KROHNE

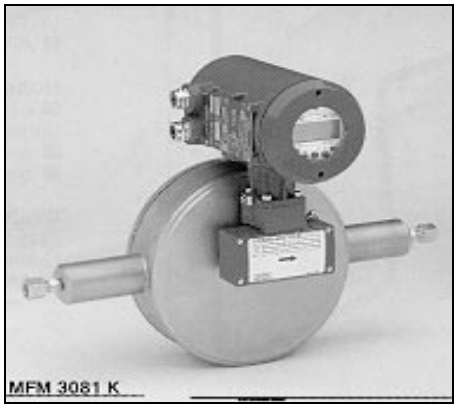
Version November 1996

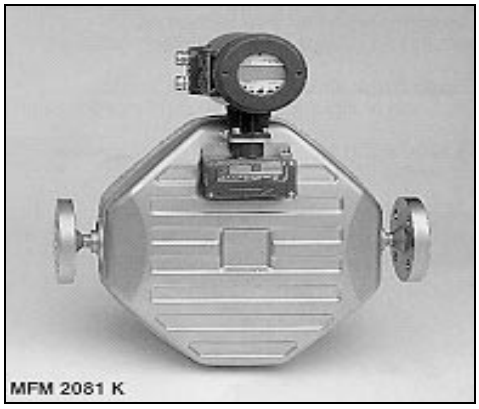
CORIMASS P and E Series

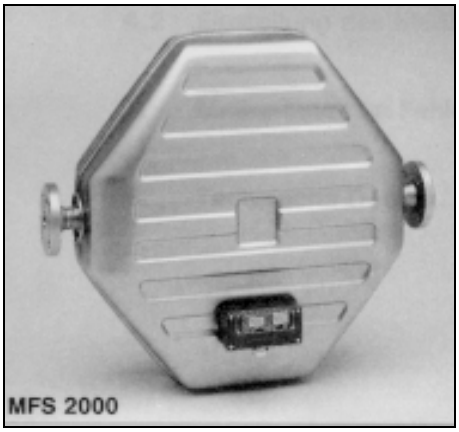
Software Version P2.20

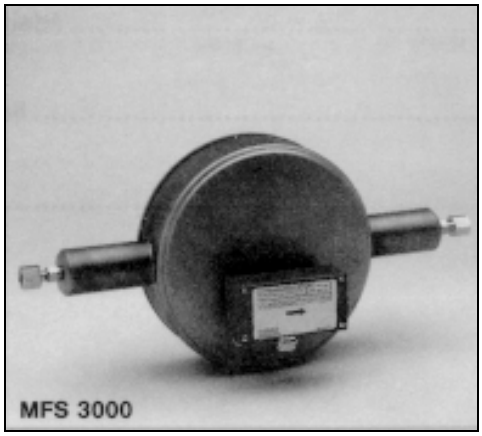
Installation and Operating Instructions

MFM 2081 K and F
MFM 3081 K and F









How to use these installation and operating instructions

For easy reference these Instructions are divided into four parts.

Only Part A (page 3) is needed for installation and initial start-up.

All CORIMASS mass flowmeters of the P- and E-Series are factory set to your order specifications.

Part A Install flowmeter in the pipeline (Sect. 1), connect up (Sect. 2) and power the flowmeter (Sect. 3).

The system is operational

Part B Operator control and functions of the MFC 081 Signal Converter.

Part C Service and functional checks.

Part D Technical data and dimensions.

Product liability and warranty

The CORIMASS mass flowmeter MFM 2081 and MFM 3081 is designed for the direct measurement of mass flow rate, product density and product temperature, and also indirectly enables measurement of parameters such as total mass, concentration of dissolved substances and the volume flow.

For **use in hazardous areas**, special codes and regulations are applicable which are specified in the special “Ex installation and operating instructions“ (supplied only with hazardous-duty equipment).

Responsibility as to suitability and intended use of our instruments rests solely with the purchaser.

Improper installation and operation of the flowmeters may lead to **loss of warranty**.

In addition, the **“general conditions of sale“** forming the basis of the purchase agreement are applicable.

If you need to return CORIMASS flowmeters to KROHNE, please complete the form on the **last page** of this manual and return it with the meter to be repaired. **Krohne regrets that it cannot repair or check your flowmeter unless accompanied by this completed form**.

CE / EMC Standards / Approvals

- The Corimass MFM 2081 and MFM 3081 with the MFC 081 signal converter meet the requirements of **the EU-EMC Directives** and bear the **CE symbol**.
- The Corimass MFM 2081 and MFM 3081 K -Ex are approved as hazardous duty equipment to the harmonised European Standards and to Factory Mutual (FM) (pending). Further details are given in the “Ex” supplementary instructions provided only with hazardous-duty equipment.

CE

Technical data subject to change without notice

Contents

Part A Installation and Start up

1. Instrument Description

1.1 The CORIMASS Measuring System

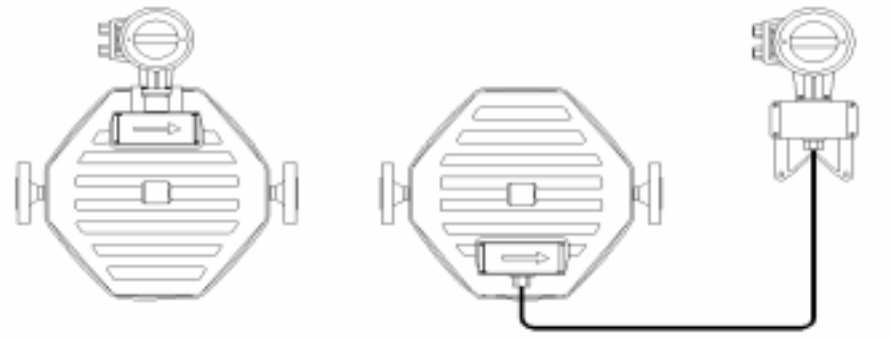
The CORIMASS Measuring System uses the Coriolis principle for measuring the mass flow rate of fluids with high accuracy.

When using this measuring principle, it is possible to measure the mass flow rate directly, independent of any other parameters of the fluid, such as density, temperature, pressure, viscosity, conductivity and flow profile. Homogeneously distributed small solid particles (slurries) and gas bubbles have no noticeable effect on the measuring accuracy.

The CORIMASS mass flow rate system is of modular type design, comprising a transducer and a converter. In the compact version MFM 2081 K / MFM 3081 K the converter is mounted directly to the transducer; in the separate version MFM 2081 / MFM 3081 the transducer MFS 2000 / MFS 3000 and the converter MFC 081 F are connected to each other via a shielded multi-conductor cable (figure 1). The MFM 2081 is also referred to as “P-Series,” and the MFM 3081 is also referred to as “E-Series”. The measurement values of mass flow rate, total mass and density are available.

Additional to the standard system for special requirements the following models are available:

- transducer with electric or liquid heating
- transducer with secondary containment or pressure relief
- hazardous duty model:
  EEx ib II B or EEx ib II C (no electric heating!) are applied
- FM Class I, II, III, Div. 1 and Div. 2, Groups B-G (pending)



Compact Version
MFM 2081 K

Separate Version
MFM 2081 F
Transducer MFS 2000 plus Converter MFC 081 F
Shielded multi-conductor cable

Fig. 1 The CORIMASS Measuring System

1.2 Mass Flow Sensor

1.2.1 Measuring Principle

Coriolis forces occur in rotating systems when accompanying bodies are moved toward or away from the rotational axis. This is illustrated by the following simple set-up: a pipe tube rotates with a constant angular velocity around the axis A - B (figure 2). The fluid particles flow with the velocity v through the loop. Between the points C and D they move away from the axis and therefore have to be accelerated from a smaller to a larger tangential velocity. Respectively, the fluid particles have to decelerate reducing their tangential velocity between points E and F. The opposing coriolis forces acting upon the two different parts of the pipe loop are directly proportional to the product of the mass and the velocity of the fluid. They cause the pipe loop to deform (DD', EE' and FF' respectively) with respect to a rotating loop filled with a flowing fluid.

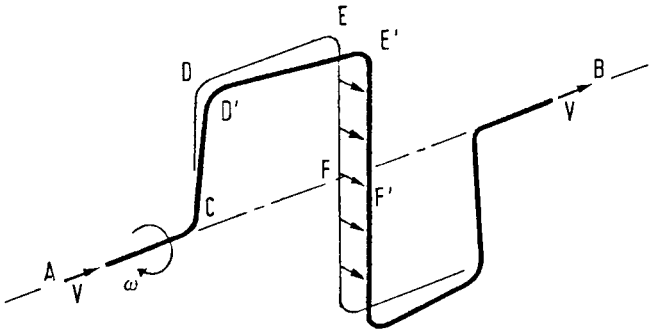


Fig. 2 Coriolis force in a rotating pipe loop

Rotation does not necessarily mean the completion of full circular orbits. Short circular segments suffice. In the event of oscillation, the deformation of the pipe loop sides oscillates, too. The total change in the motion of the pipe loop caused by the mass flow can be detected via inductive sensors. A signal directly related the mass flow rate of the fluid flowing through the pipe loop is then generated after appropriate signal processing.

1.2.2 Transducer MFS 2000 (P-Series)

For greater sized mass flow meters it has proven to be of advantage for the fluid to flow through two parallel measuring loops, which oscillate in opposite directions and with a phase difference of 180°. This symmetrical arrangement of the loops and the stiffness of the bridge (i.e. the pipe loop supports) suppress most disturbances caused by external equipment. Figure 3 displays an optimised transducer of the MFS 2000 series designed for mass flow measurement.

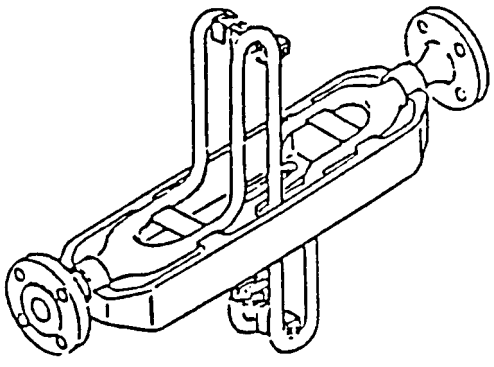


Fig. 3: Transducer MFS 2000 without housing

The use of flow dividers with optimised flow properties combined with the application of measuring tubes with a large tube cross-section ensures minimum loss of pressure. The danger of cavitation in the specified measuring range is eliminated.

The use of thick-walled measuring tubes with a large cross-section exercises a further positive effect. Due to the increase in the vibrating mass, the measuring system is less sensitive to gas bubbles in the measured medium.

1.2.3 MFS 3000 Transducer (E-Series)

The CORIMASS MFS 3000 series is comprised of precision transducers for the measurement of small fluid and gas mass flow rates with the range of 0.006 kg./min. to 33.3 kg./min. (0.013 lb./min. to 73.16 lb./min.).

In contrast to the CORIMASS P-series of instruments, the CORIMASS E-series is designed as a single-tube system with the inherent advantages of a single flow path (see Fig. 4).

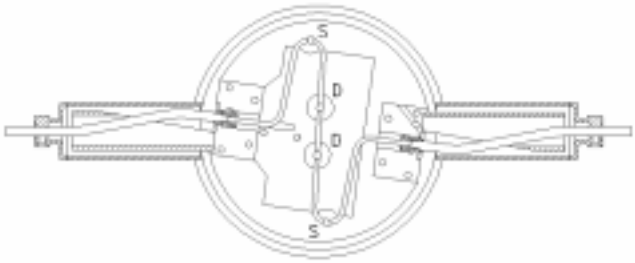


Fig. 4: MFS 3000 Transducer without housing

Due to its low-frequency tuned reference platform, the MFS 3000 is largely insensitive to interference. The unit is characterised by a rugged transducer loop, which permits optional measurements up to operating pressure levels of as much as 300 bar (4352 psig) depending on model.

A further advantage of the E-series is its ease of maintenance and servicing.

2. Installation

2.1 General Principles

The MFS 2000 and MFS 3000 CORIMASS mass flowmeters are capable of providing high accuracy and excellent repeatability. The narrow band pass digital filtering, the dual parallel tubes of the P-Series and the tuned reference platform of the E-Series provide exceptional immunity to external vibratory disturbances from process equipment in the area. Furthermore, the power of the CORIMASS with its dual driver design permits unsurpassed performance on certain types of slurries and on liquids with gas bubbles. Both designs are self-draining when installed vertically.*

As with all Coriolis mass flowmeters, the CORIMASS is an active device with its own energy source. The MFS 2000 mass flow sensor should be mounted into and by a rigid supporting piping system to avoid reflected resonant energy from adjacent piping and mounting structures in order to take advantage of the high degree of precision built into the instrument (fig. 5). A possible exception is mentioned in Section 2.2.2.

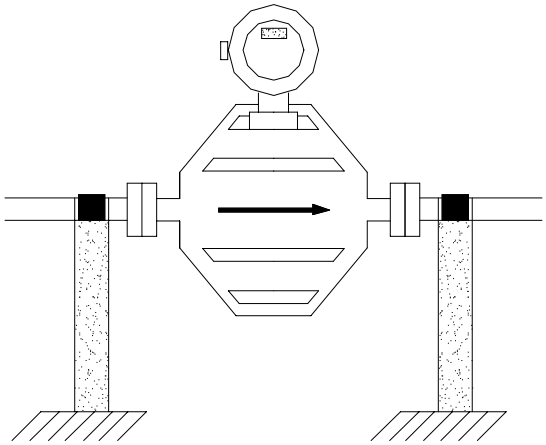


Fig. 5 Basic installation requirement
MFS 2000: rigid, stress free supporting of the transducer

The MFS 3000 transducer should be mounted by using two metallic clamps (supplied with the flowmeter), which are secured to a rigid mounting surface, as shown. For optimum performance these clamps should be positioned near the outboard ends of the transducer support tubes. They should also be well aligned to prevent undue stress on the MFS 3000 transducer housing when the clamps are secured. Adjacent piping should be rigidly supported and aligned with the transducer to avoid excess loading on the transducer process connections(See Fig. 6). For connection to tubing, process tubing should also be secured at appropriate locations (indicated by arrows in Fig. 6) to minimize vibration.

* Note: 1.5E requires aproximately 7° anti-clockwise rotation from vertical.

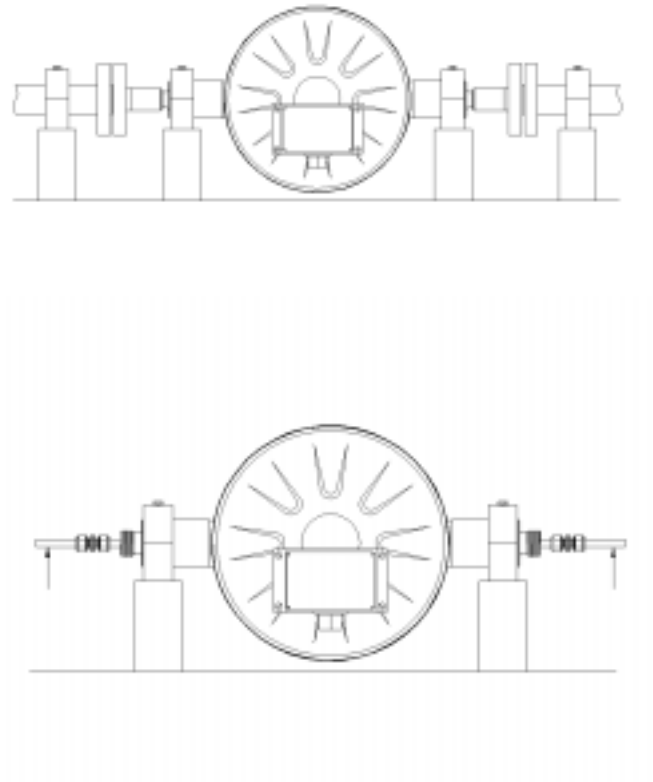


Fig. 6: Installation MFS 3000

A good installation is the basis for the high measurement accuracy of the unit.

The following installation guidelines are practical to implement, particulary if planned before the CORIMASS is first installed.

2.2 Installation Guidelines

2.2.1 Location of CORIMASS Transducer

Please ensure the following installation guidelines are adhered to as they are ***absolutely necessary*** for good measurement results and trouble-free start-up.

The transducer can be installed in any position. However, when installed in a vertical position the transducer is self-draining and allows gas bubbles to be readily purged from flowmeter during flowing conditions (see Fig. 7a and 7b).

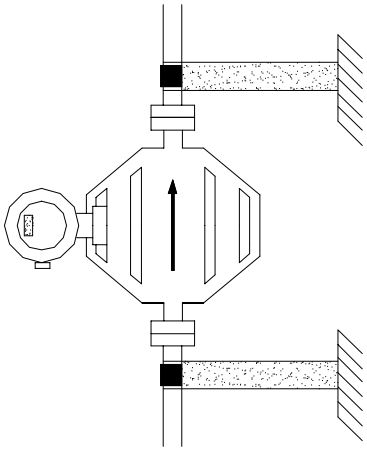


Fig. 7a Vertical installation

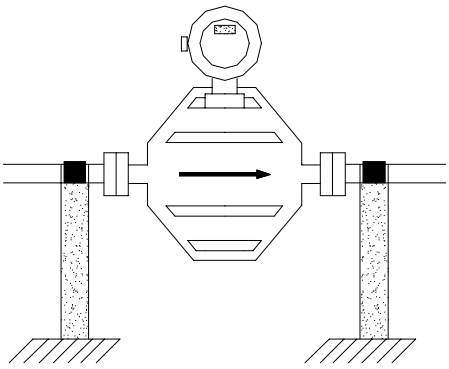


Fig. 7b Horizontal installation

Highest position in Pipeline
Avoid mounting the transducer in this position as gas bubbles may collect and remain in measuring system causing incorrect measurements (see Fig. 8).

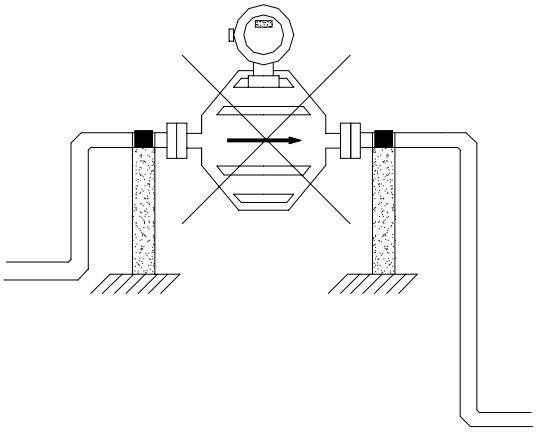


Fig. 8 Avoid highest position in pipeline

Falling Pipeline
Long downstream pipelines (> 3m) should be avoided due to degassing of the medium.

If long downstream pipelines are unavoidable install an additional vent valve as shown in Figure 9, unless there is under all operating conditions sufficient back pressure to avoid flashing of liquid to vapor.

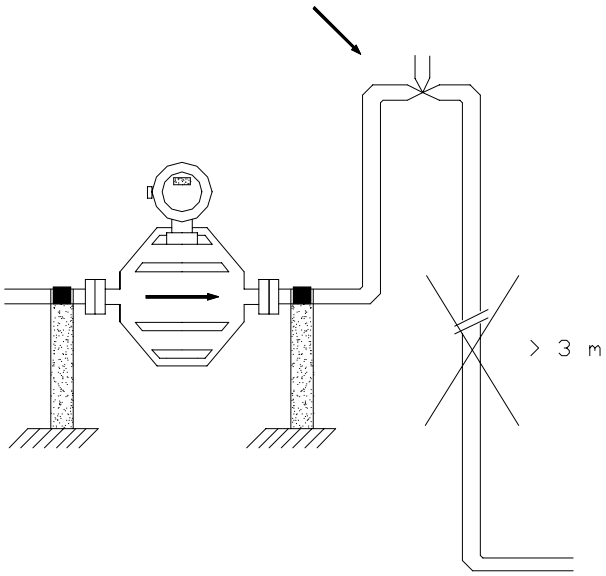


Fig. 9 Avoid long downstream pipelines after the transducer

Pumps
Pumps should be installed at least 4 × L from the transducer.

Where pumps cause excessive vibration, de-coupling by flexible hose may be necessary.

Install as shown in Figure 10.

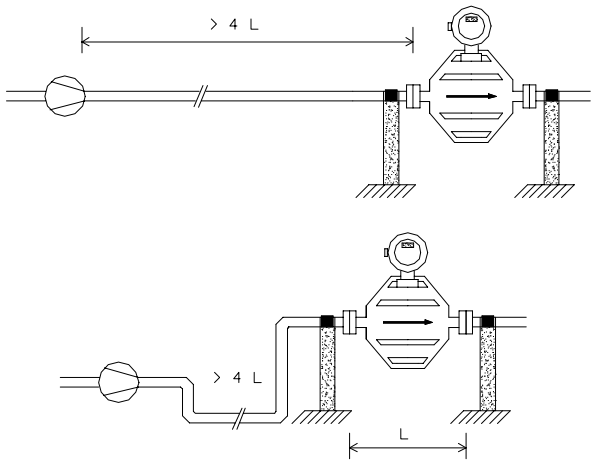


Fig. 10 Minimum distance from delivery pump 4 ×L

Additional Devices
Control valves, inspection glasses, etc., should be installed at least 1 × L from the transducer flange.

De-coupled pairs of Transducers
Transducers of the same size (or operating frequencies within 3 Hz) should not be installed in close proximity (< 4 L) in the same pipeline or connected via a mutual mounting frame unless they have been specially frequency de-coupled by the manufacturer (see Fig. 11).

The first 5 digits of the RB (shown on the Data Plate and on the Calibration Certificate) give the operating frequency of the transducer with water.

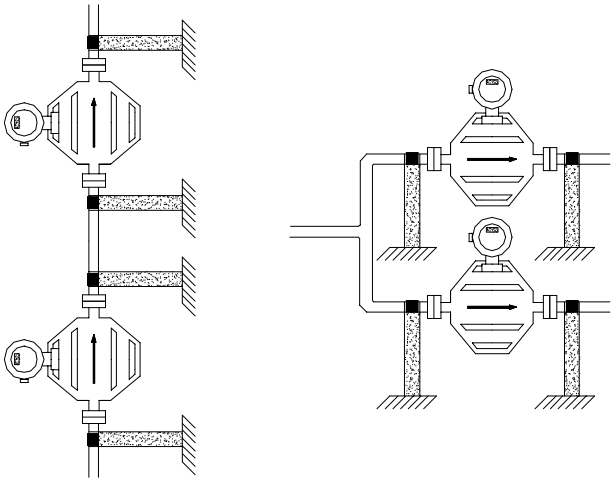


Fig. 11 Mounting of matched transducers serial or parallel

2.2.2 Requirements of the Piping System

Fixing
The mounting supports must be kept as short and as rigid as practical to prevent excitation of resonant vibrations by the transducer (see Fig. 12). Additional cross bracing is necessary when the maximum support length s_m is exceeded (see Fig. 13).

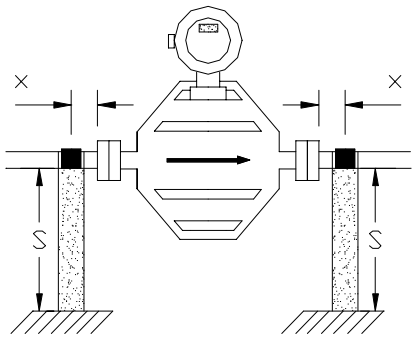


Fig. 12 Mounting with rigid supports

As an example the table indicates maximum support length for U-shape profile and the various transducer sizes.

Dimensions and maximum lengths s_m of U-shape supports. The chosen material dimensions are examples for adjusting support dimensions to transducer size.

⌴ profile	b mm (in)	h mm (in)	d mm (in)	s_m mm (in)
e.g. for				
60 P	60 (2.4)	30 (1.2)	6 (.24)	1260 (49.6)
300 P	80 (3.1)	45 (1.8)	6 (.24)	1490 (58.7)
800 P	120 (4.7)	55 (2.2)	7 (.28)	1810 (71.3)
1500 P	160 (6.3)	65 (2.6)	7.5 (.30)	2090 (82.3)

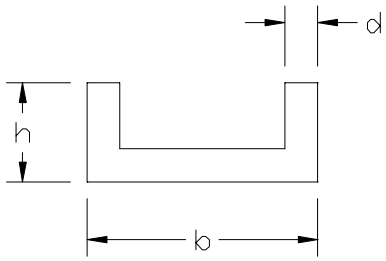


Fig. 13 U-profile

The pipe clamp on the supports should have a large surface area contact with the support and process pipe. No rubber, plastic or other material should be installed between the clamp and process pipe. The transducer should be supported and clamped free of tension on either side of the flanges as illustrated. The clamps should be equidistant and as close to the flanges as possible.

Do not mount supports on flanges or on the housing.

Process pipes on either side of the transducer should be axially aligned, and flanges should be parallel face to face within 0.4 mm (.016 in). the installation dimension (L) across the transducer flanges must be matched to the process pipe flanges within ± 2 mm (.079 in).

For long pipe runs additional pipe supports must be installed 1 to 2 transducer lengths (L) apart (fig. 14).

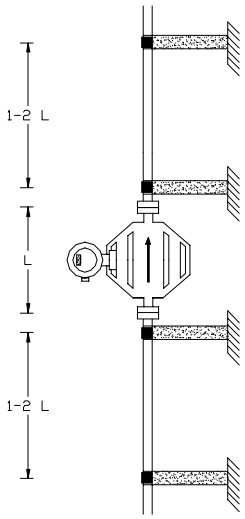


Fig. 14 Distance of additional supports

Reduction in Process Pipe
Use standard reducing connectors on process pipes when they are larger than transducer connection (fig. 15).

Fixing instructions mentioned previously must be followed.

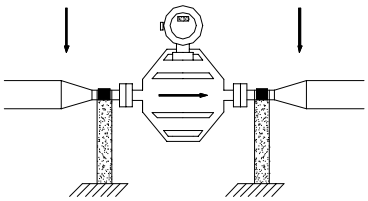


Fig. 15 Use of reducing connectors

Flexible Hoses
Generally flexible hoses should be avoided. In applications where vibration is excessive, flexible hoses can be used to de-couple the process from the transducer.

Some applications demand the use of flexible hoses and therefore the installation should comply with the diagram (fig. 16).

If in any doubt about the use of flexible hoses contact KROHNE prior to installation.

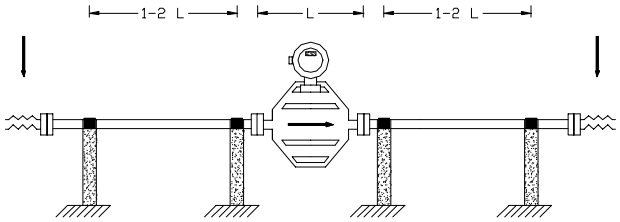


Fig. 16 Use of flexible hoses

Transport supports
Transport supports fitted to larger meters are ***not*** to be used for fixing the transducer in the pipeline (fig. 17).

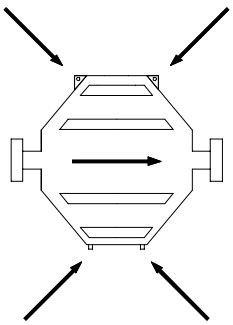


Fig. 17: Do not use transport supports for mounting

Requirement for Zero Adjustment
A shut-off valve should be installed downstream of the transducer.
Tight shut-off is important (fig. 18).

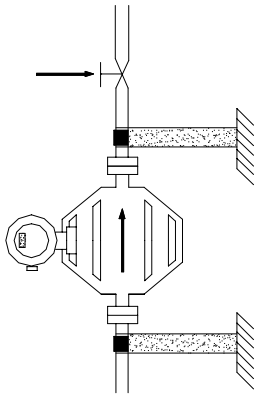


Fig. 18 Shut-off valve downstream of the transducer

For best zero adjustment the meter can be installed in a by-pass arrangement as shown in the diagram (fig. 19).
All peripheral devices can be active under operating conditions and the process flow must not be shut off.

