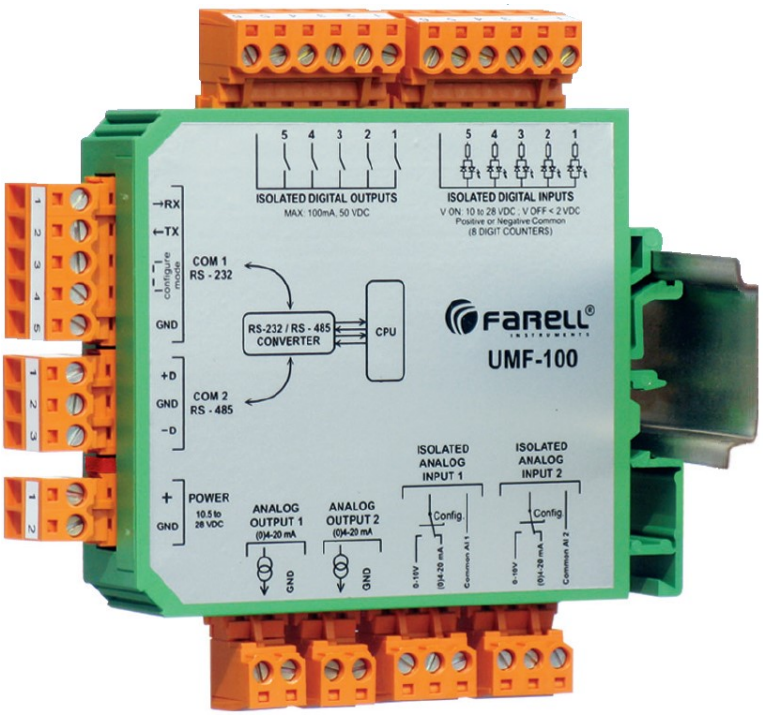
Multimode Module
RS-232/485 ⇔ I/O

UMF-100

User Guide



V2.3 (for UMF-100 firmware ≥ V3.0)

Table of Contents

Table of Contents (cont.)

(NEW FUNCTIONS : See pages 15 to 18)

1 - INTRODUCTION

Thanks for buying the UMF-100 module. This manual contains the installation and configuration instructions to use the module properly. If you need more support, contact our distributor or directly to Farell Instruments at tech@farell-i.com.

The UMF-100 I/O module offers a studied general purpose combination of digital and analog inputs and outputs. This, added to its multiple operating modes, communication ports and functions, allows to employ the module in a great variety of applications.

Adopting the UMF-100 also reduces the cost related to the use of many different modules (stock, availability, etc.). In many applications (transmission of signals, signal filtering, etc.) the UMF-100 can avoid the use of PLC's (cost and programming), and simplifies the final system.

The UMF-100 basic operating modes are:

- Slave ModBus RTU
- Autonomous I/O Transfer Mode (radio and/or cable links)
- Front-End Mode
- Intelligent RS-232/RS-485 converter
- Filtering / Isolation / Replication / Conversion of Digital and Analog Signals

The UMF-100 is a robust and well designed equipment. Special care has been taken to protect internal electronics against external electromagnetic fields. Solid state protection devices are incorporated in all I/O, COM and Power Supply ports to protect it against surges and transients. Power consumption is low, allowing the use of small power supplies or solar powered stations.

The UMF-100 has been designed to operate unattended. Neither reset push buttons are provided nor other manual operations need to be done after the module is configured and installed.

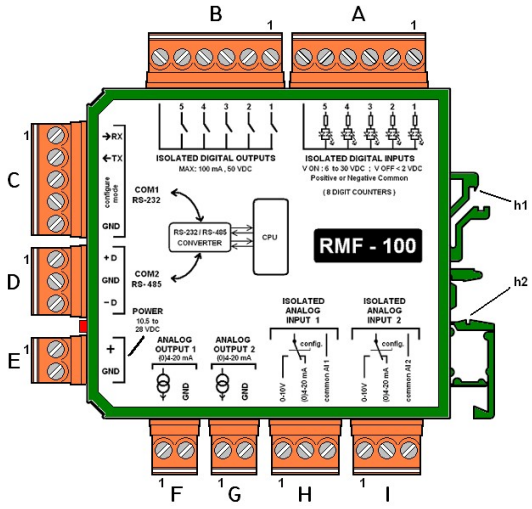
1.1 – MAIN CHARACTERISTICS

- **Multifunction Module: RS-232/485 ⇔ E/S**
- **Many different operating modes**
  - **Slave ModBus Mode: I/O with RS-232 or RS-485 link**
  - **Autonomous I/O Transfer Mode (RS-485 and/or Radio link)**
  - **Front-End Mode: Autonomous I/O Network. Radio link. ModBus RS-485 local data access**
  - **RS-232 / RS-485 Converter Mode**
  - **Signal Isolation-filtering-replication-conversion Mode**
- **I/O:**
  - **5 Isolated Digital Inputs. Voltage operated. Positive or negative common**
    - **Associated functions when pulse emitter: Totalizer (8 digits) & automated calculus of flow rate or power**
    - **Associated functions when motor status: Number of operations (8 digits) and Operating time (minutes) (8 digits)**
  - **5 Isolated Digital Outputs. Solid state relay output**
  - **2 Isolated 12 bit Analog Inputs (isolation 1/1). V and mA inputs**
  - **2 Analog 12 bit Outputs. mA outputs**
- **COM Ports:**
  - **2 serial ports: COM1 (RS-232) and COM2 (RS-485)**
  - **Speed: 1200 bps to 115200 bps**
- **Protection devices in all I/O's, COM ports and power input**
- **Wide power supply operating range: 9.0 VDC to 28 VDC**
- **Wide temperature operating range: -30 ºC to + 70 ºC (-22 ºF to 158 ºF)**
- **Small size**
- **DIN rail mounting (EN 50022)**
- **Software UMF Suite (Windows) allows:**
  - **Module configuration: intuitive, no programming, very fast**
  - **Module test**
  - **Management of configuration files: store, recall**
  - **Analog I/O Recalibration**

2 – THE UMF-100 UNIT

2.1 - CONNECTORS

***A** – Digital Inputs*
***B** – Digital Outputs*
***C** – COM1 port (RS-232)*
***D** – COM2 port (RS-485)*
***E** – Power Supply Input*
***F** – Analog Output 1*
***G** – Analog Output 2*
***H** – Analog Input 1*
***I** – Analog Input 2*



2.2 –LED

Is located between the connectors D and E.

Indications:

- **Slow blink** (1.5 blinks/Sec. *Blinks can be counted*):
  - A) The module has not received any frame addressed to it since it was powered.
    or
  - B) A time higher than *No Comm Watch-Dog Time* has elapsed since the last frame addressed to it was received (this case is only possible if *No Comm Watch-Dog Time* is configured <> 0. See configuration).

  Note: If the UMF-100 is employed exclusively as RS-232/RS-485 converter, the LED will be in slow blink permanently.

- **ON**
  - **With fluctuating intensity**: Indicates that the module is receiving frames addressed to it. The module has the parameter *No Comm Watch-Dog Time* configured <> 0. (See configuration).
  - **With constant intensity**: Indicates that the module is receiving, or has received at any time since it was powered, frames addressed to it. The module has the parameter *No Comm Watch-Dog Time* configured = 0. (See configuration).

- **Fast blink** (10 blinks/Sec. *Blinks can't be counted*): (this indication has priority)
  - Signals a warning or an alarm:
    - Vsupply out of limits: Vsupply < 9.0 V or Vsupply > 28.0 V
    - Internal temperature near or out of limits: < -20 °C (-4 °F) or > + 75 °C (167 °F)
    - Analog input 1 or 2 out of range: > 10V (0-10V) ; > 20 mA (0/4-20mA) ; < 4mA (4-20 mA)

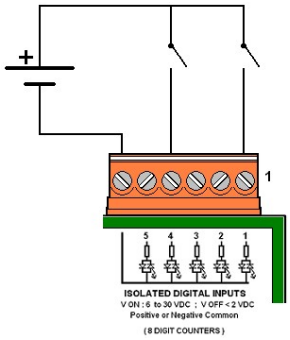
  Note: The cause of the alarm can be found with UMF Suite (Monitor function) or by reading the module's corresponding ModBus register.

2.3 – DIGITAL INPUTS (A connector)

The UMF-100 has 5 digital inputs. Inputs are group isolated and voltage operated. Positive o negative common operation is supported.

OPERATION

- ON → Input voltage from 9.0 V to 28 V
- OFF → Input voltage less than 2 V



Example of connection of inputs 1 and 4 with negative common

CURRENT CONSUMPTION

- Depends on the voltage applied to the input: 1.5 mA at 12Vdc ; 3.0 mA at 24 Vdc

FILTERING

- Two filters are available: Light and Medium. According to the selected filter, a state (ON / OFF) must have a minimum duration to be considered by the module:
  - Light: State duration longer than 5 mS
  - Medium:
    - With AC filter of 50 Hz: State duration longer than 20 mS
    - With AC filter of 60 Hz: State duration longer than 16,6 mS

ISOLATION

- By bi-directional optocouplers. Isolation voltage: 3750 V

PROTECTIONS

- Surge voltage protection by transient diode suppressors on each input

2.4 – PULSE COUNTERS and PERIODMETERS and TIMERS

The UMF-100 has five 8-digit pulse counters and period meters. Each one is associated to a digital input. Counting and period measurements are simultaneous. When associated to meter pulse emitters (water, electricity, gas, etc.) counter values correspond to measured energy (kWh) or volume (m^3, l, gal) and periods correspond to instant power (kW) or instant flow rates (m^3/h, l/s, gal/s), so two important measurements are obtained from each single pulse input.

COUNTER OPERATION (see pags. 15 to 17)

- Counter increments one count each OFF/ON transition on the corresponding input. Counting is from 00000000 to 99999999 and rollover to 00000000. When module is powered counters start from 00000000 or last values are retrieved if module is fitted with NV option.
- Maximum Input Frequency
  - Light Filter: 100 pulses/Sec
  - Medium filter, with AC filter 50 Hz: 25 pulses/Sec
  - Medium filter, with AC filter 60 Hz: 30 pulses/Sec
- Counters are available when module is in:
  - Slave ModBus RTU Mode
  - Autonomous Front-End Mode (4 counters available for each UMF-100 remote module)

PERIODMETER OPERATION (see pags. 15 to 17)

- Measures period of pulses. Measurements are made at OFF/ON transitions.
- Measurement Range:
  - New Mode: From 9.1 pulses/sec to 1 pulse each 10 minutes
  - Old Mode: Continuous from 100 pulses/sec to 1 pulse each 22 minutes
- Accuracy: Better than 0.8 % of the measured period (worst case when max input frequency)

ACCUMULATED OPERATION TIME (see pags. 15 to 17)

- Measures the accumulated operation time (8 digits) of a motor, pump, etc.. Increments during corresponding input is active. Unit: minutes. (Internal resolution: ¼ sec)

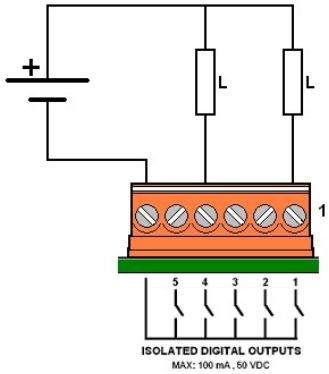
- *The COUNTERS and TIMERS values are saved automatically in case of a power outage. The values are restored automatically when power is reestablished.*

2.5 – DIGITAL OUTPUTS (B connector)

The UMF-100 has 5 digital outputs. Output 1 is on terminal 1 and common is on terminal 6.

GENERAL

- Static relay
- N.O. (normally open) type contact
- No bouncing
- No moving parts
- High reliability



Example of control of 2 loads at outputs 1 and 4. DC operation closing by negative

OUTPUT CONTACT CHARACTERISTICS

- Maximum voltage across the contact (when contact opened): 50 Vdc or 35 Vac
- Maximum continuous contact current (when contact closed): 150 mA
- Maximum peak current (10 mS): 300 mA
- Maximum resistance of the contact when closed: 8 Ω
- Maximum leakage current when contact open: 1 μA

ISOLATION

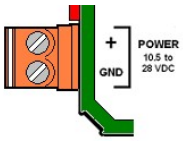
- Isolation voltage: 1500 V

PROTECTIONS

- Surge voltage protection by transient diode suppressors on each output
- Output contacts are not protected against over currents (short-circuits,..)

2.6 – POWER SUPPLY (E connector)

Two terminals removable connector. Positive on terminal 1.



POWER SUPPLY

- Vsupply from 9.0 Vdc to 28Vdc
- Transient voltage protection by fast diodes
- Reverse polarity protected

CURRENT CONSUMPTION

- Typical current consumption: 35 mA
  Add :
  - 3.5 mA for each activated digital output
  - 20 mA for each FS analog output
  - 3 mA for each connected COM port

Note: For Vsupply lower than 9.0 Vdc the module continues to operate normally (except accuracy of analog outputs) up to 7.5 Vdc approximately. For lower Vsupply the module enters in reset state. Module restarts automatically when Vsupply is higher than 7.5 Vdc approximately.

