# Fuel Sentry System

**BENOIT**

## MANUAL DE OPERACION Y MANTENCION

Av. Mexico 823 Recoleta, Santiago de Chile
www.dog.cl/FUELSENTRY  dog@dog.cl
Tel +56 2 2979 0377 Movil +56 9 8449 1011

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# SAFETY RULES AND PRECAUTIONARY MEASURES

* The manufacturer accepts no responsibility whatsoever if the instructions and procedures as described in this manual are not followed.
* Modifications of the Fuel Sentry System, implemented without preceding wirtten consent from the manufacturer, will result in the immediate termination of product liability and warranty period.
* Installation, use, maintenance and de-mounting 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 and the Fuel Sentry System
* Open the casing only of all leads are potential free.
* 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.


ABOUT THE OPERATION MANUAL

This operation manual is divided into two main sections.

The daily use of the unit is described in Chapter 2, "Operation." This instruction is meant for users. The following chapters and appendices are exclusively meant for elecricians/technicians. These provide an extensive description of all software settings and installing the hardware.

This operation manual describes the standard unit. Additional hardware is briefly dealt with in this manual. For more information, please contact your supplier.


BRIEF DESCRIPTION OF THE FUEL SENTRY SYSTEM

The Fuel Sentry System is a battery powered system driven by microprocessors for the displaying of flow rate, total and accumulated total. These figures are calculated as the differential or count up of two flows. For that purpose, two flowmeters with pulse or coil output can be connected to the Fuel Sentry System. Two outputs are standardly available:
* Pulse output (open collector); a scaled pulse mirroring the count on the display is generated for use by external instruments like counters for example.
* The passive analog output with 10-bits resolution has programmable set points according to the flowrate for both 4mA and 20mA.
Furthermore, options are available for full communication RS232/485 (also battery powered) and intrinsically safe.

The Fuel Sentry System is designed to be implemented in many types of applications. For that reason, a SETUP level is available to configure your rate/totalizer best according to your requirements. An important feature is the fact that both flows may have different sign pick-ups and K-factors. The measuring units should be the same to make the differential calculations or count up possible.
To extend the battery-life time please make use of the power-management function.

# GENERAL OPERATION

This chapter described the daily use of the rate/totalizer. This instruction is meant for the users/operators.

In general, the rate/totalizer will always act at Operator level. The information displayed is depending on the SETUP settings. Although the refresh rate of the display might be slow (due to power-management functions) each flowmeter pulse will be measured. After pressing a key, the display will be updated very fast during the first 30 seconds after which it will slow down again.

| TOTAL | m³ |
|---|---|
| | **1742638** |
| | RUN |
| RATE | 1853.9 L/MIN |

Fig. 2: Example display information during process

For the Operator, following functions are available:

* Display rate / Total or rate:
  This is the main display information of the Fuel Sentry System. After selecting other information, it will return to the main display automatically. The actual flow rate is either displayed at the bottom line or with the 17mm digits at the upper line. When "-----" is shows, the flowrate cannot be calculated. When the flow rate of flow 2 is higher than flow 1, a negative rate will be displayed, while Total will count down. The arrows indicate the increase/decrease of the flow rate.

* Clear Total:
  The value for Total can be initialized. To do so, press CLEAR twice. After pressing CLEAR once, the text "PUSH CLEAR" is displayed while the display information is flashing. To avoid initialization in that stage, press adifferent key or wait for 20 seconds. Initialization of Total DOES NOT influence accumulated Total.

* Display accumulated Total
  When the SELECT key is pressed, Total and accumulated total are displayed. Accumulated Total can never be initialized. The value will count up to 99,999,999,999. The unit and number of decimals are according to Total.

* Low-battery alarm:
  When the battery voltage drops, it must be replaced. First "low-battery" will flash, but as soon as it is displayed continuously, the battery MUST be replaced soon! Only official batteries may be used, or the warranty will be terminated. The remaining life time after the first moment of inidication is generally several days to up to some weeks.

* Alarm 01-03:
  When "alarm" is displayed, please consult Appendix B; problem solving.

# CONFIGURATION

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

    *Installation, use, maintenance and de-mounting of this equipment must be carried out by authorized technicians only.
    *Please review the Safety Rules and Precautionary Measures" in front of this manual.

PROGRAMMING SETUP LEVEL    -    GENERAL

Configuration of the Fuel Sentry System is done at SETUP level. SETUP level can be reached by pressing the PROG/ENTER key for 7 seconds; in the meantime both arrows are displayed. In order to return to the operator level, PROG will have to be pressed for 3 seconds. Also, when no keys are pressed for 2 minutes, SETUP will be left automatically.
SETUP can be reached at all times while the Fuel Sentry System remains fully operational.

PASSWORD

A password may be required to enter SETUP. Without this password, access to SETUP is denied.

SETUP is divided into several main- and sub-functions. Main functions are selected with ( arrows ) and subfunctions with ( arrows ). Each function is a unique number, which is dispayed below the word "SETUP" at the bottom of the display. The number is a combination of two figures. The first figure indicates the main-function and the second figure the sub-function; Ex: 12 is the second sub-function of main-function 1. Furthermore each function is expresed with a keyword.
After selecting a sub-function, the next main function can first be selected after scrolling through all "active" sub-functions,
(i.e. 1 , 11 , 12 ,13 , 14 , 1 , 2 , 3 , 31 etc.)

```
        ┌──────────────────────────────────────┐
        │                                      │
        │      ▐SET-UP▌                         │
        │      1          Total  No. 1         │
        └──────────────────────────────────────┘
```
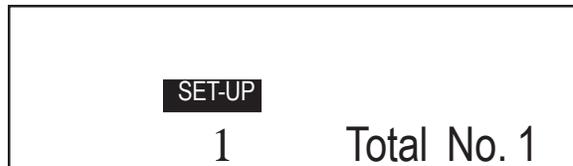
Fig. 4: Example of main-function 1.

```
        ┌──────────────────────────────────────┐
        │                            USGAL      │
        │   ▐SET-UP▌                             │
        │   11              Unit                │
        └──────────────────────────────────────┘
```
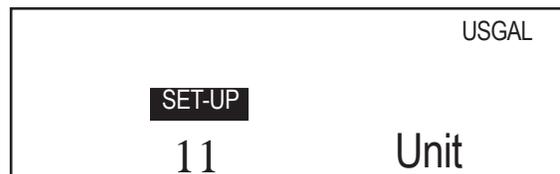
Fig. 5: Example of sub-function 11; unit for Total..

SETUP has been divided as follows:

|     |     |
|-----|-----|
| 14  | DECIMALS K-FACTOR: 0-6 |
| 13  | K-FACTOR: 0.000010-9,999,999 |
| 12  | DECIMALS: 0 - 1 - 2 - 3 |
| 11  | UNIT: L - m3 - kg - lb - GAL - USGAL - bbl - no unit |

1        TOTAL 1

|     |     |
|-----|-----|
| 28  | FILTER: 0 - 99 |
| 27  | CUT-OFF: 0.1 - 999.9 seconds |
| 26  | CALCULATION: per 1 - 255 pulses |
| 25  | DECIMALS K-FACTOR: 0 - 6 |
| 24  | K-FACTOR: 0.000010 - 9,999,999 |
| 23  | DECIMALS:  0 - 1 |
| 22  | TIME UNIT: sec - min - hour - day |
| 21  | UNIT: ml - L - m3 - mg - g - kg - ton - GAL - bbl - lb - cf - rev - no unit |

2        FLOWRATE 1

|     |     |
|-----|-----|
| 32  | DECIMALS K-FACTOR:  0 - 6 |
| 31  | K-FACTOR: 0.000010 - 9,999,999 |

3        TOTAL 2

|     |     |
|-----|-----|
| 44  | CUT-OFF: 0.1 - 000.0 seconds |
| 43  | CALCULATION: per 1 - 255 pules |
| 42  | DECIMALS K-FACTOR:  0 - 6 |
| 41  | K-FACTOR: 0.000010 - 9,999,999 |

4        FLOWRATE 2

|     |     |
|-----|-----|
| 52  | CALCULATE:  differential - add |
| 51  | FUNCTION:  total - flowrate |

5        DISPLAY

|     |     |
|-----|-----|
| 62  | BATTERY MODE:  operational - shelf |
| 61  | LCD UPDATE:  fast - 1 sec - 3 sec - 15 sec - 30 sec - off |

6        POWER MAN.

|     |     |
|-----|-----|
| 72  | SIGNAL:  npn - npn_lp  - reed - reed_lp - pnp - pnp_lp - namur - coil_hi - coil_lo |
| 71  | SIGNAL:  npn - npn_lp  - reed - reed_lp - pnp - pnp_lp - namur - coil_hi - coil_lo |

7        FLOWMETER

|     |     |
|-----|-----|
| 86  | TUNE MAX / 20mA: 0 - 9,999 |
| 85  | TUN MIN / 4mA: 0 - 9,999 |
| 84  | CUT-OFF: 0.0 - 9.9% |
| 83  | 20mA - FLOWRATE: 0 - 9,999.9 |
| 82  | 4Ma - flowrate:  0 - 9,999.9 |
| 81  | OUTPUT:  disable - enable |

**8      ANALOG**

        92      IMPULSE PER: X,XXX,XXX quantity

        91      IMPULSE WIDTH:  off  -  short  -  long

**9      PULSE**

        A3      MODE: ascii  -  rtu  -  off

        A2      ADDRESS:  1 - 255

        A1      SPEED / BAUDRATE:  1200 - 2400 - 4800 - 9600

**A      COMMUNICATION**

        B5      TAGNUMBER: 0000000 - 9999999

        B4      PASSWORD:     0000 - 9999

        B3      SERIAL NO.

        B2      SOFTWARE VERSION

        B1      TYPE/MODEL

**B      OTHERS**

# PROG - PROCEDURES

The PROG - procedure is applicable for programming, selecting or deleting values on SETUP level.  The procedures is executed as follows:

1)       press PROG briefly,
2)       enter a value or make a selection with the arrow   keys.
3)       set  the operation by pressing ENTER.

After pressing PROG, the word PROGRAM will be flashing until the PROG-procedure is completed.  To change a value, use      to select the digits and      to increase that value.  To select a setting, both and      can be used.  When the new value is not valid, 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.

Please note that alterations will only be set after the ENTER has been pressed.

SETUP                     TOTAL NO. 1 - 1

TOTAL NO. 1; MEASUREMENT UNIT - 11:

SETUP -11       determines the measurement unit for TOTAL and accumulated Total of BOTH flows. The following units can be selected:

                L - m3 - kg - lb. - GAL - USGAL - bbl - (no unit).

TOTAL NO. 1; NUMBER OF DECIMALS DISPLAYED - 12:
The decimal point determines for Total and accumulated Total the number of digits BOTH flows following the decimal point.  The following can be selected:

                0000  -  111.1  -  22.22 - 3.333

TOTAL NO. 1; K-FACTOR - 13;
This and following settings are valid for flowmeter 1 only.
With the K-factor, the flow meter pulse signals are converted to a quantity.  The K-factor is determined on the basis of the measurement unit and the number of pulses generated per unit by the flowmeter.  Enter the number of pulses generated by the flowmeter per selected measurement unit (per cubic meter, e.g).  The more accurate the K-factor, the more accurate the functioning of the system will be.

Example  1:     Calculating the K-factor
                *Ltet us assume that the flow meter generatres 2.4813 pulses per litre 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 "6".*

Example 2:      Calculating the K-Factor.
*Let us assume that the flow meter 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" .*

TOTAL NO. 1; NUMBER OF DECIMALS FOR K-FACTOR TOTAL - 14:
This function determines the number of decimals for the K-factor (see 13).
The following can be selected:

0 - 1 - 2 - 3 - 4 - 5 - 6

Please note that this function invluences the accuracy of the K-factor indirectly.
This setting has NO influence on the displayed number of digits for Total (SETUP 12).

SETUP          FLOW RATE NO 1-2

The settings for Total and flow rate and entirely separated.  In this way, different measurement units can be used like cubic meters for Total and liters for flow rate.  Please notice that all these settings influence the analog output as well.

FLOW RATE NO. 1; MEASUREMENT UNIT - 21:
SETUP - 21 determines the measurement unit for flow rate of BOTH flows.
The following units can be selected:

mL - L - m3 - mg - gr - kg - ton - GAL - bbl - lb. - cf - rev(revolutions for RPM) - _(no unit).

Alterations 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.

FLOW RATE NO. 1; TIME UNIT - 22:
The actual flow rate of BOTH flows can be calculated per second (SEC), minute (MIN), hour (HR) and day (DAY).

FLOW RATE NO. 1; NUMBER OF DECIMALS DISPLAYED - 23:
The decimal point determines for flow rate of BOTH flows the number of digits following the decimal point.
The following can be selected:

00000 - 1111.1

FLOWRATE NO. 1: K-FACTOR - 24:
This and the following settings are valid for flowmeter 1 only.   With the K-factor, the pulse signals of the flow meter are converted to a quantity.  The K-factor is determined on the basis of the measurement unit and the number of pulses generated by the flow meter per selected measurement unit (per Liter e.g).  The more accurate the K-factor, the more accurate the functioning of the system will be.  For examples see SETUP 13.

FLOWRATE NO. 1; NUMBER OF DECIMALS FOR K-FACTOR - 25:
This function determines the number of decimals for the K-factor (see 24).
The following can be selected:

      0 - 1 - 2 - 3 - 4 - 5 - 6

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).

FLOWRATE NO. 1: CALCULATION - 26:
The flow rate is calculated by measuring the time between pulses. As several types of flowmeters have
an unequal pulse-train, it is advised to calculate the flow rate over several pulses, for example 10
pulses; the maximum value is 255 pulses. Please understand that the calculation time for very low
frequencies (0.1 - 5Hz) is influenced by this setting as well; so do not program too many pulses!
When the frequency is above 3kHz during normal conditions, it is advised to calculate 50 or
more pulses.

FLOWRATE NO. 1; CUT-OFF TIME - 27:
With this setting, you determine when a flow rate is zero. When during this time less than XX-pulses
(see setting 26) are generated, the flow rate will be displayed as zero.
Please be aware that a long cut-off time does influence the accuracy as soon as the real flow is zero.
For that reason, it is advised not to program longer times as 5 seconds e.g.

FLORWARE NO. 1; FILTER - 28:
With this digital filter, the calculated flow rate (differential or sum value) can be stabilized while the filter
level can be set to desired value. The filter principal is based on three input values: the filter level (01-99),
the last calculated flow rate (ten times a second) 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 seconds | 0.2 seconds | 0.4 seconds | 0.7 seconds |
| 03 | 0.2 seconds | 0.4 seconds | 0.6 seconds | 1.2 seconds |
| 05 | 0.5 seconds | 0.7 seconds | 1.1 seconds | 2.1 seconds |
| 10 | 0.7 seconds | 1.4 seconds | 2.2 seconds | 4.4 seconds |
| 20 | 1.4 seconds | 2.8 seconds | 4.5 seconds | 13.6 seconds |
| 30 | 2.1 seconds | 4.1 seconds | 6.8 seconds | 13.6 seconds |
| 50 | 3.5 seoncds | 6.9 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 |

SETUP          TOTAL NO. 2 - 3

TOTAL NO. 2; K-FACTOR - 31
The K-factor for flowmeter 2 is determined with this setting.  With the K-factor, the flow meter pulse signals are converted to a quantity.  The K-factor is determined on the basis of the measurement unit and the number of pules generated per unit by the flow meter.
Enter the number of pulses generated per unit by the flowmeter per selected measurement unit (per cubic meter e.g.).  The more accurate the K-factor, the more accurate the functioning of the system will be.  For examples:  see SETUP 13.  The measuring unit is determined with SETUP 11.

TOTAL NO. 2; NUMBER OF DECIMALS FOR K-FATOR TOTAL - 32:
This function determines the number of decimals for the K-factor of flow meter 2 (see 31).
The following can be selected:

       0 - 1 - 2 - 3 - 4 - 5 - 6

Please not that this function influences the accuracy of the K-factor indirectly.

SETUP          FLOW RATE NO. 2 - 4

These settings for flow rate are valid for flow meter 2 only.

FLOW RATE NO. 4;  K-FACTOR 41:
With the K-factor, the pulse signals of the flowmeter are converted to a quantity.  The K-factor is determined on the basis of the measurement unit and the number of pulses generated per unit by the flow meter.  Enter here the number of pulses generated by the flow meter per selected measurement unit (per Liter e.g.).  The more accurate the K-factor, the more accurate the functioning of the system will be.  For examples see SETUP 13.

FLOW RATE NO. 2;  NUMBER OF DECIMALS FOR K-FACTOR - 24:
This function determines the number of decimals for the K-factor (see 41).
The following  can be selected:

       0 - 1 - 2 - 3 - 4 - 5 - 6

Plase note that this SETUP influences the accuracy of the K-factor indirectly.

FLOW RATE NO. 2:  CALCULATION  -  43;
The flow rate is calculated by measuring the time between pulses.  As several types of flow meters have an unequal pulse-train, it is advised to calculate the flow rate over several pulses, for example 10 pulses.  The maximum value is 255 pulses.  Please understand that the calculation time for very low frequencies (01- 5Hz) is influenced by this setting as well; so do not program too many pulses!  When the frequency is above 3kHz. during normal conditions, it is advised to calculate 50 or more pulses.

FLOW RATE NO. 2; CUT-OFF TIME - 44:
With this setting, you determine when a flow rate is zero; when during this time less than XX-pulses (see setting 43) are generated, the flow rate will be displayed as zero after this time.  Please be aware that a long cut-off time does influence the accuracy as soon as the real flow is zero.  For that reason, it is advised not to program ltimes longer  than 5 seconds e.g.

SETUP          DISPLAY - 5

DISPLAY; FUNCTION - 51
The large 17mm digits can be set to display Total or flow rate.  When Total is selected both Total and flow rate are displayed simultaneously.  When flow rate is selected, Total will be displayed after pressing select.

DISPLAY; CALCULATION - 52
The Fuel Sentry System can be set to calculate the differential between both flows or to add both flows.  This is selected with setup 52.

SETUP          POWER MANAGEMENT - 6

As the Fuel Sentry System is standardly battery powered, the user will have the concern of reliable measurement over a long period of time.  The Fuel Sentry System has several smart power management functions to extend the battery life significantly. Two of these functions can be set:

POWER MANAGEMENT; LCD NEW - 61:
The calculation of the display-information influences the power consumption significantly.  When the application does not require a fast display update, we advise you to select a slow refresh-rate.  Please understand that NO information will be lost; every pulse will be counted and the output-signals are not influenced.  The following can be selected;

        Fast - 1 sec - 3 sec - 15 sec - 30 sec - off

Example:      battery life-time with one coil pick-up, 1KHz. pulses and FAST update: about 2 years.
              battery life-time with one coild pikc up, 1KHz. pulses and 1 sec update: about 7 years.

Please note that - after a button has been pressed by the operator - the display refresh-rate will always be FAST during 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.

POWER MANAGEMENT; BATTERY MODE - 62:
The unit has two modes: operational or shelf.  When  shelf is selected, you can store the unit for several years; it will not count pulses, the display is switched off but all settings are stored.  In this mode, power consumption is extremely low.  Normally, the unit will be operational.

SETUP            FLOW METER - 7

With this function, the input signal for each flow can be selected.  Both inputs are completely separated, so different signal pick-ups can be used, with one exception:  coil input.  When both inputs are defined as coil, the setting for both must be the same:  coil LO or coil HI.

FLOWMETER NO. 1; SIGNAL - 71
With  this setting, the input signal for input 1 is defined.

FLOW METER NO. 2; SIGNAL - 72;
With this setting, the input signal for input 2 is defined.

| TYPE OF SIGNAL | EXPLANATION | RESISTANCE | POWER CONSUMPTION | FREQ/ mV | REMARK |
|---|---|---|---|---|---|
| NPN | Standard NPN input | 100K pull-up | Relative high | 16KHz. | (open collector) |
| NPN- LP | NPN with low pass filter | 100K pull-up | Relative high | 2.2 KHz. | (open collector) less sensitive |
| REED | Reed switch input | 1M pull-up | low | 2.2 KHz. | |
| REED - LP | Reed switch + low pass filter | 1M pull-up | low | 225 HZ | less sensitive |
| PNP | Standard PNP input | 100 pull-down | Relative high | 6.3 KHz. | |
| PNP - LP | PNP input with low pass filter | 100K ull-down | Relative high | 700 Hz. | less sensitive |
| NAMUR | Standard namur input | 1K  pull-down | High | 12 KHz. | External power  required |
| COIL HI | High sensitive coil input | - | Very low | 25mV p.t.p. | Sensitive for disturbance |
| COIL LO | Low sensitive coil input | - | Very low | 90 mV p.t.p. | Normal sensitivity |

# PROG - PROCEDURES (cont'd)

SETUP -         ANALOG OUTPUT - 8

A passive linear 4-20mA output signal is generated according to the flowrate with a 10 bits resolution.  The settings for flowrate (SETUP 2 and 4) influences the analog output directly.  When the analog output is not used, please make sure that setting 81 is disabled, else the battery lifetime will be decreased significantly.  When a power supply is available but the output is disabled, a 3.5mA signal will be generated.  The relationship between rate and analog output is set with the following functions.

ANALOG OUTPUT; DISABLE / ENABLE - 81:
As the D/A converter has a relatively high power consumption, it is strongly advised to power the unit externally.  When the analog output will not be used, select "disable" to switch-off the converter.  For more information see "Terminal Connectors."

ANALOG OUTPUT; MINIMUM FLOW RATE - 82:
Enter here the flow rate according which to output should generate a 4mA signal (mostly at rate "zero").  The number of decimals displayed is according to setting 23.  The time and measuring units (L/min e.g.) are according to setting 21 and 22 but cannot be displayed.

ANALOG OUTPUT; MAXIMUM FLOW RATE - 83:
Enter here the flow rate according to which the output should generate a 20mA signal (mostly at maximum possible rate).  The number of decimals displayed is according to setting 23.  The time and measuring units (L/min) are according to settings 21 nd 22 but cannot be displayed.

ANALOG OUTPUT; CUT-OFF FLOW - 84:
To ignore leakage of the flow e.g., a low-flow cut-off can be set as percentage over the full rate of 16mA.  When the flow is less than the required rate, the current will be 4mA.  Examples:

| 4mA (SETUP 62) | 20mA (SETUP 63) | Cut-Off (SETUP 64) | Required Rate | Output |
|---|---|---|---|---|
| 0  l/min | 100 l/min | 2% | (100-0)*2%= L/min | 4+ (16*2) = 4.32 mA |
| 20 L/min | 800 L/min | 3.5% | (800-20)*3.5%=27.3 L/min | 4+(16*3.5%)=4.56mA |

ANALOG OUTPUT; TUNE MIN / 4MA - 85:
The initial minimum analog output value is 4mA.  However, this value might differ slightly due to external influences such as temperature e.g.  The 4mA value can be tuned exactly with this setting.  Warning: before tuning the signal, be sure that the mA signal is not used!
After pressing PROG, the current will be about 4mA.  The current can be increased/decreased with the arrow-keys and is directly active.  Press ENTER to store the new value.

ANALOG OUTPUT; TUNE MAX / 20MA - 86:
The initial maximum analog output value is 20mA.  However, this value might differ slightly due to external influences such as temperature e.g.  The 20mA value can be tuned exactly with this setting.  Warning:  before tuning the signal, be sure that the mA signal is not used!  After pressing PROG, the current will be about 20mA.  The current can be increased / decreased with the arrow keys and directly active.  Press ENTER to store the new value.

SETUP -          PULSE OUTPUT - 9

The open-collector output is available to generate a pulse per quantity.  This frequency output is programmable and has a maximum frequency of 20Hz.

PULSE OUTPUT; IMPULSE WIDTH - 91:
When the pulse is used to drive an electro-mechanical counter, a long pulse - 100msec - will be required.  Consequently, the maximum output frequency is 5Hz.  For electronic counters a frequency of max. 20Hz is offered with a short pulse of 25msec.
Please note:  when the frequency goes out of range - when the flow rate increases for example - an internal buffer will be used to "store the pulses":  as soon as the flow rate goes down, 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 its' range.  It is advised to select "OFF" when the pulse output is not used.

PULSE OUTPUT; PULSE PER - 92
According to the settings for Total, a pulse will be generated every X-quantity.  Enter here this quantity while taking the decimal position and measuring unit into account.

SETUP -          COMMUNICATION (OPTIONAL) - A

Functions as described below deal with hardware that are not part of the standard delivery.  Programming of these functions does not have any effect if this hardware has not been installed.  Consult the communication protocol description for a detailed explanation.

COMMUNICATION; BAUD RATE (OPTIONAL) - A1:
For external control,  the following communication speeds can be selected:

      1200  -  2400  -  4800  -  9600 baud

COMMUNICATION; BUS ADDRESS (OPTIONAL) - A2:
For communication purpuses, a unique identity can be attributed to every Fuel Sentry System.  This address can vary from 1 - 255.

COMMUNICATION; MODE (OPTIONAL) - A3:
The communication is executed according to MODbus protocal ASCII or RTU mode.  With OFF, the communication is disabled.

SETUP -         OTHERS - B

OTHERS; TYPE OF MODEL - B1:
For support and maintenance it is important to have information about the characteristics of the rate/
totalizer.  Your supplier will ask for this information in case of a serious break down or a desired
extension of the system.

OTHERS; VERSION SOFTWARE - B2:
For support and maintenance is it important to have information about the characteristics of the rate/
totalizer.  Your supplier will ask for this information in case of a serious break down or a desired
extension of the system.

OTHERS; SERIAL NUMBER - B3:
For support and maintenance is it important to have information about the characteristics of the rate/
totalizer.  Your supplier will ask for this information in case of a serious break down or a desired
extension of the system.

OTHERS; PASSWORD - B4:
All SETUP - values can be password protected.  This protection is disabled with value 0000 (zero).
Up to and including 4 digits can be programmed.

OTHERS; TAG NUMBER - B7:\
For identification of the unit and communication purposes, a unique tag number of a maximum of 7 digits
can be entered.

# INSTALLATION

GENERAL DIRECTIONS

***Installation, use, maintenance and de-mounting of this equipment must be carried out by authorized technicians only***

***Take note of the "Safety Rules and Precautionary Measures" in the front of this manual.

INSTALLATION / SURROUNDING CONDITIONS

Take the valid IP classification of the casing into account (see manufacturers plate). NEVER expose even the IP67 casing to strongly varying weather conditions. When panel-mounted, the unit is IP65! When used in very cold surroundings or heavy varying temperatures, take the necessary precautions against moisture by placing in a dry sachet of silica gel e.g. before closing in the casing.

Do mount the rate/totalizer on solid ground suface to avoid vibrations.

INSTALLING THE HARDWARE

*        This unit must be installed in accordance with the EMC guidelines (Electro Magnetic Compatibility).
*        Electro static discharge does inflect irreparable damage to electronics! The electrician has to discharge himself by touching a well-grounded object before opening the casing.
*        Connect a proper grounding to the rate/totalizer when powered with 115/230VAC (option).

When the Fuel Sentry System is powered externally with 115VAC / 230VAC supply voltage (option), it is required to mount a proper grounding to the casing. The green/yellow wire between the casing and terminal block may never be removed.
The removable terminal connectors are placed at the back of the control panel. When the connector is removed, it is still possible to program the Fuel Sentry System as it is battery powered.

FOR INSTALLATION, PAY CLOSE ATTENTION TO:
*        separated cable glands with effective IP67 seals for all wires.
*        not used cable entries; do place closed IP67 plugs
*        a reliable grounding of the several components, electronics and- if applicable -metal casing.
*        an effective screened cable for signal wiring and grounding of the screening in terminal 9 (GND).

VOLTAGE SUPPLY FLOW METER PICK UP

Battery powered and loop powered applications:
A supply voltage of 3.2 Volt DC is available for the signal output of the flowmeter. This voltage MAY NOT be used to power the flow meters, electronics, converters etc. as it is not a power output! All energy used by the flow meters pick-up influences the battery lifetime directly; it is strongly advised to use a "zero power" pickup as a coil or reed switch. It is possible to use a NPN or PMP output signal, but the battery lifetime wil be reduced.
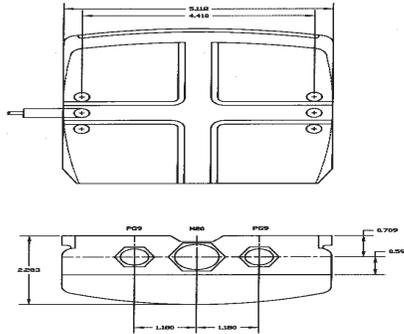
EXTERNALLY POWERED APPLICATIONS 5-24 VAC/DC:
When the Fuel Sentry System is powered with 5-24 VAC/DC supply, it is possible to power the flow meters electronics with 3.2 Volt DC (max. 2mA). The type of pick up does not influence the battery lifetime seriously as long as the external power supply is available.

NAMUR:
For a NAMUR pick up, an external power supply of 8.2-24VAC/DC is required. The voltage supply to the flow meter should be according to DIN19 234 (8.2VDC) when NAMUR-input is selected.

TERMINAL CONNECTORS

The terminal connectors have been divided into a number of groups. The standard unit includes the functionality of terminals 4, 5 and 7 up to and including terminal 14. Others are not used, unless optional optional hardware is being used.



REMARKS TERMINAL CONNECTORS:

Terminal 04-06; impulse output (SETUP - 9) and flow direction:

A transistor output generates an impulse of 100msec. (setting long) or 25msec. (setting short) according to a certain quantity. This output - terminal 5 - can be used for driving an external counter relay e.g. with output 6 a "high signal" will be available as soon as the differential total of the flows is negative.
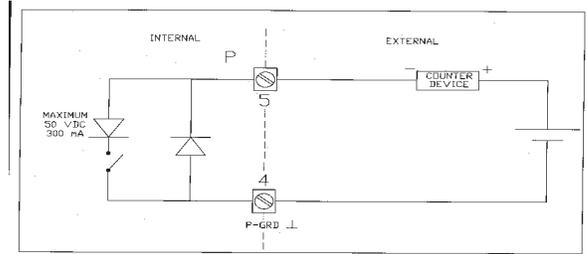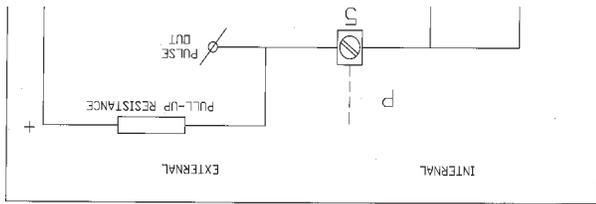
Terminal 07-08; external power supply 5-24VAC/DC - loop powered:

Connect an external power-supply of 5-24 volt AC/DC to these terminals or 4-20mA loop.  For a DC supply:  connect the "-" to terminal 7 and the "+" to terminal 8.

Terminal 07-08; analog output (SETUP - 8):

A 4-20mA current sink proportional to the flow rate is available.  A DC power supply should be connected to the Fuel Sentry System where the current is regulated by the Fuel Sentry System.  This DC supply is also used to power the unit (loop-powered).  When a power supply is available but the output is disabled, a 3.5mA signal will be generated.  Max. driving capacity 1000Ohm.
When the analog-output is NOT used, make sure that setting 81 is disabled!
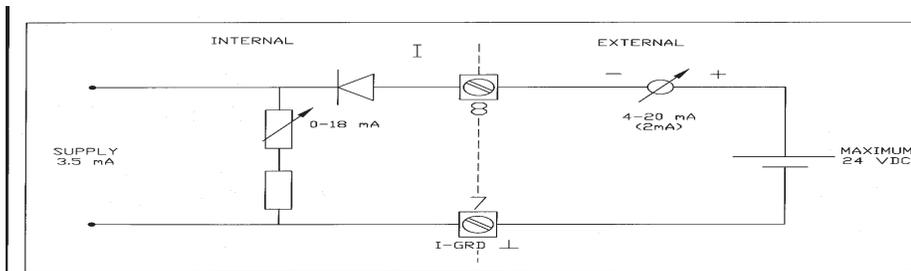


Terminal 09-14; Flow meter input:
Two basic types of f low meter signals can be connected to the Fuel Sentry System; pulse (terminal 10/13) or coil ( terminal 11/14).  The screen of the signal wire must be connected to terminal 09 (GND).  The voltage supply (3.2VDC) to the flow meter should be connected in terminal 12.  Please read  "Voltage Supply Flow Meter Pick Up" for power supply flow meter.  The maximum frequency is for each input approximately 10KHz (depending on the type of signal).
Coil Signal:
The Fuel Sentry System, is suitable for flow meters which have a coil output.  The sensitivity of the input can be selected with SETUP - 71/72.  Two selections can be made:  COIL LO: sensitivity from about 120mV peek to peek (p.t.p.) or COIL HI: sensitivity from about 20mV peek to peek.
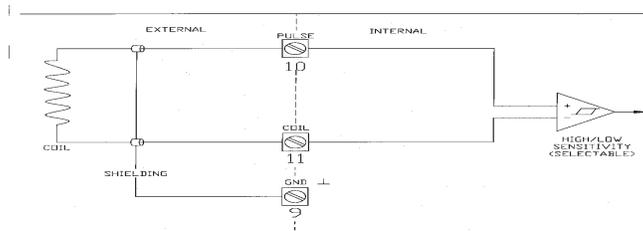
# INSTALLATION

Pulse-signal NPN/PNP:

The Fuel Sentry System is suitable for flow meters which have a pulse output that is equal or almost equal to the supply voltage (3.2VDC). For a reliable detection, the pulse amplitude has to cross 1.2VDC once per cycle. Transducers which generate a higher amplitude than 3.2VDC can be used but the detection level is still 1.2VDC. Maximum voltage input is 10VDC for NAMUR-type input; other inputs are rated for maximum pulse amplitudes of 24VDC.
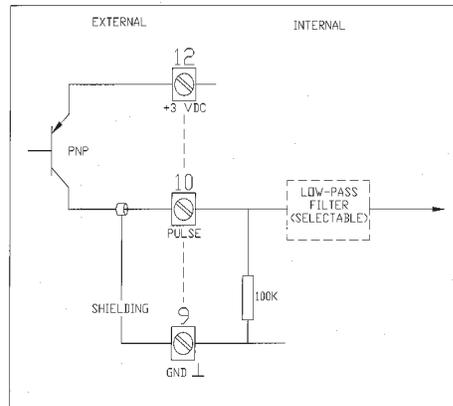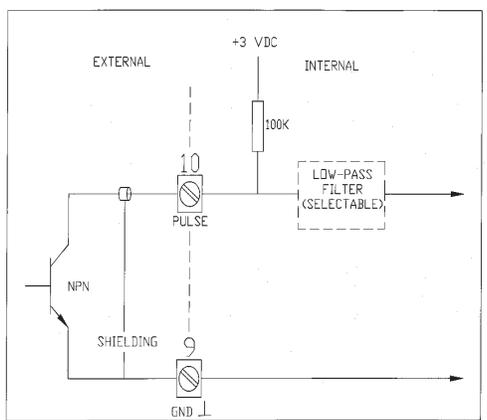


Reed Switch:

The Fuel Sentry System is suitable for flow meters which have a reed switch. To avoid pulse bounce from the reed switch, it is advised to select REED LP - low pass filter (setting 71/72).
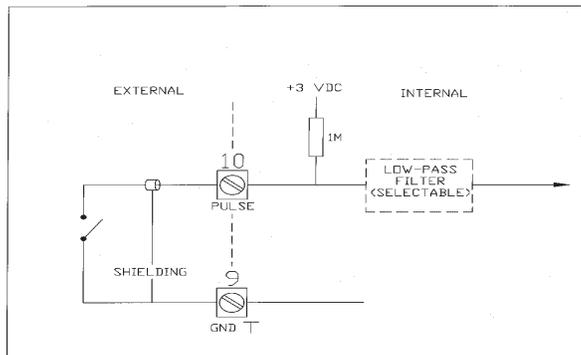


NAMUR-signal:

The signal input is according DIN 19 234. Please notice that an external power supply is required.
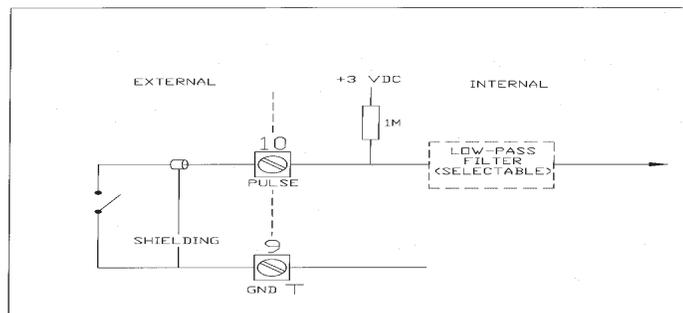
# MAINTENANCE

Terminal 15-19; Option - communication/printer RS232/RS485:

       *See the manufacturer's plate.

       *A full serial computer control and driving in accordance with RS232 (length of cable max. 15 meters)
        or RS485 (length of cable max. 1200 meters) is possible.  See the MODbus communication protocol.


General Directions:

The rate / totalizer does  not require special maintenance unless it  is used in low-temperature applications
and /or surroundings with high humidity (above 90% annual mean).  It is the customers responsibility
to take all precautions to dehumidify the internal atmosphere of the Fuel Sentry System in such a way that
no condensation will take place, for example by placing dry silical gel in the casing just before closing it.
Furthermore, it is required to replace or dry the silica gel from  time to time as advised by the silica gel supplier.


Battery Lifetime:

It is influenced by several issues such as:

-        Type of pick-up:  see SETUP - Display - 5.  NPN and PNP inputs consume more energy than coil
         inputs.
-        Analog output signal; be sure that an external power supply is connected or that the function is
         disabled if not in use. (Setting 81).
-        Display update: See setting 61.
-        Pulse output and communication.
-        Low temperatures; the available power will be less due to battery chemistry.

It is advised to disable unused functions.


Check periodically:

*        The condition of the casing, cable glands and front panel.
*        The wiring of the several components on reliability and aging symptoms.
*        The process accuracy.  As a result of wear and tear, recalibration of the flow meter might be
         necessary.  Do adapt the actual K-factors.
*        The indication for low-battery.
*        Clean the casing with soap and water.  Do not use any aggressive solvents as these might
         damage the polyester coating.

# TECHNICAL SPECIFICATIONS

GENERAL:

| | |
|---|---|
| Display | Large transflective LCD 40 x 90mm (1.6"x3.5"). With seven 17mm (0.677") and eleven 8mm (0.32") digits. |
| Control panel: | Three miro-switch keys with UV resistant polyester keypath. |
| Casing: | UV-resistant powder-coated aluminum casing.  Stainless steel bolts.  Polycarbonate window.  EPDM and PE sealings. |
| Cable Glands: | One cable gland entry M20 and two PG9's. |
| Mounting: | On flow meter, pipe-line horizontal / vertical and wall assembly IP67.  Panel Mount IP65. |
| Dimensions: | 130 x 114 x 58 mm (5.1" x 4.5" x 2.3") LxHxD. Panel cut-out: 115 x 96mm (LxH). |
| Operating temperature: | -15° . . 60°C. |
| Battery: | lithium; lifetime dependent upon settings.  Average lifetime approx., seven years. |
| Configuration: | Configuration is done at SETUP level. |
| Password: | SETUP level can be protected with a password |
| Data protection: | EEPROM backup of all settings.  Backup accumulated total every 10 minutes.  Data retention at least 10 years. |
| Flowmeter-pulse inputs: | Two completely separated pulse inputs for: coil/sine wave (sensitivity selectable), NPN/PNP, open collector, reed switch pulse, NAMUR. Input frequency: minimum 0Hz. - maximum 10KHz for each input.  Low pass filter for pulse bounce elimination available.  Digital filter.  Flow meter supply voltage: 3.2VDC. Remark: for NAMUR and some signal pickups external power to flow meter is required. |
| Analog output: | 4-20mA - 10 bits resolution; scaleable according flow rate (passive). |
| Pulse Output: | scaleable according accumulated total: pulse per "X" quantity;  maximum output frequency 20Hz.  Switch power max. 50Vdc - 300mA. |
| Flow direction output: | A signal output is available to indicate positive and negative flow.  Switch power max. 50Vdc - 300mA |
| Differential/count-up: | The flow rate, total and accumulated total which are displayed is the differential value of two flows (A-B) or the count up value (A + B). |
| External Power supply: | 4-20mA loop or 5.24VAC/DC. |
| Selection main function: | Total or flow rate will be displayed with 17mm digits. |
| Option relays/ supply: | Power module with mechanic relays to switch max: 250VAC -1A per relay.  This module replaces the battery and can be powered as 12-24 VAC/DC or 80-240 VAC. The module contains a selectable power supply to the flowmeter of 8.1-24 VDC; max. 80mA @24VDC. |
| Option communication: | RS232 or RS485 (2-wire or 4-wire).  MODbus protocol ASCII / RTU, max 9600 baud, 250 addresses.  All functionality and display information available for communication. |

# INSTALLATION

OPERATOR FUNCTIONS:

General: The Operator has three functions available:
-TOTAL and flow rate are displayed.
-TOTAL can be reset by pressing CLEAR key twice.
-After pressing SELECT, accumulated TOTAL will be displayed.

TOTAL: 17mm or 8mm character size - 7 digits.
K-factor; 7positions 0.00010 - 9,999,999.
Available units: L, m3, GAL, USGAL, KG, lb, bbl, no units.
Number of decimals: max. three. TOTAL is resettable.

ACCUMULATED TOTAL: 8mm character size - 11 digits. Value is resettable. Uses same K-factor, unit and decimals as TOTAL.

FLOW RATE: 8mm or 17mm character size 5 or 7. Settings independent of TOTAL.
K-factor: 7 posit6ions 0.000010 - 9,999,999.
Available units: mL, L, m3, Gallons, KG, ton, lb, bl, cf, rev, no unit.
Available time units: seconds, minute, hour, days.
Number of decimals: max. one.

# TROUBLE SHOOTING

PROBLEM                                         CHECK:

Flowmeter does not generate pulses:             Signal selection SETUP - 71/72
                                                Pulse amplitude (Section Terminal Connectors)
                                                Flow meter, wiring and connection of terminal connectors
                                                Power supply of flow meter

Flow meter generates too many pulses:           Settings for Total and Flow rate: SETUP 11-14, 21-27, 31-32
                                                and 41-44.
                                                Type of signal with actual signal selection SETUP 71/72
                                                Sensitivity of coil input SETUP 71 and terminal connections
                                                Proper  grounding of the Fuel Sentry System
                                                Use screened wire for flow meter signals and connect
                                                screen to terminal 9.

Pulse output does not function:                 SETUP 91 - pulse per x-quantity; is the value programmed
                                                reasonable and will the maximum output be under 20Hz?
                                                SETUP 92 - impulse width; is the external device able to
                                                recognize the selected ulse width and frequency?
                                                Connections to terminals 4 and 5.

Analog output does not function properly:        SETUP 81 - is the function enabled?
                                                SETUPS 82/83:  are the flow levels programmed correctly?
                                                connection of the external power-supply according to specs.
                                                SETU 27/44 - when 4mA should be generated as soon as the
                                                flow rate is zero, it might take this time worst case.  To get a
                                                quick response, decrease this time according to your
                                                desired response time.

Flow rate displays "O/zero" while there is a     SETUP 22-25 and 41-44: are the K-factor and time unit correct?
flow (total is counting):                       SETUP 26 -27 and 42-43:  The unit has to count the number of
                                                pulses according to setup 26/42 within the time according to
                                                setup 27/43.  Make sure that 27/43 is set like 10.0 seconds,
                                                e.g.  the result is that theunit has at least 10 seconds time to
                                                measure the number of pulses according to setup 26/42.

The password in unknown:                        If the password is not 1234; call your supplier
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 may
                                                        be corrupted.
                                                0002:   irrecoverable data-storage error:  the programming
                                                        cycle might have gone worng, check programmed values
                                                0003:   error 1 and error 2 occurred simultaneously
                                                The alarm condition willmost certainly be handled internally and
                                                if all mentioned values still appear right, no intervention of the
                                                operator is needed.  In case the alarm occurs more often or stays
                                                active for a longer time, please contact your supplier.

# COMMUNICATION - FAMILY SPECIFIC VARIABLES

Remarks: All numbers are decimals unless otherwise noted. 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 FUEL SENTRY SYSTEM - SETUP LEVEL

| VAR | DESCRIPTION | BYTES | VALUE | REMARKS |
|---|---|---|---|---|
| TOTAL NO. 1 | | | | |
| 32 (20h) | unit | 1 | 0=L<br>1=m3<br>2=kg<br>3=lb<br>4=gal<br>5=usgal<br>6=bbl<br>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! (VAR 37) |
| 37 (25h) | decimals K-factor | 1 | 0...6 | |
| TOTAL NO. 2 | | | | |
| 40 (28h) | K-factor | 3 | 1...9,999,999 | K-f 0000001-K-f 0000009 is allowed when decs < 6! (VAR 43) |
| 43 (28h) | decimals K-factor | 1 | 0...6 | |
| FLOWRATE NO. 1 | | | | |
| 48 (30h) | unit | 1 | 0=mL<br>1=L<br>2=m3<br>3=mg<br>4=g<br>5=kg<br>6=ton<br>7=gal<br>8=bbl<br>9=lb<br>10=cf<br>11=rev (revolutions for RPM)<br>12=none | |
| 49 (31h) | time unit | 1 | 0=sec<br>1=min<br>2=hyour<br>3=day | |
| 50 (32h) | decimals | 1 | 0...1 | |
| 51 (33h) | K-factor | 3 | 1...9,999,999 | K-f 0000001 - K-f 0000009 is allowed when decs < 6 (var 54) |
| 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 |

# COMMUNICATION - FAMILY SPECIFIC VARIABLES

## CONFIGURATION VARIABLES FUEL SENTRY SYSTEM - SETUP LEVEL

| VAR | DESCRIPTION | BYTES | VALUE | REMARKS |
|---|---|---|---|---|
| **DISPLAY** | | | | |
| 64 (40h) | display function | 1 | 0=total<br>1-flow rate | |
| 67 (43h) | calculation | 1 | 0=differential<br>1=add | |
| **POWER MANAGEMENT** | | | | |
| 80 (50h) | LCD update time | 1 | 0=fast<br>1=1 sec<br>2=3 sec<br>3=15 sec<br>4=30 sec<br>5=off | |
| 81 (51h) | power-mode battery | 1 | 0=operational<br>1=shelf | |
| **FLOW METER** | | | | |
| 96 (60h) | flow meter signal no. 1 | 1 | 0=npn<br>1=npn-lp<br>2=reed<br>3=reed LP<br>4=pnp<br>5=pnp-lp<br>6=namur<br>7=coil hi<br>8=coil hi | |
| 97 (61h) | flowmeter signal no. 2 | 1 | 0=npn<br>1=npn-lp<br>2=reed<br>3=reed LP<br>4=pnp<br>5=pnp-lp<br>6=namur<br>7=coil hi<br>8=coil lo | |
| **ANALOG OUTPUT** | | | | |
| 112 (70h) | analog output | 1 | 0=disable<br>1=enable | |
| 113 (71h) | minimum rate | 3 | 0...9999999 | unit, time, dec's see: var48-50 |
| 116 (74h) | maximum rate | 3 | 0...9999999 | unit, time, dec's see: var48-50 |
| 119 (77h) | cut off percentage | 1 | 0...99 | steps of 0.1% |
| 120 (78h) | tune miminum | 2 | 0...9999 | |
| 122 (7Ah) | tune maximum rate | 2 | 0...9999 | |
| **PULSE OUTPUT** | | | | |
| 128 (80h) | impulse width | 1 | 0=off<br>1=short<br>2=long | |
| 129 (81h) | pulse per x quantity | 3 | 1...9999999 | unit, decimals acc. var 32-33 |
| **OTHERS** | | | | |
| 168 (A8h) | password | 2 | x x x x | read only! |
| 170 | tagnumber | 3 | 0...999999 | Other vars: see standard table |
| **FLOW RATE** | | | | |
| 227 (E3h) | K-factor | 3 | 1...9,999,999 | K-f 0000001-K-f 0000009 is allowed when decs < 6! (VAR230) |
| 230 (E6H) | decimals K-factor | 1 | 0...6 | |
| 231 (E7h) | number of pulses | 1 | 1...255 | |
| 232 (E8h) | cut-off time | 2 | 1...9999 | steps of 100ms |

# COMMUNICATION - FAMILY SPECIFIC VARIABLES

OTHER FUEL SENTRY SYSTEM VARIABLES FOR COMMUNICATION:

Differential Total - Variable number 566 (236h) - 6 bytes

READ TOTAL:   The value of total read using communication 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 (e.g. when two decimals are selected for total and total has a value of 12345678  the display will show 12345678 while communication will read a "total" of 12345678 and a "totals 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 toal will be accepted.

Differential Accumulated Total - variable number 560 (230h) - 6 bytes
READ ACC. TOTAL:     A different between the read value and the display value, as explained for "Read total", might appear here too.
WRITE ACC. TOTAL:    Impossible.

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

        Example:        read var. 566 for differential total:
        Read var. 33 for total decimals and calculate the real value of total by multiplying total with 10

FLOW RATE No. 1 -      variable number 572 (23Ch) - 4 bytes
FLOW RATE No. 2 -      variable number 588 (24Ch) - 4 bytes
DIFFERENTIAL FLOW RATE - variable number 58 (3Ah) - 4 bytes
READ FLOW RATE:      The value difference as mentioned with total/acc. total might appear here too.
WRITE FLOW RATE:     Impossible.

# Warranty Information

Please have the following information available when you make inquiries, order replacement parts, or schedule service.

Your meter's serial number: _____

Your meter's model number: _____

Your full service Distributor: _____

Your full service Distributor's phone number: _____

## Warranty

Tuthill Transfer Systems ("Manufacturer") warrants to each buyer of its FPP Meters products (the "Buyer") for a period of 12 months from date of invoice or sales receipt, but in no event more than 18 months from date of manufacture, that goods of its manufacture ("Goods") will be free from defects of material and workmanship. Manufacturer's sole obligation under the foregoing warranties will be limited to either, at Manufacturers' option, replacing or repairing defective Goods (subject to limitations hereinafter provided) or refunding the purchase price for such Goods theretofore paid by the Buyer, and Buyer''s exclusive remedy for breach of any such warranties will be enforcement of such obligations of Manufacturer. If Manufacturer so requests the return of the Goods, the Goods will be redelivered to Manufacturer in accordance with manufacturer's instructions F.O.B. Factory. The remedies contained herein shall constitute the sole recourse of the Buyer against Manufacturer for breach of warranty. IN NO EVENT SHALL MANUFACTURER'S LIABILITY ON ANY CLAIM FOR DAMAGES ARISING OUT OF THE MANUFACTURE SALE, DELIVERY OR USE OF THE GOODS EXCEED THE PURCHASE PRICE OF THE GOODS. The foregoing warranties will not extend to Goods subjected to misuse, neglect, accident or improper installation or maintenance, or which have been altered or repaired by anyone other than Manufacturer or its authorized representative. THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OR MERCHANTABILITY, FITNESS FOR PURPOSE OF ANY OTHER TYPE, WHETHER EXPRESS OR IMPLIED. No person may vary the foregoing warranties and remedies except in writing signed by a duly authorized officer of Manufacturer. Warranties or remedies that differ from the foregoing shall not otherwise be binding on Manufacturer. The Buyer's acceptance of delivery of the Goods constitutes acceptance of the foregoing warranties and remedies, and all conditions and limitations thereof.



Av. Mexico 823 Recoleta, Santiago de Chile
www.dog.cl/FUELSENTRY  dog@dog.cl
Tel +56 2 2979 0377 Movil +56 9 8449 1011