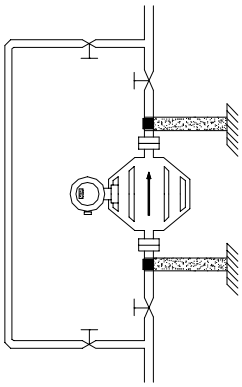


Fig. 19 By-pass installation for best Zero Adjustment

2.2.3 Special remarks on the MFS 3000

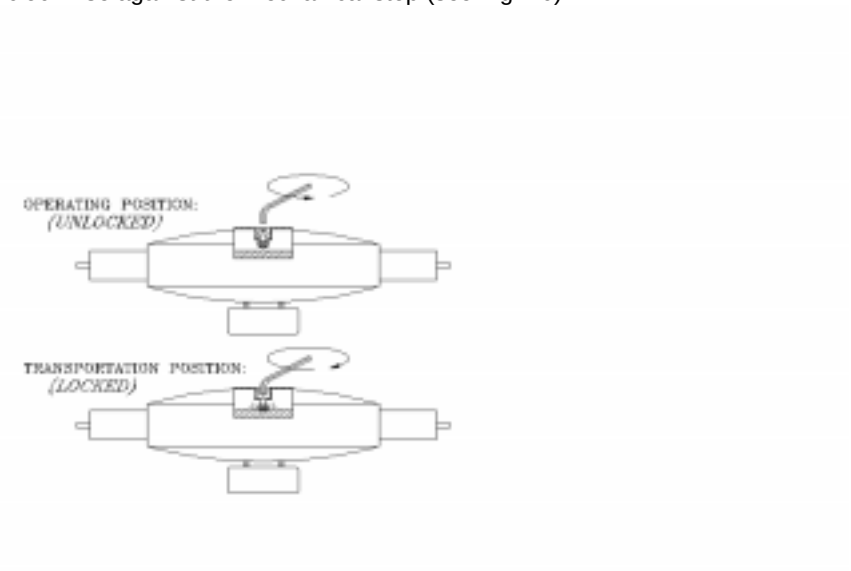
In order to guarantee the perfect function of the CORIMASS transducer MFS 3000 (even after poor transport conditions), the transducer is provided with a “Transport Safety Device”. The “Transport Safety Device” must be **inactive** for operation and **active** for transportation as follows:

Commissioning:

Before commissioning, the “Transport Safety Device” must be made *inactive* by turning the recessed Allen Screw (on reverse side of the instrument) anti-clockwise against the mechanical stop with a 6 mm Allen Key. In the case of the MFS 3000 - 30E two “Transport Safety Devices” are used, and both must be made inactive prior to commissioning (see Fig. 20).

Transport:

Before packing the unit for transport the “Transport Safety Device(s)” must be made *active* by turning clockwise against the mechanical stop (see Fig. 20).



Note: Models MFS 3000 - 0.3 E, 1.5 E, and 10 E are depicted above. Model MFS 3000 - 30 E has two transport locks (not shown) on the same side of the instrument as the single transport lock shown.

Fig. 20 Location “Transport Safety Device”

Flexible pipes or hoses can easily be connected at the permanently installed transducer.

When installing in a horizontal position, the transducer can also be turned 90° and mounted flat, as shown in Figure 21.

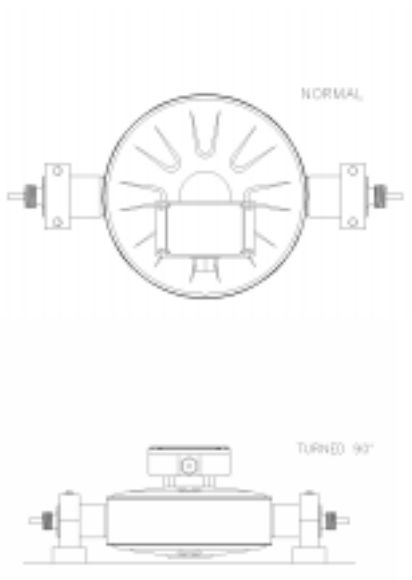


Fig. 21: Mounting variations for horizontal installation

Caution:
If the MFS 3000 transducers are operated in the flow direction contrary to that indicated by the arrow on the rating plate, the transducer constant GK may change by 0.15%

3. Electrical installation

3.1 Location and connecting cables

Location

Do not expose the compact flow meter to direct sunlight. Install a sunshade if necessary.

Connecting cables

To conform to protection category requirements, observe the following recommendations:

- Fit blanking plug PG 16 or 1/2" NPT and apply sealant to unused cable entries.
- Do not kink cables directly at cable entries.
- Provide water drip point (U bend in cable).
- Do not connect rigid conduit to cable entries. Use flexible conduit when required. Make sure conduit drains away from connection to converter and transducer.
- If cables are a tight fit, enlarge inside diameter of cable gland by removing the appropriate ring(s) from the seal.

3.2 Connection to power

Please ensure that the information about power given on the dataplate corresponds to the locally available mains voltage.

- Note information given on the instrument dataplate (voltage, frequency)!

- **Electrical connection in conformity with IEC 364** or equivalent national standard.

- Special regulations apply to installation in **hazardous areas**. Please refer to separate "Ex" installation instructions.

- The **PE protective ground conductor must** be connected to the separate U-clamp terminal in the terminal box of the signal converter.

- Do not cross or loop the **cables in the terminal box** of the signal converter. Use separate (PG or NPT) cable glands for power and output cables.

- Ensure that the **screw thread of the round cover** on the terminal box is well greased at all times.
  NOTE: The grease used must be non-corrosive to aluminium; typically it must be resin- and acid-free.

- Protect **sealing ring** from damage.

- See Figure 22 for the arrangement of power connections.

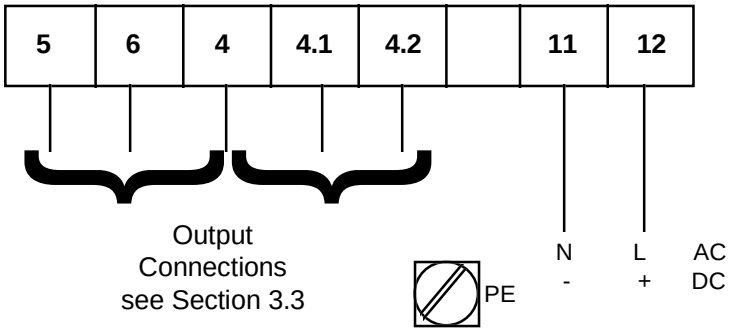


Figure 22: Power and signal connections for MFC 081 K / F

3.3 Inputs and outputs

The table below shows the input/output connection for the converter. The exact configuration depends on which optional output modules were fitted in the factory. The output options listed include presently available and planned options. See Figure 22 for the arrangement of converter connections. **Option 1 is normally supplied unless one of the other options is specifically ordered.**

Table of input/output connections

No.	Option 1 (Current, pulse, alarm and input)	Option 2* (2 current,NGI)	Option 3** (2 current,GI)
5	Common (-)	Common (-)	Current output 1 (-)
6	Current output (+)	Current output 1 (+)	Current output 1 (+)
4	Control input	Control input.	Current output2 (-)
4.1	Pulse output	Current output 2 (+)	Current output 2 (+)
4.2	Alarm output (active)	Alarm output (passive)	not used

* The inputs/outputs share a common signal ground which is galvanically isolated from ground (PE).

** Both current outputs are galvanically isolated from ground and each other.

For the standard converter, the pulse output is passive and requires an external voltage source for operation. In addition, the signal may need protection from external electrical interference. The use of screened cables and a filter capacitor next to any counter is recommended. (Fig. 23)

It is possible to connect the pulse output without using an external voltage supply. However to do this the function of the alarm output must be sacrificed. (Fig. 24).

If the alarm output is used to power the pulse signal, then the following settings **must** be made in the menus.

(i) Fct. 3.5.1 ALARM FUNCTION must be set to OFF

(ii) Fct. 3.5.2 ALARM ACTIVE LEVEL must be set to ACTIVE LOW.

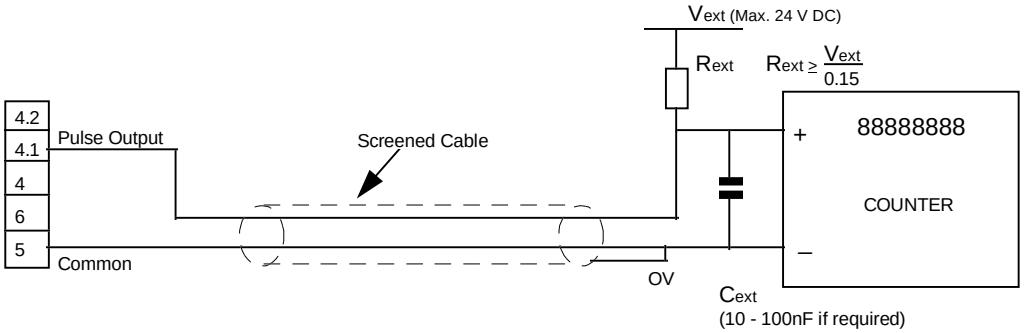


Fig. 23: Connection with external voltage source

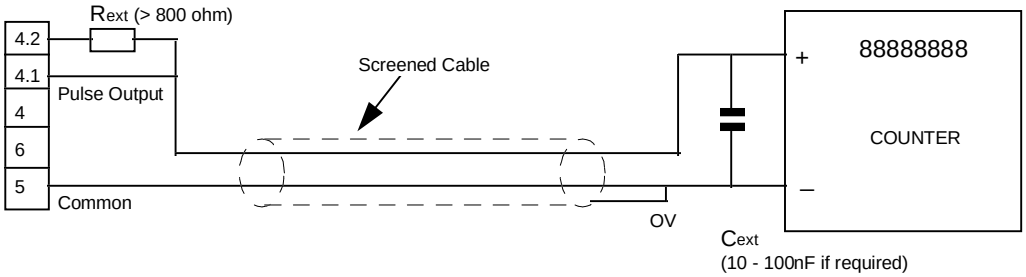


Fig. 24: Connection using converter internal voltage source

Additional input/output options

No.	Option 4 (2 current, pulse and input)	Option 5 (3 current and pulse)	Option 6 (3 current and input)	Option 7 (3 current and alarm	Option B* (Current and RS485)	Option C** (1 Current, 1 Dual phase pulse output and input)
5	Common (-)	Common (-)	Common (-)	Common (-)	Common (-)	Common (-)
6	Current output (+)	Current output 1 (+)	Current output 1 (+)	Current output 1 (+)	Current output 1 (+)	Current output 1 (+)
4	Current output 2 (+)	Current output 2 (+)	Current output 2 (+)	Current output 2 (+)	$\overline{TX}$/$\overline{RX}$	Control Input
4.1	Control Input	Current output 3 (+)	Current output 3 (+)	Current output 3 (+)	TX/RX	Pulse Output A
4.2	Pulse Output	Pulse output	Control Input	Alarm output (passive)	+5V	Pulse Output B

* Refer to separate RS 485 manual
** Refer to separate manual for this output option.

4. Start-up

4.1 Factory Set Parameters

The mass flowmeter leaves the factory ready to be used. All process data has been programmed according to the customer order. See factory programming sheet delivered with the flowmeter.

When no process details were supplied at the time of order, the mass flowmeter is programmed to a standard default set of values and functions.

The current and pulse outputs treat all flows as positive. The actual flow and quantity is thereby measured independent of the flow direction. The indicator will indicate a " – " or " + " in front of the flow rate.

These factory-set settings for current and pulse may cause an error under the following conditions: When the pump is stopped and a reverse flow is present, which is larger than the low flow cut-off or when totalizing should be indicated for both flow directions.

To avoid these possible problems:

a) Set flow mode (Fct. 3.1.8) to either flow > 0 or Flow < 0, so that back flows are ignored.
   or
b) Increase Low Flow cut-off (Fct. 3.1.7) so that small back flows are ignored.
   or
c) Set the alarm output (Fct. 3.5.1) to DIRECTION so that external equipment can differentiate between positive and negative flows.

4.2 Initial Start-up

- Please check that the power supply corresponds to the information supplied on the data plate.
- Switch on the power supply.
- On switch-on, the signal converter first carries out a self-test. The following sequence is displayed:

  TEST

  10 E **PX.XX**
  Primary Head Software Version

  STARTUP

  Mass flow will be displayed following a brief settling phase for the primary head.

  > A minimum warm-up time of 30 minutes is recommended to ensure stable measurement operation.

- For stable and accurate mass flow results the following should be checked:
  a) The quality of the mechanical installation. See Sect. 2.
  b) A good zero point calibration should be done. See Sect. 4.4. Further information regarding zero point calibration can be found in Sect. 5.

4.3 Installation factor

The extensive self-diagnosis functions of the MFM 2081 and MFM 3081 also include a so-called installation factor. This factor indicates whether the flow meter has been correctly installed in the pipeline. The installation factor should be checked during the initial start-up phase. The installation factor can be checked by way of the keystroke combination described in Section 5.

If correctly installed, the value of the installation factor when the primary head is full of water should be as per the table below. If the figure is higher, the specified accuracy of the flow meter cannot be guaranteed. Please check the installation again on the basis of the installation information (Sect. 2). If necessary adjust clamping with the meter displaying the installation factor to obtain optimum performance.

Primary Type	**Installation Factor**
MFM 2081 K/F	**< 50**
MFM 2081 K/F Ex	**< 100**
MFM 3081 K/F	**< 20**
MFM 3081 K/F Ex	**< 60**

4.4 Zero point adjustment

After installation adjust the zero point. To do this, the primary head must be completely filled with the liquid product **without gas or air inclusions**. This is best obtained by allowing the liquid product to flow through the primary head for approx. 2 minutes at a throughput rate of greater than 50% of rated flow. Subsequently ensure that flow comes to a complete stop in the primary head (see fig 10, Section 2.2.2) for setting the zero without interruption to product flow, use a bypass setup as shown in fig. 11 (Section 2.2.2).
Now initiate zero adjustment from measuring mode as described in Section 6.1.

Under certain conditions, it may not be possible to adjust the zero point:

- If the medium is in motion. Shut-off valves not tightly closed.
- If there are gaseous inclusions in the primary head. Flush the primary head and repeat the calibration.
- If resonant oscillations of the piping are interfering with the primary head. Check the clamping of the instrument.
- If there are active warning(s) in the status message list. (See section 5.6)

In such cases, the zero point adjustment procedure is automatically aborted and the following message is displayed for a short time:

ZERO.ERROR

Then the converter returns to the start of the Zero Set function 1.1.1:

Further information on zero point adjustment is given in Section 5.

The CORIMASS MFM 2081 and MFM 3081 are ready to operate after zero has been adjusted.

All parameters have been factory-set in keeping with the data specified in your order. Detailed information for further setting of the signal converter will be found in Part B of the operating instructions.

4.5 Programming the converter with a bar magnet

- The converter can be programmed by means of the magnetic sensors mounted on the face plate without removing the front lid (see Fig. 25).
- To do this, a bar magnet (standard supply) is used to activate the sensors by holding the magnet close to the glass window of the housing lid.
- These sensors then duplicate the functions of the push buttons.

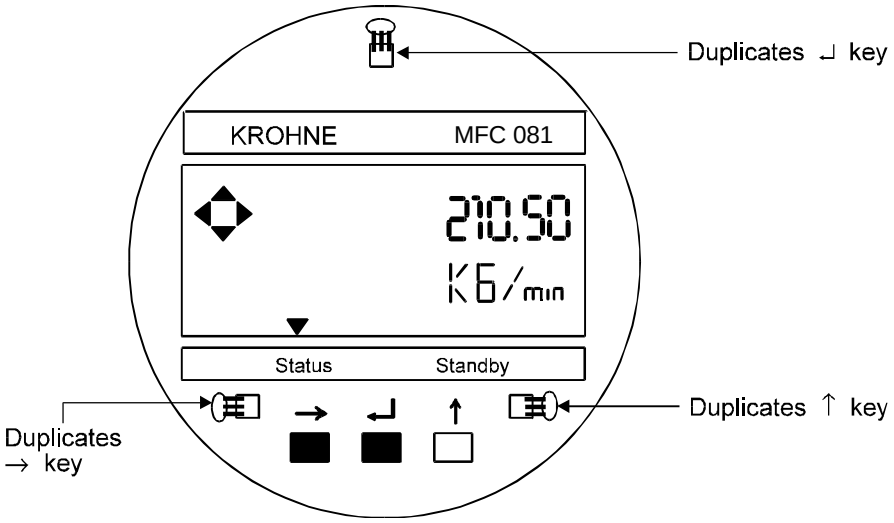


Fig. 25: Magnetic sensor locations on MFC 081 face plate

CAUTION:
For previous software versions P2.14 to P2.18, the maximum connecting cable length between transducer (primary head) and MFC 081 F signal converter is 5 meters (16.25 feet). Previous software version R2.18 and this version, P2.20, permit longer cable lengths up to 100 meters (328 feet), unless limited by CE and/or hazardous location requirements. Also note that software versions R2.18 and P2.20 have hardware changes in the MFC 081 converter, as compared to converters incorporating earlier software versions.

4.6 Installation of the Converter MFC 081 F

In the compact version the converter is mounted directly onto the transducer.

In the separate version MFC 081 F (remote mounted) it has to be noticed that the readability of the display depends on the lighting and the viewing angle. It should, therefore, be installed at eye-level and in good lighting conditions but not exposed to direct sunlight. Refer to Section D for dimensions of the MFC 081 converter.

Because of the rotatable housing it is easy to connect the wires for the power supply and the input and outputs.

The installation of the power supply wiring must comply with local Electrical Codes.

4.7 Connection of Remote Mounted Version

The BTS 12L signal cable is specifically for CORIMASS remote mounted versions and must be used to assure proper operation. This cable must be connected as described below. The color of the outer sheath is black for all standard instruments. For instruments located in hazardous areas, the cable sheath may be blue or black depending upon the specific electrical classification and the approval agency (PTB, FM, etc.). Figure 26 shows a cross-section of the BTS 12 L cable. Please note that not all conductors are used in the MFM 2081 / 3081 F application. Figures 27 through 30 depict the connection of this cable to the transducer and converter.

Minimum bend radius of cable should be 24 cm (10 inches). The cable must be fixed carefully in the vicinity of the transducer to avoid resonant vibrations of the cable. Also, all screws in the terminal boxes and covers should be securely fastened.

Maximum cable length is dependant upon software version and may also be limited by CE requirements or local requirements for hazardous locations.

CAUTION:
When blue cable is required for hazardous duty installations, it is an essential part of the approval. For other cables the hazardous duty protection approval is not valid.
Furthermore the ground terminals located on the transducers should be connected to the potential compensator for the hazardous area.

CAUTION:
For applications where CE approval is required, the supplied signal cable fittings must be properly installed to provide less than 1 milliohm contact resistance between the cable overall shield and the fitting body.

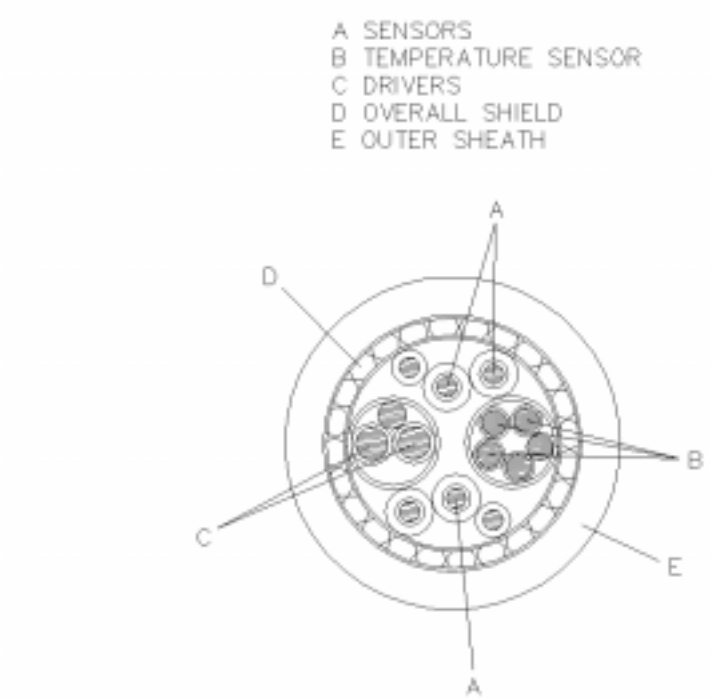
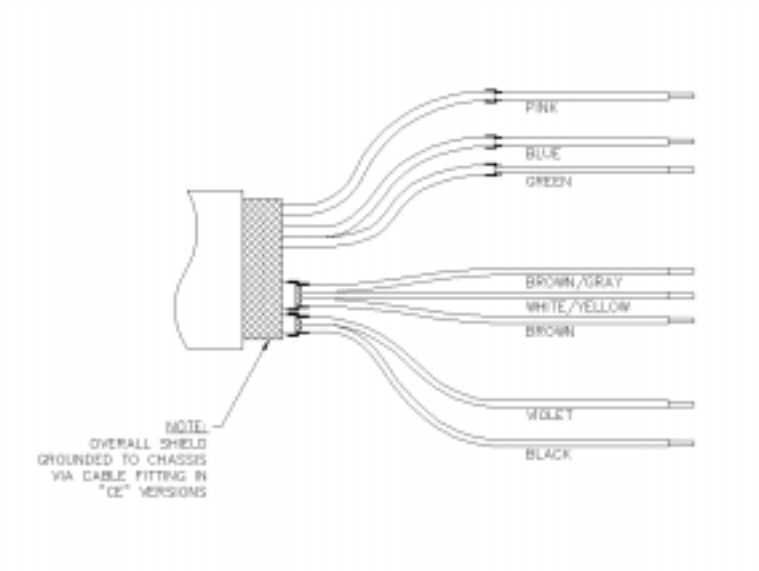
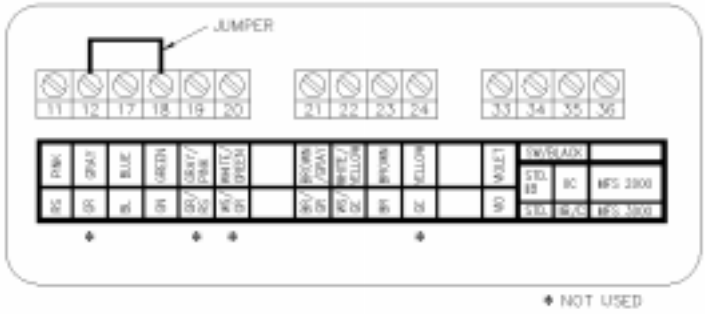


Fig. 26: BTS 12 L Signal cable cross-section



Note: On the transducer cable end individual shields are not connected and should not protrude from under the shrink tubing.

Fig. 27: Signal cable terminations - transducer end



For MFM 2081 F, the black wire should be connected to terminal 34 for standard and EEx ib II B applications, or to 35 for EEx ib II C applications

For MFM 3081 F, the black wire should be connected to terminal 34 for standard applications, or to terminal 35 for EEx ib II C applications

Fig. 28: Transducer terminal box connections

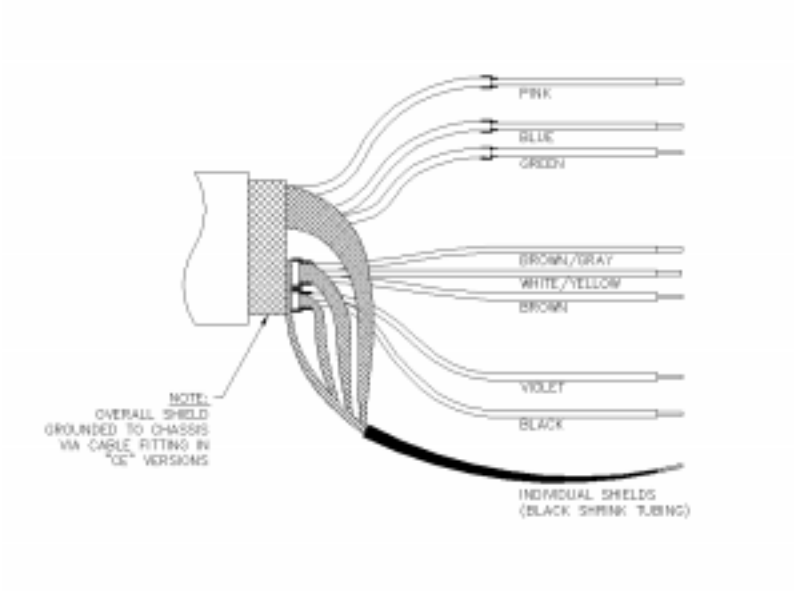


Fig. 29: Signal cable terminations - converter end

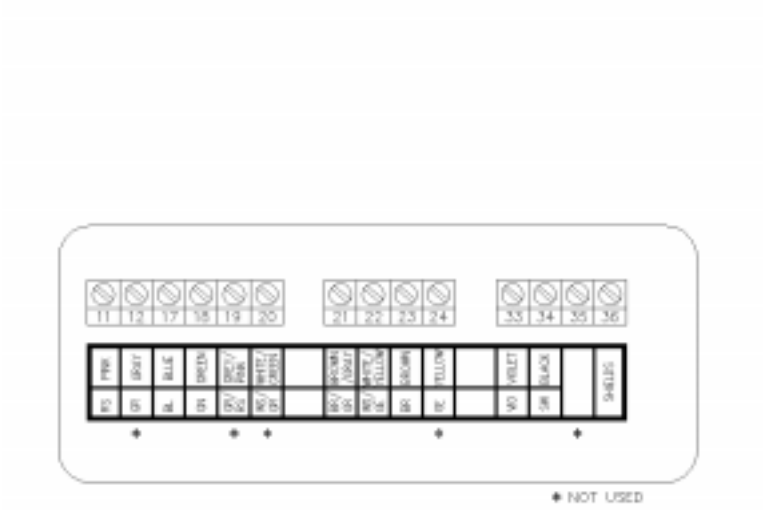


Fig. 30: Converter terminal box connections

Designation of terminals in the Converter Terminal Box:

11	Sensor A +	pink
12	not connected	-
17	Sensor B +	blue
18	Sensor B –, A –	green
19	not connected	-
20	not connected	-
21	Temperature Sensor V –	brown/grey
22	Temperature Sensor I +, V +	yellow/white
23	Temp. I –	brown
24	not connected	-
33	Exciter +	violet
34	Exciter –	black
36	Chassis Signal Shield	black (shrink)
	FITTING OVERALL SHIELD	

Designation of terminals in the Transducer Terminal Box:

11	Sensor A +	pink
12	Sensor A -	jumper to 18
17	Sensor B +	blue
18	Sensor B –	green / jumper to 12
19	not connected	-
20	not connected	-
21	Temperature Sensor V –	brown/grey
22	Temperature Sensor I +, V +	yellow/white
23	Temp. I –	brown
24	not connected	-
33	Exciter + (MFS 2000 - All) (MFS 3000 - All)	violet
34	Exciter – (MFS 2000 - Standard and EEx ib II B) (MFS 3000 - Standard)	black
35	Exciter – (MFS 2000 - EEx ib II C) (MFS 3000 - EEx ib II C)	black (alternate)
	FITTING OVERALL SHIELD	

For applicaitons where CE approval is required, the BTS 12 L cable is prepared by Krohne to the required length, ready for installation. For non-CE applications, the cable provided may be prepared only at the converter end to permit the customer to more easily route the cable during installation, and tailor the length as needed. In these cases, the transducer end of the signal cable will need to be prepared by the customer using the parts in the kit provided with the cable. The kit contains the following items:

Connector Sleeves:
- (2) - 1 mm^2 for violet and black wire ends
- (6) - 0.5 mm^2 for remaining wire ends

Shrink Tubes:
- (1) - 35 mm long, ϕ12 mm (A)
- (2) - 15 mm long, ϕ 6 mm (B)
- (3) - 15 mm long, ϕ 3 mm (C)

Connector sleeves are to be crimped on to the wire ends indicated and shrink tubes A, B, and C are to be installed as shown in Figure 31. Unused conductors should be cut back cleanly to avoid interference with the active conductors and shields.