2.7 – ANALOG INPUTS (H and I connectors)

The UMF-100 has two 12-bit analog inputs. V and mA type signals are supported. Each input is individually isolated. Analog input 1 employs connector H and analog input 2 connector I.

OPERATION

V type input (terminals 1 and 3):

- 0-10V range
- Input impedance: 51.7 KΩ ± 1 %

mA type input (terminals 2 and 3):

- Two mA ranges: 0-20 mA and 4-20 mA

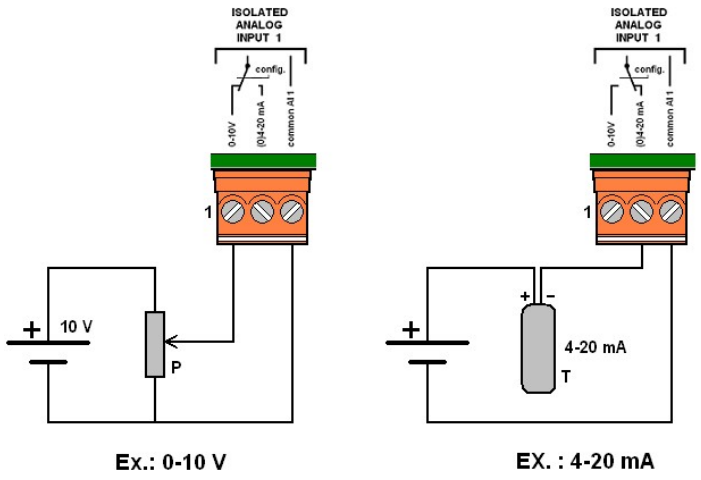
  For a transducer with an 4-20 mA output any of the two ranges can be employed. If 0-20 mA range is employed, input values less than 4 mA can indicate a faulty connection or a broken transducer.

- Very low input impedance: 28.7 Ω ± 1 %

  This low input impedance has many advantages:
  - Possibility to employ regular 4-20 mA two wire transducers at low power supply voltages (12 V or less)
  - Possibility to insert the module in an existing 4-20 mA loop without 'loading' the loop.

Module must be configured according to the input terminal employed

Examples: Connection of a potentiometric transducer to the 0-10V input and connection of 4-20 mA tw wire transducer to the mA input



FILTERING

AC filter to reject nearby AC interferences. Selectable:

- 50 Hz
- 60 Hz

Signal filter: Digital filter 'sliding window' type. Mean value of the input during a sliding window time. Selectable window time:

- No filter
- Light: 140 - 150 mS window time (with AC filter 50 Hz - 60 Hz respectively)
- Medium: 280 - 300 mS window time (with AC filter 50 Hz - 60 Hz respectively)
- Strong: 1120 - 1200 mS window time (with AC filter 50 Hz - 60 Hz respectively)

Speed (for each input):

- 14 conv./ Sec (with 50 Hz AC filter)
- 13 conv./ Sec (with 60 Hz AC filter)

A/D CONVERTER

- Resolution: 12 bits to 15 bits (depending on selected filter)
- Accuracy (25 ºC): Better than 0.05 % FS
- Typical temperature drift: ± 0.003 % FS / ºC
- Auto-zero: For V input < 14 mV on 0-10V range ; I input < 28 µA on 0-20 mA range

ISOLATION

- Each input is individually isolated
- Isolation voltage: 350 V

PROTECTIONS

- Surge voltage protection by transient diode suppressors on each input

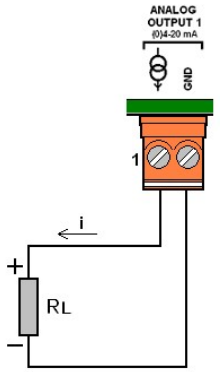
2.8 – ANALOG OUTPUTS (F and G connectors)

The UMF-100 has two 12-bit analog outputs of mA type. Analog output 1 employs connector F and analog output 2 connector G.

OPERATION

- mA type output with 0-20 mA or 4-20 mA selectable range

Example: Connection of a load to a 4-20 mA or 0-20 mA analog output.



RL (Ω) ≦ 50 (Vmodule – 5)

D/A CONVERTER

- Resolution: 12 bits
- Accuracy (25 ºC):
  - Range 4-20 mA: Better than 0,05 % FS
  - Range 0-20 mA:
    Better than 0.05 % FS for an output between 0.3 and 20 mA
    Better than 1.5 % FS for an output between 0 mA and 0.3 mA
- Typical temperature drift: ± 0.003 % FS / ºC

OUTPUT

- Maximum load resistance:

$$\boldsymbol{Rload \leq 50\,(Vsupply - 5.5)}$$

Ex: Rload ≤ 325 Ω for Vsupply = 12.0 V
Ex: Rload ≤ 925 Ω for Vsupply = 24.0 V

- Maximum load inductance: 1 mH
- Speed: More than 100 conv / Sec

ISOLATION

- Analog outputs are not isolated. The analog output GND terminals are common with power supply GND and COM GND ones.

PROTECTIONS

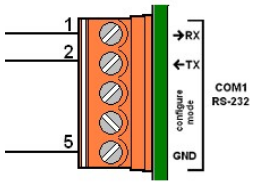
- Surge voltage protection by transient diode suppressors on each output

2.9 – COM 1 PORT: RS-232 (C connector)

The UMF-100 has one RS-232 port. This port is used in regular communications and also for module configuration and downloading firmware upgrades.

2.9.1 – Data Connection

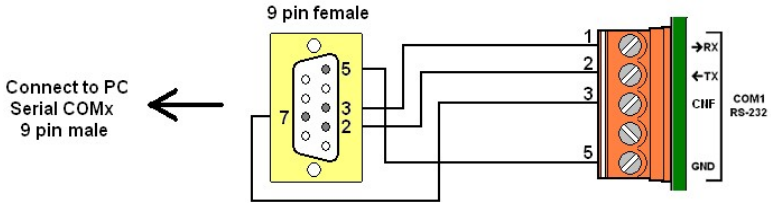
5 terminals pluggable connector. Only 3 terminals are employed: RX (1), TX (2) y GND (5). The other terminals must be left unconnected (terminal 3 is employed only by the configuration cable and terminal 4 is employed in some very special RS-485 topologies).



The GND terminal is common with power supply GND, COM2 GND and analog output GND ones.

2.9.2 – Configurating Connection: Configuration Cable

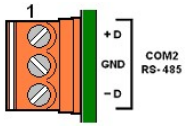
Configuration cable can be provided by Farell or can be user made. 4 lines are employed:



2.10 – COM 2 PORT : RS-485 (D connector)

The UMF-100 has one RS-485 port. This port is used in some of the operating modes.

2.10.1 – Data Connection



3 terminals pluggable connector. Connection with other RS-485 ports is made connecting +D to other +D's; -D to other –D's and GND to other GND's.
GND's connection between RS-485 ports must always be done. Up to 32 ports can be connected in the same line without the need to employ RS-485 amplifiers or repeaters. The GND terminal is common with power supply GND, COM1 GND and analog output GND ones.

It is recommended to employ twisted pair cable for the +D and –D connection. For lengthy lines and/or noisy environments, cable must be screened. The screen will be connected to GND.

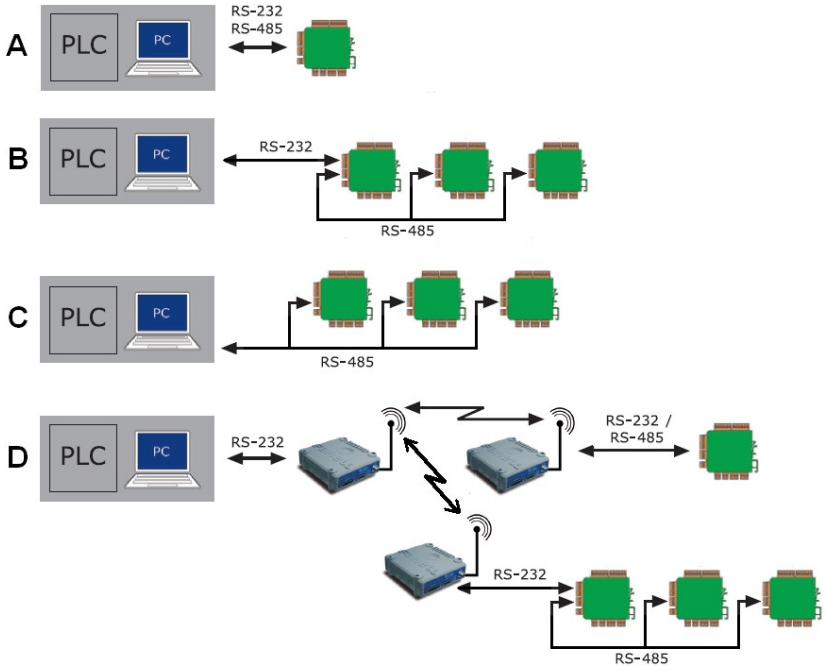
As a general practice it is not recommended to install termination resistors. If necessary (very long lines or very noisy environments) install two 220 Ω termination resistors between +D and –D terminals, one in each end of the RS-485 line and add in one of the UMF-100 a 750 Ω resistor between –D and GND and another 750 Ω resistor between +D and terminal 4 of connector C.

In case of installations with different ground potentials (permanent or transitory due to storms, etc.) it is recommended to install RS-485 isolation modules.

3 – OPPERATING MODES

3.1 – SLAVE ModBus RTU MODE

In this mode the UMF-100 can be connected through any of its two COM ports to a master ModBus RTU. The master reads and writes the UMF-100 ModBus registers to read digital and analog inputs, pulse counters, period counters (flow rates & power), operations counters, operation timers, to write digital and analog outputs, initializing counters, etc..



3.1.1 - UMF-100 ModBus RTU mode, supported ModBus RTU functions

01 – READ DIGITAL OUTPUTS
The UMF-100 also allows to read of digital inputs
02 – READ DIGITAL INPUTS
The UMF-100 also allows to read digital outputs
05 – WRITE SINGLE DIGITAL OUTPUT

15 (0FH) **– WRITE MULTIPLE DIGITAL OUTPUTS**

03 – READ ANALOG REGISTERS (Internal or analog output)
The UMF-100 also allows to read analog input registers
04 – READ ANALOG INPUT REGISTERS
The UMF-100 also allows to read analog internal or output registers
06 – WRITE SINGLE ANALOG OUTPUT REGISTER (Internal or analog output)

16 (10H) **– WRITE MULTIPLE ANALOG OUTPUT REGISTERS** (Internal or analog outputs)

Functions 01, 02, 05 and 15 are bit oriented (digital inputs and outputs). Functions 03, 04, 06 and 16 are register oriented (analog inputs, outputs and internal). The UMF-100 duplicates digital signals on analog registers. This allows reading and writing digital signals employing the analog ModBus functions.

