instrumentation
for fluids

XT5 /XT5H Converter for Flomid/Flomat Sensors

Instructions Manual

HART COMMUNICATION PROTOCOL

R-MI-XT5 Rev.: 2 English version

INDICE

1 INTRODUCTION

The XT5 converter is an electronic equipment that adapts to the Flomid and Flomat series electromagnetic flow sensors. The microprocessed electronic circuit offers the following benefits:

- Excitation of the coils by means of pulsed signal to obtain a minimal zero offset.
- Pulse and analog current outputs proportional to the flow rate and user configurable.
- Local and separate mounting.
- Easy interchangeability with other sensors.
- Display orientable 180º to adapt to the installation position.
- HART™ protocol compatibility (XT5H model).

2 ELECTRICAL CONNECTION

For the electrical connection, the XT5 has a screw terminal strip.

For the electrical installation it is recommended to use multiple conductor cables with individual cable sections in the order of 0.25 to 0.5 mm^2 in order to make it easier to connect. It is better to maintain the cables with mains voltage (power supply) separated from the cables with low level signals (4-20 mA etc.).

Before starting the installation, check that the cable glands are the right size for the cables to be used, this will guarantee the instrument will stay watertight. The PG 11 cable glands used are for cables with outside diameters between 6 mm and 10 mm.

Peel the outside insulation to free the inner cables. It is recommended to tin the ends of the wires to avoid loose ends. Pass the cables through the cable glands and screw down in the corresponding positions of the terminal strip. Once the wiring is finished make sure that the cables are well gripped by the cable glands to maintain the degree of protection.

IMPORTANT NOTE: In order to comply with the electrical safety requirements as per EN-61010-1 (IEC 1010-1), the installation of the equipment must take into account the following:

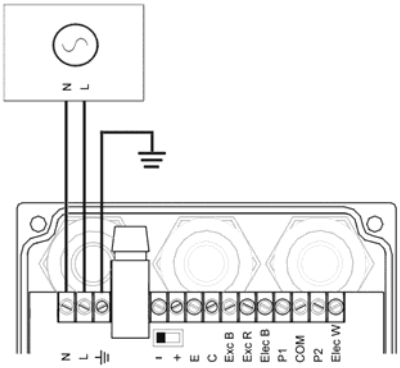
- A mains switch must be provided to disconnect the equipment. This switch must be marked as the disconnecting device for the equipment and be within easy reach of the operator.
- The mains supply must have an earth line.
- The housing must not be opened when the instrument has mains supply connected.

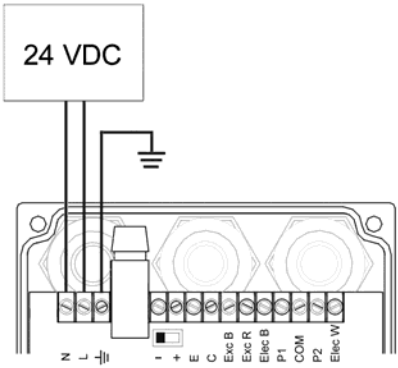
Before starting to install the equipment, check that the supply voltage available is the same as marked on the label of the instrument.

To help in the connecting of the equipment, the description of the terminals is marked on the printed circuit next to the terminal strip.

2.1 Power supply connection

Terminal	AC Power supply	DC Power supply
⏚	Earth	Earth
N	Neutral	0 V (-)
L	Phase	24 V (+)

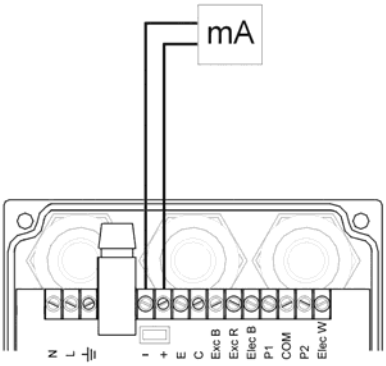




It is important to connect the mains earth to the instruments with AC power supply due to the presence of a mains filter inside that requires this connection.

2.2 Analog output connection

Terminal	
+	mA (positive).
-	mA (negative).

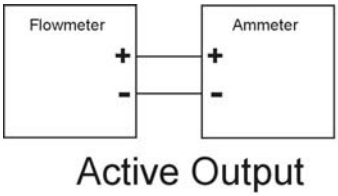


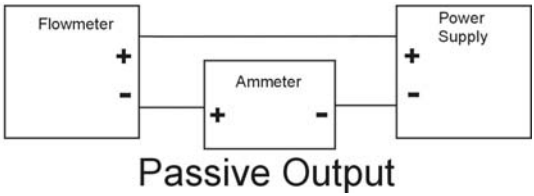
The analog output can be either active (that means the receptor must be passive) or passive (that means the receptor must supply the power for the current loop). It is recommended to use a receptor with an input resistance of less than 700 Ω to guarantee correct operation.

To configure the analog output type (active or passive) there is a slide switch situated just behind the terminal strip. For the passive mode the switch must be towards the positive terminal and for active mode the switch must be towards the negative terminal. To move the switch use the point of a small screwdriver.

In the case of using HART communication the output mode should be passive. Normally a HART master is active.

