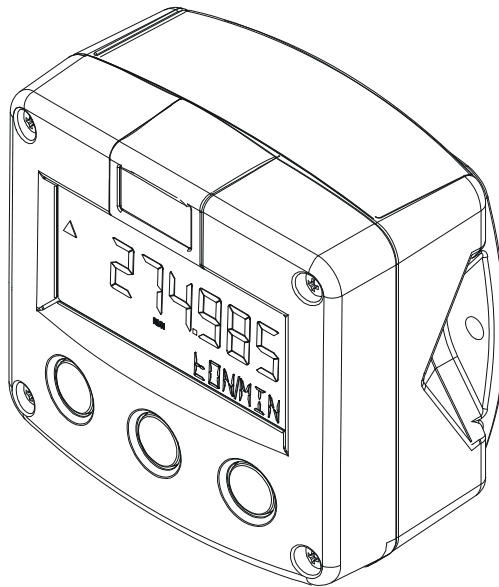


® **Badger Meter Europa GmbH**

F110P

Flowrate indicator / totalizer



INSTRUCTION MANUAL

September 2011

AC_F110P_BA_02_1109

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1. Basic safety recommendations

Before installing or using this product, please read this instruction manual thoroughly. Only qualified personnel should install and/or repair this product. If a fault appears, contact your distributor.

Installation

Do not place any unit on an unstable surface that may allow it to fall.
Never place the units above a radiator or heating unit.
Route all cabling away from potential hazards.
Isolate from the mains before removing any covers.

Power connection

Use only the type of power source suitable for electronic equipment. If in doubt, contact your distributor. Ensure that any power cables are of a sufficiently high current rating. All units must be earthed to eliminate risk of electric shock. Failure to properly earth a unit may cause damage to that unit or data stored within it.

Protection class

The device has protection class IP 67 and needs to be protected against dripping water, water, oils, etc.

Setup & operation

Adjust only those controls that are covered by the operating instructions. Improper adjustment of other controls may result in damage, incorrect operation or loss of data.

Cleaning

Switch off all units and isolate from mains before cleaning.
Clean using a damp cloth. Do not use liquid or aerosol cleaners.

Repair of faults

Disconnect all units from power supply and have it repaired by a qualified service person if any of the following occurs:

- If any power cord or plug is damaged or frayed
- If a unit does not operate normally when operating instructions are followed
- If a unit exposed to rain/water or if any liquid has been spilled into it
- If a unit has been dropped or damaged
- If a unit shows a change in performance, indicating a need for service.



RoHs

Our products are RoHs compliant.

Battery disposal

The batteries contained in our products need to be disposed of as per your local legislation acc. to EU directive 2006/66/EG.



2. Safety instructions



- Any responsibility is lapsed if the instructions and procedures as described in this manual are not followed.



- LIFE SUPPORT APPLICATIONS: The F110-P is not designed for use in life support appliances, devices, or systems where malfunction of the product can reasonably be expected to result in a personal injury. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify the manufacturer and supplier for any damages resulting from such improper use or sale.



- Electrostatic discharge does inflict irreparable damage to electronics! Before installing or opening the unit, the installer has to discharge himself by touching a well-grounded object.



- This unit must be installed in accordance with the EMC guidelines (Electro Magnetic Compatibility).



- Do not connect a proper grounding to the aluminum casing as indicated if the F110-P has been supplied with the 115-230V AC power-supply type PM. The green / yellow wire between the back-casing and removable terminal-block may never be removed.



- Intrinsically safe applications: Follow the instructions as mentioned in Chapter 9.

3. Safety rules and precautionary measures

- The manufacturer accepts no responsibility whatsoever if the following safety rules and precautions instructions and the procedures as described in this manual are not followed.
- Modifications of the F110-P implemented without preceding written consent from the manufacturer, will result in the immediate termination of product liability and warranty period.
- Installation, use, maintenance and servicing of this equipment must be carried out by authorized technicians.
- Check the mains voltage and information on the manufacturer's plate before installing the unit.
- Check all connections, settings and technical specifications of the various peripheral devices with the F110-P supplied.
- Open the casing only if all leads are free of potential.
- Never touch the electronic components (ESD sensitivity).
- Never expose the system to heavier conditions than allowed according to the casing classification (see manufacture's plate).
- If the operator detects errors or dangers, or disagrees with the safety precautions taken, then inform the owner or principal responsible.
- The local labor and safety laws and regulations must be adhered to.



4. About the operation manual

This operation manual is divided into two main sections:

- The daily use of the unit is described in chapter "Operation". These instructions are meant for users.
- The following chapters and appendices are exclusively meant for electricians/technicians. These provide a detailed description of all software settings and hardware installation guidance.

This operation manual describes the standard unit as well as most of the options available. For additional information, please contact your supplier.

A hazardous situation may occur if the F110-P is not used for the purpose it was designed for or is used incorrectly. Please carefully note the information in this operating manual indicated by the pictograms:



A "warning" indicates actions or procedures which, if not performed correctly, may lead to personal injury, a safety hazard or damage of the F110-P or connected instruments.



Caution !

A "caution" indicates actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the F110-P or connected instruments.



Note !

A "note" indicates actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned.

Hardware version:	02.01.xx
Software version:	02.02.xx

Information in this manual is subject to change without prior notice. The manufacturer is not responsible for mistakes in this material or for incidental damage caused as a direct or indirect result of the delivery, performance or use of this material.

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5. Introduction

5.1 System description of the F110-P

Functions and features

The flowrate / totalizer model F110-P is a microprocessor driven instrument designed to display flowrate, total and accumulated total.

This product has been designed with a focus on:

- Ultra-low power consumption to allow long-life battery powered applications (type PB / PC),
- Intrinsic safety for use in hazardous applications (type XI),
- Several mounting possibilities with aluminum or GRP enclosures for harsh industrial surroundings,
- Ability to process all types of flowmeter signals,
- Transmitting possibilities with analog / pulse and communication (option) outputs.

Flowmeter input

This manual describes the unit with a pulse type input from the flowmeter "-P version". Other versions are available to process (0)4-20mA or 0-10V flowmeter signals.

One flowmeter with a passive or active pulse, Namur or sine wave (coil) signal output can be connected to the F110-P. To power the sensor, several options are available.

Standard outputs

- Configurable pulse output: a scaled pulse mirroring a certain totalized quantity. Maximum frequency 60Hz.; the pulse length can be set from 7,8msec up to 2 seconds.
- Configurable linear (0)4-20mA or 0-10V analog output with 10-bits resolution mirroring the actual flowrate. Flowrate levels as well as the minimum and maximum signal output can be tuned.

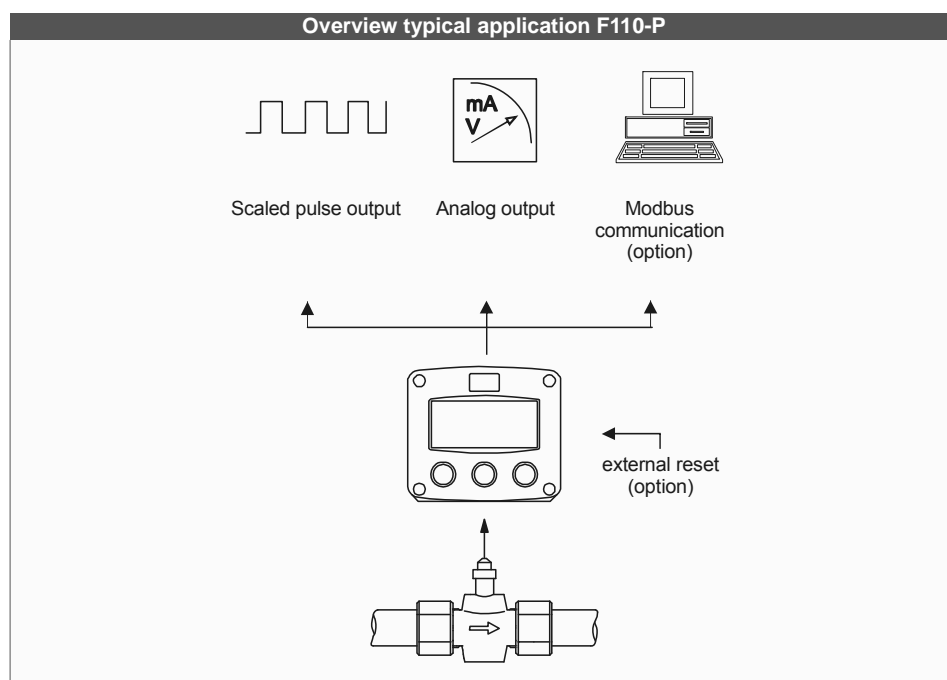


Fig. 1: Typical application for the F110-P



Configuration of the unit

The F110-P was designed to be implemented in many types of applications. For that reason, a SETUP-level is available to configure your F110-P according to your specific requirements.

SETUP includes several important features, such as K-factors, measurement units, signal selection etc. All settings are stored in EEPROM memory and will not be lost in the event of power failure or a drained battery.

To extend the battery-life time (option), please make use of the power-management functions.

Display information

The unit has a large transfective LCD with all kinds of symbols and digits to display measuring units, status information, trend-indication and key-word messages.

Flowrate and totals can be displayed either with the small 8mm digits or with the 17mm digits.

A backup of the total and accumulated total in EEPROM memory is made every minute.

Options

The following options are available: isolated or active 4-20mA / 0-10V / 0-20mA analog output, full ModBus[®] communication RS232/485/TTL (also battery powered), intrinsic safety, mechanical relay or active output, power- and sensor-supply options, panel-mount, wall-mount and weather-proof enclosures, flame proof enclosure and LED backlight.



6. Operational

6.1. General



- The F110-P may only be operated by personnel who are authorized and trained by the operator of the facility. All instructions in this manual are to be observed.
- Take careful notice of the "Safety rules, instructions and precautionary measures "in the front of this manual.

This chapter describes the daily use of the F110-P. This instruction is meant for users / operators.

6.2 Control panel

The following keys are available:

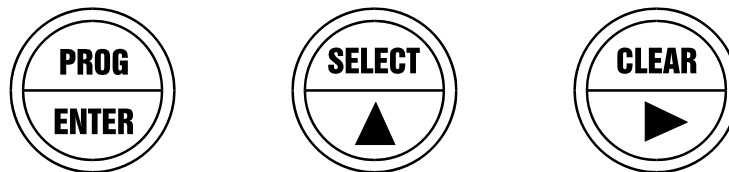


Fig. 2: Control Panel.

Functions of the keys:



This key is used to program and save new values or settings. It is also used to gain access to SETUP-level.



This key is used to SELECT accumulated total. The arrow-key ▲ is used to increase a value after PROG has been pressed or to configure the unit.



Press this key twice to CLEAR the value for total. The arrow-key ► is used to select a digit after PROG has been pressed or to configure the unit.

6.3 Operator information and functions

In general, the F110-P will always act at operator level. The information displayed is dependant upon the SETUP-settings. All pulses generated by the connected flow meter are measured by the F110-P in the background, whichever screen refresh rate setting is chosen. After pressing a key, the display will be updated very quickly during a 30 second period, after which it will slow-down again.



Fig. 3: Example of display information during process.



For the operator, the following functions are available:

Display flowrate / total or flowrate

This is the main display information of the F110-P. After selecting any other information, it will always return to this main display automatically.

Total is displayed on the upper-line of the display and flowrate on the bottom line.

It is possible to display flowrate only with the large 17mm digits; in this instance press the SELECT-key to read the total.

When "-----" is shown, then the flowrate value is too high to be displayed. The arrows \blacktriangle \blacktriangledown indicate the increase/decrease of the flowrate trend.

Clear total

The value for total can be re-initialized. To do so, press CLEAR twice. After pressing CLEAR once, the flashing text "PUSH CLEAR" is displayed. To avoid re-initialization at this stage, press another key than CLEAR or wait for 20 seconds.

Re-initialization of total DOES NOT influence the accumulated total.

Display accumulated total

When the SELECT-key is pressed, total and accumulated total are displayed. The accumulated total cannot be re-initialized. The value will count up to 99,999,999,999. The unit and number of decimals are displayed according to the configuration settings for total.

Low-battery alarm

When the battery voltage drops, it must be replaced. At first "low-battery" will flash, but as soon as it is displayed continuously, the battery MUST be replaced shortly after!

Only original batteries supplied by the manufacturer may be used, else the guarantee and liability will be terminated. The remaining lifetime after the first moment of indication is generally several days up to some weeks.



Fig. 4: Example of low-battery alarm.

Alarm 01-03

When "alarm" is displayed, please consult Appendix B: "Problem solving".



7. Configuration

7.1. Introduction

This and the following chapters are exclusively meant for electricians and non-operators. In these, an extensive description of all software settings and hardware connections are provided.



- Mounting, electrical installation, start-up and maintenance of the instrument may only be carried out by trained personnel authorized by the operator of the facility. Personnel must read and understand this Operating Manual before carrying out its instructions.
- The F110-P may only be operated by personnel who are authorized and trained by the operator of the facility. All instructions in this manual are to be observed.
- Ensure that the measuring system is correctly wired up according to the wiring diagrams. The housing may only be opened by trained personnel.
- Take careful notice of the "Safety rules, instructions and precautionary measures" in the front of this manual.

7.2. Programming SETUP-level

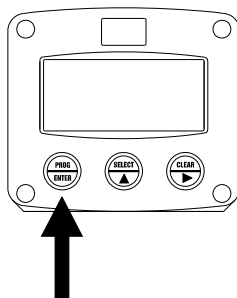
7.2.1 General


- Configuration of the F110-P is done at SETUP-level. SETUP-level is reached by pressing the PROG/ENTER key for 7 seconds; at which time, both arrows \blacktriangleleft will be displayed. In order to return to the operator level, PROG will have to be pressed for three seconds. Alternatively, if no keys are pressed for 2 minutes, the unit will exit SETUP automatically.
- SETUP can be reached at all times while the F110-P remains fully operational.



Note: A pass code may be required to enter SETUP. Without this pass code access to SETUP is denied.

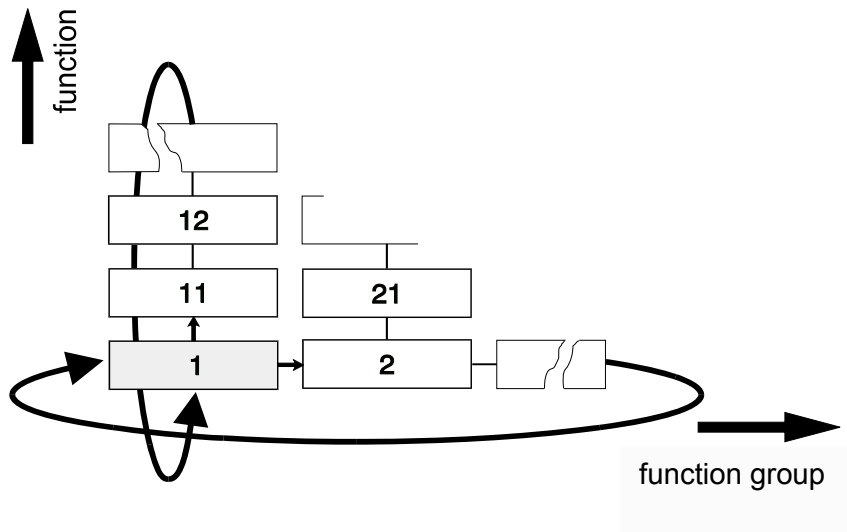
7.2.2 To enter SETUP-level



Press  for 7 seconds

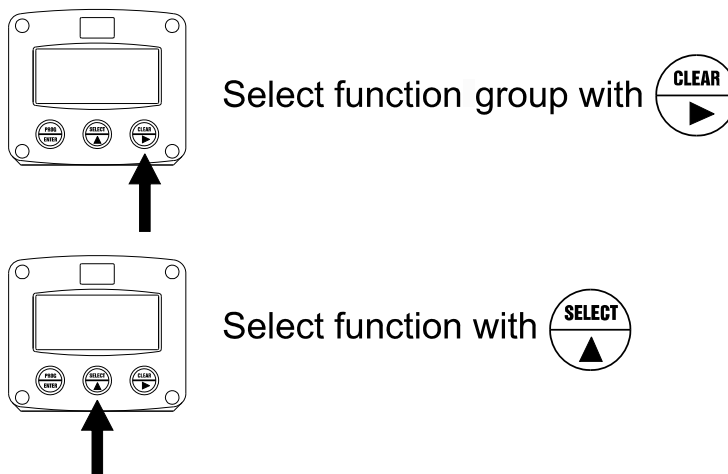
7.2.3 Matrix structure SETUP-level

Scrolling through setup-level



7.2.4 Selection of function group and function

SETUP is divided into several function groups and functions.

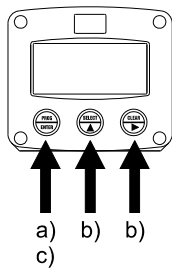






Each function has a unique number, which is displayed below the word "SETUP" at the bottom of the display. The number is a combination of two figures. The first figure indicates the function-group and the second figure the sub-function. Additionally, each function is expressed with a keyword.







After selecting a sub-function, the next main function is selected by scrolling through all "active" sub-functions (e.g. 1[▲], 11[▲], 12[▲], 13[▲], 14[▲], 1[▶], 2[▶], 3[▲], 31 etc.).



7.2.5 To change or select a value



- a) press  briefly; **PROGRAM** will start flash
- b) select or enter value with  and / or 
- c) press  to confirm the value / selection.

To change a value, use  to select the digits and  to increase that value. To select a setting, both  and  can be used. If the new value is invalid, the increase sign  or decrease-sign  will be displayed while you are programming.

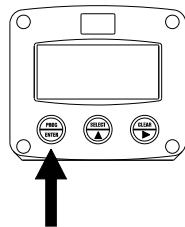
When data is altered but ENTER is not pressed, then the alteration can still be cancelled by waiting for 20 seconds or by pressing ENTER for three seconds: the PROG-procedure will be left automatically and the former value reinstated.



Note !

Note: alterations will only be set after ENTER has been pressed!

7.2.6 To return to OPERATOR level



Press  for 3 seconds

In order to return to the operator level, PROG will have to be pressed for three seconds. Also, when no keys are pressed for 2 minutes, SETUP will be left automatically.



