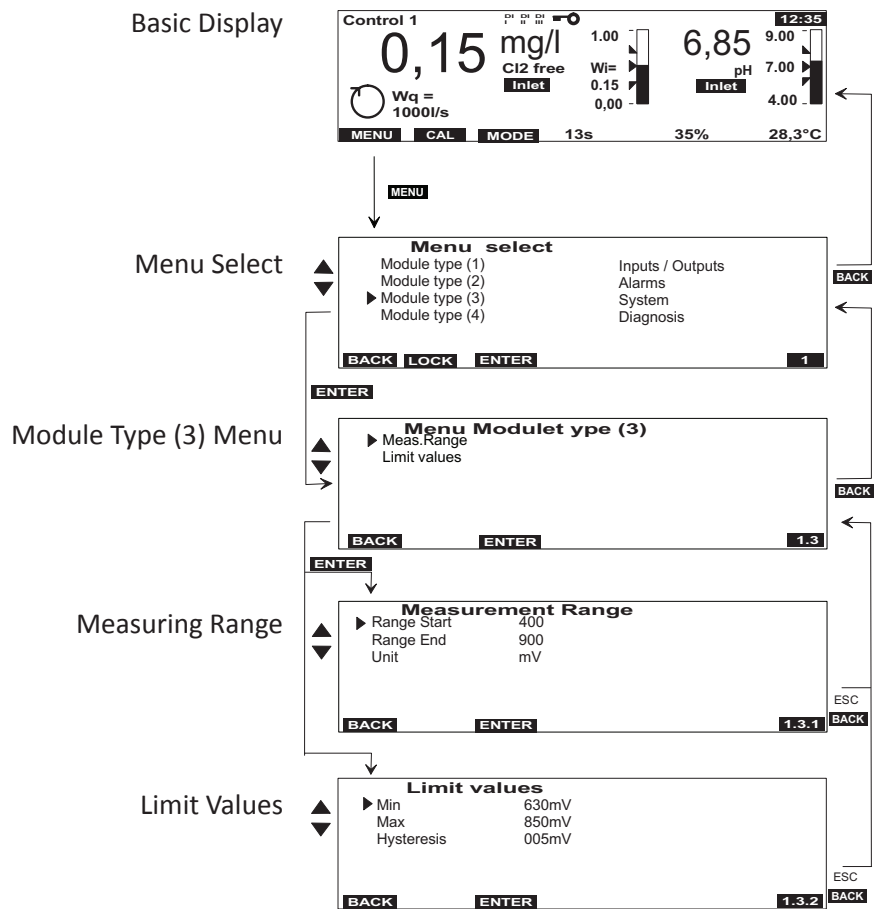
Tu	300s
Ts	40min

BACK ADAPT ENTER 1.2.8

NOTE: The displayed menus and selection parameters depend on the number of sensor measuring modules installed and the selected application. All the parameters illustrated here are not displayed at the same time. Refer to manual provided with the measurement module for detailed menus.

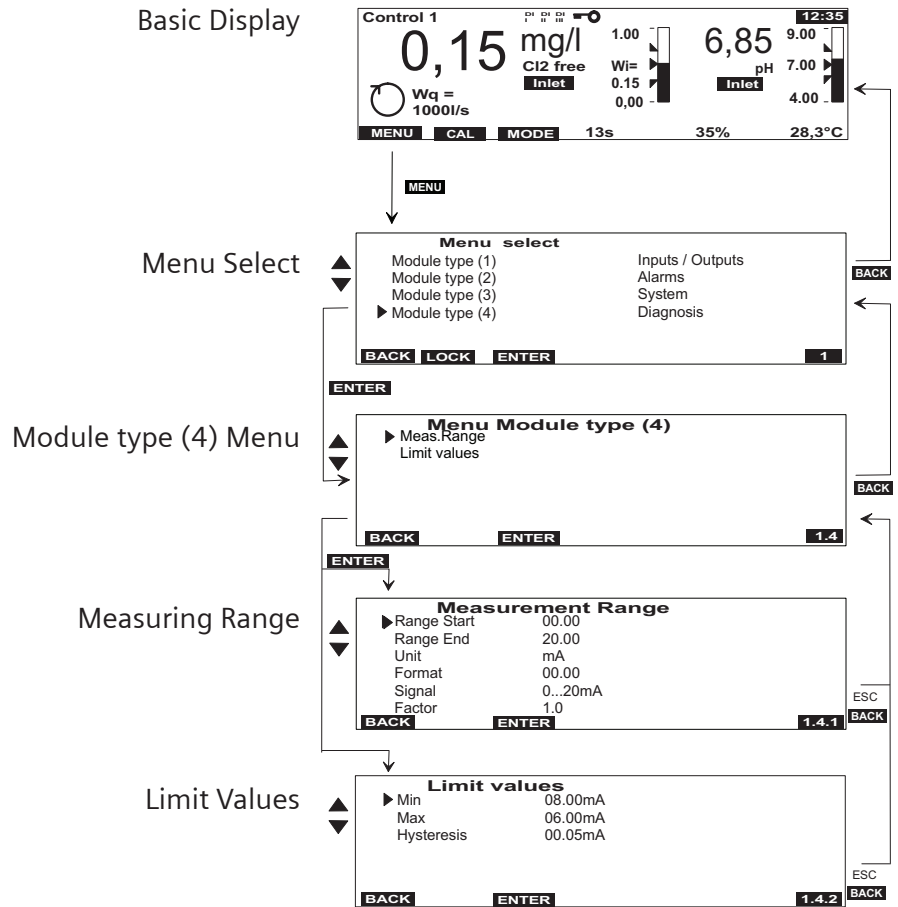
4.3.4 Module Type 3 - Menu 1.3

Display using the example of a Redox measurement. Refer to manual provided with the measurement module for detailed menus.

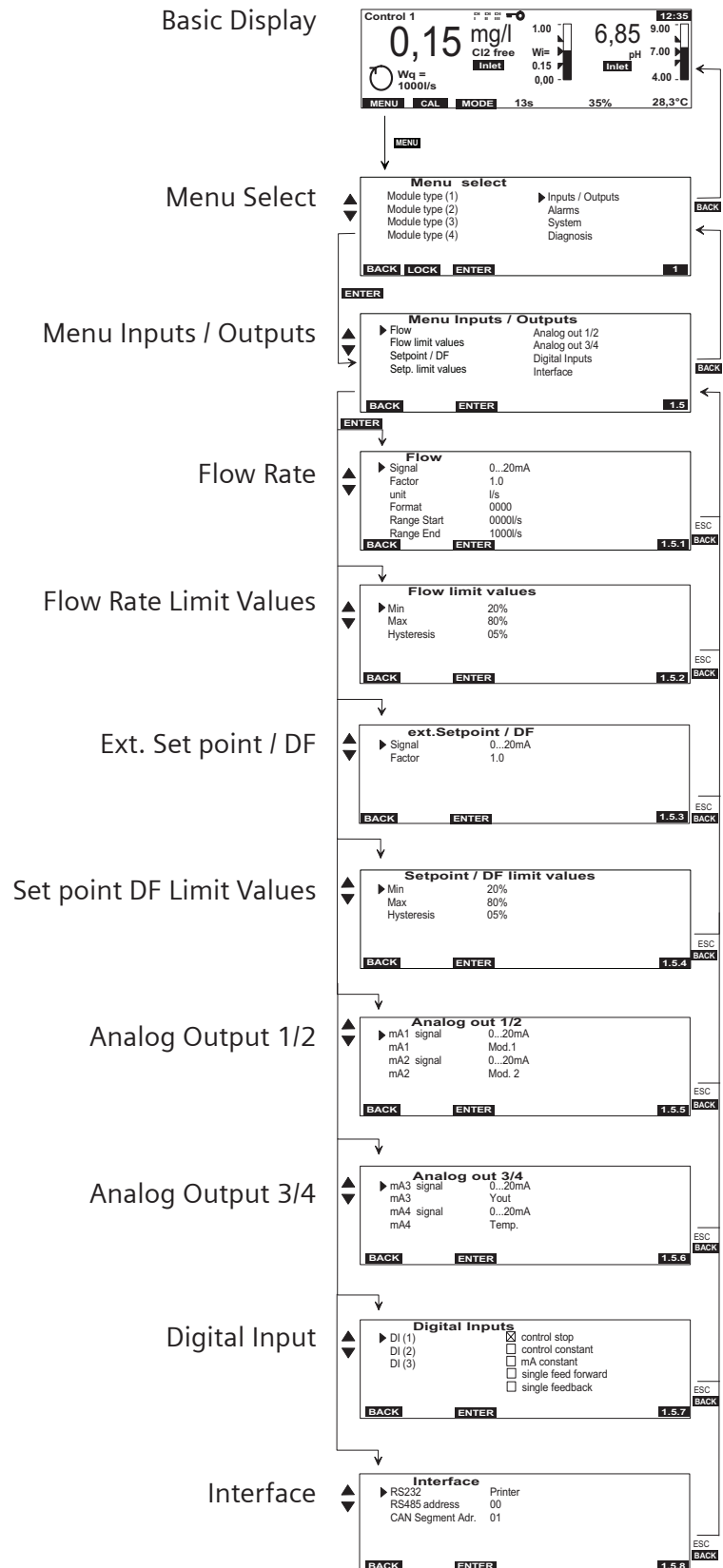


4.3.5 Module Type 4 - Menu 1.4

Display using the example of a mA/V input module. Refer to manual provided with the measurement module for detailed menus.