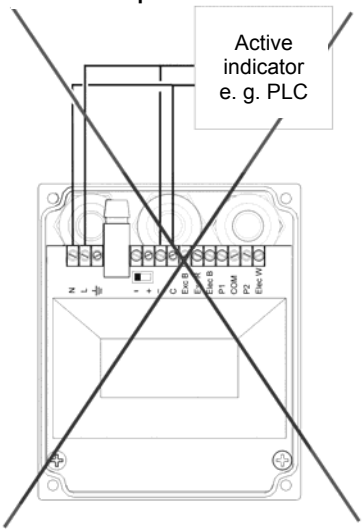
NOTE: The analog output has protection against reversed polarity. Due to another protection against over voltages, if a loop supply voltage of greater than 32 V is connected the equipment may be damaged.

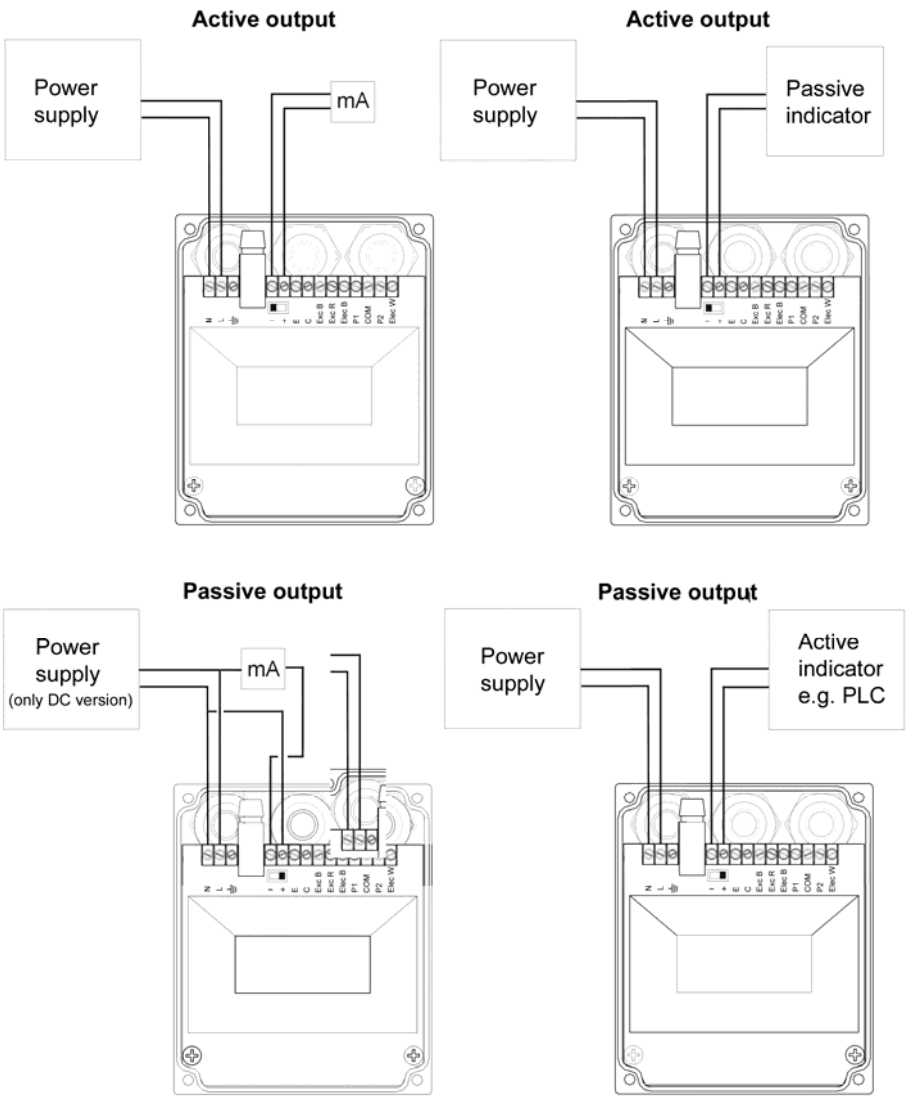




Possibilities of connection for the power supply and analog output

Passive output

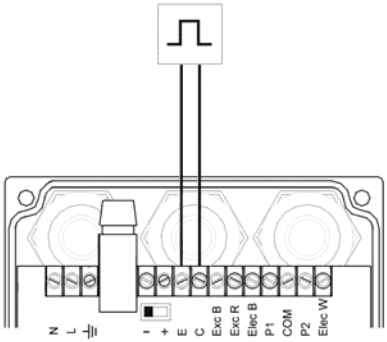



Active output
Power supply
mA
Active output
Power supply
Passive indicator
Passive output
Power supply
(only DC version)
mA
Passive output
Power supply
Active indicator e.g. PLC

mA: Ammeter

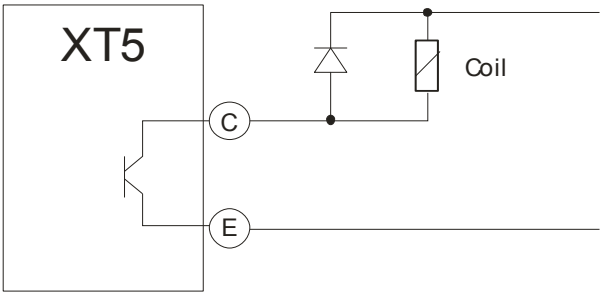
2.3 Pulse output connection

Terminal	
E	Emitter.
C	Collector.