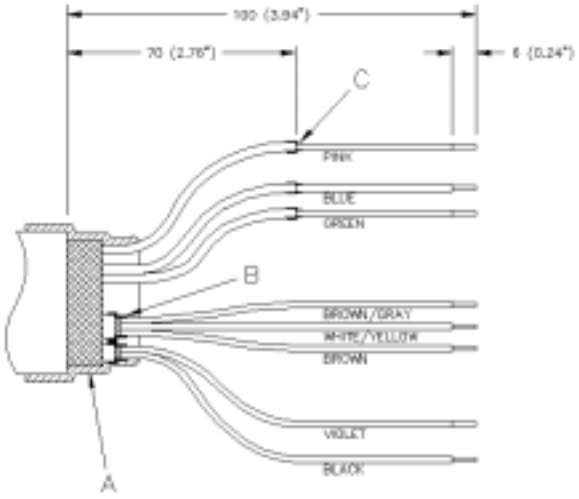
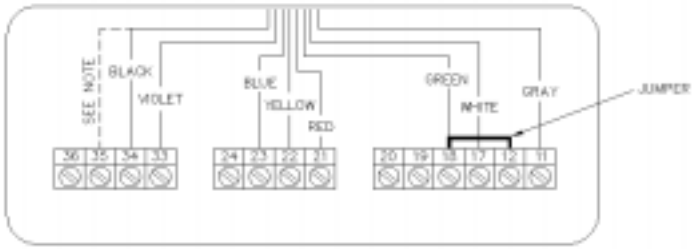


Figure 31: Stripping lengths and shrink tube locations for BTS 12 L signal cable - transducer end

4.8 Connection diagram of compact version

The connection converter - transducer of the compact version will be carried out by the manufacturer. A reconnection is only required in the case of a defective cable between terminals and electronics module. You can see the connection of the converter cable in the terminal box at Figure 32.



Note:

MFM 2081 K
Black to 34 for Standard and EEx ib II B
Black to 35 for EEx ib II C
MFM 3081 K
Black to 34 for Standard
Black to 35 for EEx ib II C

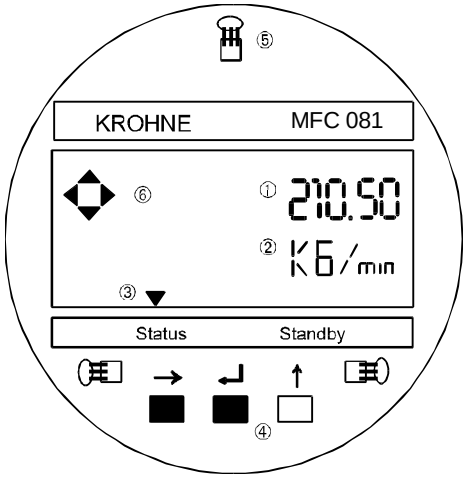
Fig. 32: Connection compact version

5. Operation of the Signal converter

5.1 Operating and check elements

The operating elements are accessible after removing the cover of the electronics section using the special wrench. The converter is also programmable with magnetic sensors and a bar magnet without removing the covers of the electronic housing.

Caution: Do not damage the screw thread and the gasket, never allow dirt to accumulate, and make sure they are well greased at all times.



① Display 1st (top) line.
② Display 2nd (middle) line.
③ Display 3rd (bottom) line, arrows (▼) to identify the state of the signal converter:
- **Status** message indicator
- **Standby** mode.

④ Keys for operator control of the signal converter.
⑤ Magnetic sensors to set the converter by means of a handheld bar magnet without opening the housing. Function of sensors same as keys 4 .
⑥ Compass field, signals actuation of a key.

The operator control concept consists of three levels (horizontal). See next page.

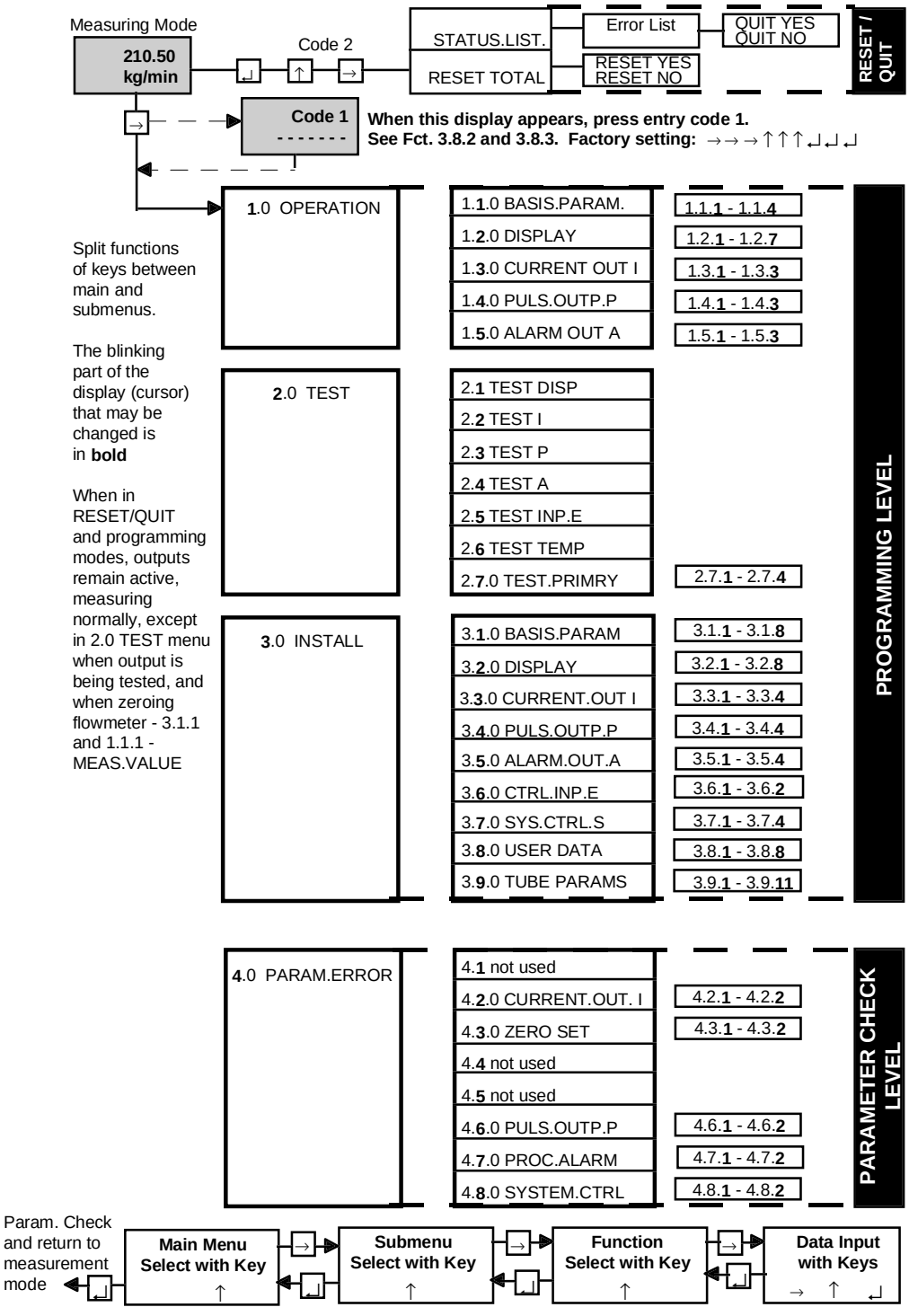
Setting level: This level is divided into three main menus:
Fct. 1.0 OPERATION: This menu contains only the most important parameters and functions of Menu 3 (install) to allow rapid changes to be made during the measurement mode.
Fct. 2.0 TEST: Test menu for checking the signal converter (displays, outputs, measuring range), and the primary (transducer) operation.
Fct. 3.0 INSTALL: All flow measurement- and flowmeter-specific parameters and functions can be set in this menu.

Parameter check level: **Fct. 4.0 PARAM.ERROR**: This level is not selectable.
After exiting from the "Setting level", the signal converter checks new data for plausibility. If an error is detected, the signal converter indicates PARAM.ERROR in Fct. 4.0. In this menu, all functions can be scanned and those changed that are not "plausible".

Reset/acknowledge level (Quit): This menu has two tasks and is selected via Entry Code 2 (↵ ↑ →)

1) Resetting of totalizer, provided that resetting is enabled under Fct. 3.8.5 ENABL.RESET, input YES.
2) Status message and acknowledgement (Quit) messages that have occurred since the last acknowledgement are indicated in a list. After elimination of the cause(s) and acknowledgement, these messages are deleted from the list.

5.2 Krohne Operating Concept



5.3 Key functions

Before pressing any keys on the MFC 081 converter, it should be noted that outputs remain in the Measurement Mode (outputs are actively measuring) even when the converter is placed in the Programming Mode with the following exceptions:

- when in the TEST menu (2.0) and actually testing an output.
- after having modified and accepted a parameter which will cause a given output to change, eg. changing the range.
- when zeroing (1.1.1 and 3.1.1) using the MEASURE. VALUE parameter at which time the flow must be shut off. The output associated with the flow rate defaults to its minimum range value (0 or 4 mA, whichever is programmed) during zeroing. When using SET VALUE, the output remains active, changing only by the SET VALUE once it is accepted.

Function of the keys	
Cursor	The location of the cursor on the display is indicated by flashing characters. This could be a single digit when entering number; numeric sign (+ or -) ; measurement units (g,kg,t etc.); or any other text field. Throughout this manual the location of the cursor, in programming examples, will be indicated by parentheses ( ) around the flashing characters.
↑	**Select** or **Up Key.** This key changes the field/digit under the cursor. - Digit: Increase value by 1 for each key press. (0 follows 9). - Dec. pt. Move decimal point. **0000(.)0000** changes to **00000(.)000** - Menu Increase menu number by 1. i.e. **Fct. 1.(1).0** changes to **Fct. 1.(2).0** When the menu number reaches its maximum the next ↑ changes the number to 1. i.e. **Fct 1.(5).0** changes to **Fct 1.(1).0** - Text Change text field. i.e. “YES” to “NO” or “g” to “kg” to “t” etc. - Sign Toggle “+” to “-”
→	**Cursor** or **Right Key.** This key moves the cursor onto the next field to be edited. (usually the next on the right). - Number Move cursor from 12(3).50 to 123(.)50 to 123.(5)0 - Text Move to next field. i.e. **(kg)/min** to **kg/(min)** - Menu Move to next menu column: i.e. from **Fct 1.(2).0** to **Fct. 1.2.(1)** **or** if the cursor is already in the rightmost column: invoke that menu function. i.e. from **Fct. 1.2.(1)** press → to edit MASS FLOW format.
↵	**Accept** or **Enter Key.**
	-Within a function Accept changes (if any) and exit the function. -Menu Move cursor to the next column on the left. i.e. from **Fct. 1.2.(1)** back to **Fct. 1.(2).0** If the cursor is already in the leftmost column then ↵ exits the menus. See next box: “To terminate” .
Note:	If numerical values are set that are outside the permissible input range, the display shows the min. or max. . acceptable value. After pressing the ↵ the number may be corrected.

5.3.1 How to enter programming mode

To start:		
	Display	Comments
→ Press	Fct. 1.0 Operation **or**	If this appears, see previous box: “Function of the keys ” .
	CodE 1 ---------	If this appears on the display, set the 9-keystroke **Entry CodE 1** . Factory setting: → → → ↵ ↵ ↵ ↑ ↑ ↑
1st- 8thplace (key)	CodE 1 ********-	Each keystroke acknowledged by " ∗ " in display.
9th place (key)	Fct. 1.0 Operation	If this appears, see box: “Function of the keys ” on previous page.
	CodE 1 (9 alpha characters)	A wrong Entry CodE 1 was keyed in. Press any key and set the correct 9-keystroke

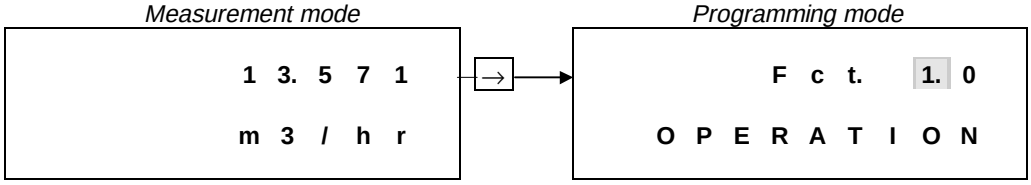
5.3.2 How to terminate Programming mode

To terminate:		
Press ↵ 1-3 times	Fct (1).0 OPERATOR	Press ↵ 1-3 times until the cursor is under the extreme left menu column. (Fct. 1.0 , 2.0 or 3.0)
↵	+ 12.345 kg/min **or**	If no changes have been made to the system’s configuration return directly to the measurement mode.
	(ACCEPT YES)	Changes have been detected. Press ↵ to accept these changes. **or**
↑	(ACCEPT NO)	Press ↵ to reject changes and return directly to measurement mode. **or**
↑	(GO BACK)	Press ↵ to return to the menus, Fct. 1.(0) to make further changes
↵	PARAM.CHECK	Assuming ACCEPT YES was selected, the system now checks the new setting for errors.
After 1-2 sec.	+ 12.345 kg/min	No errors detected. Return to measurement mode.
	or	
	Fct. (4).0 PARAM.ERROR	Errors were detected. The sub-menus of 4.0 will guide the operator to those functions where problems have been identified.

Examples

The cursor (flashing part of display) has a grey background in the following examples:

To start programming



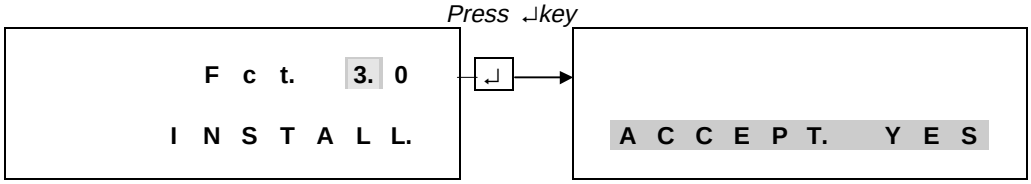
PLEASE NOTE: When "**yes**" is set under **Fct. 3.8.2 ENTRY CODE**, the following will appear in the display after pressing the → key:

CodE 1 - - - - - - - - -.

The 9-stroke entry code must now be entered.
Factory setting: → → → ↵ ↵ ↵ ↑ ↑ ↑.
Each keystroke is acknowledged by an " ∗ " in the display.

To terminate programming

Press ↵ key repeatedly until one of the following menus are displayed:
Fct. 1.0 OPERATION, Fct. 2.0 TEST or Fct. 3.0 INSTALL



To accept the new parameters
Press ↵ to confirm.
"PARAM.CHECK" will appear in the display.

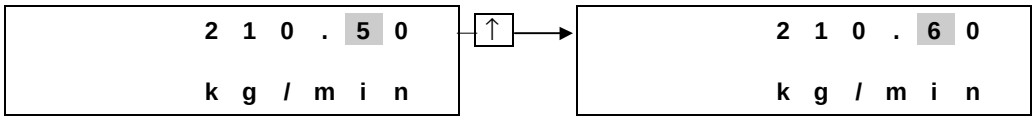
The measuring mode will continue after a few seconds with the new parameters, when no errors are detected.

When an error is detected the display will indicate "Fct. 4.0 PARAM.ERROR". The error parameters can be called up in this menu and corrected.

New parameters not to be accepted
When the new parameters are not to be accepted, the following keystrokes should be executed: Press ↑ key. The display will show "ACCEPT NO". When the ↵ key is then pressed, the instrument will return to the measurement mode using the old parameters.

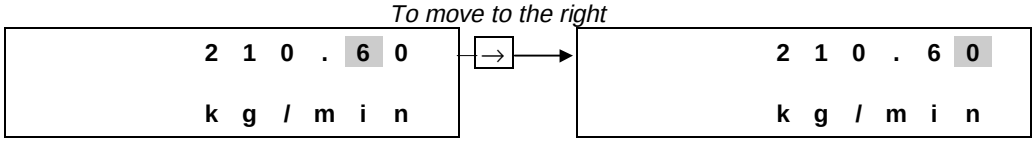
To change numeric values

Increase numeric value



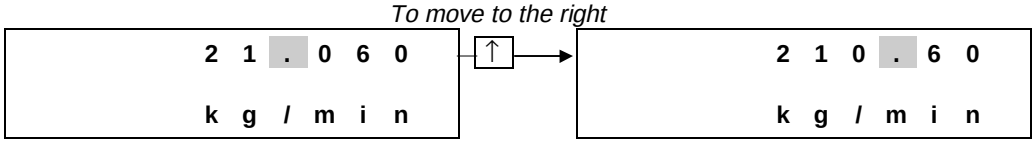
To move the cursor (flashing digit)

To move to the right



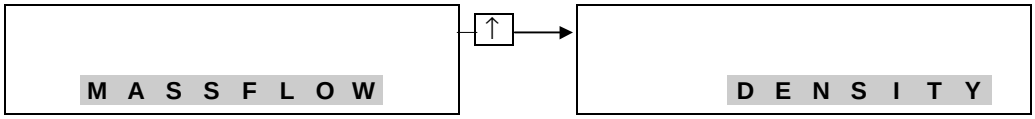
To move the decimal point

To move to the right



To change the text

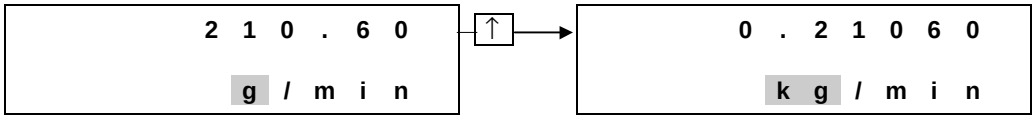
Select next text



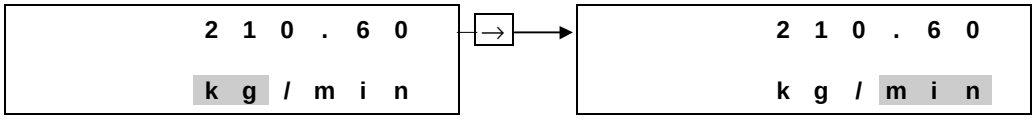
To change the units

Numeric values automatically converted

Select new unit

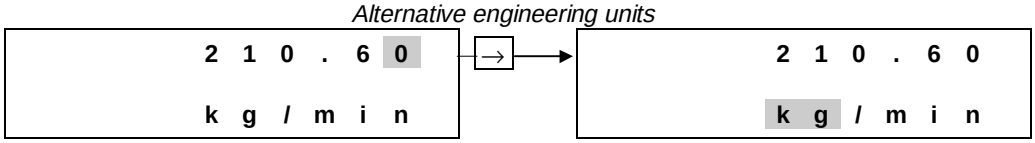


Alternative time unit

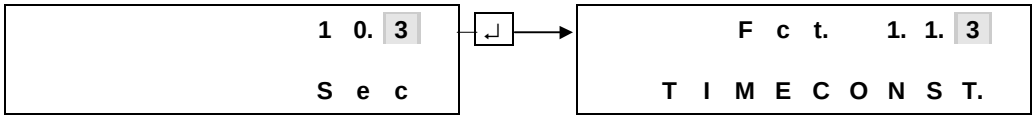


To change from numeric values back to text

Alternative engineering units



Return to function display



5.4 Table of programmable functions

Fct. No.	Text	Description and settings
1.0	**OPERATION**	**Main menu 1.0 Operation**
1.1.0	BASIS.PARAM	**Submenu 1.1.0 Base data**
1.1.1	ZERO SET	**Zero adjustment.** See Fct. 3.1.1
1.1.2	L.F. CUTOFF	**Low flow cutoff.** See Fct. 3.1.2
1.1.3	TIME CONST.	**Signal converter time constant.** See Fct. 3.1.3
1.1.4	STANDBY	**Switching between measuring operation and standby**. See Fct. 3.1.4
1.2.0	DISPLAY	**Submenu 1.2.0 Display**
1.2.1	CYCL.DISP	**Switching between steady display and cyclic display**
1.2.2	STATUS MSG	**Selects which status messages should be displayed**
1.2.3	MASS FLOW	**Unit for mass flow**. See Fct. 3.2.3
1.2.4	MASS TOTAL	**Unit for mass total.** See Fct. 3.2.4
1.2.5	DENSITY	**Unit for density.** see Fct. 3.2.5
1.2.6	TEMPERAT	**Unit for temperature.** see Fct. 3.2.6
1.2.7	VOLUME.FLOW	**Unit for volume flow.** See Fct. 3.2.7
1.2.8	VOLUME.TOTAL	**Unit for volume total.** See Fct. 3.2.8
1.2.9	CONC.MEAS	**Parameters for concentration measurement.** See separate concentration measurement instruction manual
1.2.10	CONC.MEAS	See 1.2.9
1.2.11	CONC.MEAS	See 1.2.9
1.3.0	CUR.OUTP. I	**Submenu 1.3.0 Current output I.**
1.3.1	FUNCTION I	**Function current output I.** see Fct. 3.3.1
1.3.2	MIN.VALUE*	**Minimum range for current output I** see Fct. 3.3.3
1.3.3	MAX.VALUE*	**Maximum range for current output I** see Fct. 3.3.4
1.4.0	PULS.OUTP. P	**Submenu 1.4.0 Pulse,** frequency output **P.** see Fct. 3.4.0
1.4.1	FUNCTION P	**Select. Parameter to be totalized**
1.4.2	PULSE/MASS *	**Select. Pulse per unit**
1.4.3	PULSE WIDTH *	**Select pulse width in milliseconds**
1.5.0	ALARM.OUT.A	**Submenu 1.5.0 Process alarm output A.** see Fct. 3.5.0
1.5.1	FUNCTION A	**Select alarm function.** See Fct. 3.5.1
1.5.2	ACTIV.LEVEL	**Select. active high or low.** See Fct. 3.5.2

* Exact display depends on selected function. See sub-menu 3.3.0

Fct. No.	Text	Description and settings
2.0	TEST	**Main Menu 2.0. Test functions**
2.1	TEST DISP.	**Carry out display test.** Start with the key → (Duration of test approx. 30 sec.). Stop test at any time with the ↵ key.
2.2	TEST I	**Test current output I** * SURE (NO). Use the ↑ key to select YES, then press ↵. * 0 mA will be output from the converter. Use the ↑ key to select test currents from the list below. 0 mA, 2 mA, 4 mA, 10 mA, 16mA, 20 mA, 22 mA. To exit test mode, press the ↵ key at any time.
2.3	TEST P	**Test frequency output P** * SURE (NO). Use the ↑ key to select YES ,then press ↵ key.
2.3.1	FREQUENCY	* LEVEL LOW 0 volt DC level will be output from the converter. Use the ↑ key to select test signals from the list below. * LEVEL HIGH (+ V volts dc) * 1 Hz * 100 Hz * 10 Hz *1000 Hz
2.3.2	TEST PULSE	* Test Pulse Use the ↑ key to select desired pulse width from the list below: ∗ 0.4 mSec ∗ 100.0 mSec ∗ 1.0 mSec ∗ 500.0 mSec ∗ 10.0 mSec Then press ↵. The system now sends pulses of the required width. To stop the test press ↵ twice.
2.4	TEST A	**Test alarm output** * SURE (NO). Use the ↑ key to select YES, then press ↵ * LEVEL LOW. 0 Volts is output on the alarm terminal. Press the ↑ key to switch output to: * LEVEL HIGH . +24V dc is output on the alarm terminal. To exit test mode, press the ↵ key at any time.
2.5	TEST INP.E	**Test control input** The actual input level, HI or LO, and the selected functions are displayed see Fct. 3.6.1 End test by pressing the ↵ key.
2.6	TEST TEMP.	**Test temperature** Start with the → key. The temperature in °C is displayed. Use the ↑ key to display the temperature in °F. End the test by pressing ↵ key
2.7.0	TEST.PRIMRY.	**Sub menu 2.7.0 Test primary head values.**
2.7.1	SENSOR A	**Monitor the amplitudes of sensor A and B as percentage of their max. value. (80% is ideal)** Start test with the → key. End the test with the ↵ key.
2.7.2	SENSOR B	
2.7.3	FREQUENCY	**Monitor the primary head frequency.** Start test with the → key. End the test with the ↵ key.
2.7.4	INSTAL.FACT.	**Monitor the primary head's drive level.** Start test with the → key. End test with the ↵ key.

Fct. No.	Text	Description and settings
3.0	INSTALL.	**Main menu 3.0 Installation**
3.1.0	BASIS.PARAM	**Submenu 3.1.0 Base data**
3.1.1	ZERO SET	**Zero adjustment.** Use the ↑ key to select between MEASURE.VAL. and SET VALUE then press the ↵ key. * MEAS.VALUE (ensure "ZERO" flow in the pipeline) 1) Select: CALIB.YES or NO 2) If YES: Calibration (approx. 20 sec. duration) Display: Actual flow rate as percent of the maximum rated flow for the primary head. ($Q_{100\%}$) 3) Select: ACCEPT YES or NO * SET.VALUE Direct input of a zero flow offset. Units: As selected by Fct. 1.2.1 or 3.2.1
3.1.2	L.F. CUTOFF	**Low flow cutoff** Value: 0 to 10 percent of nominal flow
3.1.3	TIME CONST.	**Time constant for output of measured values** Range 0.5 ... 20 sec. (Option: 0,2 ... 20 sec.)
3.1.4	STANDBY	**Use the key ↑ to switch between three modes of operation**, then press ↵: * MEASURE * STANDBY (tube vibrating, Mass Flow set to zero) * STOP (tube drive stopped) Note: It is not possible to switch directly from STOP to STANDBY.
3.1.5	PRIMRY.TYPE	**Type of the primary head **** Using the ↑ key select the primary head type that is connected to the converter: * 1.5 E * 10 P * 800 P * 10 E * 60 P * 1500 P * 30 E * 300 P
3.1.6	CF5	**Primary head constant. **** Displays the primary head constant as stamped on the primary head's data plate.
3.1.7	FLOW DIR.	**Define direction of flow.** Select either FORWARD or BACKWARD
3.1.8	FLOW MODE	**Define whether bi-directional or uni-directional flow is expected.** Select either: * FLOW > 0 (Ignore negative flows) * FLOW < 0 (Ignore positive flows) * FLOW +/- (Allow positive and negative flows)

** These menus are protected by the Code 4 password, see Fct. 3.8.8

Fct. No.	Text	Description and settings
3.2.0	DISPLAY	**Submenu 3.2.0 DISPLAY**
3.2.1	CYCL. DISP.	**Cyclic display required?** Setting NO or YES. If YES is selected then in measurement mode the display will switch from Mass Flow to Density to Total to Temperature every 4 seconds.
3.2.2	STATUS MSG.	**Which status messages to be displayed ?** * NO MESSAGE (= no warning messages in main display, warning system ignores status of outputs) * PRIMRY.HEAD (= light warning messages in the main display, warning system ignores status of outputs) * OUTPUT (= output saturation/alarm status messages in the main display) * ALL MSG. (= all warning messages in the main display. System responds to output status)
3.2.3	MASS FLOW	**Units and format for mass flow display** * g, kg, t, oz, lb per s, min, h, d * Number of digits after the decimal point selectable.
3.2.4	MASS TOTAL	**Units and format for totaliser** * g, kg, t, oz, lb * Number of digits after the decimal point selectable.
3.2.5	DENSITY	**Units and format for density*** * g, kg, t, per cm^3, dm^3, litre, m^3 or oz, lb per in^3 ,ft^3 , USgal, gallon or SG (Specific Gravity relative to water at 20°C) * Number of digits after the decimal point selectable.
3.2.6	TEMPERAT.	**Units for temperature** * °C or °F * Format fixed at 1 decimal place
3.2.7	VOLUME.FLOW	**Units and format for volume flow** * Select OFF (no volume flow display) or * cm^3, dm^3, litre, m^3 , in^3 ,ft^3 , USgal, or gallon per * s, min, hr, day * Number of digits after the decimal point selectable.
3.2.8	VOL.TOTAL	Units and format for totalizer cm^3, dm^3, liter, m^3, $inch^3$, ft^3, US gal, gallon.
3.2.9 to 3.2.11		Concentration menu when installed. Please refer to separate Concentration instruction manual

* See Section 6.13 for special density functions: Specific Gravity, Referred Density (option), and Fixed Density (option).

