USER MANUAL

For the lab scale

MINILOOP

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1 Introduction

The Miniloop was originally constructed by Bårdsen [1] as a part of his fifth grade project with the Department of Chemical Engineering at NTNU. Since then some work has been done on the Miniloop by Søndrol[2] as a part of his thesis. New measurements have been added and analyzed. A new user interface has been constructed to obtain the new measurements and to allow different control structures.

This user manual was written as a part of the thesis [2], however it is meant to be a stand alone user manual. This means that some of the things presented in this manual can also be found in the Diploma thesis [2].

The Miniloop is essentially very easy to use. However there are some issues the user should be aware of. It is therefore recommended to read this user manual before performing any experiments on the Miniloop.

2 Miniloop and equipment

Figure 2.1 shows an overview of the lab scale Miniloop. The different components are listed in table 2.1.

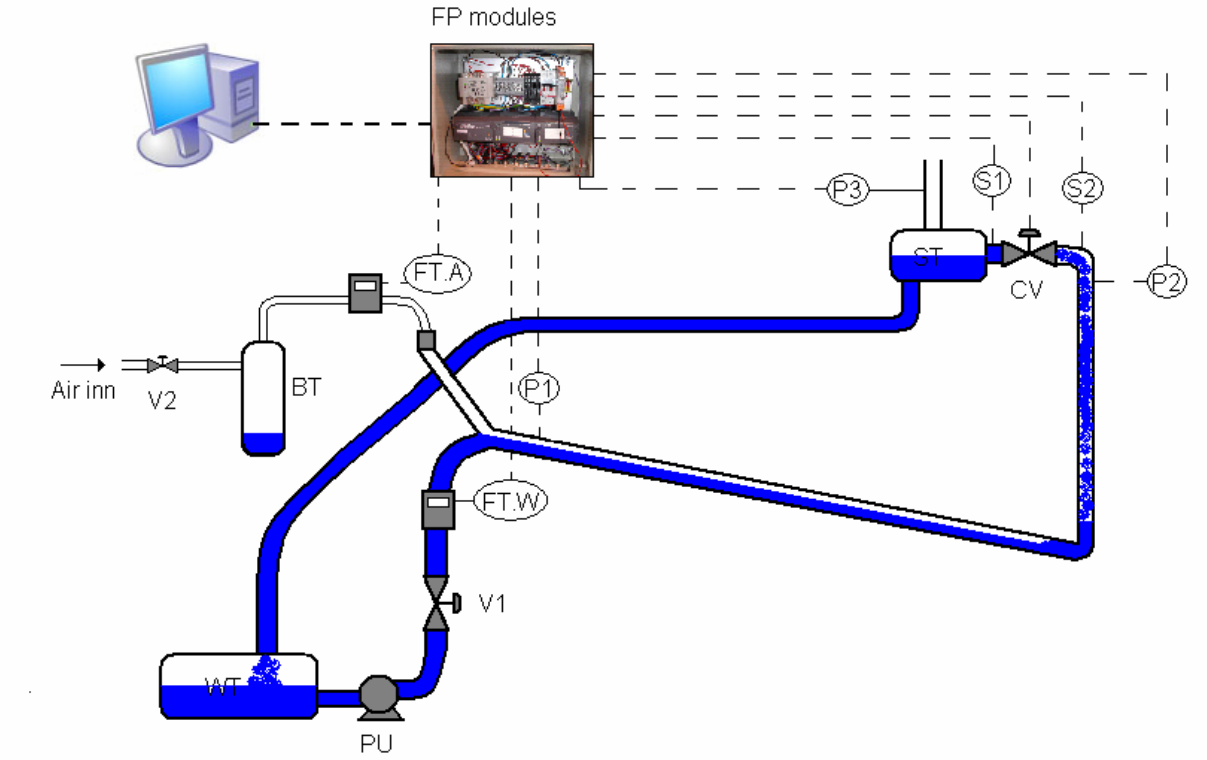


Figure 2.1 Flow sheet for the Miniloop.

As can be seen from the figure the Miniloop has a water (WT) sorce and an air source. The water is pumped from the reservoir into the system, while the air is let into the system from a pressurized air outlet in the wall. The flow rate of water and air is controlled by manually adjusting valves V1 and V2. The pipeline system is constructed of several connecting sections of transparent plastic tubes. The pipeline is meant to imitate the pipeline topography where gravity induced slugging occurs, which is a low point connected to an inclined section of the pipe. At the top of the riser the multiphase flow passes the control valve before it enters the separator. At this point the air is released out of the system through an open hole in the separator, while the water is returned to the reservoir. To monitor the behaviour of the system a combination of pressure measurements and slug sensors are used. The measured signals are transmitted to a computer through the FieldPoint (FP) modules, where they can be analyzed, stored and manipulated.

Table 2.1 List of equipment.

Denote	Equipment
FT.W	Rate meter for water(Gemu 3021)
FT.A	Rate meter for Air
P1	Pressure sensor (MPX5100DP) Feed inlet
P2	Pressure sensor (MPX5100DP) Valve
P3	Pressure sensor (MPX5100DP) Separator air outlet
S1	Slug sensor (E3X-DA-N)
S2	Slug sensor (E3X-DA-N)
PU	Pump (Eheim 1060)
WT	Reservoir
BT	Buffer tank
ST	Separator
CV	Control valve

Consult table A.1 for more info about the distributors and prises. More detailed information about the different equipment can be found in appendix B. The different equipment will be briefly discussed below.

The rate meter for water (figure 2.1) is placed in front of the mixing point of water and air. The digital display shows the rate of water in l/min. It provides a signal between 4-20mA, depending on the rate of flow, which is send to the computer.

The rate meter for air (figure 2.2) is placed in front of the mixing point of water and air. It has a digital display that shows the rate of air in percent of its operating area, witch is 0-2.2 l/min. The rate meter also provides a signal between 0-5 V which is send to the computer.

The pressure sensors (figure 2.3) are one of Motorola's differential pressure sensors that delivers a signal between 0.2-4.5 V. The relationship between voltage and pressure is linear and its operating area is between 0-100kPa.

The slug sensors (figure 2.4) are fibre optical sensors. Each slug sensor is made up of two fibre optical cables connected to a sensor. The light emitted from the senor will travel out through one of the cables and back through the other. The device will provide a signal between 1-5 V depending on how much light is transmitted between the two cables.

The pump (figure 2.5) used is a standard aquarium pump. It can deliver up to 38 l/min and work against a head of 3.1 m. Special care must be taken to make sure it doesn't pump air as this can damage the pump.

The reservoir (figure 2.6) is a cylindrical container made of transparent glass. It serves as the water source for the Miniloop, and the water is returned to the tank from the separator.

The separator (figure 2.7) is also a cylindrical glass container with one inlet and two outlets. The air is released to the surroundings through an open hole in the top, while the water is returned to the reservoir.

The buffer tank (figure 2.8) is a cylindrical container made of transparent glass. For slugs to appear the system needs a sufficiently large air volume. The air volume in the tank can be altered by adding water to the tank.

The control valve (figure 2.9) is located at the top of the riser before the separator inlet. The valve requires a 24V power supply and is controlled by a signal to the actuator between 4-20 mA. The relationship between the valve's actuator and the valve opening is linear. To operate the actuator an external pressurized air source of 4-8 bar is required to counteract the spring power. The lab has its own pressurized air source, which was used for this purpose.

Figure 2.1 Flow meter

Figure 2.1 Flow meter

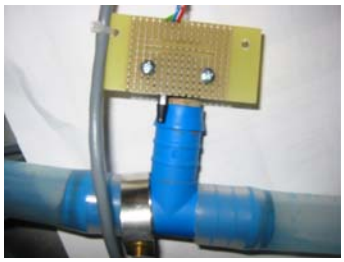


Figure 2.3 Pressure sensor

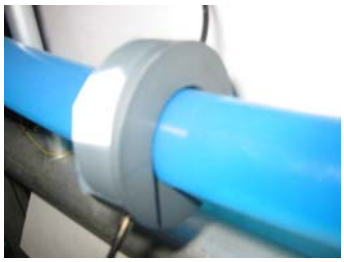


Figure 2.4 Slug sensor

Figure 2.5 Pump

Figure 2.6 Reservoir

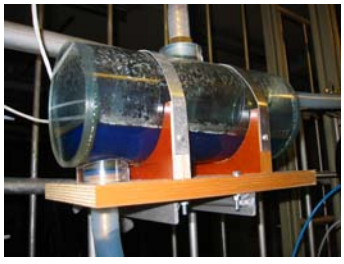


Figure 2.7 Separator

Figure 2.8 Buffer tank

Figure 2.9 control valve

3 Operating the Miniloop

3.1 Start up and shut down procedures.

Start up

1. Start the computer and open the LabVIEW program miniloop.
2. Make sure valve V1 and V2 are closed.
3. Connect the power to the field point modules.
4. Turn the field point modules on by using the switch.
5. Connect the power to the pump.
6. Put the miniloop program into run mode.
7. Turn valve V2 until the desired air flow is reached.
8. Turn valve V1 until the desired water flow is reached.

Shut down

1. Shut of the water supply first(valve V1 first), then the air supply (valve V2).
2. Disconnect the power supply to the pump
3. Turn of the field point modules with the switch.
4. Disconnect the power source to the field point modules.
5. Close LabView and shut down the computer.

Comments

- The air supply must always be turned on first and shut down last. The reason is to obtain a certain pressure inside the hose to prevent backflow of water into the buffer tank(BT).
- The pump will start to work as soon as the power supply is connected. So make sure there is no air in the pipe leading from the water reservoir to the pump. Also make sure that the water level in the reservoir tank is higher then the outlet leading to the pump.
- The valve will always close itself when the field point modules are turned off. The miniloop program therefore has to be put in run mode to open the valve before air or water is introduced to the system. Failure to do this will result in a quick pressure build up in the pipe and a blow out of the pressure sensors.

Adjusting flow rates

During system start up it is recommended to adjust the air flow to the desired flow rate before introducing water into the system. Once the air flow is adjusted the water flow rate can be adjusted to the desired rate. Take note that the water flow rate will vary depending on the upstream pressure. The water flow will normally vary around 10%. To maintain consistency it’s recommended to use the max flow rate during these variations as the reference.
The air flow measurement is dependent on the temperature inside the measuring device. This means that the measured flow rate of air will drop during the first minutes after start up as the temperature inside the device stabilize it self. Because of this its not recommended to initiate any experiments until the measurement is stable (approx. : 5-10 mins.)

3.2 User interface

The Miniloop is controlled by a computer through the user interface.

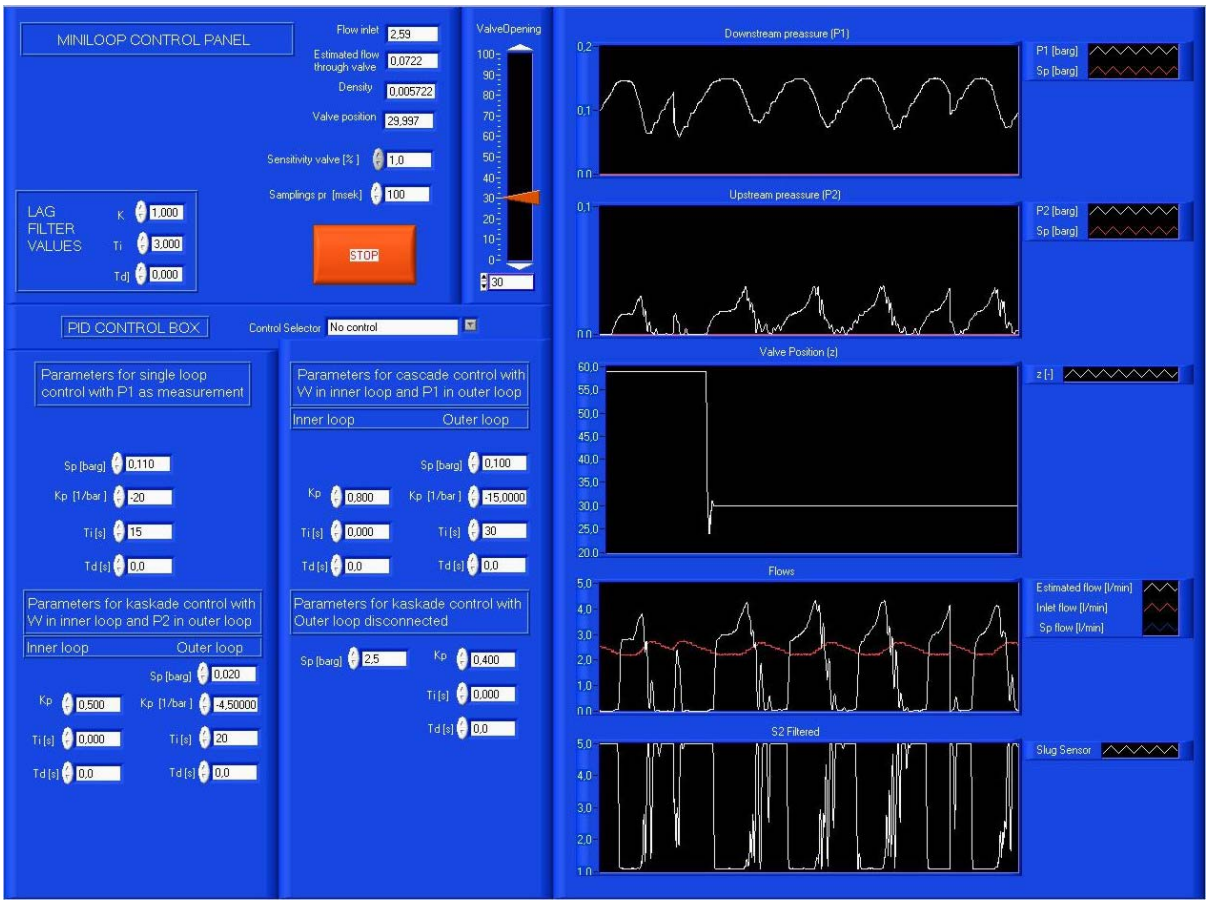


Figure 3.1 User interface for the Miniloop.

The front panel has three main areas of interest. First of you have the charts used to visualize the measurements, like pressure drop, valve opening, flow and hold up. The top chart displays the downstream pressure, while the second one displays the upstream pressure. If anti slug control is applied the mentioned charts will display the relevant set point. The third chart from the top plots the flow of water into the system and an estimate of the flow through the control valve. If a cascade controller is applied it will also show the relevant set point. The slug sensor results are plotted at the bottom. This measurement plots the filtered signal received from the optical sensors.

The PID control is located at the lower left corner of the screen. This is where the user chooses witch control structure to use. The loop is set to “no control” by default, but by clicking it you can choose from the available control configurations from a pull down menu : The tuning parameters for the different controllers are also located here, witch means the user can change them by simply entering the new value.

In the upper left corner of the front panel the user will find some additional indicators that displays additional information about the system. Most measurements are already filtered to some degree, but since the estimated flow measurement is the one most prone to disturbances, an additional lag filter has been added. The parameters for this filter can be altered by changing the values in the filter box.

3.3 Active control

To apply active control the user have to open the pull down menu in the PID control box and choose witch control configuration to use. The control selector is set to “No control” by default. Choosing a different control structure then this will immediately switch the system from open loop (manual control) to closed loop (active control). The chosen controller will use the relevant tuning parameters given in the PID control box. The default parameters will stabilize the system at the given set point. Both parameters and set points can be altered during active control. However one must pay close attention to the system if these values are changed. Wrong parameters during active control can make the valve close it self, leading to a pressure build up and a blow out of the pressure sensor. If this happens the user must switch the control selector back to “no control” to reset the valve position and prevent the build up of pressure.

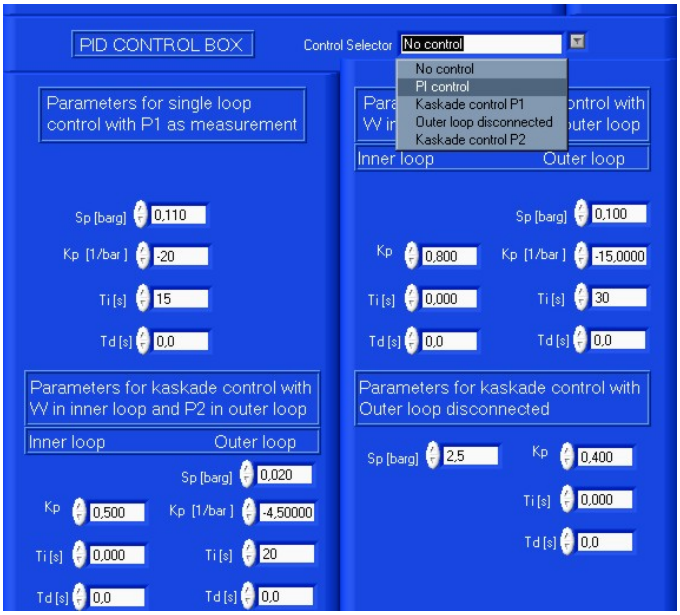


Figure 3.2 PID control box.