The pulse output is opto-isolated. The terminals are the collector and emitter of an NPN bipolar transistor. Optionally this output can be supplied for AC loads (see 9.3).

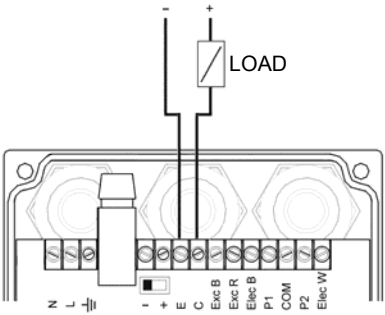
In the case of using inductive loads, in order to protect the output transistor, the use of free wheeling diodes is required.



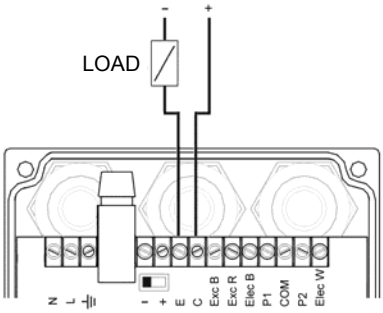
2.4 Connection examples

The two usual ways to connect the alarm outputs are NPN or PNP modes, depending on if the load is connected to the positive or negative terminal.
In the following figures, an example of connection for the alarm 2 in NPN and PNP mode can be seen.

NPN connection

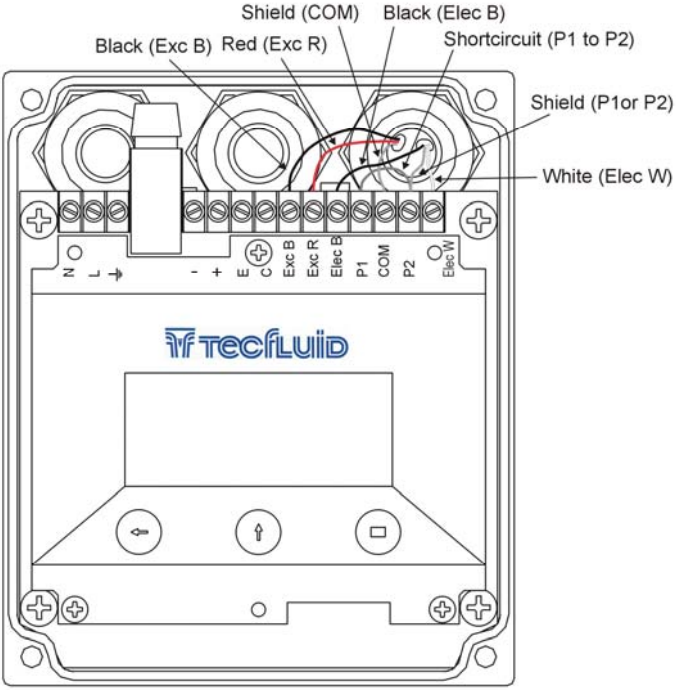


PNP connection



2.5 Sensor connection

When the electronics is mounted separate from the sensor, the interconnection is made through a cable gland. The terminals are the following:



Terminal			
Exc B	Top Coil (Black cable)	**Elec B**	Front electrode (black cable)
Exc R	Bottom coil (red cable)	**P1**	Front electrode shield (braid)
COM	Process earth (overall bried)	**P2**	Rear electrode (braid)
		Elec W	Rear electrode (white cable)

In the case of using a par-pos cable, which has two shielded pairs of cables (one for the electrodes and one for the coils) there is only one shield for the two electrode cables. In this case P1, P2 and COM terminals should be connected together and the electrode shield should be connected to one of these terminals and to the COM terminal.

3 OPERATION

The equipment is normally delivered calibrated and configured with its sensor so that it indicates the true flow rate and volume. If any configuration parameter is to be changed, this can be done without having to remove the top cover.

If the instrument has not been previously configured or, due to alteration of data in the memory the instrument recovers the default configuration, the word “PRESET” appears on the display. This indication disappears when the sequence of configuration has been completed.

In all the configuration screens the (□) key is used to jump to the next screen without making any changes in the configuration data even if digits have been changed.

3.1 Configuration of the flow rate calculation parameters

Touching the two keys (↑) & (←) at the same time the flow rate configuration process is entered.

3.1.1 Sensor factor

The first screen is to configure the sensor factor (Fc), which is given on the sensor label.

Touching the key (↑) the flashing digit will be increased. When the value of 9 is reached, on the next increment the digit will go to Zero. With the key (←) we move to the next digit to the left. If we are on the seventh digit we will go back to the first digit.

When we have the required factor on the screen, touching the two keys (↑) & (←) at the same time, the data will be stored in memory and the next screen will appear.

If not specified, the keys for the next screens have the same functions as in this first screen.

3.1.2 Electronics factor

In this screen we must introduce the electronics factor (Fe), which is indicated on the label on the front cover.

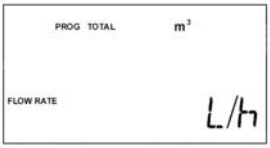
3.1.3 Nominal diameter

In this screen the nominal diameter (internal diameter) in millimetres of the sensor, or the pipe size in the case of a Flomat, is entered.