Fct. No.	Text	Description and settings
3.3.0	CUR.OUTP. I	**Submenu Current output I** For systems with 2 or more current outputs see Sect. 5.7
3.3.1	FUNCTION I	**Function current output I** * OFF (O/P current = 0 mA) * MASS FLOW (Mass flow in range MIN [Fct. 3.3.3] to MAX [Fct. 3.3.4] output as current in range [Fct 3.3.2] 0/4-20mA) * DENSITY (Density in range MIN [Fct. 3.3.3] to MAX [Fct. 3.3.4] output as current in range [Fct 3.3.2] 0/4-20 mA) * TEMPERAT. (Temperature in range MIN [Fct. 3.3.3] to MAX [Fct. 3.3.4] output as current in range [Fct 3.3.2] 0/4-20 mA) * VOLUME.FLOW (Volume flow in range MIN [Fct. 3.3.3] to MAX [Fct. 3.3.4] output as current in range [Fct 3.3.2] 0/4-20 mA) Solute flow Conc. by mass } Concentration measurement functions available if installed (see sep. instruction manual). Conc. by volume * DIRECTION (Negative flow gives current of 0/4 mA, positive flow gives current of 20 mA)
3.3.2	RANGE I	**Range for current output I:** Select from the following by pressing ↑ key and then ↵ key * 0-20 mA * 4-20 mA * 0-20/22 mA (O/P = 22 mA when error detected) * 2/4-20 mA (O/P = 2 mA when error detected) * 3.5/4-20 mA (O/P = 3.5 mA when error detected)
3.3.3 or or or or or	MIN.VALUE MIN. FLOW, MIN. DENSITY MIN. TEMP. MIN V.FLOW CONC.OPTIONS	**Value of measured quantity** as set by Fct. 3.3.1 that corresponds to the minimum output current (0 or 4 mA as set by 3.3.2) Menu not available if Function 3.3.1 is set to OFF or DIRECTION
3.3.4 or or or or or	MAX.VALUE MAX. FLOW, MAX. DENSITY, MAX TEMP MAX V.FLOW CONC.OPTIONS	**Value of measured quantity** as set by Fct. 3.3.1 that corresponds to an output current of 20 mA Menu not available if Function 3.3.1 is set to OFF or DIRECTION

Fct. No.	Text	Description and settings
3.4.0	PULS.OUTP. P	**Submenu 3.4.0 Frequency output P**
3.4.1	FUNCTION P	**Function frequency output P** * OFF (Output = 0V DC) * MASS FLOW (Frequency output 0 to MAX Freq. Hz = Mass Flow in range: MIN. FLOW to MAX FLOW as set in Fct. 3.4.3 and 3.4.4) * MASS TOTAL(1 pulse = fixed mass as set in Fct 3.4.2) * DENSITY (Frequency output 0 to MAX Freq. Hz = Density in range: MIN.DENSITY to MAX.DENSITY as set in Fct. 3.4.3 and 3.4.4) * TEMPERAT. (Frequency output 0 to MAX Freq. Hz = Temperature in range: MIN. TEMP to MAX. TEMP as set in Fct. 3.4.3 and 3.4.4) * VOLUME.FLOW(Frequency output 0 to MAX Freq. Hz = Volume flow in range: MIN. V.FLOW to MAX. V.FLOW as set in Fct. 3.4.3 and Fct. 3.4.4) * VOL.TOTAL(1 pulse = fixed volume as set in Fct 3.4.2) Solute flow Solute total Conc. by mass Conc. by volume } Concentration parameters if option installed. See separate instruction manual. * DIRECTION (Negative flow gives output of 0 volts DC, Positive flow gives output of +V volts DC)
3.4.2 or or	PULSE/MASS PULSE/VOL. PULSE/TIME	**Mass per pulse value** for function TOTAL MASS **Volume per pulse value** for function VOL. TOTAL **Maximum frequency value** for functions MASS FLOW, DENSITY, TEMPERATUR and VOLUME.FLOW or CONC.OPTIONS. Not accessible for functions OFF and DIRECTION.
3.4.3 or or or or or or	MIN.VALUE MIN. FLOW, MIN. DENSITY, MIN. TEMP. MIN. V.FLOW CONC.OPTIONS PULSE.WIDTH	**Value of measured quantity that corresponds to 0 Hz output** For functions MASS TOTAL, VOL.TOTAL OR SOL.TOTAL. Not accessible for functions OFF and DIRECTIONS
3.4.4 or or or or or	Full Scale MAX. FLOW, MAX. DENSITY MAX TEMP. MAX V.FLOW CONC.OPTIONS	**Value of measured quantity that corresponds to Max. Frequency** Not accessible for functions OFF, DIRECTION, TOTAL MASS TOTAL, or VOL. TOTAL

Fct. No.	Text	Description and settings
3.5.0	ALARM.OUT.A	**Sub menu 3.5.0 Process alarm output**
3.5.1	FUNCTION A	**Function for alarm output P** * OFF (Output goes to its inactive state) * MASS FLOW (Alarm active if mass flow goes outside limits as set in Fcts. 3.5.3 and 3.5.4) * MASS TOTAL (Alarm active if totaliser goes outside limits as set in Fcts. 3.5.3 and 3.5.4) * DENSITY (Alarm active if density goes outside limits as set in Fcts. 3.5.3 and 3.5.4) * TEMPERAT. (Alarm active if temperature goes outside limits as set in Fcts. 3.5.3 and 3.5.4) * VOLUME.FLOW (Alarm active if volume flow go outside limits as set in Fcts. 3.5.3 and 3.5.4) * VOL.TOTAL (Alarm active ... Solute flow Conc. by mass Conc. by volume } Concentration option if installed. See separate instruction manual * I 1.SAT (Alarm active if value output on current output exceeds the range as set in Fct. 3.3.3 and 3.3.4) * P 1.SAT (Alarm active if value output on pulse output is either: > 1.3 x Max Limit as set in Fct 3.3.4 or < Min Limit as set in Fct 3.3.3 * ANY O/P.SAT (Alarm active if value output on either current or pulse output exceeds the selected ranges) * SEVERE ERR. (Output active if a severe error is detected) * ALL MSG. (Output active if any warnings occur) * DIRECTION (Output active for positive flows, inactive for negative flows)
3.5.2	ACTIV.LEVEL	**Select the desired voltage level for the active state** * ACTIVE.HIGH (24 V dc); INACTIVE LOW (0 Vdc) * ACTIVE LOW (0 V dc); INACTIVE HIGH (24 Vdc)
3.5.3	MIN. LIMIT or	**Minimum allowable value for functions** TOTAL MASS, MASS FLOW, DENSITY, TEMPERATUR and VOLUME.FLOW Units: depend on function but will correspond to those set in Fcts. 3.2.1 to 3.2.5 Not accessible for all other functions
3.5.4	MAX. LIMIT. or	**Maximum allowable value for functions** MASS TOTAL, MASS FLOW, DENSITY, TEMPERATUR and VOLUME.FLOW Units: depend on function but will correspond to those set in Fcts. 3.2.1 and 3.2.5 Not accessible for all other functions

Fct. No.	Text	Description and settings
3.6.0	CTRL.INP.E	**Submenu 3.6.0 Control input**
3.6.1	FUNCTION E	**Function of the control input** * OFF (control input inactive) * STANDBY (When active converter switches to STANDBY) * ZERO SET (Zero calibration triggered on the transition from inactive to active on the control input) * RESET TOTAL (Totaliser reset to zero on the transition from inactive to active on the control input) * CLEAR. MSG. (Status warnings cleared on the transition from inactive to active on the control input)
3.6.2	ACTIV.LEVEL	**Set the desired voltage level for the input to be active** * ACTIVE LOW (0 to 2 V) * ACTIVE.HIGH (4 to 24 V)
3.7.0	SYS.CTRL S	**Submenu 3.7.0 System control**
3.7.1	FUNCTION S	**Function for system control** * OFF (System control inactive) * FLOW = OFF (Mass flow readings forced to zero, totaliser frozen) * FLOW = 0/RST. (Mass flow readings forced to zero, totaliser frozen while active but reset to zero as condition becomes inactive. Not available with Custody Transfer Protection) * OUTPUTS OFF (Forces all outputs to their OFF states)
3.7.2	REFERENCE	**Condition for triggering the above function** * DENSITY (Function is triggered if density goes outside Max or Min limits as set in Fcts 3.7.3 and 3.7.4) * TEMPERATUR (Function is triggered if temperature goes outside Max or Min limits as set in Fct 3.7.3 and 3.7.4) Function not available with Custody Transfer Protection.
3.7.3	MIN. LIMIT.	**Minimum allowable value of temperature or density selected in Fct. 3.7.2** Units: depend on function but will correspond to those set in Fct. 3.2.1 and 3.2.5 Function not available with Custody Transfer Protection.
3.7.4	MAX. LIMIT.	**Maximum allowable value of temperature or density selected in Fct. 3.7.2** Units: depend on function but will correspond to those set in Fct. 3.2.1 and 3.2.5 Function not available with Custody Transfer Protection.

Fct. No.	Text	Description and settings
3.8.0	USER DATA	**Submenu 3.8.0 User data**
3.8.1	LANGUAGE	**Language for display text** * GB/USA (= English) * F (= French) * D (= German)
3.8.2	ENTRY.CODE1	**Entry code for accessing menus required?** * NO (Entry to menus with the → key only) * YES(Entry with → key and 9-keystroke code see Fct 3.8.3)
3.8.3	CODE 1	**Set Code 1** (Fct. 3.8.2 must be set to YES otherwise this function is not available) * Factory setting: → → → ↵ ↵ ↵ ↑ ↑ ↑ * If a different code is required: press any 9-keystroke combination and then press the same key combination again. Each keystroke is acknowledged by "*". CODE WRONG (incorrect entry) appears if 1st and 2nd entries are not the same. Press ↵ then → keys and repeat the procedure.
3.8.4	LOCATION	**Tag name setting** (measuring point number) Required only for flow meters using the MIC 500 Hand Held Communicator (HHC), connected to current output).. Factory setting: “MFC 081” Characters assignable to each place: A...Z / 0...9 / + / - / * / = / // (> = blank character)
3.8.5 **RESET/ACKNOWLEDGE**	ENABL. RESET	**Allow totaliser reset from the** **menu or with Control.Input E** Select : NO/YES
3.8.6	CSTDY CODE 3	**Custody transfer required?** The function is protected by the **CODE E** password. After pressing the → key enter a 9-keystroke password. If incorrect, 9 characters are displayed which can be decoded in the factory, otherwise select: * NO (No protection) * YES (Custody Transfer Protection required)
3.8.7	CODE 3	**CodE E setting** (9 characters). (If custody transfer is active then this function is unavailable) * Factory setting: ↵ → ↑ ↵ ↑ → ↵ → ↑ * If a different code is required, press any 9-keystroke combination and then press the same key combination again. Each keystroke is acknowledged by "*". **CODE WRONG** appears if 1st and 2nd entries are not the same. Press ↵ then → keys and repeat the procedure.
3.8.8	PARAM.CODE 4	Extra code ↵ ↑ to allow subsequent access to Menus: Fct. 3.1.5 Fct. 3.9.1 - 3.9.9 Fct. 3.1.6

Fct. No.	Text		Description and settings
3.9.0	TUBE PARAMS		**Submenu 3.9.0 Transducer calibration and compensation parameters***
3.9.1	Fgw	CF1	**Drive frequency - water: from Calibration Certificate**
3.9.2	Fcw	CF2	**Coriolis frequency - water: from Calibration Certificate**
3.9.3	Fgl	CF3	**Drive frequency - air: from Calibration Certificate**
3.9.4	Fcl	CF4	**Coriolis frequency - air: from Calibration Certificate**
3.9.5	GK	CF5	**Transducer mass flow calibration constant: from Calibration Certificate**
3.9.6	LIN	CF6	**Linearity adjustment: from Calibration Certificate**
3.9.7	Tcl	CF7	**Mass flow temperature compensation: from Calibration Certificate**
3.9.8	Tc0	CF8	**Mass flow temperature compensation at zero flow: from Calibration Certificate**
3.9.9	TcD	CF9	**Density temperature compensation: from Calibration Certificate**
3.9.10 select	D.REF.WATER		Use ↑ key to select between two modes, then press ↵ to submenu and then ↑ for choice of parameters * **MEAS.VALUE** CALIB. NO CALIB. YES * **SET VALUE** freq Hz temp °C (°F) density g/cm^3
3.9.11 select	D.REF.AIR		Use ↑ key to select between two modes, then press ↵ to submenu and then ↑ for choice of parameters * **MEAS.VALUE** CALIB. NO CALIB. YES * **SET VALUE** freq Hz temp °C (°F) density g/cm^3

* Many, but not necessarily all, compensation parameters are shown on instrument data plate.

These menus, except 3.9.10 and 3.9.11, are protected by the Code 4 password; see Fct. 3.8.8.

Fct. No.	Text	Description and settings
4.0	PARAM.ERROR	**Main Menu 4.0** Parameter error
4.1	Not Used	
4.2.0	CUR.OUTP.I	**Range settings incorrect** LOW SCALE ≥ FULL SCALE
4.2.1	LOW SCALE	**Low scale range for current output I** see Fct. 3.3.3
4.2.2	FULL SCALE	**Full scale range for current output I** see Fct. 3.3.4
4.3.0	ZERO	**Zero calibration incorrect.** **The measured zero offset must be less than ±10 % of the primary head's full scale flow rating.**
4.3.1	ZERO SET	**Zero calibration** see Fct. 3.1.7
4.3.2	PRIMRY.TYPE	Type of primary head see Fct. 3.1.5
4.4	Not Used	
4.5	Not Used	
4.6.0	PULS.OUTP. P	**Range setting incorrect** LOW SCALE ≥ FULL SCALE
4.6.1	LOW SCALE	**Low scale range for pulse output** see Fct. 3.4.3
4.6.2	FULL SCALE	**Full scale range for pulse output** see Fct. 3.4.4
4.7.0	PROC. ALARM	**Minimum and maximum limits incorrect** MIN.LIMIT > 96 % of MAX.LIMIT
4.7.1	MIN.LIMIT	**Minimum limit for range checking** see Fct. 3.5.3
4.7.2	MAX.LIMIT	**Maximum limit for range checking** see Fct. 3.5.4
4.8.0	SYS.CTRL.S	**Minimum and maximum limits incorrect** MIN.LIMIT > 96 % of MAX.LIMIT
4.8.1	MIN. LIMIT	**Minimum limit for condition checking** see Fct. 3.7.3
4.8.2	MAX. LIMIT	**Maximum limit for condition checking** see Fct. 3.7.4

5.5 Reset / Quit Menu - Totalizer reset and status indication acknowledgement

Totalizer reset

Button	Display	Description
	10.36 kg	Measurement mode
↵	**CodE 2** – –	Enter access Code 2 for reset/quit menu: ↑ →
↑ →	**RESET.TOTAL**	Totalizer reset menu Only appears if "yes" programmed in Fct. 3.8.5. Reset enable No or Yes. If "no" is programmed "status light" only appears. See next section.
↑	**RESET.YES**	If the reset function is enabled RESET **YES** will be shown, press ↵ to execute the function. To cancel the reset operation press ↑ to get RESET **NO** and then press ↵ If the reset function is disabled by menus Fct. 3.8.5 or 3.8.6 then BLOCKED is displayed. Press ↵ to continue
↵↵	0.00 kg	Assuming RESET YES was selected the totalisers will now be cleared.

View status message(s) and quit

Button	Display	Description
	0.36 **kg/min** **∇**	Measurement mode The presence of the ∇ marker above **Status** on the display indicates the presence of warning messages in the status list.
↵	**CodeE 2** **– –** **∇**	Enter access code for reset/quit menu: ↑ →
↑→	**RESET.TOTAL** **∇**	Totalizer reset menu.
↑	**STATUS.LIST** **∇**	View/Quit Status message menu
→	**≡ 1 Err ≡** **MASS FLOW** **∇**	This display shows that there is just 1 warning in the list, in this case MASS FLOW. The ≡ symbols indicate that this is a new error and not one that has been previously acknowledged. Use either the ↑ or → keys to view other messages in the list. Otherwise press ↵ to exit.
→	**≡ 1 Err ≡** **QUIT YES** **∇**	At the end of the message list the QUIT **YES** prompt is shown. Selecting YES will clear if possible messages in the list. To cancel the operation press ↑ to get QUIT **NO** and then press ↵
↵	**STATUS.LIST**	Assuming the conditions that caused the message have passed (i.e. mass flow is back within the meter's range) then the Status marker, ∇ will disappear.
↵	**0.36** **kg/min**	Assuming RESET YES was selected, the totalisers will now be cleared.

5.6 Status messages

ERROR MESSAGES	TYPE	COMMENT
SAMPLING	Severe	PLL out of range
SENSOR A	Severe	Sensor A voltage signal less than 5% of desired value
SENSOR B	Severe	Sensor B voltage signal less than 5% of desired value
RATIO A/B	Severe	One sensor signal much larger than the other
EEPROM	FATAL	Unable to save data in EEPROM. Hardware fault
SYSTEM	FATAL	Indicates software error, will always occur with WATCHDOG
WATCHDOG	Severe	Reset due to SYSTEM error or temporary power supply drop-off
NVRAM	Severe	NVRAM check sum error, previous data lost
DC A	Severe max.	DC voltage part of sensor A is larger than 20% of ADC
DC B	Severe max.	DC voltage part of sensor B is larger than 20% of ADC
NVRAM FULL	Light	NVRAM has exceeded its specified number of write cycles
MASS FLOW	Light	Mass flow rate > 2 $\times$ nominal flow *
ZERO ERROR	Light	Mass flow rate at zero adjust is larger than > 20% of nominal (100%) flow rate *
TEMPERATUR	Light	Temperature > outside operating range
CURRENT.SAT	Output	Current output saturated **
FREQ.SAT	Output	Frequency output saturated **
ALARM.OUT.A	Output	Process alarm limit check exceeded **
ROM DEF	Light	EEPROM check sum error, defaults loaded from ROM
TOTAL O/F	Light	Custody transfer only. Mass total has overflowed the display, i.e. it has gone from 99999999 $\rightarrow$ 00000000
TEMP.CUST	Light	Custody transfer only. Operating temperature has drifted by more than $\pm$30°C from the zero calibration temperature
POWER.FAIL	Light	Custody transfer only. There has been an interruption of power to the converter.

* Actual mass flow rate is too big or manual zero offset PUTIN.VAL in Fct. 1.1.1 was programmed incorrectly.

** Change output range to avoid saturation.

5.7 Menu variations for systems with other output options (Refer to Section 3.3)

Fct. No	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5	OPTION 6	OPTION 7	OPTION B	OPTION C
OPERATOR									
Fct. 1.3	CUR.OUTP.I	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I	CUR.OUTP.I
Fct. 1.4	PULS.OUT.P	BLOCKED	BLOCKED	PULS.OUT.P	PULS.OUT.P	BLOCKED	BLOCKED	BLOCKED	PULS.OUT.P
Fct. 1.5	ALARM.OUT.A	ALARM.OUT.A	BLOCKED	BLOCKED	BLOCKED	BLOCKED	ALARM.OUT.A	BLOCKED	BLOCKED
TEST									
Fct. 2.2	TEST I	TEST I*	TEST I*	TEST I*	TEST I*	TEST I*	TEST I*	TEST I	TEST I
Fct. 2.3	TEST P	BLOCKED	BLOCKED	TEST P	TEST P	BLOCKED	BLOCKED	BLOCKED	TEST P
Fct. 2.4	TEST A	TEST A	BLOCKED	BLOCKED	BLOCKED	BLOCKED	TEST A	BLOCKED	BLOCKED
Fct. 2.5	TEST.INP.E	TEST.INP.E	BLOCKED	BLOCKED	BLOCKED	TEST.INP.E	BLOCKED	BLOCKED	BLOCKED
INSTALL									
Fct. 3.3	CUR.OUTP.I	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I	CUR.OUTP.I
Fct. 3.4	PULS.OUTP.P	BLOCKED	BLOCKED	PULS.OUTP.P	PULS.OUTP.P	BLOCKED	BLOCKED	BLOCKED	PULS.OUTP.P
Fct. 3.5	ALARM.OUT.A	ALARM.OUT.A	BLOCKED	BLOCKED	BLOCKED	BLOCKED	ALARM.OUT.A	BLOCKED	BLOCKED
Fct. 3.6	CTRL.INP.E	CTRL.INP.E	BLOCKED	CRTL.INP.E	BLOCKED	CTRL.INP.E	BLOCKED	BLOCKED	BLOCKED
PARAM.ERROR									
Fct. 4.2	CUR.OUTP.I	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I*	CUR.OUTP.I	CUR.OUTP.I
Fct. 4.6	PULS.OUTP.P	N/A	N/A	PULS.OUTP.P	PULS.OUTP.P	N/A	N/A	N/A	PULS.OUTP.P
Fct. 4.7	ALARM.OUT.A	ALARM.OUT.A	N/A	N/A	N/A	N/A	ALARM.OUT.A	N/A	N/A

* These menus access two or more current outputs.
Press → and a flashing "1" appears. i.e. Fct. 1.3.0
CUR.OUTP.I**1**

USE THE ↑ TO SELECT THE REQUIRED OUTPUT NUMBER THEN PRESS ↵ TO SELECT.
REFER TO SECTION 3.3 FOR ADDITIONAL INFORMATION ON OUTPUT OPTIONS
NOTE: Listed options may not all be currently available

6. Description of Functions

6.1 Zero point adjustment

When operating the system for the first time, it is necessary to set the zero point of the instrument.

Once the zero point has been adjusted, the installation should not undergo any further modifications in order to maintain the quality of the measurement. This means that after system changes (such as the piping), it is advisable to re-adjust the zero-point.

To achieve a successful zero calibration the primary head should be completely full of process fluid at normal operating pressures and temperatures. Ideally there should be no air inclusions in the fluid, particularly for horizontal installations, so it is recommended that the primary head be flushed with the process fluid at a high flow rate (>50%), for 2 minutes, prior to starting the adjustment. After flushing, flow in the primary head must be brought back to zero by tightly closing appropriate valves.

The zero off-set can either be measured automatically or entered manually using the display keys. If an automatic adjustment is to be made then the operator should trigger this, with the front cover still in place (compact systems only), using the bar magnet provided to operate the magnetic sensors on the display. This is to ensure that the zero adjustment is carried out with the mechanical installation **exactly** the same as for normal operation.

Begin from the measuring mode.

Key	Display line 1	line 2
→	9-key stroke entry code (if enabled)	
	Fct. (1).0 OPERATOR	
↑	Fct. (2).0 TEST	
↑	Fct. (3).0 INSTALL	
→	Fct. 3.(1) BASE DATA	
→	Fct. 3.1.(1) ZERO SET	
→	(MEAS.VALUE)	

NOTE:
The brackets around parts of the above text indicates the cursor position, these characters will be flashing on the display. Flashing values can now be changed with the ↑ key. Pressing the → key moves the cursor to the next “field” which then starts to flash.

The operator can now choose either A) Automatic (recommended) or B) manual adjustment.

A) Automatic adjustment :

key	Display line 1	line 2
↵		CALIB. (NO)
↑		CALIB. (YES)
↵	X.X	PERCENT*
↵		ACCEPT (YES)
4x↵	Return to measuring mode	

* Display of transducer live zero as a % of maximum flow rate, for a period of 20 seconds.

B) Manual adjustment :

Key	Display line 1	line 2
↑		SET.VALUE
↵	(0).000	kg/min
	Input zero value in the sequence : dimension, sign, numeric value.	
↵		
4x↵	Return to measuring mode.	

In all the following examples, a short notation is used for the setting of the signal converter. Pushing a key several times is indicated by the number of times without the intermediate display messages. Only the final display output is listed. If programming is possible in the different menus 1.0 or 3.0 the only change is in the function number (e.g. for zero adjustment 1.1.1. instead of 3.1.1.), the inputs for the programming of the functions are the same.

Under certain conditions, it may not be possible to adjust the zero point, for instance when :

- The medium is in motion, because the shut-off valves etc. are not functioning properly.
- There are still gaseous inclusions in the primary head because it was flushed insufficiently.
- Resonant vibration of the piping interferes with the primary head because of poor installation.

In such cases the zero point adjustment will not be accepted. If the zero adjustment was started by the binary input, the converter will show the message :

ZERO.ERROR

This will appear in the display for a short time after the adjustment. The converter also reports the ZERO.ERROR in the status list.

If the zero calibration was started from the menus then Parameter Error 4.3 will be displayed when the operator tries to accept the new values.

Under certain circumstances, when the media consists of unevenly mixed components, it might be difficult to adjust the zero point. In such a case, the zero point adjustment procedure must be carried out under special conditions :

- Media which tend to vaporise or degas should be kept under higher pressure.
- Two-phase media consisting of a separable solid component (slurry): In such a case it might be advisable to fill the primary head with the carrier medium only.
- Other two-phase media .

If it is not possible to separate the solid or gaseous components, the operator can fill the measuring system with a substitute liquid (e.g. with water).

6.2 Low Flow Cutoff (Fct. 1.1.2 and 3.1.2)

If the FLOW MODE (Fct. 3.1.8) is set to FLOW +/- then at zero flow small signal fluctuations will average out to nothing and the totaliser will remain fixed. However, if "one-way flow" is selected, this averaging process will not work and the totaliser reading will increase slowly with time. To prevent this the Low Flow Cutoff should be set.

The Low Flow Cutoff is entered as a percentage of the rated flow of the primary head. The cutoff may be set in the range of 0.0 to 10.0% in steps of 0.1%.

Thus, for a 10E instrument with a low flow cutoff of 0.2%, any flows less than 0.02 kg/min are taken as 0 kg/min.

To set the Low Flow Cutoff to 1% :

Key.	Display line 1	line 2
→→→	Fct. 1.1.(1)	ZERO SET
↑	Fct. 1.1.(2)	L.F.CUTOFF
→	(0)0.0	PERCENT
→↑	(1).0	PERCENT
↵	Fct. 1.1.2	L.F. CUTOFF
4x↵		

6.3 Time constant

Measurements taken from the primary head require filtering in order to give stable readings in the presence of fluctuating flows. The degree of filtering also affects how quickly the reading responds to rapid changes in flow.

SHORT TIME CONSTANT:
FAST RESPONSE
FLUCTUATING READING

LONG TIME CONSTANT:
SLOW RESPONSE
STABLE READING

Figure 33 shows the typical response of the system for varying Time Constants and a sharp change in flow.

To set the Time Constant :

Begin from measuring mode.

Key	Display line 1	line 2
→→→	Fct. 1.1.(1)	ZERO SET
↑↑	Fct. 1.1.(3)	TIME. CONST.
→	(0)4.0	TIME C. S.
	Edit the time constant in seconds in range 0.5 to 20.	
↵	Fct. 1.1.(3)	TIME.CONST
4x↵		

This filtering only applies to mass and volume flow readings and any outputs that use them. The mass totaliser is independent of the time constant.

The standard range for the time constant is 0.5 to 20 seconds. For faster response times, a range of 0.2 to 20 seconds is available as a factory set option.