4.3.6 Inputs/Outputs - Menu 1.5



Basic Display

Refer to main menu

Menu Select

Display of all available menus

Menu Inputs/Outputs

Display of all available input/output settings

Flow Rate

Signal	0–20 mA, 4–20 mA, 0–10 V
Factor	0.1 to 4.0
Unit	Max. 5 digits (any combination)
Format	Measurement display 000.0 / 00.00 / 0000
Range-start	Unlimited
Range-end	Unlimited

Flow Rate Limit Value

Min	Min. limit value within measuring range
Max	Max. limit value within measuring range
Hysteresis	0.1 to 5.0%

Ext. Set point/DF

Signal	0–20 mA, 4–20 mA
Factor	0.1 to 4.0

Set point DF Limit Values

Min	Min. limit value of the external signal input 0–100.0%
Max	Max. limit value of the external signal input 0–100.0%
Hysteresis	0–25%

Analog output 1/2

mA 1 signal	0–20 mA, 4–20 mA, 0–10 mA, off
mA 1	Sensor module 1-4, flow rate Wq, temperature, ext. Setpoint/DF, Yout/Ym (1), Ypi (1)
mA 2 signal	0–20 mA, 4–20 mA, 0–10 mA, off
mA 2	Sensor module 1-4, flow rate Wq, temperature, ext. Setpoint/DF Yout/Ym (1), Ypi (1)

Analog output 3/4

mA 3 signal	0–20 mA, 4–20 mA, 0–10 mA, off
mA 3	Sensor module 1-4, flow rate Wq, temperature, ext. Setpoint/DF, Yout/Ym (1), Ypi (1)
mA 4 signal	0–20 mA, 4–20 mA, 0–10 mA, off
mA 4	Sensor module 1-4, flow rate Wq, temperature, ext. Setpoint/DF Yout/Ym (1), Ypi (1)

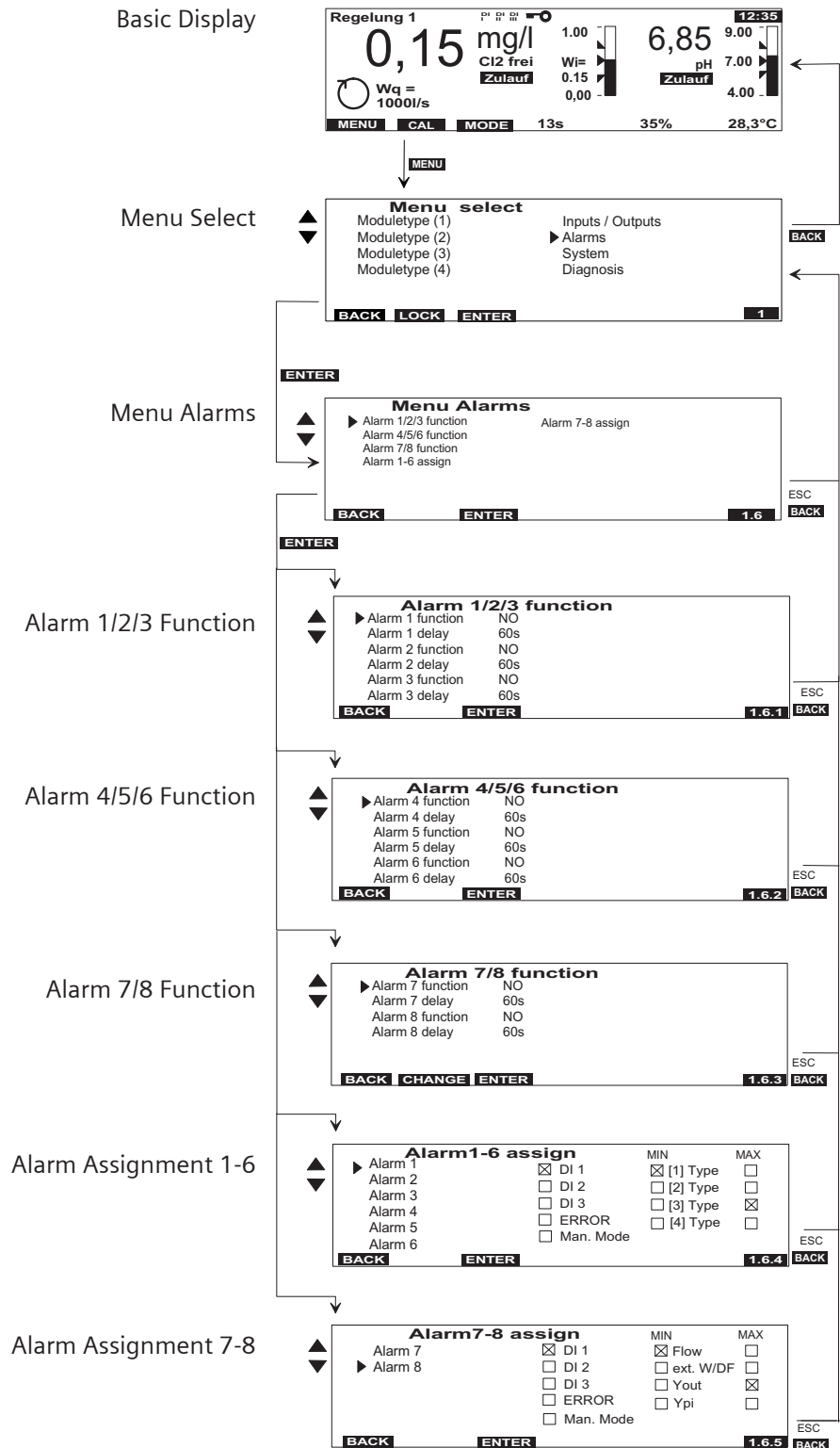
Digital Input

DI (1), DI (2), DI (3), DI (4)	A function can be assigned to each digital input.
Stop control	Yout = 0%, dosing, mA analog output = 0%
Constant control	Yout remains constant (i.e., the control signals are kept constant).
Constant mA	All mA outputs remain unchanged, while DI is active.
Ratio	If the DI is active, the control mode switches from MOD 1 to ratio control. Only if the control mode changeover is set to combi-control via DI3.
Feedback control	If the DI is active, the control mode switches from MOD 1 to single feed- back closed-loop control. Only if the control mode changeover is set to combi-control via DI3.

Interface

RS232	Out, printer, IAP download, parameter
RS485 address	Bus addresses 00 to 31 (0)
CAN segment addr.	01...31 (-- = off)

4.3.7 Alarm - Menu 1.6



Basic Display

Refer to main menu

Menu Select

Display of all available menus

Menu Alarms

Display of all available settings

Alarm 1/2/3 Function

Alarm 1 function	Defines the alarm relay contact conditions, if the alarm is inactive. N.O. unlatched N.C. unlatched N.O. latched with reset N.C. latched with reset N.O. latched with confirmation N.C. latched with confirmation
Alarm 1 delay	00:00 – 10:00 h ON delay
Alarm 2 function	See description of alarm 1
Alarm 2 delay	See description of alarm 1
Alarm 3 function	See description of alarm 1
Alarm 3 delay	See description of alarm 1

Alarm 4/5/6 Function

Alarm 4 function	See description of alarm 1
Alarm 4 delay	See description of alarm 1
Alarm 5 function	See description of alarm 1
Alarm 5 delay	See description of alarm 1
Alarm 6 function	See description of alarm 1
Alarm 6 delay	See description of alarm 1

NOTE: Assigning alarms 1, 3, 5 and 7 allows you to enter the min/max limit values for module 1 to 4, digital input

1 - 3, error and manual mode. Assigning alarms 2, 4, 6 and 8 allows you to enter the min/max limit values for the flow rate, ext. set point/dosing factor, Yout and Ypi control signals, digital input 1 to 3, error and manual mode. Alarm 5 and 6 appear only when application 1, 2 or 5 is selected. Alarm 7 and 8 appear only when application 1 is selected.