3.1.4 Measuring units

In the next screen the flow rate and volume totalizer units are selected.

To change the flow rate units the key (↑) is used. To change the volume totalizer units the key (←) is used.



The possible units for the flow rate and the volume totalizer are the following:

Flow Rate:

There are 9 combinations for the 3 units for volume and the 3 units for time.

Volume	/	time
l (litres)	/	s (second)
m3 (cubic metres)	/	m (minute)
ga (US gallons)	/	h (hour)

Volume totalizer:

There are 3 possible units for volume, l (litres), m3 (cubic metres), ga (US gallons).

Note: 1ga = 3.785 litres.

If the instrument has a mains power supply connection with the selected working units, touching the two keys (↑) & (←) at the same time, we return to the normal working screen.

3.1.5 Mains frequency

If the instrument has a DC power supply, user must configure the mains frequency of the country where the instrument is installed. This is done for filtering out line frequency noise found in the electrodes signal.

With the (↑) key the local mains frequency is selected (50 Hz or 60 Hz) and touching the two keys (↑) & (←) at the same time, we return to the normal working screen.

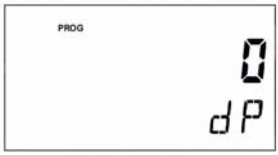
3.2 Configuration of the rest of the parameters.

Touching the two keys (↑) & (□) at the same time the configuration sequence for the display and output parameters is accessed.

3.2.1 Decimals

In the first screen the number of decimals for the flow rate indication is configured.

For this, touching the key (↑) the flashing digit will be increased. When the value of 2 is reached, on the next increment the digit will go to zero. When we have the required factor on the screen, touching the two keys (↑) & (←) at the same time, the data will be stored in memory.



To select the number of decimals it must be taken into account that the instrument has 4 digits for flow rate indication. If two decimals have been selected, these will be seen whilst the flow rate is not greater than 99.99. Above this value the indication will automatically change to one decimal, and when the flow rate is greater than 999.9 the indication will be done without decimals.

If one decimal is selected, the flow rate indication will have a maximum of one decimal.

If indication without decimals is selected, the flow rate will always be shown without decimals.

For the selection of the flow rate units and the number of decimals it must be taken into account that an indication with an excess of decimals may give the sensation of instability of the reading. As a general rule it can be considered that the reading should not have more than a total of 3 digits (integer + decimals).

3.2.2 Current output

Next, the screens for programming the current loop appear. The flow rate units will be those selected previously.

In the first screen the flow rate for the 4 mA point (lower range) is configured. In the next screen the flow rate for the 20 mA point (upper range) is configured.

3.2.3 Pulse output

In this screen, there are two options.

a) Frequency output (Hz). This is meant for transmitting the instantaneous flow rate to a remote unit. The output pulse frequency for a flow velocity of 5 m/s is programmed here (see limits in 9.3).

b) Pulse output per unit of volume (P/U). This is meant for remote totalizing. The number of pulses per unit of volume totalizer are programmed here. The pulse width is 80 ms. The maximum frequency is 6.25 Hz.

First the pulse output mode (Hz or P/U) is selected using the (↑) key. Once the output mode is selected, touch the (←) key and then enter the corresponding numerical value for the frequency at 5 m/s or pulses/unit according to the output mode selected.

3.2.4 Cut off

The sensor Flomid/Flomat with converter XT5, being an electromagnetic flow meter, has its maximum deviation in the low end of its working range. Due to this, a cut off flow rate can be configured, that means, the flow rate below which the flow rate indication will be zero.

3.2.5 Damping

The Flomid/Flomat XT5 flow meter has an adaptive filter (damping) to provide stable flow rate and analog output readings in the presence of continuous flow rate fluctuations.

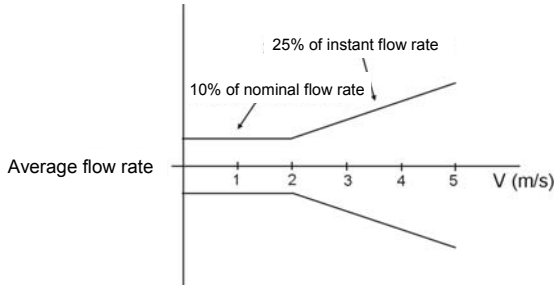
The configuration of this filter can be very useful in the cases where the flow rate readings have some instability (due to air bubbles, solids in suspension, etc…).

Only the flow rate indication of the display and the analog output are affected by the filter. The pulse output and the totalizer act according to the instant flow rate. By selecting a filter with a longer or shorter integration time will provide more or less stable readings and will also affect the response time to small variations of flow rate.

The integration time is selected in seconds, with a minimum value of 0.1 and a maximum value of 20.0 seconds. For example, with an integration time of 15 seconds, the display will indicate the flow rate reading of the average flow rate over the last 15 seconds from the last update of the display. This does not mean that the display is refreshing its data every 15 seconds. The display shows a new value several times per second, indicating an average of the flow rate values of the last 15 seconds.

When there is a sudden variation of the flow rate then the filter should react as fast as possible to give a correct reading of the new value. For this, the filter controls for each reading the deviation of the instant flow rate with respect to a reference. If this deviation exceeds the established limits, the filter will stop acting, indicating the instant value, and will start again the filtering process.

In the following figure we can see the allowed deviation for the filter to continue giving average values.