3.1.2 – UMF-100 ModBus Register Map in Slave Mode

DIGITAL INPUTS registers (ModBus functions: 01, 02, 05 y 15) **(Allows R)**

Digital Input 1	0000 H (0000 D)	('1' indicates activated input)
Digital Input 2	0001 H (0001 D)	" "
Digital Input 3	0002 H (0002 D)	" "
Digital Input 4	0003 H (0003 D)	" "
Digital Input 5	0004 H (0004 D)	" "
	0005 H (0005 D) to 000F H (0015 D) are meaningless	

DIGITAL OUTPUT registers (ModBus functions: 01, 02, 05 y 15) **(Allows R & W)**

Digital Output 1	0010 H (0016 D)	('1' activated output)
Digital Output 2	0011 H (0017 D)	" "
Digital Output 3	0012 H (0018 D)	" "
Digital Output 4	0013 H (0019 D)	" "
Digital Output 5	0014 H (0020 D)	" "
--	0015 H (0021 D) to 001F H (0031 D) are meaningless	

ANALOG INPUTS and SPECIAL Registers (ModBus functions: 03, 04) **(Allows R)**

MODULE TYPE	2000 H (8192 D)	'5' → UMF-100
VERSSION	2001 H (8193 D)	High register byte: Loader Version: Ex.'10h' → V1.0
		Low register byte: Firmware Version: Ex.'10h' → V1.0
SERIAL NUMBER	2002 H (8194 D)	High register byte: 1st character (ASCII): Ex.'30h' → '0'
		Low register byte: 2nd character (ASCII)
	2003 H (8195 D)	High register byte: 3rd character (ASCII)
		Low register byte: 4th character (ASCII)
	2004 H (8196 D)	High register byte: 5th character (ASCII)
		Low register byte: 6th character (ASCII)
	2005 H (8197 D)	High register byte: 7th character (ASCII)
		Low register byte: 8th character (ASCII)
Configuration 0	2006 H (8198 D)	*Only for manufacturer use*
Configuration 1	2007 H (8199 D)	
		b15-b13: '000': Analog Output 2 inactive
		'001': Analog Output 2 in range 4-20 mA
		'010': Analog Output 2 in range 0-20 mA
		b12-b10: '000': Analog Output 1 inactive
		'001': Analog Output 1 in range 4-20 mA
		'010': Analog Output 1 in range 0-20 mA
		b9-b8: *Only for manufacturer use*
		b7-b5: '000': Analog Input 2 in range 4-20 mA
		'001': Analog Input 2 in range 0-20 mA
		'010': Analog Input 2 in range 0-10 V
		b4-b2: '000': Analog Input 1 in range 4-20 mA
		'001': Analog Input 1 in range 0-20 mA
		'010': Analog Input 1 in range 0-10 V
		b1-b0: *Only for manufacturer use*
Configuration 2	2008 H (8200 D)	
		b15-b6: *Only for manufacturer use*
		b5-b4: '00': Digital Input filter : Light: 5 mS
		'01': " " : Medium: (16–20 mS)
		b3-b2: '00': Analog Input filter : No filtering
		'01': " " : Light (140 – 150 mS)
		'10': " " : Medium (280 – 300 mS)
		'11': " " : Strong (1120 – 1200 mS)
		b1-b0: *Only for manufacturer use*
Only for manufacturer	2009 H (8201 D)	
Only for manufacturer	200A H (8202 D)	
Only for manufacturer	200B H (8203 D)	
Alarms & Warnings	200C H (8204 D)	
		b15-b4 *Only for manufacturer use*
		b3: '1' → Alarm: Analog input 2 out of range
		b2: '1' → Alarm: Analog input 1 out of range
		b1: '1' → Warning/Alarm:Temperature < -20°C or >75°C
		b0: '1' → Alarm: Vsupply < 9.0 V or Vsupply > 28.0 V
Module supply voltage	200D H (8205 D)	Vsupply (V) = 30 (VALIM / 32767)
Module temperature	200E H (8206 D)	Temp. (°C) = (TEMPM / 252) – 30
Analog Input 2	200F H (8207 D)	0 to 7FFF H (0 to 32767 D) all ranges
Analog Input 1	2010 H (8208 D)	0 to 7FFF H (0 to 32767 D) all ranges
Digital Inputs (analog format)	2011 H (8209 D)	b4-b0: inputs 5-1 resp. '1' indicates activated input

ANALOG OUTPUTS and DIGITAL OUTPUTS (ModBus Functions.: 03, 04, 06, 16) **(NEW v2.5)**

Digital outputs (analog format)	2012 H (8210 D)	b4-b0: output 5-1 resp. '1' to active output
Analog Output 1	2013 H (8211 D)	0 to 7FFF H (0 to 32767 D) all ranges
Analog Output 2	2014 H (8212 D)	0 to 7FFF H (0 to 32767 D) all ranges

TOTALIZERS / OPERATIONS (LONG WORD HEX register format)(ModBus Functions.: 03, 04, 16) **(NEW v2.5)**
0x0000-0x0000 → 0x0000-0x0001 → …. → 0x05F5-0xE0FF → 0x0000-0x0000 → ….

Totalizer / Operations 1 (Pulses on digital input 1)	202E H (8238 D) 202F H (8239 D)
Totalizer / Operations 2 (Pulses on digital input 2)	2030 H (8240 D) 2031 H (8241 D)
Totalizer / Operations 3 (Pulses on digital input 3)	2032 H (8242 D) 2033 H (8243 D)
Totalizer / Operations 4 (Pulses on digital input 4)	2034 H (8244 D) 2035 H (8245 D)
Totalizer / Operations 5 (Pulses on digital input 5)	2036 H (8245 D) 2037 H (8247 D)

TOTALIZERS / OPERATIONS (2 WORD BCD register format) (ModBus Functions.: 03, 04, 16)
0x0000-0x0000 → 0x0000-0x0001 → .. → 0x0000-0x9999 → 0x0001-0x0000 → 0x9999-0x9999 → 0x0000-0x0000

Totalizer / Operations 1 (Pulses on digital input 1)	2015 H (8213 D) 2016 H (8214 D)
Totalizer / Operations 2 (Pulses on digital input 2)	2017 H (8215 D) 2018 H (8216 D)
Totalizer / Operations 3 (Pulses on digital input 3)	2019 H (8217 D) 201A H (8218 D)
Totalizer / Operations 4 (Pulses on digital input 4)	201B H (8219 D) 201C H (8220 D)
Totalizer / Operations 5 (Pulses on digital input 5)	201D H (8221 D) 201E H (8222 D)

Notes:

- *To assure the integrity of a counter, the two registers of a counter (totalizer / operations) must be read o written in a unique frame. Register writing will not be accepted by the module if the first address register to write corresponds to a low word value of a totalizer/operation.*
- *Totalizer/operation value is incremented in one unit each time the corresponding input is activated.*
- *The totalizer/operation value is saved automatically in case of a power outage. The value is restored automatically when power is reestablished.*

FLOW RATE or POWER (1 WORD HEX register format) (ModBus Functions: 03, 04) **(NEW v2.5)**

Flow rate / Power 1 (Pulses on digital input 1)	2038 H (8248 D)
Flow rate / Power 2 (Pulses on digital input 2)	2039 H (8249 D)
Flow rate / Power 3 (Pulses on digital input 3)	203A H (8250 D)
Flow rate / Power 4 (Pulses on digital input 4)	203B H (8251 D)
Flow rate / Power 5 (Pulses on digital input 5)	203C H (8252 D)

- Maximum accepted input pulse frequency: 9.1 pulses/seg
- Results are refreshed each: 5.5 sec
- Result is zero when 10 minutes without a new pulse. This is to reduce time to arrive to zero when pulses (meter) stops (this fixes the minimum measurable flow/power).

Examples for water meter:

*Pulse = 1 l --> **Q in l/h** ; Divide by 1000 to obtain m3/h*
Qmax: 32.767 m3/h
Qmin: 0.006 m3/h
Resolution: 0.001 m3/h

*Pulse = 10 l --> **Q in l/h x 10** ; Divide by 100 to obtain m3/h*
Qmax: 327.67 m3/h
Qmin: 0.06 m3/h
Resolution: 0.01 m3/h

*Pulse = 100 l --> **Q in l/h x 100** ; Divide by 10 to obtain m3/h*
Qmax: 3,276.7 m3/h
Qmin: 0.6 m3/h
Resolution: 0.1 m3/h

*Pulse = 1 m3 --> **Q in m3/h***
Qmax: 32,767 m3/h
Qmin: 6 m3/h
Resolution: 1 m3/h

*Pulse = 10 m3 --> **Q in m3/h x 10** ; Multiply by 10 to obtain m3/h*
Qmax: 327,670 m3/h
Qmin: 60 m3/h
Resolution: 10 m3/h

- *This example also valid for electricity meters, substituting liters by Wh and m3/h by kW*
- *Other multiplying factors need to be employed to obtain results on different units.*

FLOW RATE or POWER registers (old Format) (ModBus functions: 03, 04) **(Allows R)**

PERIOD1	201F H (8223 D)	Last digital input 1 period value (unit: 20 mS) (1 to FFFFh)
PULSE1	2020 H (8224 D)	Number of digital input 1 pulses, during last period (1 to FFFFh)(*)
CPERIOD1	2021 H (8225 D)	Time since last digital input 1 period measurement (unit: 20 mS)(0 a FFFFh)
PERIOD2	2022 H (8226 D)	Last digital input 2 period value (unit: 20 mS) (1 to FFFFh)
PULSE2	2023 H (8227 D)	Number of digital input 2 pulses, during last period (1 to FFFFh) (*)
CPERIOD2	2024 H (8228 D)	Time since last digital input 2 period measurement (unit: 20 mS)(0 a FFFFh)
PERIOD3	2025 H (8229 D)	Last digital input 3 period value (unit: 20 mS) (1 to FFFFh)
PULSE3	2026 H (8230 D)	Number of digital input 3 pulses, during last period (1 to FFFFh) (*)
CPERIOD3	2027 H (8231 D)	Time since last digital input 3 period measurement (unit: 20 mS)(0 a FFFFh)
PERIOD4	2028 H (8232 D)	Last digital input 4 period value (unit: 20 mS) (1 to FFFFh)
PULSE4	2029 H (8233 D)	Number of digital input 4 pulses, during last period (1 to FFFFh) (*)
CPERIOD4	202A H (8234 D)	Time since last digital input 4 period measurement (unit: 20 mS)(0 a FFFFh)
PERIOD5	202B H (8235 D)	Last digital input 5 period value (unit: 20 mS) (1 to FFFFh)
PULSE5	202C H (8236 D)	Number of digital input 5 pulses, during last period (1 to FFFFh) (*)
CPERIOD5	202D H (8237 D)	Time since last digital input 5 period measurement (unit: 20 mS)(0 a FFFFh)

CALCULUS NEEDED TO OBTAIN THE FLOW RATE/POWER RESULT

This method allows the best flow rate resolution and the highest refreshing speed.
We must know:

- Pulse emitter weight (K), in m^3
- Minimum flow rate of the meter (Qmin) in m^3/h. For lower flow rate results we will do Q=0

The calculated Q will be expressed in m^3/h units *(see note)*
It is necessary to periodically read the ModBus registers:

- PERIODx
- PULSEx
- CPERIODx

Where x is 1, 2, 3, 4 or 5 depending of which meter input is employed. The 3 registers need to be read in a same frame, to assure they correspond to a same module measurement.

Depending of the K value we obtain the P value
For K=0.001 → P = 180
For K=0.010 → P = 1.800
For Si K=0.100 → P = 18.000
For K=1.000 → P = 180.000
For K=10.00 → P = 1.800.000

After each register reading it is necessary to do the following calculus to obtain the final flow rate (Q)

If PULSEx <> 0
Q1 = (PULSEx / PERIODx) P
If CPERIODx > 125
Q2 = P / (CPERIODx - 125)
If Q2 < Q1
If Q2 > Qmin → **Q = Q2**
If Q2 ≤ Qmin → **Q = 0**
If Q2 ≥ Q1
If Q1 > Qmin → **Q = Q1**
If Q1 ≤ Qmin → **Q = 0**
If CPERIODx ≤ 125
If Q1 > Qmin → **Q = Q1**
If Q1 ≤ Qmin → **Q = 0**
If PULSEx = 0 it is necessary to wait until a first calculus of Q can be done

Note: For other K values or if Q must be expressed in other units, consult FARELL to obtain the corresponding P value

❑ ***A module does not answer frames that try to read or write nonexistent registers.***

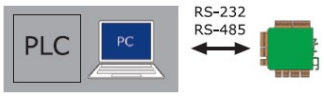
OPERATING TIME (LONG WORD HEX register format) (ModBus Functions.: 03, 04, 16) **(NEW v3.0)**
0x0000-0x0000 → 0x0000-0x0001 → …. → 0xFFFF-0xFFFF → 0x0000-0x0000 → ….

Operating time 1 (Input 1)	**203D H (8253 D)** **203E H (8254 D)**
Operating time 2 (Input 2)	**203F H (8255 D)** **2040 H (8256 D)**
Operating time 3 (Input 3)	**2041 H (8257 D)** **2042 H (8258 D)**
Operating time 4 (Input 4)	**2043 H (8259 D)** **2044 H (8260 D)**
Operating time 5 (Input 5)	**2045 H (8261 D)** **2046 H (8262 D)**

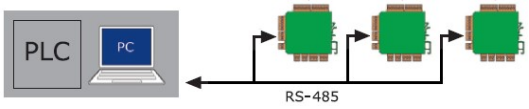
Notes:

- *To assure the integrity of a counter, the two registers of a counter (operating time) must be read o written in a unique frame. Register writing will not be accepted by the module if the first address register to write corresponds to a low word value of an operating time counter.*
- *Operating time value **is incremented each minute** the corresponding input remains active (unit is minutes).* (Internal resolution: ¼ sec)
- *The Operating time value is saved automatically in case of a power outage. The value is restored automatically when power is reestablished.*

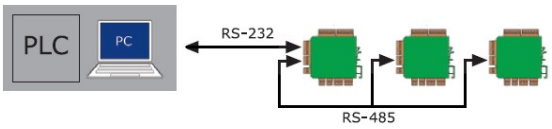
3.1.3 – Typical Set-up Topologies



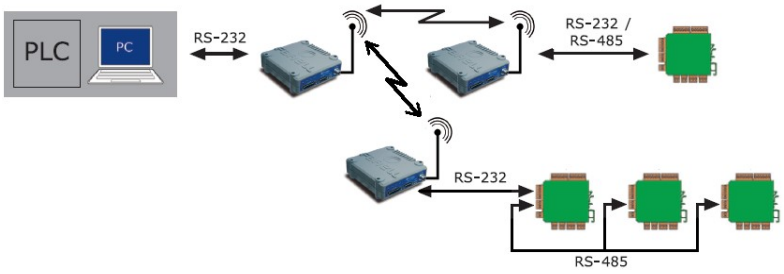
- In this case only one module is connected through COM1 (RS-232) or COM2 (RS-485) to a master ModBus (PC, PLC,...).