3.4 Manual control

When the control selector is set to “No control” in the PID control box the process will run in open loop mode. The user can adjust the valve opening by adjusting the slide bar or by entering the new value for the valve opening in the small box below.

Figure 3.3 Manual valve control.

4 The Miniloop block diagram.

In this chapter the most important components or subVi's in the block diagram will be briefly explained. Understanding of the block diagram is essential if the user wish to add more code or alter the existing code. More information about the detailed tasks of each component can be learned by reading the text boxes inside each subVi or by using the help function in LabVIEW.

4.1 The subVi's

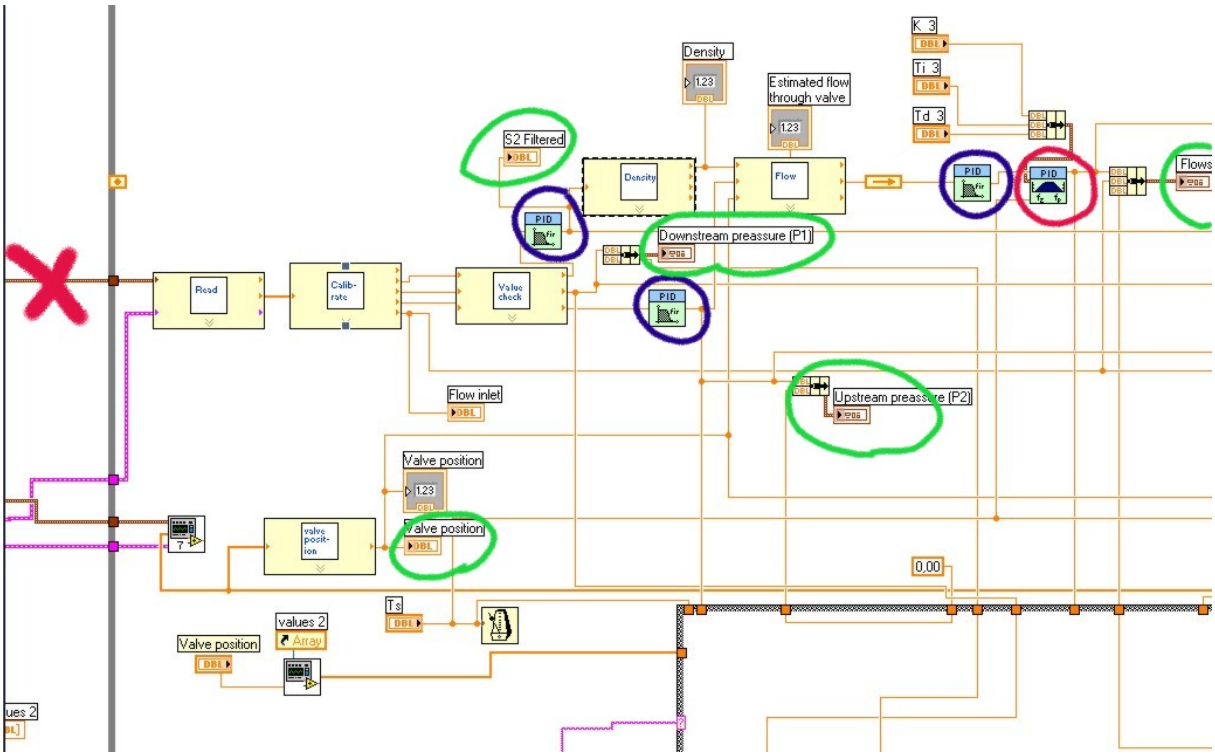


Figure 4.1 The block diagram.

Figure 4.1 shows a section of the block diagram. The yellow boxes with name tags in the middle are different SubVi's. Each of them contains additional code that can be accessed by double clicking the block in the actual program. The programming follows the flow of data. A while loop encompasses most of the code and the measurements will enter the while loop in the wire marked with a big red X. Once it is inside the while loop it will pass from box to box by following the different wiring.

The different subVI's and their purpose are listed below.

Read: Here the data is indexed and tagged.
Calibrate: The data is split into separate data streams and calibrated.
Value check: Here the different measurements are checked to ensure they don't take inconsistent values. Disturbance and noise may cause a measurement to take illegal values i.e. a pressure becoming negative. This subVi will remove these values and force the measurement to take values within a given limit.

Density: The slug sensor signal is send to this SubVi, and the density is calculated based on the equations inside the SubVi.

Flow: This subVi needs the density calculated in the previous subVi, the pressure drop across the valve and the valve opening. It will then estimate the total mass flow through the valve.

Valve position: This subVi will calculate the valve opening from the actuator position.

4.2 Filters and charts.

The block diagram in figure 4.1 are marked with green, blue and red circles. They are there so the user can quickly identify the following components.

Green circles: The componets inside the green circle are indicators. They plot the corresponding data in the charts located in the front panel. The different measurements being plotted are downstream pressure P1, upstream pressure P2, valve position z, flow Q and W, and the slug sensor S2.

Blue circles: The blue circles encompass the PID Control Input Filters. These filters apply a fifth-order low-pass FIR filter to the input value. Filter cut-off frequency is designed to be 1/10 of the sample frequency of the input value. Use this function to filter measured values (such as process variable) in control applications.

Red circle: The red circle encompasses a lag filter. This filter has been added to the estimated mass flow measurement. The filter parameters can be adjusted in the filter box on the front panel.

4.3 CASE structure and the controllers.

The different control structures are located inside within the case structure. New control configurations can be included in the program by adding a new case and filling in the relevant code. Below is an example of case 3. This is a cascade configuration that uses mass flow W in the inner loop and upstream pressure P1 in the outer loop. The measurements and set point is passed from the while loop to the case. The controllers then calculate the valve position and sends it back to the while loop.

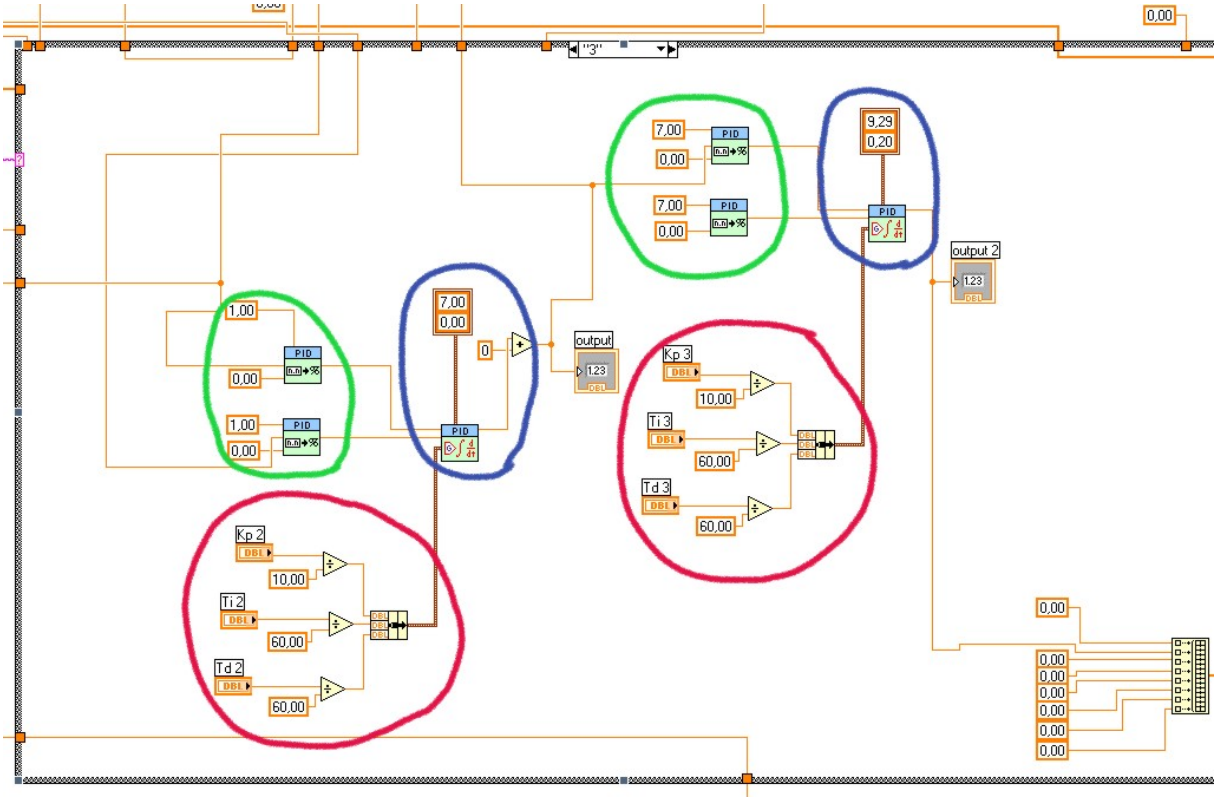


Figure 4.2 Case structure, the controller.

The PID controllers: The actual PID controllers are located within the ***blue*** circles. The parameters associated with the PID controller are the min-max output signals the controller can take. In case of the outer loop, these parameters represent the values that the set point in the inner loop may take

The tuning parameters: These are located within the ***red*** circles. They actual values are set in the front panel.

Set point and variable: The set points and measurements have to be converted from engineering units to percent of operating area, this is done in the ***green*** circles**.** The parameters set here correspond to the min and max values that the set point and variables can take.

4.4 Writing the data to a file.

The miniloop program will automatically write the selected data to a .txt file when the program is stopped using the large stop button. The data will be stored in the following format.

Table 4.1 Format of stored data.

t [msek]	S [V]	P_1 [Barg]	P_2 [Barg]	Q_{inlet} [l/min]	$W_{estimated}$ [kg/min]	Z [-]
…	…	…	…	…	…	…
…	…	…	…	…	…	…

To store additional data to file use the following procedure.

1. Open the block diagram and locate the “write to file” function in the right most section of the diagram. All the data will be collected in the yellow block, and collected in one array. Its then send the the little white block and written to file upon termination of the program.

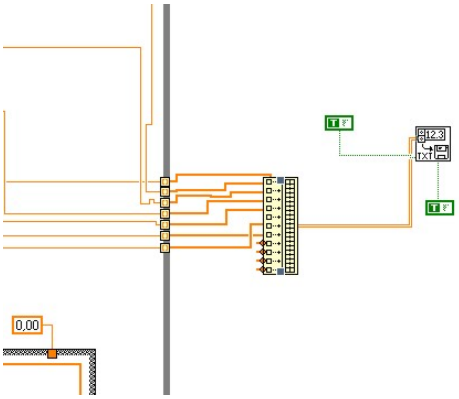


Figure 4.3 Create a free node.

2. By clicking the yellow box and holding you can increase the length of it, allowing more data stream to be added to it. The box in figure 4.3 has been increased to allow 4 more data streams.

3. The next stage is to locate the data you wish to store to the file. Then simply wire it to an available node on the yellow box(figure 4.4). The additional data stream will now be stored to the same file.

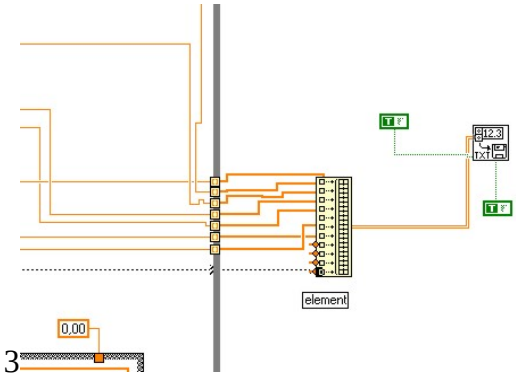


Figure 4.4 Wire the data.

5 Maintenance.

The Miniloop do not require much maintenance. However the user should be aware of a few things.

5.1 Reservoir tank.

The user has to make sure the liquid level in the reservoir tank doesn't get to low. From figure 5.1. one can see that there are two tubes connected to the tank. The top tube is connected to the separator, and the water will return to the reservoir through this tube. The second tube is connected on the flat end side of the tank. This is connected to the pump witch pumps the water into the Miniloop. Before the pump is turned on the user has to make sure the liquid level is higher then this outlet, if not air may enter the tube. This can damage the pump, and in the worst case damage it. The water level should at least be 3 cm higher then the outlet. Additional water can be added to the tank through the open hole on the flat side, above the outlet. There is a water source available with a long enough hose in close proximity to the loop. To empty the tank the user can remove both tubes and pour the liquid into the sink.
If the user wish to clean the tank with water make sure it is not to hot. Using only hot water to clean the tank may cause the glass to crack.

Figure 5.1 Reservoir tank.

5.2 Buffer tank.

The buffer tank is used to create enough upstream volume for the gas. This is a prerequisite for slugging to occur. The volume available for the gas will influence the amplitude of the pressure oscillations. The volume can be altered by adjusting the liquid volume inside the tank. To add more water the user has to disconnect both tubes leading to it. As for the reservoir tank the buffer tank mustn't be cleaned with to hot water as this may result in cracks.

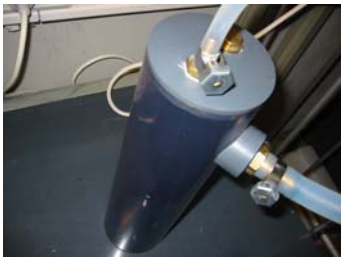


Figure 5.2 Buffer tank.

5.3 The slug sensor

There are quite a few things that can cause the slug sensor to fail. The slug sensor should always be checked to make sure it is operating as intended before an experiment is started. The easiest way to check the sensor is to make sure the slug sensor chart in the user interface (miniloop program front panel, figure 3.1) is taking values between 1 and 5. It should be 1 when measuring pure water and 5 when measuring only air. If this is not the case, something is causing the sensor to malfunction. Take note that the problem may not be with the sensor itself, but with the Miniloop. This chapter will show the user how to reconfigure the sensor from start. However, if the sensor is malfunctioning consult the trouble shooting in chapter 5.3.2. Figure 5.3 shows the actual sensor and the different settings on it.

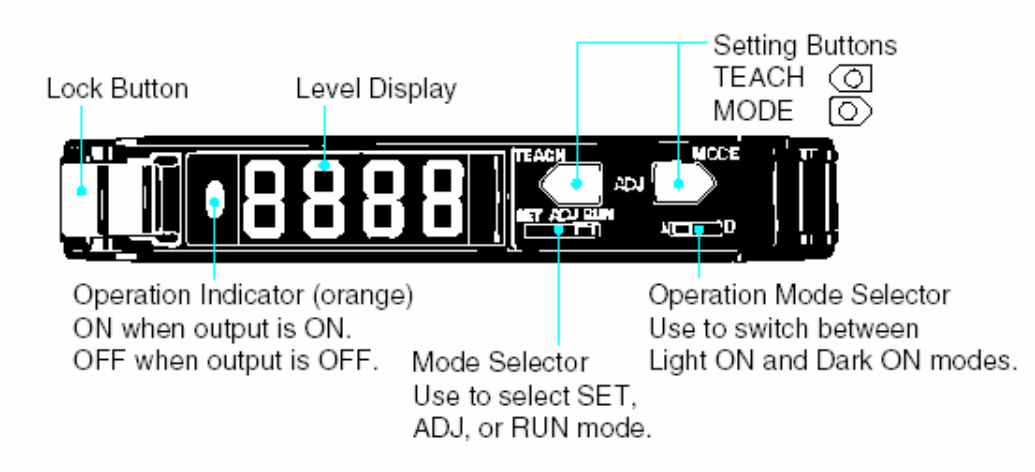


Figure 5.3 The sensor settings.

5.3.1 Calibrating the slug sensor.

Step 1) Reset the sensor to default settings as shown in figure 5.4.

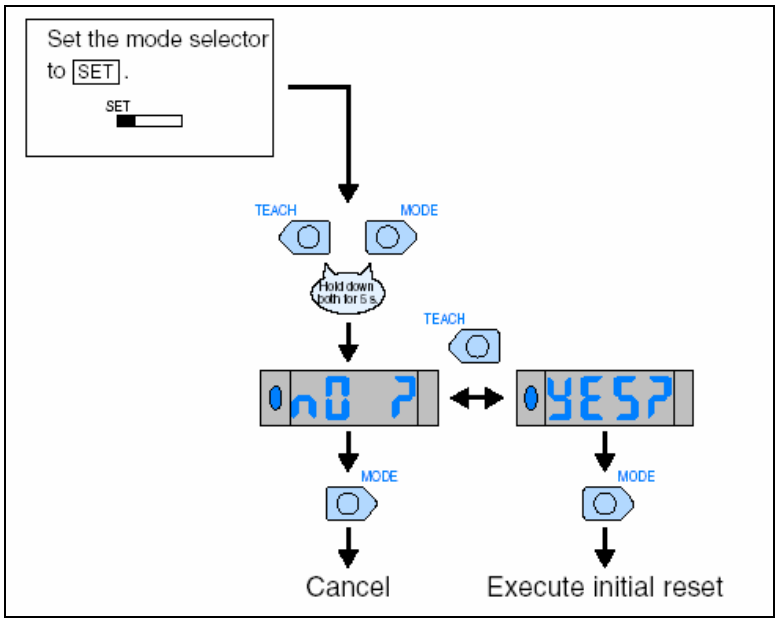


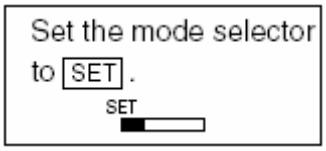
Figure 5.4 Resetting the slug sensor to default setting.