Alarm 7/8 function

Alarm 7 function	See description of alarm 1
Alarm 7 delay	See description of alarm 1
Alarm 8 function	See description of alarm 1
Alarm 8 delay	See description of alarm 1

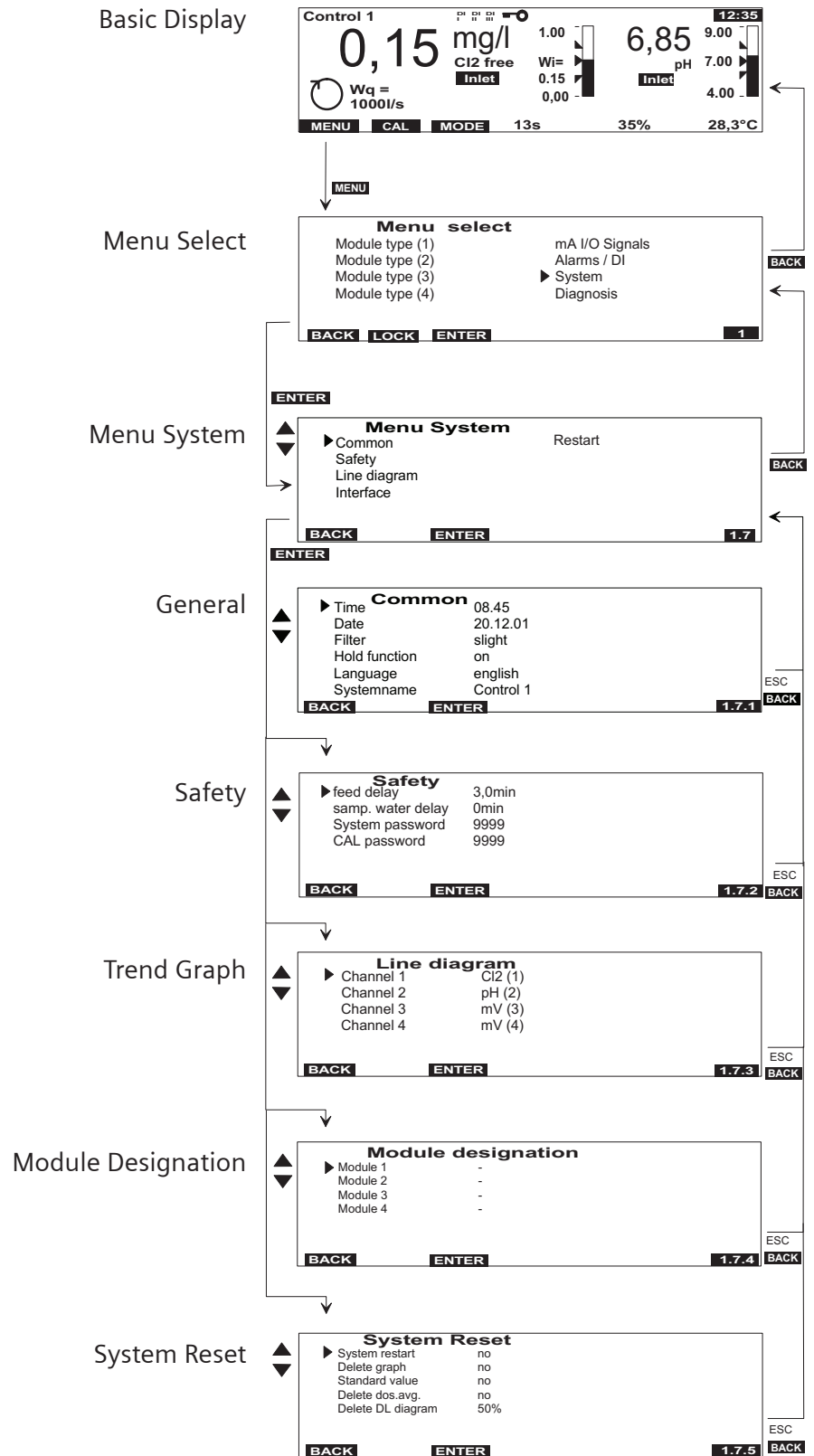
Alarm Assignment 1-6

Display of all available alarm assignments. Alarms 1 and 2 automatically assigned to power relays for Micro/2000® and Deox/2000® modules. Alarms 3 and 4 can be configured for sample line dosing for Micro/2000® and Deox/2000® modules only.

Alarm Assignment 7-8

Display of all available alarm assignments.

4.3.8 System - Menu 1.7



Basic Display

Refer to main menu

Menu Select

Display of all available menus

Menu System

Display of all available system settings

General

Time (hh:mm)	Current time
Date (dd.mm.yy)	Current date
Measure filter	off / low / high
Hold function	Off / On (see chapter 4.4 "Calibration")
Language	German, English, French
System name	12 characters, each with character set A-Z and digits 1-9 including special characters

Safety

Feed delay	00:00 – 10:00 (03min : 00s)
Samp. water delay	00:00 – 10:00 (01min : 00s) (sample water delay)
System password	four-digit numeric code (activate with Soft key "LOCK" in the "Menu Select" window)
Calibration password*	four-digit numeric code (activate with Soft key "LOCK" in the "Menu Select" window)

* only if system password is set

Trend Graph

Channel 1 to 4	Assignment of a measured value to the line diagram. The selected measured value is plotted in the trend graph (can be traced back up to 7 days). All the following measured values are possible: module 1 - 4, flow rate Wq, external set point/dosing factor, temperature, control signals Yout from module 1, Ypi from module 1 or Yout from module 2. If "Off" is selected, that channel is not recorded.
----------------	--

NOTE: If Ym is available, the Yout value for module 1 is displayed in Ym.

Module Designation

Module 1 to 4

Max. 6 digits, customised entry.
If blanks are entered, the module description is switched off.

System Reset

System restart

yes / no

Delete graph

yes / no

Standard value

yes / no

Delete dos. avg

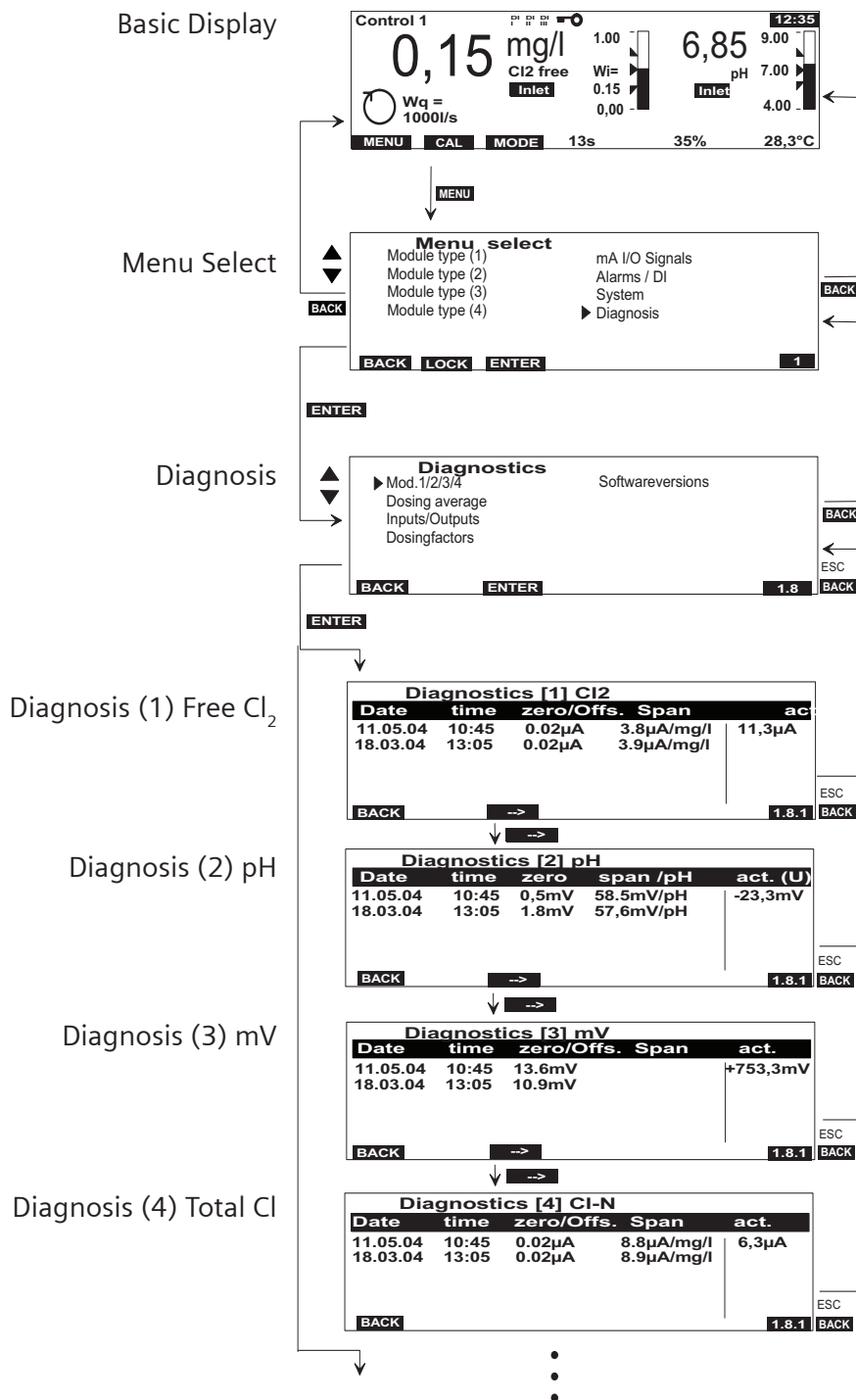
yes / no

Delete DL diagram

0–100%

4.3.9 Diagnosis - Menu 1.8

The examples below are for description only. Refer to manual provided with measurement module for detailed menus.