- In this case various modules are connected trough COM2 (RS-485) to a master ModBus (PC, PLC,...). It is also possible to connect other equipment to the same RS-485 line employing ModBus or other protocols.



- This case is a variant of the previous one. Here the master ModBus is provided with a RS-232 port so the master is connected to COM1 (RS-232) of one of the modules and the integrated RS-232/RS-485 converter of this module is employed to connect to the other modules. Apart from of acting as a RS-232/RS-485 converter the module simultaneously performs the I/O functions as any of the other modules. From the master point of view, this mounting is identical to the previous one. It is also possible to connect other equipment to the same RS-485 line employing ModBus or other protocols. In this last case baudrate and character format must coincide.



- In this case there is a network with two branches linked by radio. The radio modem is protocol transparent. In one of the branches the radio modem is connected to the modules by RS-232 employing the integrated RS-232/RS-485 converter of the 'first' module. Apart from of acting a as a RS-232/RS-485 converter the 'first' module simultaneously performs all the I/O functions as any of the other modules. Modules baudrate must be configured according to the radio modem supported baudrate.

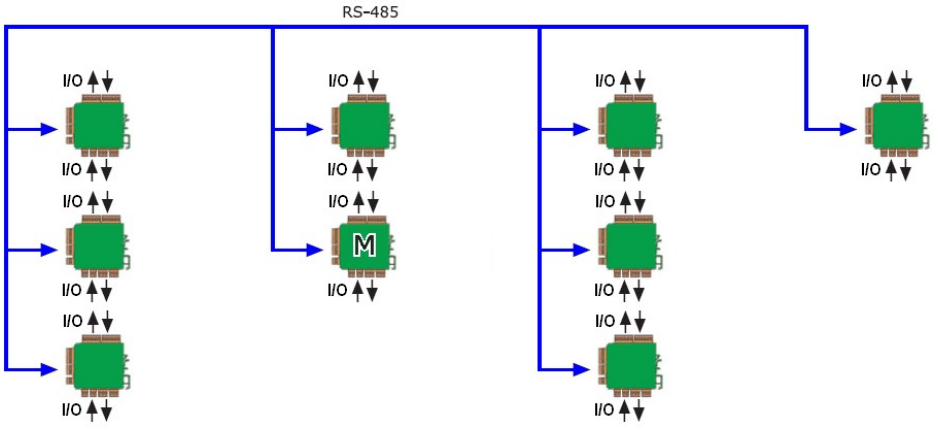
  If in this case one or more modules need to be connected locally to the master (by wire) an additional port on the master should be used for this purpose. Employing the same master COM port for remote radio and local links is not recommended (this is because of the different data delays of the two media links).

3.1.4 – Module Configuration with UMF Suite

- **Do a CONNECT and close window**
- **In CONFIG / BASIC**
    1. Module Address: Module address (1 to 255). Each module in a network must have a different ModBus address.
    2. Network Role: Slave
    3. Input and Output Analog Ranges: As needed
    4. Analog Input Filter: As needed
    5. Digital Input Filter: As needed
    6. AC Frequency Filter: 50 Hz or 60 Hz, according to the mains frequency of the installation.
- **In CONFIG / COMMUNICATIONS**
    1. Configure COM1 and COM2 as needed. COM1 and COM2 configuration must be equal. When module communicates through radio modem, the module baudrate will be configured less or equal to the radio baudrate of the radio modem.
    2. Configure COM1 EOF Chars = COM2 EOF Chars = 3.5
    3. No Com Watch-Dog Time: This is the maximum time that a module waits between frames addressed to it. If this time is exceeded, the module does an auto-reset. Digital and analog outputs are reset (open contact for digital outputs and minimum range value for analog outputs). Counters are kept. The value 0 deactivates this security function. Unit is the second.
    4. Close CONFIG window
- **In SEND**
    1. Mark Configuration Only and make a SEND
    2. CLOSE when sending is finished

Once a module is configured it is recommendable to identify it for example by sticking an adhesive label with the configured address.

3.2 – AUTONOMOUS I/O TRANSFER. RS-485 NETWORK MODE



In this mode a group of UMF-100 modules (2 to 32) autonomously communicate in a RS-485 network to transfer inputs (digital and analog) to outputs (digital and analog). The communication between modules is managed by one of the modules, configured as the 'master'.

- Any input signal (digital or analog) of a module can be associated to one or more outputs (digital or analog) of one or more modules (itself included).
- Any internal generated measurement (temperature and supply voltage) can be associated to one or more outputs (analog) of one or more modules (itself included)

3.2.1 – Module Configuration with UMF Suite

One of the modules will be configured as Master and the rest of the modules as Slaves. The association between inputs and outputs is defined in a table (polling table) that is downloaded to the module that acts as the master (M). The master performs all the communication tasks between modules in order to read inputs and write to the corresponding outputs.

3.2.1.1 – Master Module Configuration

- **Do a CONNECT and close window**
- **In CONFIG / BASIC**
    1. Module Address: 1 (no other value is possible)
    2. Network Role: Master
    3. Input Analog Ranges: As needed
    4. Output Analog Ranges: As needed (we recommend to select the same range as the associated analog input) or 0-20 mA for ones associated to internal measurement
    5. Analog Input Filter: As needed
    6. Digital Input Filter: As needed
    7. AC Frequency Filter: 50 Hz or 60 Hz, according to the mains frequency of the installation.
- **In CONFIG / COMMUNICATIONS**
    1. COM2 Baudrate = 115200 bps (Other baudrates are possible. All slave modules must have the same baudrate)
    2. COM2 Character Format : 8N1
    3. COM2 EOF Chars : 3.5
    4. Com Watch-Dog Time (Sec): This is the maximum time that the module waits between frames addressed to it. If this time is exceeded, the module does an auto-reset. Digital and analog outputs are reset (open contact for digital outputs and minimum range value for analog outputs). Counters are not modified. The value 0 deactivates this security function. Usually = 30
    5. The other parameters in this window are meaningless
- **In CONFIG / MASTER**
    1. Max Fails to Deactivate: 3
    2. Cycles To Try Reactivate: 10
    3. The other parameters in this window are meaningless
    4. Close CONFIG window
- **In POLLING TABLE / MASTER POLLING TABLE**
    1. Each installed slave module must have a unique address and will be identified by it. Each slave module must be activated marking with √ on the appropriate position in column *En*. Slave modules may have any direction in the 2 to 32 range. Modules don't need to have consecutive addresses. Address 1 is always reserved for the Master module and is always active.
    2. In the column *Rep* write 0 in all positions corresponding to active slave units
    3. In the column *Port* write COM2 in all positions corresponding to active slave units
    4. In the column Asc, open *Edit* and configure for each active slave module and for the master the corresponding associated inputs to each one of their outputs.
        a. Each Digital Output must be assigned to a Digital Input of any of the modules (master or slaves).
        b. Each Analog Output must be assigned to an Analog Input or Internal Analog measurement (Temperature or Input voltage) of any of the modules (master or slaves)
    5. When finished, do OK (or Cancel)
- **In SEND**
    1. Select *Configuration and Polling Table* and do a SEND
    2. When finished, do a CLOSE

3.2.1.2 – Slave Modules Configuration

- **Do a CONNECT and close window**
- **In CONFIG / BASIC**
    1. Module Address: 2 to 32 (module addresses can't be duplicated)
    2. Network Role: Slave
    3. Input Analog Ranges: As needed
    4. Output Analog Ranges: As needed (we recommend to select the same range as the associated analog input). If the output is associated to an Internal Analog signal, we recommend 0-20 mA.
    5. Analog Input Filter: As needed
    6. Digital Input Filter: As needed
    7. AC Frequency Filter: 50 Hz or 60 Hz, according to the mains frequency of the installation.
- **In CONFIG / COMMUNICATIONS**
    1. COM2 Baudrate = 115200 bps (Other baudrates are possible. All slave modules must have the same baudrate)
    2. COM2 Character Format : 8N1
    3. COM2 EOF Chars : 3.5
    4. Com Watch-Dog Time: This is the maximum time that the module waits between frames addressed to it. If this time is exceeded, the module does an auto-reset. Digital and analog outputs are reset (open contact for digital outputs and minimum range value for analog outputs). Counters are not modified. The value 0 deactivates this security function. Unit is the second. Usually = 30
    5. The other parameters in this window are meaningless
- **In SEND**
    1. Select *Configuration Only* and do a SEND
    2. When send is finished, do a CLOSE

Once a module has been configured it is convenient to identify it. An adhesive label marked with the module address can be appropriate.

3.2.2 – Refreshing Time

It is the maximum time that elapses between a change in an input and the output of this change on its associated output(s). The refreshing time is the same for digital and analog signals.

The refreshing time depends on the number of modules and the port baudrate.

Cases:

- With COM2 at 115,200 bps: *Refreshing Time (mS) = 6 Nm*
- With COM2 at 19,200 bps: *Refreshing Time (mS) = 21 Nm*

Where:

***Nm** : Total number of modules in the network*

The delays caused by selected filtering over digital or analog inputs have not been taken into account.

3.2.3 – Security

UMF-100 modules have been designed and manufactured according to the most advanced engineering and production methods. They also satisfy the most demanding standards relatied to electromagnetic compatibility. Protection devices are incorporated in all signal, power and communication ports. Hardware and firmware methods have been adopted to ensure continuous, non assisted operation. Each module is individually tested and calibrated prior to shipping.

3.2.3.1 – Implemented Functions

There are some security functions implemented at the network level. Some functions are done by each module in the network and others specifically by the module that acts as the master.

Functions done by each module

- Just after a module is powered-up all its digital outputs are 'open' and analog outputs are at the minimum value (0 or 4 mA according to the range configured). This is the module's *'initial state'*.
- If a module misses communication during a time bigger than the *No Com Watch-Dog Time,* does a self-reset and its outputs (digital and analog) go to the *'initial state'.* The *No Com Watch-Dog Time* is configurable. If configured as 0, this functions is inhibited.

Functions done by the master module

- A digital output of any module associated to a digital input of a module that does not communicate or has ceased to communicate (deactivated module), passes to open state.
- An analog output of any module associated to an analog input or internal analog measurement of a module that does not communicate or has ceased to communicate (deactivated module), passes to minimum value (0 or 4 mA according to the range configured).
- The master module considers an slave module as a 'deactivated module' after N consecutive query frames without answer. N may be configured on the master (*Max Fails To Deactivate*)
- The master retries bi-directional communication with each 'deactivated module' each M general pulling cycles. M may be configured on the master (*Cycles To Try Reactivate*).
- The master continues to send uni-directional frames each pulling cycle to each one of the 'deactivated modules', if any. These frames contain the values associated to the outputs of these modules, in case the modules can listen to the master. No answer from the modules is requested.

3.2.3.2 - Protocol

The protocol employed is based on codified frames that include error detection based on CRC polynomial. The probability of decoding as correct a corrupted frame is extremely low.

3.2.3.3 – Digital Outputs to supervise the Communication State

Digital outputs that indicate the communication state of each module can be implemented. To do so, it is necessary to employ a digital input on every module to be monitored (supervision input). Each supervision input will be associated to a digital output that will inform about the communication state of the associated supervised module.

Example: Network with 3 modules H, I and J. Implementation of the communication state of the modules H , I and J in module J

- Module H: Digital input 5 hardware connected to active state (Power +)
- Module I: Digital input 5 hardware connected to active state (Power +)
- Module J: Digital input 5 hardware connected to active state (Power +)

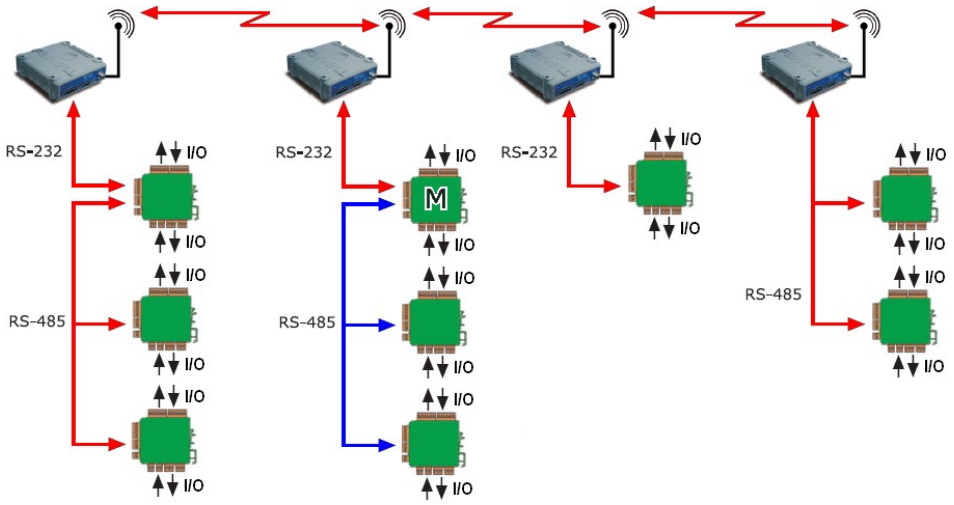
- Module J: Digital output 1 associated to digital input 5 of module H
- Module J: Digital output 2 associated to digital input 5 of module I
- Module J: Digital output 3 associated to digital input 5 of module J

Digital output states of Module J:

Output 3	Output 1	Output 2	Meaning
OFF	x	x	Module J do not communicates. Communication states of modules H and I are unknown
ON	ON	ON	Modules H , I and J communicate OK
	OFF	ON	Module H without communication. Modules I and J communicate OK
	ON	OFF	Module I without communication. Modules H and J communicate OK

The supervision of a module can be done simultaneously from as many modules as needed. It is only necessary to assign in each one a digital output to the supervision input of the module to monitor.