Step 2) Recording the sensor value corresponding to pure water..

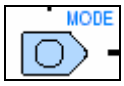
Record the value showing in the sensors digital display when measuring pure water. The display will vary between 0 and 4000. The value will depend on the amount of light being returned to the sensor. 4000 means all the light has returned(as for air). When measuring water the display should take a value between 500 and 1500. If the value is higher then 1500 the water is absorbing to little light. Add more colouring matter as described in chapter 5.4 until the value is within the given bounds.

Step 3)Setting the lower limit for monitoring.

The user must then set the lower limit for monitoring a bit higher then the value recorded for pure water. This is done to remove the unwanted spikes caused by the surface of the phase transitions. If the digital display is showing a value of 1000 for pure water the user should set the lower limit for monitoring at 1200.



Press and hold the mode button



until the display shows :

Then press and hold the teach button until the display show the desired value for the lower limit as shown in figure 5.5. The lower limit will increase in increments of 100. When the desired value is reached release the teach button and switch the mode selector back to run mode.

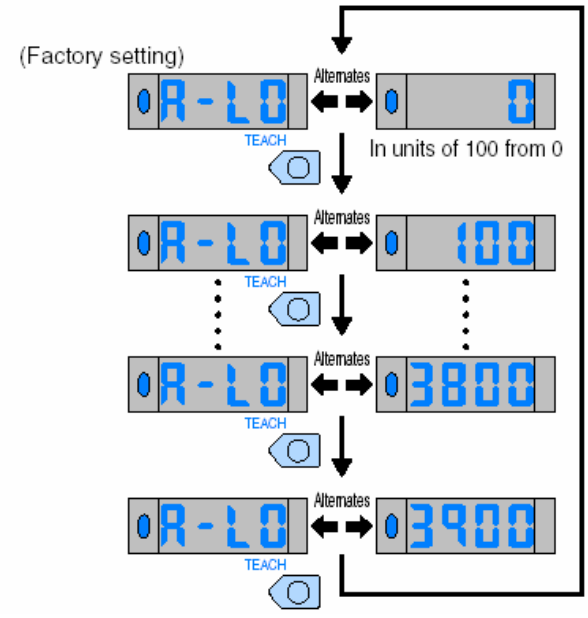


Figure 5.5 Setting the lower limit for monitoring.

5.3.2 Troubleshooting the slug sensor.

This chapter should solve the most common problems with the slug sensor.

Problem: The slug sensor chart in the user interface is not taking values between 1 and 5.

The slug sensor chart is showing values below 5 for pure air when it should show 5.

Solution: When there is only air in the tube no light should be absorbed, and the sensor should show its max value. Check the digital display on the sensor. The display should show 4000 when only air is present. If it shows less something is interfering with the light beam. Make sure the sensor is not placed on a stained part of the pipe as stains may block some of the light, moving it to a different location or changing the stained section of pipe will most likely solve the problem. The cables may also be bent resulting in a failure within the cable. Make sure the cable is running loosely and smoothly from the sensor to the bracket without to large angels.

The slug sensor chart is showing values higher then 1 for pure water when it should show 1.

Solution: Most likely the lower limit for monitoring is set to high, or there is too little colouring matter in the water. Check step 2 in chapter 5.3.1.

5.4 Colouring matter

The colouring matter used to give the water a blue colour is called Vulcanosol-Blau 684. More colouring matter can be obtained from Engineer Arne Fossum at his office in K3-019. Very little substance is needed to dye the water. It's recommended to gradually add small amounts of substance until the desired slug sensor value has been achieved. The system should be set to pump water through the system to disperse to substance properly.
One spatula is enough to dye all the water in the system if the reservoir tank is half full.

6 References

[1] Bårdsen, I., “Anti-slug control for two phase flow. Experimental verification (In Norwegian),” NTNU, autumn 2003.
[2] Søndrol, M., “Anti-slug control. Experimental testing and verification,” NTNU, spring 2005

Appendix A Equipment suppliers and prises

Table A.1 lists the suppliers and prises for the different components in the Miniloop.

Table A.1 List of equipment, suppliers and prises.

Equipment	Type	Delivered by	Prise [NOK]
Rate meter for water Control Valve	Gemu 3021 Gemu 554	J.S. Cock 3991 P.O.BOX 68 Stovner N-0913 OSLO Phone:+47 22 21 51 00	3991 4502
Rate meter for air	D-5110-HAB	Flow-Teknikk as Olav Brunborgsv.27 P.O.BOX 244 1377 Billingstad Phone : +47 66 77 54 00	9914
A1-Module AO-Module Termination base Communication module	FP-AI-100 FP-AO-210 FP-TB-2 FP-1000	National Instruments 2745 P.O.BOX 177 N-1386 Asker Phone:+47 66 90 76 60	2745 3555 1512 3105
Signal transducer for the control valve	MICROANALOG DC/DC Select	JF.Knudtzen AS P.O.BOX 160 N-1378 Nesbru Phone:+47 66 98 33 50	1550
3 x Pressure sensors	MPX5100DP	Silica/Avnet Nortec AS P.O.BOX 63 N-1371 Asker Phone:+47 66 77 36 00	796
Pumpe	Eheim 1060	Petshop at city syd	1566
3x Optic sensors	E3X-DA-N	Omron P.O.BOX 109 Bryn N-0611 OSLO Phone:+47 22 65 75 00	2825
3x Tanks	Transparent glass	Produced by NTNU	9000
Tubes	Silicone		4000

Appendix B Equipment manuals

The equipment manuals are large and comprehensive. Because of this not all of them will be appended to this user manual. However the table below will list where they can be found.

The manuals for the equipment listed in table B.1 can be found in appendix B in [1], while the manuals listed in table B.2 can be found in this appendix.

Table B.1 Reference to equipment manuals.

Equipment	Page
Pressure sensor	43
Signal transducer (control valve)	51
FieldPoint A1-Module	55
FieldPoint AO-Module	69
FieldPoint Terminal base	81

Table B.2 Reference to equipment manuals.

Equipment	Appendix
Rate meter for liquid	B1
Rate meter for gas	B2
Optic sensor (In Danish)	B3

GEMÜ®

Flow transmitter

Construction

An intelligent flow transmitter which can be used for measuring liquid inert and corrosive aqueous media. The keypad at the front of the unit enables simple setting of measurement units, required display values etc.

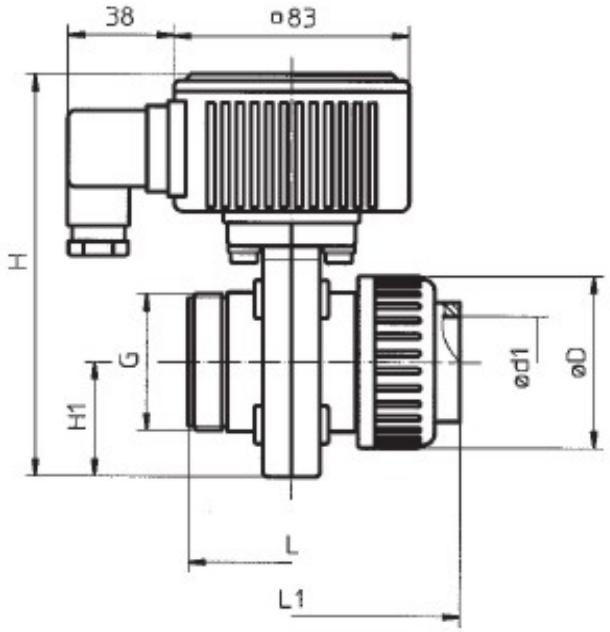
Features

- High-resolution turbine flow measurement
- Medium wetted parts in plastic and ceramics
- Can be used as totalizer (flow counting) or batch controller (dosing function)
- Extremely low pressure loss

Advantages

- Easy operation via keypad
- Process adaptable
- Short inlet and outlet distances
- Freely scalable measurement range
- Integrated flow rectifier

Dimensional drawing GEMÜ 3021 (mm)



DN	L	L1	H1	ød1	øD	G	H
25	73	123	40	32	60	G 1 1/2	140
50	105	187	63	63	103	G 2 3/4	189

GEMÜ® 3021

Technical specifications

Working medium

Any liquid inert or corrosive aqueous media subject to the correct choice of body and seal materials.

Max. perm. temperature of working medium: see datasheet "Technical Information on Plastic Materials"

Electrical specifications

Power supply U:	18-30 V DC
Power consumption P:	typ. 1 W
Current consumption I:	typ. 40 mA (for current output = 0 mA)
Output signals:	
Pulse output, PNP	$U-U_{Drop}$
typ. U_{Drop}	1.7 V at 24 V / 5 mA 2.5 V at 24 V / 10 mA 5.0 V at 24 V / 20 mA
Pulse rate	≤ K-factor/2 (adjustable, K-factor see measuring certificate)
Current	0/4-20 mA
Resolution	≤ 23 µA (10 bit)
Accuracy	±1,5 bit
Load impedance ≤ 500 Ohm, load control 0.25 %	
Relay	(resistive load)
Voltage	250 V AC / 220 V DC
Current	2 A AC / 2 A DC
Power	≤ 60 W
Electrical connection:	Plug according to DIN 43650-A
Cross section of cable:	8-10 mm

Measuring ranges:	DN 25	DN 50
Measuring span	120-7200 l/h	500-25000 l/h
Start-up	≤ 80 l/h	≤ 500 l/h
Medium	aqueous liquids	

Accuracy:	±1 % FS
Repeatability:	±0,5 % FS
(FS = full scale)	
Optical display:	LC-Display 2 x 16 characters digit height 5.55 mm

Working conditions

Ambient temperature:	-10 ... +60° C
Storage temperature:	-20 ... +60° C
Type of medium:	liquid
	≤ 120 $\frac{mm^2}{s}$ (120 cSt)
Medium temperature:	
Ref. no. 1 PVC-U	-10° ... +60° C
Ref. no. 20 PVDF	-10° ... +80° C
Working pressure:	≤ 10 bar (20° C)
Characteristic see "Technical Information on Plastic Materials".	

General information

Housing protection class to EN 60529:	IP 65
Weight: DN 25:	600 g
DN 50:	1500 g
Dimensions L x W x H:	see dimensional drawing
Mounting position:	optional
Mounting note:	Inlet/outlet distances 5 x DN

Note:
We recommend installation of a dirt filter for filtering particles contained in the medium
Mesh width 100 µm

Directives:	EC Machine directive 98/37/EC EMC 89/336/EEC
Measuring certificate:	Calibration data for water 20°C are included

Materials

Medium wetted parts
- Inner turbine components: PVDF
- Body: PVC-U or PVDF
- Bearing / shaft: Glass / ceramics (Al2O3)
- Seals: FPM

Flow transducer:
- Housing: ABS
- Housing cover of measuring instrument, size B: PMMA
- Housing seal: NBR
- Housing bolt: 1.4303

Plug:
- Plug housing: PA 6
- Plug bolt: VQSt 36-2-4,8
- Profile packing: Nitrile rubber

Further housing materials upon request

Order specifications

Nominal size	Ref. no.
DN 25	25
DN 50	50

Seal material		Ref. no.
FPM	Viton®	4

Body configuration	Ref. no.
Straight through	D

Display position	Ref. no.
See diagrams on last page	

Connection	Ref. no.
Unions (metric)	7
Unions (imperial)	33

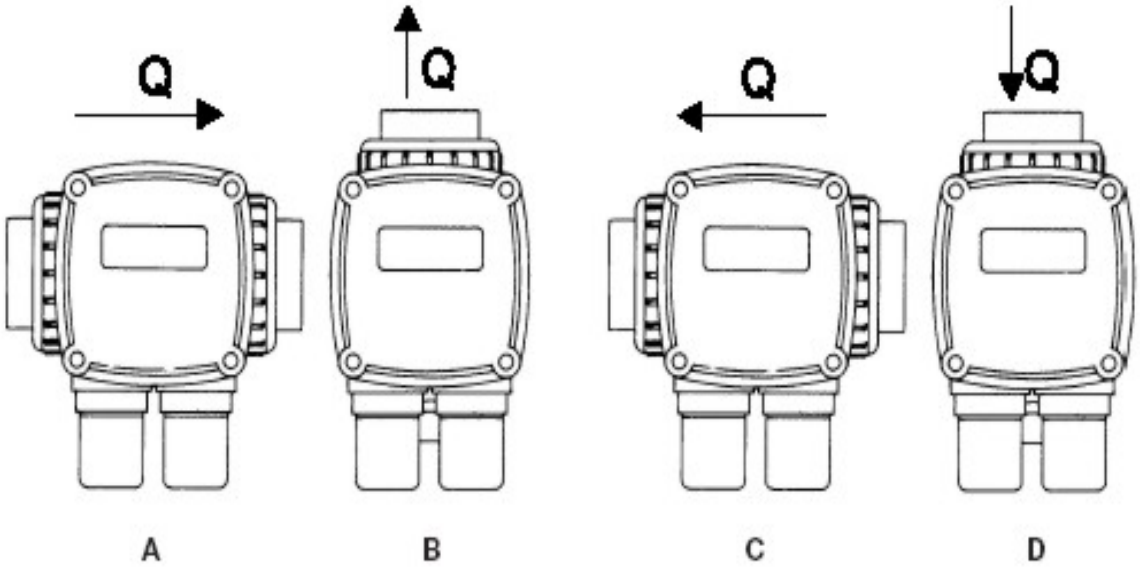
Functional profile	Ref. no.
Totalizer (0/4-20 mA + pulse output)	T41
Batch controller (2x Relay outputs)	BR2

Body material	Ref. no.
PVC-U	1
PVDF	20

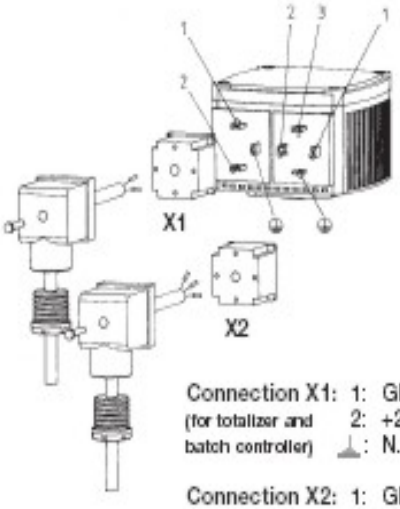
Supply voltage	Ref. no.
24 V DC	C1

Order example	3021	25	D	7	1	4	A	T41	C1
Type	3021								
Nominal size (ref. no.)		25							
Body configuration (ref. no.)			D						
Connection (ref. no.)				7					
Body material (ref. no.)					1				
Seal material (ref. no.)						4			
Display position (ref. no.)							A		
Functional profile (ref. no.)								T41	
Supply voltage (ref. no.)									C1

Display position with regard to flow direction



Electrical connection diagram



Connection X1: 1: GND
(for totalizer and batch controller) 2: +24V
⊥: N.C.

Connection X2: 1: GND
(for totalizer) 2: Current output (0 / 4 - 20 mA)
3: Impulse output (PNP)
⊥: N.C

Connection X2: 1: Common
(for batch controller) 2: Relay output BQty
3: Relay output BFast
⊥: N.C.

Flow-Teknikk as

Mass Flow Meters and Controllers for Gases

MASS-STREAM®

M+W Instruments
Your partner

Key Facts

M+W Instruments was founded in 1988 and has always specialised in mass flow meters and controlers.

In 1995, M+W Instruments was the first company to introduce the direct measuring principle for thermal mass flow meters with the sensor following the constant temperature anemometer principle.

In 1997 M+W Instruments joined the Bronkhorst Group.

Today we are working along side more than 20 distributors worldwide. You will find your personal contact on the back page of this brochure or under www.mw-instruments.com.

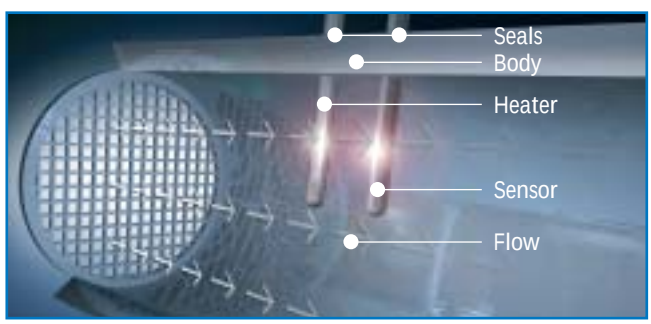
Our intruments are suitable for the use in the pharmaceutical, chemical and semiconductor industries as well as in the gas and food industry. Of course we are your competent address for special solutions.