For example, consider a DN25 flow meter whose average flow rate is 4000 l/h.

4000 l/h corresponds to a liquid velocity of 2,27 m/s, situated in the second zone of the graphic. This means that the filter will continue giving average readings whilst the instant flow rate does not deviate more that 25% (1000l/h) from the average flow rate.

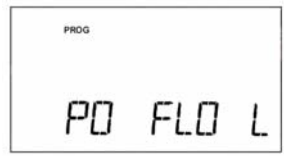
Since the average flow rate is 4000 l/h, the filter acts whilst the instant flow rate is within 3000 l/h and 5000 l/h.

If the average flow rate is for example 2000 l/h, it corresponds to a liquid velocity of 1,14 m/s, in this case we are in the first zone of the figure. This means that the filter will continue acting whilst the instant flow rate does not deviate from the average flow rate more that 10% from the nominal flow rate, that is 880 l/h (flow rate at 0,5 m/s in a DN25 = 880 l/h).

Since the average flow rate is 2000 l/h, the filter continues to act whilst the instant flow rate is within 1120 l/h and 2880 l/h.

3.2.6 Flow rate direction

In this screen the flow direction for which the flow rate indication will show a positive value can be programmed.



Using the (↑) key we change the positive flow direction from left to right (R) to right to left (L).

Note: In a Flomid sensor the left and right of the sensor are when looking at the sensor in a horizontal pipe and with the earth connection stud at the back. In a Flomat sensor left to right flow is indicated by the arrow on the sensor.

When the flow rate is negative the volume totalizer will not count.

3.2.7 Empty pipe detection

In the last screen the empty pipe detection (EP) can be enabled or disabled, using the (↑) key to change from ON (enabled) to OFF (disabled)

In an XT5H converter, if during a configuration sequence a HART^{TM} command, which should be attended, is received, the local configuration sequence will not be valid and all the data of that configuration sequence will be lost. The screen will return to the normal working screen and the word “PROG” will be displayed to show that this event has occurred. The word “PROG” will be turned off when touching either of the two keys (↑) or (←).

3.3 Zero offset adjustment

In order to obtain a perfect linearization of the instrument, it is recommended to make an adjustment of the zero offset.

IMPORTANT: The flow meter is delivered with the zero offset adjusted. Do not make a new adjustment if not necessary. An adjustment not done properly can become in incorrect flow rate values.

In order to make the adjustment, it is necessary that the flow rate through the instrument is zero.

The first step is to deactivate the adjustment. To do this, press the key (←) and the following screen is displayed.

Press the key (↑) until the word OFF appears. Press then the keys (←) & (↑). With this, the adjustment is deactivate.

Before doing the next step, be sure that the pipe is full and that there is not flow rate through the instrument.

Press the key (↑) again and change until the word ON appear. Press the keys (←) & (↑) and the zero offset adjustment is completed.

3.4 Visualization of the serial number and software version

Touching the three keys at the same time we access a screen where the serial number of the converter is shown.

In order to see the software version and return to the normal working screen, touch any key.

3.5 Empty pipe indication

When the XT5 detects that the pipe is empty the flow rate indication will disappear and in its place 4 dashes will be shown.

NOTE: When the XT5 is connected to the power supply the screen shows Empty Pipe until this state has been checked.

3.6 Reset

Touching the (←) and (□) keys at the same time the volume totalizer counter will be reset to zero and it will continue counting.

4 KEYBOARD DISABLE AND "WRITE PROTECT"

The instrument has a jumper, placed behind the display on the left side, which can be used to avoid changes in the configuration. When the jumper is connected the instrument can be configured by means of the keyboard and via HART™. When the jumper is removed, the keyboard is disabled and "Write Protect" is activated for HART™, thus avoiding any changes in the configuration.

5 CHANGING THE POSITION OF THE DISPLAY

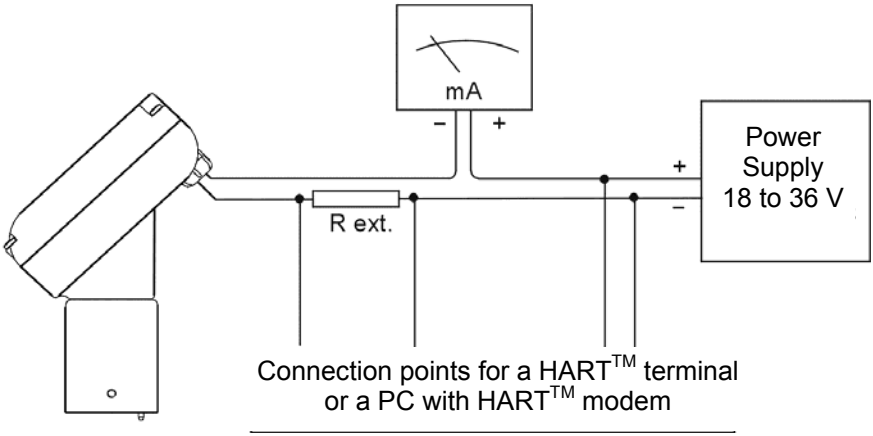
To change the orientation of the display in order to adapt it to the instrument mounting position, first disconnect the equipment from the power supply and remove the front cover. Remove the three screws that hold the display PCB to the base PCB (two screws in the corners opposite to the terminal strip and one central screw next to the terminal strip). Holding the PCB, pull on it to disconnect it. Rotate the display PCB 180º and reconnect it to its connector avoiding the pins to be bent. Reassemble the three screws that hold the display PCB and reassemble the front cover. Reconnect the instrument to its power supply

6 HART™ COMMUNICATION

The XT5H converter has a MODEM for HART™ communication.