3.3 – AUTONOMOUS I/O TRANSFER. RADIO and/or RS-485 NETWORK



In this mode a group of UMF-100 modules autonomously communicate in a radio network (marked red in the figure) and local network (marked in blue) to transfer inputs (digital and analog) to outputs (digital and analog).

Employed radio-modems must support serial data communication and be protocol transparent.

Simultaneously or only another 'local' RS-485 network (marked blue on the figure) can coexist. Inputs (digital and analog) can be autonomously transferred to outputs between modules, regardless of the network: radio (red) or RS-485 (blue). The maximum supported number of modules, both networks added, is 32.

One of the modules must be configured as master (marked with M on the figure). The rest are configured as slaves. The master module connects to the radio network through its COM1 and to the 'local' RS-485 network through its COM2.

- Any input signal (digital or analog) or internal analog signal (temperature and Vsupply) of a module can be output to one or more outputs (digital or analog) of one or more modules, the originating module included.

The association between inputs and outputs is defined in a table (polling table) that is downloaded to the module that acts as the master (M). The master performs all the communication tasks between modules in order to read inputs and write to the corresponding outputs.

The polling table is generated and downloaded to the Master by the supplied UMF-Suite app.

3.3.1 – Radio-Modem characteristics

- Must be adequate to the distance to cover
  - TX transmitting power
  - RX sensibility
  - Working RF band
- Must incorporate a serial port (RS-232 or RS-485) and must operate without the need of control signals (data activated)
- Must be transparent to the data protocol
- Half-duplex

If necessary, radio repeaters can be employed. Two different type of radio repeaters are supported:

Back-to-Back repeaters:

This repeater consists of two standard radio modems connected through the serial port. Each one operates at a different radio frequency. When a frame is received at one of the radio-modems it is simultaneously transmitted by the other radio-modem.

Advantages:

- The frame delay introduced by this type of repeater is very small. Usually the delay is only some tenths of milliseconds.
- High gain antennae (directive) can be employed, at least in the upstream modem

Disadvantages:

- Cost (2 radio-modem per repeater)
- Use of 2 radio channels: upstream channel and downstream channel
- As there is simultaneous radio reception and transmission, both radio channels must be conveniently separated to avoid RX desensibilización. If only one antenna is employed it is necessary to add a duplexer. If two antennae are employed, must be installed conveniently separated one from the other and a RF tuned notch filter or band pass filter can be necessary.

Store&Forward Repeaters:

This repeater consists of only one radio-modem that incorporates the Store&Forward function. When a Store&Forward radio-modem receives a frame stores it in internal memory. When the frame reception is finished the radio-modem analyzes it in order to detect if the frame must be re-transmitted and if yes, it retransmits the frame.

Advantages:

- Cost (1 radio-modem per repeater)
- Use of only one radio channel
- No RX de-sesibilization: No simultaneous reception and transmission
- Only one antenna
- As many repeaters as needed. Great radio path flexibility
- Any remote station can also be a repeater station

Disadvantages:

- A whole frame must be received before being retransmitted (delay)
- Usually only omnidirectional (low gain) antennae can be employed

Radio repeater stations also accept the local connection of UMF-100 modules.

3.3.2 – Mounting

Master Station

- The Master module will be connected through COM1 (RS-232) to the radio-modem and through COM2 (RS-485) to the local modules (if any). The Master module communicates simultaneously by both networks.

Remote Stations

- Stations with only one UMF module: The COM1 (RS-232) or COM2 (RS-485) ports of the module can be employed.
- Stations with more than one UMF modules: If the radio-modem has an RS-485 port, then the modules will connect through COM2 (RS-485). If the radio-modem has an RS-232 port, then the 'first' module will be connected through COM1 (RS-232) to the radio-modem and the rest of the modules will be connected through their COM2 (RS-485) to the COM2 (RS-485) of the 'first' module. In this case the 'first' module acts also as a RS-232/RS-485 converter. Any of the modules of the station can be employed as the 'first' module.

3.3.3 – Module Configuration: UMF Suite

3.3.3.1 – Master Module Configuration

- **Do a CONNECT and close the window**
- **In CONFIG / BASIC**
  1. Module Address: 1 (no other value is possible)
  2. Network Role: Master
  3. Input Analog Ranges: As needed
  4. Output Analog Ranges: As needed (we recommend to select the same range as the associated analog input)
  5. Analog Input Filter: As needed
  6. Digital Input Filter: As needed
  7. AC Frequency Filter: 50 Hz or 60 Hz, according to the mains frequency of the installation.
- **In CONFIG / COMMUNICATIONS**
  1. COM1 Baud rate: Select the same as the radio-modem radio baud rate. The baud rate of the radio-modem data port must be configured the same (Eg.: Select 4800 bps if T-MOD C48 or select 9600 bps if T-MOD 400).
  2. COM1 Character Format : 8N1
  3. COM1 EOF Chars : 3.5
  4. No Com Watch-Dog Time (Sec): This is the maximum time that the master module waits without receiving an answer from any slave module from COM1 or COM2. If this time is exceeded, the module does an auto-reset. Digital and analog outputs are reset (open contact for digital outputs and minimum range value for analog outputs). The value 0 deactivates this security function. If configured different from 0, it must be configured with a time at least 2 or 3 times the Intercycle Start Time (see Config/Master)
  5. COM2 Baud rate = 115200 bps (If needed, other lower baud rates can be selected)
  6. COM2 Character Format : 8N1
  7. COM2 EOF Chars : 3.5

- **In CONFIG / MASTER**
    1. COM1 Repeater Type: Select the type, if any (Back-to-Back or Store&Forward). If both repeater types are employed then select Store&Forward. If no repeaters are employed then the selected type is meaningless.
    2. COM2 Repeater Type: No used (the selected type is meaningless)
    3. Radio-modem Latency Time (mS): Is related to the lap time from the first character of a frame entering the data port of a transmitting radio-modem, to this same character being received by a receiving radio-modem. This is the real frame delay (RFD mS) introduced by the radio-modem and is specified by the radio-modem manufacturer or can also be measured. The Radio-modem Latency Time must be set to the RFD + 20 mS. If not known, select 100 mS or higher values (not critical). (Eg. Select 55 mS if T-MOD C48 or T-MOD 400 radio-modems are employed). This parameter is used by the master module to calculate how long it must wait for an answer from a remote module. For this calculation the master also takes into account the selected baud rate, the frame length (query and answer) and the number of radio repeaters up to the queried remote module. Only related to COM1.
    4. Max Fails to Deactivate: 3
    5. Cycles To Try Reactivate: 10
    6. Intercycle Start Time (Sec): Is the time between the start of two consecutive pooling cycles through COM1 (radio). If 0, a new cycle starts as soon as the previous one has finished. In some cases it is employed in order to reduce the power consumption of remote stations. Example: In remote stations linked by radio and powered by photovoltaic cells, the reduction of the pooling frequency can suppose a significant reduction of the station power consumption. If *Intercycle Start Time* is set different from 0, then pay attention to the setting of *Com Watch-Dog Time* parameter of the slave modules connected through radio.
    7. Close CONFIG window
- **In SEND**
    1. Select *Configuration Only* and do a SEND
    2. When finished, do a CLOSE

- **In POLLING TABLE / MASTER POLLING TABLE**
    1. Each slave module will have a different address. Each slave module must be activated marking with √ on the appropriate position in column *En*. Slave modules may have any direction in the 2 to 32 range. Address 1 is always reserved for the Master module and is always active. Modules don't need to have consecutive addresses
    2. In the column *Rep* write the number of radio repeaters between the master and the slave. 0 if there are no repeaters. Write 0 in all positions corresponding to local modules (connected to COM2 of the master).
    3. In the column *Port* select COM1 in the positions of modules linked by radio and select COM2 in the positions of local modules
    4. In the column *Asc*, open *Edit* and configure for each existing module (module 1 included) the required correspondence between outputs and inputs.
        a. A digital input (DI1 to DI5) of any of the existing modules can be assigned to every digital output (DO1 to DO5) of the module in configuration
        b. An analog input (AI1 to AI2) or internal analog measurement (Temperature or Voltage) of any of the existing modules can be assigned to every analog output (AO1 to AO2) of the module in configuration
    5. Once the configuration of all the existing modules is finished, exit with OK (or Cancel)
- **In SEND**
    1. Select *Polling Table Only* and do a SEND
    2. When finished, do a CLOSE

3.3.3.2 – Slave(s) Module(s) Configuration (radio and local)

- **Do a CONNECT and close the window**
- **In CONFIG / BASIC**
    1. Module Address: 2, 3, …,32 (module addresses mustn't be duplicated)
    2. Network Role: Slave
    3. Input Analog Ranges: As needed
    4. Output Analog Ranges: As needed (we recommend to select the same range as the associated analog input) or 0-20 mA for ones associated to internal measurements
    5. Analog Input Filter: As needed
    6. Digital Input Filter: As needed
    7. AC Frequency Filter: 50 Hz or 60 Hz, according to the mains frequency of the installation
- **In CONFIG / COMMUNICATIONS**
    1. COM1 Baud rate:
        a. **Modules in a radio remote station**: Select the same as the radio-modem radio baud rate. The baud rate of the radio-modem data port must be configured the same (Eg.: Select 4800 bps if T-MOD C48 or select 9600 bps if T-MOD 400).
        b. **Modules local to the master (direct RS-485 connected)**: Configure COM1 the same as the master COM2
    2. COM2 Baud rate:
        a. **Modules in a radio remote station**: Configure COM2 equal to the COM1 of the same module.
        b. **Modules local to the master (direct RS-485 connected)**: Configure COM2 the same as the master COM2
    3. COM1 and COM2 Character Format: 8N1
    4. COM1 and COM2 EOF Chars : 3.5
    5. Com Watch-Dog Time (Sec): This is the maximum time that a module waits between frames addressed to it. If this time is exceeded, the module does an auto-reset. Digital and analog outputs are reset (open contact for digital outputs and minimum range value for analog outputs). The value 0 deactivates this security function.
        a. For modules connected through radio an usual value can be 60. In installations where this security function must be precisely trimmed, it must be set at a value slightly higher than the calculated *Refreshing Time* (see 3.3.4). If the *Intercycle Start Time* of the master has been configured different from 0, the *Com Watch-Dog Time* must be higher than that.
        b. For modules connected by wire to the master, a usual value is 5 (can be less if there are few modules).
    6. The other parameters in this window are meaningless
- **In SEND**
    1. Select *Configuration Only* and do a SEND
    2. When finished, do a CLOSE

Once a module is configured it is recommendable to identify it for example by sticking an adhesive label with the configured address.

3.3.4 – Refreshing Time

It is the maximum time that elapses between a change on one input and the output of this change on its associated output(s). The refreshing time is the same for digital as for analog signals.

The refreshing time depends on the number of modules and the port baudrate.

- Origin of the signal (module in the radio network or in the local cable network)
- Destination of the signal (module in the radio network or in the local cable network)
- The *Radio-modem Latency Time* of the radio-modem
- The radio speed of the radio-modem
- The repeater type (if any)
- The number of radio repeaters (if any)
- *The Intercycle Start Time* configured in the master (if different from 0)

Cases:

- Network without radio repeaters

  Refreshing Time (mS) = Nmd [(380 / Br) + 2 Lt]

- Network with 1 radio repeater, Store&Forward type

  Refreshing Time (mS) = Nmd [(380 / Br) + 2 Lt] + Nmr [(760 / Br) + 4 Lt]

- Network with 1 radio repeater, Back-to-Back type

  Refreshing Time (mS) = Nmd [(380 / Br) + 2 Lt] + Nmr [(38 / Br) + 4 Lt]

  Where:

  ***Nmd** : Number of modules on the radio network, directly linked to the master*
  ***Nmr** : Number of modules on the radio network, linked to the master through radio repeater*
  ***Lt** : Latency Time of the radio-modem (mS). Is the lap time from the first character of a frame entering the data port of a transmitting radio-modem and this same character being received by a receiving radio-modem. This is the real frame delay introduced by the radio-modem. This value must be specified by the radio-modem manufacturer or can be measured. Do not confuse with Attack Time or other similar times specified by different radio-modem manufacturers.*
  ***Br** : Radio-modem data radio speed (bps). Is the real radio-modem radio speed.*

In these examples the delays caused by selected filtering over digital or analog inputs have not been taken into account.