Basic Display

Refer to main menu

Menu Select

Display of all available menus

Diagnosis

Display of all available diagnosis displays

Diagnosis (1-4) Using the Example of Cl₂, pH, mV, Cl⁻N

Information about the available measuring inputs
(Scroll with soft key "-->")

Inputs/Output Diagnosis

Information on

- The assignment of the mA outputs
- The current mA output in mA and %
- The current dosing output Yout for module 1 as well as Ypi
- The current dosing output for module 2
- The current switching conditions of the relays:
☐ Relay off ☐ Relay on
- The selected application
- The send/receive condition of both interfaces RS485, RS232 and CAN
- The current switching conditions of the digital inputs 1, 2 and 3
- The current flow measurement (Wq) input signal
- The current input signal of the external set point (We) or external dosing factor (ext. DF)

Second Display - Input/Output (Combi-Control Only)

Information on

- Module 1 measured value
- Combi-control Yout in %
- Ypi-share of Yout in %
- Deviation Xd in %
- Dosing rate (DL) in % acc. to the current flow rate from the dosing factor table
- nL delay until new DL value is accepted in the dosing factor table (entry at 120)
- SPtr running delay until trim set point is reactivated

Dosing Average Diagnosis

Displays the dosing average of the previous hour, day, week, month

Dosing Factor Diagnosis

Displays the learned DL dosing factors for the combi (fuzzy) control output depending on Wq (display in 5% increments).

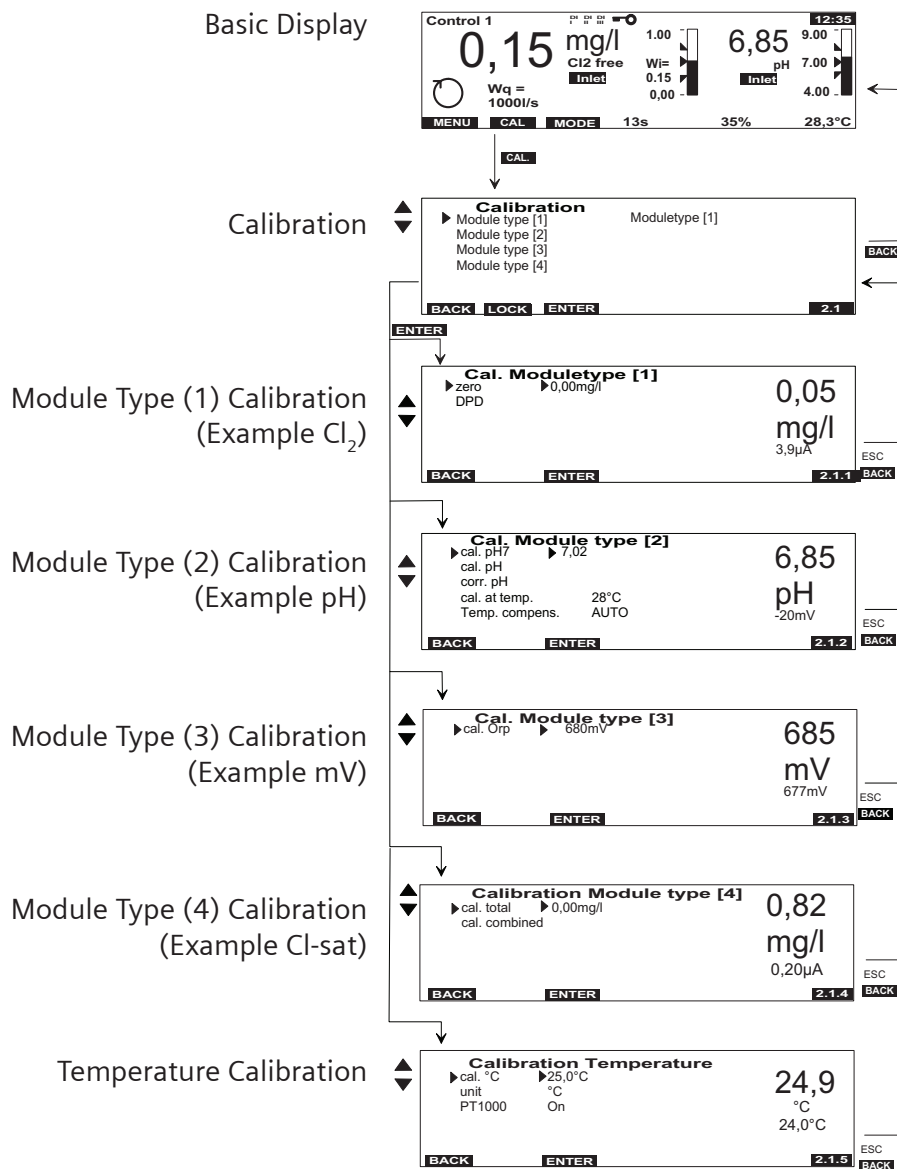
N describes the training meter, how often a dosing factor was learned for this Wq value. This table can be displayed as a diagram (toggle with the ---> key).

Software Version Diagnosis

Displays the software version of the sensor measuring module, the display and the main CPU

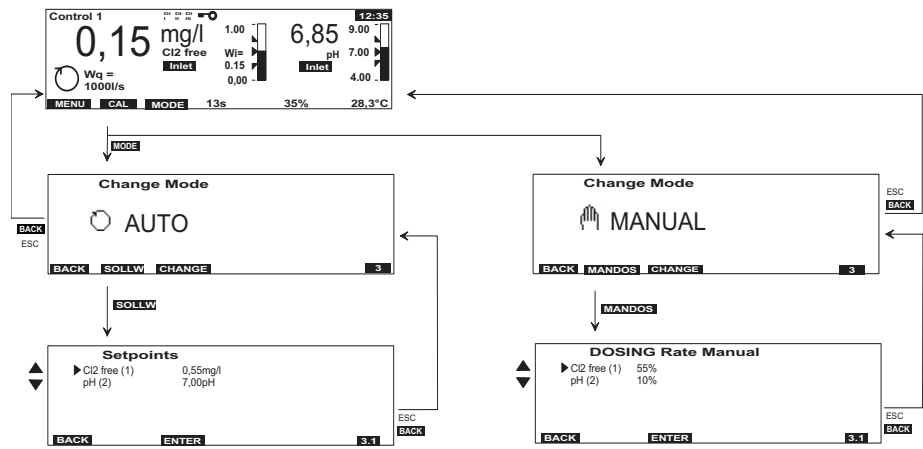
4.3.10 Calibration - Menu 2.1

The following parameters are shown for menu structure reference only. Refer to the calibration section of the manual provided with the measurement module for detailed calibration procedures.



4.3.11 Mode - Menu 3

Display using an example (module 1 = Cl₂ free and module 2 = pH).



Basic Display

Refer to main menu

Manual / Automatic

AUTO / MANUAL toggle using the “CHANGE” soft key

Set points

Cl₂ free(1) within measuring range
pH (2) within measuring range

Dosing rate MANUAL

Cl₂ free (1) %
pH (2) %

Description of the Operating Modes

MANUAL

In MANUAL mode dosing is not automatically controlled. The values must be continuously monitored.

MANUAL mode is used:

- In the event of any possible system faults
- During maintenance/cleaning work or while checking the system

NOTE: When MANUAL mode is set: The pumps are off, the positioner remains in its current position, if necessary unlock the positioner and close either by hand or with the Man.dos. menu.

AUTOMATIC

Automatically controls the measured variables acc. to the selected application

STOP

STOP mode is automatically activated:

- When the sample water flow is faulty
- When a stop signal is received via the digital inputs

After activation:

- Pumps off, positioner closed, mA analog output = 0%. If the stop conditions are no longer active, the system automatically switches to automatic mode.

ADAPTION

ADAPTION mode is activated, if the adaption for the single feedback closed-loop control module 1 or module 2 is started.

For adaption refer to 3.10, Adaption.

4.4 Errors

Error Messages

The following table shows and explains all possible error messages which can be displayed. If several errors occur at the same time, the corresponding messages appear alternately in succession. When the error has been remedied, the error message is automatically deleted.