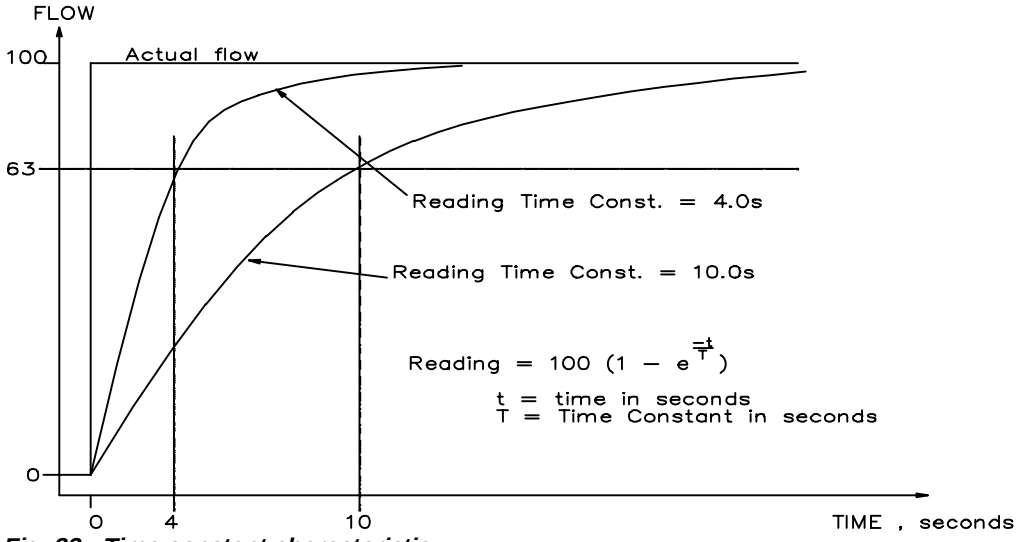


Fig. 33: Time constant characteristic

6.4 Programming the display for measurement values (Fct. 1.2. and 3.2.)

The following measurement functions can be displayed :

Fct. 1.2.1	CYCL.DISP
Fct. 1.2.2	STATUS MSG.
Fct. 1.2.3	MASS FLOW
Fct. 1.2.4	MASS TOTAL
Fct. 1.2.5	DENSITY
Fct. 1.2.6	TEMPERAT.
Fct. 1.2.7	VOLUME.FLOW
Fct. 1.2.8	VOL.TOTAL

For systems with concentration software their specific extra displays will be added to the above list from Fct. 1.2.9 onwards.

The displayed measurement function can be changed in the measurement mode by pressing ↑ key.
The setting of the display output is demonstrated for the example of displaying the mass flow rate in kg/h.
Starting from the display of measurement values, the following programming steps are necessary.

Begin from measuring mode.

Key	Display line 1	line2
→	Fct. (1).0	OPERATOR
2x↑	Fct. (3).0.	INSTALL
→	Fct. 3.(1).0.	BASE DATA
↑	Fct. 3.(2).0.	DISPLAY
→↑↑	Fct. 3.2.(3).	MASS FLOW

After pressing → key the display shows :

0000.0000 (kg)/min

This display means that mass flow will be displayed in units of kg/min to a resolution of 4 decimal places.
The brackets around 'kg' indicate the cursor position, these characters will be flashing on the display. The flashing value can now be changed with the ↑ key. By pressing the → key the cursor moves to 'min' which starts to flash.

This dimension may now also be changed by using the ↑ key. After pressing the → key again, the cursor moves to the output format of the numeric value which can then be edited.

To change the display to kg/h with 5 decimal places, follow the following procedure.

Key	Display line 1	line 2
	0000.0000	(kg)/min
→	0000.0000	kg/(min)
↑	0000.0000	kg/(h)
→	0000(.)0000	kg/h
↑	00000(.)000	kg/h
↑	000000(.)00	kg/h
↑	0000000(.)0	kg/h
↑	00000000(.)	kg/h
↑	0(.)0000000	kg/h
↑	00(.)000000	kg/h
↑	000(.)00000	kg/h
↵	Fct. 3.2.(3). MASS FLOW	

The setting of the display for TOTAL MASS or DENSITY is done the same way.

Temperature is displayed with a fixed position of one decimal place. However, the user can choose between °C and °F.

Begin from measuring mode

Key	Display line 1	line 2
→	Fct. (1).0	OPERATOR
→↑	Fct. 1.(2).0.	DISPLAY
5x↑	Fct. 1.2.(6).	TEMPERATUR
→		(°C)
↑		(°F)
↵	Fct. 1.2.(6).	TEMPERATUR

Volume flow is an optional display in the measurement mode. To turn on this display with units dm3/hr :

Key	Display line 1	line 2
↑	Fct. 1.2.(7)	VOL.FLOW.
→		(OFF)
↑	00000.000	(cm3)/S
↑	00000.000	(dm3)/S
→↑↑	00000.000	dm3/(hr)
→	00000(.)000	dm3/ hr
↑↑	0000000(.)0	dm3/hr
↵	Fct. 1.2.(7)	VOL.FLOW

For a list of available units for each display refer to Section 5, Technical data.

If a cyclic display of all measurement values is desired the following inputs have to be added to the previous steps :

Key	Display line 1	line 2
↵→	Fct. 1.2.(1).	CYCL. DISP.
→		(NO)
↑		(YES)
↵	Fct. 1.2.(1).	CYCL. DISP.
4x↵		

With the cyclic display enabled, the converter will switch displays in the measuring mode every 3 to 4 seconds as if the operator had pressed the ↑ key.

6.5 Programming Numeric Data

Various functions on the MFC 081 require numeric data to be entered by the operator. Numeric data is always entered in the following manner.

Using setting FULL SCALE of current output, Fct. 1.3.3 as an example:

Begin from the measuring mode:

Key	Display line 1	line 2
→	Fct. (1).0	OPERATOR
→↑↑	Fct. 1.(3).0	CUR.OUTP. I
→↑	Fct. 1.3.(2)	MIN. FLOW
	(assume function is set to MASS FLOW)	
↑	Fct. 1.3.(3)	MAX. FLOW
→	(0)*5.0000	kg/min
	Current setting of MAX.FLOW Units and accuracy are as set by the format Fct. 1.2.3	
↑	(1)5.0000	kg/min
→	1(5).0000	kg/min
5x↑	1(0).0000	kg/min
→	10(.)**0000	kg/min
	Decimal point may now be moved one digit to the right for each press of the ↑ key	
→↑	10.(1)000	kg/min
↵	Fct. 1.3.(3)	MAX FLOW
4x↵		

Return to measuring mode

* The flashing '0' to the left of the number to be edited allows extra digits to be added, as in this example. If no extra digits are required, pressing the → key will cause this leading zero to be blanked.

(0)5.0000 kg/min
→ (5).0000

** Some values do not allow the decimal point to be moved.

NOTE:
Some numerical values have fixed permissible limits. For example, Menu 3.1.2., L.F. CUT OFF only allows values in the range 0 to 10%. If, for example, the operator tries to enter a value of 15%, the converter responds as follows :

Key	Display line 1	line 2
	15.0	PERCENT
↵	10.0	MAX.VALUE
Press ↵ again to correct the number:		
↵	(0)10.0	PERCENT
Re-edit the number or press ↵ again to accept this value.		

6.6 Setting the current output (Fct. 1.3. and 3.3)

The current output can be programmed to the following measurement values :

- Mass Flow
- Density
- Temperature
- Volume Flow Rate
- Flow Direction

For the current output of the MFC 081, five ranges are available :

0 to 20 mA
4 to 20 mA
0 to 20 mA warning state: 22 mA
4 to 20 mA warning state: 2 mA
4 to 20 mA warning state; 3.5 mA

All output ranges will overrange to 20.5 mA. The 4 - 20 mA ranges will under range to 3.8 mA.

All functions except flow direction have a minimum and a maximum value. When the current output is set to one of these quantities, then the output range (4 to 20 or 0 to 20 mA) will correspond to the appropriate minimum and maximum (see Fig. 34).

For example, to use the current output for density with the following parameters :

MIN DENSITY = 0.5g/cm^3
MAX DENSITY = 2.0g/cm^3
RANGE 4 to 20 mA

Density	Current	
0.50 g/cm^3	4 mA	(minimum)
1.25 g/cm^3	12 mA	
2.00 g/cm^3	20 mA	(maximum)

If the current output is used to indicate the direction of flow the output is as follows :

Flow	Current
pos.	20 mA
neg.	0 or 4 mA depending on range.

Where the current range has a warning state, the output will jump to this current level when the meter detects an abnormal condition. When the condition clears, the current output returns to normal automatically.

To program the density example above:

Begin from measuring mode

Key	Display line 1	line 2
→	Fct. (1).0	OPERATOR
2x↑	Fct. (3).0	INSTALL
→↑↑	Fct. 3.(3).0.	CUR.OUTP.I
→	Fct. 3.3.(1).	FUNCTION I
→		(TEMPERATUR)
↑		(VOLUME.FLOW)
:		(OFF)
:		(MASS FLOW)
↑		(DENSITY)
↵	Fct. 3.3.(1).	FUNCTION 1
↑	Fct. 3.3.(2).	MIN.DENSITY
→	Input of min. value.	
↵	Fct. 3.3.(2).	MIN.DENSITY
→	Fct. 3.3.(3).	MAX.DENSITY
→	Input of max. value.	
↵	Fct. 3.3.(3).	MAX.DENSITY
↑	Fct. 3.3.(4).	RANGE I
→		(0-20/22mA)
↑		(2/4-20mA)
↑		(3.5/4-20mA)
↑		(0-20mA)
↑		(4-20mA)
↵	Fct. 3.3.(4).	RANGE I
4x↵		

If during operation the density measured falls outside the set maximum and minimum limits, the output is said to be saturated. This may cause problems with external instrumentation. Saturation may be indicated to the customer using either the process alarm (section 6.7) or the status warnings (section 6.12.).

If the output function is set to OFF or to DIRECTION then sub-menus Fct. 3.3.3 and Fct. 3.3.4 are not available.

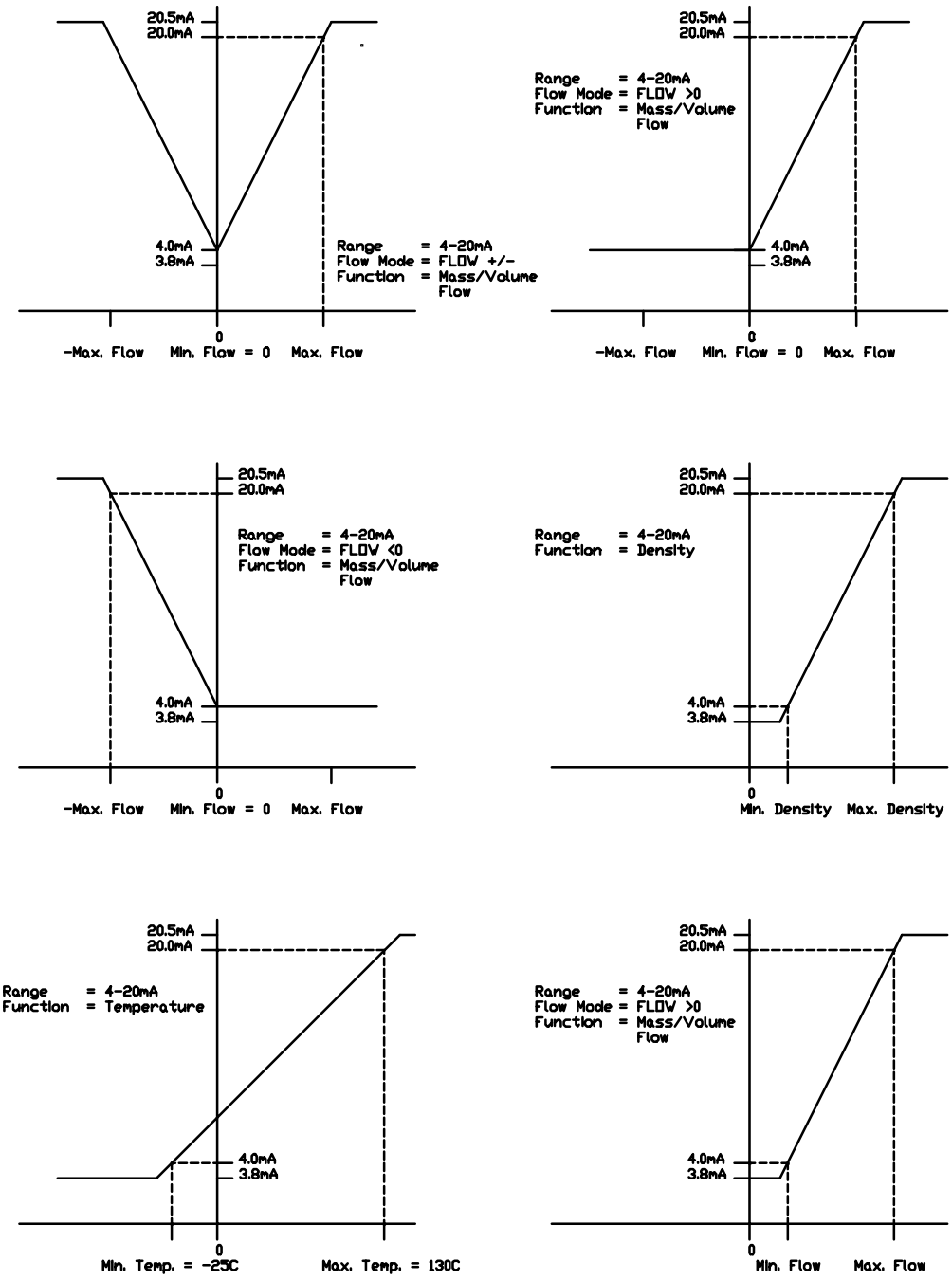


Fig. 34: Current output characteristics

6.7 Setting the frequency/pulse output (Fct. 3.4. and 1.4)

The frequency/pulse output allows the transfer of one of the following measurement values :

VALUE	OUTPUT TYPE
Mass Total	Pulse
Mass Flow Rate	Frequency
Density	Frequency
Temperature	Frequency
Volume Total	Pulse
Volume Flow Rate	Frequency
Flow Direction	Binary 0 or V+

For systems with the Concentration option, the following functions are also available:

VALUE	OUTPUT TYPE
Concentration by mass / Brix	Frequency
Concentration by volume	Frequency
Solute flow / Brix rate	Frequency
Solute Total	Pulse

The exact programming of this output depends on the measurement value selected.

Pulse Outputs:
When the pulse output (Fct. 1.4.1 or 3.4.1) is set to either MASS TOTAL, VOL.TOTAL OR SOL.TOTAL (Concentration systems only) then the following sub menus are available:

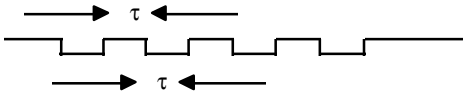
Fct. 3.4.1	FUNCTION P
Fct. 3.4.2	PULSE/MASS
(or	PULSE/VOL.)
Fct. 3.4.3	PULSE.WIDTH

For these functions the output sends out a series of pulses where each pulse represents a fixed mass or volume. So, for example, to set the converter for 1 pulse equal to 20g, proceed as follows :

Begin from measuring mode

Key	Display line 1	line 2
→↑↑	Fct. (3).0.	INSTALL.
→↑↑↑	Fct. 3.(4).0.	PULS.OUTP. P
→	Fct. 3.4.(1).	FUNCTION P
→		(OFF)
↑		(MASS FLOW)
:		(TOTAL MASS)
:		(DENSITY)
:		(TEMPERAT)
:		(VOLUME.FLOW)
:		(VOL. TOTAL)
↑		(DIRECTION)
↵	Fct. 3.4.(1).	FUNCTION P
↑	Fct. 3.4.(2).	PULSE/MASS
→	1.000	1 P. = (KG)
	Current setting	1kg per pulse
4x↑	1.000	1 P. = (g)
→	(0)1.000	1 P. = g
↑↑	(2)1.000	1 P. = g
→9x↑	2(0).000	1 P. = g
↵	Fct. 3.4.(2).	PULSE/MASS

Menu Fct. 3.4.3 can now be used to set the minimum pulse width, τ , in the range 0.4 to 500 ms.



In this way the operator can be sure that the pulses produced by the impulse output will never be shorter than the specified width.

When setting the pulse width, τ, and the mass (or volume) per pulse, Q, the operator should take into account the maximum flow rate, $Flow_{max}$, he expects through the meter, such that:

$$Flow_{max} < \frac{Q}{2\tau}$$

where:

$Flow_{max}$ is in units g/s (or cm^3/s)
Q is in units of g (or cm^3)
τ is in units of seconds

If $Flow_{max}$ exceeds the above, limit saturation will occur and pulses will be lost and any external counter connected will under-read. It is possible to generate warnings of saturation in one of two ways:

I. Set the Alarm output, Fct. 3.5.1 to either **P1 SAT** or **ANY OP.SAT**. If the pulse output saturates now the Alarm output will signal a warning.
II. Set the **STATUS MSG**. function Fct. 1.2.2 to either **OUTPUT** or **ALL MSGS**. If the pulse output becomes saturated now the **Status** arrow on the display will be lit and the display will start to flash.

To program the pulse width to 10 ms

	Fct. 3.4.(2)	PULSE/MASS
↑	Fct. 3.4.(3)	PULSE.WIDTH
→	(0)0.4	mSec
↑	(1)0.4	mSec
→ →	10.(4)	mSec
6 × ↑	10.0	mSec
↵	Fct. 3.4.(3)	PULSE.WIDTH
4 × ↵		

Having programmed this, one pulse will be sent from the output for every 20g of process fluid going through the primary head.

NOTE:
The pulse output ignores the sign, positive or negative of the flow. To ensure reliable operation, the system should be set for one-way flow with suitable low flow cutoff.

Frequency:
For these values the frequency output sends out a continuous square wave with a frequency representing the corresponding measured value. As with the current output, the frequency output is scaled to match the maximum and minimum settings for these values. The range of the frequency output may also be set by Fct. 1.4.2. or Fct. 3.4.2..

Example 1 :

Measured value	=	mass flow
Max flow	=	5 kg/min
Min flow	=	0
Max frequency	=	500 Hz

Flow	Frequency
0 kg/min	0 Hz
1 kg/min	100 Hz
5 kg/min	500 Hz
6.5 kg/min	650 Hz (1.3xMax Flow)
>6.5 kg/min	650 Hz

Example 2 :
Measured value = temperature
Max temperature = 75°C
Min temperature = -25°C
Max frequency = 1000 Hz

Temperature	Frequency
< - 25°C	0 Hz
0°C	250 Hz
20°C	450 Hz
75°C	1000 Hz
> 95°C	1300 Hz

To set up example 1, proceed as follows :

Begin from measuring mode.

Key	Display line	line 2
→↑↑	Fct. (3).0.	INSTALL.
→↑↑↑	Fct. 3.(4).0.	PULS.OUTP. P
→	Fct. 3.4.(1).	FUNCTION P
→		(TOTAL MASS)
↑		(MASS FLOW)
↵	Fct. 3.4.(1).	FUNCTION P
↑	Fct. 3.4.(2).	PULSE/TIME
→	(0)1000	MAX Hz
	Current max. frequency 1000 Hz.	
→9x↑	(0)000	MAX Hz
→	0(0)00	MAX Hz
5x↑	0(5)00	MAX Hz
↵	Fct. 3.4.(2).	PULSE/TIME
↑	Fct. 3.4.(3).	MIN. FLOW
→	Input min. flow of 0 kg/min	
↵↑	Fct. 3.4.(4).	MAX. FLOW
→	Input max. flow of 5 kg/min	
↵	Fct. 3.4.(4).	MAX. FLOW
4x↵		

The frequency output will allow flows to be registered up to 1.3 times the maximum value. (Note : for mass flow and volume flow, all flows are assumed positive).
The absolute maximum output frequency is 1300 Hz so the Max. Value allowed for Fct. 3.4.2. is 1000 Hz allowing for the 1.3 x over-range. See Figure 35 for the frequency output characteristics of examples 1 and 2.

NOTE:
The frequency output has a duty cycle of 50% for a frequency range > 1Hz. For a frequency range < 1Hz, the duty cycle is not 50%.

Binary output:
If the frequency output is set to signal the flow direction, Fct. 3.4.2. is suppressed and the output is as follows :

Flow	Direction
pos.	+ V
neg.	0 Volts

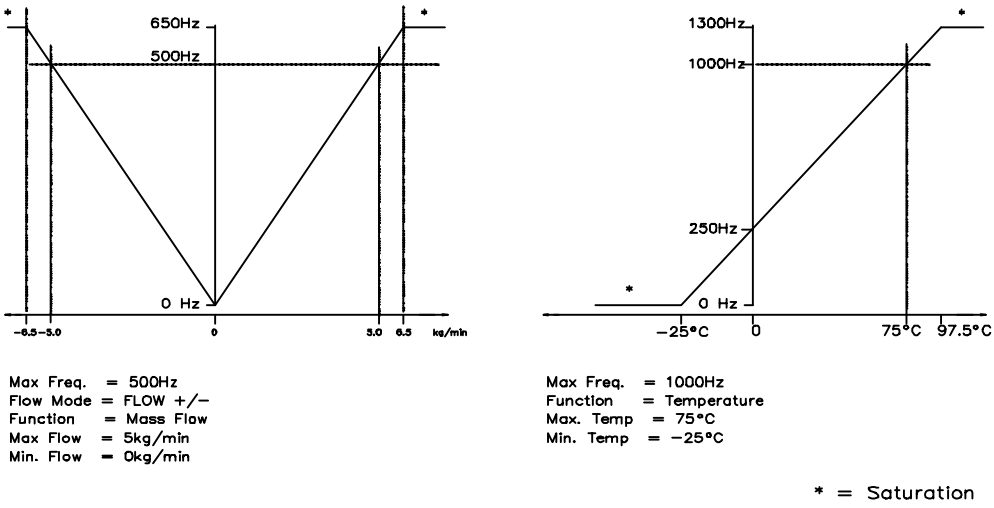


Fig. 35: Frequency output characteristic of examples 1 and 2

6.8 Setting the process alarm output (Status)

The process alarm output is a two state signal (active or inactive) that can be used to indicate a variety of meter and process states, as shown in the table below.

For all functions it is possible to define whether the output is to be active high, 24 Volts or active low, 0 Volts (Fct. 3.5.2). The first five functions check measured values against user-defined limits. While the value is within these limits the Process Alarm output is inactive. If the value exceeds the limits then the output becomes active. To prevent multiple switching of the output when the measured value is just on the limits, hysteresis is built in. Refer to Figure 36; as mass flow increases past the maximum limit the output switches to active. However, as flow then decreases the output will not switch to inactive until it becomes less than MAX - H where H = 2% of upper limit.

Process alarm functions:

Function	Inactive	Active
Mass total	Total in range	Total out of range
Mass flow	Mass flow in range	Mass flow out of range
Density	Density in range	Density out of range
Temperature	Temp. in range	Temperature out of range
Volume flow	Volume flow in range	Volume flow out of range
Concentration by mass *	Concentration in range	Concentration out of range
Concentrationby volume *	Concentration in range	Concentration out of range
Solute Mass Flow Rate*	Solute flow rate in range	Solute flow rate out of range
Current outputs I 1,2 3	Specified current output OK	Current output saturated
Frequency output	Frequency output OK	Output saturated
Any Output	All outputs OK	At least one output saturated
All status messages	No converter errors	At least one error detected
Severe errors	No serious converter faults	Major converter fault;measurement stops
Flow direction	neg. flow (-ve)	pos. flow (+ve)

* If concentration option installed.

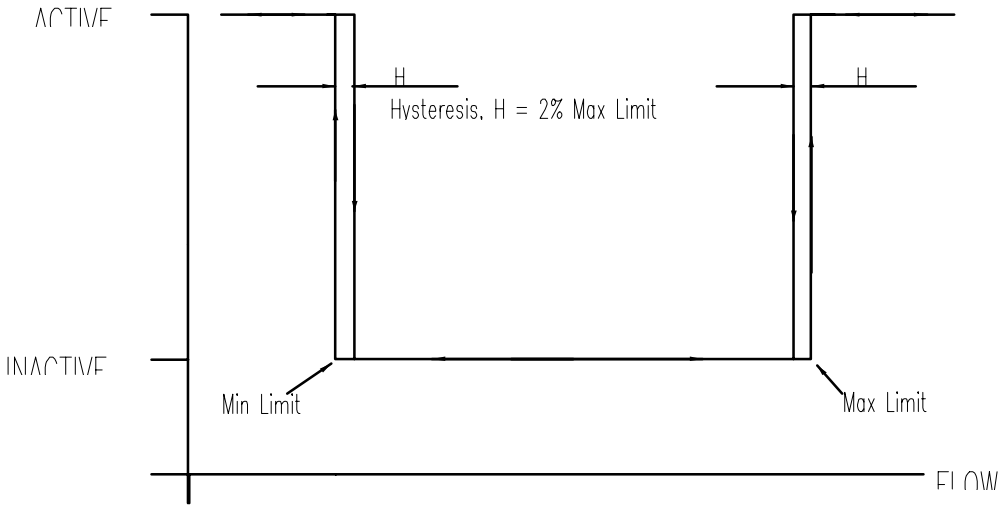


Fig. 36: Process alarm characteristics

For example, a process requires that the process fluid temperature stays within the range 30 to 40°C and the low level signal is required to indicate that the temperature has gone out of range.
Begin from measuring mode

Key	Display line 1	line 2
→↑↑	Fct. (3).0.	INSTALL
→4x↑	Fct. 3.(5).0.	ALARM.OUT.A
→	Fct. 3.5.(1).	FUNCTION A
→		(OFF)
↑		(MASS FLOW)
:		(MASS TOTAL)
:		(DENSITY)
↑		(TEMPERATURE)
↵	Fct. 3.5.(1).	FUNCTION A
↑	Fct. 3.5.(2).	ACTIV.LEVEL
→		(ACTIVE.HIGH)
↑		(ACTIVE LOW)
↵	Fct. 3.5.(2).	ACTIV.LEVEL
↑	Fct. 3.5.(3).	MIN. LIMIT
→	Input minimum temperature	
↵	Fct. 3.5.(3).	MIN. LIMIT
↑	Fct. 3.5.(4).	MAX. LIMIT
→	Input maximum temperature	
↵	Fct. 3.5.(4).	MAX. LIMIT
4x↵		

Return to measuring mode.
NOTE: For functions other than range checking Fct. 3.5.3. and 3.5.4. are not accessible.

6.9 Setting the control input (Binary)

The MFC 081 has an input connection which allows certain meter functions to be controlled remotely. These functions are:

- Reset totaliser
- Standby
- Acknowledge status message
- Start zero calibration

The function will be triggered when the input becomes active. For standby the converter will be held in standby for as long as the input is active. The other functions are triggered on the transition of the input from inactive to active. The active level of the input may be defined using Fct. 3.6.2. as active high (4 - 24 volts) or active low (0 - 2 volts).

NOTE:
Internal resistors attached to the control input pull it low, 0V, when the input is not driven (see Figure 37).

Example:

Using a TTL signal to reset the totaliser when the signal goes from high (+5V) to low (0V).

Begin from measuring mode

Key	Display line 1	line 2
→↑↑	Fct. (3).0	INSTALL
→5x↑	Fct. 3.6.0	CTRL.INP.E
→	Fct. 3.6.(1)	FUNCTION E
→		(OFF)
↑		(STANDBY)
:		(ZERO SET)
↑		(RESET MASS)
↵	Fct. 3.6.(1)	FUNCTION E
↑	Fct. 3.6.(2)	ACTIV.LEVEL
→		(ACTIVE.HIGH)
↑		(ACTIVE. LOW)
↵	Fct. 3.6.(2)	ACTIV.LEVEL
4x↵		

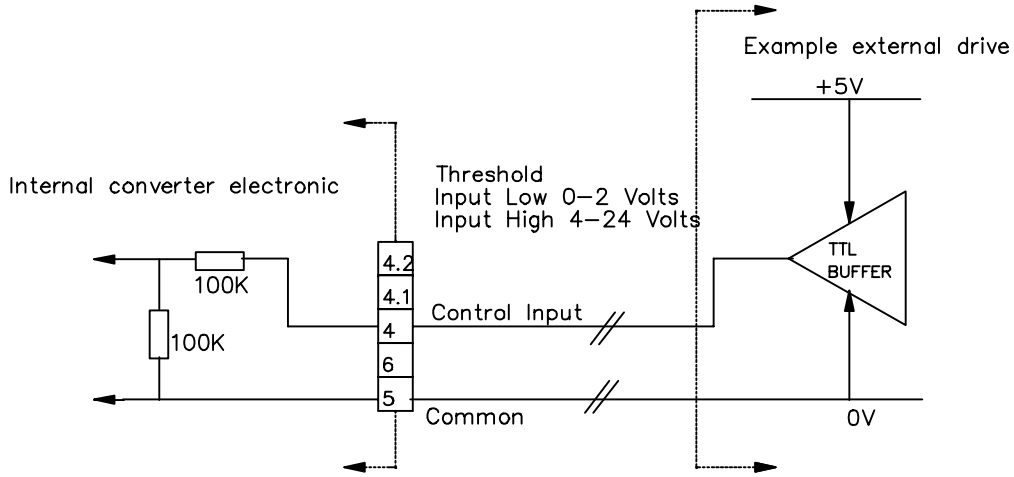


Fig. 37: Driving the control input

6.10 Setting the system control

Some applications for the MFM 2081 and MFM 3081 may require measurement to be suspended at particular times, such as during steam cleaning. The system control functions allow the converter to automatically detect user-defined conditions and then to act accordingly.