Characteristics of some Farell Instruments narrow band radio-modem models:

Model	*Radio Baudrate (bps)*	*Latency Time (mS)*	*Store & Forward Mode Repeater*	*Back-to-Back Repeater*	*Radio Bands*
T-MOD C-48	*4800*	*22 (14)*	*√*	*√*	*UHF*
T-MOD 400	*9600*	*35*		*√*	*VHF & UHF*

3.3.5 – Security

UMF-100 modules have been designed and manufactured according to the most advanced engineering and production methods. They also satisfy the most demanding standards related to electromagnetic compatibility. Protection devices are incorporated in all signal, power and communication ports. Hardware and firmware methods have been adopted to ensure continuous, non assisted operation. Each module is individually tested and calibrated prior to shipping.

3.3.5.1 – Implemented Functions

There are some security functions implemented at the network level. Some functions are done by all the modules in the network and other specifically by the module that acts as the master.

Functions done by each module

- Just after a module is powered-up all its digital outputs are 'open' and analog outputs are at the minimum value (0 or 4 mA according to the range configured). This is the module's *'initial state'*.
- If a module misses communication during a time longer than the *No Com Watch-Dog Time,* does a self-reset and its outputs (digital and analog) go to the *'initial state'.* The *No Com Watch-Dog Time* is configurable. If configured as 0, this function is inhibited

Functions done by the master module

- A digital output of any module associated to a digital input of a module that does not communicate or has ceased to communicate (deactivated module), passes to open state

- An analog output of any module associated to an analog input or internal analog measurement of a module that does not communicate or has ceased to communicate (deactivated module), passes to minimum value (0 or 4 mA according to the range configured)

- The master module considers an slave module as a 'deactivated module' after N consecutive query frames without answer. N may be configured on the master (*Max Fails To Deactivate*)

- The master retries bi-directional communication with each 'deactivated module' each M general pulling cycles. M may be configured on the master (*Cycles To Try Reactivate*)

- The master continues to send uni-directional frames each pulling cycle to each one of the 'deactivated modules', if any. These frames contain the values associated to the outputs of these modules, in case the modules can listen to the master. No answer from the modules is requested.

3.3.5.2 – Protocol

The employed protocol is based on codified frames that include error detection based on CRC polynomial. The probability of decoding as correct a corrupted frame is extremely low.

3.3.5.3 – Digital Outputs to supervise the Communication State

Digital outputs that indicate the communication state of each module can be implemented. To do so, it is necessary to employ a digital input on every module to be monitored (supervision input). Each supervision input will be associated to a digital output that will inform about the communication state of the associated supervised module.

Example: Installation of 3 modules, H, I and J. Implementation of the communication state of the modules H , I and J from module J

- Module H: Digital input 5 hardware connected to active state (Power +)
- Module I: Digital input 5 hardware connected to active state (Power +)
- Module J: Digital input 5 hardware connected to active state (Power +)

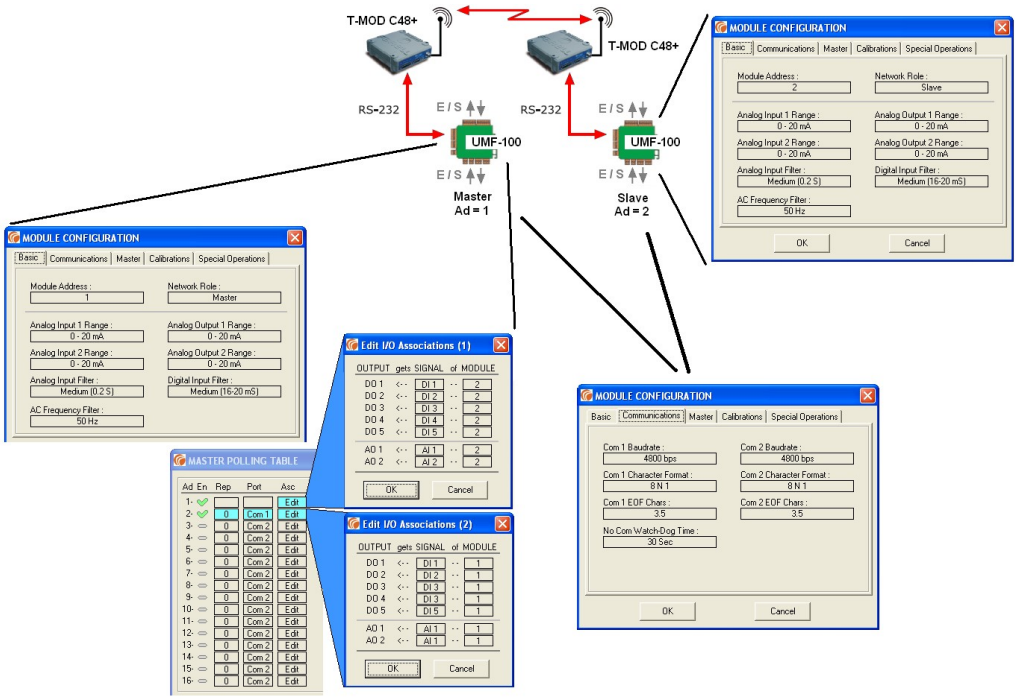
- Module J: Digital output 1 associated to digital input 5 of module H
- Module J: Digital output 2 associated to digital input 5 of module I
- Module J: Digital output 3 associated to digital input 5 of module J

Digital output states of Module J:

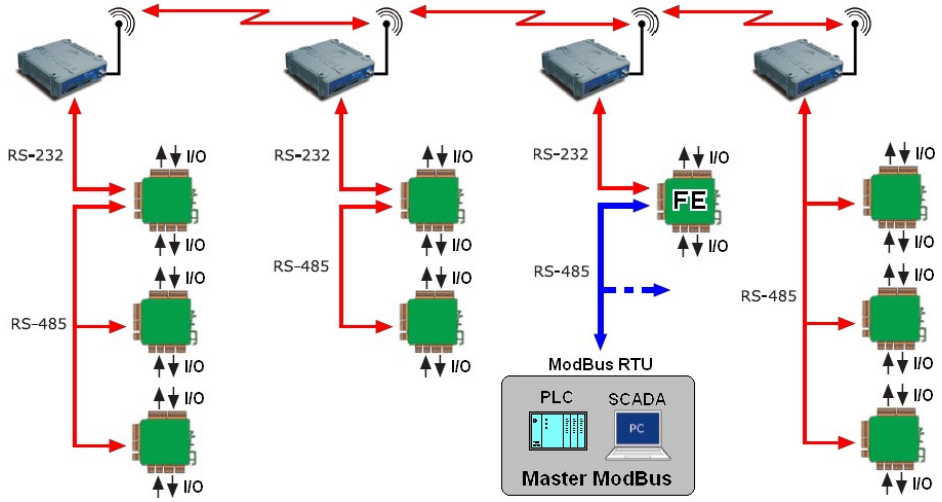
Output 3	Output 1	Output 2	Meaning
OFF	x	x	Module J do not communicates with master. Communication states of modules H and I are unknown
ON	ON	ON	Modules H , I and J communicate OK
	OFF	ON	Module H without communication. Modules I and J communicate OK
	ON	OFF	Module I without communication. Modules H and J communicate OK

The supervision of one module can be done simultaneously from as many modules as needed. It is only necessary to assign a digital output to the supervision input of the module to monitor.

3.3.6 – Example: Configuration of Autonomous Mode for one Master and one Slave



3.4 – FRONT-END MODE



In this mode a number of UMF-100 modules are linked by radio (by means of radio-modems) and communicate autonomously. One of the modules is configured as the Front End module (FE) and acts as the master of this radio network. Simultaneously the Front End module acts as a ModBus slave from a ModBus Master (PLC, SCADA, etc).

From the ModBus Master point of view the FE module is a unique 'super-module' that holds all the network I/O data. Each input, output, counter, etc. of every UMF-100 module of the network has its associated ModBus register in the FE module. The Master ModBus unit reads and writes all the network data (I/O states, internal measurements, counters,..) directly on the FE module.

The FE module continuously and autonomously updates all the I/O data to and from the remote UMF-100 modules.

The Front End mode simplifies enormously the communication tasks on the ModBus Master and allows other ModBus slaves, in addition to the FE module, to be connected on the same ModBus bus.

In the figure we can see a system composed by 3 remote stations. In one station the modules are connected by RS-485 to theuir radio-modem. In the other two, the 'first module' is connected to the radio-modem by RS-232 and the rest are connected by RS-485. In these cases the 'first module' also acts as RS-232/RS-485 converter.

3.4.1 - UMF-100 Front-End (FE) mode, ModBus RTU supported functions

03 – READ ANALOG REGISTERS (Internal or analog output)
The FE also allows to read analog input registers
04 – READ ANALOG INPUT REGISTERS
The FE also allows to read analog internal or output registers
06 – WRITE ANALOG OUTPUT REGISTER (Internal or analog output)

16 (10H) **– WRITE MULTIPLE ANALOG OUTPUT REGISTERS** (Internal or analog outputs)

3.4.2 – UMF-100 ModBus Register Map of Front-End module

ANALOG INPUTS and SPECIAL registers (ModBus functions: 03, 04) **(Allow reading)**

Module 1 (master FE)	1000 h (4096 d)	Analog input 1
	1001 h (4097 d)	Analog input 2
	1002 h (4098 d)	Internal temperature
	1003 h (4099 d)	Supply voltage
Module 2	1004 h (4100 d)	Analog input 1
	1005 h (4101 d)	Analog input 2
	1006 h (4102 d)	Internal temperature
	1007 h (4103 d)	Supply voltage
.....		
Module 32	107C h (4220 d)	Analog input 1
	107D h (4221 d)	Analog input 2
	107E h (4222 d)	Internal temperature
	107F h (4223 d)	Supply voltage

In general:

Addr. Analog Input 1 module N (1 to 32) = 4096 + 4 (N-1) (Address in decimal)
Addr. Analog Input 2 module N (1 to 32) = 4097 + 4 (N-1) (Address in decimal)
Addr. Internal Temperature module N (1 to 32) = 4098 + 4 (N-1) (Address in decimal)
Addr. Supply Voltage module N (1 to 32) = 4099 + 4 (N-1) (Address in decimal)

DIGITAL INPUT Registers (ModBus functions: 03, 04) **(Allow reading)**

Module 1 (master FE) and 2	1080 h (4224 d)	Dig. Inputs module 1 (bits 12-8); Dig. Inputs module 2 (bits 4-0)
Module 3 y 4	1081 h (4225 d)	Dig. Inputs module 3 (bits 12-8); Dig. Inputs module 4 (bits 4-0)
.....		
Module 31 y 32	108F h (4239 d)	Dig. Inputs module 31 (bits 12-8); Dig. Inputs module 32 (bits 4-0)

In general:

Addr. Digital Inputs of odd modules N (1, 3,.., 31) = 4224 + (N-1)/2 (Address in decimal)
The bits 12-8 of the read register correspond to the state of inputs 5-1 respectively

Addr. Digital Inputs of even modules N (2, 4,.., 32) = 4224 + (N-2)/2 (Address in decimal)
The bits 4-0 of the read register correspond to the state of inputs 5-1 respectively

COUNTER Registers (ModBus functions: 03, 04) **(Allow reading)**

Module 1 (master FE)	1090 h (4240d)	Counter 1, 4 high digits (BCD)
	1091 h (4241 d)	" , 4 low digits (BCD)
	1092 h (4242 d)	Counter 2, 4 high digits (BCD)
	1093 h (4243 d)	" , 4 low digits (BCD)
	1094 h (4244 d)	Counter 3, 4 high digits (BCD)
	1095 h (4245 d)	" , 4 low digits (BCD)
	1096 h (4246 d)	Counter 4, 4 high digits (BCD)
	1097 h (4247 d)	" , 4 low digits (BCD)
Module 2	1098 h (4248 d)	Counter 1, 4 high digits (BCD)
	1099 h (4249 d)	" , 4 low digits (BCD)
	109A h (4250 d)	Counter 2, 4 high digits (BCD)
	109B h (4251 d)	" , 4 low digits (BCD)
	109C h (4252 d)	Counter 3, 4 high digits (BCD)
	109D h (4253 d)	" , 4 low digits (BCD)
	109E h (4254 d)	Counter 4, 4 high digits (BCD)
	109F h (4255 d)	" , 4 low digits (BCD)
.....		
Module 32	1188 h (4488 D)	Counter 1, 4 high digits (BCD)
	1189 h (4489 D)	" , 4 low digits (BCD)
	118A h (4490 D)	Counter 2, 4 high digits (BCD)
	118B h (4491 D)	" , 4 low digits (BCD)
	118C h (4492 D)	Counter 3, 4 high digits (BCD)
	118D h (4493 D)	" , 4 low digits (BCD)
	118E h (4494 D)	Counter 4, 4 high digits (BCD)
	118F h (4495 D)	" , 4 low digits (BCD)