If you are unable to remedy the error yourself, please contact the following service address:

Evoqua Water Technologies Corp.
 Vineland, NJ
 Phone 856.507.9000
 Fax 856.507.4125
 E-mail: wtus.tech.water@Evoqua.com

Table 4.1 - Error Message

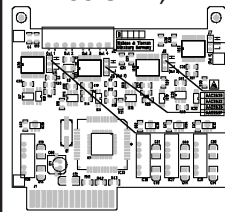
Error message	Cause	Remedy
Positioner feedback flashes	Positioner in manual mode	Press the adjusting nob on the positioner
DI I flashes	Sample water flow recently insufficient (delay running)	Check sample water flow rate (approx. 33 l/h)
DI I Permanent display	Sample water flow insufficient for some time (delay elapsed)	Clean or replace the preliminary filter Multi-sensor incorrectly connected or defective
DI II and DI III	Signal on signal input DI II or DI III	Check connection and setting
mA output 1? mA output 2? mA output 3? mA output 4?	Load error: The mA output cannot drive its mA output current through the connected current loop (400 Ohm at 20 mA max.).	Check whether the mA signal is required at all (e.g. for plotter). If not, switch off the output signal in the "INPUTS/OUTPUTS" menu (analog output). Check mA signal cable for interruption
	Resistance in the current loop > 400 Ohm	Reset the respective bridge on the plug-in module "mA outputs": L: < 400 Ohm, H: < 1000 Ohm  W&T00056
Temperature?	Interruption in the temperature sensor or cable	Check multi-sensor and cable
Mod X?	Set point error in module 1 or 2: Due to modification of the measuring range, the controller set point is outside the measuring range.	Reset the controller set point or adjust the measuring range

Table 4.1 - Error Message (Cont'd)

Error message	Cause	Remedy
Positioner Ym?	Ym range too narrow:	Set gap between 0 % and 100 % to at least 60 % of the entire path
	Position 0% or 100% incorrectly calibrated	
	Positioner selected, but not connected	Check setting: Positioner with Ym
	Feedback signal incorrect	Check feedback signal (1kOhm)
	Positioner feedback incorrectly connected or defective	Check (refer to section 5, "Wiring Diagrams")
Module?	Sensor module was removed Sensor module defective	Refit or replace the sensor module
Adaption?	Adaption terminated with error	Refer to section 3.9, Adaption
Set point trim?	Measuring range and unit for Mod 1 and Mod 2 not identical	Set measuring range and unit for Mod 1 the same, e.g. Mod 1 = 1.00 mg/l Mod 2 = 1.00 mg/l

Error

The following table shows and explains possible errors which can occur. If you are unable to remedy the error yourself, please contact the Evoqua Water Technologies service department.

Table 4.2 - Errors

Error	Cause	Remedy
No indication on device	No power supply	External switch or fuse off
	Device fuse defective	Check the power supply and replace fuse
	Housing cover is fitted incorrectly	Check, fit the housing cover correctly (cable possibly trapped)
Displayed/output value incorrect	Change on sensor or in the sample water	Calibrate
Low controller quality (controller swings, set point not reached)	Incorrect control parameters	Check, adjust controller parameters; perform automatic adaption on single feedback closed-loop control
	Dosing chemical tank empty	Fill, replace
	Incorrect actuator selected	Check, correct actuator
	Positioner or pump defective	Check, replace positioner/pump
Measured value display not available, although the appropriate measuring module is installed	Measuring module defective or fitted incorrectly	Check, refit module correctly, replace measuring module
Positioner/pump does not work	Positioner in manual mode	Engage manual knob
	Dosing device selected incorrectly	Select correct dosing device
	Positioner/pump incorrectly connected	Connect the positioner/pump correctly
	Relay card defective or fitted incorrectly	Check, replace relay card
	Incorrect application	Check (refer to sections 3.4, Applications & 5, MFC Schematic Wiring)
Positioner runs in wrong direction	Positioner incorrectly connected	Correct connections
Positioner closes	Positioner feedback interrupted	Correct connections
Digital outputs without function	Digital inputs not activated	Activate digital inputs

SECTION 5

SECTION 5 - SERVICE

List of Contents

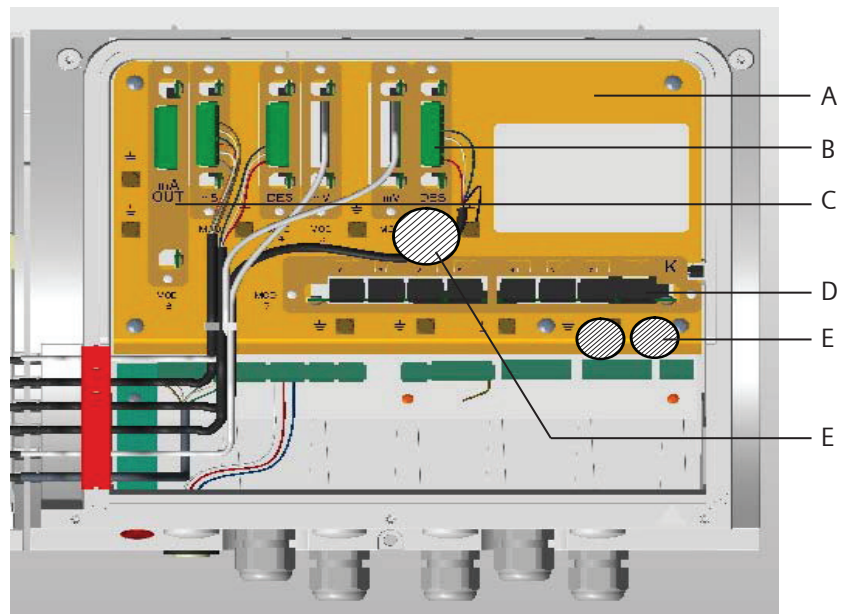
	PARA. NO.
Replacing a Fuse	5.1
Replacing the Battery	5.2

5.1 Replacing a Fuse



WARNING: ONLY AUTHORISED AND QUALIFIED ELECTRICIANS ARE PERMITTED TO OPEN THE HOUSING. THE DEVICE IS NOT EQUIPPED WITH A MAINS SWITCH.

1. Disconnect the device from the power supply.
2. Remove the cover of the MFC electronic module.
3. Remove all sensor measuring module plug-in cards (B) Remove the mA-out plug-in card (C).
4. Remove the relay card (D).
5. Remove the 4 outer screws on the metal cover (A).
6. Remove the metal cover.
7. Replace the plug-in fuses (E).
TR5 fuse W&T-Ref. AAC5527 for 230/115V.
For 24V: W&T-Ref. W2T321281.
8. Reassemble the device.



A	Metal cover
B	Sensor measuring module plug-in card
C	plug-in card with mA-out
D	Relay card
E	Plug-in fuse

5.2 Replacing the Battery

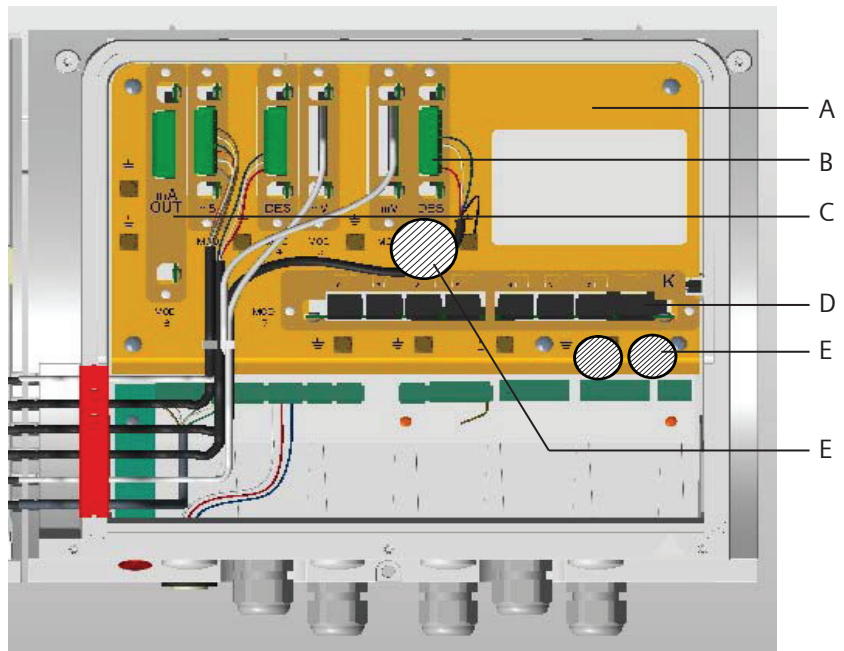


WARNING: ONLY AUTHORIZED AND QUALIFIED ELECTRICIANS ARE PERMITTED TO OPEN THE HOUSING. THE DEVICE IS NOT EQUIPPED WITH A MAINS SWITCH.

The battery is necessary for the supply of the data storage (e.g. for the trend graphs) and of the real time clock in the case of a power failure. Replace the battery if these functions are not working properly.

1. Disconnect the device from the power supply.
2. Remove the cover of the MFC electronic module.
3. Remove all sensor measuring module plug-in cards (B).
4. Remove the mA-OUT plug-in card (C).
5. Remove the relay card (D).
6. Remove the 4 outer screws on the metal cover (A).

Remove the metal cover. Reassemble the device.



A	Metal cover
B	Sensor measuring module plug-in card
C	plug-in card with mA-out
D	Relay card
E	Battery

SECTION 6

SECTION 6 - SPARE PARTS

6.1 MFC Spare Parts

Description		Part No.
Set of strips	for MFC cover application 1 to 5	AAC4561
Fuse	for 200–240 V / 100–120 V for 24 V	AAC5527 W2T321281
Varta battery CR2032		W2T439137
Accessory set 2 cable unions, 4 cable bushings, 2 fuses	for 200–240V / 100–120 V for 24 V	AAC5962 AAC6010
MFC motherboard	test for 24 V, with software test for 115/230 V, with software	AAD4531 W2T431177

SECTION 7

**STEP BY STEP COMPLIANCE
PROCEDURE FOR U.S. EPA
METHOD 334.0**

BOOK NO.: WT.050.000.000.UA.IM.0614

REGIONAL OFFICES**INSTALLATION, OPERATION, MAINTENANCE, AND SERVICE INFORMATION**

Direct any questions concerning this equipment that are not answered in the instruction book to the Reseller from whom the equipment was purchased. If the equipment was purchased directly from Evoqua Water Technologies, Colorado Springs, CO contact the office indicated below.