The detail of the characteristics with respect to the HART™ communication are available in the corresponding “Field Device Specification” document.

To be able to use HART™ communication, a resistance (R ext.), whose value must not be lower than 200 Ohms, should be added to the current loop. The points at which a terminal or a PC with a HART™ modem can be connected are shown in the following figure.



Summary of the principal communication characteristics:

Manufacturer, Model and Revision	Tecfluid S.A., XT5 converter, Rev. 1
Device type	Transmitter
Hart Revision	6.0
Device Description available	No
Number and type of sensors	1, exterior
Number and type of actuators	0
Number and type of host side signals	1, 4 – 20 mA Analog
Number of Device Variables	2
Number of Dynamic Variables	1
Mappable Dynamic Variables	No
Number of Common Practice Commands	14
Number of Device Specific Commands	8
Bits of Additional Device Status	17
Burst mode?	No
Write Protection?	Yes

7 MAINTENANCE

No special maintenance is required .

For cleaning, a humid cloth can be used, and if necessary with a little soap. Solvents or other aggressive liquids which could damage the housing (polycarbonate) should not be used.

7.1 Fuse

In the event that the fuse blows, this should be replaced with a slow blow “T” fuse, size Ø5 x 20 mm and of the same rating as indicated on the label inside the equipment.

8 EXAMPLES OF USEFUL CALCULATIONS

8.1 Measurement error correction

The calibration of flow meters is made with water at 20 ^{o}C, obtaining a calibration for a liquid density of 1 kg/l and viscosity of 1 mPa·s. If the flow meter is used with a liquid of other characteristics from the above specified or for reasons of turbulences in the flow, measurement errors can be induced.

To correct these types of errors we can modify the value of the Fc factor programmed in the instrument.

Example - Shortage of volume

If we have a flow meter body which specifies Fc = 0.985, and when we check the volume of a batch, we find that instead of having 100 litres as programmed, we only have 95 litres (5% less), then the following correction must applied:

Fc	= Original sensor factor	= 0.985
V	= Expected Volume	= 100
Vr	= Real Volume	= 95
Fcn	= New sensor factor	= ? (1.037)

$$F_{cn} = \frac{F_c \cdot V}{V_r}$$

8.2 Configuration of pulses / unit of volume

As indicated in the point 3.2.3, the maximum frequency of the pulse output in mode pulses / unit is 6,25 Hz. In order to know if the desired number of pulses per unit of volume can reach this frequency, the following formula can be applied:

$$f_{max} = \text{Flow rate}_{max}\ (u/s) \times F_{p/u}$$

Where

fmax = Maximum frequency at the output

Flow rate$_{max}$ (u/s) = Maximum flow rate in units of volume per second

$F_{p/u}$ = Factor of pulses per unit of volume programmed in the converter

Example - Sensor DN 25 and programmed Factor = 100 pulses / litre

Firstly, we need to know what is the maximum flow rate that could pass through the flow meter. For example 9500 litres / hour.

Changing the flow rate to units of volume per second we obtain:

$$9500\ /\ 3600 = 2.639\ \text{litres / second}$$

Note that the units of volume are litres because in this example the programmed factor is 100 pulses / litre.

In this case, applying the formula, the maximum frequency at the output is:

$$f_{max} = 2.639 \times 100 = 263.9 \text{ Hz}$$

As the value exceeds 6.25 Hz, this factor can not be applied.

In this case there would be 2 solutions:

1. To change the factor to 1 pulse per litre, becoming the maximum frequency 100 times smaller, fmax = 2.639 Hz.
2. To change the units of volume to m3. With this, the maximum flow rate is divided by 1000 and therefore the maximum frequency becomes fmax = 0.2639 Hz.

9 TECHNICAL CHARACTERISTICS

9.1 Power supply

230, 240, 115, 24 VAC 50, 60 Hz . 24 VDC.
Power consumption: ≤ 5 VA

9.2 Analog output

4-20 mA. Active or passive. Galvanically isolated from the power supply.

9.3 Pulse output

Opto-isolated. Vmax: 30 VDC. Imax: 30 mA.
Maximum frequency in mode “P/U” : 6.25 Hz
Maximum frequency in mode “Hz” : 10 000 Hz
Minimum frequency in mode “Hz” : 0.04 Hz

Optional: Vmax: 240VAC / 350 VDC. Imax: 100 mA
Maximum frequency in mode “P/U” : 6.25 Hz
Maximum frequency in mode “Hz” : 75 Hz

9.4 Totalizer

Nº of digits:	7 (2 decimals)**
Digit size:	8 mm
Reset:	By means of key

9.5 Flow rate indication

Nº of digits:	4 (up to 2 decimals configurable)**
Digit size:	5 mm

** When the available digits are full and the integers overflow a decimal is automatically lost.

9.6 General characteristics

Protection rating:	IP67
Ambient temperature range:	0 ... +60 ºC

9.7 Electrical characteristics referred to the analog loop and communications

Reception impedance:

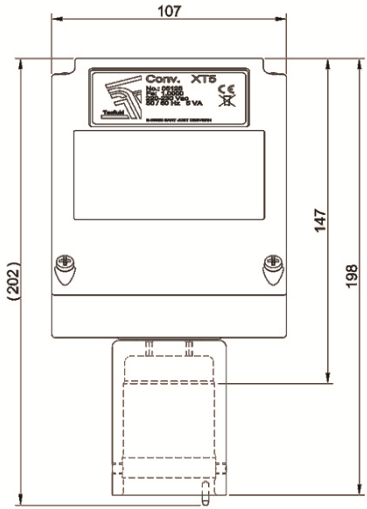
Rx	>	8,5 MΩ
Cx	<	200 pF

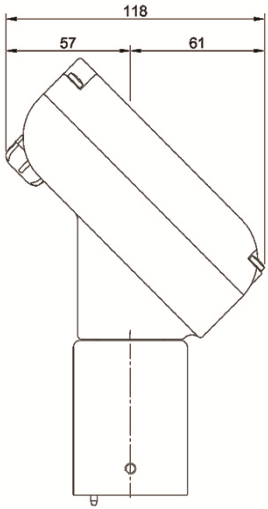
This equipment complies with the following EEC directives:
Low voltage (73/23/CEE)
Electromagnetic compatibility (89/336/CEE)

CE

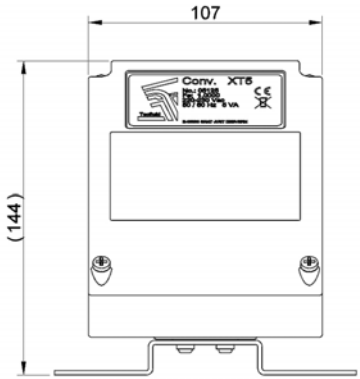
10 DIMENSIONS

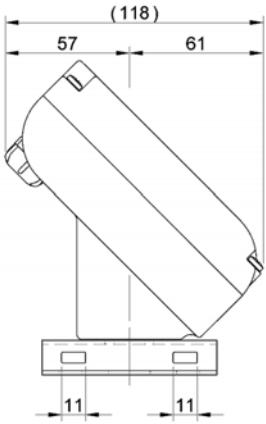
COMPACT MODEL

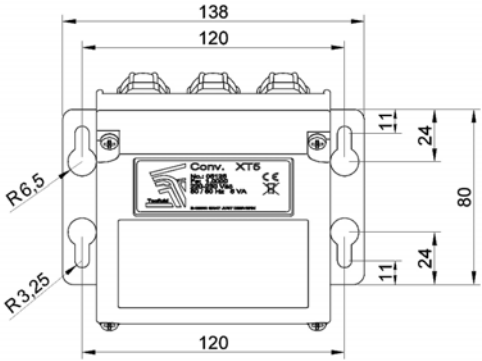




WALL MOUNTING MODEL





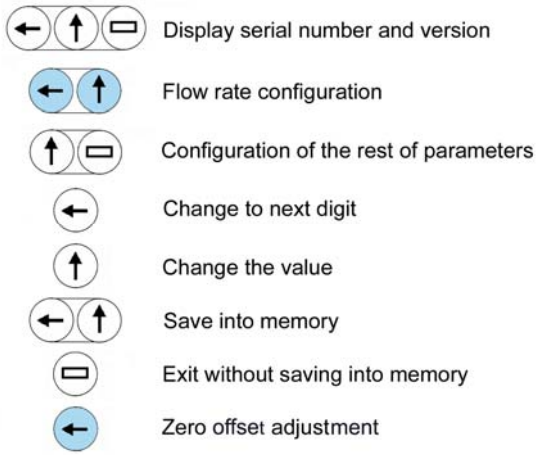


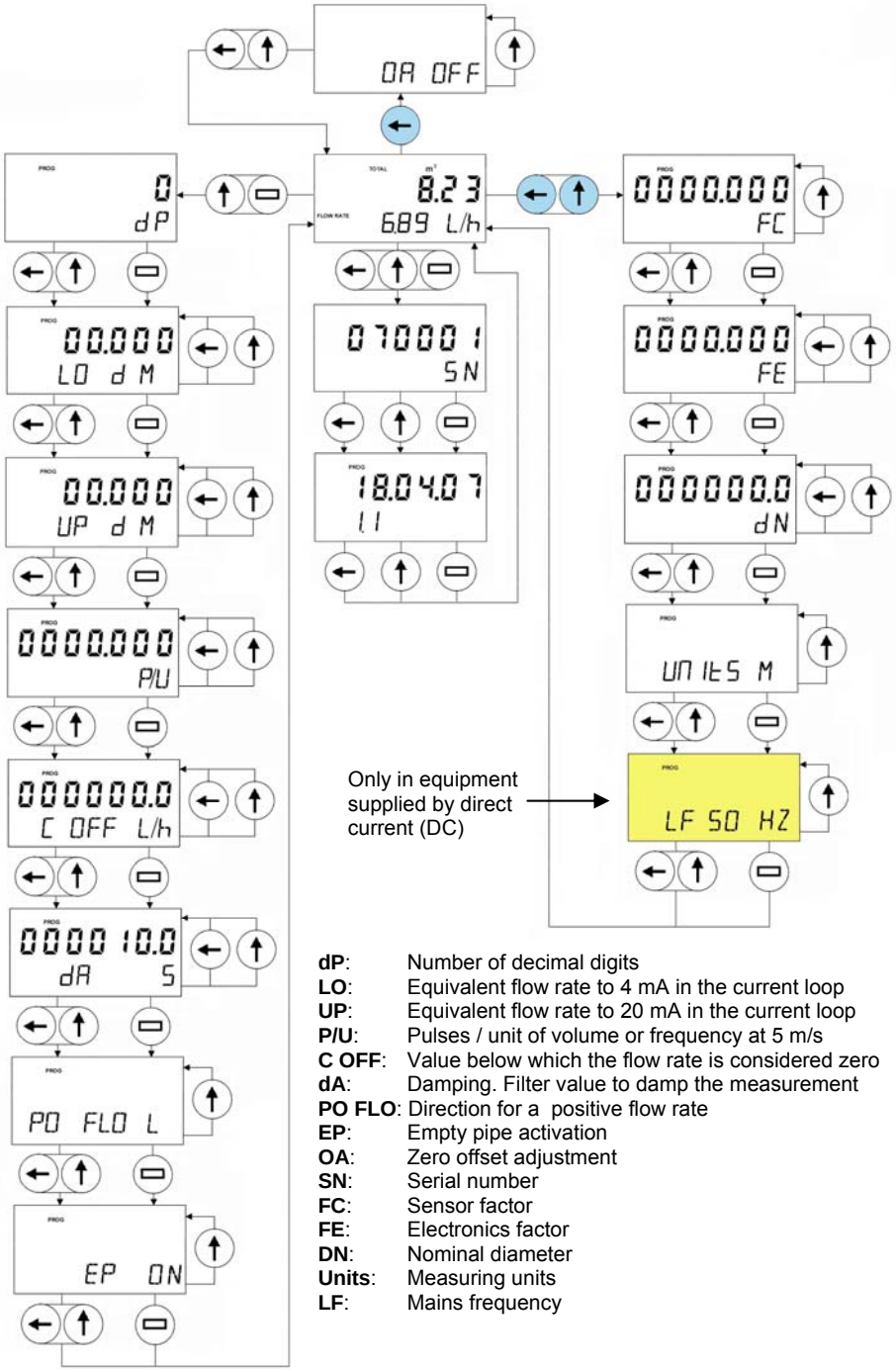
11 TROUBLESHOOTING

Problem	Probable cause	Remedy
The flow rate is not displayed. In its place there are dashes	The pipe is empty.	Make sure that the pipe is completely full, installing the flow meter in a section upstream of the pipe.
	The functional earth is not connected.	Connect the functional ground of the flow meter to a metallic point of the installation in contact with the liquid.
	Isolation of the electrodes.	Clean the sensor electrodes.
	Electrode cable disconnected	Connect the cable between the sensor and the electronic converter.
	Liquid with very low conductivity	The flow meter is not adequate for the application.
The flow rate is unstable	Dirt on the electrodes.	Clean the sensor electrodes.
	The product contains air or non-conductive particles in suspension.	Verify that the flow meter is adequate for this application.
	Alignment of the sensor (Flomat)	Verify that the orientation of the sensor is such that the arrow is orientated along the direction of the fluid.
The flow rate displayed is 0	Coil cable disconnected	Connect the cable between the sensor and the electronic converter.
	The flow rate is smaller than programmed as CUT OFF.	Decrease the value of the cut off (see page 9).
The instrument displays a value when there is not flow	The sensor is damaged due to electrodes corrosion.	Electrode material not adequate for the liquid.
	The functional earth is not connected and the empty pipe option is OFF.	Connect the functional ground of the flow meter to a metallic point of the installation in contact with the liquid.
The flow rate displayed is higher than expected	The electrodes are immersed but the pipe is not completely full.	Make sure that the pipe is completely full, installing the flow meter in a section upstream of the pipe.

Problem	Probable cause	Remedy
The display is blank	Fused fuse.	Change the fuse.
The analog output gives always 4 mA or 20 mA	Current output range not properly programmed.	Program the range properly (see page 9).
The analog output gives 0 mA	Cable disconnected	Check the cable connection
The pulse output does not work well	In pulse / unit of volume mode, the frequency is higher than 6,25 Hz	Decrease the pulses / unit of volume or change to frequency output mode (see page 9).
The totalizer does not change its value	The flow rate is negative (with respect to the fluid direction)	Program the positive flow rate direction according to the fluid direction (see page 11).
The keys do not act	The keys are locked “write protect”	Unlock the keys by placing the jumper (see page 13).

12 PROGRAMMING DIAGRAM





dP: Number of decimal digits
LO: Equivalent flow rate to 4 mA in the current loop
UP: Equivalent flow rate to 20 mA in the current loop
P/U: Pulses / unit of volume or frequency at 5 m/s
C OFF: Value below which the flow rate is considered zero
dA: Damping. Filter value to damp the measurement
PO FLO: Direction for a positive flow rate
EP: Empty pipe activation
OA: Zero offset adjustment
SN: Serial number
FC: Sensor factor
FE: Electronics factor
DN: Nominal diameter
Units: Measuring units
LF: Mains frequency