In general:

Addr. Counter 1 module N (1 to 32) = 4240 + 8 (N-1) (high digits) y (+1) (low digits) (Address in decimal)
Addr. Counter 2 module N (1 to 32) = 4242 + 8 (N-1) (high digits) y (+1) (low digits) (Address in decimal)
Addr. Counter 3 module N (1 to 32) = 4244 + 8 (N-1) (high digits) y (+1) (low digits) (Address in decimal)
Addr. Counter 4 module N (1 to 32) = 4246 + 8 (N-1) (high digits) y (+1) (low digits) (Address in decimal)

COMMUNICATION STATE Registers (ModBus functions: 03, 04) **(Allow reading)**

Module 2	1190 h (4496 d)	State of module 2 (bit 3)	(Address in decimal)
Module 3 and 4	1191 h (4497 d)	State of module 3 (bit 11); State of module 4 (bit 3)	(Address in decimal)
.....			
Module 31 and 32	119F h (4511 d)	State of module 31 (bit 11); State of module 32 (bit 3)	(Address in decimal)

- b3 and b11 indicate the state of the communication between a remote UMF module and the FE module:
  - '0' indicates no communication (lost)
  - '1' indicates communication
- Only the bits that correspond to existing modules have meaning (modules activated on the program of the FE module)

DIGITAL OUTPUT Registers (ModBus functions: 03, 04, 06 y 16) **(Allow reading and writting)**

Module 1 (FE) and 2	11A0 h (4512 d)	DO's module 1 (bits 12-8); DO's module 2 (bits 4-0) (Addr. in decimal)
Module 3 and 4	11A1 h (4513 d)	DO's module 3 (bits 12-8); DO's module 4 (bits 4-0) (Addr. in decimal)
.....		
Module 31 and 32	11AF h (4527 d)	DO's module 31(bits 12-8); DO's module 32(bits 4-0) (Addr. in dec.)

In general:

Addr. Digital Outputs of odd modules N (1, 3,.., 31) = 4512 + (N-1)/2 (*)
The bits 12-8 of the read or written register correspond to the state of outputs 5-1 respectively

Addr. Digital Outputs of even modules N N (2, 4,.., 32) = 4512 + (N-2)/2 (*)
The bits 4-0 of the read or written register correspond to the state of outputs 5-1 respectively

(*) Addresses in decimal

ANALOG OUTPUT Registers (ModBus functions: 03, 04, 06 y 16) **(Allow reading and writing)**

Module 1 (FE)	11B0 h (4528 d)	Analog Output 1
	10B1 h (4529 d)	Analog Output 2
Module 2	10B2 h (4530 d)	Analog Output 1
	10B3 h (4531 d)	Analog Output 2
.....		
Module 32	11EE h (4590 d)	Analog Output 1
	11EF h (4591 d)	Analog Output 2

In general:

Addr. Analog Output 1 module N (1 a 32) = 4528 + 2 x (N-1) (Addr. in decimal)
Addr. Analog Output 2 module N (1 a 32) = 4529 + 2 x (N-1) (Addr. in decimal)

Value interpretation and Register ranges

- *Bit values corresponding to digital inputs:*
  Bit value = '0' indicates non activated input
  Bit value = '1' indicates activated input
- *Bit values corresponding to digital outputs:*
  Bit value = '0' indicates non activated output (open contact)
  Bit value = '1' indicates activated output (closed contact)
- *Register values corresponding to analog inputs:*
  0-10 V range : Value = 0 for input = 0 V ; Value= 7FFFh (32767) for input = 10V
  0-20 mA range : Value = 0 for input = 0 mA ; Value = 7FFFh (32767) for input = 20 mA
  4-20 mA range: : Value = 0 for input = 4 mA ; Value = 7FFFh (32767) for input = 20 mA
- *Register values corresponding to internal analog measurements (temperature and supply voltage):*
  Temperature: Temp. (°C) = (Register Value / 252) – 30
  Supply Voltage : Vsupply (V) = 30 (Register Value / 32767)
- *Register values corresponding to analog outputs:*
  Range 0-20 mA : Value = 0 for output = 0 mA ; Value = 7FFFh (32767) for output = 20 mA
  Range 4-20 mA : Valor = 0 for output = 4 mA ; Value = 7FFFh (32767) for output = 20 mA

- *To assure the integrity of a counter, the two registers of the counter must be read o written in a unique frame.*
- ***A module does not answer frames that try to read or write nonexistent registers.***

3.4.3 – Radio-Modem characteristics

- Must be adequate to the distance to cover
  - TX transmitting power
  - RX sensibility
  - Working RF band
- Must incorporate a serial port (RS-232 or RS-485) and must operate without the need of control signals (data activated)
- Must be transparent to the data protocol
- Half-duplex

If radio repeaters are needed, two different types are supported:

Back-to-Back repeaters:

This repeater consists of two standard radio modems connected through the serial port. Each one operates at a different radio frequency. When a frame is received at one of the radio-modems it is simultaneously transmitted by the other radio-modem.

Advantages:

- The frame delay introduced by this type of repeater is very small. Usually the delay is only some tenths of milliseconds.
- High gain antennae (directive) can be employed, at least in the upstream modem

Disadvantages:

- Cost (2 radio-modem per repeater)
- Use of 2 radio channels: upstream channel and downstream channel
- As there is simultaneous radio reception and transmission the two radio channels must be conveniently separated to avoid RX desensibilización. If only one antenna is employed it is necessary to add a duplexer. If two antennae are employed, must be installed conveniently separated one from the other and a RF tuned notch filter or band pass filter can be necessary.

Store&Forward Repeaters:

This repeater consists of only one radio-modem that incorporates the Store&Forward function. When a Store&Forward radio-modem receives a frame stores it in internal memory. When the frame reception is finished the radio-modem analyzes it in order to detect if the frame must be re-transmitted and if yes, retransmits the frame.

Advantages:

- Cost (1 radio-modem per repeater)
- Use of only one radio channel
- No RX de-sesibilization: No simultaneous reception and transmission
- Only one antenna
- As many repeaters as needed. Great radio path flexibility
- Any remote station can also be a repeater station

Disadvantages:

- A whole frame must be received before being retransmitted (delay)
- Usually only omnidirectional (low gain) antennae can be employed

Both repeater types do accept the local connection of UMF-100 modules.

3.4.4 – Mounting

The module configured as Front-End (FE) connects to the radio-modem through COM1 (RS-232) and to the ModBus RTU master through COM2 (RS-485). If necessary RS-232/RS-485 converters can be employed.

3.4.5 – Module Configuration: UMF Suite

3.4.5.1 – Front-End (FE) Module Configuration

- **Do a CONNECT and close the window**
- **In CONFIG / BASIC**
    1. Module Address: 1 (The FE module address must always be 1)
    2. Network Role: Front-End
    3. Input Analog Ranges: As needed
    4. Output Analog Ranges: As needed (we recommend to select the same range as the associated analog input)
    5. Analog Input Filter: As needed
    6. Digital Input Filter: As needed
    7. AC Frequency Filter: 50 Hz or 60 Hz, according to the mains frequency of the installation.
- **In CONFIG / COMMUNICATIONS**
    8. COM1 Baud rate: Select the same as the radio-modem radio baud rate. The baud rate of the radio-modem data port must be configured the same (Eg.: Select 4800 bps if T-MOD C48 or select 9600 bps if T-MOD 400).
    1. COM1 Character Format : 8N1
    2. COM1 EOF Chars : 3.5
    3. No Com Watch-Dog Time (Sec): This is the maximum time that the FE module waits without receiving a ModBus frame addressed to it from the ModBus Master (COM2) and without receiving an answer from any slave module (COM1). If this time is exceeded (on COM1 and on COM2), the module does an auto-reset. Digital and analog outputs are reset (open contact for digital outputs and minimum range value for analog outputs). Counters are not modified. The value 0 deactivates this security function. If configured different from 0, it must be configured with a time at least 2 or 3 times the Intercycle Start Time (see Config/Master)
    4. COM2 Baud rate: The same as the Master ModBus RTU
    5. COM2 Character Format : The same as the Master ModBus RTU
    6. COM2 EOF Chars : 3.5
- **In CONFIG / MASTER**
    1. COM1 Repeater Type: Select the type, if any (Back-to-Back or Store&Forward). If booths repeater types are employed the select Store&Forward. If no repeaters are employed then the selected type is meaningless.
    2. COM2 Repeater Type: No used (the selected type is meaningless)
    3. Radio-modem Latency Time (mS): Is related to the lap time from the first character of a frame entering the data port of a transmitting radio-modem, to this same character being received by a receiving radio-modem. This is the real frame delay (RFD mS) introduced by the radio-modem and is specified or can be measured. The Radio-modem Latency Time must be set to the RFD + 20 mS. If not known, select 100 mS or higher values (not critical). (Eg. Select 55 mS if T-MOD C48 or T-MOD 400 radio-modems are employed). This parameter is used by the FE module to calculate how long it must wait for an answer from a remote module. Only related to COM1.
    4. Max Fails to Deactivate: 3
    5. Cycles To Try Reactivate: 10
    6. Intercycle Start Time (Sec): Is the time between the start of two consecutive pooling cycles through COM1 (radio). If 0, a new cycle starts as soon as the previous one has finished. In some cases it is employed in order to reduce the power consumption of remote stations. Example: In remote stations linked by radio and powered by photovoltaic cells, the reduction of the pooling frequency can provide important reductions on the power consumed. If *Intercycle Start Time* is set different from 0, then pay attention to the setting of *Com Watch-Dog Time* parameter of the slave modules connected through radio.
    7. Close CONFIG window

- **In POLLING TABLE / MASTER POLLING TABLE**
    1. Each slave module must have a different address and must be activated marking √ on the appropriate position in column *En*. Addresses are in the range 2 to 32. Address 1 is always reserved for the FE module and is always active. Modules don't need to have consecutive addresses.
    2. In the column *Rep* write the number of radio repeaters (if any) between the master and each slave. 0 means no repeater.
    3. In the column *Port* select COM1 in the positions corresponding to the slaves
    4. The other parameters in this window are meaningless
    5. Once the configuration of all the existing modules is finished, exit with OK (or Cancel)
- **In SEND**
    1. Select *Configuration and Polling Table* and do a SEND
    2. When finished, do a CLOSE

3.4.5.2 – Slave Modules Configuration

- **Do a CONNECT and close window**
- **In CONFIG / BASIC**
    1. Module Address: 2 to 32 (module addresses can't be duplicated)
    2. Network Role: Slave
    3. Input Analog Ranges: As needed
    4. Output Analog Ranges: As needed
    5. Analog Input Filter: As needed
    6. Digital Input Filter: As needed
    7. AC Frequency Filter: 50 Hz or 60 Hz, according to the mains frequency of the installation
- **In CONFIG / COMMUNICATIONS**
    1. COM1 Baud rate: Configure the same as the COM1 of the FE module
    2. COM2 Baud rate: Configure the same as the COM1 of the FE module
    3. COM1 and COM2 Character Format : 8N1
    4. COM1 and COM2 EOF Chars : 3.5
        a. Com Watch-Dog Time (Sec): This is the maximum time that a module waits between frames addressed to it. If this time is exceeded, the module does an auto-reset. Digital and analog outputs are reset (open contact for digital outputs and minimum range value for analog outputs). Counters are not modified. The value 0 deactivates this security function. An usual value can be 60. In installations where this security function must be precisely trimmed, it must be set at a value slightly higher than the *Refreshing Time* (see 3.4.6). If the *Intercycle Start Time* of the FE module has been configured different from 0, then the *Com Watch-Dog Time* must be higher than it (2 or 3 times at least).
        b. The other parameters in this window are meaningless
- **In SEND**
    1. Select *Configuration Only* and do a SEND
    2. When finished, do a CLOSE

Once a module is configured it is recommendable to identify it for example by sticking an adhesive label with the configured address.

3.4.6 – Refreshing Time

It is the maximum time that elapses between a change in an input of a remote module and this change is updated on the corresponding FE register. It is also the maximum time that elapses between a writing on a FE register and this change been updated on the corresponding output of the associated module. The refreshing time is the same for digital and for analog signals.