Selectable conditions (Fct. 3.7.2.) are :

Density out of range
Temperature out of range

The ranges for these conditions are set by Fct. 3.7.3. and 3.7.4. (These range checks are subject to hysteresis in the same way as the process alarm, see Sect. 6.7).

When such a condition is met, the converter takes one of the following actions :

1. Flow reading forced to zero, totaliser stopped, any output registering flow will go to zero.

2. Flow reading forced to zero as above, but totaliser is cleared to zero when measurement restarts.

3. Disable outputs. All outputs, current, frequency and alarm are forced to their zero/inactive state.

Example:
A process has to be steam cleaned regularly. The user has the pulse output set to total mass, but he does not want pulses sent to his instrumentation during cleaning. However, he still requires a temperature reading from the current output. The nominal density of his process fluid is 1.2g/cm3.

Begin from measuring mode

Key	Display line 1	line 2
→↑↑	Fct. (3).0.	INSTALL
→6x↑	Fct. 3.(7).0.	SYS.CTRL.S
→	Fct. 3.7.(1).	FUNCTION S
→		(OFF)
↑		(FLOW OFF)
↵	Fct. 3.7.(1).	FUNCTION S
↑	Fct. 3.7.(2).	REFERENCE
→		(TEMPERATUR)
↑		(DENSITY)
↵	Fct. 3.7.(2).	REFERENCE
↑	Fct. 3.7.(3).	MIN. LIMIT
→	Input minimum density of 0.5g/cm3	
↵	Fct. 3.7.(3).	MIN. LIMIT
↑	Fct. 3.7.(4).	MAX. LIMIT
→	Input maximum density of 5.0g/cm3. This value is set high as only low fluid density are of interest in this case.	
NOTE :	The max. value in this case will set a hysteresis of 0.1g/cm3	
↵	Fct. 3.7.(4).	MAX. LIMIT
4x↵		

As the line is drained and prior to steam cleaning, density reading will fall below 0.5g/cm3. When this happens the converter will read zero flow and no more pulses will be sent from the pulse output. The current output registering temperature will function as normal. When the line is refilled and density exceeds 0.6g/cm3, measurement will restart.

When this function becomes active then the standby indicator on the display becomes lit. All displays for mass flow, density, temperature etc. work as normal. However, if functions 1 or 2 above are selected then the mass flow (and hence volume flow) will be zero and will be displayed as shown below.

0.0000
STANDBY.

6.11 Standby function (Fct. 1.1.4. and 3.1.4.)

The instrument may be switched to a 'STANDBY' state. Once in this state, all outputs go to their off state and the mass totaliser is frozen. The main display will have the STANDBY indicator set and will display either the frozen totaliser or just STANDBY.

Begin from measuring mode

Key	Display line 1	line 2
		STANDBY
↑	3.456	kg Frozen Totalizer
↑		STANDBY

While in this state the measuring tube still vibrates and the measurements can come back on line in an instant.

There is an additional standby state, 'STOP', in this case the drive to the primary head is disabled and vibrations cease. However, when leaving STOP the converter has to return to STARTUP before measurements can resume.

The instrument can be switched to STANDBY either by the keys on the display or by the control input signal (see section 6.9). STOP can only be set by the keys.

To set STANDBY or STOP :

Begin from measuring mode

Key	Display line 1	line 2
→	Fct. (1).0.	OPERATOR
→→	Fct. 1.1.(1).	ZERO SET
3x↑	Fct. 1.1.(4).	STANDBY
→		(MEASURE)
↑		(STANDBY)
↑		(STOP)
	Use the ↑ key to select the desired mode.	
↵	Fct. 1.1.(4)	STANDBY

If STANDBY or STOP was selected the instrument goes immediately into that state.

To return to measurement, go back to Fct. 1.1.4. and select MEASURE.

NOTE:
It is not possible to change mode directly from STOP to STANDBY, as the converter must first be switched to MEASURE to restart the primary head vibrations.

In addition to these 'standby' modes the SYSTEM CONTROL function provides a fully automated way of switching to similar modes using either the density or temperature of the process fluid as a control (see section 6.10).

6.12 Density Calibration Adjustment

6.12.1 Water as the reference liquid:

It is often convenient to do a field calibration of the density function using water as the reference liquid. Fill the flowmeter with water which is free of air. It is best to be operating the system at process flow rates and at a stable temperature. The calibration will automatically input the operating frequency, temperature and the density of water at the temperature according to the reference table on the following pages. Note the metric units for the reference tables are Kg/m^3. To convert to g/cm^3 divide by 1000.

Follow the key strokes in the diagram below to accomplish this calibration. Begin from the measuring mode:

Key	Display line 1	line 2	Step #
→	Fct.(1).0	OPERATOR	1. Enter programming mode
2x↑	Fct.(3).0	INSTALL	2.
	→	Fct.3,(1).0	BASIS.PARAM 3.
8x↑	Fct.3.(9).0	TUBE PARAMS	4.
→	Fct.3.9.(1)	CF1 Fgw	5.
9x↑	Fct.3.9.(10)	D.REF.WATER	6.
→		(MEAS.VALUE)	7.
↵		CALIB. (NO)	8.
↑		CALIB. (YES)	9.
↵	Fct.3.9.(10)	D.REF.WATER	10.
4x↵			11. Return to measuring mode

6.12.2 Process fluid as the reference fluid:

Often it is very convenient to use the actual process fluid to calibrate the density output under actual operating conditions against the in-plant density reference. Be certain the process is running in a stable fashion at or near normal operating conditions. To perform this calibration, proceed with key strokes as in 6.12.1 above except after having reached step 10, proceed as follows:

Key	Display line 1	line 2	Step #
→		(MEAS. VALUE)	11.
↑		(SET VALUE)	12.
↵	+132.3566	FREQUENCY	13. set automatically in step 9: do not adjust.
↵	+ 67.5	(°C)	14. set automatically in step 9: do not adjust.
↵	0.9990	$(g)/cm^3$	15. set mass units
→	0.9990	$g/(cm^3)$	16. set volume units
→	(0)0.9990	g/cm^3	17. adjust to process density value - ex. 0.9794 g/cm^3 *
as req'd	0.9794	g/cm^3	18. density which will be the output when measuring.
5x↵			19. return to the measuring mode.

After returning to the measurement mode, the density should read 0.9794 g/cm^3 if the above procedure was carried out correctly and the process is stable.

* If insufficient number of digits appear to permit adequate resolution refer to Section 6.5 which explains how to increase the number of digits.

Density of water as a function of temperature

Temperature in		Density in		Temperature in		Density in	
°C	°F	kg/m^3	lb/ft^3	°C	°F	kg/m^3	lb/ft^3
0	32	999.8396	62.41999	25	77	997.0468	62.24563
0.5	32.9	999.8712	62.42197	25.5	77.9	996.9176	62.23757
1	33.8	999.8986	62.42367	26	78.8	996.7861	62.22936
1.5	34.7	999.9213	62.42509	26.5	79.7	996.6521	62.22099
2	35.6	999.9399	62.42625	27	80.6	996.5159	62.21249
2.5	36.5	999.9542	62.42714	27.5	81.5	996.3774	62.20384
3	37.4	999.9642	62.42777	28	82.4	996.2368	62.19507
3.5	38.3	999.9701	62.42814	28.5	83.3	996.0939	62.18614
4	39.2	999.9720	62.42825	29	84.2	995.9487	62.17708
4.5	40.1	999.9699	62.42812	29.5	85.1	995.8013	62.16788
5	41	999.9638	62.42774	30	86	995.6518	62.15855
5.5	41.9	999.9540	62.42713	30.5	86.9	995.5001	62.14907
6	42.8	999.9402	62.42627	31	87.8	995.3462	62.13947
6.5	43.7	999.9227	62.42517	31.5	88.7	995.1903	62.12973
7	44.6	999.9016	62.42386	32	89.6	995.0322	62.11986
7.5	45.5	999.8766	62.42230	32.5	90.5	994.8721	62.10987
8	46.4	999.8482	62.42053	33	91.4	994.7100	62.09975
8.5	47.3	999.8162	62.4185	33.5	92.3	994.5458	62.08950
9	48.2	999.7808	62.41632	34	93.2	994.3796	62.07912
9.5	49.1	999.7419	62.41389	34.5	94.1	994.2113	62.06861
10	50	999.6997	62.41125	35	95	994.0411	62.05799
10.5	50.9	999.6541	62.40840	35.5	95.9	993.8689	62.04724
11	51.8	999.6051	62.40535	36	98.6	993.6948	62.03637
11.5	52.7	999.5529	62.40209	36.5	97.7	993.5187	62.02537
12	53.6	999.4975	62.39863	37	98.6	993.3406	62.01426
12.5	54.5	999.4389	62.39497	37.5	99.5	993.1606	62.00302
13	55.4	999.3772	62.39112	38	100.4	992.9789	61.99168
13.5	56.3	999.3124	62.38708	38.5	101.3	992.7951	61.98020
14	57.2	999.2446	62.38284	39	102.2	992.6096	61.96862
14.5	58.1	999.1736	62.37841	39.5	103.1	992.4221	61.95692
15	59	999.0998	62.37380	40	104	992.2329	61.94510
15.5	59.9	999.0229	62.36901	40.5	104.9	992.0418	61.93317
16	60.8	998.9432	62.36403	41	105.8	991.8489	61.92113
16.5	61.7	998.8607	62.35887	41.5	106.7	991.6543	61.90898
17	62.6	998.7752	62.35354	42	107.6	991.4578	61.89672
17.5	63.5	998.6870	62.34803	42.5	108.5	991.2597	61.88434
18	64.4	998.5960	62.34235	43	109.4	991.0597	61.87186
18.5	65.3	998.5022	62.33650	43.5	110.3	990.8581	61.85927
19	66.2	998.4058	62.33047	44	111.2	990.6546	61.84657
19.5	67.1	998.3066	62.32428	44.5	112.1	990.4494	61.83376
20	68	998.2048	62.31793	45	113	990.2427	61.82085
20.5	68.9	998.1004	62.31141	45.5	113.9	990.0341	61.80783
21	69.8	997.9934	62.30473	46	114.8	989.8239	61.79471
21.5	70.7	997.8838	62.29788	46.5	115.7	989.6121	61.78149
22	71.6	997.7716	62.29088	47	116.6	989.3986	61.76816
22.5	72.5	997.6569	62.28372	47.5	117.5	989.1835	61.75473
23	73.4	997.5398	62.27641	48	118.4	988.9668	61.74120
23.5	74.3	997.4201	62.26894	48.5	119.3	988.7484	61.72756
24	75.2	997.2981	62.26132	49	120.2	988.5285	61.71384

Temperature in		Density in	
°C	°F	kg/m^3	lb/ft^3
50	122	988.0839	61.68608
50.5	122.9	987.8592	61.67205
51	123.8	987.6329	61.65793
51.5	124.7	987.4051	61.64371
52	125.6	987.1758	61.62939
52.5	126.5	986.9450	61.61498
53	127.4	986.7127	61.60048
53.5	128.3	986.4788	61.58588
54	129.2	986.2435	61.57118
54.5	130.1	986.0066	61.55640
55	131	985.7684	61.54153
55.5	131.9	985.5287	61.52656
56	132.8	985.2876	61.51150
56.5	133.7	985.0450	61.49636
57	134.6	984.8009	61.48112
57.5	135.5	984.5555	61.46580
58	136.4	984.3086	61.45039
58.5	137.3	984.0604	61.43489
59	138.2	983.8108	61.41931
59.5	139.1	983.5597	61.40364
60	140	983.3072	61.38787
60.5	140.9	983.0535	61.37203
61	141.8	982.7984	61.35611
61.5	142.7	982.5419	61.34009
62	143.6	982.2841	61.32400
62.5	144.5	982.0250	61.30783
63	145.4	981.7646	61.29157
63.5	146.3	981.5029	61.27523
64	147.2	981.2399	61.25881
64.5	148.1	980.9756	61.24231
65	149	980.7099	61.22573

Temperature in		Density in	
°C	°F	kg/m^3	lb/ft^3
65.5	149.9	980.4432	61.20907
66	150.8	980.1751	61.19233
66.5	151.7	979.9057	61.17552
67	152.6	979.6351	61.15862
67.5	153.5	979.3632	61.14165
68	154.4	979.0901	61.12460
68.5	155.3	978.8159	61.10748
69	156.2	978.5404	61.09028
69.5	157.1	978.2636	61.07300
70	158	977.9858	61.05566
70.5	158.9	977.7068	61.03823
71	159.8	977.4264	61.02074
71.5	160.7	977.1450	61.00316
72	161.6	976.8624	60.98552
72.5	162.5	976.5786	60.96781
73	163.4	976.2937	60.95002
73.5	164.3	976.0076	60.93216
74	165.2	975.7204	60.91423
74.5	166.1	975.4321	60.89623
75	167	975.1428	60.87816
75.5	167.9	974.8522	60.86003
76	168.8	974.5606	60.84182
76.5	169.7	974.2679	60.82355
77	170.6	973.9741	60.80520
77.5	171.5	973.6792	60.78680
78	172.4	973.3832	60.76832
78.5	173.3	973.0862	60.74977
79	174.2	972.7881	60.73116
79.5	175.1	972.4890	60.71249
80	176	972.1880	60.69375

6.13 Density - Special Functions

6.13.1 Specific Gravity

From Software version P2.14 and higher the operator has the option of displaying density as A SPECIFIC GRAVITY.

Specific Gravity = Density of Process Fluid ÷ Density of Water at 20° C

To set the display for Specific Gravity go to menu Fct. 1.2.5 or 3.2.5:

	Fct. 1.2.(5).	DENSITY
→	0000.0000	(g) / cm^3
Press the ↑ key repeatedly until the display shows		
↑	0000.0000	(lb) / cm^3
↑	0000.0000	(S.G.)
↵	Fct. 1.2.(5).	DENSITY

6.13.2 Referred Density (Option)

Referred density is a factory-installed option which expands the type of density outputs available to three different variations - “actual” (normal density output), “fixed”, and “referred”. Any one of these three options can be selected in Fct. 1.2.5 or Fct. 3.2.5 - the “DENSITY” function of the “DISPLAY” submenu. Program “actual” if the “Referred” or “Fixed” Options are not desired.

Referred density corrects the actual density value to a standardized density value based on a reference temperature. The reference temperature and the slope are programmable. The sign of the slope coefficient (α) is always positive based on the assumption that increasing temperature decreases the actual density measured. The referred density equation is as follows:

$$\rho_r = \rho_a + \alpha (t_a - t_r)$$

where “ρ“ is the density and “t” the temperature. Subscripts “r” and “a” indicate “referred” or “reference” and “actual” respectively.

Note that the above equation is linear. Referred density accuracy is determined by how precise a fit a linear function is to the actual temperature-density relationship of the process over the range of operating temperatures. Also note that the coefficient, α , depends on the temperature units selected, °F or °C, as well as the density units selected. The units of α are the change in density per degree change in temperature.

Key strokes for the “referred density” option shown below - start from the measuring mode:

Key	Display line 1	line 2	Step #
→	Fct.(1).0	OPERATOR	1. enter programming mode
2×↑	Fct.(3).0	INSTALL	
→	Fct.3.(1).0	BASIS.PARAM	
↑	Fct.3.(2).0	DISPLAY	
→	Fct.3.2.(1)	CYCL.DISP.	
4×↑	Fct.3.2.(5)	DENSITY	
→		ACTUAL	
↑		FIXED	
↑		REFERRED	
↵	0.0000000	(g)/cm^3	2. set mass units in this step (or S.G.)
→	0.0000000	g/(cm^3)	3. set volume units in this step
→	0(.)0000000	g/cm^3	4. set decimal point location in this step
↵	+ 20.0	REF.TEMP (°C)	5. set ref. temp. -°F or °C, sign and value
↵	(0).000000	SLOPE/°C	6. set slope (α) of temperature coefficient
↵	Fct.3.2.(5)	DENSITY	7. enter inputs
4×↵			8. return to measuring mode

6.13.3 Fixed Density (Option):

The “Fixed Density” Option permits setting a fixed, specific density value for the purpose of calculating volumetric flowrate and/or volumetric total from mass flow. This is useful when dealing with pure liquids or liquids with a known, fixed composition when it is desired to know the volumetric flow referenced to a specific (fixed) density at a specific temperature.

It is programmed by selecting “FIXED” rather than “REFERRED” and programming the fixed density value in that step (step #4) of the program shown in 6.13.2 where the decimal point is adjusted for “Referred Density”. After setting the fixed density value, press 4x ↵ to return to the measuring mode. “Actual Density” is programmed in similar fashion except the density value is not entered as with “Fixed Density”.

6.14 User data

6.14.1 Programming the display language

The converter can display its messages and prompts in one of three languages, German, English or French. The language may be changed using Menu 3.8.1..

Example: Setting for German language

Begin from measuring mode.

Key	Display		
	line 1	line 2	
→	Fct. (1).0	OPERATOR	
↑↑	Fct. (3).0	INSTALL	
→7x↑	Fct. 3.(8).0	USER DATA	
→	Fct. 3.8.(1)	LANGUAGE	
→		(GB/USA)	
↑		(F)	French
↑		(D)	German
↵	Fct. 3.8.(1)	SPRACHE	
		German selected	
↵	Fct. 3.(8).0	USER DATEN	
↵↵↵			

6.14.2 Password protection of menus

As mentioned in Section 5.2, access to the menus can be protected by a password. This password protection is enabled by Menu 3.8.2. and the password itself can be altered by Menu 3.8.3.. To enable password protection and to change the password from its factory setting, proceed as follows (Note: the password must be enabled in Fct. 3.8.2. before it can be changed in Fct. 3.8.3.).

Begin from measuring mode

Key	Display	
	line 1	line 2
→	Fct. (1).0	OPERATOR
→→	Fct. (3).0	INSTALL
→7x↑	Fct. 3.(8).0	USER DATA
→↑	Fct. 3.8.(2)	ENTRY.CODE.1
→		(NO)
↑		(YES)
↵	Fct. 3.8.(2)	ENTRY.CODE.1.
↑	Fct. 3.8.(3)	CODE 1
→	CodE 1	---------
any key x9	CodE 1	*********
	Enter new password	
	CodE 1	---------
	Enter the new password again	

If the new password was entered the same both times it will be accepted, otherwise "CODE WRONG" will be displayed.

NOTE:
The default value of the password protection code when leaving the factory is: → → → ↵ ↵ ↵ ↑ ↑ ↑

6.14.3 Custody transfer protection code

The converter can be set for measurement with or without the custody transfer protection enabled.

When using custody transfer protection, any additional provisions of the local calibration authority must be adhered to and the entire instrument must be approved by that authority.

The custody transfer protection can naturally also be used without official approval. The calibration protection in the converter affects only the total summating counter. All settings which alter the measured value of mass flow can no longer be altered when the calibration protection is active.

The following cannot be altered :
- Primary head type and CF 5
- Low flow cutoff
- Custody transfer password
- Mass total display units and format.
- Flow direction
- Flow mode (Set to FLOW > 0 only)
- Standby
- Control input function. (Only acknowledge messages still allowed)
- System control. (Conditions and limits that trigger the system control function are locked. 0 FLOW+RST function not allowed).
- Mass totaliser can no longer be reset. When the totaliser rolls over from 99999999 to 00000000 a status message will be set.

When custody transfer protection is enabled a warning message will be generated on any interruption of the mains supply, or if the process fluid temperature varies by more than ±30°C from the temperature that the zero calibration was performed at.
To enable or disable the custody transfer protection, use menu Fct. 3.8.6. CSTDY CODE.

Begin from measuring mode.

Key	Display line 1	line 2
→	Fct. (1).0	OPERATOR
2x↑	Fct. (3).0	INSTALL.
→	Fct. 3.(1).0	BASE DATA
7x↑	Fct. 3.(8).0	USER DATA
→	Fct. 3.8.(1)	LANGUAGE
5x↑	Fct. 3.8.(6)	CSTDY CODE
→		CodE 3
	Input 9-keystroke Entry-Code	
		CODE (NO)
↑		CODE (YES)
4x↵		

The default value of the custody transfer protection code when leaving the factory is

↵→↑↵↑→↵→↑

This password may be changed using Menu 3.8.7.. However, this can only be done if custody transfer protection is disabled first, as described above.

Begin from measuring mode.

Key	Display	
	line 1	line 2
→	Fct. (1).0	OPERATOR
2x↑	Fct. (3).0	INSTALL.
→	Fct. 3.(1).0	BASE PARAM.
7x↑	Fct. 3.(8).0	USER DATA
→	Fct. 3.8.(1)	LANGUAGE
6x↑	Fct. 3.8.(7)	CODE 3
→	CodeE 3	- - - - - - - -
	Enter new custody transfer password two times.	
	Fct. 3.8.(7)	CODE 3
4x↵		

If the two entered passwords are different the message "CODE WRONG" is displayed.

The message has to be acknowledged with the ↵ key and input must be repeated with Fct. 3.8.7.. Then the protection state 'active' or 'inactive' can be chosen with Fct.3.8.6..

NOTE:
If the input of the custody transfer password is wrong, a 9-character code is displayed. With this character code the manufacturer can decode the password in cases where the password is lost.

It is also possible to protect just the mass totaliser. Menu 3.8.5. ENABL.RESET determines whether the operator can clear the mass total from the ACKNOWLEDGE/RESET MENU.

Begin from measuring mode.

Key	Display	
	line 1	line 2
→	Fct. (1).0	OPERATOR
2x↑	Fct. (3).0	INSTALL
→7x↑	Fct. 3.(8).0	USER DATA
→4x↑	Fct. 3.8.(5)	ENABL.RESET
→		(YES)
↑		(NO)
↵	Fct. 3.8.(5)	ENABL.RESET
4x↵	+110.25	kg
	Mass Total Display	
↵	CodE 2	- -
↑→		RESET MASS
→		BLOCKED
	Totaliser Reset is disabled	
↵↵		

6.14.4 Primary head type and tube parameters (CF1-9)

The primary head type and tube parameters are factory set and should not normally be changed by the customer. They are only normally needed if the converter has to be replaced in the field. In this case, the new converter must be programmed with the correct primary head type and transducer-specific parameters.

In the case of remote mounted converters, particularly, the customer may wish to verify that the correct converter is connected to a given transducer. This may be accomplished by comparing the primary type and CF5 (GK) programmed in the converter with the corresponding data printed on the transducer data tag.

To view these parameters, begin from the measuring mode:

Key	Display line 1	line 2
→↑↑	Fct. (3).0	INSTALL
→→4x↑	Fct. 3.1.(5)	USER DATA
→	check for correct primary type	
		1.5E - 1500P
↵↑	Fct. 3.1.(6)	CF5
→	Value	CF5
	Compare value with data tag	
4x↵		

To view the other transducer-specific parameters, proceed to Fct. 3.9.0 TUBE PARAMS. Check the values programmed against the Data Plate and/or Calibration Certificate data. If the data is incorrect, it can be adjusted in Fct. 3.9.0 by first unprotecting the parameters via Code 4 password (see Fct. 3.8.8).

6.14.5 Location

It is possible to program each unit with an individual identification number. This is especially useful if the 'SMART' option is being used. To set the location number :

Begin from measuring mode:

Key	Display line 1	line 2
→↑↑	Fct. (3).0	INSTALL
→7x↑	Fct. 3.(8).0	USER DATA
→↑↑↑	Fct. 3.8.(4)	LOCATION
→		(M)FC 081
		Factory Setting

Use the ↑ key to change the character under the cursor. The sequence is :
A to Z, 0 to 9, +, -, *, /, =, SPACE.

Use the → key to move the cursor to the next character.

Press ↵ key when completed.

Part C Special options, Functional checks, Service and Order numbers

7. Special Options

7.1 Use in hazardous areas

MFM 2081 K and MFM 3081 K - Ex Coriolis massflow meters are approved for use in hazardous areas as electrical equipment in conformance with the harmonised European Standards, Factory Mutual (FM) (pending), and Canadian Standards Association (CSA) (pending). Conformity between the temperature classes and the temperature of the process fluid, meter size and material of the measuring tube is defined in the test certificate. The Test Certificate, certificate of conformity and wiring instructions are included in the Installation and Operating instructions for Ex equipment.

This is a separate manual to the standard Installation and Operating manual and is only supplied when an instrument for use in a hazardous area is ordered. If you have an "Ex" instrument, please ensure that you have this manual and read it carefully before using the massflow meter.

7.2 Converter with non-standard output options

The flowmeter may be supplied with one or more of the output options as mentioned in Part B, Section 5.7. These are factory fitted options and changes should not be attempted by unqualified personnel. Most of these options are hi-pot-tested to comply with the requirements of Ex and CE and if field exchanged these requirements may be violated. * Krohne will also not accept responsibility or honour the warranty if this is done. If you need an option change, please contact your nearest office for advice.
*All options are not compatible in certain configurations with older versions of software.

7.3 Concentration measurement and Special Density Options

The Corimass P- and E-Series may be fitted with a concentration measurement option. This option enables the meter to measure solute / solvent concentration of a two-component solution as % by weight or volume, as well as °Brix or °Baumé, concentration by mass or volume.
The fluid may be a liquid / liquid or a liquid / solid suspension mixture. If the meter has been fitted with this option a separate Concentration manual will be supplied with the meter.

The special density option for Referred Density and Fixed Density is available as a factory set option. This option is mutually exclusive with the Concentration option. The option is described in Section 6.13.2 and 6.13.3.

If you have any questions, please contact your local Krohne office for further assistance.

7.4 Converter with Smart / Hart communication option

The instrument menu can be accessed and programmed remotely via the 4 - 20 mA output. The following options are available:

a) H.H.C Hand-Held Communicator with Krohne Smart or Hart (may not be available at time of first printing) communications protocol.
b) MS DOS PC via an RS 232 adaptor and CONFIG software

Detailed instructions are supplied when these options are purchased. Refer to the section with the Order numbers for ordering details or contact Krohne.

7.5 Converter with RS 485 Communication option

When this option is fitted only one analog 4 - 20 mA output is fitted as well.

Detailed description of the Krohne RS 485 protocol is available on request or when the meter is ordered a copy is included in the instruction package. (This option is not available with software versions 2.18 and lower.)

7.6 Custody Transfer option

The P- and E-Series has been approved for custody transfer applications in Germany. If you have a custody transfer application, please check with your local authorities in the weights and measures department for local requirements.

Krohne will gladly assist in obtaining a local approval.

8. Functional checks

8.1 Test functions

Menu 2.0. contains a number of test functions. These allow the current, frequency and alarm outputs to be driven at a number of fixed test levels, so that the communication between the converter and the customer's equipment can be verified. In addition, other functions allow various measured parameters from the primary head to be viewed directly for trouble shooting purposes.

8.1.1 Testing the display

This function sends a test sequence to the LCD display which causes each element of the display to be lit in sequence. If any segments fail to light, this indicates that the display is faulty and should be replaced.