7.2.7 Overview functions SETUP level


Setup functions and variables			
1 Total			
	11	UNIT	L - m3 - kg - lb - GAL - USGAL - bbl - no unit
	12	DECIMALS	0 - 1 - 2 - 3 (Ref: displayed value)
	13	K-FACTOR:	0.000010 - 9,999,999
	14	DECIMALS K-FACTOR	0 - 6
2 Flowrate			
	21	UNIT	mL - L - m3 - mg - g - kg - ton - GAL - bbl - lb - cf - REV - no unit - scf - Nm3 - NL - P
	22	TIME UNIT	sec - min - hour - day
	23	DECIMALS	0 - 1 - 2 - 3 (Ref: displayed value)
	24	K-FACTOR	0.000010 - 9,999,999
	25	DECIMALS K-FACTOR	0 - 6
	26	CALCULATION	per 1 - 255 pulses
	27	CUT-OFF	0.1 - 999.9 seconds
3 Display			
	31	FUNCTION	total - flowrate
4 Power management			
	41	LCD UPDATE	fast - 1 sec - 3 sec - 15 sec - 30 sec - off
	42	BATTERY MODE	operational - shelf
5 Flow meter			
	51	SIGNAL	nnp - npn_lp - reed - reed_lp - pnp - pnp_lp - namur - coil_hi - coil_lo - act_8.1 - act_12 - act_24
6 Analog			
	61	OUTPUT	disable - enable
	62	MINIMUM SIGNAL	0000.000 - 9,999,999 unit/time unit
	63	MAXIMUM SIGNAL	0000.000 - 9,999,999 unit/time unit
	64	CUT-OFF	0.0 - 9.9%
	65	TUNE MIN - (0)4mA / 0V	0 - 9,999
	66	TUNE MAX- 20mA / 10V	0 - 9,999
	67	FILTER	00 - 99
7 Impulse			
	71	PERIOD TIME	0 - 250
	72	IMPULSE PER	X,XXX,XXX quantity
8 Communication			
	81	SPEED / BAUDRATE	1200 - 2400 - 4800 - 9600
	82	ADDRESS	1 - 255
	83	MODE	ASCII - rtu - off
9 Others			
	91	TYPE / MODEL	
	92	SOFTWARE VERSION	
	93	SERIAL NO.	
	94	PASS CODE	0000 - 9999
	95	TAGNUMBER	0000000 - 9999999



7.2.8 Explanation of SETUP functions

1 - Total	
Measurement unit 11	<p>SETUP - 11 determines the measurement unit for total, accumulated total and pulse output. The following units can be selected:</p> <p style="text-align: center;">L - m3 - kg - lb. - GAL - USGAL - bbl - _ (no unit).</p> <p>Alteration of the measurement unit will have consequences for operator and SETUP-level values. Please note that the K-factor has to be adapted as well; the calculation is not done automatically.</p>
Decimals 12	<p>The decimal point determines for total, accumulated total and pulse output the number of digits following the decimal point. The following can be selected:</p> <p style="text-align: center;">0000000 - 111111.1 - 22222.22 - 3333.333</p>
K-factor 13	<p>With the K-factor, the flowmeter pulse signals are converted to a quantity. The K-factor is based on the number of pulses generated by the flowmeter per selected measurement unit (SETUP 11), for example per cubic meter. The more accurate the K-factor, the more accurate the functioning of the system will be.</p> <p>Example 1: Calculating the K-factor. <i>Let us assume that the flowmeter generates 2.4813 pulses per liter and the selected unit is "cubic meters / m3". A cubic meter consists of 1000 parts of one liter which implies 2,481.3 pulses per m3. So, the K-factor is 2,481.3. Enter for SETUP - 13: "2481300" and for SETUP - 14 - decimals K-factor "3".</i></p> <p>Example 2: Calculating the K-factor. <i>Let us assume that the flowmeter generates 6.5231 pulses per gallon and the selected measurement unit is gallons. So, the K-Factor is 6.5231. Enter for SETUP - 13: "6523100" and for SETUP - 14 decimals K-factor "6".</i></p>
Decimals K-factor 14	<p>This setting determines the number of decimals for the K-factor entered. (SETUP 13). The following can be selected:</p> <p style="text-align: center;">0 - 1 - 2 - 3 - 4 - 5 - 6</p> <p>Please note that this setting influences the accuracy of the K-factor indirectly. (i.e. the position of the decimal point and thus the value given). This setting has NO influence on the displayed number of digits for total (SETUP 12)!</p>




2 – Flow rate	
<p>The settings for total and flowrate are entirely separate. In this way, different units of measurement can be used for each e.g. cubic meters for total and liters for flowrate. The display update time for flowrate is one second or more. Note: these settings also influence the analog output.</p>	
<p>Measurement unit 21</p>	<p>SETUP - 21 determines the measurement unit for flowrate. The following units can be selected: mL - L - m3 - mg - g - kg - ton - GAL - bbl - lb - cf - REV - no unit - scf - Nm3 - NL - P.</p> <p>Alteration of the measurement unit will have consequences for operator and SETUP-level values. Please note that the K-factor has to be adapted as well; the calculation is not done automatically.</p>
<p>Time unit 22</p>	<p>The flowrate can be calculated per second (SEC), minute (MIN), hour (HR) or day (DAY).</p>
<p>Decimals 23</p>	<p>This setting determines for flowrate the number of digits following the decimal point. The following can be selected: 00000 - 1111.1 - 2222.22 - 3333.333</p>
<p>K-factor 24</p>	<p>With the K-factor, the flowmeter pulse signals are converted to a flowrate. The K-factor is based on the number of pulses generated by the flowmeter per selected measurement unit (SETUP 21), for example per liter. The more accurate the K-factor, the more accurate the functioning of the system will be. For examples read SETUP 13.</p>
<p>Decimals k-factor 25</p>	<p>This setting determines the number of decimals for the K-factor (SETUP 24). The following can be selected: 0 - 1 - 2 - 3 - 4 - 5 - 6</p> <p>Please note that this SETUP - influences the accuracy of the K-factor indirectly. This setting has NO influence on the displayed number of digits for "flowrate" (SETUP 23)!</p>
<p>Calculation 26</p> <div style="text-align: center;">  Note ! </div>	<p>The flowrate is calculated by measuring the time between a number of pulses, for example 10 pulses. The more pulses the more accurate the flowrate will be. The maximum value is 255 pulses.</p> <p>Note: this setting does influence the update time for the analog output directly (maximum update 10 times a second). If the output response is too slow, decrease the number of pulses.</p> <p>Note: the lower the number of pulses, the higher the power consumption of the unit will be (important for battery powered applications).</p> <p>Note: for low frequency applications (below 10Hz): do not program more than 10 pulses else the update time will be very slow.</p> <p>Note: for high frequency application (above 1kHz) do program a value of 50 or more pulses.</p>
<p>Cut-off time 27</p>	<p>With this setting, you determine a minimum flow requirement threshold, if during this time less than XXX-pulses (SETUP 26) are generated, the flowrate will be displayed as zero. The cut-off time has to be entered in seconds - maximum time is 999 seconds (about 15 minutes).</p>



3 - Display	
Function 31	<p>The large 17mm digits can be set to display total or flowrate. When "total" is selected, both total and flowrate are displayed simultaneously.</p> <p>When "flowrate" is selected, only flowrate will be displayed with it's measuring unit while total will be displayed after pressing SELECT.</p>

4 - Power management	
<p>When used with the internal battery option, the user can expect reliable measurement over a long period of time. The F110-P has several smart power management functions to extend the (optional) battery life time significantly. Two of these functions can be set:</p>	
lcd new 41	<p>The calculation of the display-information influences the power consumption significantly. When the application does not require a fast display update, it is strongly advised to select a slow refresh rate. Please understand that NO information will be lost; every pulse will be counted and the output signals will be generated in the normal way.</p> <p>The following can be selected:</p> <p style="text-align: center;">Fast - 1 sec - 3 sec - 15 sec - 30 sec - off.</p> <p>Example 3: Battery life-time Battery life-time with a coil pick-up, 1KHz. pulses and FAST Update: about 2 years. Battery life-time with a coil pick-up, 1KHz. pulses and 1 sec Update: about 5 years.</p> <p>Note: After a button has been pressed by the operator - the display refresh rate will always switch to FAST for 30 seconds. When "OFF" is selected, the display will be switched off after 30 seconds and will be switched on as soon as a button has been pressed.</p>
Battery-mode 42	<p>The unit has two modes: operational or shelf.</p> <p>After "shelf" has been selected, the unit can be stored for several years; it will not count pulses, the display is switched off but all settings and totals are stored. In this mode, power consumption is extremely low.</p> <p>To wake up the unit again, press the SELECT-key twice.</p>



5 - Flowmeter				
Signal 51  Note !	The F110-P is able to handle several types of input signal. The type of flowmeter pickup / signal is selected with SETUP 51. Note: The selections "active pulse" offer a detection level of 50% of the supply voltage. Read also "Flowmeter input terminal 09-11" on page 28.			
Type of signal	Explanation	Resistance	Freq. / mV	Remark
NPN	NPN input	100K pull-up	6 kHz.	(open collector)
NPN - LP	NPN input with low pass filter	100K pull-up	2.2 kHz.	(open collector) less sensitive
REED	Reed-switch input	1M pull-up	1.2 kHz.	
REED - LP	Reed-switch input with low pass filter	1M pull-up	120 Hz.	Less sensitive
PNP	PNP input	100K pull-down	6 kHz.	
PNP - LP	PNP input with low pass filter	100K pull-down	700 Hz.	Less sensitive
NAMUR	Namur input	820 Ohm pull-down	4 kHz.	External power required
COIL HI	High sensitive sine-wave (coil) input	-	20mVp-p.	Sensitive for disturbance!
COIL LO	Low sensitive sine-wave (coil) input	-	90mVp-p.	Normal sensitivity
ACT_8.1	Active pulse input 8.1 VDC	3K9	10KHz.	External power required
ACT_12	Active pulse input 12 VDC	4K	10KHz.	External power required
ACT_24	Active pulse input 24 VDC	3K	10KHz.	External power required





6 - Analog output

A linear analog (0)4-20mA or 0-10V signal is generated according to the flowrate with a 10 bits resolution. The settings for flowrate (SETUP - 2) influence the analog output directly. The relationship between rate and analog output is set with the following functions:

Disable / enable 61
The analog output can be disabled. In case of a passive analog output type AP, 3.5mA will be generated if a power supply is available but the output is disabled.

Minimum flowrate 62
Enter here the flowrate at which the output should generate the minimum signal (0/4mA or 0V) - in most applications at flowrate "zero". The number of decimals displayed depend upon SETUP 23. The time and measuring units (L/min for example) are dependant upon SETUP 21 and 22 but are not displayed.

Maximum flowrate 63
Enter here the flowrate at which the output should generate the maximum signal (20mA or 10V) - in most applications at maximum flow. The number of decimals displayed depend upon SETUP 23. The time and measuring units (L/min for example) are dependant upon SETUP 21 and 22 but can not be displayed.

Cut-off 64
To ignore leakage of the flow for example, a low flow cut-off can be set as a percentage of the full range of 16mA, (or 20mA or 10V). When the flow is less than the required rate, the current will be the minimum signal (0/4mA or 10V).
Examples:

4mA (SETUP 62)	20mA (SETUP 63)	Cut-off (SETUP 64)	Required rate	Output
0 L/min	100 L/min	2%	$(100-0)*2\% = 2.0 \text{ L/min}$	$4+(16*2\%) = 4.32\text{mA}$
20 L/min	800 L/min	3.5%	$(800-20)*3.5\%= 27.3 \text{ L/min}$	$4+(16*3.5\%)=4.56\text{mA}$

Tune min / 4MA 65

The initial minimum analog output value is 0/4mA or 0V. However, this value might differ slightly due to external influences such as temperature for example. The 0/4mA or 0V value can be tuned precisely with this setting.

- **Before tuning the signal, be sure that the analog signal is not being used for any application!**

After pressing PROG, the current will be about 4mA (or 0mA / 0V). The current can be increased / decreased with the arrow-keys and is directly active. Press ENTER to store the new value.
Remark: the analog output value can be programmed "up-side-down" if desired, so 20mA at minimum flowrate for example!

Tune max / 20mA 66

The initial maximum analog output value is 20mA (or 10V). However, this value might differ slightly due to external influences such as temperature for example. The 20mA value (or 10V) can be tuned precisely with this setting.


- **Before tuning the signal, be sure that the analog signal is not being used for any application!**

After pressing PROG, the current will be about 20mA. The current can be increased / decreased with the arrow-keys and is directly active. Press ENTER to store the new value.
Remark: the analog output value can be programmed "up-side-down" if desired, so 4mA at maximum flowrate for example!

Continued next page >>>



6 - Analog output (continued)				
Filter 67	This function is used to stabilize the analog output signal. The output value is updated every 0.1 second. With the help of this digital filter a more stable but less precise reading can be obtained. The filter principal is based on three input values: the filter level (01-99), the last analog output value and the last average value. The higher the filter level, the longer the response time on a value change will be. Below, several filter levels with their response times are indicated:			
Filter value	Response time on step change of analog value.			
	Time in seconds			
	50% Influence	75% Influence	90% Influence	99% Influence
01	filter disabled	filter disabled	filter disabled	filter disabled
02	0.1 second	0.2 second	0.4 second	0.7 second
03	0.2 second	0.4 second	0.6 second	1.2 seconds
05	0.4 second	0.7 second	1.1 seconds	2.1 seconds
10	0.7 second	1.4 seconds	2.2 seconds	4.4 seconds
20	1.4 seconds	2.8 seconds	4.5 seconds	9.0 seconds
30	2.1 seconds	4 seconds	7 seconds	14 seconds
50	3.5 seconds	7 seconds	11 seconds	23 seconds
75	5.2 seconds	10 seconds	17 seconds	34 seconds
99	6.9 seconds	14 seconds	23 seconds	45 seconds

7 - Relay output			
One transistor or mechanic relay output is available as scaled pulse output according to the accumulated total.			
Period time Pulse output 71  Note !	The period time determines the time that the transistor or relay will be switched; in other words the pulse length. The minimum time between the pulses is as long as the selected period time. One period is approx. 7.8 msec. If the value selected is "zero", the pulse output is disabled. The maximum value is 255 periods. Note: If the frequency should go out of range - when the flowrate increases for example - an internal buffer will be used to "store the missed pulses": As soon as the flowrate reduces again, the buffer will be "emptied". It might be that pulses will be missed due to a buffer-overflow, so it is advised to program this setting within it's range. If a mechanic relay is used for the pulse output, it is recommended to reduce the max. output frequency to 0.5Hz, else the life time will be reduced significantly.		
	Number of periods	Period time	Max. frequency
	0	disabled	disabled
	1	0,0078 seconds	64 Hz.
	2	0,0156 seconds	32 Hz.
	3	0,0234 seconds	21 Hz.
	64	0,5000 seconds	1 Hz.
255	1,9922 seconds	0.25 Hz.	
Pulse per 72	According to the measurement unit settings for total, a pulse will be generated every X-quantity. Enter this quantity here while taking the displayed decimal position and measuring unit into account.		



8 - Communication (optional)	
The functions described below deal with hardware that is not part of the standard delivery. Programming of these functions does not have any effect if this hardware has not been installed. Consult Appendix C and the ModBus® communication protocol description for a detailed explanation.	
Baudrate 81	For external control, the following communication speeds can be selected: 1200 - 2400 - 4800 - 9600 baud
Bus address 82	For communication purposes, a unique identity can be attributed to every F110-P. This address can vary from 1-255.
Mode 83	The communication protocol is ModBus® ASCII or RTU mode. Select OFF to disable this communication function.

9 - Others	
Type of model 91	For support and maintenance it is important to have information about the characteristics of the F110-P. Your supplier will ask for this information in the case of a serious breakdown or to assess the suitability of your model for upgrade considerations.
Version software 92	For support and maintenance it is important to have information about the characteristics of the F110-P. Your supplier will ask for this information in the case of a serious breakdown or to assess the suitability of your model for upgrade considerations.
Serial number 93	For support and maintenance it is important to have information about the characteristics of the F110-P. Your supplier will ask for this information in the case of a serious breakdown or to assess the suitability of your model for upgrade considerations.
Pass code 94	All SETUP-values can be pass code protected. This protection is disabled with value 0000 (zero). Up to and including 4 digits can be programmed, for example 1234.
Tagnumber 95	For identification of the unit and communication purposes, a unique tag number of maximum 7 digits can be entered.



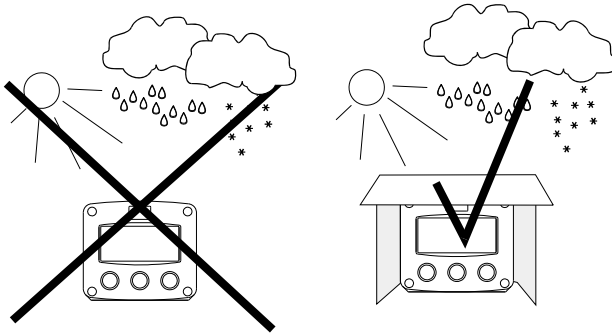
8. Installation

8.1. General directions



- Mounting, electrical installation, start-up and maintenance of this instrument may only be carried out by trained personnel authorized by the operator of the facility. Personnel must read and understand this Operating Manual before carrying out its instructions.
- The F110-P may only be operated by personnel who are authorized and trained by the operator of the facility. All instructions in this manual are to be observed.
- Ensure that the measuring system is correctly wired up according to the wiring diagrams. Protection against accidental contact is no longer assured when the housing cover is removed or the panel cabinet has been opened (danger from electrical shock). The housing may only be opened by trained personnel.
- Take careful notice of the " Safety rules, instructions and precautionary measures " at the front of this manual.

8.2. Installation / surrounding conditions

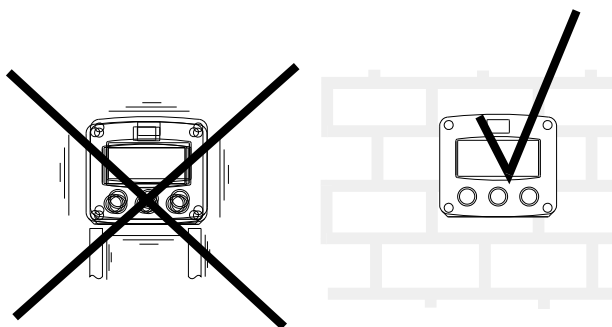


Take the relevant IP classification of the casing into account (see manufactures plate). Even an IP67 (NEMA 4X) casing should NEVER be exposed to strongly varying (weather) conditions.

When panel-mounted, the unit is IP65 (NEMA 4)!