Content

Principle of Operation

Basically the instruments consits of a metal block with a straight bore. Two stainless steel probes protrude inside the bore; a heater probe and a temperature probe. A constant difference in temperature (ΔT) is created between the two and the energy required to maintain this ΔT is dependent of the mass flow rate.

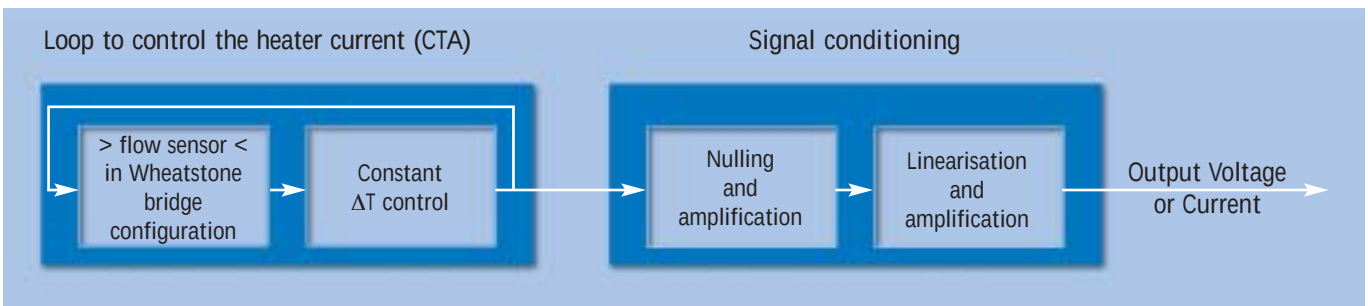
Generally speaking we can say that the higher the flow the more energy is required to maintain the chosen ΔT, which is usually approx. 38° C. Overall we can state that King's law applies to the relationship between heater energy and mass flow, and the following formula can be derived.



Basic structure of the Mass-Stream®-flow sensor

$$P = P_0 + C\emptyset_m^{\,n}$$

P = total heater power
P_0 = heater power offset at zero flow
C = constant
$\emptyset_m$ = mass flow
n = dimensionless number (typ. 0.5)



"MASS-STREAM®"
Features and Applications

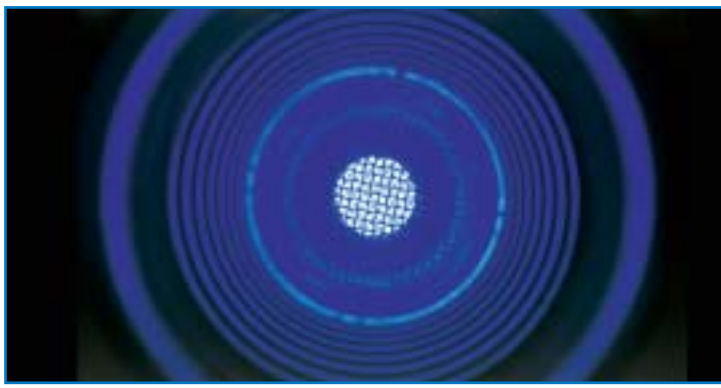
Worth knowing

MASS-STREAM® is the synonym for a metering principle having the following advantages:

Smallest standard range
0,005...0,1 l_n/min (Air)

Highest standard range
100.0...7500.0 l_n/min (Air)

Lower and higher ranges available on request.

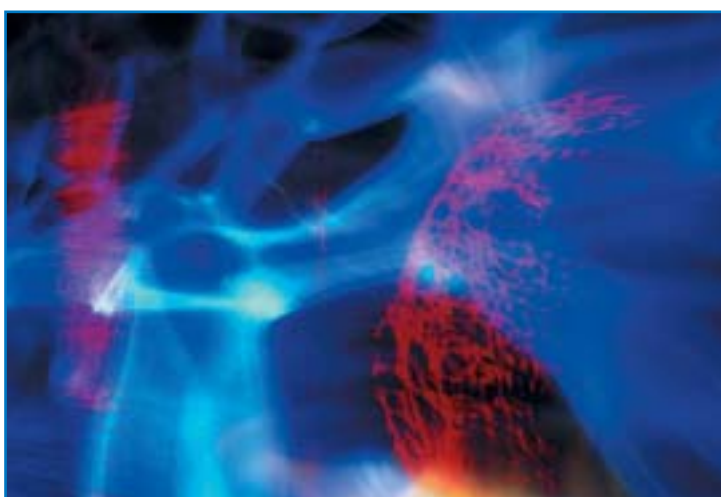


Features

- Low pressure drop
- Rugged design
- Lower sensivity concerning dirt and humidity
- Measuring independent of pressure and temperature changes
- Installable in virtually any position
- No moving parts
- Bodies in stainless steel or as a more economical aluminium version

Applications

- Gas consumption metering
- Exhaust gas metering
- Semiconductor industry
- Analytical intruments
- N_2/O_2-generators
- Fuel cells
- Mechanical engineering
- And much more



Options

- "Low ΔP" version
- Integrated totalisation
- Integrated actual display
- Integrated setpoint potmeter
- Readout systems

Mass Flow Meters

Principle of Operation

Flowmeters of M+W Instruments are suitable for all kinds of applications in industrial, chemical, medical and laboratory environments.

- Usuable for virtually every kind of gases
- No moving parts
- Very low pressure drop
- Unique all stainless steel sensor
- Pressure and temperature independent metering system

Main advantages of these instruments are:

- Installable in virtually every position
- No inlet pipes needed (62xx series)
- Optional with integrated flow display
- Optional with totalisation
- No maintance needed
- Two body materials on stock (others on request)

The 62xx series working principle is shown on page 2.

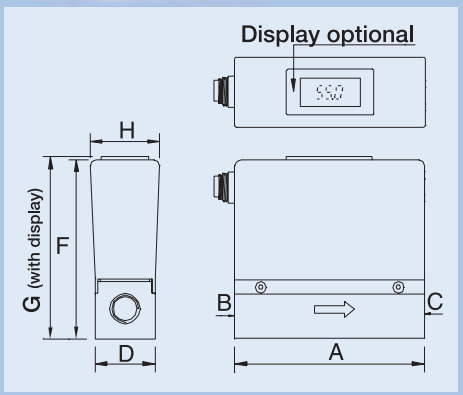
For lower flow values the by-pass measurement principle is applied.

Standard Flow Capacities

Mass Flow Meters Model			Flow capacitiy (Air) (intermediate ranges available)	
D-5110	- AAA - BB - AA -	12 - A - A - A	0.005...0.1	l_n/min Air
		22	0.010...0.2	l_n/min Air
		52	0.025...0.5	l_n/min Air
		13	0.05...1.0	l_n/min Air
		23	0.1...2.0	l_n/min Air
		53	0.25...5.0	l_n/min Air
		14	0.5...10.0	l_n/min Air
D-6210	- HAB - BB - AA -	53 - A - A - A	0.25...5.0	l_n/min Air
		14	0.5...10.0	l_n/min Air
		24	1.0...20.0	l_n/min Air
D-6230	- HAB - BB - AA -	24 - A - A - A	1.0...20.0	l_n/min Air
		54	2.5...50.0	l_n/min Air
		15	5.0...100.0	l_n/min Air
D-6250	- HAB - CC - AA -	15 - A - A - A	5.0...100.0	l_n/min Air
		25	10.0...200.0	l_n/min Air
		45	20.0...400.0	l_n/min Air
D-6270	- HAB - CC - AA -	55 - A - A - A	25.0...500.0	l_n/min Air
		16	50.0...1000.0	l_n/min Air
		26	100.0...2000.0	l_n/min Air
D-6280	- HAB - DD - AA -	36 - A - A - A	150.0...3000.0	l_n/min Air
		46	200.0...4000.0	l_n/min Air
		56	250.0...5000.0	l_n/min Air
D-6290	- HAB - DD - AA -	66 - A - A - A	300.0...6000.0	l_n/min Air
		76	375.0...7500.0	l_n/min Air

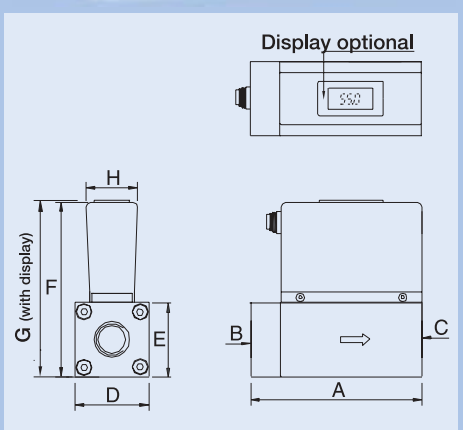
Higher flows and other current junctions on application.

Model D-6210 MFM



Model	A	B	C	D	F	G	H
D-5110	95	G1/4"	G1/4"	30	90	92	35
D-6210	95	G1/4"	G1/4"	30	90	92	35
D-6230	95	G1/4"	G1/4"	30	90	92	35
D-6250	95	G1/2"	G1/2"	30	90	92	35

Model D-6270



Model	A	B	C	D	F	G	H
D-6270	116	G1"	G1"	50	123	125	35
D-6280	116	G1"	G1"	70	141	143	35
D-6290	143	G1"	G1"	110	171	173	35

All specifications subject to change without notice.

Mass Flow Controllers (MFC)

Principle of Operation

Based on the concepts of our flow meters; compact flow controllers are also available.

The modular construction solenoid valve is integrated to the base when flows are up to approx. 500l/min. N_2 equivalent.

When higher flows are needed an external valve is employed.

The following kv_s-values are available: 6,6E-2, 0,35; 1,0;
(for higher values please contact factory)

Features

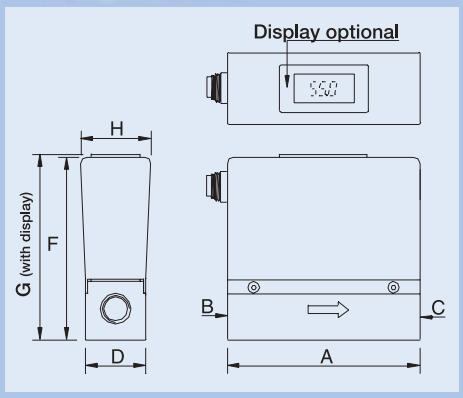
- Suitable for almost all gases and mixtures
- No moving parts in the sensor
- Good response times
- PI-control loop
- No inlet pipe necessary (D-62xx series)
- Optional: integrated actual flow display
- Optional: integrated totalisation display
- No maintainance required
- Almost independent to attitude

Standard Flow Capacities

Mass Flow Controllers Model			Flow capacitiy (Air) (intermediate ranges available)	
D-5111	- AAA - BB - AA -	12 - A - A - A	0.005...0.1	l_n/min Air
		22	0.010...0.2	l_n/min Air
		52	0.025...0.5	l_n/min Air
		13	0.05...1.0	l_n/min Air
		23	0.1...2.0	l_n/min Air
		53	0.25...5.0	l_n/min Air
		14	0.5...10.0	l_n/min Air
D-5121	- AAA - BC - AA -	14 - A - A - A	0.5...10.0	l_n/min Air
		24	1.0...20.0	l_n/min Air
		54	2.5...50.0	l_n/min Air
D-6211	- AAA - BB - AA -	53 - A - A - A	0.25...5.0	l_n/min Air
		14	0.5...10.0	l_n/min Air
		24	1.0...20.0	l_n/min Air
D-6231	- AAA - BB - AA -	24 - A - A - A	1.0...20.0	l_n/min Air
		54	2.5...50.0	l_n/min Air
		15	5.0...100.0	l_n/min Air
D-6251	- AAA - CC - AA -	15 - A - A - A	5.0...100.0	l_n/min Air
		25	10.0...200.0	l_n/min Air
		55	20.0...400.0	l_n/min Air
D-6271/004	- AAA - CC - AA -	55 - A - A - A	20.0...500.0	l_n/min Air
		16	50.0...1000.0	l_n/min Air

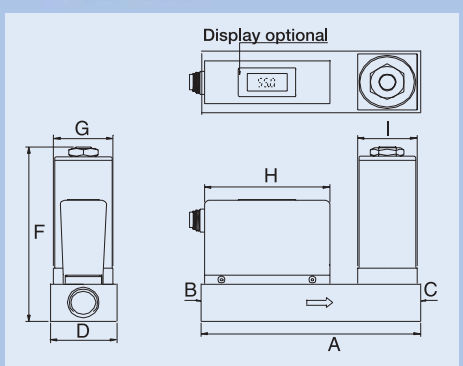
Higher flows and other current junctions on application.

Model D-5121 MFC with LCD display



Model	A	B	C	D	F	G	H
D-5111	95	G1/4"	G1/4"	30	90	92	35
D-5121	95	G1/2"	G1/4"	30	94	96	35
D-6211	95	G1/4"	G1/4"	30	90	92	35
D-6231	95	G1/4"	G1/4"	30	90	92	35

Model D-6251



Model	A	B	C	D	F	G	H	I
D-6251	145	G1/2"	G1/2"	50	132	45	95	45
D-6271	Dimensions please on application							

All specifications subject
o change without notice.

Conversion factors

The MASS-STREAM®-Series flow meters are normally calibrated on air. For use on other gases than air a conversion factor must be applied. This factor is determined by applying a complex formula.
However, for a number of common gases you will find the values below:

Conversion factor table

(L_n: 1013mbar und 0°C air temperature)

Series / Gas	D-62xx	D-51xx
Air	1.00	1.00
Ar	2.01	1.40
CH_4	0.67	0.76
C_2H_2	0.75	0.61
C_2H_4	0.89	0.60
C_2H_6	0.89	0.60
C_3H_8	0.63	0.34
C_4H_{10}	0.42	0.25
C_5H_{12}	0.25	0.21
CO	1.04	1.00
CO_2	1.20	0.74

Series / Gas	D-62xx	D-51xx
H_2	0.15	1.01
He	0.24	1.41
HCL	1.58	0.99
N_2	1.00	1.00
NH_3	0.80	0.77
NO	1.02	0.97
N_2O	1.15	0.71
N_2O_2	1.00	1.00
O_2	0.98	0.98
Xe	6.08	1.38

Factors for further gases available on request.

Best accuracy is reached by calibrating the instruments und actual process conditions. The conversation factor introduces an additional error in abolute accuracy in order of:

CF ≥ 1 : 2xCF in % FS
CF ≤ 1 : 2/CF in % FS

When using our D-62xx serie with balloon gases like helium and hydrogene it is always recommended to make use of the optional gas calibration.

Flow profile sensivity

Normally mass flow measurement principles are sensitive to variations in the shape of the flow profile.

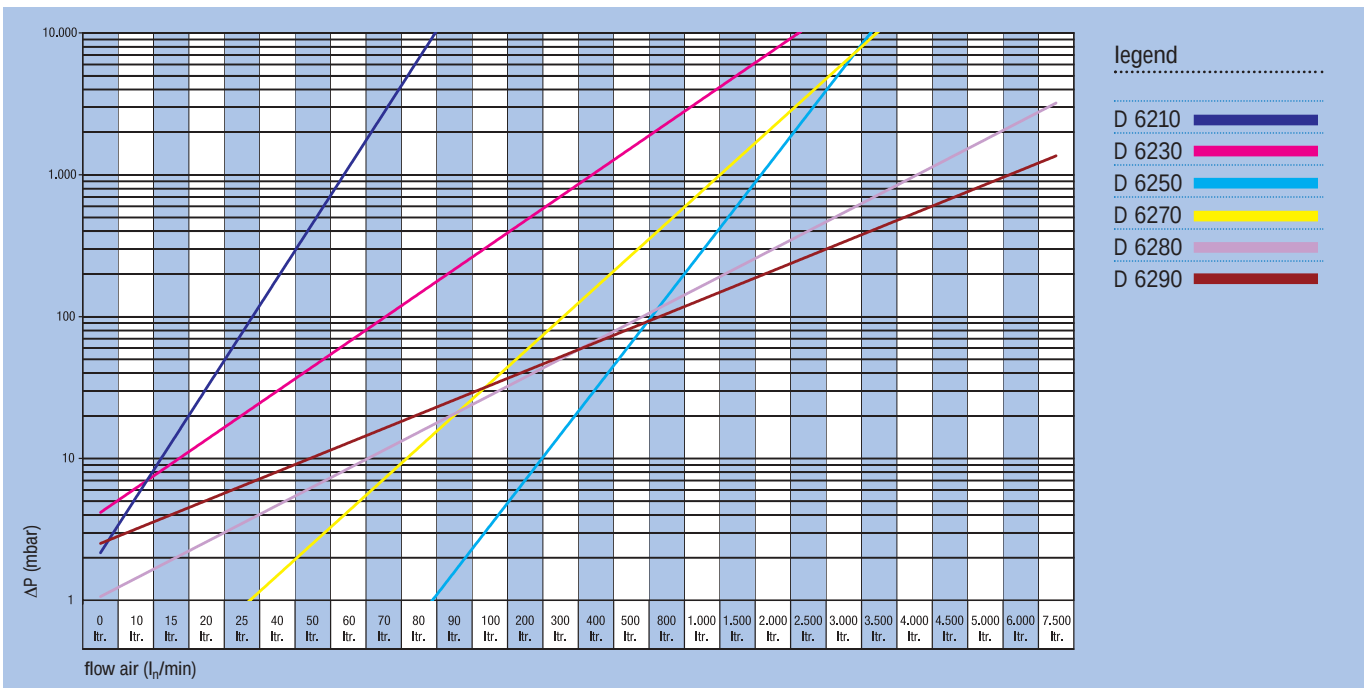
The MASS-STREAM®-Flow meters has been designed in such a way that there is always a fully developed flow profile in the metering section ans is thus virtually insensitive to changes upstream piping conditions.