Begin from measuring mode.

Key	Display line 1	line 2
→↑	Fct. (2).0	TEST
→	Fct. 2.(1)	TEST DISP.
→	Display blanks then starts its test sequence	

The test may be terminated at any time by pressing the ↵ key, otherwise the display returns automatically when the sequence is complete.

8.1.2 Testing current output

This function allows a number of fixed current levels from 0 to 22 mA to be driven from the current output. This function interrupts the normal operation of the output, so the operator will be asked if he is sure before the test commences.

Key	Display line 1	line 2
	Fct. 2.(1)	TEST DISP.
↑	Fct. 2.(2)	TEST I
→		SURE (NO)
↑		SURE (YES)
↵		(0 mA)
		0 mA is output
↑		(2 mA)
↑		(4 mA)
↑		(10 mA)
↑		(16 mA)
↑		(20 mA)
↑		(22 mA)
↑		(0 mA)

Press the ↵ key at any time to stop the test and return the output to normal operation.

Systems with two or more current outputs

From software P2.14 onwards programming of any current output will be by menus Fct. 1.3.0 and Fct. 3.3.0 (testing will be by menu Fct. 2.2) regardless of how many current outputs are fitted. When programming (or testing) a system with two current outputs the operator must first select the desired output number.

	Fct. 3.(3).0	CUR.OUT.I
→	Fct. 3.3.0	CUR.OUT.I(1)
↑	Fct. 3.3.0	CUR.OUT.I(2)
	Use the ↑ key to select the desired output number	
↵	Fct. 3.3.(1)	FUNCTION I
	Program the selected output as normal	

8.1.3 Testing pulse output

This function allows the frequency/pulse output to be tested. The frequency output has an open collector transistor drive which requires a pull-up resistor to an external DC power supply. (Sect. 3.3). When this output is connected to the customer's instrumentation, reliable operation can only be ensured if the customer takes proper care to ensure the connection is properly screened against external electrical interference. Therefore, it is important that this output connection should be thoroughly tested before being put into use.

To test the frequency, connect a frequency meter to the pulse output terminals and proceed as follows:

Key	Display line 1	line 2
	Fct. 2.(2)	TEST I
↑	Fct. 2.(3)	TEST P
→		SURE (NO)
↑		SURE (YES)
↵↵	Fct. 2.3.(1)	FREQUENCY
→		(LEVEL LOW)
		0V on the output
↑		(LEVEL HIGH)
		+V on the output
↑		1 Hz
		A frequency meter connected to the output will show 1Hz.
↑		10 Hz
↑		100 Hz
↑		1000 Hz
		After testing the 1000 Hz signal connect a counter to the output.
↵	Fct.2.3.(1)	FREQUENCY

To test the pulse output, connect an external counter to the output terminals. When testing the pulse output, the operator has the choice of the following pulse widths: 0.4 ms, 1.0 ms, 10.0 ms, 100.0 ms and 500 ms. The operator should choose the pulse width that best matches the performance of his external pulse counter.

Connect a pulse counter to the impulse output and proceed as follows:

	Fct. 2.(3).0	TEST P
→		SURE (NO)
↑		SURE (YES)
↵	Fct. 2.3.(1)	FREQUENCY
↑	Fct. 2.3.(2)	TEST PULSE
→		(0.4 mSec)
	Use the ↑ to select the desired pulse width	
↑		(1.0 mSec)
↑		(10.0 mSec)
↑		(100.0 mSec)
	Having selected the pulse width zero the external counter and then press ↵	
↵	625	100.0 mSec

The meter now issues a stream of pulses with the set width. The running total of pulses sent is shown on the display. The test stops when either 100,000 pulses have been sent or the operator presses the ↵ key.

If the counter reads a smaller number than the actual number of pulses sent, or the frequency meter under reads, then this indicates that a weak signal is reaching the frequency meter/pulse counter. In this case try the following suggestions:-

(i) Decrease the external pull-up resistor
(ii) Decrease/remove the filter capacitor.
(iii) Decrease the cable length between the converter and the counter.
(iv) Add external buffers to boost the signal.

If the pulse counter reads a larger number than the converter, or if the frequency meter reading is high or unstable, then this indicates the presence of external interference. Try one or more of the following:-

(i) Add/increase the size of the filter capacitor. (10 - 100nF)
(ii) Use high quality screened cable.
(iii) Keep cable lengths as short as possible, avoiding high power equipment/switchgear and any cabling connected to them.
(iv) Use external buffers.

8.1.4 Testing alarm output

This is a simple function that allows the alarm output to be tested at both its high and low states.

Key	Display line 1	line 2
	Fct. 2.(3)	TEST P
↑	Fct. 2.(4)	TEST A
→		SURE (NO)
↑		SURE (YES)
↵		(LEVEL LOW) 0V on the output
↑		(LEVEL HIGH) +24V on the output
↵	Fct. 2.(4)	TEST A

8.1.5 Testing control input

Menu 2.5 allows the state of the control input signal to be tested.

Key	Display line 1	line 2
	Fct. 2.(4)	TEST A
↑	Fct. 2.(5)	TEST INP.E
→	HI	RESET MASS

Line 1 of the display shows the current state of the input. HI = 4 - 24 Volts, LO = 0 - 2 Volts. Line 2 shows the currently selected function of the input. As the voltage on the input changes so the display will change from HI to LO accordingly. However, whilst using the test function no action will be taken in response to the input (i.e. the total will not be reset).
NOTE: If the input is disconnected it will read LO.

8.1.6 Viewing temperature

Menu 2.6 allows the current temperature readings to be monitored. These figures are used internally by software for flow and density compensation.

Key	Display line 1	line 2
	Fct. 2.(5)	TEST INP.E
↑	Fct. 2.(6)	TEST TEMP.
→	20.0	°C
	Current temperature °C	
↑	68.0	°F
	Current temperature °F	
↵	Fct. 2.(7)	TEST TEMP.

8.1.7 Viewing primary head signal conditions

Menu 2.7 allows four measured parameters from the primary head to be displayed.

Sensor A, Sensor B (Fct. 2.7.1 and 2.7.2)
These give the normalised sensor signal levels from the primary head. In normal operation these are controlled so that they both read about 80 - 85%.

If the sensors read less than this it indicates that the vibrations of the primary head are being impeded. This could be due to a poor installation or a large quantity of air in the process fluid.

Frequency (menu 2.7.3)
This function displays the current resonant frequency of the primary head. This value is primarily used to calculate the density of the process fluid.

Installation factor (menu 2.7.4)
This factor is a measure of the quality of the primary head's installation. This figure shows roughly how much energy is required to sustain the oscillations in the primary head. Generally, the lower the installation factor the better the installation. See Section 4.3 for guidelenes on installation factor values. In addition, if the process fluid has a large gas content this will have the effect of damping out primary head oscillation, which will in turn cause the installation factor to increase.

9. Service and Troubleshooting

9.1 Threads and "O" Ring of the converter housing lid

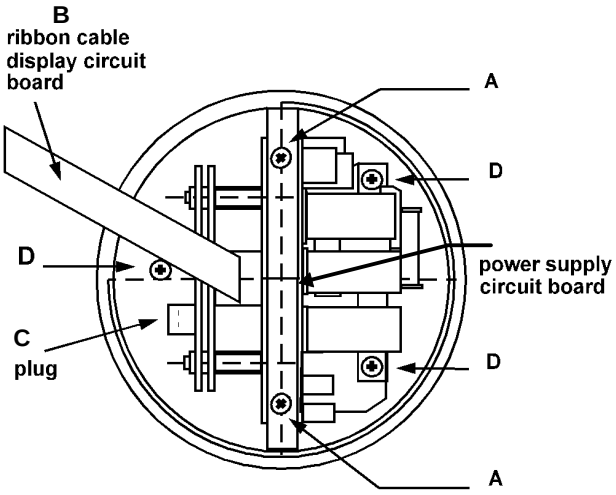
The screw threads and gaskets of both housing covers should be well greased at all times. Always check for signs of damage and never allow dust to accumulate. Defective gaskets and lids should be replaced immediately to maintain the integrity of the protection category.

The grease used must be non-corrosive to aluminium and should be acid- and resin-free.

9.2 Replacing the converter electronics

Always switch off power before commencing work!
For Ex version allow 30 minutes to cool before opening housing.

1. Use the special wrench to remove the cover from the terminal compartment.
2. Disconnect all cables from the terminals in the rear terminal compartment.:
   MFC 081 : term. 5/6/4/4.1/4.2/11/12
3. Use the special wrench to remove the cover from the electronic compartment.
4. Undo screws A and fold display board to side.
5. Remove plug C (10-pin, signal cable).
6. Undo screws D using a screwdriver for recessed-head screws and carefully remove the complete electronics.
7. On the electronics, check the supply voltage and fuse F9, and change / replace if necessary, see Sect. 9.3.
8. Reassemble in reverse order (points 6 to 1).
9. Primary head specific parameters, as printed on the Data Plate and Calibration Certificate, must now be entered into the new converter. (see section 5.4, Fct. 3.9.0, and section 6.14.4).
10. Subsequently be sure to check the zero and store the new zero value.



A. Screws that hold the display PCB in place.

B. Ribbon cable connecting display PCB to converter electronics.

C. 10-pin sensor connector.

D. Screws that hold the converter electronics in place.

Important: Ensure that the screw thread of the covers on the electronics and terminal compartments are well greased at all times. The grease used must be non-corrosive to aluminium and should be acid- and resin-free.

9.3 Change of operating voltage and power fuse F9

Always switch off power source before commencing work!

Remove electronics as described in Section 9.2.

9.3.1 Replacement of power fuse F9

The mains fuse F9 of the converter, sits on the power supply board beside the transformer, as shown in Figure 38.
The fuse will not blow, unless there was either a connection error or a fault in the converter itself .
The table below shows the right fuse for the different voltages the converter could be set to. Do not use any other than the specified type.

For position of fuses, see power supply board layout diagram.

Voltage	Fuse F9
200,230/240 VAC	160 mA T
100,115/120 VAC	315 mA T
42,48 VAC	800 mA T
21,24 VAC	1.6 A T

The fuses should be an anti-surge type with a breaking capacity of 1500 A at 250 V AC.
For part numbers, see table under section 10, Order numbers.

9.3.2 Changing the operating voltage

1. Insert voltage select cable into the correct position on the power supply circuit board, to obtain desired voltage.
2. If necessary, change fuse F9 to suit the new voltage. (See fuse table for values of F9)

IMPORTANT
If the operating voltage has been altered from the factory setting, ensure that the primary head's data plate and the label on the F9 fuse holder are amended accordingly.

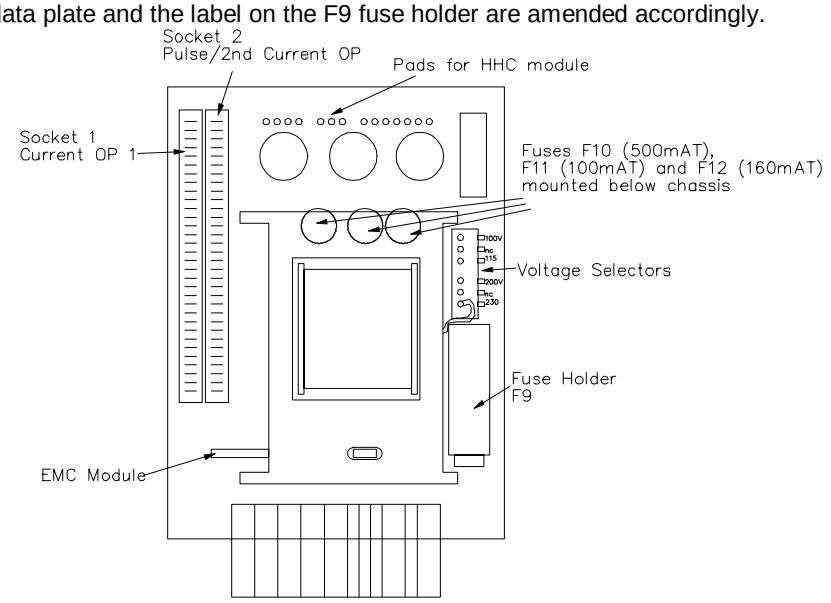


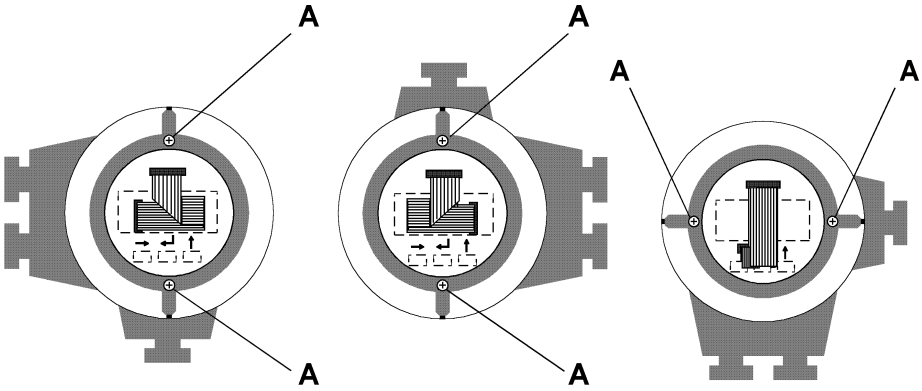
Fig. 38: Power supply layout

9.4 Turning the display circuit board

To ensure horizontal positioning of the display irrespective of the location of the MFM 2081 K and MFM 3081 K compact flow meter, the display circuit board can be turned through 90° or 180°.

1. **Switch off the power supply!**
2. Unscrew the cover from the electronics compartment using the special wrench.
3. Remove screw A from the display board.
4. Turn display board into desired position.
5. Fold the ribbon cable as shown in the following drawings. Please follow directions scrupulously so as to avoid damage to electronic components and printed boards! For the version on the right the screws A must be repositioned on the display board.
6. Carefully screw down the display board.

Directions for folding the ribbon cable on the display circuit board:



9.5 Turning the signal converter housing

To facilitate access to connecting, indicating and operating elements on MFM 2081 K and MFM 3081 K compact flow meters that are installed in locations that are hard to get at, the signal converter housing can be turned through 90°.

1. The connection wires between primary head and signal converter housing are extremely short and can break easily.
2. **Switch off the power source!**
3. Clamp the flow meter firmly by the primary head housing.
4. Secure the converter housing against slipping and tilting.
5. Loosen slightly but **do not remove** the 4 bolts connecting the two housings.
6. Carefully turn the converter housing clockwise or anti-clockwise a maximum of 90°, but do not lift the housing. If the gasket should stick, do not attempt to lever it off.
7. To conform to the requirements of protection category IP 67, keep connecting faces clean and tighten the 4 fixing bolts uniformly.

Any faults resulting from failure to follow these instructions scrupulously shall not be covered by our warranty!

WARNING: Ex/Hazardous duty versions may not be turned. Please order correct position at time of placing order or consult Krohne.

9.6 Troubleshooting

Operational errors may be caused by:

- The process medium
- The installation
- The measuring system

Most frequently, errors occur in the measuring system when it is installed and switched on for the first time. They are normally due to incorrect installation of the primary head.

When the measuring system is switched on and the converter's self-test has been carried out (Display message 'TEST') the message 'STARTUP' is displayed. During this time, the converter tries to activate the primary head. Usually, the desired value for the oscillation amplitude is reached after a few seconds and the converter starts displaying mass flow. However, if the display is flashing, the system cannot enter the measuring mode. The problem is signalled by the arrow to 'Status' on the front plate.

First of all, it is advisable to inspect the installation to determine if it was installed in compliance with the installation instructions. If this is the case, then the following steps should be taken for localising the fault :

If the primary head is not installed in a vertical position, increase the flush period and flow rate in order to remove air bubbles and solid materials from the primary head.
If the primary head starts to oscillate, but the measured values are erratic or the primary head keeps returning to STARTUP, then the possible cause of the trouble could be:

1. Poor installation causing an excessively high installation factor.
2. Bad zero calibration.

Monitor the primary head's INSTAL.FACT using Fct. 2.7.4. If the reading is high, (see Section 2) then this indicates either poor meter clamping or excessive gas in the process fluid. For horizontally installed systems, flush the meter at a high flow rate to remove any air bubbles that may have collected. Shut off the flow and recheck the drive level. If the drive reading is still high, check that the meter has been installed and clamped correctly. In a poor installation, drive power is wasted in transmitting vibrations to the attached pipe work, and this greatly degrades meter performance. As a general guide, the clamping should be adjusted as described in the installation manual.

Sympathetic vibrations, which are transmitted to the primary head via the floor or the pipe system, can lead to an unstable zero point. This can cause the mass totalizer to “creep” with time, even when the flow is shut off.

Another reason for an increase in the display of the flow rate is due to calibrating the zero point with a non-zero flow rate. In this case, make sure that the shutoff valves are completely closed and then re-calibrate the zero point.

Problems occurring during the measuring process

During operation the system is continually checking itself and its measured values against various conditions. If one or more of these conditions are broken, then the system indicates that a problem has occurred and various messages are stored in an internal message list. Whenever a new problem is found the display starts to flash and the status arrow is lit, drawing the operator's attention to the problem. The display will continue to flash indefinitely until the operator acknowledges the warnings.

The operator may inspect the message list at any time, using the RESET/ACKNOWLEDGE menu. As the operator goes through the list, if a message is marked with '≡' characters, this indicates a new warning that the operator had not previously acknowledged. At the end of the list the operator is asked to acknowledge the warnings with 'QUIT (YES)' prompt. If the operator selects YES by pressing the ↵ key, the system will attempt to remove the warnings from the list. If the source of a problem is still present (say mass flow is too high for example) the warning can not be removed from the list. When the operator returns to the measurement mode the display will have stopped flashing showing that all the problems detected so far have been acknowledged. However, the status arrow will only be extinguished if there are no longer any messages present in the list. It is also possible to indicate in the main display if so desired (see section 6.12).

In summary

The display flashes if the meter has detected problems that have not been acknowledged by the operator.
The status arrow is shown until all warnings have been acknowledged and cleared.

- The warning message shown in the display, if cause is still present.
- A warning is contained in the message list if :
  The cause of the problem is still present.
  The cause of the problem is no longer present, but the warning has not yet been acknowledged.
- A message shows three bars "≡" as long as it has not been acknowledged.

A complete list of warning messages and their causes are given on the following page.

Status messages

ERROR MESSAGES	TYPE	COMMENT
SAMPLING	Severe	PLL out of range
SENSOR A	Severe	Sensor A voltage signal less than 5% of desired value
SENSOR B	Severe	Sensor B voltage signal less than 5% of desired value
RATIO A/B	Severe	One sensor signal much larger than the other
EEPROM	FATAL	Unable to save data in EEPROM. Hardware fault.
SYSTEM	FATAL	Indicates software error, will always occur with WATCHDOG
WATCHDOG	Severe	Reset due to SYSTEM error or temporary power supply drop-off
NVRAM	Severe	NVRAM check sum error, previous data lost
DC A	Severe	DC voltage part of sensor A is larger than 20% of ADC max
DC B	Severe	DC voltage part of sensor B is larger than 20% of ADC max
NVRAM FULL	Light	NVRAM has exceeded its specified number of write cycles
MASS FLOW	Light	Mass flow rate > 2 nominal flow *
ZERO ERROR	Light	Mass flow rate at zero adjust is larger than > 20% of nominal (100%) flow rate *
TEMPERATUR	Light	Temperature > outside operating range
CURRENT.SAT	Output	Current output saturated **
FREQ.SAT	Output	Frequency output saturated **
ALARM.OUT.A	Output	Process alarm limit check exceeded **
ROM DEF	Light	EEPROM check sum error, defaults loaded from ROM
TOTAL O/F	Light	Custody transfer only. Mass total has overflowed the display, i.e. it has gone from 99999999 to 00000000
TEMP.CUST	Light	Custody transfer only. Operating temperature has drifted by more than ±30°C from the zero calibration temperature
POWER.FAIL	Light	Custody transfer only. There has been an interruption of power to the converter.

* Actual mass flow rate is too big or manual zero offset SET.VAL in Fct. 1.1.1 or 3.1.1 was programmed incorrectly.

** Change output range to avoid saturation.

9.7 Fault finding

Most of the common faults and symptoms experienced with the flowmeter can be resolved with the help of the following table.
To simplify the use of the table, the faults and symptoms are grouped together:

GROUPS
- D Display, inputs and outputs
- I Current output
- P Pulse output
- A Alarm output (Status)
- E Control input (Binary)
- OP Measurement mode and commissioning
- ST Commissioning and Start-up of the flowmeter

Please check the following table of hints and advice before calling your KROHNE Service Department.

Group	Fault / Symptom	Cause	Remedy
Group D			
D1	No display or outputs	Power not switched on	Switch on power
		Power supply fuse F9 blown	Replace fuse as per Section 9.3.1
		Fuses F10, and/or F12 blown	Replace converter as per Sect. 9.2 or call Krohne service.
D2	Fluctuating display and outputs	Time constant too small	Increase time constant as per Section 6.3.
D3	Mass flow display incorrect	The wrong value for parameters CF5 (GK) programmed. (This is stamped on the data plate)	Check and correct according to Sections 6.12 and 6.14.4
		Zero calibration	Re-do zero, check manual offset
		Primary sensor faulty	Check as per Section 9.8
D4	Density display and outputs not correct	Density Parameters	Check and correct according to 6.12
		Excitation frequency of primary sensor not correct when filled with water (see section 2.7.3)	Check for air in meter. Call Krohne.
		Primary sensor faulty	Check as per Section 9.8
Group I			
I1	Connected instrument displays 0 or negative values	Connection polarity wrong	Correct as per Sect. 3.3
		Connected instrument faulty or current output faulty	Check output with a mA meter. I Test OK Check cabling and connected instrument and replace if necessary. I Test faulty Current output faulty. Replace converter or call Krohne service.

Group	Fault / Symptom	Cause	Remedy
		Current output switched off.	Switch on as per Fct. 3.3.1
I2	Wrong display on connected instrument	Current programming not correct.	Correct the programming as per Fct. 3.3.1 - 3.3.4
I3	Fluctuating display on connected instrument	Time constant too small	Increase the time constant as per Fct. 3.1.3
Group P			
P1	Connected totalizer not counting	Connection / polarity not correct.	Check and correct as per Section 2.3
		Totalizer or external supply voltage faulty.	Check output with totalizer: Test OK Check cabling and totalizer. Check external voltage supply Test faulty Pulse output faulty. Replace converter or call Krohne Service.
		Alarm output is used as external voltage supply, a possible electrical short-circuit or alarm/pulse output faulty.	Check connections as per Section 2.3. Voltage between terminals 5 and 4.2 approx. 24 V. Correct short circuit if present. If still faulty the alarm or pulse output is faulty. Re-place converter or call Krohne Service.
		Pulse output is switched off	Switch on as per Fct. 3.4.1
P2	Fluctuating pulse rate	Time constant too small	Increase time constant as per Fct. 3.1.3
P3	Pulse rate too high or too low	Programming of pulse output incorrect.	Correct programming as per Fct. 3.4.1 - 3.4.4
		External induced noise dueto low quality cable or unscreened cable.	Check cabling and replace with screened cable. See Section 2.3
Group A			
A1	Alarm output not functioning	Connection / polarity incorrect.	Correct as per Sect. 2.3
		Alarm output or external instrument faulty	Program alarm output to “direction” as per Fct. 3.5.1. Set flow direction to negative and check alarm output. Test OK Check external instrument and if necessary replace. Test faulty Alarm output faulty. Replace converter or call Krohne Service.
		Alarm o/p switched off	Switch on as per Fct. 3.5.1
A2	Incorrect voltage level at output terminals Hi/Lo)	Incorrectly programmed in Fct. 3.5.2	Correct as follows: Hi = 24 V Lo = 0 V

Group	Fault / Symptom	Cause	Remedy
Group E			
E1	Control input does not function	Connection / polarity incorrect.	Correct as per Sect. 3.3
		Programming incorrect	Correct the programming as per Fct. 3.6.1 - 3.6.2. Test as per Fct. 2.15. If test is faulty, the output is faulty. Replace converter or call Krohne Service.
		Control input switched off.	Switch on as per Fct. 3.6.1
Group ST			
ST1	Display keeps returning to “test”. (during start-up)	Poor/intermittant power. Supply to meter.	Check incoming supply
		Hardware failure	Replace converter or call Krohne Service.
ST2	Display returns to “Start up” and the status arrow is illuminated.	Possible poor mechanical installation.	Check install factor and correct installation as per Section. 1
			Check the status list in reset/quit menu as per Section 5.5 and acknowledge the error message.
		Primary Sensor faulty	Check as per Sect. 9.8
		Fuse F11 blown. (negative analog voltage).	Call Krohne Service.
ST3	Display returns to Start-up and the primary sensor is noisy.	Sensor cannot vibrate freely due to poor mechanical installation.	Correct installation as per Section 1 and try again.
Group OP			
OP1	Installation factor larger than value given in Sect. 4.3	Mechanical installation not correct or air bubbles in process fluid. External influences due to pumps, motors, etc.	Check installation and correct if necessary (see Section 1). Flush process pipe work to get rid of air.
OP2	Display indicates a flow-rate during zero setting. Valves closed.	Valves not shut tight or air in process fluid.	Check valves for tight shut-off. Flush lines with high velocity.
		Zero calibration not OK	Check that flow is zero and pipe is full without air bubbles. Do automatic calibration as per Section 6.1 and ensure that a “0” is programmed in the zero set function.

9.8 Checking the Primary Head

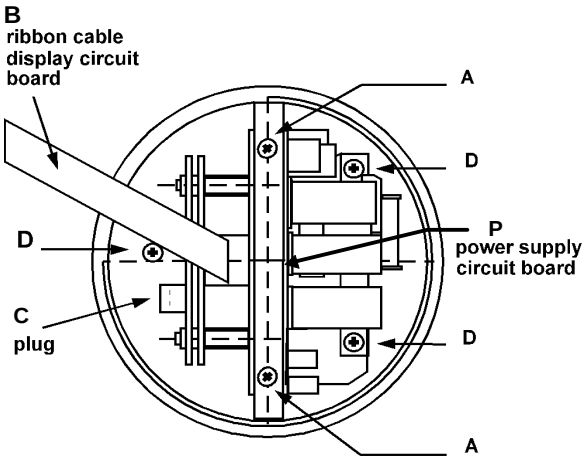
Remember! Always switch the power off before opening the converter housing.

If application and installation criteria have been carefully reviewed and the converter electronics is deemed not at fault, the following checks can be performed on the primary head. Whether the system has a remote or compact converter, it is most convenient to first remove the 10 pin sensor connector (C) from the converter as outlined below to isolate the converter electronics.

For compact systems, remove the rectangular cover to the connection compartment mounted to the primary head. Note, one of the four screws can only be loosened so the cover can be rotated out of the way around this screw. Using an appropriate ohmmeter, check the resistance between the various terminals according to the wire colors described on the next page. Color/terminal identification can be seen in Section 4.8, Fig. 32. The pin out for the various wire colors for the converter connector is shown below should the cable need to be checked.

For remote mounted converters, the same procedure can be followed as for the compact systems by checking at the converter connection compartment first. If a problem is found, a similar test should be performed at the primary head (transducer) connection compartment to check out the connecting cable and its connections. Refer to the cable connection diagrams in Section 4.7.