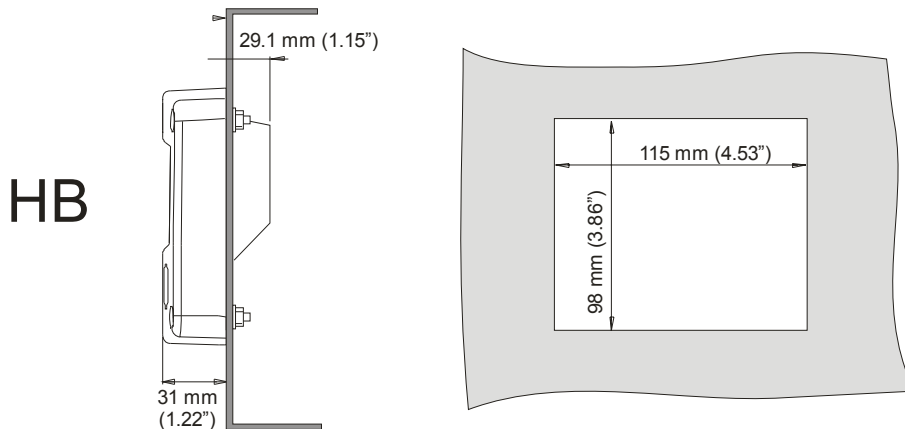
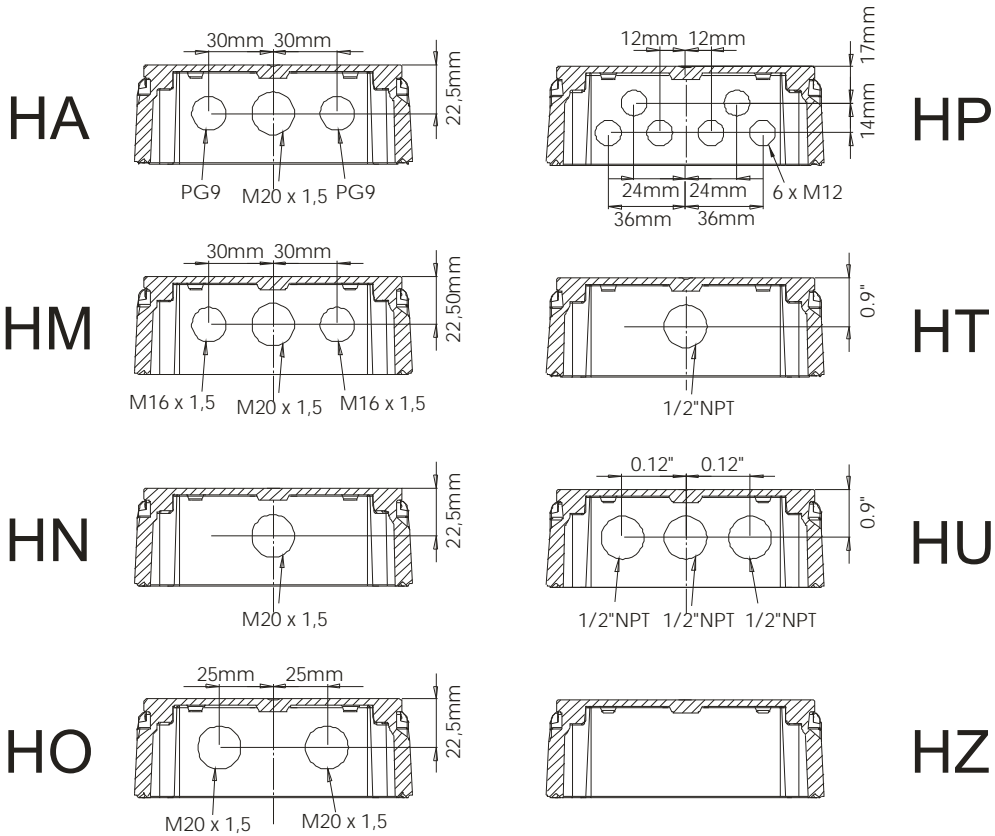
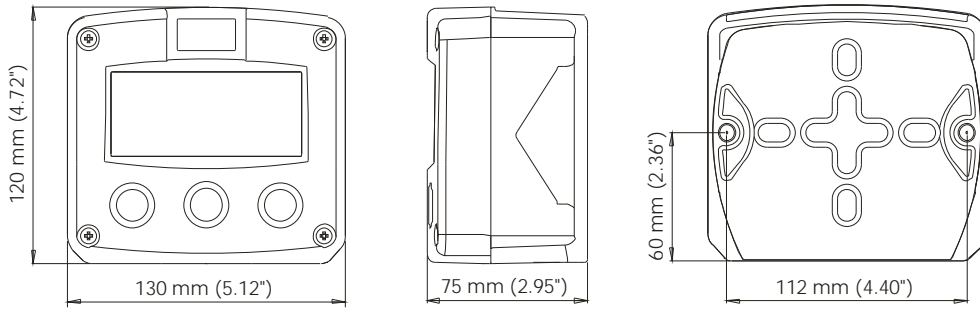
When used in very cold surroundings or varying climatic conditions, take the necessary precautions against moisture by placing a dry sachet of silica gel, for example, inside the instrument case.

Mount the F110-P on a solid structure to avoid vibrations.

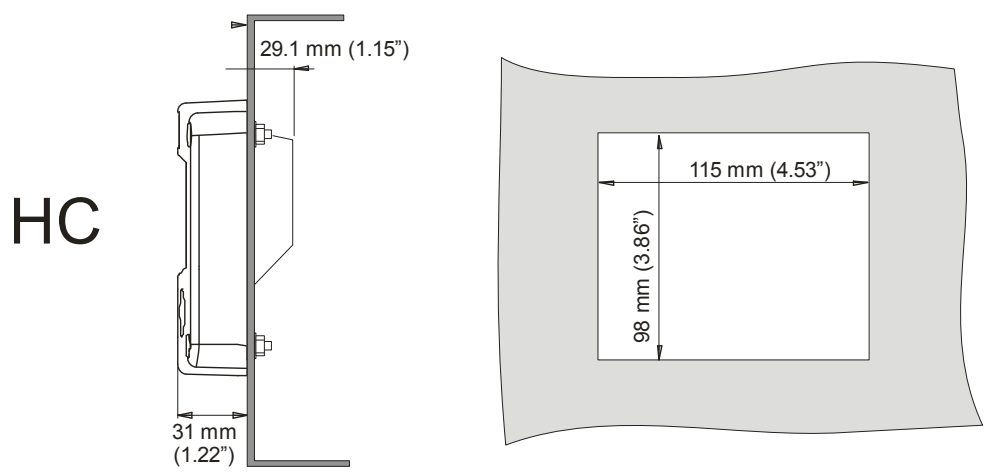
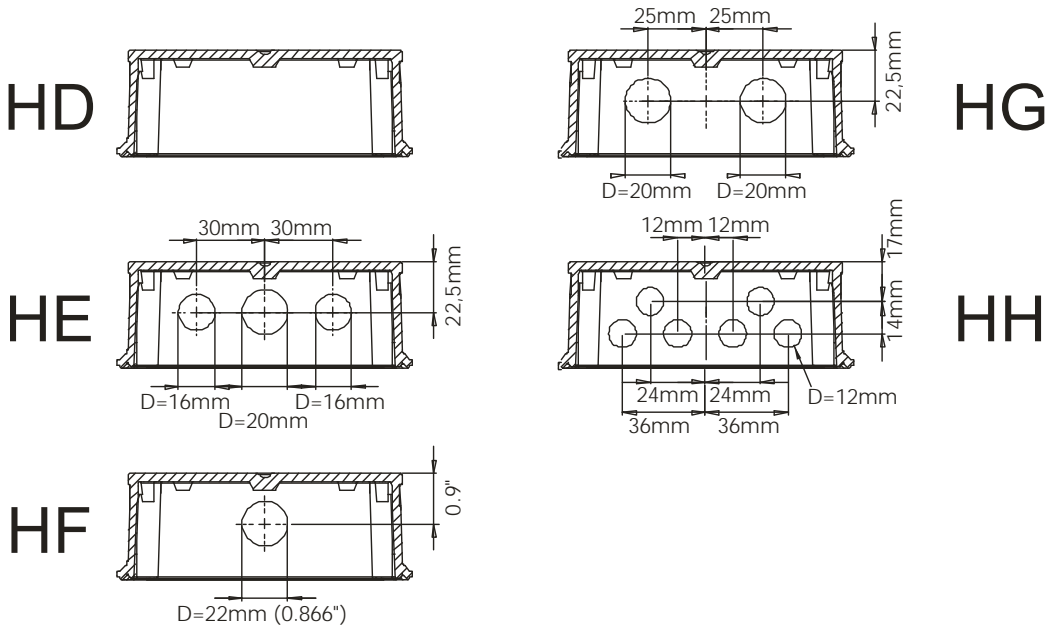
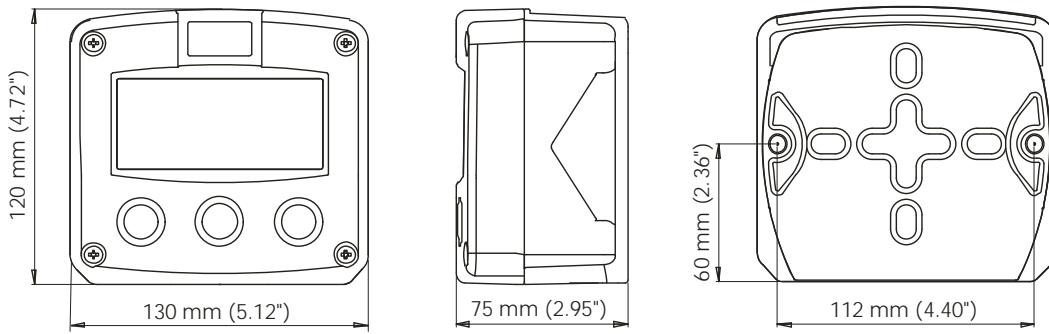


8.3 Dimensions of enclosure

Aluminum enclosures



GRP enclosures



8.4 Installing the hardware

8.4.1. Introduction



- Electrostatic discharge does inflict irreparable damage to electronics! Before installing or opening the unit, the installer has to discharge himself by touching a well-grounded object.



- This unit must be installed in accordance with the EMC guidelines (Electro Magnetic Compatibility).



- Do ground the aluminum casing properly as indicated, if the F110-P has been supplied with the 115-230V AC power-supply type PM. The green / yellow wire between the back-casing and removable terminal-block may never be removed.

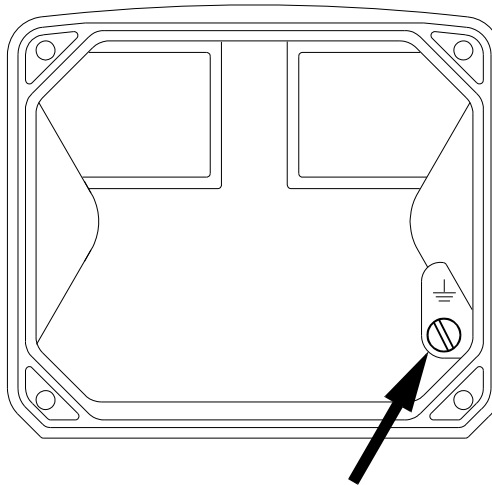


Fig. 7: Grounding aluminum enclosure with type PM 115-230V AC.

8.4.2 For installation, pay attention to

- Separate cable glands with effective IP67 (NEMA4X) seals for all wires.
- Unused cable entries: ensure that you fit IP67 (NEMA4X) plugs to maintain rating.
- A reliable ground connection for both the sensor, and if applicable, for the metal casing.

An effective screened cable for the input signal, and grounding of its screen to terminal 9 (GND) or at the sensor itself, whichever is appropriate to the application.



8.5 Voltage selection sensor supply

8.5.1 For intrinsically safe applications

Type PB / PC / PX (AP) - battery powered and output loop-powered applications:

Terminal 11 provides a limited supply voltage of 3.2 V DC (coil signals 1.2V) for the signal output of the flowmeter.



Note: This voltage MAY NOT be used to power the flowmeters electronics, converters etc, as it will not provide adequate sustained power! All energy used by the flowmeters pick-up will directly influence the battery life-time. It is strongly advised to use a "zero power" pickup such as a coil or reed-switch when operating without external power. It is possible to use some low power NPN or PNP output signals, but the battery life time will be significantly reduced (consult your distributor).

Type PD / PF / PM: Sensor supply: 1.2 - 3.2V - 8.2V - 12V or 24 V DC:

With this option, a real power supply for the sensor is available. The flowmeter can be powered with 8.2 - 12 or 24 V DC.

Total power consumption PD: max. 50mA@24V and PF / PM: max. 400mA@24V.

The voltage is selected with the three switches inside the enclosure.



- **Warning: be sure that all the leads to the terminals are disconnected from the unit when the internal plastic protection cover has been removed !**
- **HIGH VOLTAGE 400V !! NEVER connect the mains power supply to the unit when the plastic protection cover has been removed !!!**

First, remove the terminal strip(s) after which the internal plastic cover can be removed. The switches are located in the top left corner (type PD) or on the right hand (type PF / PM) as indicated:

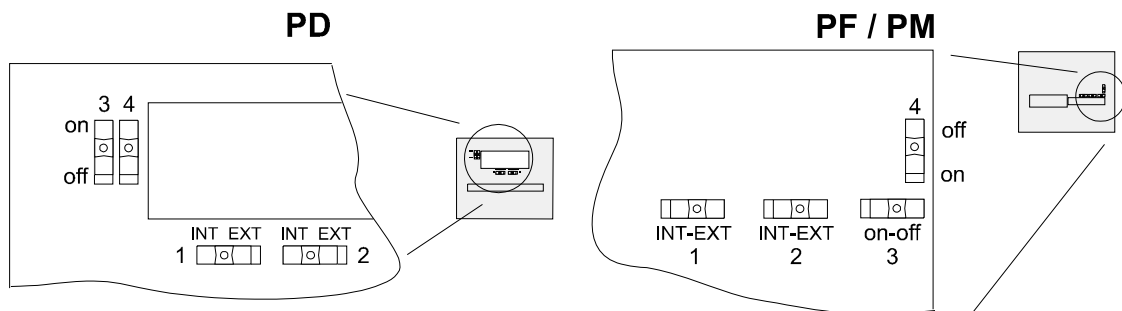


Fig. 8: Switch setting sensor supply voltage



8.5.2 Switch positions

Sensor A	
Switch 1	Voltage
Internal	3.2 V DC
External	Switch 3+4

Sensor B	
Switch 2	Voltage

Voltage selection		
Switch 3	Switch 4	Voltage
on	on	8.2 V DC
on	off	12 V DC
off	off	23 V DC

Function switch 1: Voltage selection sensor A - terminal 11.
Function switch 2: Not available for this Model.
Function switch 3+4: The combination of these switches determines voltage as indicated.
 Do move switch 1 and / or switch 2 to the OFF position to enable the selected voltage with switch 3+4.

8.6 Terminal connectors

For Intrinsically Safe applications:

The following terminal connectors are available:

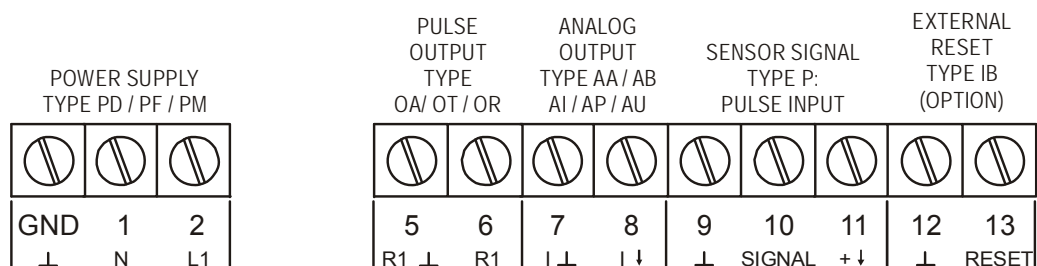


Fig. 9: Overview of terminal connectors standard configuration F110-P and options.



Remarks: Terminal connectors

Terminal GND- 01- 02: Power Supply - only available with type PD / PF or PM:

Type	Sensor supply	Terminal			Backlight	Type AA	Type AU	Type OA	Type OR
		GND	01	02					
PD 8-24V AC	8,2-12-24V max. 50mA		AC	AC	◇	◇	◇	◇	
PD 8-30V DC	8,2-12-24V max. 50mA	L-	L+		◇	◇	◇	◇	
PF 24V AC ± 15%	8,2-12-24V max. 400mA		AC	AC	◇	◇			◇
PF 24V DC ± 15%	8,2-12-24V max. 400mA	L-	L+		◇	◇			◇
PM 115-230V AC ± 15%	8,2-12-24V max. 400mA	EARTH	AC	AC	◇	◇	◇	◇	◇
Note PD	do not use a AC autotransformer (Spartrafo) without a galvanic isolation.								
Note PF / PM	The total consumption of the sensors and outputs may not exceed 400mA@24V								

◇=option



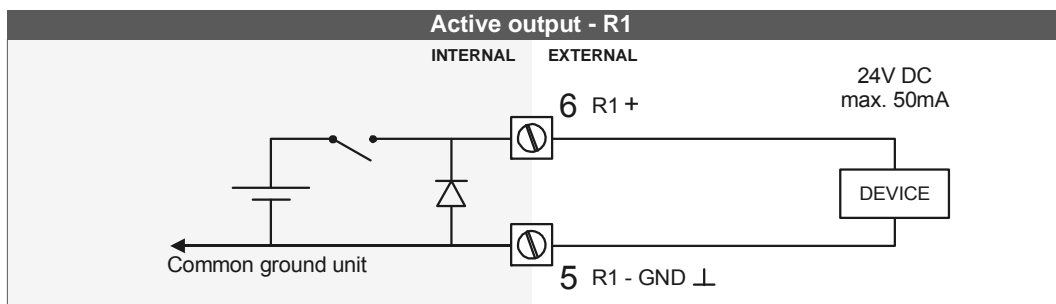
Note: for power supply type PX

8.6.1 Terminal 05-06; scaled pulse output R1

Setup 7 (par. 3.4.4.) determines the pulse output function. The maximum pulse frequency of this output is 60Hz. If a relay output option has been supplied, be sure that the output frequency does not exceed 5Hz or else the life-time of the relay will be reduced significantly.

Type OA

An active 24V DC pulse signal output is available with this option. Max. driving capacity 50mA@24V per output (requires power supply type PD / PF / PM).

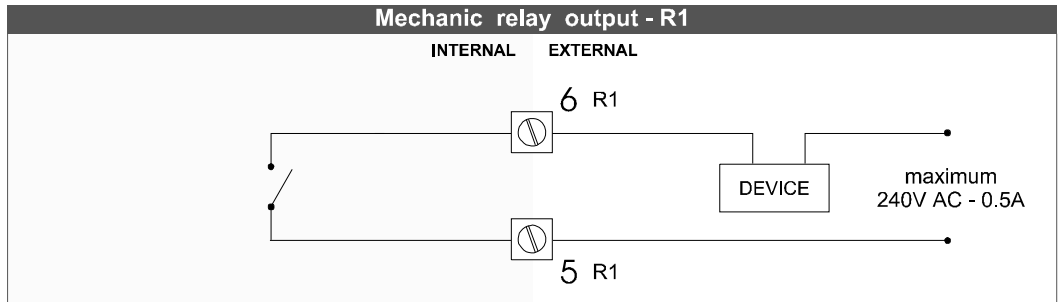


Type OR

A mechanical relay output is available with this option.

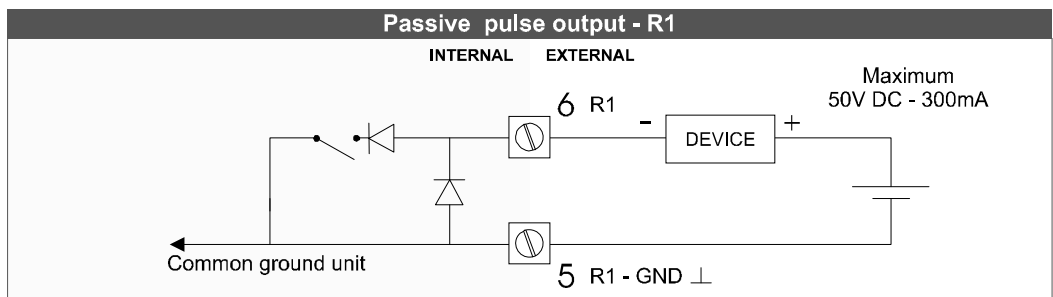
Max. switch power 240V 0,5A per output (requires power supply type PF / PM).

Be sure that the output frequency does not exceed 5Hz, else the relay life time will be reduced significantly.



Type OT

A passive transistor output is available with this option. Max. driving capacity 300mA@50V DC.



Terminal 07-08; basic POWER SUPPLY - type PX - output loop powered

Connect an external power supply of 8-30VDC to these terminals or a 4-20mA loop.

Do connect the "-" to terminal 7 and the "+" to terminal 8. When power is applied to these terminals, the (optional) internal battery will be disabled / enabled automatically to extend the battery life time.



Caution !

Only valid for standard passive output type AP!

Terminal 07-08 analog output (SETUP 7)

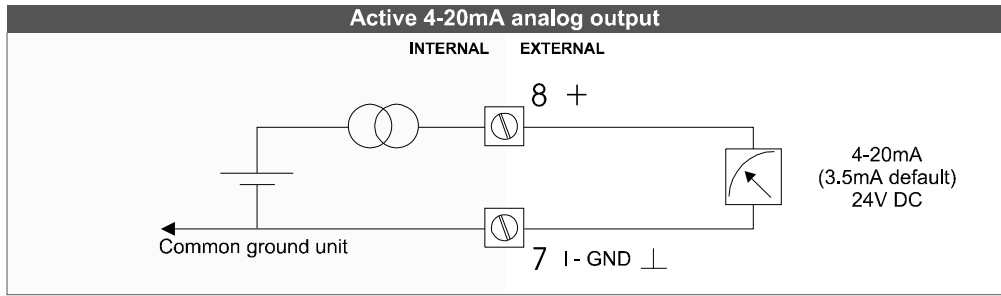
An analog output signal proportional to the flowrate is available as standard.

Type AA

An active 4-20mA signal proportional to the flowrate is available with this option. When the output is disabled, a 3.5mA signal will be generated on these terminals.

Max. driving capacity 1000 Ohm @ 24VDC. (Requires power supply type PD / PF / PM).

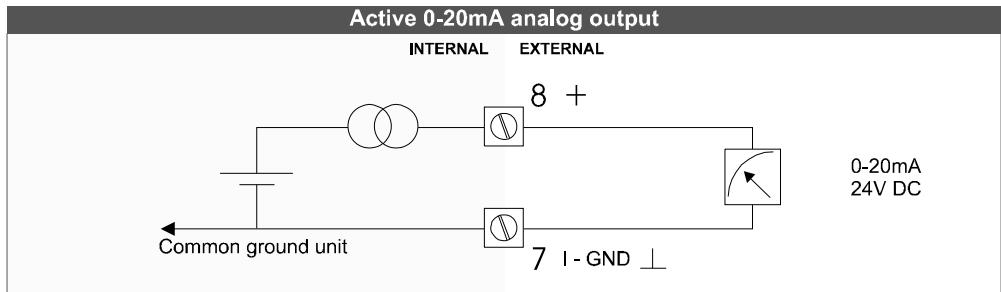




Type AB:

An active 0-20mA signal proportional to the flowrate is available with this option.

Max. driving capacity 1000 Ohm @ 24VDC. (Requires power supply type PD / PF / PM).



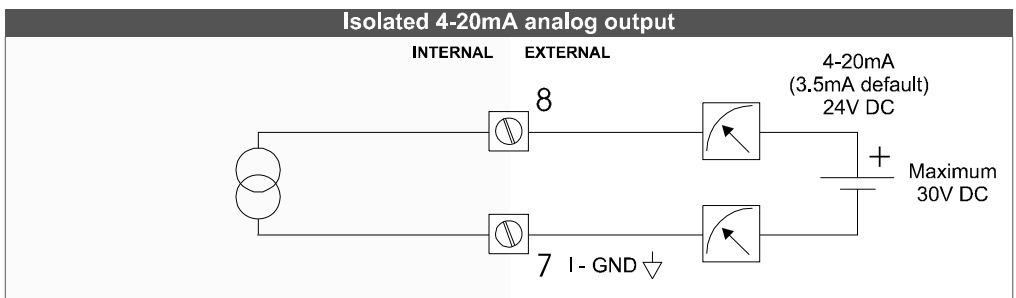
Type AF

For the Intrinsically Safe floating 4-20mA signal

Type AI:

An isolated 4-20mA signal proportional to the flowrate is available with this option. When the output is disabled, a 3.5mA signal will be generated on these terminals. Max. driving capacity 1000 Ohm @ 30VDC.

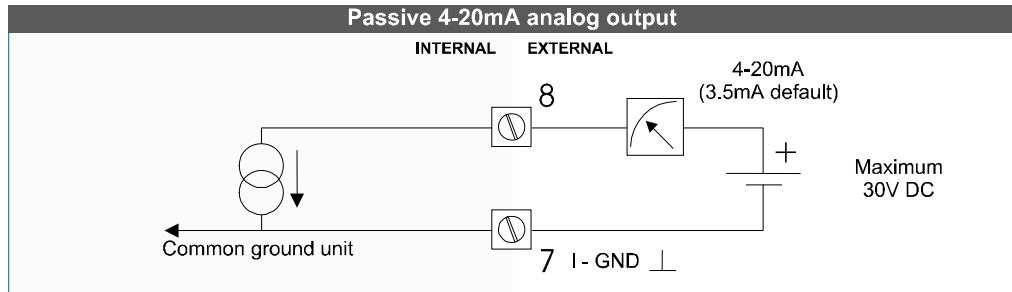
This option can be used with a battery powered unit but the life time of the battery is about 2 -3 years.



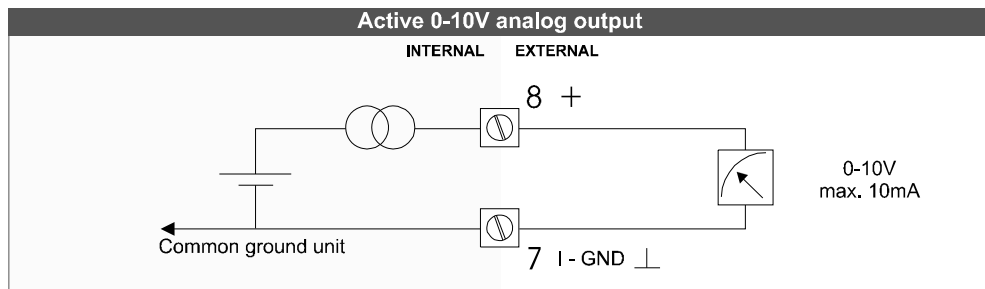
Type AP

A passive 4-20mA signal proportional to the flowrate is available with this option. When a power supply is connected but the output is disabled, a 3.5mA signal will be generated.

Max. driving capacity 1000 Ohm. This output does loop power the unit as well (type PX).

**Type AU**

A 0-10VDC signal proportional to the flowrate is available with this option. Max. load 10mA @ 10VDC. (Requires power supply type PD / PF / PM).

**Terminal 09-11; Flowmeter input**

Three basic types of flowmeter signals can be connected to the unit: pulse, active pulse or sine-wave (coil). The screen of the signal wire must be connected to the common ground terminal 09 (unless earthed at the sensor itself).

The maximum input frequency is approximately 10 kHz (depending on the type of signal). The input signal type has to be selected with the correct SETUP-function

Sine-wave signal (Coil)

The F110-P is suitable for use with flowmeters which have a coil output signal. Two sensitivity levels can be selected with the SETUP-function:

COIL LO: sensitivity from about 120mVp-p.

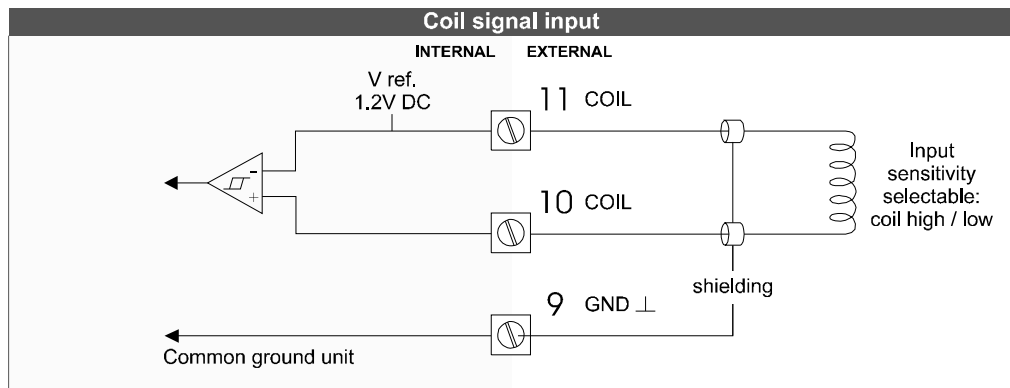
COIL HI: sensitivity from about 20mVp-p.

Type ZF offers for setting COIL HI: sensitivity from about 10mVp-p.

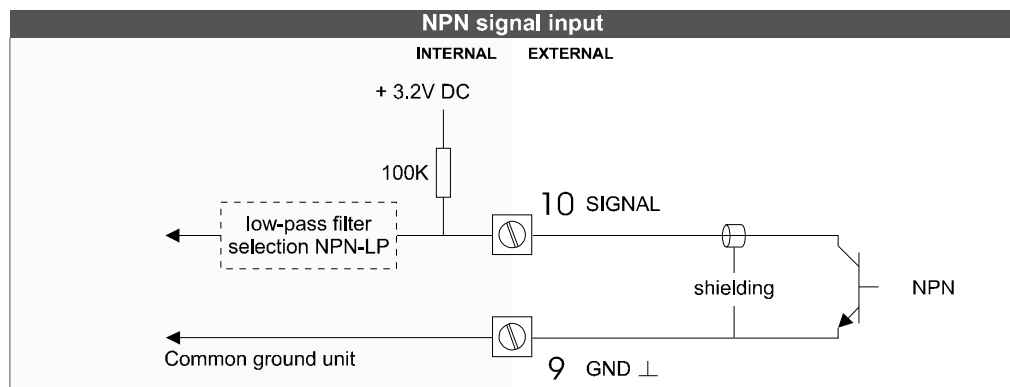
Type ZG offers for setting COIL HI: sensitivity from about 5mVp-p.



Pulse-signal NPN / NPN-LP



The F110-P is suitable for use with flowmeters which have a NPN output signal. For reliable pulse detection, the pulse amplitude has to go below 1.2V. Signal setting NPN-LP employs a low-pass signal noise filter, which limits the maximum input frequency.

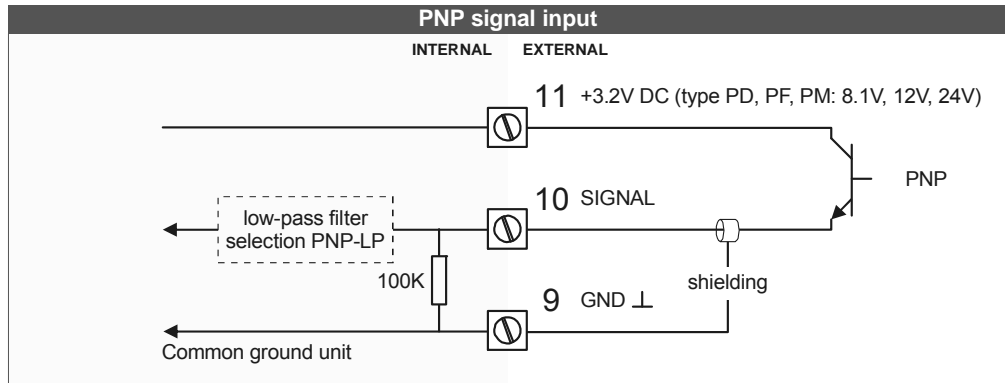


Pulse-signal PNP / PNP-LP

The F110-P is suitable for use with flowmeters which have a PNP output signal. 3.2V is offered on terminal 11 which has to be switched by the sensor to terminal 10 (SIGNAL). For a reliable pulse detection, the pulse amplitude has to go above 1.2V. Signal setting PNP-LP employs a low-pass signal noise filter, which limits the maximum input frequency - read par. 3.2.3.

A sensor supply voltage of 8.1, 12 or 24V DC can be provided with power supply type PD, PF, PM.

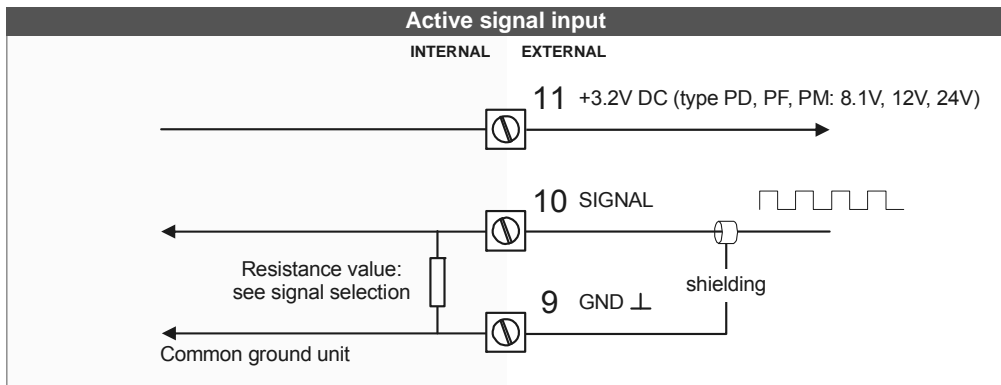
For a signal detection level of 50% of the supply voltage: please refer to "active signals".



Active signals 8.1V - 12V and 24V:

If a sensor gives an active signal, please read par. 3.2.3. The detection levels are 50% of the selected supply voltage; approximately 4V (ACT_8.1) or 6V (ACT_12) or 12V (ACT_24).

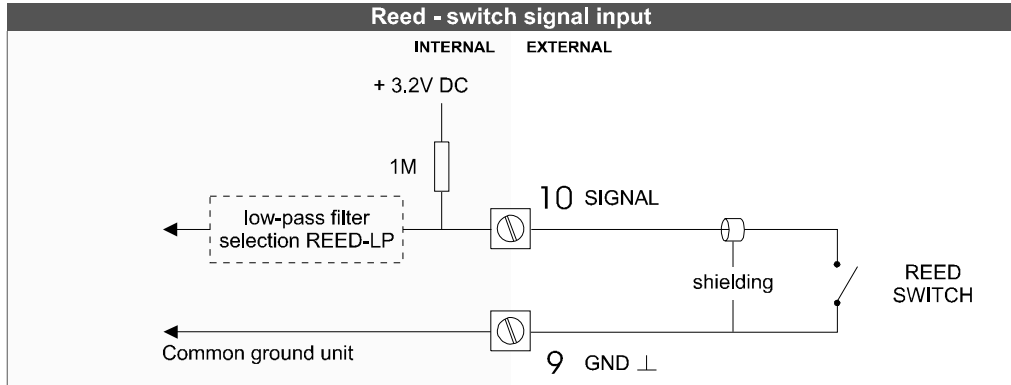
Active signal selection may well be desired in the case of power supply type PD, PF, PM being supplied for sensor supply.



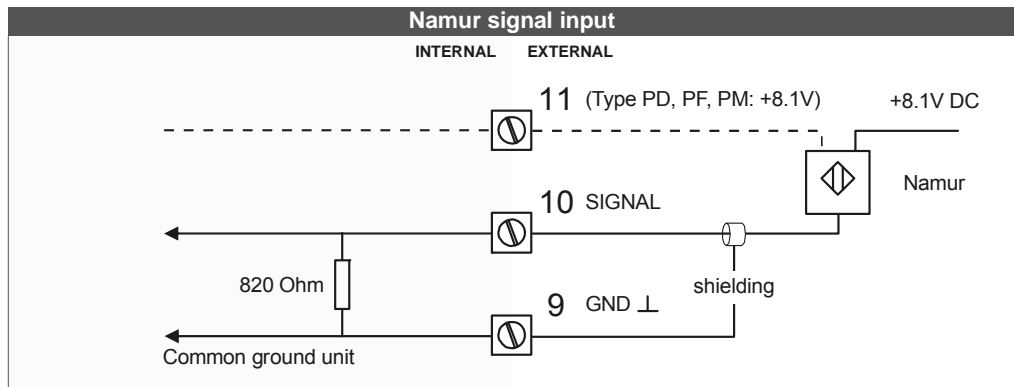
Reed-switch

The F110-P is suitable for use with flowmeters which have a reed-switch. To avoid pulse bounce from the reed-switch, it is advised to select REED LP - low-pass filter.

NAMUR-signal

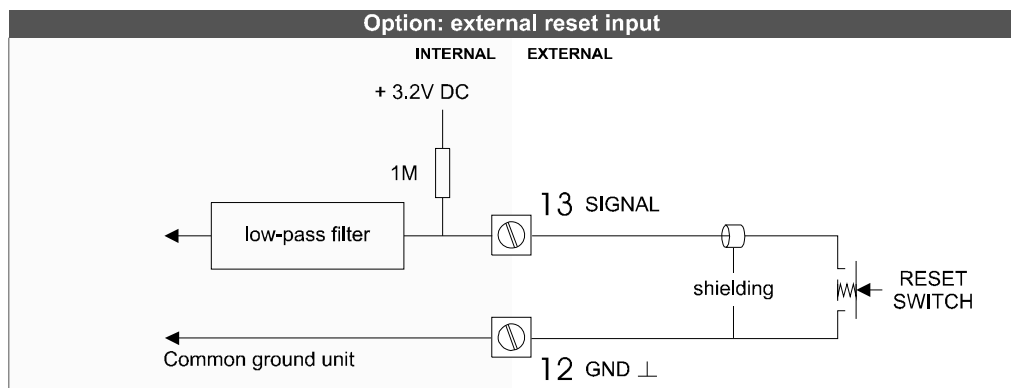


The F110-P is suitable for flowmeters with a Namur signal. The standard F110-P is not able to power the Namur sensor, as an external power supply for the sensor is required. However, a 8.2V sensor supply voltage (terminal 11) can be provided with power supply type PD, PF, PM.



Type IB - Terminal 12-13; external reset (option)

With this function, the total can be reset to zero with an external switch. The input must be switched with a potential free contact to the GND-terminal number 12.



Terminal 26-31: type CB / CH / CI / CT - communication RS232 / RS485 / TTL (option)

Full serial communications and computer control in accordance with RS232 (length of cable max. 15 meters) or RS485 (length of cable max. 1200 meters) is possible.

Read the ModBus® communication protocol and Appendix C.

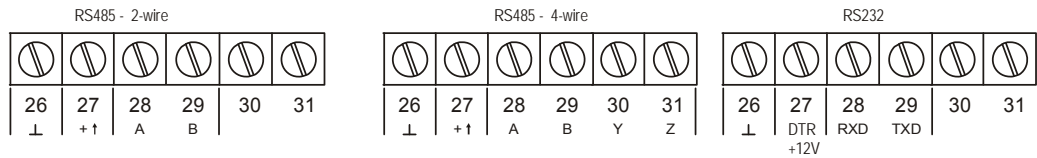


Fig. 10: Overview terminal connectors communication option.

When using the RS232 communication option, terminal 27 is used for supplying the interface. Please connect the DTR (or the RTS) signal of the interface to this terminal and set it active (+12V). If no active signal is available it is possible to connect a separate supply between terminals 26 and 27 with a voltage between 8V and 24V.

Terminal 26-31: backlight - type ZB (option):



Note: If the unit is supplied with a power supply type PD, PF or PM, the backlight supply is integrated, so the text following is not applicable.

To power the backlight, provide a 12-24V DC to terminal 26 (-) and 27 (+). An external trimmer 1kOhm trimmer can be used to tune the brightness of the backlight, or if not desired, a short-cut between these terminals have to be made which will result in the maximum brightness.



Note: Intrinsically Safe as well as 4-wire RS485 communication is not possible in combination with type ZB, except if a PD, PF or PM power supply is being used.

Option type ZB: adjustable backlight

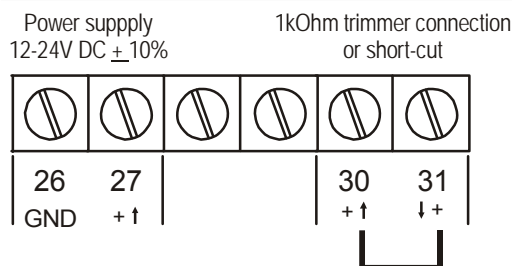


Fig. 11: Overview terminal connectors backlight option.



9. Intrinsically safe applications



- Mounting, electrical installation, start-up and maintenance of this device may only be carried out by trained personnel authorized by the operator of the facility. Personnel must read and understand this Operating Manual before carrying out its instructions.
- This device may only be operated by personnel who are authorized and trained by the operator of the facility. All instructions in this manual are to be observed.
- Ensure that the measuring system is correctly wired up according to the wiring diagrams. Protection against accidental contact is no longer assured when the housing cover is removed or the cabinet has been opened (danger of electric shock). The housing may only be opened by trained personnel.
- Take careful notice of the "Safety rules, instructions and precautionary measures" in the front of this manual.

Safety instructions



- For European Community: The installation of this intrinsically safe device must be in accordance with the ATEX directive 94/9/EC.
- This device has to be installed in accordance with the product certificate KEMA 03ATEX1074 X.
- Exchange of Intrinsically Safe battery - certified KEMA 03ATEX1071 U - is allowed in hazardous area.

Please note



- Special conditions for safe use mentioned in both the certificate and the installation instructions must be observed for the connection of power to both input and / or output circuits.
- When installing this device in hazardous areas, the wiring and installation must comply with the appropriate installation standards for your industry.
- Study the following pages with wiring diagrams per classification.

Label information (inside and outside the enclosure)

Model: F1.. - P-XI - Signal input: pulse, coil, namur
 Tamb = -30°C to +70°C / -22°F to +158°F
 Battery: certified FW-LiBat-00x battery only.

KEMA03ATEX1074 X - Intrinsically safe

Ex II 1 GD EEx ia IIB/IIC T4 T100°C

Possible static hazard. DO NOT RUB.
 IP6x - NEMA 4X

Please note that the special conditions for safe use mentioned in both the certificate and the installation instructions must be observed for the connection of power supply to both input and / or output circuits.

Remark: consult the manual

CE 0344

MODEL: F1xx-P-XI
 Signal input: pulse, coil, namur

CE 0344

Intrinsically Safe - Possible static hazard - Do not rub

Ex II 1 GD KEMA03ATEX1074 X EEx ia IIB/IIC T4 T100°C

IP67
 NEMA 4X

Tamb
 -30°C to +70°C
 -22°F to +158°F

YEAR	WEEK	NUMBER
03	24	167
SETUP		
93 SERIALNR		

Serial number and year of production

This information can be looked-up on the display: setup function.



Terminal connectors F110-P-XI:

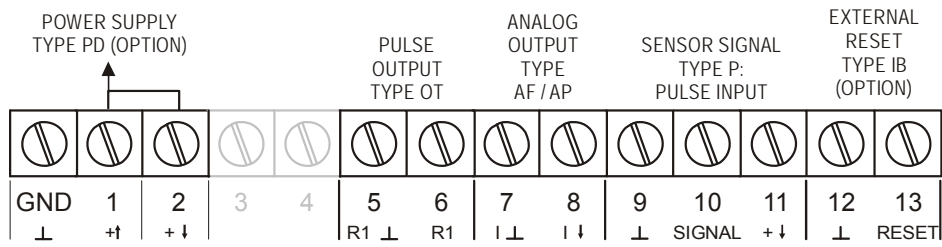


Fig. 12: Overview terminal connectors XI - Intrinsically safe applications.

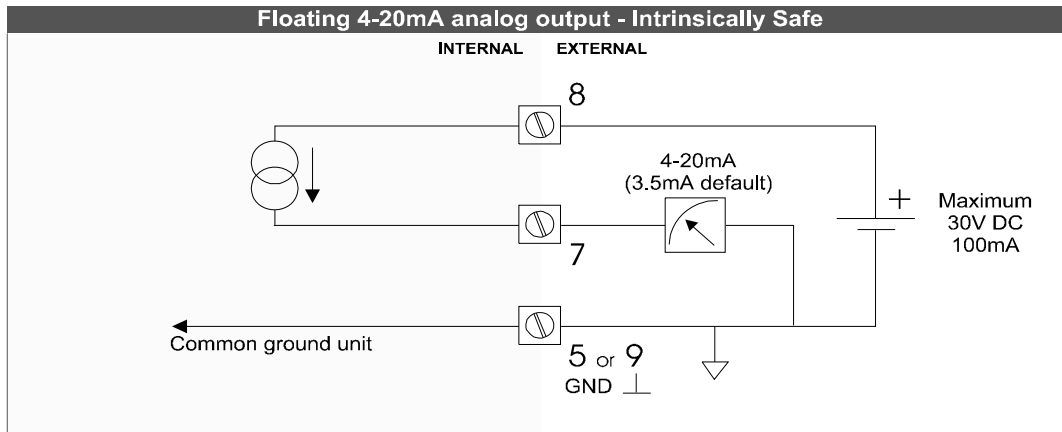
Explanation intrinsically safe options:

Type AF - Intrinsically Safe floating 4-20mA analog output - Terminal 7-8:

A floating 4-20mA signal proportional to the flowrate is available with this option. When the output is disabled, a 3.5mA signal will be generated. Max. driving capacity 1000 Ohm @ 30V DC.



Note! It is required to link the minus from the analog output - terminal 7 - with a ground terminal of the unit; terminal: GND, 3, 5, 9, 12 or 15.



Type PD - Intrinsically Safe power supply and sensor supply - Terminal GND- 01 and 11.

Type	Sensor supply	terminal		
		GND	01	02
PD Input voltage: 8-30V DC	3,2 - 8,1V	L-	L+	internally linked with terminal 01.

Terminal 02: this terminal offers the same voltage as connected to terminal 01.
Terminal 11: this terminal offers a 3.2V or 8.1V to power the sensor. This voltage is selected with the switch(es) inside the enclosure. First, remove the terminals after which the internal plastic cover can be removed.

Switch position terminal 11		Switch position no function	
SWITCH 1	VOLTAGE	SWITCH 2	
on	8.1 V DC	not available	
off	3.2 V DC		

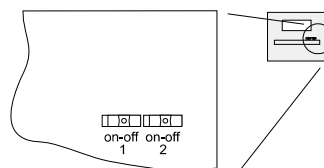


Fig. 13: Switch position voltage selection type PD-XI.



Configuration example n° 1

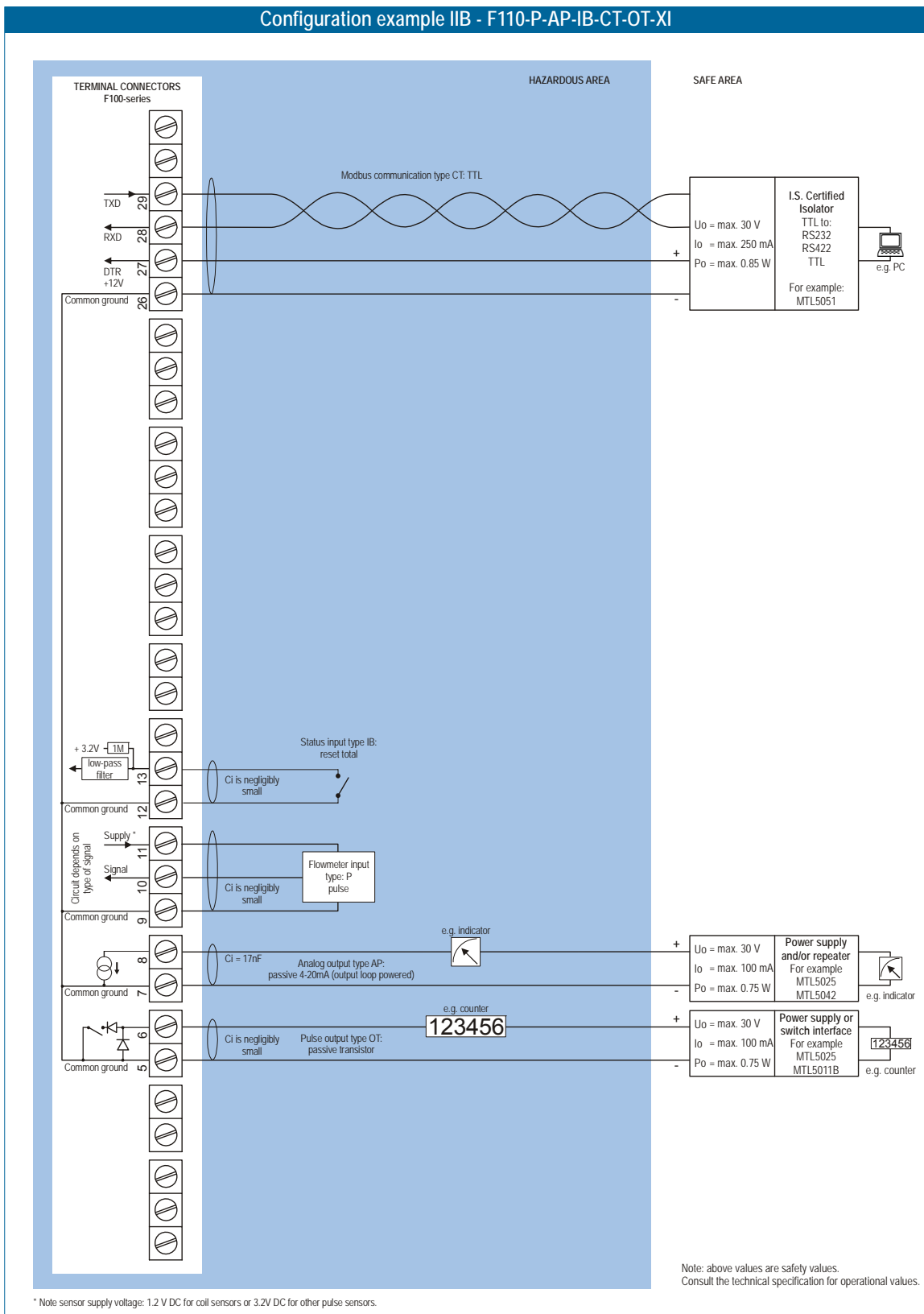


Fig. 14: Configuration example intrinsically safe.



Configuration example n° 2

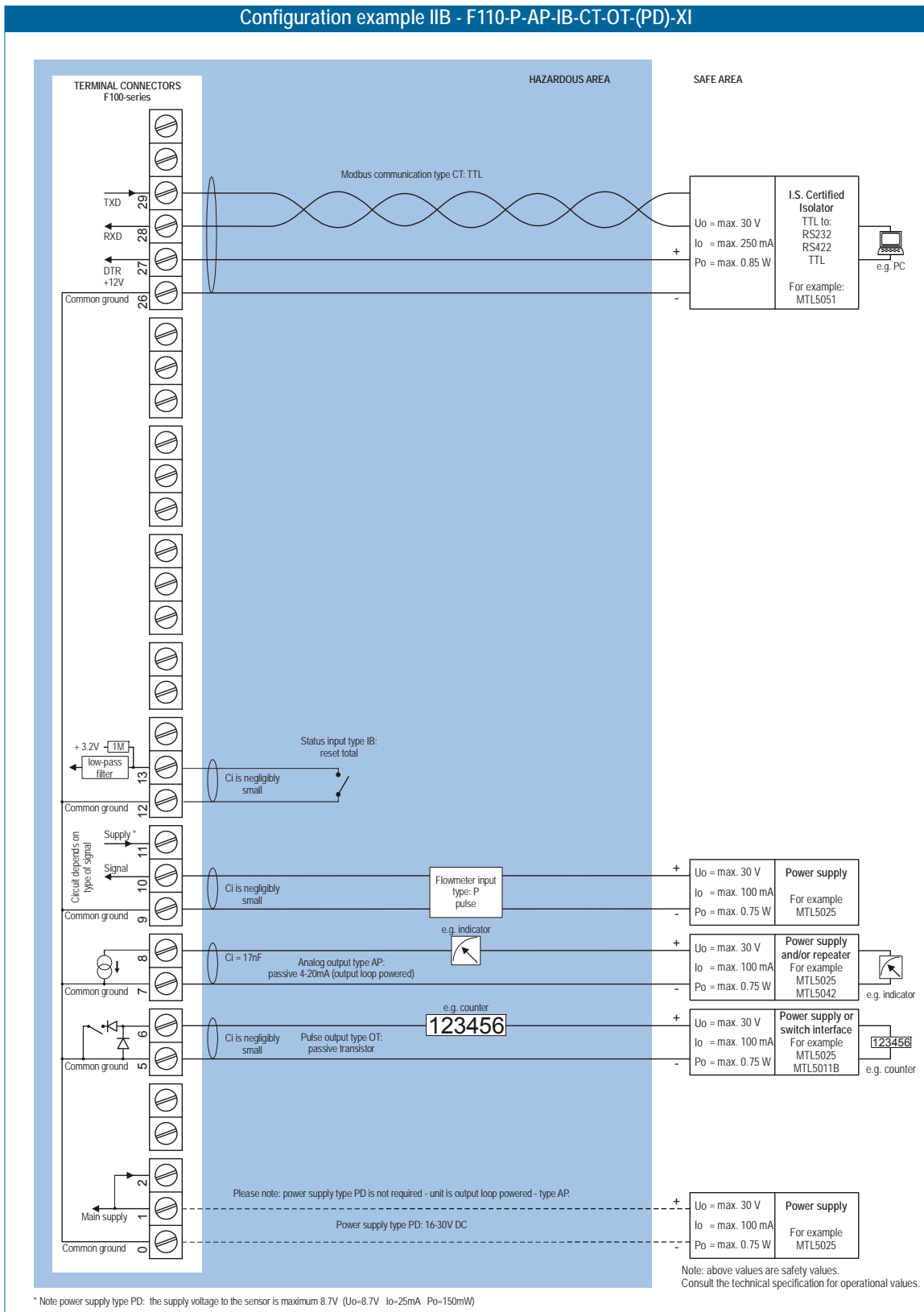


Fig. 15: Configuration example intrinsically safe



Configuration example n° 3

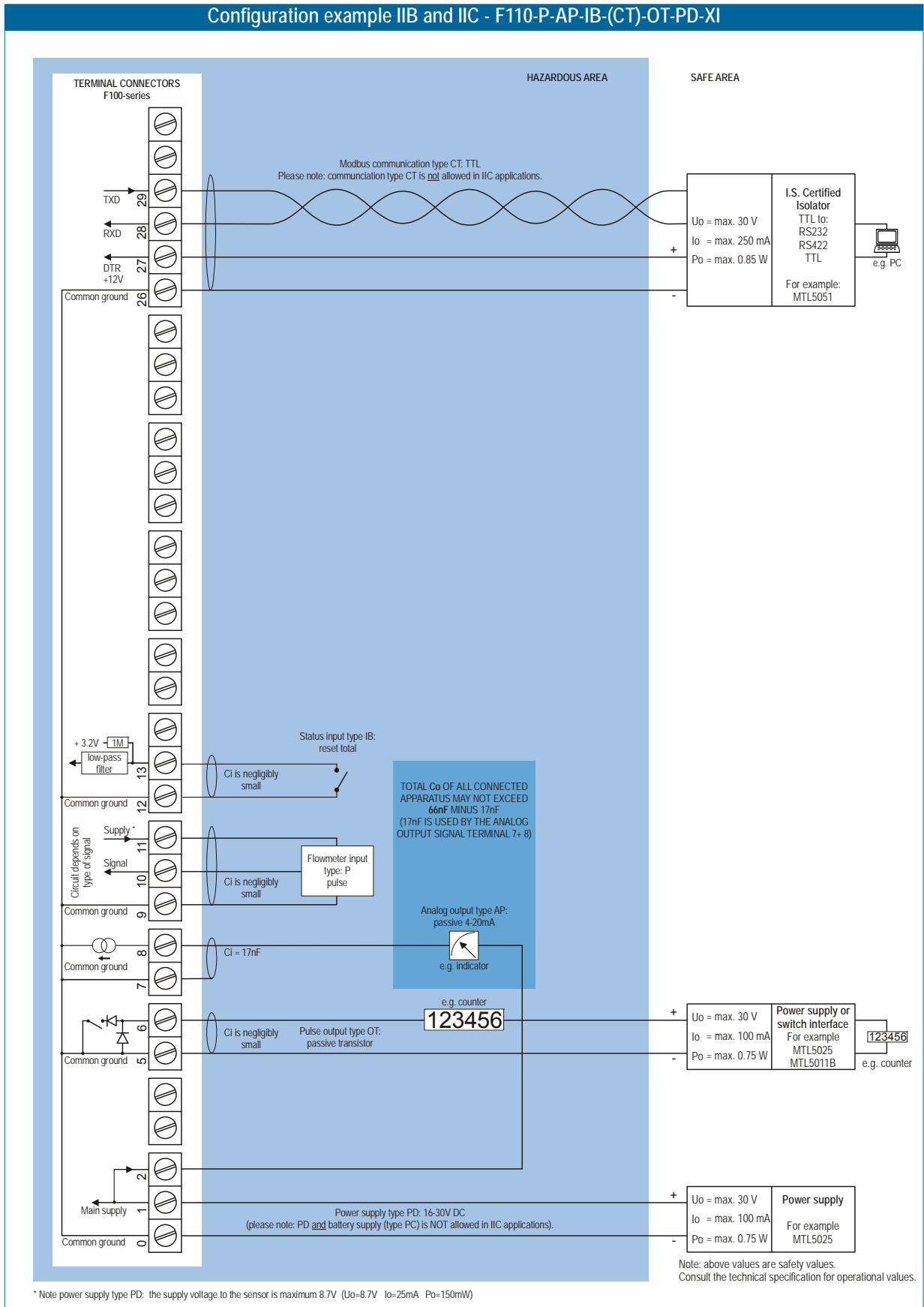


Fig. 16: Configuration example intrinsically safe.



Configuration example n° 4

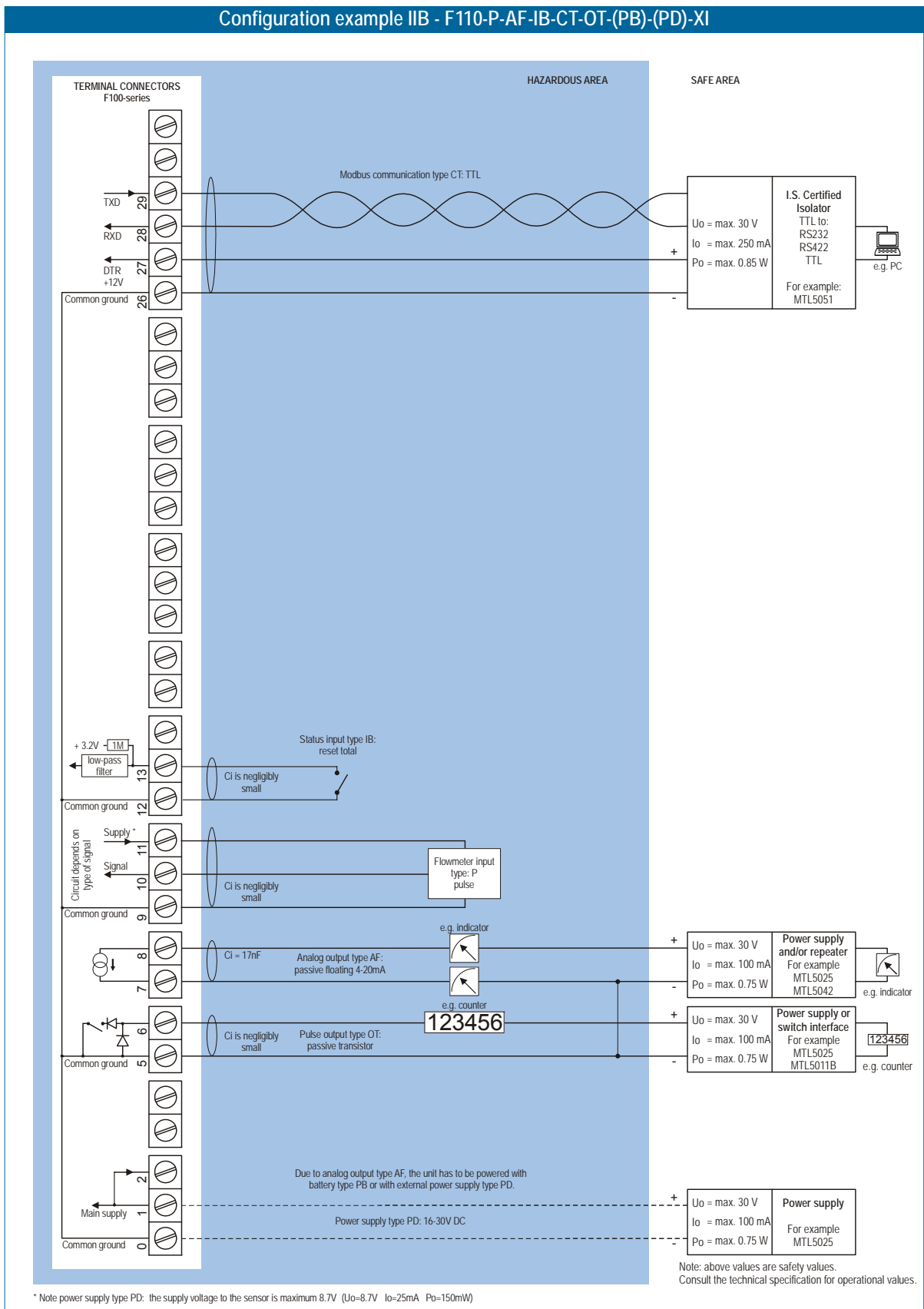


Fig. 17: Configuration example intrinsically safe



Configuration example n° 5

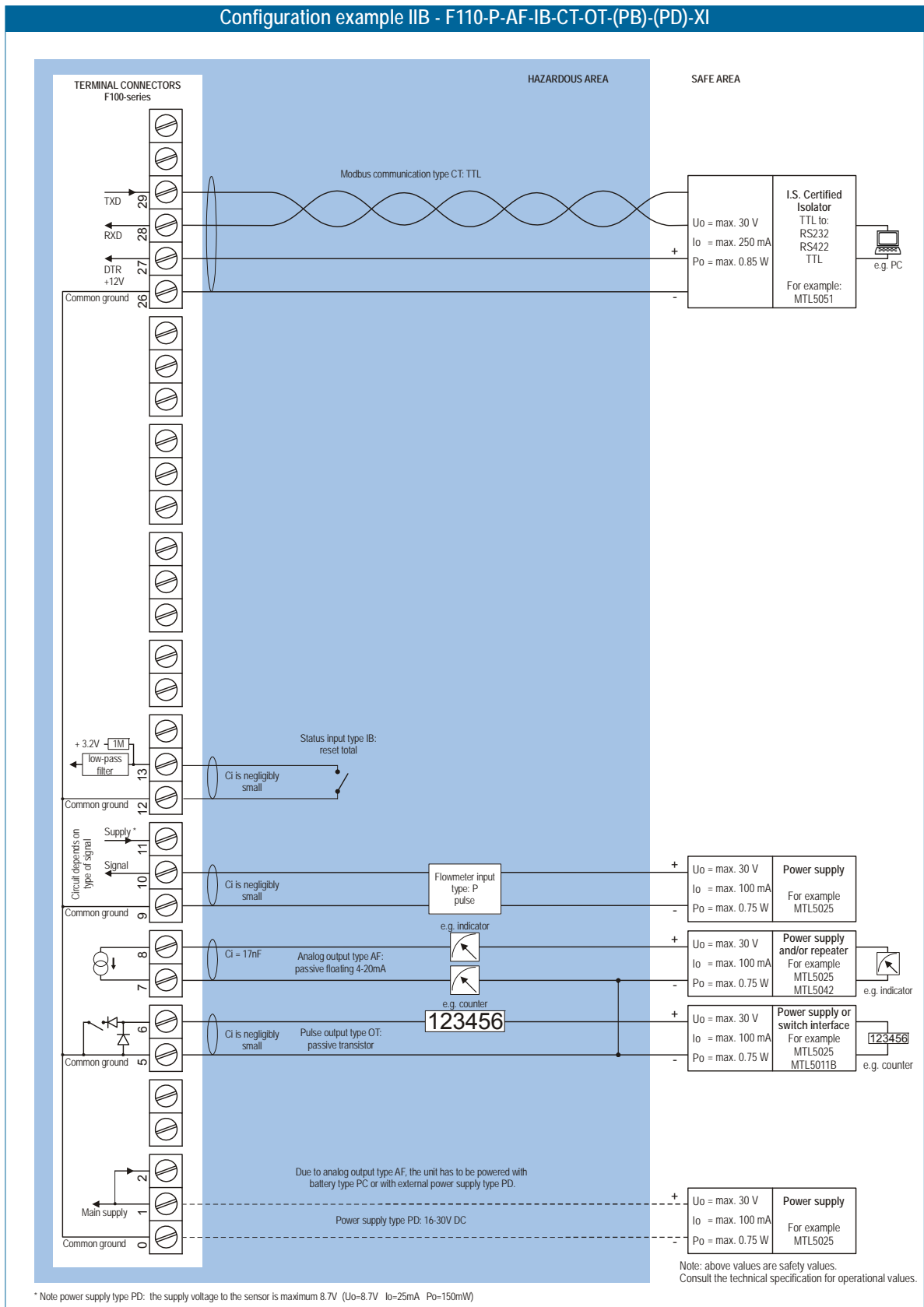


Fig. 18: Configuration example intrinsically safe



Configuration example n° 6

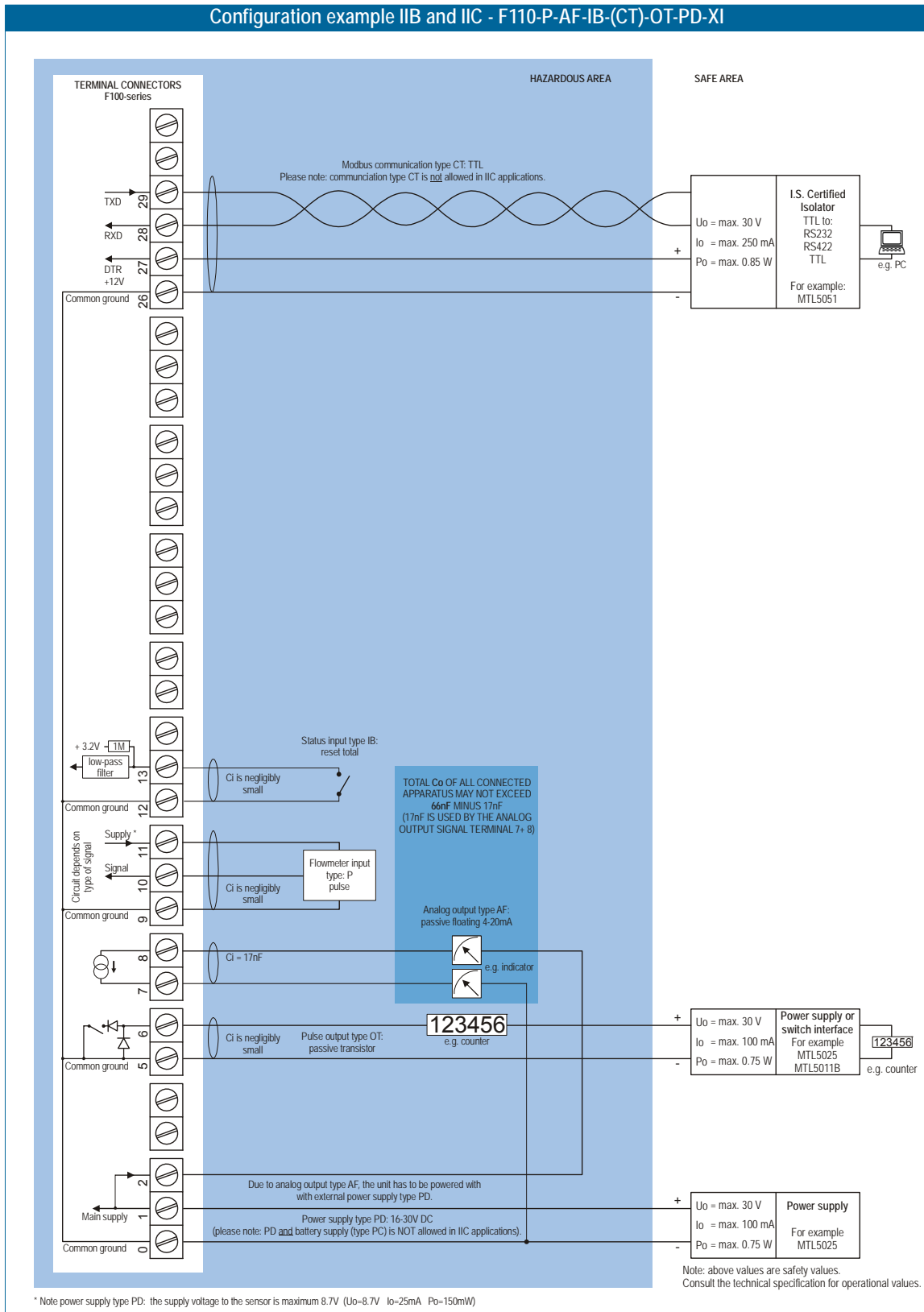


Fig. 19: Configuration example intrinsically safe



10. Maintenance

10.1 General directions



Caution !

- Mounting, electrical installation, start-up and maintenance of the instrument may only be carried out by trained personnel authorized by the operator of the facility. Personnel must read and understand this operating manual before carrying out its instructions.
- The F110-P may only be operated by personnel who are authorized and trained by the operator of the facility. All instructions in this manual are to be observed.
- Ensure that the measuring system is correctly wired up according to the wiring diagrams. Protection against accidental contact is no longer assured when the housing cover is removed or the panel cabinet has been opened (danger from electrical shock). The housing may only be opened by trained personnel.
- Take careful notice of the "Safety rules, instructions and precautionary measures" in the front of this manual.

The F110-P does not require special maintenance unless it is used in low-temperature applications or surroundings with high humidity (above 90% annual mean). It is the users responsibility to take all precautions to dehumidify the internal atmosphere of the F110-P in such a way that no condensation will occur, for example by placing dry silica-gel sachet in the casing just before closing it. Furthermore, it is required to replace or dry the silica gel periodically as advised by the silica gel supplier.

Battery life-time:

It is influenced by several issues :

- Type of sensor: NPN and PNP inputs consume more energy than coil inputs.
- Input frequency: The higher the frequency, the shorter the battery life-time.
- Flow rate calculation: The lower number of pulses (SETUP 26) the shorter the battery life-time.
- Analog output signal; be sure that an external power supply is connected or that the function is disabled if not in use; or else it will have a influence on the battery life-time (SETUP 61).
- Display update: Fast display update uses significantly more power; SETUP 41.
- Pulse output and communications .
- Low temperatures; the available power will be less due to battery chemistry.



Note !

Note: It is strongly advised to disable unused functions.

Check periodically:

- The condition of the casing, cable glands and front panel.
- The input/output wiring for reliability and aging symptoms.
- The process accuracy. As a result of wear and tear, re-calibration of the flowmeter might be necessary. Do not forget to re-enter any subsequent K-factor alterations.
- The indication for low-battery.
- Clean the casing with soapy-water. Do not use any aggressive solvents as these might damage the polyester coating.

10.2. Repair

This product cannot be repaired by the user and must be replaced with an equivalent certified product. Repairs should only be carried out by the manufacturer or his authorized agent.



11. General ModBus® communication protocol

11.1 Introduction

11.1.1 General

This communication protocol is compatible with ModBus®, used for Modicon Plc's e.g. This protocol is described in "Protocol Reference Guide" (Modicon doc-nr. PI-MBUS-300 rev. C).

We support both modes of the above mentioned protocol: ASCII-mode and RTU-mode. The selection between both modes is done at SETUP-level (100-series) or parameter-level (300-series), just as setting the baudrate, bus address and delay time.

The baudrate is selectable through values 1200, 2400, 4800, 9600. The bus address can be set from 1 up to and including 255.

Our equipment uses eight databits, no parity, a startbit and one stopbit. The least significant bit of every byte is send first.

This manual describes the general ModBus® protocol implementation for all 100- and 300-series products. The product specific variables are described in the appendix of the operation manual.

11.1.2 Design choices in perspective to ModBus® specification

This communication package supports ModBus® functions "read holding registers" (03) and "preset multiple registers" (16). It should be noted that for these functions ModBus® specifies a register as being two bytes. Since some of the variables have a length which exceeds two bytes, a variable might need to be represented in more than one register. Therefore for reading or writing a variable its number (register number) and its length (number of registers) need to be supplied. The internal variable table may be visualised as a collection of small groups of registers, with each group representing a unique variable. This leads to the implication that it is not possible to read/write multiple variables in one request.

11.2 ASCII record structure

11.2.1 General

In ASCII-mode the databytes are ASCII-coded. This means that each (hexadecimal) databyte is split up into two nibbles; each nibble is send as its ASCII code afterwards. In this way every databyte is transferred as two ASCII-bytes.

Example:

The databyte 4Ah is transferred as 34h (= '4') and 41h (= 'A').

The advantage of this protocol-mode is that an ASCII-terminal can be used to "overhear" the dataline during debugging. A disadvantage is the quantity of data almost doubles.

The most significant nibble is send first.

msn : most significant nibble ASCII coded

lsn : least significant nibble ASCII coded



Following the example: msn = 34h and lsn = 41h.

ASCII byte n°	Data byte n°	Contents	Meaning
00	00	":" (3Ah)	Start of record marker
01	01	address msn	Bus address product
02	01	address lsn	Bus address product
03	02	function msn	Function to be executed
04	02	function lsn	Function to be executed
05	03	msg-byte 0 msn	Data for/from the function
06	03	msg-byte 0 lsn	Data for/from the function
07	04	msg-byte 1 msn	Next byte
08	04	msg-byte 1 lsn	Next byte
//	//	etc.	//
05+2*x	03+x	msg-byte x msn	Last function data byte
06+2*x	03+x	msg-byte x lsn	Last function data byte
07+2*x	04+x	ERROR CHECK msn	LRC: LongitudinalRedundancy
08+2*x	04+x	ERROR CHECK lsn	Check: see below
09+2*x	05+x	CR (0Dh)	End of record marker 1
10+2*x	06+x	LF (0Ah)	End of record marker 2

Table 1: ASCII-mode

Since each databyte is now represented as two ASCII-bytes, numbering of data-bytes in the record does not count up synchronously with the real number of bytes transferred over the line.

11.2.2 LRC-checksum

The checksum is calculated by adding all databytes in the record together from bus-address (data-byte 01) up to and including the last function data-byte (03+x) and take the two's complement of the least significant byte, which means inverting the byte and adding 1. The calculated LRC-byte is now added to the record as its ASCII-coded 2-byte value.

The receiver must use the same kind of calculation and compare the result with the received checksum. A less complicated procedure is to calculate from the bus address up to AND INCLUDING the checksum (this means databytes 1 up to and including 04+x). If the record is not mutilated after receiving, the result must be 00.

All characters different as CR, LF, '0' - '9', ':', 'A' - 'F' point out a mutilated message.



11.3 RTU record structure

11.3.1 General

RTU byte n°	Data byte n°	Contents	Meaning
		A time of at least 0.11 seconds between records is used as record separator!	
01	01	address	Bus address product
02	02	function	Function to be executed
03	03	msg-byte 0	Data for/from the function
04	04	msg-byte 1	Next byte
//	//	etc.	//
05+x	05+x	msg-byte x	Last function data byte
06+x	06+x	ERROR CHECK lsb	CRC: Cyclic Redundancy Check
07+x	07+x	ERROR CHECK msb	CRC: Cyclic Redundancy Check
		A time of at least 0.11 seconds between records is used as record separator!	

Table 2: RTU-mode.

In the table above, databyte-number 0 is NOT used by purpose to express the similarity with the ASCII-mode.

RTU-mode sends all databytes without conversion; time outs are used as record separators. Please notice that the time between two databytes WITHIN a record may not exceed 0.11 seconds! This time-to-wait is enlarged to two "PC-clockticks" (2/18.2 sec) compared with the original ModBus® specification, to get a more reliable and simplified time-out detection.

In RTU-mode the databyte-numbers in the record do count up synchronously with the real number of bytes transferred over the line, since each byte is transferred in its original form.

11.3.2 CRC-error check

The CRC-error check method uses the following polynomial:

$$X^{16} + X^{15} + X^2 + X^0$$

Description applied procedure:

- 1 Initialise a 16 bit-register with 0FFFFh (sixteen ones).
- 2 Put pointer to first byte (databyte no. 1 (address)).
- 3 Initialise a bit-counter to 8.
- 4 Put EXOR from LSbyte 16 bits-reg and pointed byte in LSbyte 16 bits-reg.
- 5 Shift the 16 bits-reg one position to the right; shift in a zero at the left side, save the shifted-out bit (LSbit).
- 6 Is the shifted-out bit "1", then EXOR the 16 bits-reg with A001h.
- 7 Is the shifted-out bit "0", then don't do anything at all.
- 8 Decrement bit-counter; if not all bits done, return to step 5.
- 9 Increment pointer to next byte, if not all bytes done, return to step 3.
- 10 Now, the sender adds the contents of the 16 bits register to the end of the message to be send.

WARNING: The CRC checksum bytes are in LSB-MSB order! (Contrary to the other words in the message which are in MSB-LSB order).



This CRC must be calculated from the bus-address (data-byte 01) up to and including the last data-byte (05+x).

The receiver can determine the CRC by following the same procedure, but now up to and including both checksum bytes (06+x/07+x). The now calculated checksum must equate zero, otherwise a mutilated message was received.

Extending the procedure to including the checksum bytes avoids the need for a compare of received and newly calculated checksum.

11.4 Explanation function codes

11.4.1 General

The table below contains an overview of the communication-functions. The second column contains the standard ModBus® description.

To be compatible with the several ModBus®-implementations in software-programs as SCADA e.g., only the Read en Write holding registers functions are used.

The third column shows our name. The last column indicates the paragraph which contains more detailed explanation of the function.

Due to the standard table-begin for all the equipment, it is possible to detect the type of product, software-version etc. of each product present on the communication bus.

Modicon function codes		Our imlementation	Par.
00	Not defined		
01	Read Coil(s) status		
02	Read input(s) status		
03	Read holding registers	Read table data	5.2
04	Read input registers		
05	Force single Coil		
06	Preset single register		
07	Read exception status		
08	Loopback diagnostic test		
09	Program (484 only)		
10	Poll prog. complete (484)		
11	Fetch event count.comm.		
12	Fetch comm. event log		
13	Program (184,384,484,584)		
14	Poll prog. (see 13)		
15	Force multiple coils		
16	Preset multiple reg's.	Write table data	5.3
17	Report slave id.		
18	Program 884 & micro 84		
19	Reset comm. link		
20	Read general ref. (584)		
21	Write general ref. (584)		
22-64	Reserv.f. exp. funct.		
65-72	Reserv.f. user funct.		
73-119	Illegal functions		
120-127	Reserv.f. intern. use		
128-255	Exception responses	Error response	5.4



11.5 Explanation function codes

11.5.1 General

In the diagrams below, following lay-out is used:

The upper line indicates the sequence number of each byte. These sequence numbers correspond with the databyte-numbers.

The byte(s) 'CS' contains the CheckSum. In ASCII-mode this is a one-byte LRC (which will be represented in two bytes, just like all databytes in an ASCII record) and for RTU-mode this is a two byte CRC.

11.5.2 Read table data

This function complies with the ModBus® specified function "Read holding registers" (03). It is used to read variables from the system. The system will respond to this type of message by sending either an acknowledge or an error response. Below you will find the record structures that are used to request and acknowledge this function.

1	2	3	4	5	6	7	← Databyte numbers
ADDRESS	FUNCTION	VARIABLE NUMBER		NUMBER OF WORDS		CS	
address	03t	msbyte	lsbyte	msbyte	lsbyte		

The read request record looks like:

1	2	3	4	5	← Databyte numbers	
ADDRESS	FUNCTION	BYTE-	VARIABLE 1			//
address	03t	count n	msbyte	lsbyte		//

$2+2*n$	$3+2*n$	$4+2*n$	← Databyte numbers
VARIABLE n		CS	
msbyte	lsbyte		

Address refers to the bus-address of the slave module that needs to execute the function. Function holds the ModBus® function code. Variable number tells the system which variable to read, a complete table of variable numbers can be found in chapter 6 and Appendix A.

These tables also show the number of bytes that need to be read to get the complete value. It is by no means possible to read more bytes than the real length of the variable as mentioned in this table. When such a request is made though, the system will respond with an error. This implies it is only possible to read one variable per request.



It should be noted that the read request record supplies the system with the number of words instead of the number of bytes to read. When variables with an odd number of bytes need to be read the number of words is rounded up (e.g. to read 1-byte bus address -> requested number of words is 1). This will result in an response which holds one extra byte, which will always be 0. The result is valid though, because this extra byte will always be the MS-byte of the returned data.

In contrary to reading too much bytes, it is possible to read a variable partially. When a request is made to read less bytes than the complete length of the variable, the system will return the requested number of bytes from the least significant part of the variable (e.g. datetime holds 6 bytes YMDHMS, when you request 2 words DHMS will be returned).

When the read request record is correctly received by the system and all data-members turn out to be valid, the system will return the read response record as mentioned above. The address and function bytes are an exact copy of the ones in the read request record, bytecount shows the number of bytes of data that the record holds. Of course as many bytes as requested are returned, so this number always equates $2 * \text{number_of_words}$.

In case any data-members in the read request record turn out to be invalid, the system will return an error response record. Paragraph 11.5.4 holds an exact description of all possible error records with an explanation of the possible causes. When the system does not return any record at all the cause might be found in a wrong bus-address, wrong checksum or a distortion in the communication process.

11.5.3 Write table data

This function complies with the ModBus® specified function “Preset multiple registers” (16). It is used to write variables in the system. The system will respond to this type of message by sending either an acknowledge or an error response. Below you will find the record structures that are used to request and acknowledge this function.

It is not always possible to write a variable. Some variables are never writeable (e.g. serial number) and some others can become temporarily unavailable for writing (e.g. baudrate). The standard table for products (chapter 11.6) contains a column which shows the writeability of a variable. For the product specific variables mentioned in Appendix A goes that the ones that are also programmable on the unit itself (configuration variables) are unavailable for writing during local programming, to avoid conflicts between local and remote programming. Other, non-programmable, product specific variables are never writeable unless mentioned otherwise.



The write request record looks like:

1	2	3	4	5	6	7	← Databyte numbers
ADDRESS	FUNCTION	VARIABLE NUMBER	NUMBER OF WORDS		BYTE COUNT	//	
address	16t	msbyte	lsbyte	msbyte	lsbyte	//	

	8	9	10	11	2n+6	2n+7	2n+8	← Databyte numbers
//	WORD 1		WORD 2		WORD n		CS	
//	msbyte	lsbyte	msbyte	lsbyte	msbyte	lsbyte		

An write response record looks like:

1	2	3	4	5	6	7	← Databyte number :
ADDRESS	FUNCTION	VARIABLE NUMBER	NUMBER OF WORDS		CS		
address	16t	msbyte	lsbyte	msbyte		lsbyte	

Address, function, variable number and number of words are used the same way as with the read request record which was explained in the previous paragraph. Furthermore the bytecount should hold the number of bytes that need to be written to the given variable. The system will only accept a write request record when the bytecount equates the doubled value of the number of words (bytecount=2*number_of_words).

The number of words may never exceed the true length of the variable as given in the variable table. When variables with an odd number of bytes need to be written the number of words is rounded up (e.g. to write 1-byte bus address -> number of words is 1). This implies that the bytecount should always be an even number and therefore a dummy-byte needs to be added when variables of odd length are written. This dummy-byte should always be zero and must be added as the most significant byte in the data to write.

Example

We want to change the communication mode of the system. In the standard begin table for our products we find that the variable number is 11 (0Bh). We also find that this variable is only one byte in length. Furthermore The ModBus® function code for writing is 16 (10h) and we assume the bus-address as being 01 for the system in question. We are willing to write the byte XX to this variable. The write request record should look like this:

01 10 00 0B 00 01 02 00 XX CS

The highlighted part shows we request 1 word, which leads to a bytecount of 2 and we add an extra '0'-dummy-byte at the most significant part of the data to write.



In contrary to writing too much bytes, it is possible to write a variable partially. When a request is made to write less bytes than the complete length of the variable, the system will overwrite the least significant part of the variable in question.

When the write request record is correctly received by the system and all data-members turn out to be valid, the system will return the write response record as mentioned above. This response record is an exact copy of the request record, only without the bytecount and the written databytes.

In case any data-members in the write request record turn out to be invalid, the system will return an error response record. Paragraph 11.5.4 holds an exact description of all possible error records with an explanation of the possible causes. When trying to write a variable from the “standard begin-table for our products” that is not implemented on the system in question the write request will be confirmed, but of course this has no influence on the system whatsoever.

When the system does not return any record at all the cause might be found in a wrong bus-address, wrong checksum or a distortion in the communication process.

11.5.4 Error response codes

When a request is made and the system finds one of the data-members in the record to be invalid it will make this not acknowledge clear by sending an error response record.

1	2	3	4	← Databyte numbers
ADDRESS	FUNCTION	ERROR	CS	
address	OR 80h			

To let the master system know this is an error record the ModBus® function code will be changed. While the ms-bit of this code is normally always 0 it will be set to 1 (=OR 0x80). The master system can determine what went wrong by reading the error code on the third position of the error response record. In the table below you can find these error codes with an explanation of its meaning and the possible cause(s).

Error code 0 = Reserved for future use

Error code 1 = Illegal function

Meaning: The function code received by the system does not represent an executable function.

Possible causes:

1. Requested function is not implemented on this system.
2. Function code does not represent a valid ModBus® function.



Error code 2 = Illegal data address

Meaning: The received data cannot be linked to a variable in the system

Possible causes:

1. Variable number does not represent a valid variable on this system.
2. Length of record does not comply with the expected length.
3. Number of words exceeds the real length of the variable.

Error code 3 = Illegal data value

Meaning: The data is not valid with this variable

Possible causes:

1. Value is not valid for this variable. It exceeds the value range of this variable (too low/high).
2. Dummy byte does not equate zero when writing an odd number of bytes.

Error code 4 = Failure in associated device

Meaning: the message contains an illegal request, so it can not be processed

Possible causes:

1. The communication index is out of range when trying to access an indexed variable.

Error code 5: Reserved for future use.**Error code 6 = Slave device busy**

Meaning: The variable is not available for remote access

Possible causes:

1. Writing to a read-only variable.
2. System is currently being used in program-mode, so remote access is temporarily disabled for the variable that is being programmed.

When a function is requested and no response frame comes back within a short time (with regards to the Comdelay value!) the possible causes might be:

1. Communication protocol is set to off,
2. Message was mutilated due to a distortion on the line,
3. A hardware problem,
4. Wrong bus-address,
5. Baudrate of communicating devices differs (2400 <-> 9600),
6. Communication mode of communicating devices differs (RTU <-> ASCII),
7. Startbit, stopbit or number of databits of communicating devices differs,
8. Wrong checksum.



11.6 Standard begin-table

11.6.1 General

Not all functions are implemented in every product. This may vary per device and product family. It is even possible that a product with the same product number has different software and/or hardware.

The function codes 3 and 16 (read and write table data) are implemented in every product. To make it possible to access any product (also future products) via this protocol, the table-begin as described below is mandatory. With this standard begin, communication software can conclude which other functions are implemented.

N°	Variable name	Length	Not writable
00	Kind of product	2 bytes	never writable
01	Model number	2 bytes	never writable
02	Serial number product	4 bytes	never writable
03	Hardware options	2 bytes	never writable
04	Software options	2 bytes	never writable
05	Protocol options	2 bytes	never writable
06	Software version	2 bytes	never writable
07	Protocol version	2 bytes	never writable
08	Display languages	2 bytes	never writable
09	Bus address	1 byte	during local programming
10	Baud rate	2 bytes	during local programming
11	Communication mode	1 byte	during local programming
12	Comm. index use	2 bytes	always writable
13	Comm. index	1 byte	always writable
14	Comdelay	2 bytes	
15	general status	2 bytes	never writable
16	indexed status	1 byte	never writable
17	reserved		
18	reserved		
19	reserved		
20	Inputs		never writable
21	Outputs		never writable
22	Beep command	1 byte	always
23	Time and date	6 bytes	during local programming
24	Print command		not implemented
25	Reboot	2 bytes	always writable
26	reserved		
27	reserved		
28	reserved		
29	reserved		
30.....	Further product dependant variables only!!		

Table 5: Standard begin-table products



N°	Variable explanation	
00	Kind of product	Batch controller, PC, printer etc.
01	Model number	Type of product
02	Serial number	Serial number binary coded
03	Hardware options	Extra hardware mounted, inputs / outputs e.g.
04	Software options	Extra software functionality, temperature compensation e.g.
05	Protocol options	Protocol extensions, also other protocol implementation e.g.
06	Software version	Product software version
07	Protocol version	Communication software version
08	Display languages	Code for the display languages available
09	Bus address	The communication address
10	Baud rate	Communication speed 1200=0, 2400=1, 4800=3, 9600=4
11	Communication mode	BUS_ASCII=0, BUS_RTU=1, OFF=2 Warning: can not be enabled remotely
12	Comm. index use	User options of the comm. index: 00 : no features 01 : auto increment after each usage 02 : auto decrement after each usage 04 : auto functions also during broadcast access
13	Comm. index	Pointer for indexed values
14	Comdelay	{ 0..9999 } In milliseconds!!
15	General status	Device status, general alarm etc. Meaning of bits [msb...lsb] for 100-series: 0x0001: PCF error 0x0002: EEPROM error 0x0004: data corrupted (communication) 0x0008: receive buffer full (communication)
16	Indexed status	status per liquid; busy, overrun, pause etc, new data
17	Reserved	
18	Reserved	
19	Reserved	
20	Inputs	See device description
21	Outputs	See device description
22	Beep command	One byte in units of 0.1 seconds.
23	Date time	Order used: year,month,day,hour,minutes,seconds All bytes binary coded.
24	Print command	Not implemented yet
25	Reboot	0xA50F (warm reboot) or 0x5AF0 (cold reboot). A warm reboot resets the unit, but all programmed variables are stored. A cold reboot resets the unit and all of its programmed variables. Note that also the accumulated total will be lost!
26	Reserved	
27	Reserved	
28	Reserved	
29	Reserved	
30.....	Further product dependant variables only!!	



11.6.2 Indexed variables

Some products use an array of multiple variables, for example a linearisation table which holds multiple frequency-correction pairs or an array of multiple batch sizes. To make easy use of such an array, a communication index needs to be used.

The variable that will be returned depends of the value of this index. When a larger part of the array needs to be read or written it is possible to auto-increment or decrement the index, meaning that after each successful read/write the index will point to the next or previous variable in the array. This way complete arrays can be accessed fairly easily.

Note that if index=0 the first array member will be returned, so an array of 5 variables uses indices 0 through 4. Be aware that this index can only be used for variables which are marked as indexed in this manual, it is never possible to use the index to read/write multiple un-indexed variables!

Example

Assume we are communicating with a unit that uses linearisation and has a bus-address of 01. We are willing to read the complete linearisation table from it. Of course we can initialise the index, read the variable, increment the index, write the new index, read again and repeat this procedure until the whole table is read, however it is more easily to use the next steps:

1. Initialise the communication index to the first array-member, we need to write:
01 10 00 0D 00 01 02 00 00 DF (LRC checksum! ASCII-mode only!)
2. Set the communication index use to auto-increment, we need to write:
01 10 00 0C 00 01 02 00 01 DF
3. Now we are ready to read the first array-member, for our example the linearisation table start at address 0400h and each entry contains 6 bytes:
01 03 04 00 00 03 F5
4. The index is now auto-incremented to 01, so now we only need to repeat step 3. until the whole table is read!

For safety reasons the auto-increment/decrement function is disabled for our products which are used in broadcast-mode (e.g. FW/0300 series), but can still be enabled if desired (see standard begin-table products, variable 12)



11.7 General remarks

11.7.1 General

All numeric variables are binary coded. There are variables with different lengths:

byte : 8 bits
word : 16 bits
double word : 32 bits

When transmitting multibyte variables, the msb is transmitted first.

In tables, the length of variables is given in bytes.

Several on/off variables use "0" for off-position. A value unequal "0" indicates that the concerning variable is "on".

Variables that indicate a decimal position contain as value the number of digits behind the decimal point. This corresponds with the negative value of the exponent from 10 from the number to be multiplied with the concerning variable.

Example:

K-factor = 1031, decimal position K-factor = 2.

This means that the K-factor has two digits behind the decimal point; the K-factor is 10.31 This corresponds with the multiplying with $0.01 = 10E-2$. The last 2 corresponds (but without minus sign) with decimal position 2.

Time variables - if no other time unit indicated - use a time base of 0.1 second.

If the programmed overrun-time in a batch controller is 6.5 seconds for example, then the "communication-value" will be 65.

Some variables are always write protected such as the product and serial number. It is always allowed to read a variable.



12. Appendix A: Technical specification

12.1 General

Display	
Type	High intensity reflective numeric and alphanumeric LCD, UV-resistant.
Digits	Seven 17mm (0.67") and eleven 8mm (0.31"). Various symbols and measuring units.
Refresh rate	User definable: 8 times/sec - 30 secs.
Type ZB	Transflective LCD with green LED backlight. Good readings in full sunlight and darkness. Note: only available for safe area applications. Power requirements: 12-24V DC + 10% or type PD, PF, PM. Power consumption max. 1 Watt.

Enclosures	
General	Die-cast aluminum or GRP (Glassfibre Reinforced Polyamide) enclosure with Polycarbonate window, silicone and EPDM gaskets.
Control Keys	UV stabilized and flame retardant material.
Painting	Three industrial micro-switch keys. UV-stabilized silicone keypad. Aluminum enclosure only: UV-resistant 2-component industrial painting.
Panel-mount enclosures	Dimensions: 130 x 120 x 60mm (5.10" x 4.72" x 2.38") – LxHxD.
Classification	IP65 / NEMA4
Panel cut-out	115 x 98mm (4.53" x 3.86") LxH.
Type HC	GRP panel-mount enclosure
Type HB	Aluminum panel-mount enclosure
Field/wall-mount enclosures	Dimensions: 130 x 120 x 75mm (5.10" x 4.72" x 2.95") – LxHxD.
Classification	IP67 / NEMA4X
Aluminum enclosures	Drilling: 2x PG9 – 1x M20.
Type HA	Drilling: 2x M16 – 1x M20.
Type HM	Drilling: 1x M20.
Type HN	Drilling: 2x M20.
Type HO	Drilling: 6x M12.
Type HP	Drilling: 1x ½"NPT.
Type HT	Drilling: 3x ½"NPT.
Type HU	No drilling.
Type HZ	
GRP enclosures	
Type HD	No drilling.
Type HE	Drilling: 2x 16mm (0.63") – 1x 20mm (0.78").
Type HF	Drilling: 1x 22mm (0.87").
Type HG	Drilling: 2x 20mm (0.78").
Type HH	Drilling: 6x 12mm (0.47").
Option ZS	Silicone free ABS enclosure with EPDM and PE gaskets. UV-resistant polyester keypad. Note: This option comes with type HD only.



Operating temperature	
Operational	-30°C to +80°C (-22°F to +178°F).
Intrinsically safe	-30°C to +70°C (-22°F to +158°F).

Power supply	
Type PB	Lithium battery - life-time depends upon settings - up to 5 years.
Type PC	Intrinsically safe lithium battery - life-time depends upon settings - up to 5 years.
Type PD	8-24V AC / DC \pm 10%. Power consumption max. 10 Watt. Intrinsically safe: 16-30V DC; power consumption max. 0.75 Watt.
Type PF	24V AC / DC \pm 10%. Power consumption max. 15 Watt.
Type PL	Input loop powered from sensor signal 4-20mA (type A).
Type PM	115-230V AC \pm 10%. Power consumption max. 15 Watt.
Type PX	Output loop powered: 8-30V DC. Power consumption max. 0.5 Watt.
Note PF / PM	The total consumption of the sensors, backlight and outputs may not exceed 400mA@24V.
Note I.S. applications	For intrinsically safe applications, consult the safety values in the certificate.

Sensor excitation	
Type PB / PC / PX	3.2V DC for pulse signals and 1.2V DC for coil pick-up. Note: This is not a real sensor supply. Only suitable for pulse sensors with a very low power consumption like coils (sine wave) and reed-switches.
Type PD	1.2 - 3.2 - 8.2 - 12 and 24V DC - max. 50mA@24V DC
Type PD-XI	Intrinsically safe: Pulse signals: 1.2 - 3.2 - 8.2 - max. 7mA@8.2V DC. Analog signals: the sensor supply voltage is according to the power supply voltage connected to terminal 1. Also terminal 2 offers the same voltage.
Type PF / PM	1.2 - 3.2 - 8.2 - 12 and 24V DC - max. 400mA@24V DC.

Terminal connections	
Type:	Removable plug-in terminal strip. Wire max. 1.5mm ² and 2.5mm ² (Type PM / PF)

Data protection	
Type	EEPROM backup of all setting. Backup of running totals every minute. Data retention at least 10 years.
Pass code	Configuration settings can be pass code protected.

Hazardous area (option)	
Intrinsically safe Type XI	ATEX approval ref: <EX> II 1 GD EEx ia IIB/IIC T4 – T100°C.
Explosion proof Type XD/XF	ATEX approval ref: <EX> II 2 GD EEx d IIB T5. Weight appr. 15kg. Dimensions of enclosure: 350 x 250 x 200mm (13.7" x 9.9" x 7.9") LxHxD.

Environment	
Electromagnetic compatibility	Compliant ref: EN 61326 (1997), EN 61010-1 (1993).



12.2 Inputs

Flowmeter	
Type P	Coil/sine wave (minimum 20mVp-p or 80mVp-p - sensitivity selectable), NPN/PNP, open collector, reed-switch, Namur, active pulse signals 8 - 12 and 24V.
Frequency	Minimum 0 Hz - maximum 7 kHz for total and flowrate. Maximum frequency depends on signal type and internal low-pass filter. E.g. Reed switch with low-pass filter: max. frequency 120 Hz.
K-Factor	0.000010 - 9,999,999 with variable decimal position.
Low-pass filter	Available for all pulse signals.
Type A	(0)4-20mA - with signal calibration feature at any current within the range.
Type U	0-10 V - with signal calibration feature at any voltage within the range.
Accuracy	Resolution: 14 bit.. Error < 0.025mA / $\pm 0.125\%$ FS. Low level cut-off programmable.
Span	0.000010 - 9,999,999 with variable decimal position.
Update time	Four times a second.
Voltage drop	2.5 Volt.
Load impedance	3kOhm
Relationship	Linear and square root calculation.
Note	For signal type A and U: external power to sensor is required; e.g. Type PD.

12.2 Outputs

Analog output	
Function	Transmitting flowrate.
Accuracy	10 bit. Error < 0.05% - update 10 times a second. Software function to calibrate the 4.00mA and 20.00mA levels precisely within set-up.
Load	max. 1 kOhm
Type AA	Active 4-20mA output (requires type OA + PD, PF or PM).
Type AB	Active 0-20mA output (requires type OA + PD, PF or PM).
Type AF	Passive floating 4-20mA output for Intrinsically Safe applications (requires PC, PD or PL).
Type AI	Passive galvanically isolated output (requires PB, PD, PF, PL or PM).
Type AP	Passive 4-20mA output - output loop powered (type PX).
Type AU	Active 0-10V output (requires type OA + PD, PF or PM).

Transistor output(s)	
Pulse output	Max. frequency 60Hz. Pulse length user definable between 7,8msec up to 2 seconds.
Function	One pulse output - transmitting accumulated total.
Type OA	Active 24V DC transistor output; max. 50mA per output (requires type AA + PD, PF or PM).
Type OR	Isolated mechanic relay output; max. switch power 230V AC - 0,5A (requires type PF or PM).
Type OT	Passive transistor output - not isolated. Load max. 50V DC - 300mA.



Communication option	
Functions	Reading display information, reading / writing all settings.
Protocol	ModBus® ASCII or RTU
Speed	1200 - 2400 - 4800 - 9600 baud
Addressing	Maximum 255 addresses.
Type CB	RS232
Type CH	RS485 2-wire
Type CI	RS485 4-wire
Type CT	TTL Intrinsically Safe communication.
Type CX	No communication.

12.3 Operational

Operator functions	
Displayed functions	<ul style="list-style-type: none"> • Total and/or flowrate. • Total and accumulated total. • Total can be reset to zero by pressing the CLEAR-key twice.

Total	
Digits	7 digits.
Units	L, m3, GAL, USGAL, KG, lb, bbl, no unit.
Decimals	0 - 1 - 2 or 3.
Note	Total can be reset to zero.

Accumulated total	
Digits	11 digits.
Units / decimals	According to selection for total.

Flowrate	
Digits	7 digits.
Units	mL, L, m3, Gallons, KG, Ton, lb, bl, cf, RND, ft3, scf, Nm3, NI, ical - no units.
Decimals	0 - 1 - 2 or 3.
Time units	/sec - /min - /hr - /day.



13. Appendix B: Problem solving

In this appendix, several problems are included that can occur when the F110-P is going to be installed or while it is in operation.

13.1 Flowmeter does not generate pulses

Check:

- Signal selection SETUP - 51
- Pulse amplitude
- Flowmeter, wiring and connection of terminal connectors
- Power supply of flowmeter

13.2 Flowmeter generates "too many pulses"

Check:

- Settings for total and Flowrate: SETUP 11-14 and 21-27,
- Type of signal selected with actual signal generated - SETUP - 51,
- Sensitivity of coil input - SETUP - 51
- Proper grounding of the F110-P
- Use screened wire for flowmeter signals and connect screen to terminal 9. (unless connected at sensor)

13.3 Analog output does not function properly

Check:

- SETUP 61 - is the function enabled?
- SETUP 62 / 63: are the flow-levels programmed correctly?
- Connection of the external power-supply according to the specification.

13.4 Pulse output does not function

Check:

- SETUP 71 - pulse per "x" quantity; is the value programmed reasonable and will the maximum output be under 20Hz?
- SETUP 72 - impulse width; is the external device able to recognize the selected pulse width and frequency?

13.5 Flowrate displays "0 / zero" while there is flow (total is counting)

Check:

- SETUP 22 / 25: are the K-factor and time unit correct?
- SETUP 26 / 27: The unit has to count the number of pulses according to SETUP 26 within the time according to SETUP 27. Make sure that 27 is set to 10.0 seconds for example: the result is that the unit has at least 10 seconds time to measure the number of pulses according to SETUP 26.

13.6 The pass code is unknown

If the pass code is not 1234, there is only one possibility left: call your supplier.

13.7 Alarm

When the alarm flag starts to blink an internal alarm condition has occurred. Press the "select button" several times to display the 5-digit error code. The codes are:

0001: irrecoverable display-data error: data on the display might be corrupted.

0002: irrecoverable data-storage error: the programming cycle might have gone wrong: check programmed values.

0003: error 1 and error 2 occurred simultaneously



The alarm condition will almost certainly be handled internally and if all mentioned values still appear correct, no intervention by the operator is needed. If the alarm occurs more often or stays active for a longer time, please contact your supplier.



14. Appendix C: Communication variables

14.1 Remarks

- Below, an overview of the F110-P specific variables; other common variables are described in the standard table.
- All numbers are decimal numbers, unless otherwise noted.
- The following variables of the standard table (var00-var30) are not valid for this product and will be responded with value 1: var00, 03-05, 07, 08, 16-22, 24, 26-29.

CONFIGURATION VARIABLES F110-P - SETUP-LEVEL:				
VAR	DESCRIPTION	BYTES	VALUE	REMARKS
TOTAL				
32 (20h)	Unit	1	0=L 1=m3 2=kg 3=lb 4=gal 5=usgal 6=bbbl 7=none	
33 (21h)	Decimals	1	0...3	
34 (22h)	K-factor	3	1....9.999.999	K-f 0000001 - K-f 0000009 is allowed when decs < 6! (VAR37)
37 (25h)	decimals K-factor	1	0..6	
FLOWRATE				
48 (30h)	unit	1	0=mL 1=L 2=m3 3=mg 4=g 5=kg 6=ton 7=gal 8=bbbl 9=lb 10=cf 11=rev (revolutions for RPM) 12=none 13=scf 14=NM3 15=NL 16=p	
49 (31h)	time unit	1	0=sec 1=min 2=hour 3=day	
50 (32h)	decimals	1	0...3	
51 (33h)	K-factor	3	1....9.999.999	K-f 0000001 - K-f 0000009 is allowed when decs < 6! (VAR54)



54 (36h)	Decimals K-factor	1	0..6	
55 (37h)	Number of pulses	1	1..255	
56 (38h)	Cut-off time	2	1.. 9999	steps of 100ms
VAR	DESCRIPTION	BYTES	VALUE	REMARKS
DISPLAY				
64 (40h)	display function	1	0=total 1=flowrate	
68 (44h)	set flowrate monitor	1	0=operator level 1=SETUP level	
POWERMANAGEMENT				
80 (50h)	LCD update time	1	0=fast 1=1sec 2=3sec 3=15sec 4=30sec 5=off	
81 (51h)	power-mode battery	1	0=operational 1=shelf	
FLOWMETER				
96 (60h)	flowmeter signal	1	0=npn 1=npn-lp 2=reed 3=reed LP 4=pnp 5=pnp-lp 6=namur 7=coil hi 8=coil lo	
ANALOG OUTPUT				
112 (70h)	analog output	1	0=disable 1=enable	
113 (71h)	minimum rate	3	0..9999999	unit, time, decimals acc. var48-50
116 (74h)	maximum rate	3	0..9999999	unit, time, decimals acc. var48-50
119 (77h)	cut off percentage	1	0..99	steps of 0.1%
120 (78h)	tune minimum rate	2	0..9999	
122 (7Ah)	tune maximum rate	2	0..9999	
99 (63h)	filter	1	0....99	
PULSE OUTPUT				
128 (80h)	impulse width	1	0=off 1=short 2=long	
129 (81h)	pulse per X quantity	3	1..9999999	unit, decimals acc. var32 -33
OTHERS				
168 (A8h)	pass code	2	xxxx	read only!
170 AAh	tagnumber	3	0..9999999	Other vars: see standard table



14.2 OTHER F110-P VARIABLES FOR COMMUNICATION

TOTAL - variable number 566 (236h) – 6 bytes

Read total: The value of total read using RS communications might differ from the value that appears on the display. This is due to the fact that the display can only display up to seven digits (for example when two decimals are selected for total and total has a value of 123456,78 the display will show 23456,78 while communication will read a “total” of 12345678 and a “total decimals” of 2).

Write total: Total can only be cleared. This means writing a value different from 0 will result in the reply of an error message. Only writing 6 bytes of zero’s to total will be accepted.

ACCUMULATED TOTAL - variable number 560 (230h) – 6 bytes

Read acc. total: A difference between the read value and the display value, as explained for “Read total”, might appear here too.

Write acc. total: Not possible.

When reading or writing total or accumulated total it should be noted that the used values are given including the decimals. This means that a read/write to one of these variables should be accompanied with a read/write to the variable that holds the number of decimals for this variable:

Example: read var. 566 for total:

Read var. 33 for total decimals and calculate the real value of total by multiplying total with $10^{(total\ decimals)}$

FLOWRATE - variable number 572 (23Ch) – 4 bytes

Read flowrate: The value difference as mentioned with total/acc. total might appear here too.

Write flowrate: Not possible.



LIST OF CONFIGURATION SETTINGS			
SETTING	DEFAULT	DATE :	DATE :
1 - TOTAL	Enter your settings here		
11 unit	L		
12 decimals	0000000		
13 K-factor	0000001		
14 decimals K-factor	0		
2 - FLOWRATE			
21 unit	L		
22 time unit	/min		
23 decimals	0000000		
24 K-factor	0000001		
25 decimals K-factor	0		
26 calculation / pulses	010		
27 cut-off time	30.0 sec.		
3 - DISPLAY			
31 function	total		
4 - POWER MANAGEMENT			
41 LCD-new	1 sec.		
42 mode	operational		
5 - FLOWMETER			
51 signal	coil-lo		
6 - ANALOG OUTPUT			
61 output	disabled		
62 min. flowrate 4-mA	0000000		
63 max. flowrate 20mA	9999999		
64 cut off percentage	0.0%		
65 tune min - 4mA	0208		
66 tune max - 20mA	6656		
67 filter	01 (off)		
7 - PULSE OUTPUT			
71 impulse width	000 periods		
72 pulse per	0001000		
8 - COMMUNICATION			
81 baud-rate	2400		
82 address	1		
83 mode	BUS-ASC		
9 - OTHERS			
91 model	F110-P	F110-P	F110-P
92 software version			
93 serial number			
94 pass code	0000		
95 tagnumber	0000000		



15. Return of goods for repair / Harmlessness declaration

Please copy, fill in and sign hereafter harmless declaration and enclose it for any return of goods you may send back for repair.

No repair will be performed prior to receiving the harmless declaration duly filled and signed.

Harmlessness declaration

To : _____
Attn. : _____
From : _____
Dept. : _____

Please note that no repair will be performed prior to receiving of this declaration duly signed by you!

Please send all parts clean from medium and inform us about possible medium wastes remaining in the part. For this purpose, please use this form. A security specification sheet of the medium must accompany this declaration in the following cases: Toxic, dangerous or objectionable media, or media belonging to any dangerous materials class. We inform you that uncleaned parts lead to additional costs. Extra clean costs will be charged to you.

Declaration

We herewith confirm that the part(s) sent for repair has/have been cleaned and is/are free of any liquid and/or solid wastes of the medium and/or cleaning medium: Any eventually remaining wastes are:

- harmless
- dangerous, toxic, etc. – Security specifications are attached

Signature of person in charge: _____

Name of the person in charge in capital letters: _____

Date: _____

Company stamp: _____



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