Pressure drop

The pressure drop of the instruments (serie D-62xx) is almost comparable to a straight run of pipe of the diameter ans is thus negible.

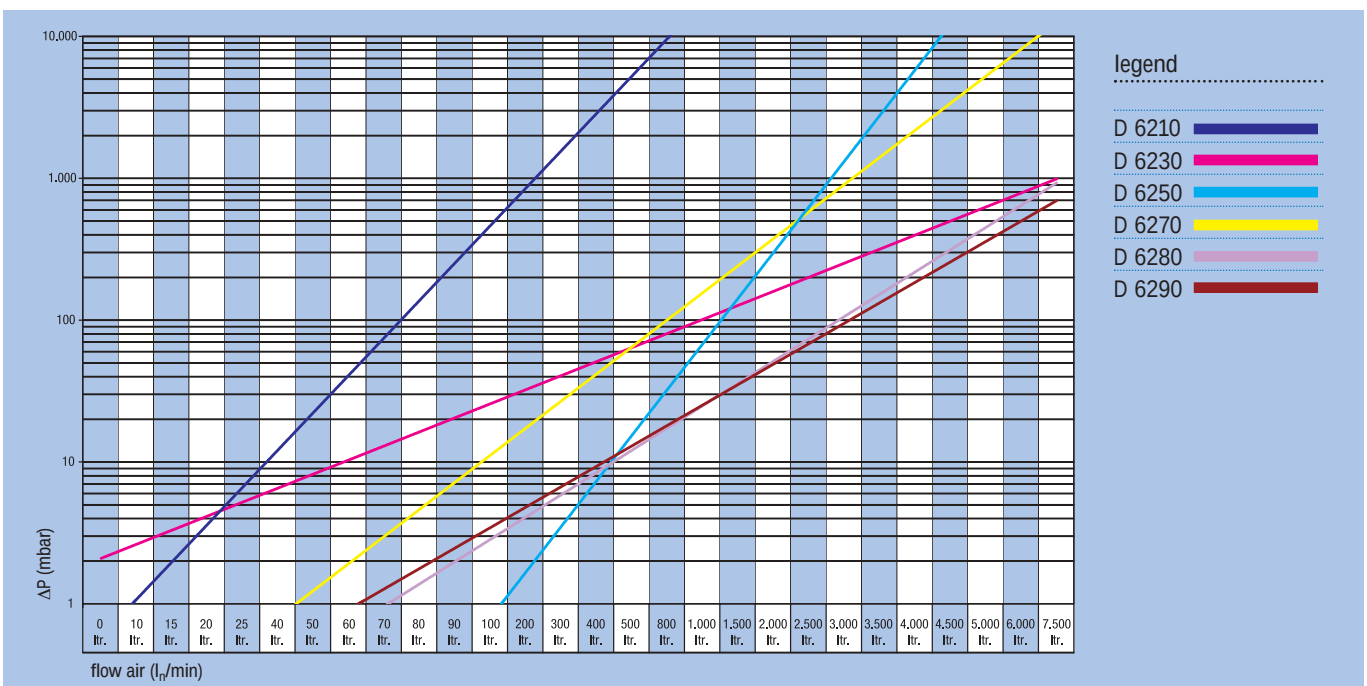
However, to make the instruments insensitive to upstream piping configurations, a number of mesh screens are required to condition the flow profile. These meshes create a certain pressure drop as can be seen from the table set out below.

For further informations please contact factory.



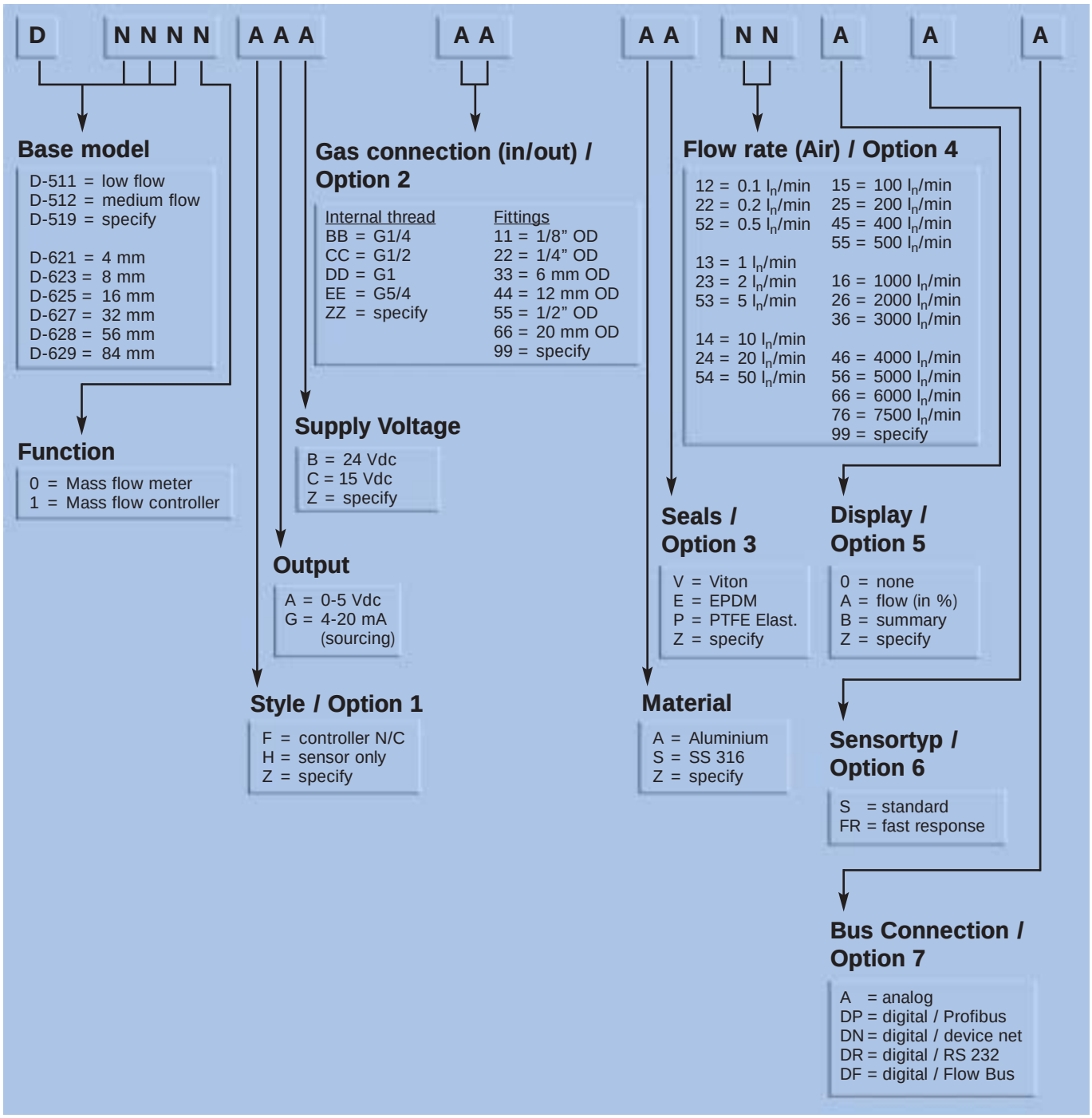
In some applications a very low pressure drop is required. To fulfil these inquires we are able to build a special version of our instruments where the pressure drop is extremely low.

For further information please refer to the second table set out below.



Model Number Identification

Options and Model Numbers MASS-STREAM®



Enquiry and Ordering Information

In order to supply the correct instrument for your application we request you to state: type of gas, flow range, operating temperature and pressure (for controllers supply pressure and back pressure), electrical connection, desired output signal, type of process connection and seals.

Based on this information we perform the following actions/ calculations:

- Convert the desired flow to Air-equivalent flow, i.e., divide the desired flow by the conversion factor.
- Only for controllers, check if the pressure differential across the valve (ΔP) is within the limits.
- Only for controllers, check if the calculated Kv-value is within the specifications allowed.

Technical Specifications

Measurement System

Accuracy (based on air calibration)	± 3% FS incl. non-linearity (better one's on request)
Repeatability	± 0.5% FS (better one's on request)
Time constant (63.2%)	τ = 0.7 sec (standard, better one's s. p. 10)
Pressure sensitivity	0.2% / bar typical (air)
Attitude sensitivity	± 0.1% °C
Leak integrity	< 2 x 10^{-9} mbar l/s He
RFI	According to CE

Operating Limits

Range	3...100%
Type of gases	All gases compatible with materials chosen
Temperature	0...70°C
Pressure	10 bar; higher on application
Warming up time	30 min for optimum accuracy;
	within 30 sec for accuracy ±4% FS
Installation	
Series D-5100...	10 D straight pipe upstream
Series D-6200...	Unrestricted

Mechanical Part

Sensor	AISI 316L
Body	AISI 316L or Aluminium (anodised), please specify
Sieves / rings	Stainless steel / teflon
Protection	IP40 (IP 65 on application)

Electrical Properties

Supply voltage	24 Vdc ±10% or 15 Vdc ±10%	
Current peak values		
Series D-5100...	75 mA max.	
Series D-6200...	Inrush current	250 mA max.
	No flow	75 mA max.
	100% flow	175 mA max.
Control valve, if applicable	Add 250 mA max.	
Output signal	0...5 Vdc or 4...20 mA	
Cable	6-wire DIN or 15-wire SUB-D	

Ultra-Fast Sensor

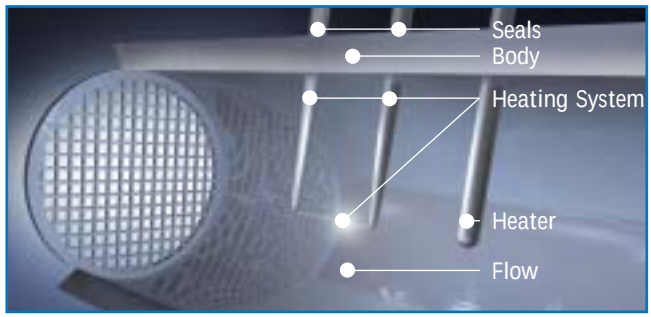
"Fast response" version

M+W Instruments Mass Flow Meters and Controllers are used for a wide variety of applications and for this reason the sensor has been set up with "smooth-response" characteristics thereby avoiding any possible overshoot of the setpoint.
There are, however, applications where the response time of the sensor or the control valve is the decisive factor and for these applications M+W Instruments has developed a sensor with the following features:

Response time (5τ): up to <100ms

When using this sensor in connection with a flow controller the following response times are possible:

Response time (5τ): up to <1,5s



If even faster times are required then we would recommend using this sensor in conjunction with our digital pc-board. Further information is available within the section headed "Digital version".

Dimensions as standard, s. p. 4/5
Model number identification, s. p. 8

Digital version

All our standard products are equipped with an analog pc-board, a feature that ensures that they are very economically priced. However, our well thought-out modular system allows us to offer a digital pc-board as well thereby giving the options of analog voltage or current output together with Profibus DP, Device Net, RS 232 or Flowbus protocols.

Flow Controller response times down to 0.5 sec and less are possible when using the "fast response" sensor.

Readout Systems
with integrated Power Supply

General

This series comprises standard types for use with analog mass flow meters and controllers. The most commonly used functions are offered in compact single channel table top housing, DIN panel mount cassette and multi-channel versions in 1/2 19" or 19" table top or rack housing.

Functions

- Power Supply for MFM/MFC
- Indication of flow rate
- Totalization
- Setpoint-potentiometer

Electrical data

- Power supply 110 or 230 Vac, 50/60 Hz.
- Suitable for connection of instruments with output signal 0...5 Vac
- Sub-D socket for instrument connection
- Max. power +24 Vac, 0.5 A per channel

Model number identification

Code			Housing	
D - 11			1/2 19" table top	42 TE
D - 12			19" table top	84 TE
D - 13			1/2 19" rack	42 TE
D - 14			19" rack	84 TE
D - 15			Table top cassette	14 TE
D - 16			Panel mount cassette	14 TE
D - 19			Other/specify	
	Code		Supply voltage	
	- 00		100...240 Vac	
	- 10		230 Vac	
	- 20		110 Vac	
		Code	Modules with blind front (14TE)	
		- 00	Rearpanel with power supply + mains entry (incl. cable)	
		- 01	Rearpanel with power supply / sub D connector	
		- 02	Rearpanel with Sub D connector	
		- 03	Rearpanel blind	
		Code	Modules with flow indication (actual display) (14TE)	
		- 10	Rearpanel with power supply + mains entry (incl. cable)	
		- 11	Rearpanel with power supply / sub D connector	
		- 12	Rearpanel with Sub D connector	
		- 13	Rearpanel blind	
		Code	Modules with indication of totalised flow (14TE)	
		- 20	Rearpanel with power supply + mains entry (incl. cable)	
		- 21	Rearpanel with power supply / sub D connector	
		- 22	Rearpanel with Sub D connector	
		- 23	Rearpanel blind	
		Code	Modules with flow indication + control (14TE)	
		- 30	Rearpanel with power supply + mains entry (incl. cable)	
		- 31	Rearpanel with power supply / sub D connector	
		- 32	Rearpanel with Sub D connector	
		- 33	Rearpanel blind	
		Code	Modules with total flow + control (14TE)	
		- 40	Rearpanel with power supply + mains entry (incl. cable)	
		- 41	Rearpanel with power supply / sub D connector	
		- 42	Rearpanel with Sub D connector	
		- 43	Rearpanel blind	

Model D-15

Model D-11

Model D-14

M+W Instruments is a member of Brookhurst group

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M+W Instruments

OMRON

Digital fiberforstærker

E3X-DA-N

Brugervenlig og med tydeligt display

- Vælg imellem 3 tydelige display visninger:
  Digital 12 bit visning (0 til 4000)
  Digital procentvisning
  Analog visning
- Multifunktion og stort modelprogram. Bl.a. blå LED, BUS typer for nem fortrådning samt M8 IP66 model
- Beskyttelse mod gensidig interferrens
- Skalérbar 1 til 5v analog udgang

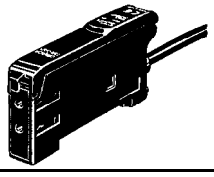
Programmeringsenhed

- Giver mulighed for fjernbetjent programmering
- Copy og paste funktion og 10 hukommelsesbanker
- Aflåsning af parametre beskytter mod uhensigtsmæssig betjening

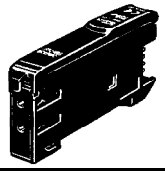
Typeoversigt

■ Forstærkerenheder

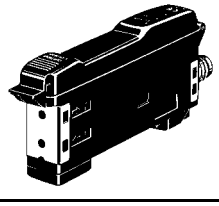
Med kabel

Enhed	Udseende	Udgang	Model	
			NPN udgang	PNP udgang
Standard model		ON/OFF udgang	E3X-DA11-N	E3X-DA41-N
Med analog udgang		ON/OFF udgang Analog udgang	E3X-DA21-N	E3X-DA51-N
Mærkeaftaster med blå LED		ON/OFF udgang	E3X-DAB11-N	---

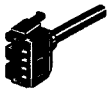
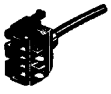
Til BUS forbindelse

Enhed	Udseende	Stik med kabel (Bestilles separat)		Udgang	Model	
					NPN udgang	PNP udgang
Standard model		Master	E3X-CN11	ON/OFF udgang	E3X-DA6	E3X-DA8
		Slave	E3X-CN12			
Med analog udgang		Master	E3X-CN21	ON/OFF udgang Analog udgang	E3X-DA7	E3X-DA9
		Slave	E3X-CN22			

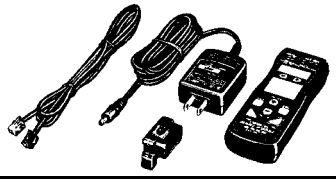
Med M8 stik og IP66 udførsel

Enhed	Udseende	Udgang	Model	
			NPN udgang	PNP udgang
Standard model		ON/OFF udgang	E3X-DA14V	E3X-DA44V

■ Stik med kabel til BUS model (Bestilles separat)

Enhed	Udseende	Kabel længde	Antal ledere	Model
Master stik		2 m	3	E3X-CN11
			4	E3X-CN21
Slave stik			1	E3X-CN12
			2	E3X-CN22

■ Programmeringsenhed (Bestilles separat)

Udseende	Strømforsyning	Model	Bemærkning
	Genopladeligt batteri	E3X-MC11-EU	Komplet tilbehørspakke for trådløs programmering er inkluderet

■ Bestykning af fiberforstærker med BUS funktion

Eksempel hvis man ønsker BUS forbindelse mellem 5 forstærkere

Forstærker enheder		
Type	NPN	PNP
Standard model	E3X-DA6	E3X-DA8
Analog udgang model	E3X-DA7	E3X-DA9

+

Stik med kabel	
Master forbindelse	Slave forbindelse
E3X-CN11 (3-leder)	E3X-CN12 (1-leder)
E3X-CN21 (4-leder)	E3X-CN22 (2-leder)

Bestykning ved 5 sæt

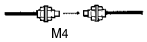
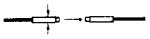
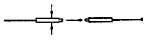
Forstærker enheder 5 stk.	+	Master forbindelse 1 stk., Slave forbindelse 4 stk.

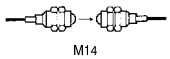
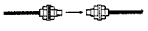
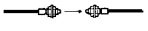
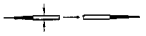
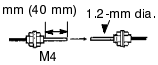
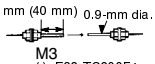
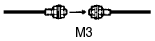
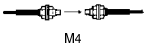
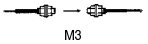
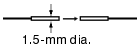
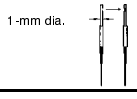
■ Fiber enheder

Separat sender/modtager

✂ Indikerer modeller, hvor det er tilladt at forkorte fiberen ved hjælp af den medfølgende saks.

: Super-lang-tasteafstand : Standard mode : Super-high-speed mode

Appli-kation	Egenskaber	Udseende	Forstærker	Tasteafstand (mm) (Værdier i parantes : ved anvendelse af E39-F1 linse)	Standard objekt *3 (mindste uigennem sigtige emne)	Model	Tilladelig bøjnings radius
Lang taste-afstand	M4	 M4	E3X-DA□-N	1,660 (4,000) / 1,330 (3,200) / 490 (1,200)	1.4-mm dia. (0.02-mm dia.)	E32-T11L ✂	25 mm
			E3X-DAB11-N	150 / 120 / 75			
	3-mm dia.	 3-mm dia.	E3X-DA□-N	1,660 / 1,330 / 490	1.4-mm dia. (0.01-mm dia.)	E32-T12L ✂	
Lang taste-afstand	M3	 M3	E3X-DA□-N	500 / 440 / 180	0.9-mm dia. (0.01-mm dia.)	E32-T21L ✂	25 mm
	2-mm dia.	 2-mm dia.	E3X-DA□-N	500 / 440 / 180		E32-T22L ✂	

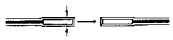
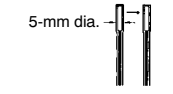
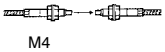
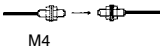
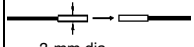
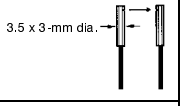
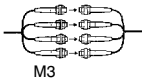
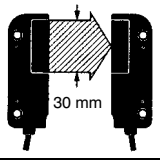
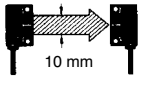
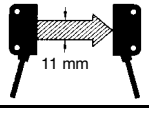
Applikation	Egenskaber	Udseende	Forstærker	Tasteafstand (mm) (Værdier i parantes : ved anvendelse af E39-F1 linse)	Standard objekt *2 (mindste uigennemsigtige emne)	Model	Tilladelig bøjnings radius
Lang tasteafstand	M14, med linser, ideel til eksplosionssikre applikationer	 M14	E3X-DA□-N	20,000 *1 20,000 *1 9,800	10-mm dia. (0.01-mm dia.)	E32-T17L	25 mm
Almindelig brug	M4	 M4	E3X-DA□-N	950 (4,000) 760 280 (2,100)	1.0-mm dia. (0.01-mm dia.)	E32-TC200	25 mm
			E3X-DAB11-N	100 (700) 75 (550) 45 (350)			
	M3, mulighed for vinkelaftastning med E39-F5 vinkellinser	 M3	E3X-DA□-N	850 680 250		E32-TC200A	
	M3	 M3	E3X-DA□-N	250 220 90	0.5-mm dia. (0.01-mm dia.)	E32-TC200E	
			E3X-DAB11-N	25 20 10			
Tynd fiber	2-mm dia.; små emner	 2-mm dia.	E3X-DA□-N	250 220 90	0.5-mm dia. (0.01-mm dia.)	E32-T22	25 mm
	ø1.2-mm, Bøjeligt metal fiberrør i enden	 90 mm (40 mm) 1.2-mm dia. M4 ( ): E32-TC200B4	E3X-DA□-N	950 760 280	1.0-mm dia. (0.01-mm dia.)	E32-TC200B E32-TC200B4	
			E3X-DAB11-N	100 75 45			
	ø0.9-mm, Bøjeligt metal fiberrør i enden	 90 mm (40 mm) 0.9-mm dia. M3 ( ): E32-TC200F4	E3X-DA□-N	250 220 90	0.5-mm dia. (0.01-mm dia.)	E32-TC200F E32-TC200F4	
Fleksibel fiber	Kan bøjes som en ledning. Bøjningsradius=1mm	 M4	E3X-DA□-N	670 (4,000) 530 (3,700) 200 (1,400)	1-mm dia. (0.01-mm dia.)	E32-T11R	1 mm
		 M3	E3X-DA□-N	150 130 50	0.5-mm dia. (0.01-mm dia.)	E32-T21R	
Fleksibel fiber. Meget hårdfør	Ideel til montage på kørende dele	 M4	E3X-DA□-N	850 (4,000) 680 (3,600) 250 (1,300)	1.0-mm dia. (0.01-mm dia.)	E32-T11	4 mm
Fleksibel fiber. Meget hårdfør	Ideel til montage på kørende dele	 M3	E3X-DA□-N	220 200 80	0.5-mm dia. (0.01-mm dia.)	E32-T21	4 mm
		 1.5-mm dia.	E3X-DA□-N	220 200 80		E32-T22B	
Vinkelaftastning	Lang tasteafstand; pladsbesparende	 3-mm dia.	E3X-DA□-N	570 460 170	1.0-mm dia. (0.01-mm dia.)	E32-T14L	25 mm
			E3X-DAB11-N	50 40 25			
	Til små emner	 1-mm dia.	E3X-DA□-N	150 130 55	0.5-mm dia. (0.01-mm dia.)	E32-T24	

Note: 1. Størrelsen på standardobjektet er den samme som fiberens diameter (anvendes linse, er det linsediameteren).

2. Det mindst aftastbare emne med sender/modtager er fundet, når fotoaftasteren i digital 12 bits visning er indstillet til at modtage lys, der overstiger værdien 1000 på displayet.

*1 Fibrene på E32-T17L er 10 m.

*2 Indikerer værdier for standard mode.

Applikation	Egenskaber	Udseende	Forstærker	Tasteafstand (mm) (Værdier i parantes : ved anvendelse af E39-F1 linse)	Standard-objekt *4 (mindste uigennemsigtige emne)	Model	Tilladelig bøjnings radius
Modstår kemikalier og andre hårde miljøer	**Teflon belagt*1; (Omgivelsestemperatur imellem -30°C til 70°C)**	 5-mm dia.	E3X-DA□-N	3,800 3,000 1,100	4.0-mm dia. (0.01-mm dia.)	**E32-T12F**	40 mm
	Teflon belagt*1; vinkelaftastning (Omgivelsestemperatur imellem -30°C til 70°C)	 5-mm dia.	E3X-DA□-N	500 400 150	3.0-mm dia. (0.01-mm dia.)	**E32-T14F**	
Varmebestandig	**Modstår 200°C; fleksibel; Teflon belagt*1 (Omgivelsestemperatur imellem -40°C til 200°C)**	 M4	E3X-DA□-N	350 280 100	1.0-mm dia. (0.01-mm dia.)	**E32-T61R**	10 mm
	Modstår 150°C*2; (Omgivelsestemperatur imellem -40°C til 150°C)	 M4	E3X-DA□-N	950 760 280	1.5-mm dia. (0.01-mm dia.)	**E32-T51**	35 mm
	Vinkelaftastning;modstår 150°C*2; detektion af små emner; (Omgivelsestemperatur imellem -40°C til 150°C)	 2-mm dia.	E3X-DA□-N	290 230 80	1.0-mm dia. (0.01-mm dia.)	**E32-T54**	35 mm
Gaffel	**Ideel til aftastning af etiketter o.lign.**		E3X-DA□-N	10 10 10	4.0-mm dia. (0.16-mm dia.)	**E32-G14**	25 mm
			E3X-DAB11-N	10 10 10			
Lille spredning af lyskegle	**Aftastning af lille højdevariation**	 3-mm dia.	E3X-DA□-N	2,300 1,900 700	1.7-mm dia. (0.01-mm dia.)	**E32-T22S**	10 mm
	Vinkelaftastning; aftastning af lille højdevariation	 3.5 x 3-mm dia.	E3X-DA□-N	1,700 1,300 500	2-mm dia. (0.01-mm dia.)	**E32-T24S**	
Aftastning af areal	**4 følerhoveder for genkendelse af former og højder**	 M3	E3X-DA□-N	700 610 250	2.0-mm dia. (0.01-mm dia.)	**E32-M21**	25 mm
	Taster i et område på 30mm	 30 mm	E3X-DA□-N	2,300 1,800 660	(0.3-mm dia.) *2	**E32-T16W**	10 mm
Aftastning af areal	**Taster i et område på 10 mm; lang tasteafstand**	 10 mm	E3X-DA□-N	3,500 2,800 1,000	(0.6-mm dia.)	**E32-T16**	25 mm
	Taster små emner i et område på 11 mm; IP50	 11 mm	E3X-DA□-N	1,400 1,100 420	(0.2-mm dia.) *2	**E32-T16P**	10 mm

Note: 1. Størrelsen på standardobjektet er den samme som fiberens diameter (anvendes linse, er det linsediameteren).

2. Det mindst aftastbare emne med sender/modtager er fundet, når fotoaftasteren i digital 12 bits visning er indstillet til at modtage lys, der overstiger værdien 1000 på displayet.

*1 Teflon er et registreret varemærke

*2 Maks. vedvarende temperatur er 130°C.

*3 Indikerer varmemodstanden på spidsen.

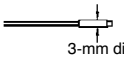
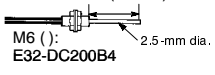
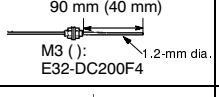
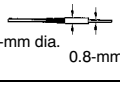
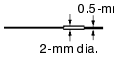
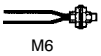
*4 Indikerer værdier i standard mode.

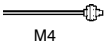
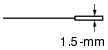
*5 Fibren er 2 m.

Typer for diffus reflektion

✂ Indikerer modeller, hvor det er tilladt at forkorte fiberen ved hjælp af den medfølgende saks.

■ : Super-lang-tasteafstand ■ : Standard mode □ : Super-high-speed mode

Applikation	Egenskaber	Udseende	Forstærker	Tasteafstand (mm) *1	Standard objekt (min. tasteemne *2: Guld tråd)	Model	Tilladelig bøjningsradius
Lang tasteafstand	**M6**	 M6	E3X-DA□-N	500 400 150	500×500 (0.01-mm dia.)	**E32-D11L** ✂	25 mm
			E3X-DAB11-N	44 35 22	(0.1-mm dia.)		
	3-mm dia.	 3-mm dia.	E3X-DA□-N	300 230 100	300×300 (0.01-mm dia.)	**E32-D12** ✂	25 mm
	M4	 M4	E3X-DA□-N	160 130 45	200×200 (0.01-mm dia.)	**E32-D21L** ✂	
	3-mm dia.	 3-mm dia.	E3X-DA□-N	160 130 45		**E32-D22L** ✂	
Almindelig brug	**M6**	 M6	E3X-DA□-N	400 300 100	400×400 (0.01-mm dia.)	**E32-DC200** ✂	25 mm
			E3X-DAB11-N	32 25 16	(0.1-mm dia.)		
	M3	 M3	E3X-DA□-N	100 80 30	100×100 (0.01-mm dia.)	**E32-DC200E** ✂	
			E3X-DAB11-N	8 6 4	(0.2-mm dia.)		
Tynd fiber	**2.5-mm dia.; Bøjeligt metal fiberrør i enden**	 90 mm (40 mm) M6 ( ): E32-DC200B4 2.5-mm dia.	E3X-DA□-N	400 300 100	400×400 (0.01-mm dia.)	**E32-DC200B** **E32-DC200B4** ✂	25 mm
			E3X-DAB11-N	32 25 16	(0.1-mm dia.)		
	1.2-mm dia.; Bøjeligt metal fiberrør i enden	 90 mm (40 mm) M3 ( ): E32-DC200F4 1.2-mm dia.	E3X-DA□-N	100 80 30	100×100 (0.01-mm dia.)	**E32-DC200F** **E32-DC200F4** ✂	
	0.8-mm dia.; præcis aftastning	 3-mm dia. 0.8-mm dia.	E3X-DA□-N	21 16 6	25×25 (0.01-mm dia.)	**E32-D33** ✂	
	0.5-mm dia.; præcis aftastning	 0.5-mm dia. 2-mm dia.	E3X-DA□-N	4 3 1		**E32-D331**	
Fleksibel	**Kan bøjes som en ledning. Bøjningsradius =1mm**	 M6	E3X-DA□-N	220 170 80	300×300 (0.01-mm dia.)	**E32-D11R** ✂	1 mm
		 M3	E3X-DA□-N	40 30 10	50×50 (0.01-mm dia.)	**E32-D21R** ✂	

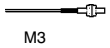
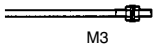
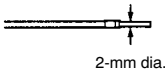
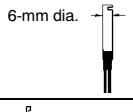
Flek-sibel fi-ber. Meget hårdfør	**Ideel til montage på kørende dele**	 M6	E3X-DA□-N	220 170 80	300 × 300 (0.01-mm dia.)	**E32-D11**	4 mm
		 M3	E3X-DA□-N	40 30 10	50 × 50 (0.01-mm dia.)	**E32-D21**	
		 M4	E3X-DA□-N	90 70 25	100 × 100 (0.01-mm dia.)	**E32-D21B**	
		 1.5-mm dia.	E3X-DA□-N	40 30 10	50 × 50 (0.01-mm dia.)	**E32-D22B**	

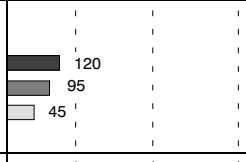
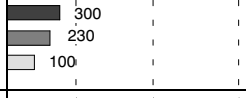
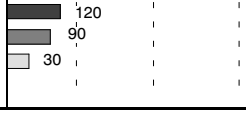
Note: 1. Værdien er opgivet for et standardobjekt.

2. Det kan være nødvendigt at udføre et- eller to-punkts teach for at opnå samme resultat.

*1 Tasteafstand ved hvidt papir

*2 Indikerer værdier i standard mode.

Applikation	Egenskaber	Udseende	Forstærker	Tasteafstand (mm) *1	Standard-objekt (min. tasteemne *5: Guld tråd)	Model	Tilladelig bøjnings radius
Coaxial fiber	**M6 coaxial; Stor aftastnings-nøjagtighed ved lang afstand**	 M6	E3X-DA□-N	400 300 100	500 × 500 (0.01-mm dia.)	**E32-CC200**	25 mm
			E3X-DAB11-N	32 25 16	(0.1-mm dia.)		
	3-mm dia. coaxial; Stor aftastnings-nøjagtighed	 3-mm dia.	E3X-DA□-N	200 150 50	300 × 300 (0.01-mm dia.)	**E32-D32L**	
	M3 coaxial; Stor aftastnings-nøjagtighed; muligt at montere linse for smalt spot (E39-F3A-5/F3B/F3C)	 M3	E3X-DA□-N	100 75 25	25 × 25 (0.01-mm dia.)	**E32-C31**	
	M3 coaxial; Stor aftastnings-nøjagtighed; muligt at montere linse for smalt spot (E39-F3A-5/F3B/F3C)	 M3	E3X-DA□-N	45 35 10	50 × 50 (0.01-mm dia.)	**E32-C41**	
	2-mm dia. coaxial; Stor aftastnings-nøjagtighed; muligt at montere linse for smalt spot (0.1 til 0.6 dia) (E39-F3A)	 2-mm dia.	E3X-DA□-N	45 35 10	50 × 50 (0.01-mm dia.)	**E32-C42**	
	2-mm dia. coaxial; Stor aftastnings-nøjagtighed; muligt at montere linse for smalt spot (0.5 til 1 dia) (E39-F3A)	 2-mm dia.	E3X-DA□-N	100 75 25	100 × 100 (0.01-mm dia.)	**E32-D32**	
Vinkel-aftastning	**6-mm dia.; lang tasteafstand**	 6-mm dia.	E3X-DA□-N	150 110 50	200 × 200 (0.01-mm dia.)	**E32-D14L**	25 mm
	2-mm dia.; små byggemål	 2-mm dia.	E3X-DA□-N	40 30 10	50 × 50 (0.01-mm dia.)	**E32-D24**	

Applikation	Egenskaber	Udseende	Forstærker	Tasteafstand (mm) *1	Standard-objekt (min. tasteemne *5: Guld tråd)	Model	Tilladelig bøjnings radius
Modstår kemikalier og andre hårde miljøer	**Teflon belagt*3; (Omgivelsestemperatur imellem -30°C til 70°C)**	 6-mm dia.	E3X-DA□-N	 120 95 45	200×200 (0.01-mm dia.)	**E32-D12F**	40 mm
Varme-bestandig	**Modstår 150°C*2; (Omgivelsestemperatur imellem -40°C til 150°C)**	 M6	E3X-DA□-N	 300 230 100	200×200 (0.01-mm dia.)	**E32-D51**	35 mm
	Modstår 300°C*4; med rustfri spiral fiberbeskyttelse (Omgivelsestemperatur imellem -40°C til 300°C)	 M6	E3X-DA□-N	 120 90 30		**E32-D61**	25 mm

Note: 1. Værdien er opgivet for et standardobjekt.

2. Det kan være nødvendigt at udføre et- eller to-punkts teach for at opnå samme resultat.

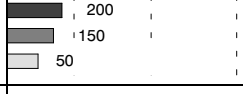
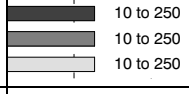
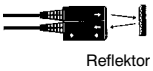
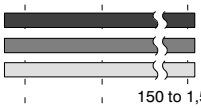
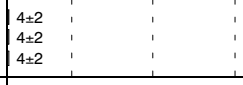
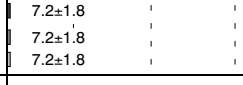
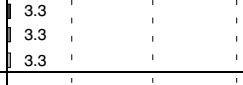
*1 Tasteafstand indikerer, værdier opnået med hvidt papir.

*2 Max. vedvarende temperatur er 130°C.

*3 Teflon er et registreret varemærke fra Dupont Company.

*4 Indikerer temperaturen målt på fiberspidsen.

*5 Indikerer værdier for standard mode.

Applikation	Egenskaber	Udseende	Forstærker	Tasteafstand (mm) *1	Standard objekt (min. tasteemne *2: Guld tråd)	Model	Tilladelig bøjnings radius
Aftastning af areal	**Taster i et stort område ud fra siden**		E3X-DA□-N	 200 150 50	300×300 (0.01-mm dia.)	**E32-D36P1**	25 mm
Aftaster med refleksbrik	**Aftastning af transparente emner**	 M6 Reflektor E39-R3	E3X-DA□-N	 10 to 250 10 to 250 10 to 250	35-mm dia. (0.1-mm dia.)	**E32-R21 +E39-R3 (tilbehør)**	25 mm
	Aftastning af transparente emner; IP66	 Reflektor E39-R1	E3X-DA□-N	 150 to 1,500	35-mm dia. (0.2-mm dia.)	**E32-R16 +E39-R1 (tilbehør)**	
Fast taste-afstand	**Positionering af glas**		E3X-DA□-N	 4 to 12	100×100	**E32-L56E1 E32-L56E2**	35 mm
	Aftastning af små højdeforskelle; (Omgivelsestemperatur imellem -40°C til 105°C); IP50		E3X-DA□-N	 4±2 4±2 4±2	25×25 (0.01-mm dia.)	**E32-L24L**	10 mm
			E3X-DA□-N	 7.2±1.8 7.2±1.8 7.2±1.8		**E32-L25L**	
Fast taste-afstand	**Aftastning af små højdeforskelle; IP50**		E3X-DA□-N	 3.3 3.3 3.3		**E32-L25**	25 mm
			E3X-DA□-N	 3.3 3.3 3.3		**E32-L25A**	
Kontrol af væsker	**Montering på rør**		E3X-DA□-N	---	Væske	**E32-L25T**	10 mm

Note: 1. Værdierne for det mindste aftastbare objekt er opnået ved en ikke oplyst afstand.

2. Det kan være nødvendigt at udføre et- eller to-punkts teach, for at opnå samme resultat.

*1 Tasteafstand indikerer, værdier opnået med hvidt papir.

*2 Indikerer værdier for standard mode.

Specifikationer

■ Tekniske data

Fiberforstærker

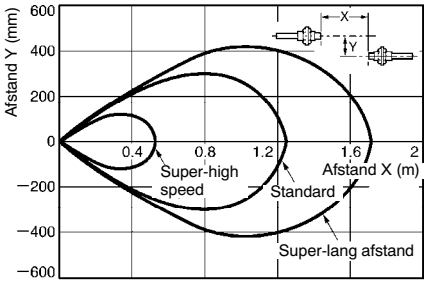
Enhed		Standard model		Med analog udgang		Mærkeaftaster	Med M8 stik IP66
Udgangstype	NPN udgang	E3X-DA11-N	E3X-DA6	E3X-DA21-N	E3X-DA7	E3X-DAB11-N	E3X-DA14V
	PNP udgang	E3X-DA41-N	E3X-DA8	E3X-DA51-N	E3X-DA9	---	E3X-DA44V
Lyskilde (bølgelængde)		Rød LED (660 nm)				Blå LED (470 nm)	Rød LED (660 nm)
Strømforsyningsspænding		12 til 24 VDC ± 10%, ripple (p-p) 10% max.					
Strømforbrug		Normalt: 960 mW max. (strømforbrug: 40 mA max. ved 24 VDC forsyning) Eco Mode: 720 mW max. (strømforbrug: 30 mA max. ved 24 VDC forsyning) Display slået fra: 600 mW max. (strømforbrug: 25 mA max. ved 24 VDC forsyning)					
Kontrol udgang	**ON/OFF udgang**	NPN/PNP (afhængig af model) åben collector; belastningsstrøm: 50 mA max.; Restspænding: 1 V max.; Light ON/Dark ON kan vælges				NPN åben collector; belastningsstrøm: 50 mA max.; restspænding:1V max.; Light ON/Dark ON kan vælges	NPN/PNP (afhængig af model) åben collector; belastningsstrøm: 50 mA max.; Restspænding: 1 V max.; Light ON/Dark ON kan vælges
	Analog udgang	---		Belastning 1 til 5 VDC, 10 kΩ min.		---	---
Beskyttelse af kredsløb		Omvendt polaritet, kortslutning af udgang, gensidig påvirkning					
Responstid		Super-high-speed mode: 0.25 ms for drift eller reset Standard mode: 1 ms for drift eller reset Super-long-distance mode: 4 ms for drift eller reset					
Følsomhedsindstilling		Teach eller manual metode					
Funktioner	**Timer funktion**	Forsinket frafaldstimer: 0 til 200 ms; (0 til 20ms justeres i spring af 1 ms, og 20 til 200 ms i spring af 5 ms)					
	Automatisk strøm kontrol	Sikrer ensartet lysmængde i hele levetiden				---	Sikrer ensartet lysmængde i hele levetiden
	Zero-reset	Displayværdierne kan resettes til 0, hvis ønsket (negative værdier kan også vises)					
	Total reset	Mulighed for at stille tilbage til fabriksindstilling					
	Skalering af analog udgang	---		Øvre og nedre grænser kan skaleres i enheder af 100.		---	---
Display		Udgangsindikator (orange), 7-segment display (rød og grøn). Vælg mellem 3 visninger: 12 bit visning, procent visning eller analog bargraf visning					
Andre display visninger		Vælg mellem Normal/Peak høj/Peak lav visning					
Display orientering		Vælg mellem normal og omvendt visning					
Justering af optiske akser		Mulighed for at indstille optiske akser ved hjælp af hyper-flashing funktion					
Omgivende belysning		Glødelampe: 10,000 lx max.; Sollys: 20,000 lx max.					
Omgivelsestemperatur		Drift: I gruppe med 1 til 3 forstærkere: −25°C til 55°C I gruppe med 4 til 11 forstærkere: −25°C til 50°C I gruppe med 12 til 16 forstærkere: −25°C til 45°C (uden tilisning eller kondens) Opbevaring: −30°C til 70°C (uden tilisning eller kondens)					
Omgivende luftfugtighed		Drift og opbevaring: 35% to 85% (uden tilisning eller kondens)					
Insolationsmodstand		20 MΩ min. (ved 500 VDC)					
Stødspænding		1,000 VAC ved 50/60 Hz i 1 minut					
Vibrationsmodstand		10 til 55Hz, 1.5-mm dobbelt amplitude eller 300 m/s^2(ca.30G) i 2 timer i retning X, Y og Z					
Slagstyrke		500 m/s^2 (ca.50G) 3 gange i hver retning X, Y og Z					
Beskyttelsesgrad		IP50					IP66
Forbindelsesmetode		Kabel 2 m	Stik	Kabel 2 m	Stik	Kabel 2 m	M8 stik
Vægt i pakket tilstand		Ca. 100 g	Ca. 55 g	Ca. 100 g	Ca. 55 g	Ca. 100 g	Ca. 100 g
Materiale	**Hus**	PBT					
	Dæksel	Polycarbonate					
Tilbehør		Engelsk/Japansk instruktionsvejledning					

Grafiske Data

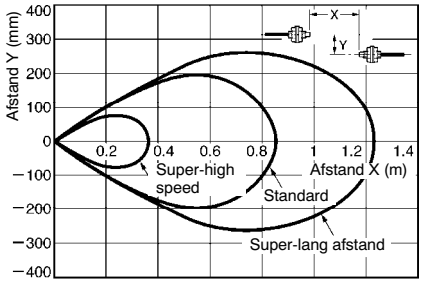
■ E3X-DA□-N

Parallelt aftastningsområde (typisk) ved max. følsomhed.

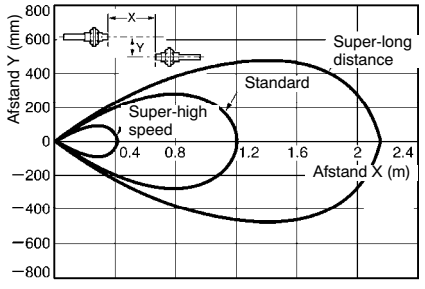
E32-TC200 (Sender/modtager)



E32-T11R (Sender/modtager)

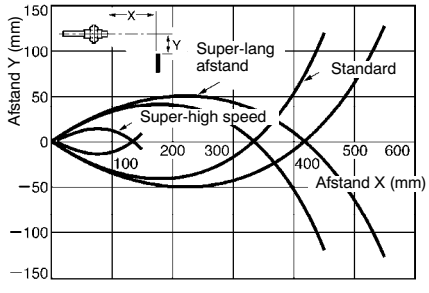


E32-T11 (Sender/modtager)

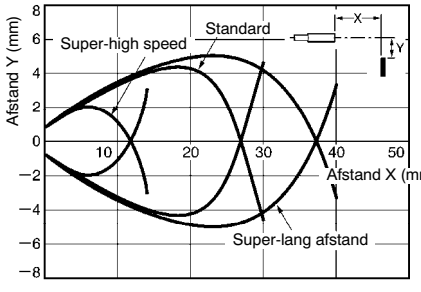


Driftsområde (typisk) standardobjekt aftastet ved max. følsomhed.

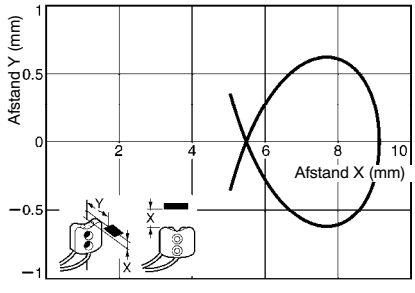
E32-DC200 (Diffus reflektion)



E32-D33 (Diffus reflektion)

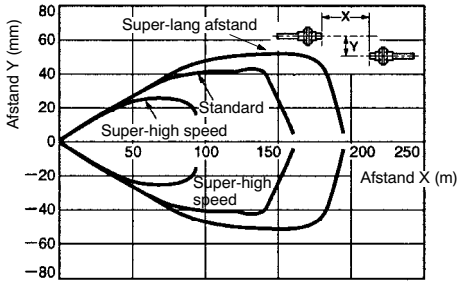


E32-L25L (Begrænset diffus reflektion)

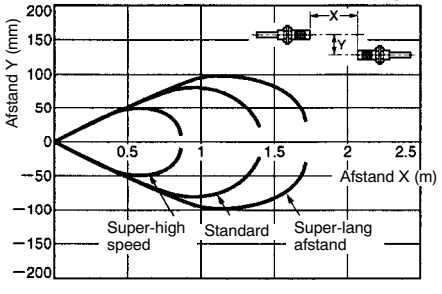


■ E3X-DAB11-N Parallelt aftastningsområde (typisk) Ved max. følsomhed.

E32-TC200 (Sender/modtager)

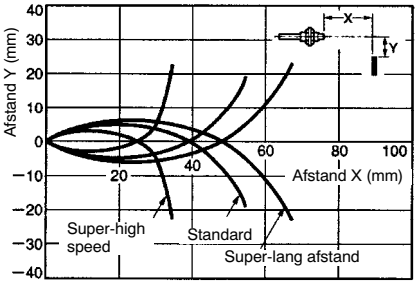


E32-TC200+E39-F1 (Sender/modtager)

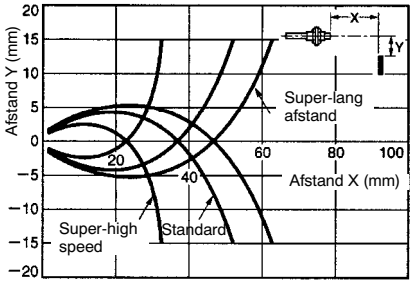


Driftsområde (typisk) Standardobjekt aftastet ved max. følsomhed.

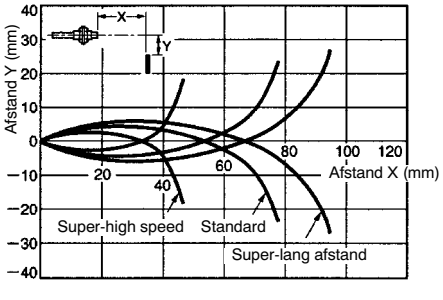
E32-DC200 (Diffus reflektion)



E32-CC200 (Diffus refleksion)

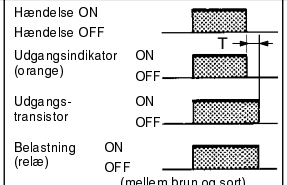
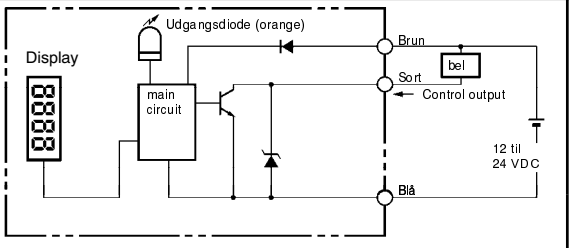
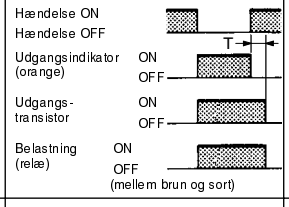
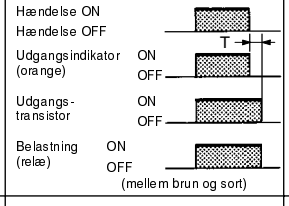
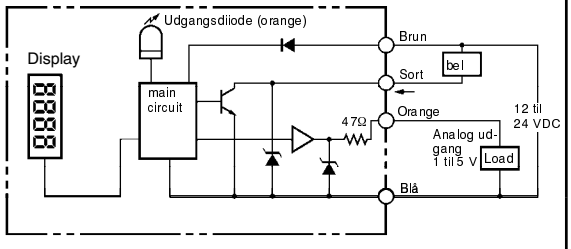
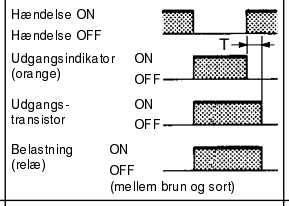
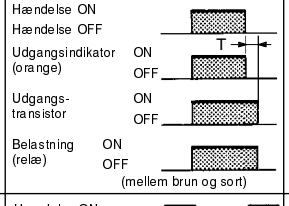
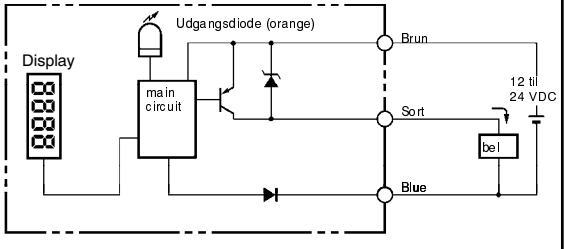
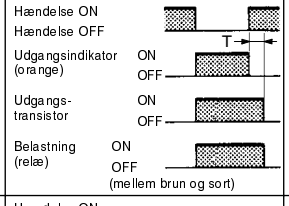
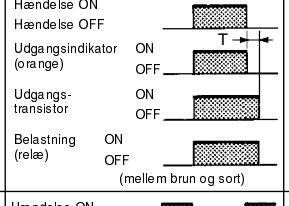
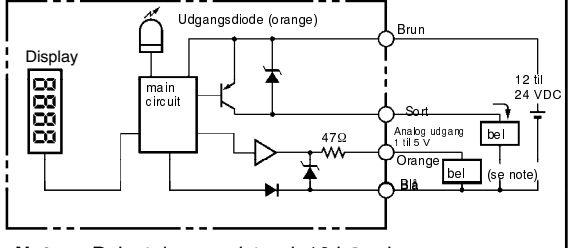
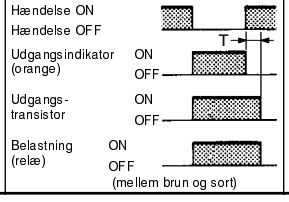


E32-D11L (Diffus reflektion)



Drift

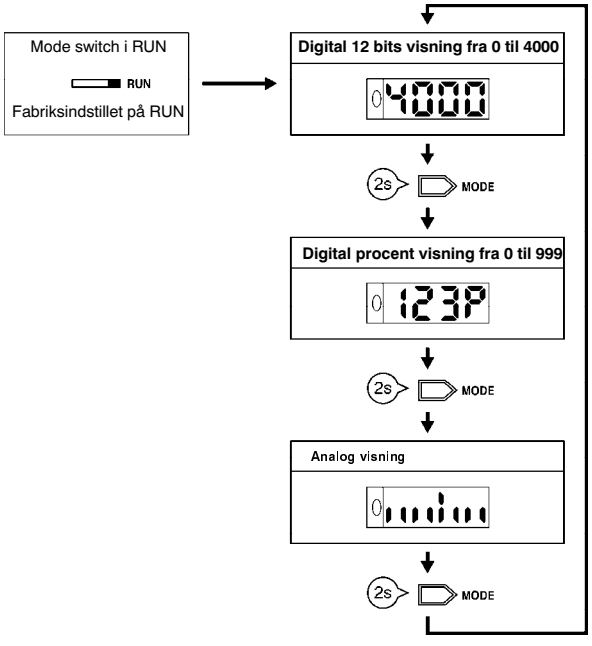
■ Udgangskredsløb

Udgang	Model	Driftmåde vælger	Tidssekvensdiagram	Udgangs status	Udgangskredsløb
NPN	E3X-DA11-N E3X-DAB11-N E3X-DA6 E3X-DA14V	LIGHT ON (L/ON)		Light ON	
		DARK ON (D/ON)		Dark ON	
	E3X-DA21-N E3X-DA7	LIGHT ON (L/ON)		Light ON	
		DARK ON (D/ON)		Dark ON	**Note:** Belastningsmodstand: 10 kΩ min.
PNP	E3X-DA41-N E3X-DA8 E3X-DA44V	LIGHT ON (L/ON)		Light ON	
		DARK ON (D/ON)		Dark ON	
	E3X-DA51-N E3X-DA9	LIGHT ON (L/ON)		Light ON	
		DARK ON (D/ON)		Dark ON	**Note:** Belastningsmodstand: 10 kΩ min.

Drift

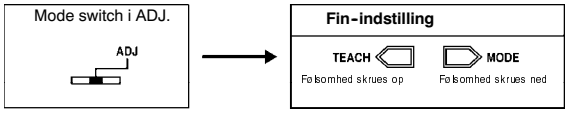
Nem at anvende

Display visninger i RUN Mode



Manual indstilling i ADJ Mode. (Piletaster anvendes til fin-indstilling)

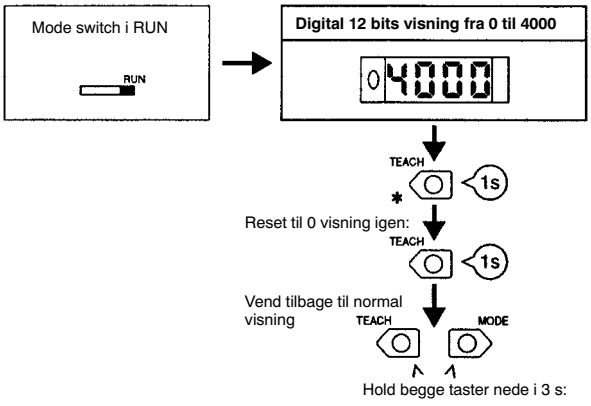
Manuel indstilling eller fin-indstilling efter Teaching



Visning i ADJ mode er forskellig fra visning i RUN mode.

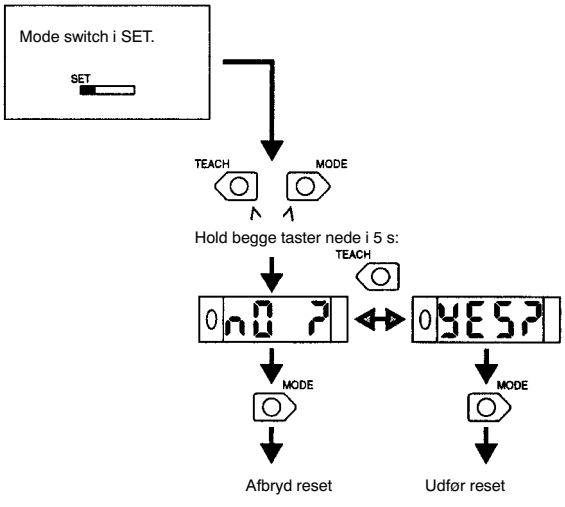
RUN mode		ADJ mode
Digital 12 bit aktuel værdi	→	Digital 12 bit indstillet værdi
Digital procent aktuel værdi	→	Digital procent aktuel værdi
Aktuel analog værdi	→	Aktuel analog værdi

Zero-reset (RUN Mode)



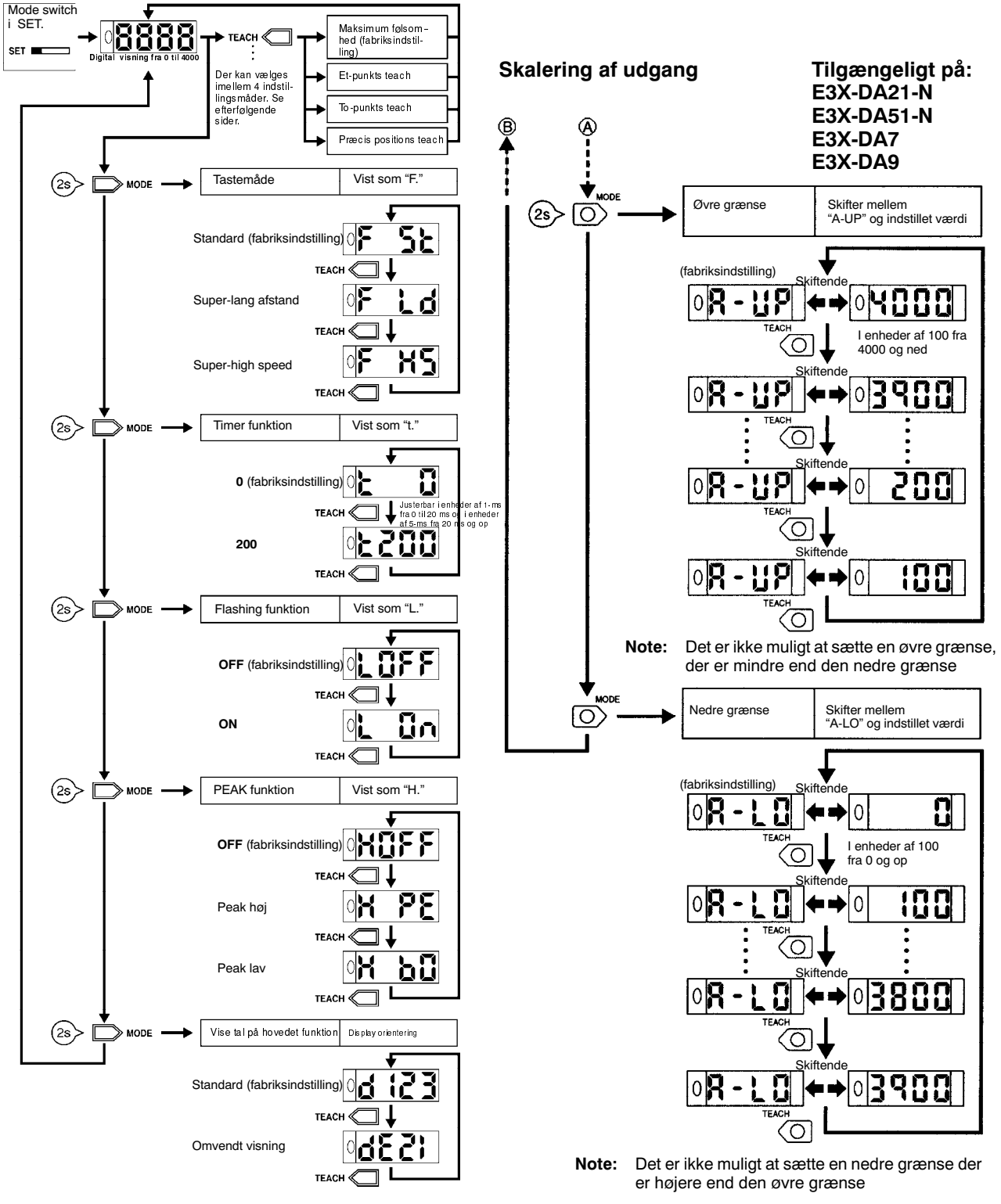
Note: Zero-reset kan udføres, så ofte man ønsker

Reset til fabriksindstilling (SET Mode)



Nem at anvende

Indstillinger i SET Mode



Skalering af udgang

Tilgængeligt på:
E3X-DA21-N
E3X-DA51-N
E3X-DA7
E3X-DA9

Note: Det er ikke muligt at sætte en øvre grænse, der er mindre end den nedre grænse

Note: Det er ikke muligt at sætte en nedre grænse der er højere end den øvre grænse

■ Følsomhedsindstilling/Teach (SET Mode)

Der er 4 måder at udføre Teach på

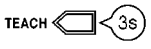
Når Teach er udført, vil forstærkeren fungere med den indlærte værdi. Hvis displayet blinker, er der sket en fejl under Teach, og proceduren skal gentages.

Indstil mode switch i SET for at påbegynde Teach.

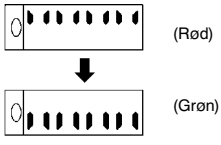
Maximal følsomhed

1. Sæt mode switchen på SET.

2. Tryk på TEACH knappen i minimum 3 sekunder.



3. Teach er udført, når niveau displayet skifter fra rød til grøn. Niveau displayet vil vise den aktuelle værdi senere.

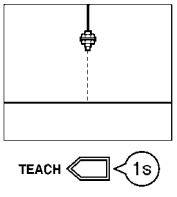


4. Sæt mode switchen tilbage på RUN

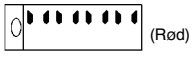
Et-punkts Teach uden emne

1. Sæt mode switchen på SET.

2. Tryk på TEACH knappen i ca. 1 sekund.

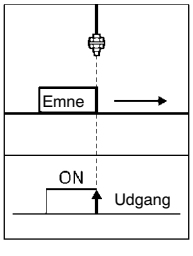


3. Teach er udført, når niveau displayet skifter til rød. Niveau displayet vil vise den aktuelle værdi senere.



4. Sæt mode switchen tilbage på RUN.

5. Indstillingsværdien bliver automatisk indlært, når næste emne passerer fiberen.



Note: Hvis et-punkts teach ikke kan udføres, er forskellen mellem emnet og baggrund for lille. Prøv da to-punkts teach.

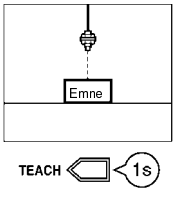
Light ON/Dark ON omskifter

Funktionsmåde		Indstilling
Light ON	L• ON	L (Fabriksindstilling)
Dark ON	D• ON	D

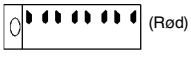
To-punkts Teach (med og uden emne)

1. Sæt mode switchen på SET.

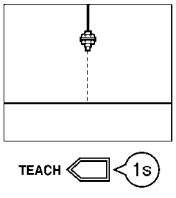
2. Tryk på TEACH knappen i ca. 1 sekund, når emnet er i tasteposition.



3. Niveau displayet lyser rødt.



4. Tryk på TEACH knappen i ca. 1 sekund uden emne.



5. Teach er udført, når niveaudisplayet skifter fra rød til grøn. Niveau displayet vil vise den aktuelle værdi senere.

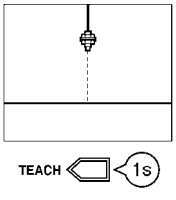
6. Sæt mode switchen tilbage på RUN.

Note: Om man udfører Teach med emnet først eller emnet sidst, betyder intet.

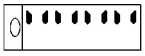
Præcis positions Teach

1. Sæt mode switchen på SET.

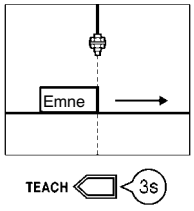
2. Tryk på TEACH knappen i ca. 1 sekund uden emne.



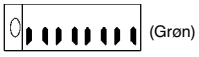
3. Niveau displayet lyser rødt.



4. Anbring emnet i den ønskede position, og tryk på TEACH knappen i min. 3 sekunder.



5. Teach er udført, når niveau displayet skifter fra rød til grøn. Niveau displayet vil vise den aktuelle værdi senere.



6. Sæt mode switchen tilbage på RUN.

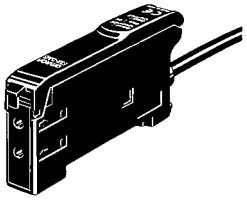
Dimensioner

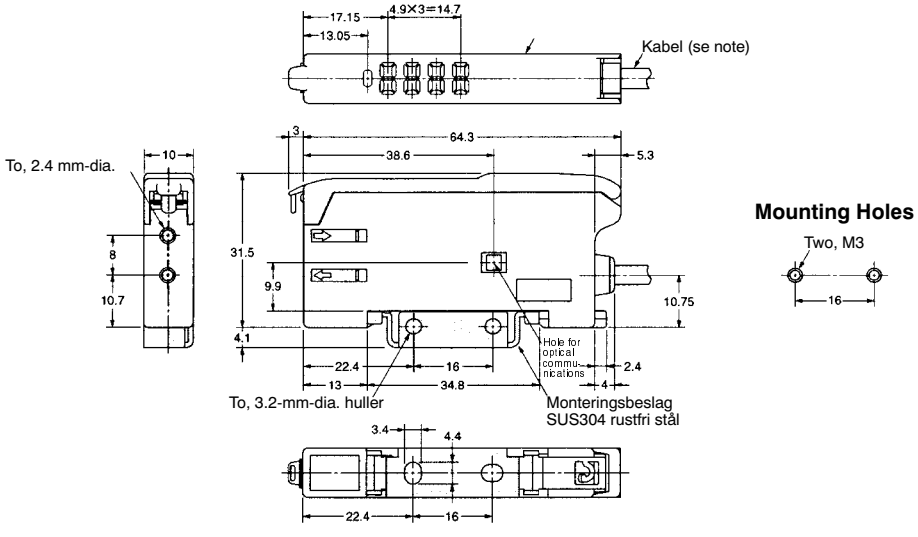
Note: Alle enheder er angivet i millimeter, hvis ikke andet angivet.

■ Forstærker

Forstærker med kabel og monteringsbeslag

E3X-DA11-N
E3X-DA21-N
E3X-DAB11-N
E3X-DA41-N
E3X-DA51-N





Mounting Holes

Note: På E3X-DA11-N/DA41-N/DAB11-N, anvendes ø4, 3-leder PVC kabel med et ledertværsnit på 0.45 mm^2
På E3X-DA21-N/DA51-N, anvendes ø4, 4-leder PVC kabel med et ledertværsnit på 0.2 mm^2