UNITED STATES

725 Wooten Road
Colorado Springs, CO 80915
TEL: (800) 524-6324

CANADA

If the equipment was purchased directly from Evoqua Water Technologies, Canada, contact the nearest office indicated below.

ONTARIO

Evoqua Water Technologies Ltd.
2045 Drew Road
Mississauga, Ontario
L5S 1S4
(905) 944-2800

QUEBEC

Evoqua Technologies des Eaux Itée
505 Levy Street
St. Laurent, Quebec
H4R 2N9
(450) 582-4266

INTRODUCTION

In order to comply with the US EPA method 334.0 for the use of on-line chlorine analyzers when used for reporting purposes, this addendum will provide you with a suggested step by step procedure for calibration of the on-line chlorine analyzer after initial installation as well as day to day use thereafter.

Please note that this addendum does not take the place of a thorough review of the US EPA published method, but is strictly an attempt to provide guidance on how to comply with the method if the instrumentation described herein is utilized.

Please note that this addendum does not replace any of the instructions provided in the equipment specific instruction manuals and it is highly recommended that all instruction manuals be reviewed in detail prior to installation and operation.

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Summary of Required Steps

1. Procedure for the initial verification of the P334 colorimeter calibration or A790 titrator (Section 2)
2. Initial Demonstration of Capability using the P334 photometer or A790 titrator (Section 3 & Appendix A)
3. Initial grab sample comparison testing to put on-line analyzer in use for compliance monitoring (Section 4 & Appendix C)
4. Establishing frequency of routine analyzer checks (Section 5 & Appendix D)
5. Routine quality check for on-line chlorine analyzer (Section 7)

1 Initial Start up of the On-line Analyzer Instrument

After the analyzer electronics and complete flow cell are installed as per the instructions provided in the equipment specific instruction manual, the analyzer system should be leak tested and all electrical connections should be checked for accuracy.

Start sample water flow through the flow cell as per the instruction manual. Again check for leaks and maintain sample flow through the flow cell.

Initialize power to the instrument. As is noted in the instruction manual of your instrument, our analyzers are not provided with their own power switch and therefore power is usually initialized by an external breaker or power switch.

NOTE: Connected devices, such as chemical feed equipment have to be switched off during input of operating data in order to prevent uncontrolled start-up or malfunctions. Only when the operating data input is complete and checked may other devices be switched on.

NOTE: The analyzer should be left in operation with sample water flowing and power on for a period of 24 hours prior to the initial calibration is performed. During this time, the analyzer output should not be used for automatic disinfectant feed.

2 Initial Procedure for the Use of the Evoqua P334 Colorimeter

The initial calibration of the on-line analyzer will require the analysis of a grab sample. For ease of use in drinking water applications, a DPD colorimetric method using our Evoqua P334 colorimeter is suggested.

(Those facilities that are already using amperometric titration with the Evoqua A 790 titrator for calibration purposes should continue to use this calibration procedure)

The following grab sample analysis procedure must be followed during the initial start-up of the on-line analyzer:

To ensure the accuracy of the Evoqua P334 colorimeter is dependent on whether the instrument being used is factory calibration certified or whether field verification is necessary:

- For factory certified P334 instruments, perform an initial P334 colorimeter calibration check utilizing the primary chlorine standard provided. The primary chlorine standard must be analyzed within +/- 15% of its expected concentration.
- For P334 instruments that are not factory certified and require field calibration verification of the instrument. The instrument calibration curve must be verified by performing a calibration check of the P334 instrument with a blank sample and 3 calibration standards that span the concentration range. Each calibration standard must be analyzed within +/- 15% of its expected concentration.
- For the A-790 titrator, the calibration of the instrument should be confirmed with calibration standards that span the concentration range.

The accuracy of the grab sample method should be confirmed quarterly with the use of a primary chlorine standard.

3 Initial Demonstration of Capability with Use for the Grab Sample Analysis

To ensure the operator is well schooled in the use of the colorimeter (or titrator if it is being used) it is required that the operator perform 5 consecutive analysis of samples that have the same chlorine concentration to confirm his initial demonstration of capability (IDC).

The concentration of the 5 consecutive samples used should be near the expected concentration of the water samples under normal water plant operating conditions.

The average concentration of the 5 consecutive analyses must be within +/- 15% of the expected value.

Calculate the relative standard deviation (RSD) of the 5 consecutive analyses using the equation:

$$\text{RSD} = S / X \times 100\%$$

Where 'S' is the standard deviation of the replicate values
And 'X' is the average value of the replicate values

The relative standard deviation (RSD) of the results of the replicate analyses must be less than or equal to 15%.

Utilize the Appendix A to establish the initial demonstration of capability (IDC) and file completed form.

Please see Appendix B for troubleshooting of the Evoqua P334 photometer when the above measurements fail to provide an acceptable result.

4 Initial Calibration of the On-line Analyzer and Placing Into Service for Compliance Monitoring

An initial analyzer calibration should be performed only after the analyzer has been in operation for a 24 hour period in which the sensor reaches its working equilibrium.

Follow the calibration procedure as it pertains to your specific measurement module as described in the instruction manual supplied with your analyzer.

NOTE: The initial demonstration of capability of the use of the Evoqua P334 photometer (or Evoqua A-790 titrator) should be completed before proceeding (see Section 3).

Perform the analyzer calibration and note both the grab sample and on-line analyzer result on a table, a sample of which is supplied in Appendix C.

Continue to perform on-line chlorine analyzer calibration check with a grab sample analysis once per day for a period of fourteen days.

Perform additional checks of the on-line analyzer as needed but re-initiate the fourteen day daily calibration check utilizing the Evoqua P334 photometer (or Evoqua A-790 titrator) if the on-line analyzer requires calibration during this trial period.

Only after the on-line analyzer readings are within the required tolerance of 15% of the grab sample concentration measurement for fourteen consecutive days is the on-line analyzer ready to be put into use for compliance monitoring.

5 Establishing a Frequency of Routine Grab Sample Comparisons to Online Analyzer Readings

To establish the routine grab sample comparison schedule additional testing is required to gain a level of historical confidence in the on-line to grab sample comparison.

The flowchart in Section 6 illustrates the required comparison testing required to set up a grab sample comparison frequency of every 3, 4, 5, 6 or 7 consecutive days.

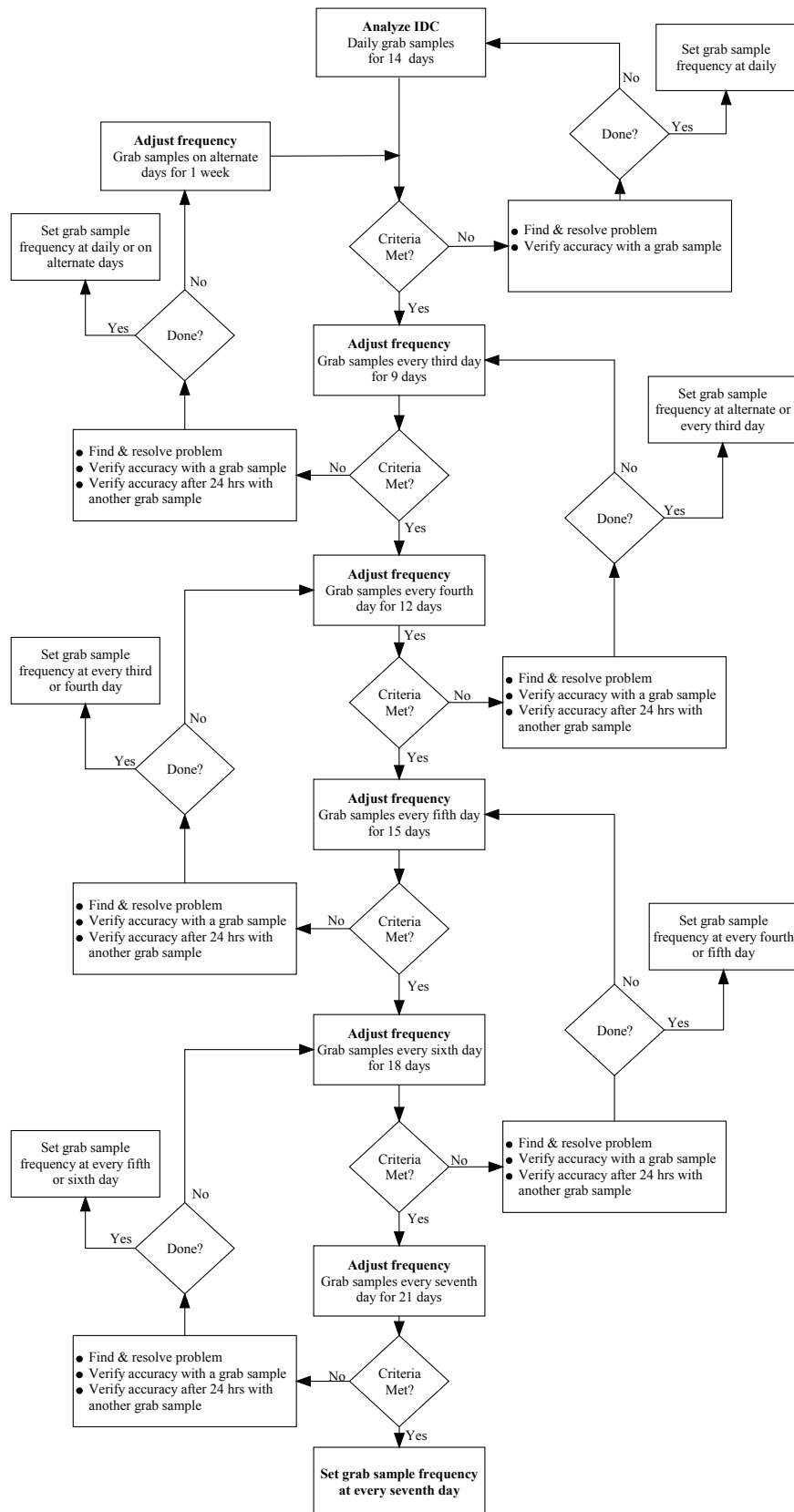
If troubleshooting of the on-line analyzer is required as part of any troubleshooting procedures during this testing period, it is suggested to refer to the troubleshooting guide supplied in the instruction manual of each on-line chlorine analyzer.