Required tools and test equipment
- Phillips screwdriver
- Multimeter
- Special wrench to unscrew converter housing lids



A. Screws that hold the display PCB in place.

B. Ribbon cable connecting display PCB to converter electronics.

C. 10-pin sensor connector.

D. Screws that hold the converter electronics in place.

P. Power supply circuit board

Preliminary preparation
- Remove front lid of electronic housing
- Unscrew the two screws “A” that hold down the display PCB and fold the ribbon cable and PCB carefully to one side.
- Unplug blue primary connector “C” from amplifier board

10-Pin Sensor Connector “C“ (Connector between primary and converter)

* except for CE versions of wall mount configurations; this terminal used for ground

Testing the resistance values of the sensors and exciter (compact systems)		**Typical values (ohm)**	**Assesment of measured values**
1	**Measuring tube driver**: Measure between violet and black	P-Series Std. 41 - 50 Ex II b 41 - 50 Ex II c 62 - 73 E-Series Std. 71 - 87 Ex II c 262 - 296	
2	**To check sensor A and B**: Measure between: white* and green (Sensor A) gray* and green (Sensor B) white and gray (Sensors A and B)	**P-Series** / **E-Series** 5-10 / 35-44 5-10 / 35-44 10-18 / 71-87	**Measurements outside typical values:** Primary faulty Replace or call Krohne service.
3	**To check the temperature sensor (RTD)**: Measure between: red and yellow red and blue yellow and blue	**P- and E-Series** 80 - 180 1 - 2 ** 80 - 180	**Measurements inside typical values:** Sensor OK

* For remote mounted converters, the wire colors gray and green are interchanged on the converter connection compartment

** Values will be higher for remote converters depending on cable length

9.9 Status Warnings

The MFC 081 can detect a number of anomalous conditions during operation. These are classed into four groups as follows :

LIGHT

These include :

- Mass flow >2x primary head rating.
- Temperature outside operating range
- Mass total overflow.

Typically these indicate a problem with the use of the instrument, not the instrument itself.

OUTPUT
These warnings occur where the converter is trying to drive a signal on either the current or frequency output which is outside the selected range. For example: Max flow = 10kg/min but actual flow is 15kg/min. If the current output was set for mass flow then it would saturate at 20mA (10kg/min) plus over-range. Saturation of the outputs in this way may or may not be a problem for the operator, so it is optional as to whether a warning is set or not in this case. (If required, the process alarm could be used to indicate independently the saturation of the outputs). In addition, if the Process Alarm is used to detect that a measured value is out of range then this also generates an output warning.

SEVERE
These include any fault that causes the primary head to stop vibrating. This may be due to large quantities of air in the process fluid or to poor clamping of the instrument. Severe errors may also be due to a hardware fault. The instrument will restart as soon as the fault clears.

FATAL
Fatal errors indicate a major fault with the converter. In this case the converter stops completely and then tries to restart as if it had just been switched on. Normally such errors will require repair by service personnel.

Viewing and acknowledging warning messages
Whenever a warning occurs the display will start to flash and the status arrow on the display will be set. The flashing display enables the operator to see from a distance that a problem has occurred. The operator can now inspect the list as follows:
Begin from measuring mode.

Key	Display line 1	line 2
↵	CodE 2	- -
↑	CodE	* -
→		RESET MASS
↑		MSG. LIST
→	≡2 Err≡	MASS FLOW
	(Flow > 2 x Nominal tube flow)	
	The "≡" symbols indicate that this warning has not previously been acknowledged.	
→	2 Err	I1 SAT
	(Current output saturated)	
↵		QUIT (YES)
↵		MSG. LIST

If the operator selects "QUIT YES" the status arrow will disappear if the causes of the warning have themselves cleared. However, if for example the mass flow is still too large, then the arrow will remain. On returning to the measurement, however, the display will have stopped flashing. This shows that the warnings have been acknowledged by the operator even if it was not possible to clear them. In this event, the flow rate should be reduced and "QUIT YES" selected again.

The user can control the level of warnings from Fct.1.2.2. This menu also allows the warning to be viewed directly from within the measurement mode if desired.

The operator can choose from:

NO MESSAGE
No warnings will be displayed in the main displays. Output saturation warnings ignored. Light warnings do not cause display to flash.

PRIMARY HEAD
Light warnings registered in main display. Output warnings ignored.

OUTPUT
Only output warnings in main display.

ALL MESG.
All warning messages displayed.

NOTE:
Only if "OUTPUT" or "ALL MESGS." are selected above will saturation of the outputs trigger a converter warning (display flashing etc.), otherwise these conditions are completely ignored.

If this facility is enabled then the operator may view the warnings as follows :
Begin from measuring mode

Key	Display line 1	line 2
	(23.124	kg/min)
	whole display flashing	
↑	(≡2 Err≡	Mass Flow)
	error not yet acknowledged	
↑	(0.98	g/cm3)
↑	(2 Err	I1 SAT)
↑	(1244.344	kg)
↑	(≡2 Err≡	Mass Flow)
↑	(20.4	°C)

To set up the converter to display errors in the measuring mode:

Begin from measuring mode

Key	Display line 1	line 2
→	Fct. (1).0.	OPERATOR
→↑	Fct. 1.(2).0.	DISPLAY
→↑	Fct. 1.2.(2)	STATUS MSG.
→		(NO MESSAGE)
↑		(PRIMRY.HEAD)
↑		(OUTPUT.)
↑		(ALL MESGS.)
↵	Fct. 1.2.(2)	STATUS MSG
4x↵		

If the current output is set to a range with a warning state (e.g. 0 - 20/22mA) then the output will jump to that state when any anomalous condition occurs.

10. Order numbers

Standard Converters			Order Number
100 - 240 V AC	Smart	CE	2107301000
21 - 48 V AC	Smart	CE	2107303400
24 V DC	Smart	CE	2107291000

Ex Converters			Order Number
100 - 240 V AC	Smart	CE	2107311000
21 - 48 V AC	Smart	CE	2107313400
24 V DC	Smart	CE	2107771000

Power Supply - Fuse F9		
Value	Order number	Fuse type
160 mA T	5.07379.00	5 × 20 mm G-Fuse Switching capacity 1500 A
315 mA T	5.05804.00	
800 mA T	5.08085.00	
1.6 A T	5.07823.00	
1.25 A T	5.09080.00	TR 5, switching capacity 35 A

Fuse		Value
F 10	+5 V Analog voltage	500 mA T
F 11	Negative Analog voltage	100 mA T
F 12	Input /output functions	160 mA T

These fuses F10, F11 & 12 are soldered into the power supply and are essential to ensure the system complies with the European Union's low voltage directive. Any attempt to replace these fuses will invalidate the waranty and should not be attempted by the customer. These fuses will only blow in the event of:

- Customer abuse, i.e. removing the display with the power still on.
- Hardware fault

Spares and accessories		Order number
1.	Special spanner for lid	3.07421.01
2.	Lid "O"ring seal	
3.	RS 232 Adaptor and Config. Software	2.10209.00
4.	MIC 500 hand-held communicator	2.07302.00
5.	Magnet	2.07053.00

Part D Technical Data and Dimensions

11. Technical Data

11.1 Primary Head

CORIMASS MFS 3000 - ...		1.5	10	30
Measuring ranges (for water at 20°C **or** 68°F)				
Nominal value		1.5 kg/min **or** 3.3 lb/min	10 kg/min **or** 22 lb/min	30 kg/min **or** 66 lb/min
Flowrates:	min	0.035 kg/min **or** 0.007 lb/min	0.25 kg/min **or** 0.55 lb/min	0.75 kg/min **or** 1.65 lb/min
	max	2.5 kg/min **or** 5.5 lb/min	13 kg/min **or** 29 lb/min	33.3 kg/min **or** 73.16 lb/min
Connections				
Screw fittings	Standard	Ermeto 6	Ermeto 8	Ermeto 12
	NPT (female)	¼" F and M	¼" F and M	½" F and M
	Swagelock	6 mm (0.24")	8 mm (0.31")	12 mm (0.47")
	Gyrolock	6 mm (0.24")	8 mm (0.31")	12 mm (0.47")
Flanges	DIN 2635 / PN 40	-	DN 15	DN 15/25
	ANSI 150 & 300RF	-	½"	½" / ¾"
Sanitary connections		on request	on request	on request
Pressure loss (for water at nominal flowrate, 20°C or 68°F)		0.6 bar **or** 8.7 psig	1.6 bar **or** 23 psig	1.8 bar **or** 25.8 psig
Product parameters				
Temperature	Standard	-50 to +80°C **or** -58 - +176°F	-50 to +80°C **or** -58 - +176°F	-50 to +80°C **or** -58 - +176°F
	Special vers.	-50 to +150°C **or** -58 to +392°F	-50 to +200°C **or** -58 to +392°F	-50 to +200°C **or** -58 to +392°F
Density		10 - 2000 kg/m^3 **or** 0.6 - 125 lb/ft^3	10 - 2000 kg/m^3 **or** 0.6 - 125 lb/ft^3	10 - 2000 kg/m^3 **or** 0.6 - 125 lb/ft^3
Nominal Pressure		160 bar **or** 2300 psig	250 bar **or** 3600 psig	300 bar **or** 4320 psig
Density error limits (0.5 - 2.0 g/cm^3 or 30 - 125 lb/ft^3 measuring range, field calib.)		± 0.007 g/cm^3 or ± 0.34 lb/ft^3	± 0.004 g/cm^3 or ± 0.15 lb/ft^3	± 0.002 g/cm^3 or ± 0.075 lb/ft^3
Thermal shock resistance		ΔT ≤ 10 K **or** ≤ 18°F per second		
Ambient temperature				
In operation		-30 to +60°C **or** -22 to +140°F		
In storage		-50 to +85°C **or** -58 to +185°F		
Materials				
Measuring tube		CrNi steel 1.4435, 1.4571 **or** SS 316 L, 316 Ti - AISI, Hastelloy C		
Housing		CrNi steel 1.4301 **or** SS 304 - AISI		
Terminal box		die-cast aluminium with epoxy finish		
Housing pressure resistance		information supplied on request		
Protection category (IEC 529 / EN 60529)		IP 67, equivalent to NEMA 6		
Hazardous-duty versions		pending		
Custody transfer		PTB certification 5.411 / 94.08		
Special versions				
Insulated measuring tube		on request		
Flameproof enclosure		25 bar **or** 360 psig		

CORIMASS MFS 2000 - ...	**1.5**	**10**	**30**	
Measuring ranges (for water at 20°C **or** 68°F)				
Nominal value	3.6 t/h **or** **1**30 lb/min	18 t/h **or** 660 lb/min	48 t/h **or** 1760 lb/min	90 t/h **or** 3300 lb/min
Flowrates: min	0.09 t/h **or** 3.3 lb/min	0.45 t/h **or** 16.5 lb/min	1.2 t/h **or** 44 lb/min	2.25 t/h **or** 82 lb/min
max	5.4 t/h **or** 200 lb/min	24 t/h **or** 880 lb/min	72 t/h **or** 2640 lb/min	120 t/h **or** 4400 lb/min
Connections / Materials				
Standard				
14571: DIN 2635/PN40	DN 25	DN 40	DN 80	DN 100
316 L: ANSI 150 RF	1”	2”	3”	4”
Hast.C: DIN 2636/PN 40	DN 15	DN 25	-	-
Special versions				
14571: DIN 2635/PN 40	DN 15	DN 25	DN 65	DN 80
DIN 2636/PN 63	DN 15	DN 25	DN 65	DN 80
ANSI 150 RF	¾”	1½”	2”	3”
ANSI 300 RF	¾”	1½”	3”	4”
SD tapered socket t o DIN 11851	DN 15	DN 25	DN 65	DN 80
SC screw connect.	DN 15	DN 25	DN 65	DN 80
TRI-Clamp	1”	1½”	3”	4”
JIS 2210 20 K	15 A	25 A	-	-
10 K	-	-	65 A	80 A
Pressure loss (for water at nom. flowrate, 20°C or 68°F)	0.7 bar **or** 10 psig	0.6 bar **or** 8.7 psig	0.5 bar **or** 7.3 psig	0.5 bar **or** 7.3 psig
Permissible gas volume percent (depending on application conditions)	< 15%	< 5%	< 2%	< 2%
Product parameters				
Temperature: Standard	-25 to +200°C **or** -13 to +392°F	-25 to +200°C **or** -13 to +392°F	-25 to +200°C **or** -13 to +392°F	-25 to +200°C **or** -13 to +392°F
Hazardous-duty version.	-25 to +130°C **or** -13 to 266°F	-25 to +130°C **or** -13 to 266°F	-25 to +130°C **or** -13 to 266°F	-25 to +130°C **or** -13 to 266°F
Density	500 - 2000 kg/m^3 or 30 - 125 lb/ft^3	500 - 2000 kg/m^3 or 30 - 125 lb/ft^3	500 - 2000 kg/m^3 or 30 - 125 lb/ft^3	500 - 2000 kg/m^3 or 30 - 125 lb/ft^3
Nominal Pressure (dependent on connection)	63 bar or 910 psig	63 bar or 910 psig	63 bar or 910 psig	63 bar or 910 psig
Density error limits (0.5 - 2.0 g/cm^3/30 - 125 lb/ft^3 measuring range, field calib.)	± 0.006 g/cm^3 **or** ± 0.29 lb/ft^3	± 0.003 g/cm^3 **or** ± 0.14 lb/ft^3	± 0.002 g/cm^3 **or** 0.10 lb/ft^3	± 0.002 g/cm^3 **or** ± 0.10 lb/ft^3
Thermal shock resistance	Δ T ≤ 10 K **or** ≤ 18°F per second			
Ambient temperature				
In operation	-25 to +60°C **or** -13 to +140°F			
In storage	-50 to +60°C **or** -58 to +140°F			
Materials				
Measuring tube Standard	CrNi steel 1.4435 SS 316 L, AISI,			
Special vers.	Hastelloy C (MFS 2000 - 60, - 300 only), CrNi steel 1.4571 or SS 316 Ti-AISI			
Housing	CrNi steel 1.4301 **or** SS 304 - AISI			
Terminal box	die-cast aluminium with epoxy finish			
Protection category (IEC 529 / EN 60529)	IP 67, equivalent to NEMA 6			
Hazardous-duty versions				
European Standard	pending			
FM approvals	pending			
Special versions				
Special versions				
Sanitary version, 3 A approval	Krohne America approval No. 529			
	Tubes are crevice free and electropolished to better than # 150 grit (70µ inches) finish.			
	Clean-In-Place design			
Insulated measuring tube	on request			
Flameproof enclosure	on request			

11.2 MFC 081 Signal Converter

Measured quantities and units			
Mass flowrate	g, kg, to, oz, lb per second, minute, hour, day		
Total mass (or total volume	g, kg, to, oz, lb (or cm^3, dm^3, m^3, liter, in^3, ft^3, imp. or US gallons)		
Density	g, kg, to per cm^3, dm^3, m^3, liter or oz, lb per in^3, ft^3, imp. or US gallons		
Volume flowrate	cm^3, dm^3, liter, m^3, in^3, ft^3, imp. or US gall per sec., minute, hour, day		
Temperature	°C or °F		
Option	sugar concentration in °Brix or Baumè, mass or volume concentration		
Settable functions	display format, physical units, current, pulse and status outputs, low-flow cut-off, time constant, primary constant, lower/upper range limits,, forward/reverse measurement, standby, zero and reset of total mass		
Input and outputs / versions	Standard	Option 1	Option 2
Current output	1 ×	2 × **not** galvanically isolated	2 × galvanically isolated from one another
Pulse (frequency) output	1 ×	–	–
Status output	1 × (active)	1 × (passive)	–
Binary input	1 ×	1 ×	–
Current output			
Function	– all operating data adjustable – galvanically isolated via optocoupler		
Current	0 - 20 mA or 4 - 20 mA		
Load	≤ 500 ohms		
Linearity	≤ 0.2% of measured value in range of 2 - 20 mA ≤ 0.02% of full scale deflection in range of 0 - 2 mA		
Pulse output	**not** provided if fitted with option (version) 1 or 2, see above "input and outputs"		
Function	– all operating data adjustable – open collector – galvanically isolated via optocoupler		
Pulse rate	up to 1300 Hz		
Amplitude	max. 24 V		
Load rating	≤ 150 mA		
External voltage	≤ 24 V DC		
Status indication output	**not** provided if fitted with option (version) 2, see "input and outputs" above. – all operating data adjustable – galvanically isolated via optocoupler		
Function	status, limit value, direction identification		
Voltage	max. 24 V, also suitable as voltage source for the pulse output		
Load rating	short-circuit proof		
Binary input	**not** provided if fitted with option (version) 2, see "input and outputs" above		
Function	– settable for totalizer reset, zero point, status acknowledgement or changeover standby ◄⟷► measuring mode – galvanically isolated via optocoupler – active "high" or "low"		
Control signals	high: 4 - 24 V or terminals open low: 0 - 2 V or terminals closed input current: < 0.2 mA		
Low-flow cut-off	0 - 10% of nominal full-scale range		
Time constant for flow	1 - 20 seconds (optionally: 0.5 - 20 seconds)		
Power supply			
Standard	230 V AC, ± 10% or 120 V AC, +10/-15%, 48 - 63 Hz (changeable 100, 200 or 115 V AC, ± 10%, 48 - 63 Hz)		
Special versions	21, 24, 42, 48 V AC, +10/-15%, 48 - 63 Hz 24 V DC, ± 30%		
Power consumption	AC : 18 VA DC : 10 W		

Operator control / interfaces		
Keypad	3 keys → ↵ ↑	
Local display: Type	3-line, illuminated LCD display 1st (top) line: 8 -character, 7 segments for numerals and signs 2nd (middle) line: 10-character, 14 segments for texts 3rd (bottom) line: 6 markers ▼ for status identification	
Function	actual measured value, forward, reverse or sum totaliser (7 characters), each can be set for continuous or cyclic display and status output.	
Measured quantities and units	see page 6 “measured quantities and units”	
Plain text language	English, German, French	
Magnetic sensors MP	same function as the 3 keys, operation by means of hand-held bar magnet without opening the housing	
smartSystem		
(option) Operator control	MIC 500 hand-held communicator	
Connection	to the two current output terminals	
Distance	max. 1000 m or 3300 ft between MIC 500 and signal converter	
Technical data	see separate “smartSystem” Data Sheet	
Housing material	die-cast aluminium with polyurethane finish	
Mass flow - Accuracies as % of measured value. (water, 20°C or 68°F)		
Span:	1 : 5	0.2%
	1 : 10	0.3%
	1 : 20	0.8%
	1 : 40	2.0%

11.3 Measuring Accuracy / Error limits

	CORIMASS MFS 3000 -			CORIMASS MFS 2000 - ...			
	1.5 E	**10 E**	**30 E**	**60 P**	**300 P**	**800 P**	**1500 P**
Mass flow	better than ± 0.15% MV + Cz			better than ± 0.15% MV + Cz			
Density (range 0.5-2 g/cm³or 30 to 125 lb/ft³, field calibration)	±0.004g/cm³ ±0.26 lb/ft³	±0.002g/cm³ ±0.13 lb/ft³	±0.001g/cm³ ±0.007 lb/ft³	±0.002g/cm³ ±0.13 lb/ft³	±0.002g/cm³ ±0.13 lb/ft³	±0.001g/cm³ ±0.007 lb/ft³	±0.001g/cm³ ±0.007 lb/ft³
Temperature (within temperature range)	≤1°C/≤1.8°F	≤1°C/≤1.8°F	≤1°C/≤1.8°F	≤1°C/≤1.8°F	≤1°C/≤1.8°F	≤1°C/≤1.8°F	≤1°C/≤1.8°F
Zero stability	±0.0003kg/min ±0.0007lb/min	±0.0014 g/min ±0.0031lb/min	±0.0045kg/min ±0.0099lb/min	±0.012kg/min ±0.03 lb/min	±0.045kg/min ±0.10 lb/min	±0.118 kg/min ±0.26 lb/min	±0.227kg/min ±0.50 lb/min
Repeatability	better than ± 0.04% MV = Cz MV = measured value $Cz = \left\{ \frac{\text{zero stability} \times 100\%}{\text{mass flow}} \right\}$			better than ± 0.04% MV = Cz MV = measured value $Cz = \left\{ \frac{\text{zero stability} \times 100\%}{\text{mass flow}} \right\}$			

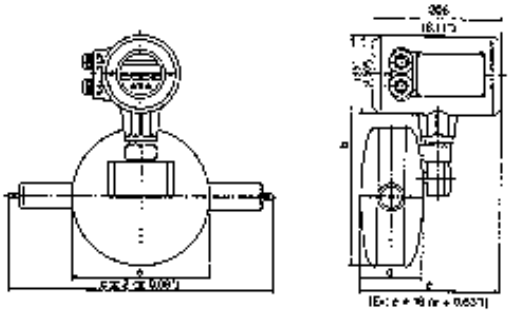
11.4 Dimensions and Weights

11.4.1 Compact Systems MFS 3081 K / MFS 2081 K

Dimensions in mm and (inches)	**Compact Systems**						
	MFM 3081 K			**MFM 2081 K**			
	1.5 E	**10 E**	**30 E**	**60 P**	**300 P**	**800 P**	**1500 P**
a	171 (6.73)	248 (9.76)	356 (14.02)	394 (15.51)	537 (21.14)	810 (31.98)	1152 (45.35)
b	313 (12.32)	382 (15.04)	500 (19.69)	564 (22.20)	736 (28.98)	890 (35.04)	946 (37.24)
c DIN flanges PN40	–	550 (21.65)	740 (29.13)	500 (19.69)	640 (25.20)	950 (37.40)	1300 (51.18)
c ANSI 150/300 RF	–	550 (21.65)	740 (29.13)	500 (19.69)	676 (26.61)	950 (37.40)	1300 (51.18)
c DIN flanges PN63	–	550 (21.65)	740 (29.13)	514 (20.24)	676 (26.61)	982 (38.66)	1328 (52.28)
c Screw	400 (15.75)	475 (18.70)	740 (29.13)	–	–	–	–
d	100 (3.94)	115 (4.53)	171 (6.73)	160 (6.30)	200 (7.87)	270 (10.63)	324 (12.76)
e	237 (9.33)	250 (9.84)	219 (8.62)	284 (11.18)	322 (12.68)	350 (13.78)	370 (14.57)
Weight in kg & (lb)	11 (24)	15 (33)	16.5 (37)	24 (53)	33 (73)	95 (210)	148 (327)

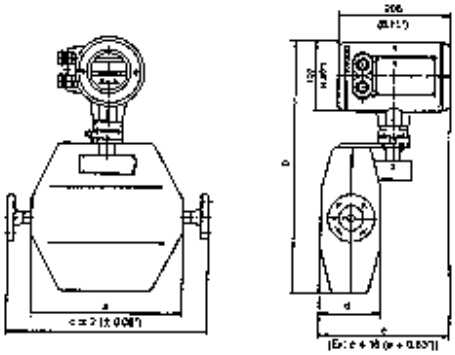
E Series

MFM 3081 K compact system



P Series

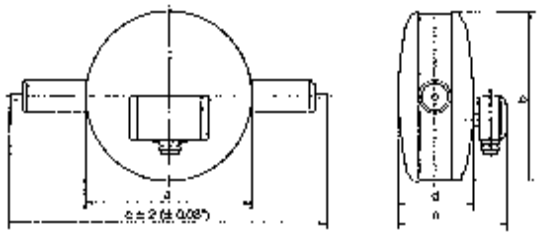
MFM 2081 K compact system



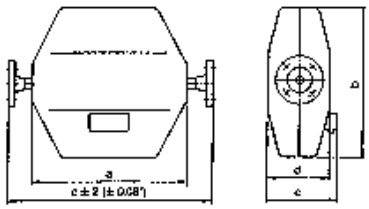
11.4.2 Remote Systems - MFS 3081 F / MFS 2081 F

Dimensions	**Transducer MFS 3000**			**Transducer MFS 2000**			
in mm and (inches)	**1.5 E**	**10 E**	**30 E**	**60 P**	**300 P**	**800 P**	**1500 P**
a	168....(6.61)	248 (9.76)	356 (14.02)	394 (15.51)	537 (21.14)	810 (31.98)	1152 (45.35)
b	168 (6.61)	248 (9.76)	500 (19.69)	424 (16.69)	596 (23.46)	750 (29.53)	824 (32.44)
c DIN flanges PN40	–	550 (21.65)	740 (29.13)	500 (19.69)	640 (25.20)	950 (37.40)	1300 (51.18)
c ANSI 150/300 RF	–	550 (21.65)	740 (29.13)	500 (19.69)	676 (26.61)	950 (37.40)	1300 (51.18)
c DIN flanges PN63	–	550 (21.65)	740 (29.13)	514 (20.24)	676 (26.61)	982 (38.66)	1328 (52.28)
c Screw	400 (15.75)	475 (18.70)	740 (29.13)	–	–	–	–
d	137 (5.40)	132 (5.20)	171 (6.73)	160 (6.30)	200 (7.87)	270 (10.63)	324 (12.76)
e	169 (6.65)	191 (7.52)	219 (8.62)	192 (7.56)	230 (9.06))	300 (11.81)	339 (13.35)
Weight in kg & (lb)	7 (15)	11 (24)	16.5 (37)	20 (44)	29 (64)	84 (185)	148 (327)

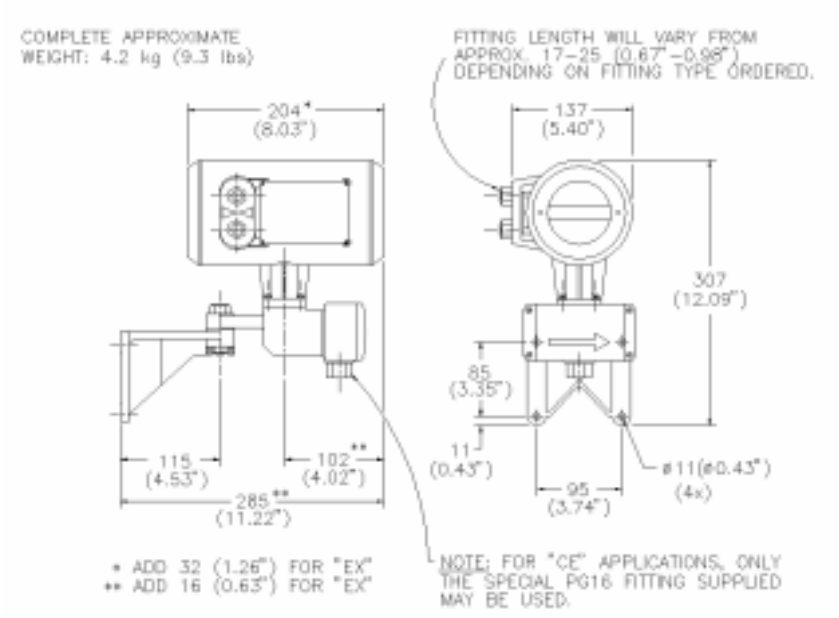
MFS 3000



MFS 2000



Converter - MFC 081 F



If you need to return flow meters for testing or repair to KROHNE

Your CORIMASS mass flow meter

- has been wet calibrated in an accurate flow meter test rig.

If installed and operated in accordance with these operating instructions, your flow meter will rarely present any problems.
Should you nevertheless need to return a CORIMASS flow meter for checkout or repair, please pay strict attention to the following points:

Due to statutory regulations concerning protection of the environment and the health and safety of our personnel, Krohne may only handle, test and repair returned flow meters that have been in contact with liquids if it is possible to do so without risk to personnel and environment. This means that Krohne can only service your flow meter if it is accompanied by a certificate in line with the following model confirming that the flow meter is safe to handle.

If the flow meter has been operated with toxic, caustic, flammable or water-endangering liquids, you are kindly requested

- to check and ensure, if necessary by rinsing or neutralising, that all cavities in the flow meter are free from such dangerous substances. (Directions on how you can find out whether the primary head has to be opened and then flushed out or neutralised are obtainable from Krohne on request.)
- to enclose a certificate with the flow meter confirming that the flow meter is safe to handle and stating the liquid used.

Krohne regret that they cannot service your flow meter unless accompanied by such a certificate.

SPECIMEN certificate

Company: ..... Address: .....

Department: ..... Name: .....

Tel. no.: .....

The enclosed Coriolis mass flow meter

CORIMASS, Type: ..... Krohne order no. or series no.: .....

has been operated with the following liquid:

.....

Because this liquid is water-endangering */toxic */caustic */flammable * we have:

- checked that all cavities in the flow meter are free from such substances*
- flushed out and neutralised all cavities in the flow meter *

(*delete if not applicable)

We confirm that there is no risk to man or environment through any residual liquid contained in this flow meter.

Date: ..... Signature: .....

Company stamp: