EngineMeter

EFMS100 USER MANUAL

Revision 1.1

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Revision history

Revision	Changes	Date
1	N/A	Sept. 2011
1.1	• Added link cable connector pinout • Added info about resistor spark plugs	Oct. 2012

Acronyms

ABS	Acrylonitrile Butadiene Styrene (thermoplastic material)
ADC	Analog to Digital Converter
AVG	Average
CHT	Cylinder Head Temperature
DC	Direct Current
EFMS	Engine and Fuel Monitoring System
EGT	Exhaust Gas Temperature
FF	Fuel Flow
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MT	Empty
NTC	Negative Temperature Coefficient (= thermistor = type of temperature sensor used for moderate temperatures: water, oil or air temperature)
RPM	Revolution Per Minute

1 Key specifications and benefits

The EFMS100 Engine and Fuel Monitor System is based on TX100 sender unit and RX100 display unit.
The sender unit is typically installed near the engine
The display unit is typically facing the user

EFMS100 System highlights

- All sensors are connected to the sender unit. Only 1 small cable connects to the display unit
- Very low power requirements: Operates from the vehicle battery (e.g. 12V battery) or 1 small 9V battery
- No additional battery required to save user configuration: all configurations and data are saved in FLASH memory

RX100 display unit highlights

- Large, anti-glare, anti-scratch, high contrast, 128x64 pixels LCD display
- Fully customizable parameter screen (parameter names, locations and character size)
- Easy to use: menu driven interface with navigation button on the side

TX100 sender unit highlights

High quality terminal block connections ("rising cage design") allow you to use probes (EGTs, CHTs, etc...) from any vendor

Engine tachometer and hour meter

- Supports all types of 2-stroke and 4-stroke engines
- Sensor cable (provided) simply wraps around engine ignition wire

Temperatures

- 4 thermocouple inputs (EGT, CHT, water, oil, etc...)
- Ambient temperature sensor built into the sender unit

Battery voltage: Monitors the vehicle battery voltage (or the voltage of the 9V supply battery).

Fuel information based on optional fuel flow sensor

- Fuel flow
- Fuel used
- Fuel onboard
- Time to tank empty
- Distance to tank empty (after entering your speed)

Auxiliary inputs

- 2 general purpose inputs
- Examples of applications:
    - Fuel level sensor or detector
    - NTC thermistor (temperature sensor)
    - Additional voltmeter
    - Etc.

Timer

- Various purposes (i.e. flight time, engine run time, etc...)
- Multiple options for activating the timer

Alarms

- Alarms can be set on any parameter
- Ultra bright red flashing LED on display unit alerts the user of an alarm condition. In addition, the parameter is immediately highlighted on the screen

Statistics Records minimum, maximum and average values of any parameter

Parts supplied in EFMS100 system

- TX100 Sender unit
- RX100 Display unit
- Link cable (cable from sender unit to display unit)
- Tachometer sensor cable
- 9V battery enclosure with built-in ON/OFF switch (in case the vehicle has no battery)

Optional accessories

- Temperature sensors (e.g. EGT and CHT)
- Fuel flow sensor (see www.enginemeter.com)

2 Detailed specifications

All parameters are refreshed every second.

2.1 Engine tachometer

All types of 2-stroke and 4-stroke engines are supported.

Table 1 - Tachometer range

Type of ignition system	Minimum (RPM)	Maximum (RPM)
2 sparks per revolution	250	150000 with 1% accuracy…
1 spark per revolution	500	
1 spark per 2 revolutions	1000	300000 with 2% accuracy…

2.2 Engine hour meter

- Counts the engine time in hours.
- Resolution: 0.01 hour
- Maximum: >8000 years…

2.3 Thermometers

Temperatures can be displayed in Celsius or Fahrenheit.

2.3.1 Temperatures using thermocouples

- Up to 4 thermocouples
- Support for both type J and type K thermocouples
- Support both grounded and ungrounded thermocouples

Maximum temperatures:

- 800℃ (1450℉) using type J thermocouples
- 1000℃ (1800℉) using type K thermocouples

2.3.2 Ambient temperature

- Sensor built in the sender unit

2.4 Battery voltmeter

- This feature is built in the sender unit
- Resolution: 0.1 Volt
- Range: see sender unit operating voltage range in section 2.10

2.5 Fuel flow (optional sensor)

Fuel information based on fuel flow sensor inserted in the fuel line between the tank and the engine.
The following parameters can be displayed:

- Fuel flow
- Fuel used
- Fuel onboard
- Time to tank empty
- Distance to tank empty

See section “5.9 FUEL FLOW menu” for detailed information

2.6 Auxiliary inputs

- Many applications:
    - Low fuel level detector (float switch)
    - Fuel level sensor (e.g. using a resistive sensor)
    - Thermistor (NTC or other type) temperature sensor
    - Etc…
- 2 inputs labeled “AUX1” and “AUX2”
- Full range: 0 to 2.5V
- Resolution: 12bits (4096 steps)
- Out of range voltage protection: -20 to +20V will not damage the unit
- AUX1 is a high input impedance (floating) input. Leakage current < 50nA
- AUX2 has a 1kOhm/1% resistor internally connected to a 2.5V voltage reference and a 150Ohm/1% resistor is series with the terminal.
- Can display calibrated values in order to match the characteristics of any sensor
- See section “5.10 AUX1 INPUT and AUX2 INPUT menu” for detailed information

2.7 Regulated voltage +3.3V output

- The sender unit terminal is labeled “+3.3V OUT”
- Can help the implementation of auxiliary inputs
- Maximum output (sourcing current only / no sinking current) current = 10mA !!!
- Do not use unless you know exactly what you are doing

2.8 Timer

- Display format: HH:MM (Hours:Minutes)
- Roll over to 00:00 after 99:99
- 2 modes of operation:
    - Counts time
    - Counts engine run time
- 2 options for the power up value
    - Timer is reset (00:00)
    - Timer is restored to its value before power down
- 2 options for timer start
    - Starts immediately
    - Starts when the engine is started

2.9 Alarms

- Flashing LED on display unit
- Up to 10 alarms can be programmed:
    - Choice of the parameter monitored
    - Alarm state (disabled, low alarm or high alarm)
    - Alarm threshold

2.10 Power supply

The sender unit operates from a DC power source (typically a 12V battery).
Minimum operating voltage: 7V
Maximum operating voltage: 20V
Current consumption: 13mA (total sender unit + display unit)

Built in power supply protections:

- Protected against voltage spikes that can be caused by the starter or the ignition of the engine.
- Short circuit protection. Protects the battery from failures of electronic components inside the sender unit.

- Reverse polarity protection up to 20V.

2.11 Sender unit

Dimensions: 90mm x 66mm x 28mm (3.5 x 2.6 x 1.1 inches)
Weight: 90grams (3.2 ounces-US&UK)

2.12 Display unit

Dimensions: 95mm x 62mm x 28mm (3.7 x 2.4 x 1.1 inches)
Weight: 80grams (2.8 ounces-US&UK)

2.12.1 Using a 9V standard battery

In case the engine does not have a battery (engine with manual start), a standard 9V battery (size/format is called EN22 or 6LR61 or 6AM6) can be used.

The table below provides the battery life type for the most common types of batteries.

The battery life can be estimated by:

Battery life = Battery capacity / Current consumption
(in hours) (in mA.hour) (in mA)

Table 2 – Battery life

Battery type	Typical capacity (mA.hour)	Battery life (hours)
9V Alkaline	600	46
9V Lithium (Lithium Manganese Dioxide)	1200	92

In order to receive a low battery warning for 9V batteries, it is recommended to set the “POWER UP BATTERY TEST” parameter around 7.9V (see section “5.5 GENERAL menu” for more information)
and
to add a “low alarm” on the battery voltage around 7.7V (see section “5.8 ALARMS menu” for more information).

Nickel Metal Hydride (NiMH) and Nickel Cadmium (NiCd) rechargeable batteries are not recommended because of their low voltage (7.2V nominal instead) and their low capacity (around 150mA.h for NiMH and even less for NiCd).

Connecting thermocouples (TC1 to TC4) has no impact on the current consumption.

The optional fuel flow sensor has a small impact on the current consumption (about 7mA).

3 Installation

3.1 IMPORTANT !!!

The sender and display units must be **protected** from:

- Excessive levels of **vibrations**
  - The sender unit must be isolated from vibrations using a foam
- Excessive **temperatures**
  - Do not mount the unit next to the engine cylinder
- Projections of **liquids**: water, fuel, oil, etc...
- Excessive **radiated electrical perturbations**
  - Do not mount the unit near the ignition system

For your safety, make sure all cables are secured (typically with several plastic cable ties)

3.2 Sender unit power and ground

3.2.1 GROUND

Connect the ground (i.e. one GROUND terminal) of the sender unit to the **chassis** of the motor.
The preferred location on the chassis is near the thermocouples (e.g. EGT and CHT).
The shield of the thermocouple cable is connected to the body of sensor (and therefore to the chassis) and can be used to connect the ground of the sender unit to the chassis.

In most cases the negative terminal of the battery is already connected to the chassis.
Only if this is not the case (e.g. when using a 9V battery), connect the negative terminal of the battery to the ground of the sender unit.

3.2.2 +POWER IN

This terminal provides power to the unit and is typical connected to the positive terminal of the battery.

Switch
If the main switch of the motor cannot be used for this function, a dedicated power switch should be added in series with this connection.

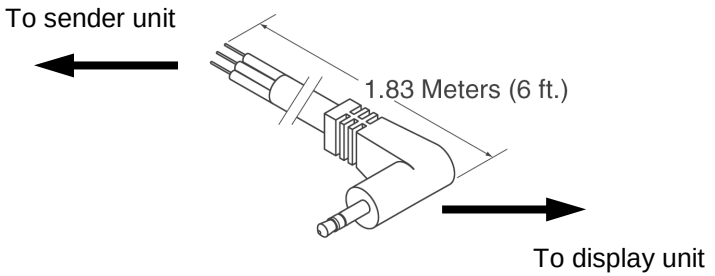
Fuse
In order to protect the battery from short circuits (which could be caused by damaged wires for example), it is **strongly recommended to insert a fuse in series** with this connection.
The fuse should be as close as possible to the battery positive terminal.

Example of inline fuse holder:

Description: 30-Amp Inline Mini Blade-Type Fuse Holder
Vendor: www.radioshack.com
P/N: 270-1237

A fuse is not needed when using a 9V battery.

3.3 Link cable

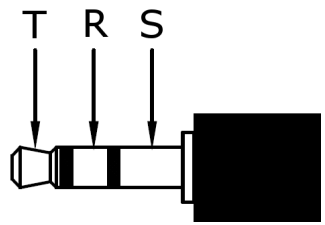


The link cable connects the sender unit to the display unit.
The cable should be connected to the sender unit as described in the table below.

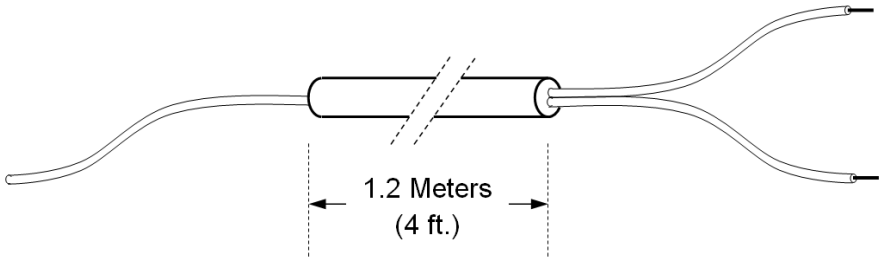
Table 3 – Link cable

Wire	Function	Terminal on sender unit	Connector pinout
Shield	Ground	GROUND	Sleeve (S)
White	Data from sender unit to display unit	DATA OUT	Ring (R)
Red	Power provided by the sender unit to the display unit	+VPWR OUT	Tip (T)

Connector pinout
The connector is a standard 3.5mm diameter (1/8 inch) analog audio stereo connector (used on most headset). This type of connector is often called “TRS connector” (Tip, Ring, Sleeve)



3.4 Tachometer cable



3.4.1 Sender unit side

The tachometer cable should be connected to the sender unit as described in the table below.

Table 4 - Tachometer cable

Wire	Function	Terminal on sender unit
Black	Ground	GROUND
Red	Tachometer pickup	TACH IN

WARNING: connecting the tachometer cable to another terminal may damage the sender unit

3.4.2 Ignition wire side

On the other side of the cable, the pickup wire (red wire) should be WRAPPED around the ignition wire.
Start with 2 turns. Increase the number of turns only if needed.
For most engines 3 or 4 turns around the spark plug wire works well. Be sure to **secure the wire** with two (one on each side of the coil) plastic wire ties (tie-wrap) so the tachometer cable stays securely wrapped around the spark plug wire.

Issue	Solution
Reading “LOW” or lower than expected	Add (wrap) 1 turn
Reading “HIGH” or higher than expected	Remove (unwrap) 1 turn

3.4.3 Spark plug type

Using a resistor spark plug is **more than strongly recommended**.

This is because resistor spark plugs reduce electromagnetic interference with on-board electronics (computers, radios, GPS, etc.).
Most spark plug vendors add the letter “R” in the designation of the spark plug to indicate a resistor spark plug.
For example NGK "R" resistor spark plugs use a 5k ohm ceramic resistor in the spark plug to suppress ignition noise generated during sparking.
NGK BR9ES is the resistor version of NGK B9ES.

3.5 Thermocouples (EGT, CHT, etc.)

A good source for EGT and CHT sensors is Westach: www.westach.com

By construction, thermocouples probes are either grounded or ungrounded:

- Grounded means that the thermocouple junction (located where the temperature is measured) is connected to the body. Most thermocouples are of the grounded type which is easier to produce. Westach probes are of the grounded type.
- Ungrounded (or “isolated”) means the thermocouple junction is isolated from the body of the probe.

For both grounded and ungrounded thermocouples

- Connect the positive wire of the thermocouple (white wire on Westach probes) to the positive input of the sender unit (e.g. +TEMP1 IN).
- Connect the negative wire (black wire on Westach probes) of the thermocouple to the negative input of the sender unit (e.g. -TEMP1 IN).

ONLY for ungrounded (rare) thermocouples

- Connect the negative input of the sender unit (e.g. -TEMP1 IN) to the ground of the sender unit.

Using cable extensions if the cable of the thermocouple is too short
Thermocouples wires are made of special materials.

For example, for a type K thermocouple, the negative wire is made of Alumel and the positive wire is made of Chromel.
If you need to add an extension, use only an extension of the same type (e.g. type K extension for a type K thermocouple).

3.6 Fuel Flow Sensor (option)

At the heart of the meter is a precision turbine that rotates freely on robust sapphire bearings. Chemically resistant ceramic magnets that are detected through the chamber wall by a Hall Effect detector (magnetic field detector).

Table 5 – Fuel Flow Sensor

Wire	Function	Terminal on sender unit
Shield	Ground	GROUND
Red	Power provided by the sender unit to the fuel flow sensor	+VPWR OUT
Blue	Signal from fuel flow sensor to sender unit	FLOW IN

IMPORTANT: Detailed information on the installation is provided in the fuel flow sensor installation guide.

4 Operation of the display unit

4.1 Using the navigation button

The navigation button located on the side of the unit allows you to configure and use the display unit.

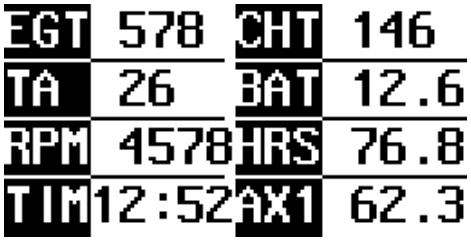
The button has 3 functions:

1. Push up ▲
2. Press inward ◄
3. Push down ▼

4.2 Normal screens

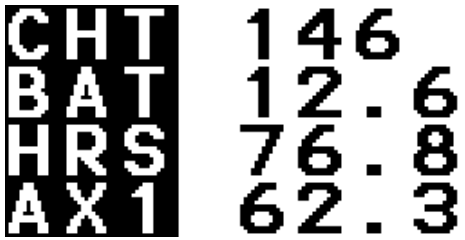
There are 4 “normal screens”:

1. “Main screen”: 8 parameters (user configurable) shown with **large** characters.

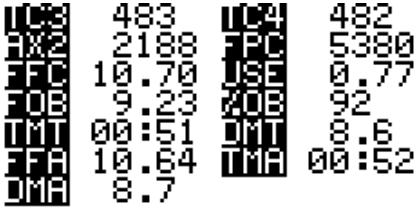


2. “Column 1 screen”: The 4 parameters of the 1st column of the main screen indicated with **very large** characters.

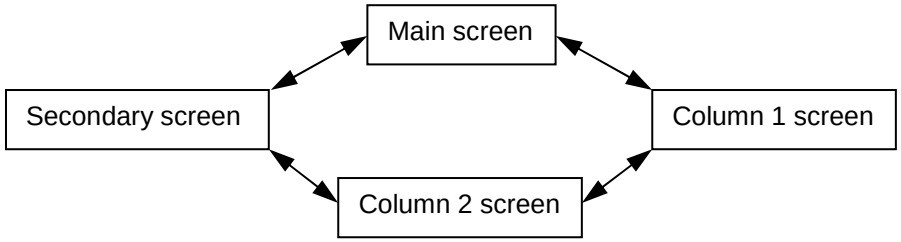
3. “Column 2 screen”: The 4 parameters of the 2nd column of the main screen indicated with **very large** characters.



4. “Secondary screen”: All the parameters not present on the main screen indicated with **normal** characters.



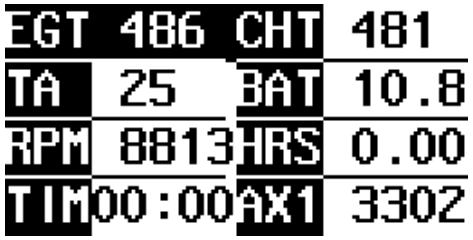
Push ▲ or ▼ to toggle between the 4 normal screens.



4.3 Display of an alarm condition

If an alarm condition occurs, it will be indicated by:

1. Alarm LED flashing
2. If the parameter is on the screen, its value will be displayed in inverse video mode (clear characters on dark background)



If the parameter is not displayed in the normal screen currently selected, an “alarm screen” will appear

The alarm screen will display all the alarms unless they are already displayed on the normal screen currently selected.
The display will toggle between the normal screen and the alarm screen every 4 seconds.

4.4 Display of very large numbers (rare)

The values of the parameters are displayed with up to 5 characters.
If the value is higher than 99999 or lower than -9999 it cannot be displayed with the regular numbers.
In these rare cases the value is displayed using the “scientific notation”.
Examples:

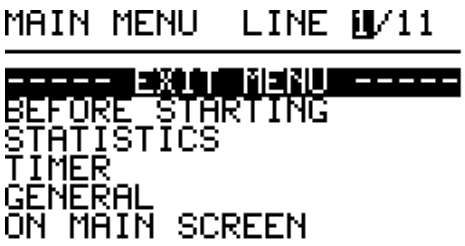
- 123456 will be been displayed 123E3 (123 and add 3 zeros = 123000)

-890000 will be displayed -89E4 (-89 and add 4 zeros = -890000)

5 Configuration of the display unit

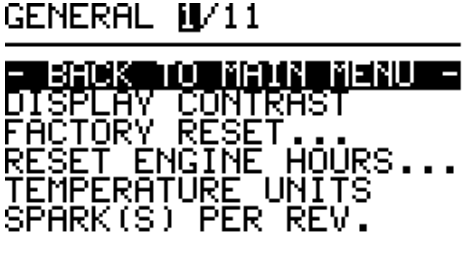
5.1 Main menu

From any normal screen, use ◀ to enter the menu mode.



Use ▲ or ▼ to scroll through the menu lines.

Use ◀ to enter a (sub) menu or select a function.



Timeout

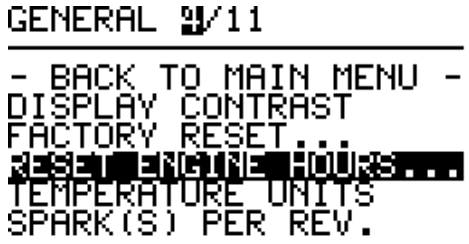
Whenever the unit is in menu mode, a timeout will return the unit to the normal screen mode if the navigation button is not activated during more than 10 seconds.
If a parameter is being modified but the modification has not been validated by pressing ◀ the modification will be cancel.

Exiting menu mode quickly

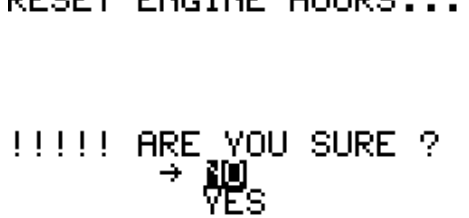
In menu mode, press ◀ for 3 seconds to go back to normal screen mode.
If a parameter is being modified the modification will be cancel.

Confirmation

"…" at the end of a line (e.g. "RESET ENGINE HOURS...") indicates that a confirmation will be requested before any modification is done.



Screen after pressing ◀



As usual, use ▲ or ▼ to select "YES" or "NO" and validated with ◀

Table 6 – MAIN NEMU

Menu title	Description
BEFORE STARTING	Functions useful before starting the engine
STATISTICS	Record parameters minimum, average and maximum
TIMER	Set the various timer parameters
GENERAL	General settings
ON MAIN SCREEN	To select the parameters indicated on the main screen
SHORT NAMES	To define the short name (3 characters) of each parameter
ALARMS	To setup alarms
FUEL FLOW	Related to the fuel flow sensor
AUX1 INPUT	Settings of AUX1 IN (auxiliary 1 input)
AUX2 INPUT	Settings of AUX2 IN (auxiliary 2 input)

5.2 BEFORE STARTING menu

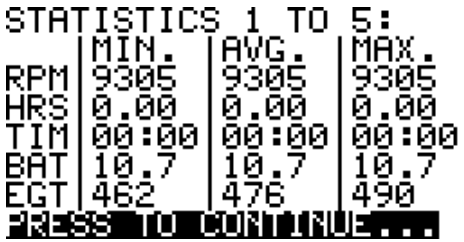
These functions are useful before starting the engine.

Table 7 – BEFORE STARTING menu functions

Function	Description
INITIAL FUEL VOLUME	Used in conjunction with the fuel flow sensor. Sets the initial volume of fuel in the tank. This is the volume of fuel in the tank when the fuel used is reset (see “RESET FUEL USED” ” in the “FUEL FLOW” menu for more information). The unit is VOLUME. VOLUME is the unit used to set “PULSE/VOLUME RATIO” in the “FUEL FLOW” menu.
RESET TIMER	Resets the timer to 00:00 (Hours:Minutes) See “TIMER” menu for more information on the timer.
RESET FUEL USED	Used in conjunction with the fuel flow sensor. Resets “FUEL FLOW PULSE COUNT” to 0. Therefore “FUEL USED (VOL.)” is also reset to 0. Therefore “FUEL ONBOARD (VOL.)” is set to “INITIAL FUEL VOLUME”. This function also resets the time period used to calculate the average fuel flow. See “AVERAGE FUEL FLOW” parameter for more information.
RESET STATISTICS	Resets all the statistical parameters (i.e. minimum, average and maximum).
RESET TIM.+FUEL+STATS	See “RESET TIMER”, “RESET FUEL USED” and “RESET STATISTICS” in this menu.

5.3 STATISTICS menu

Table 8 – STATISTICS menu functions

Function	Description
SHOW STATISTICS	Displays minimum (MIN.), average (AVG.) and maximum (MAX.) for the 5 monitored parameters. 
STAT. OPERATES	• ALWAYS: The parameters are always taken into account for the statistics. • WHEN ENGINE RUNNING: The parameters are taken into account for the statistics only when the engine is running. The detection of engine running is provided by the tachometer.
STAT. PARAMETER 1 (to 5)	Select the parameter monitored. Changing the parameter monitored resets its statistics without resetting the statistics of the 4 other parameters. 

5.4 TIMER menu

Memo: the timer format is HH:MM (Hours:Minutes).
Note: The timer is independent from the engine hour meter.

Table 9 – TIMER menu functions

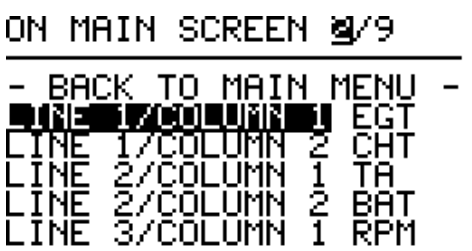
Function	Description
DISPLAY UNIT POWER UP	• TIMER RESETS TO 00:00: at power up, the timer is reset to 00:00. • TIMER=PREVIOUS VALUE: at power up, the timer continues from its previous value (i.e. before the power down of the display unit). Power up refers to the power up of the display unit.
TIMER COUNTS	• TIME: the timer simply counts the time. • ENGINE RUN TIME: the timer counts only the time when the engine is running. The detection of engine running is provided by the tachometer.
TIME TIMER STARTS	This setting is only relevant if “TIMER COUNTS” = “TIME” • “IMMEDIATELY”: The timer will start immediately. • “WITH ENGINE RPM”: The timer will start when the engine RPM is **above** “START WITH RPM: RPM” (see below in this menu) **during more than** “START W. RPM: SECONDS” (see below in this menu). After the timer is started, it will continue regardless of the engine RPM.
START WITH RPM: RPM	This setting is only relevant if “TIMER COUNTS” = “TIME” and “TIME TIMER STARTS” = “WITH ENGINE RPM” “START WITH RPM: RPM” is used to start the timer automatically based on the engine RPM. See “TIME TIMER STARTS” in this menu for more information.
START W. RPM: SECONDS	This setting is only relevant if “TIMER COUNTS” = “TIME” and “TIME TIMER STARTS” = “WITH ENGINE RPM” “START W. RPM: SECONDS” is a time in seconds used to start the timer automatically based on the engine RPM. See “TIME TIMER STARTS” in this menu for more information.

5.5 GENERAL menu

Table 10 – GENERAL menu functions

Function	Description
DISPLAY CONTRAST	Sets the contrast of the display
FACTORY RESET...	**Warning**: This resets **ALL** the configuration parameters to factory default value. **Only the engine hour meter is not reset.**
RESET ENGINE HOURS...	**Warning**: This resets the engine hour meter to **zero (0)**.
TEMPERATURE UNITS	• CELSIUS: all temperatures will be displayed in Celsius • FAHRENHEIT: all temperatures will be displayed in Fahrenheit
SPARK(S) PER REV.	• 2 SPARKS PER REV.: for engines with ignition generating 2 sparks per revolution • 1 SPARK PER REV. : for engines with ignition generating 1 spark per revolution • 1 SPARK PER 2 REV. : for engines with ignition generating 1 spark per 2 revolutions
TC1 THERMOCOUPLE TYPE	• TYPE J: use when the thermocouple connected to TC1 input is type J. • TYPE K: use when the thermocouple connected to TC1 input is type K. Notes: Most CHT sensors are type J. Most EGT sensors are type K.
TC2 THERMOCOUPLE TYPE	Same as above for TC2 input.
TC3 THERMOCOUPLE TYPE	Same as above for TC3 input.
TC4 THERMOCOUPLE TYPE	Same as above for TC4 input.
POWER UP BATTERY TEST	A warning message is displayed at power up if the battery voltage is below this value. This function is mostly useful if the power supply source is a 9V battery.

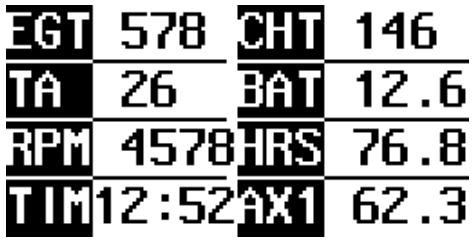
5.6 ON MAIN SCREEN menu



Select a parameter for each location of the main screen.

LINE 1/COLUMN 1	LINE 1/COLUMN 2
LINE 2/COLUMN 1	LINE 2/COLUMN 2
LINE 3/COLUMN 1	LINE 3/COLUMN 2
LINE 4/COLUMN 1	LINE 4/COLUMN 2

Example (factory default):



5.7 SHORT NAMES menu

Use this menu to set a custom 3 character name for the parameter that can be displayed on the main screen. This allows the user to select a 3 character name that best represents the parameter to them.

Table 11 – SHORT NAMES menu functions

Function	Factory default name	Description
ENGINE TACHOMETER	RPM	Engine tachometer. The value is indicated in Revolutions Per Minute.
ENGINE HOURS	HRS	Engine hour meter for engine maintenance. Measures the engine run time.
TIMER (HH:MM)	TIM	Timer. Refer to the menu “TIMER” for more information. The display format is Hours:Minutes.
BATTERY VOLTAGE	BAT	Power supply voltage on the pin +POWER IN. The value is indicated in volts.
TC1 TEMPERATURE	EGT	Temperature provided by the thermocouple connected to TC1 input.
TC2 TEMPERATURE	CHT	Idem with TC2
TC3 TEMPERATURE	TC3	Idem with TC3

Function	Factory default name	Description
TC4 TEMPERATURE	TC4	Idem with TC4
AMBIENT TEMPERATURE	TA	Ambient temperature measured by the sender unit.
AUX1 INPUT	AX1	Value based on the voltage applied to the AUX1 input (“AUX1 IN”). See “AUX1 INPUT” menu for more information.
AUX2 INPUT	AX2	Idem with AUX2 input.

Table 12 – SHORT NAMES menu functions <u>using the fuel flow sensor</u>

Function	Factory default name	Description
FUEL FLOW PULSE COUNT	FPC	Number of pulses generated by the fuel flow sensor. The number of pulses is proportional to the volume of fuel used. This parameter is useful for the calibration or the test of the fuel flow sensor.
FUEL USED (VOL.)	USE	Volume of fuel measured by the fuel flow sensor. “FUEL USED (VOL.)” = “FUEL FLOW PULSE COUNT” / “PULSE/VOLUME RATIO” The unit is VOLUME (e.g. liters or US gallons). VOLUME is the unit used to set “PULSE/VOLUME RATIO” in the “FUEL FLOW” menu.

Function	Factory default name	Description
FUEL ONBOARD (VOL.)	FOB	Volume of fuel in the fuel tank. "FUEL ONBOARD (VOL.)" = "INITIAL FUEL VOLUME" - "FUEL USED (VOL.)" The unit is VOLUME. VOLUME is the unit used to set "PULSE/VOLUME RATIO" in the "FUEL FLOW" menu.
FUEL ONBOARD (% INIT.)	%OB	Quantity of fuel in the fuel tank. The unit is % of the **"INITIAL FUEL VOLUME"**. "INITIAL FUEL VOLUME" is set in the "BEFORE STARTING" menu.
FUEL FLOW (VOL./HOUR)	FFC	**Current** fuel flow measured by the fuel flow sensor. The measurement is done during the "AVERAGING TIME (SEC.)" (set with the "FUEL FLOW" menu). The unit is VOLUME per hour. VOLUME is the unit used to set "PULSE/VOLUME RATIO" in the "FUEL FLOW" menu.
AVERAGE FUEL FLOW	FFA	**Average** fuel flow calculated with: "AVERAGE FUEL FLOW" = "FUEL USED" / TIME Where TIME is the **engine run time** since the fuel used was reset using "RESET FUEL USED".

Function	Factory default name	Description
TIME TO EMPTY	TMT	The **current** fuel flow is used to calculate the amount of time until the tank is empty: "TIME TO EMPTY" = "FUEL ONBOARD" / "FUEL FLOW" The display format is Hours:Minutes.
TIME TO MT AT AVG FF	TMA	Meaning: Time to tank empty (MT) using the **average** (AVG) fuel flow (FF) Same as "TIME TO EMPTY" but using the "**AVERAGE** FUEL FLOW" instead of the current "FUEL FLOW". "TIME TO MT AT AVG FF" = "FUEL ONBOARD" / "AVERAGE FUEL FLOW" The display format is Hours:Minutes.
DISTANCE TO EMPTY	DMT	The **current** fuel flow is used to calculate the distance until the tank is empty: "DISTANCE TO EMPTY" = "TIME TO EMPTY" x "SPEED" The unit is the unit used to set "SPEED" in the menu "FUEL FLOW".

Function	Factory default name	Description
DIST TO MT AT AVG FF	DMA	Meaning: Distance (DIST) to tank empty (MT) using the **average** (AVG) fuel flow (FF) Same as “DISTANCE TO EMPTY” but using the “**AVERAGE** FUEL FLOW” instead of the current “FUEL FLOW”. “DIST TO MT AT AVG FF” = “TIME TO MT AT AVG FF” x “SPEED” The unit is the unit used to set “SPEED” in the menu “FUEL FLOW”.

5.8 ALARMS menu

Step 1: Select one of the 10 available alarms	**Step 2: Select the type of alarm**
	Each alarm can be: • “ALARM DISABLED” : the parameter is not tested • “LOW ALARM”: alarm if the parameter is less or equal to the threshold • “HIGH ALARM”: alarm if the parameter is higher or equal to the threshold
ALARMS 0/11 - BACK TO MAIN MENU - ALARM 1 ALARM 2 ALARM 3 ALARM 4 ALARM 5	ALARM 1 HIGH ALARM (3/3) PARAMETER: RPM 1/21 ENGINE TACHOMETER THRESHOLD: +00000.0

Step 3: Select the parameter monitored by this alarm Each alarm can be set on any parameter defined in the menu “SHORT NAMES”.	**Step 4: Select alarm threshold**
ALARM 1 HIGH ALARM (3/3) PARAMETER: RPM 1/21 ENGINE TACHOMETER THRESHOLD: +00000.0	ALARM 1 HIGH ALARM (3/3) PARAMETER: RPM 1/21 ENGINE TACHOMETER THRESHOLD: +03000.0

5.9 FUEL FLOW menu

Table 13 – FUEL FLOW menu functions

Function	Description
PULSE/VOLUME RATIO	Set the characteristic of the fuel flow sensor. See fuel flow calibration procedure below.
AVERAGING TIME (SEC.)	Set the period of time (in seconds) used to calculate the fuel flow rate: “FUEL FLOW (VOL./HOUR)”
SPEED (DISTANCE/h)	Set the speed of the machine. This value is used to estimate the “DISTANCE TO EMPTY”. Enter the value in kilometers per hour if you would like the “DISTANCE TO EMPTY” indicated in kilometers. Enter the value in miles per hour if you would like the “DISTANCE TO EMPTY” indicated in miles. For more information see “DISTANCE TO EMPTY” in the menu “SHORT NAMES”.

BUTTON PUSH DOWN	Assign the function of the navigation button in normal screens when the button is pushed down. • "TOGGLE SCREEN": pushing the navigation button down toggles the normal screens ("main screen", "column 1 screen", "column 2 screen" and "secondary screen") • "CHANGE SPEED": pushing the navigation button down provides a fast method to change the SPEED parameter described in this menu.

5.9.1 Calibration of the fuel flow sensor

The calibration procedure is required to ensure the best accuracy of the measurements provided by the flow sensor.
The calibration procedure is also **very important to make sure the sensor is working properly**.

For maximum accuracy several parameters are important for the calibration.

1. Viscosity of the fuel
2. Flow rate
3. Installation of the sensor

It is therefore important to calibrate the sensor by running the engine in normal operating conditions.

5.9.1.1 Calibration procedure

1. Install the sensor **according to its installation guide**.

2. Fill the fuel tank and make sure that you will be able to fill it with the exact same amount of fuel next time.

3. Reset the parameter "FUEL FLOW PULSE COUNT" using the function "RESET FUEL USED" in the menu "BEFORE STARTING".

4. Run the engine in normal conditions. For best accuracy you should burn at least 50% of the volume of the tank.

5. Write down the value of "FUEL FLOW PULSE COUNT".

6. Fill the fuel tank **back to its initial amount of fuel**. This time you need to fill the tank with a graduated container so that **you know the exact amount of fuel you have added to fill the tank**. This amount of fuel is the amount of fuel burnt during the calibration procedure.

7. Using the “FUEL FLOW” menu set “PULSE/VOLUME RATIO” to the value calculated with

   (FUEL FLOW PULSE COUNT) / (Volume of fuel burnt)

This value of “PULSE/VOLUME RATIO” calculated should be within +/-5% of the value provided in the installation guide of the fuel flow sensor. If this is not the case, it means that the fuel flow sensor is not working properly. Typically this means that the sensor is not installed properly. In this case, you **should not use the value calculated but instead, you should fix the problem.**

5.9.1.2 Example

“FUEL FLOW PULSE COUNT” after running the engine = 35484

Volume of fuel burnt during the calibration procedure = 5.17 liters

The “PULSE/VOLUME RATIO” should be set to

35484 / 5.17 = 6863 pulses per liter

5.10 AUX1 INPUT and AUX2 INPUT menus

This menu allows displaying either the “RAW VALUE” or the “CALIBRATED VALUE” defined below.

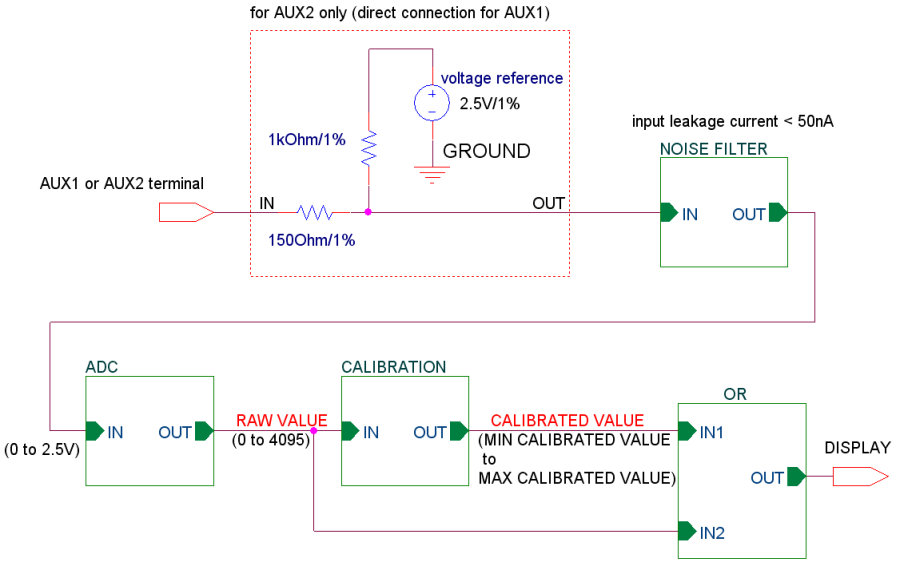


Figure 1 – AUX inputs block diagram

5.10.1.1 ADC block characteristic

The ADC block is a 12-bit Analog to Digital Converter.
12 bits provide 2^{12} = 4096 values (0 to 4095).
The input voltage range of the ADC is 0 to 2.5V.
A voltage of 0V (or below) is converted into a RAW VALUE of 0.
A voltage of 2.5V (or above) is converted into a RAW VALUE of 4095.
A voltage between 0 and 2.5V is converted into a RAW VALUE proportional to the voltage.

5.10.2 CALIBRATION block characteristic

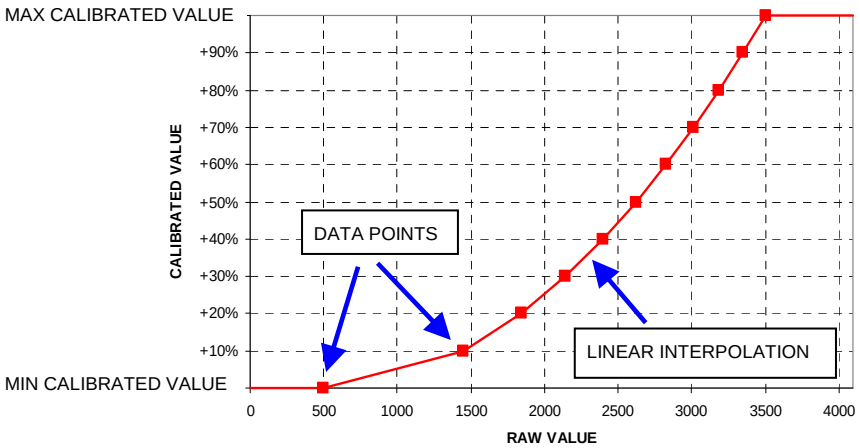
The characteristic of the calibration block is defined by 11 data points and 2 values (MIN CALIBRATED VALUE and MAX CALIBRATED VALUE).

By definition,
100% = “MAX CALIBRATED VALUE” – “MIN CALIBRATED VALUE”

The following values are used as an **example**:

Table 14 – Example of calibration

Data point	Parameter	Value (example)
1	RAW AT CAL=MIN	500
2	RAW AT CAL=MIN+10%	1448
3	RAW AT CAL=MIN+20%	1841
4	RAW AT CAL=MIN+30%	2143
5	RAW AT CAL=MIN+40%	2397
6	RAW AT CAL=MIN+50%	2621
7	RAW AT CAL=MIN+60%	2823
8	RAW AT CAL=MIN+70%	3009
9	RAW AT CAL=MIN+80%	3183
10	RAW AT CAL=MIN+90%	3346
11	RAW AT CAL=MAX	3500



As shown on the above example:

- Raw values below “RAW AT CAL=MIN” are displayed with a calibrated value of “MIN CALIBRATED VALUE”.
- Raw values above “RAW AT CAL=MAX” are displayed with a calibrated value of “MAX CALIBRATED VALUE”.
- For raw values between 2 data points a linear interpolation is used to provide the calibrated value.

The data points must be strictly increasing **or** strictly decreasing.

This means:

RAW(1) < RAW(2) < … < RAW(10) < RAW(11)

or

RAW(1) > RAW(2) > … > RAW(10) > RAW(11)

If this condition is not met, “INVAL” (invalid characteristic) will be indicated on the main screen.

Table 15 – AUX1 INPUT and AUX2 INPUT menu functions

	Function	Description	Data point
	DISPLAY	Choose the value that will appear on the main screen: • RAW VALUE • CALIBRATED VALUE	
	AVERAGING TIME (SEC.)	Set the period of time used to calculate the value.	
CALIBRATION DEFINITION	MIN CALIBRATED VALUE	Minimum calibrated value	
	MAX CALIBRATED VALUE	Maximum calibrated value	
	RAW AT CAL=MIN	Raw value when the calibrated value is MIN CALIBRATED VALUE	1
	RAW AT CAL=MIN+10%	Raw value when the calibrated value is MIN CALIBRATED VALUE + 10%	2
	RAW AT CAL=MIN+20%	Same with +20%	3
	RAW AT CAL=MIN+30%	Same with +30%	4
	RAW AT CAL=MIN+40%	Same with +40%	5
	RAW AT CAL=MIN+50%	Same with +50%	6
	RAW AT CAL=MIN+60%	Same with +60%	7
	RAW AT CAL=MIN+70%	Same with +70%	8
	RAW AT CAL=MIN+80%	Same with +80%	9
	RAW AT CAL=MIN+90%	Same with +90%	10
	RAW AT CAL=MAX	Raw value when the calibrated value is MAX CALIBRATED VALUE	11

5.10.3 Example of application

In this example, the AUX1 input is used for fuel level indication.
A fuel level sender provides a voltage which is proportional to the **height** of the fuel in the tank.
The user wants to have the fuel onboard indicated in % of the tank **volume**.
The capacity of the tank is 10 liters.
Because the section of the tank varies (e.g. wide at the bottom and narrow at the top) a careful calibration is required.

Step 1:
- Set “MIN CALIBRATED VALUE” to 0 (0% = tank empty)
- Set “MAX CALIBRATED VALUE” to 100 (100% = tank full)

Step 2:
- Make sure the tank is empty
- Make sure “AUX1 INPUT” is displayed on the main screen (see “ON MAIN SCREEN” menu)
- Set “DISPLAY” to “RAW VALUE” (see “AUX1 INPUT” menu)

Step 3:
- Write down the “RAW VALUE” indicated on the main screen
- Add 10% of fuel. In this example, 10% of 10 liters is 1 liter.

Step 4: Repeat Step 3 until the tank is full.

Step 5: Using the AUX1 INPUT menu, enter the 11 data points written down starting with “RAW AT CAL=MIN” and ending with “RAW AT CAL=MAX”.

Step 6: Set “DISPLAY” to “CALIBRATED VALUE” (see “AUX1 INPUT” menu)

The value indicated on the main screen is now correct.

6 Troubleshooting

6.1 Incorrect values

Value indicated	Meaning	Solutions
LOW	The parameter cannot be measured because it is too low.	Make sure that the sensor is connected to the sender unit and that the parameter measured is within the range specified in this document.
HIGH	The parameter cannot be measured because it is too high.	
RANGE	The sensor provides a signal which is out of range and therefore cannot be measured.	
?????	The value cannot be displayed because no data was received by the display unit.	Make sure the link cable is properly connected.
ERROR	The value cannot be displayed because the data was not received properly.	Make sure the link cable is properly connected. Make sure the link cable is not too close to the ignition system of the engine.
-----	The display unit needs more data from the sender unit.	Wait a few seconds.
WAIT	The value cannot be displayed because the engine has not been running since the “FUEL USED” was reset.	The value will be displayed when the engine is started.
INVAL	= INVALID The parameter cannot be calculated because the characteristic of the sensor provided is invalid.	Correct the characteristic of the sensor in order to meet the requirements listed in this document.

6.2 Tachometer

Value indicated	Solutions
“LOW” or a value abnormally low	1. Make sure that the sensor is connected to the sender unit and that the parameter measured is within the range specified in this document. 2. Make sure the wraps around the ignition wire are tight 3. Make sure the ignition wire is not shielded. 4. Increase the number of turns of the pickup wire around the ignition wire.
“HIGH” or a value abnormally high	• Decrease the number of turns of the pickup wire around the ignition wire.

6.3 Temperatures

6.3.1 Thermocouples

Value indicated	Issue	Solution
Value abnormally low	A type K thermocouple is used but the unit is configured for type J.	Change the configuration to match the type of thermocouple used.
Value abnormally high	A type J thermocouple is used but the unit is configured for type K.	Change the configuration to match the type of thermocouple used.
The value decreases when the temperature increases	The polarity is reversed.	Swap the positive wire with the negative wire to correct the polarity.
Temperature readings are erratic	Bad grounding	See section 3.5