A spreadsheet to record the results of the testing is supplied in Appendix D.

NOTE: In order to proceed down the rows of comparison testing in the table provided in Appendix D, the on-line analyzer concentration recorded must be within +/- 0.1 mg/l or +/- 15% (which ever is larger) of the grab sample measurement.

NOTE: For existing online analyzer installations, only the initial demonstration of capability of the online analyzer is required, as described on the previous page. The grab sample comparison test frequency thereafter can be set to every seven days.

6 The flow chart below shows how to establish a grab sample check every 7th day



7 Routine Operation of the On-line Chlorine Analyzer

Let us review the calibration requirements of the on-line analyzer for routine operation:

1. Record the on-line analyzer chlorine reading
2. Immediately thereafter collect a grab sample as close as possible to the on-line analyzer flow cell
3. Perform analysis of the grab sample with either a colorimeter or amperometric titrator.
4. If the on-line analyzer concentration recorded is within ± 0.1 mg/l or $\pm 15\%$ (which ever is larger) of the grab sample measurement no action is required.
5. If the on-line analyzer concentration recorded is not within ± 0.1 mg/l or $\pm 15\%$ (which ever is larger) of the grab sample measurement, calibration of the on-line chlorine analyzer is required. You may wish to collect a second grab sample before proceeding with the calibration procedure to confirm calibration is indeed required. Please refer the instruction manual of your particular on-line chlorine analyzer for calibration instructions.
6. If calibration of the on-line analyzer is required, please note that the P334 colorimeter calibration (or A790 titrator calibration) **must be confirmed by calibration with a primary chlorine standard.**
7. An additional grab sample comparison should be performed after one day of operation to verify that the calibration adjustment was performed properly.
8. Please refer to Appendix B for troubleshooting guidance if you encounter difficulties with the use of the P334 colorimeter. Please note the use of secondary chlorine standards is recommended to help troubleshoot the colorimeter in order to minimize the use of the primary chlorine standard for that purpose.
9. Please refer to the instruction manual of your particular on-line chlorine analyzer if you encounter difficulties with calibration.

NOTE: A grab sample comparison should be performed at least once per week.

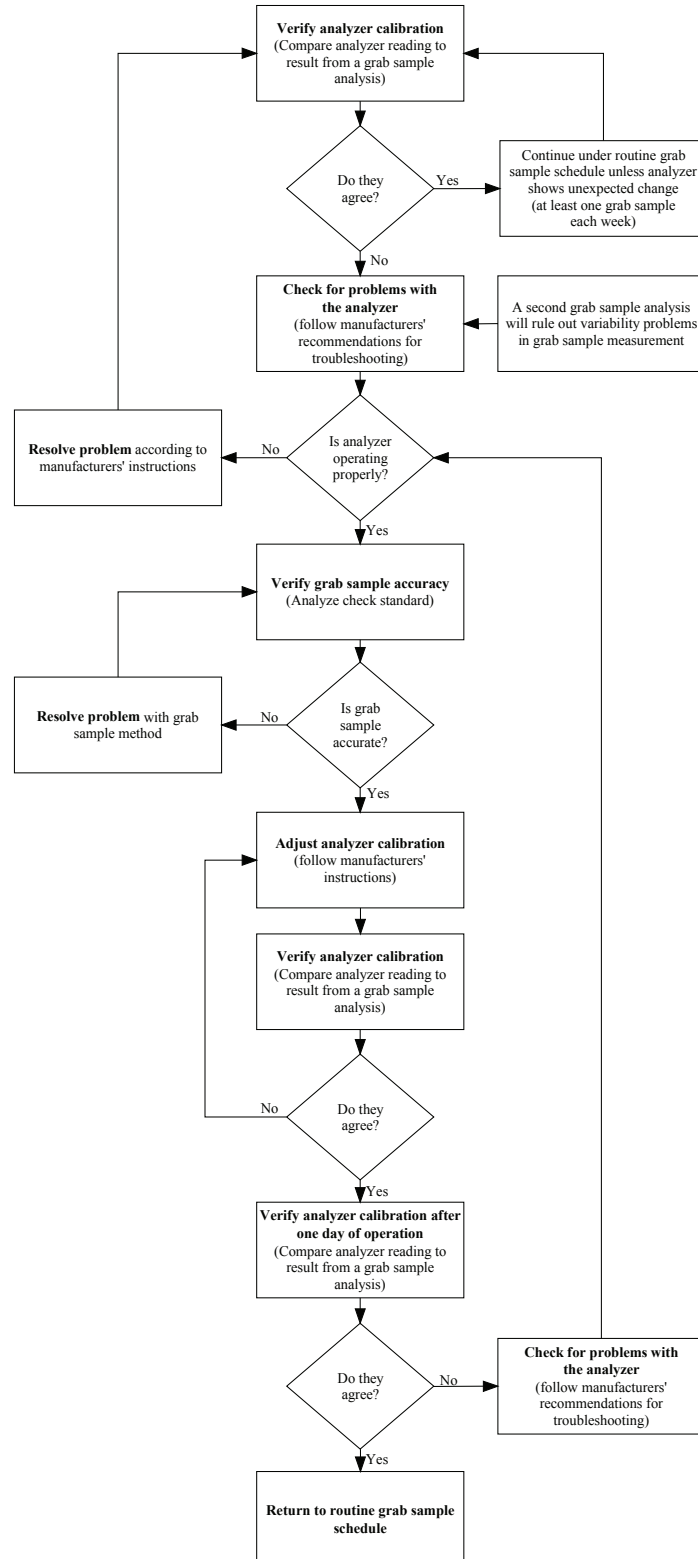
COMPLIANCE FOR EPA METHOD 334.0

Illustration of on-line analyzer readings and grab sample analysis comparison:

On-line analyzer reading	re-calibrate	Acceptable grab sample analysis range			re-calibrate
1.0	< 0.9	0.9	-	1.2	> 1.2
1.1	< 0.9	0.9	-	1.3	> 1.3
1.2	< 1.0	1.0	-	1.4	> 1.4
1.3	< 1.1	1.1	-	1.5	> 1.5
1.4	< 1.2	1.2	-	1.6	> 1.6
1.5	< 1.3	1.3	-	1.7	> 1.7
1.6	< 1.4	1.4	-	1.8	> 1.8
1.7	< 1.4	1.4	-	2.0	> 2.0
1.8	< 1.5	1.5	-	2.1	> 2.1
1.9	< 1.6	1.6	-	2.2	> 2.2
2.0	< 1.7	1.7	-	2.3	> 2.3
2.1	< 1.8	1.8	-	2.4	> 2.4
2.2	< 1.9	1.9	-	2.5	> 2.5
2.3	< 2.0	2.0	-	2.6	> 2.6
2.4	< 2.0	2.0	-	2.8	> 2.8
2.5	< 2.1	2.1	-	2.9	> 2.9
2.6	< 2.2	2.2	-	3.0	> 3.0
2.7	< 2.3	2.3	-	3.1	> 3.1
2.8	< 2.4	2.4	-	3.2	> 3.2
2.9	< 2.5	2.5	-	3.3	> 3.3
3.0	< 2.6	2.6	-	3.5	> 3.5
3.1	< 2.6	2.6	-	3.6	> 3.6
3.2	< 2.7	2.7	-	3.7	> 3.7
3.3	< 2.8	2.8	-	3.8	> 3.8
3.4	< 2.9	2.9	-	3.9	> 3.9
3.5	< 3.0	3.0	-	4.0	> 4.0
3.6	< 3.1	3.1	-	4.1	> 4.1
3.7	< 3.1	3.1	-	4.3	> 4.3
3.8	< 3.2	3.2	-	4.4	> 4.4
3.9	< 3.3	3.3	-	4.5	> 4.5
4.0	< 3.4	3.4	-	4.6	> 4.6
4.1	< 3.5	3.5	-	4.7	> 4.7
4.2	< 3.6	3.6	-	4.8	> 4.8
4.3	< 3.7	3.7	-	4.9	> 4.9
4.4	< 3.7	3.7	-	5.1	> 5.1
4.5	< 3.8	3.8	-	5.2	> 5.2
4.6	< 3.9	3.9	-	5.3	> 5.3
4.7	< 4.0	4.0	-	5.4	> 5.4
4.8	< 4.1	4.1	-	5.5	> 5.5
4.9	< 4.2	4.2	-	5.6	> 5.6
5.0	< 4.3	4.3	-	5.8	> 5.8

Routine quality check for on-line chlorine analyzer

The flowchart illustrates a means of performing the quality check of the on-line analyzer.



APPENDIX A

Initial Demonstration of Capability (IDC) for use with the Evoqua P334 Photometer (or A790 Titrator)

Date:	Operator:	Evoqua Instrument:
-------	-----------	--------------------

Perform five consecutive analysis of a water sample with constant chlorine concentration (the five analyses should be performed within a 20 minute period) & note all five readings below:

	Concentration	Lowest Allowable Concentration	Highest Allowable Concentration
Sample 1			
Sample 2			
Sample 3			
Sample 4			
Sample 5			

Calculate the allowable deviation by multiplying the result in sample 1 by 0.9 to gain the lowest allowable concentration deviation and multiplying the result in sample 1 by 1.1 to gain the highest allowable concentration deviation and note both results in the table above.

If the sample 2 through 5 do not fall within the allowable concentration ranges, repeat the testing procedure of 5 additional consecutive samples.

1. Calculate the mean (average): add all five sample concentration values and divide by 5 –
note the result – Mean (X) =

2. Calculate the difference of each of the five samples from the mean and square the result and note the result in the table below:

Sample	Mean	Sample – Mean	(Sample - Mean) Squared
1			
2			
3			
4			
5			

Add these 5 squared results

Added result divided by 5:

Now take square root of the result (calculator) (S) =

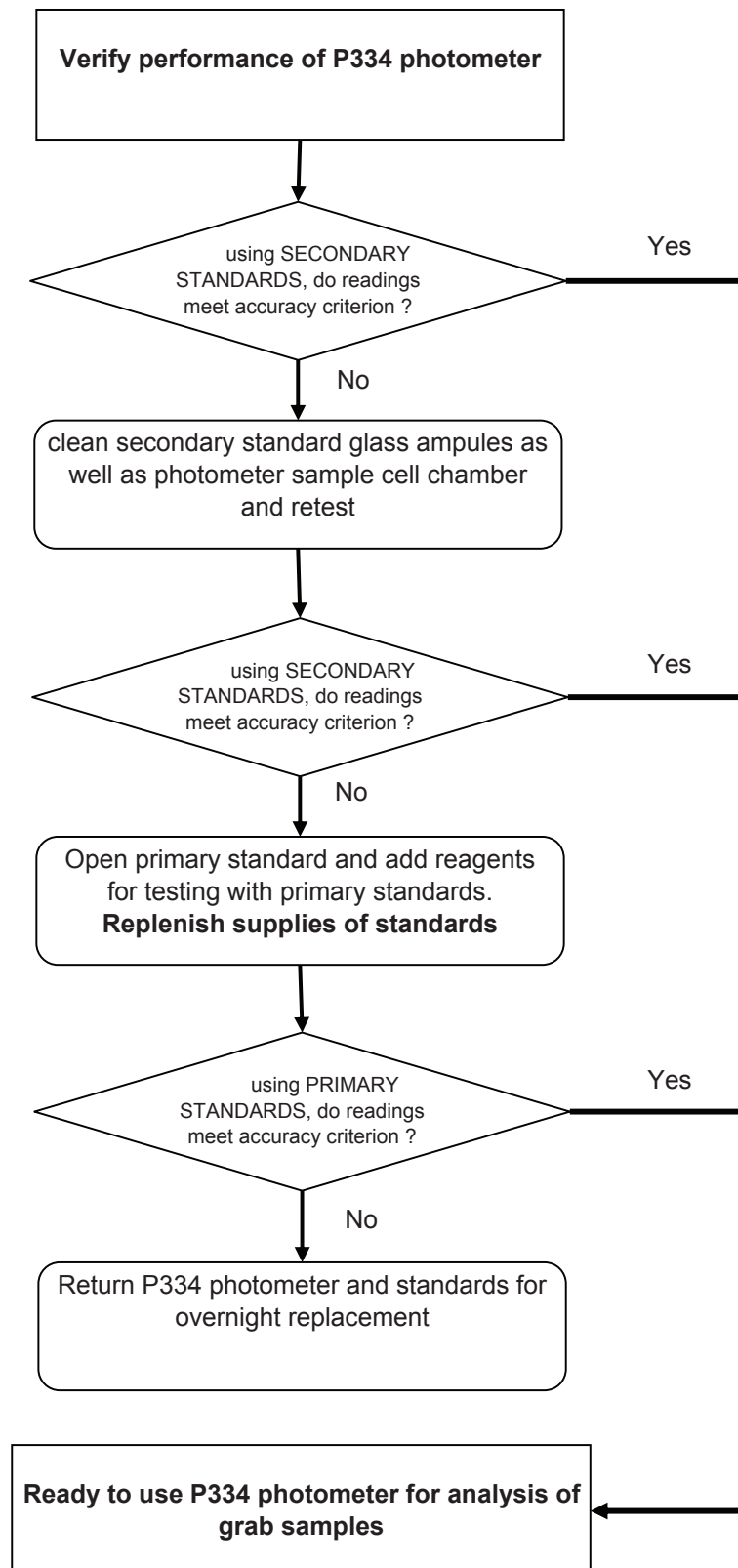
Divide the standard deviation (S) result by the mean (X) calculated earlier and multiply by 100 to calculate the required relative standard deviation.

RSD = (S) / X * 100 (result is noted as a %), where (S) is the standard deviation and X is the mean.

The resulting RSD value must not exceed 15 %.

APPENDIX B

Troubleshooting the Evoqua P334 Photometer



COMPLIANCE FOR EPA METHOD 334.0

APPENDIX C

Initial On-line Analyzer Initial Demonstration of Capability (IDC) Period

Date:	Operator:	Evoqua Instrument:
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Period	Day	Date	Analyzer Reading	Grab Sample Reading
Initial on-line analyzer trial (IDC) period	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			
	14			

COMPLIANCE FOR EPA METHOD 334.0

APPENDIX D

Spreadsheet to Set Up Routine On-analyzer Checks to Every 4th Day:

Date:	Operator:	Evoqua Instrument:
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Period	Day	Date	Analyzer Reading	Grab Sample Reading	Date	Analyzer Reading	Grab Sample Reading
Initial calibration	1				<div>Use the additional data blocks provided below if one of the calibration steps needs to be repeated.</div>		
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
adjust frequency to every 3rd day	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
adjust frequency to every 4th day	23						
	24						
	25						
	26						
	27						
	28						
	29						
	30						
	31						
	32						
	33						
	34						
	35						
	36						

NOTE: In order to proceed down the rows of comparison testing, the on-line analyzer concentration recorded must be within +/- 0.1 mg/l or +/- 15% (which ever is larger) of the grab sample measurement)

COMPLIANCE FOR EPA METHOD 334.0

APPENDIX D (cont'd)

Spreadsheet to Set Up Routine On-analyzer Checks to Every 6th Day:

Date:	Operator:	Evoqua Instrument:
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Period	Day	Date	Analyzer Reading	Grab Sample Reading	Date	Analyzer Reading	Grab Sample Reading
<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Use the additional data blocks provided below if one of the calibration steps needs to be repeated. </div>							
adjust frequency to every 5th day	37						
	38						
	39						
	40						
	41						
	42						
	43						
	44						
	45						
	46						
	47						
	48						
	49						
adjust frequency to every 6th day	50						
	51						
	52						
	53						
	54						
	55						
	56						
	57						
	58						
	59						
	60						
	61						
	62						
63							
64							
65							
66							
67							
68							
69							

COMPLIANCE FOR EPA METHOD 334.0

APPENDIX D (cont'd)

Spreadsheet to Set Up Routine On-analyzer Checks to Every 7th Day:

Date:	Operator:	Evoqua Instrument:
-------	-----------	--------------------

Period	Day	Date	Analyzer Reading	Grab Sample Reading	Date	Analyzer Reading	Grab Sample Reading
					Use the additional data blocks provided below if one of the calibration steps needs to be repeated.		
adjust frequency to every 7th day	70						
	71						
	72						
	73						
	74						
	75						
	76						
	77						
	78						
	79						
	80						
	81						
	82						
	83						
	84						
	85						
	86						
	87						
	88						
	89						
	90						