The refreshing time depends mainly on the radio link:

- The *Radio-modem Latency Time* of the radio-modem
- The data speed of the radio-modem
- The number and type of the radio-modem repeaters
- *The Intercycle Start Time* configured in the FE (if different from 0)

Examples:

- Network without radio repeaters

  Refreshing Time (mS) = Nmd [(380 / Br) + 2 Lt]

- Network with 1 radio repeater, Store&Forward type

  Refreshing Time (mS) = Nmd [(580 / Br) + 2 Lt] + Nmr [(1140 / Br) + 4 Lt]

- Network with 1 radio repeater, Back-to-Back type

  Refreshing Time (mS) = Nmd [(580 / Br) + 2 L)] + Nmr [(600 / Br) + 4 Lt]

Where:

***Nmd** : Number of modules on the radio network, directly linked to the FE*
***Nmr** : Number of modules on the radio network, linked to the master through radio repeater*
***Lt** : Latency Time of the radio-modem (mS). Is the lap time from the first character of a frame entering the data port of a transmitting radio-modem and this same character being received by a receiving radio-modem. This is the real frame delay introduced by the radio-modem. This value must be specified by the radio-modem manufacturer or can be measured. Do not confuse with Attack Time or other similar times specified by different radio-modem manufacturers.*
***Br** : Radio-modem data radio speed (bps). Is the real radio-modem radio speed.*

In these examples the delays caused by selected filtering over digital or analog inputs have not been taken into account.

Characteristics of some Farell Instruments narrow band radio-modem models:

Model	*Radio Baudrate (bps)*	*Latency Time (mS)*	*Store & Forward Mode Repeater*	*Back-to-Back Repeater*	*Radio Bands*
T-MOD C-48	*4800*	*22 (14)*	*√*	*√*	*VHF & UHF*
T-MOD 400	*9600*	*35*		*√*	*VHF & UHF*

3.4.7 – Security

UMF-100 modules have been designed and manufactured according to the most advanced engineering and production methods. They also satisfy the most demanding standards related to electromagnetic compatibility. Protection devices are incorporated in all signal, power and communication ports. Hardware and firmware methods have been adopted to ensure continuous, non assisted operation. Each module is individually tested and calibrated prior to shipping.

3.4.7.1 - Implemented Functions

Functions done by each module

- Just after a module is powered-up all its digital outputs are 'open' and analog outputs are at the minimum value (0 or 4 mA according to the range configured). This is the module's *'initial state'*.
- If a module misses communication during a time longer than the *No Com Watch-Dog Time,* does a self-reset and its outputs (digital and analog) go to the *'initial state'.* The *No Com Watch-Dog Time* is configurable. If configured as 0, this function is inhibited

Functions done by the FE module

- After being powered-up, the FE module initializes all the internal registers corresponding to digital and analog outputs and inputs of the remote modules to the value '0000h'.
- Depending on the state of its digital input 5, the FE module starts or stops the autonomous radio communication with slaves. If digital input 5 is hardwired with a FE digital output, the start/stop of the autonomous radio communication with slaves can be controlled by the Master ModBus. This allows the ModBus master, after a power-up of the system, to first write the wanted states of the slave outputs to the FE prior the starting of the radio communications. This function can also be used to momentarily halt FE radio communications during ModBus master maintenance, etc. The slave modules will hold the last received output states during a maximum time equal to their configured *Com Watch-Dog Time* (or indefinitely if *Com Watch-Dog Time* = 0) . If this function is not required, digital input 5 of the FE module can be activated cabling it to +Power of the module.
- The FE module considers an slave module as a 'deactivated module' after N consecutive query frames without answer. N may be configured on the master (*Max Fails To Deactivate*)
- The FE retries bi-directional communication with each 'deactivated module' each M general pulling cycles. M may be configured on the master (*Cycles To Try Reactivate*)
- The FE continues to send uni-directional frames each pulling cycle to every 'deactivated module', if any. These frames contain the values associated to the outputs of this modules, in case the modules can listen to the master. No answer from the modules is requested.

3.4.7.2 - Protocol

The protocol between the FE module and the ModBus master is standard ModBus RTU.

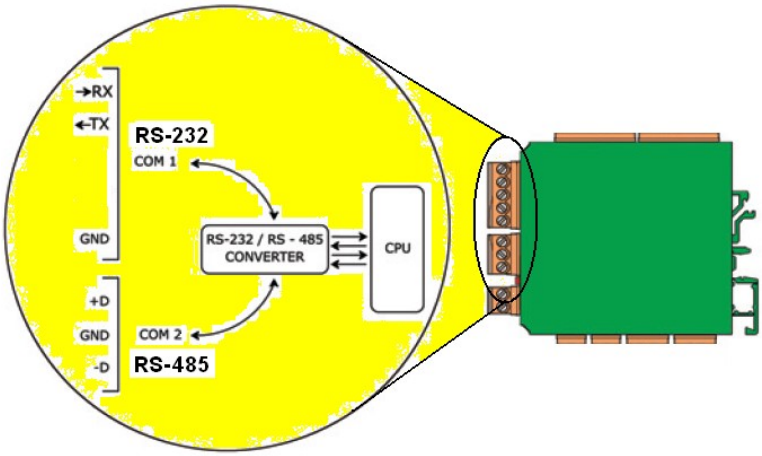
The protocol employed by the FE module to communicate with the remote modules is specifically adapted to radio communication and is very efficient (to maximize speed). It is based on encrypted and codified frames and includes error detection based on cyclic redundancy codes (CRC). In case of a parasitic noise or interference the probability of a frame being misinterpreted is near zero.

3.4.7.3 – Start/Stop/Halt of Radio Communications

Depending on the state of digital input 5, the FE module starts or stops the autonomous radio communication with slaves. If digital input 5 is hardwired with a FE digital output, the start/stop of the autonomous radio communication can be controlled by the Master ModBus. This allows the ModBus master, after a power-up of the system, to first write the wanted states of the slave outputs to the FE prior the starting of the radio communications. This function can also be used to momentarily halt FE radio communications during ModBus master maintenance, etc. The slave modules will hold the last received output states during a maximum time equal to their configured *Com Watch-Dog Time* (or indefinitely if *Com Watch-Dog Time* = 0) . If this function is not required, digital input 5 of the FE module can be activated cabling it to (*Power+*) terminal of the module.

The digital input 5 can also be software controlled if cabled to one of the outputs of the FE module.

3.5 – RS-232/RS-485 CONVERTER MODE



In this mode a UMF-100 is exclusively employed as **intelligent RS-232 / RS-485 converter** (no need of control signals), **for any** type of character orientated **protocol**.

COM1 is the RS-232 port and COM2 is the RS-485 one.

Data baudrate can be configured between 1200 bps and 115200 bps. Also character format can be configured: 8N1, 8E1, 8O1, 8M1

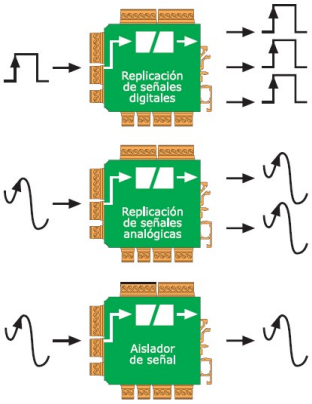
The data direction TX/RX of the RS-485 port is automatically detected by the module. The TX mode of the RS-485 port is activated each time a new character is received on the RS-232 side, and is deactivated (RX mode) as soon as the character has been sent. Many protocols (including ModBus RTU) have been tested and no incompatibilities have been found .

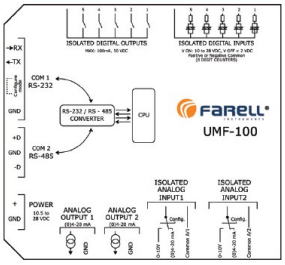
3.5.1 – Module Configuration

- **Do a CONNECT and close window**
- **In CONFIG / BASIC**
    1. Network Role: Slave
    2. AC Frequency Filter: 50 Hz or 60 Hz, according to the mains frequency of the installation.
    3. The other parameters in this window are meaningless
- **In CONFIG / COMMUNICATIONS**
    1. COM1 Baudrate = COM2 Baudrate: The required
    2. COM1 Character Format = COM2 Character Format: The required
    3. No Com Watch-Dog Time: 0 (inhibited function)
    4. The other parameters in this window are meaningless
    5. Close the CONFIG window
- **In SEND**
    1. Select *Configuration Only* and do a SEND
    2. When finished, do a CLOSE

3.6 –SIGNAL FILTERING-ISOLATING-DUPLICATING MODE

In this mode a UMF-100 is employed exclusively to isolate and/or filter and/or duplicate digital or analog signals.





3.6.1 – Digital Signals

A digital input is associated to one or more digital outputs on the same module.

- **Filtering**
  The module can filter the input signal, so the outputs will correspond to the filtered input.

- **Isolation**
  As digital inputs and digital outputs are isolated, the corresponding outputs will be isolated from the inputs (and from the rest of the module).

- **Replication**
  One input can be associated to many outputs. Each output will replicate the same associated input.

3.6.2 – Analog Signals

An analog input is associated to one or more analog outputs on the same module.

- **Filtering**
  The module can filter the input signal, so the outputs will correspond to the filtered input
- **Isolation**
  As analog inputs are isolated, the corresponding outputs will be isolated from the inputs (but not from the power supply of the module).
- **Replication**
  One input can be associated to two outputs. Each output will replicate the same associated input.
- **Type or Range Conversion**
  An input signal of type V can be converted to type mA:
  From 0-10 V to 0-20 mA or to 4-20 mA
  An input signal of type mA can be range converted:
  From 0-20 mA to 4-20 mA or from 4-20 mA to 0-20 mA

3.6.3 – Module Configuration

- **Do a CONNECT and close window**
- **In CONFIG / BASIC**
    1. Module Address: 1
    2. Network Role: Master
    3. Analog Input Ranges: As needed
    4. Analog Output Ranges: As needed
    5. Analog Input Filter: As needed
    6. Digital Input Filter: As needed
    7. AC Frequency Filter: 50 Hz or 60 Hz, according to the mains frequency of the installation.
- **In CONFIG / COMMUNICATIONS**
    1. No Com Watch-Dog Time: 0 (the function is inhibited)
    2. The other parameters in this window are meaningless
- **In CONFIG / MASTER**
    1. Max Fails to Deactivate: 3
    2. Cycles To Try Reactivate: 10
    3. The other parameters in this window are meaningless
    4. Close CONFIG window
- **In POLLING TABLE / MASTER POLLING TABLE**
    1. Activate only the position of module 1 on the En column (by default)
    2. In the column Asc, open *Edit* and configure for the module 1 the appropriate association between inputs and outputs.
    3. When finished, do OK (or Cancel)
- **In SEND**
    1. Select *Configuration and Polling Table* and do a SEND
    2. When finished, do OK (or Cancel)

4 – UMF Suite

The UMF Suite can be downloadable from Farell Instruments WEB www.farell-i.com. Runs on Windows and allows:

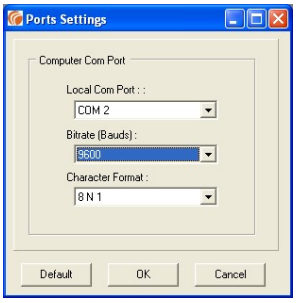
- UMF-100 module configuration
- UMF-100 module test:
  - Reading digital and analog inputs
  - Reading counters
  - Reading internal analog measurements (temperature and supply voltage)
  - Forcing digital and analog outputs.
- Recalibrate analog inputs and outputs, if necessary (*UMF-Suite Plus option*)
- Store and retrieve module configuration files (*UMF-Suite Plus option*)
- Firmware upgrading of the module (through COM1) (*UMF-Suite Plus option*)

The communication between the UMF Suite and a module employs a serial port on the PC and the module's COM1 and a configuration cable. The configuration cable can be supplied by Farell or can be made by the installer.

The detailed description of the operations needed to configure a module in every possible operating mode can be found on the previous chapters.

4.1 – CONFIGURATION WINDOWS

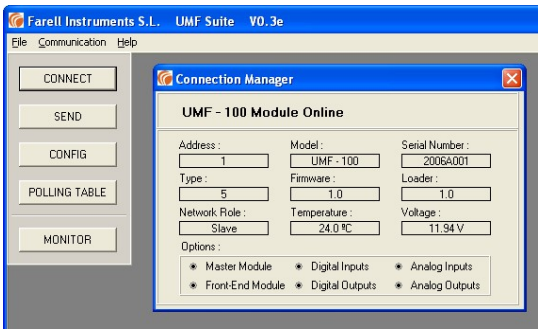
Once the application is running it is necessary to configure the PC communication parameters: In *Communication*



Select the PC port in *Local Com Port* and select *Bitrate* = 9600 bps and *Character Format* = 8N1. Exit with *OK*

Next connect the module to the PC and power-up the module.

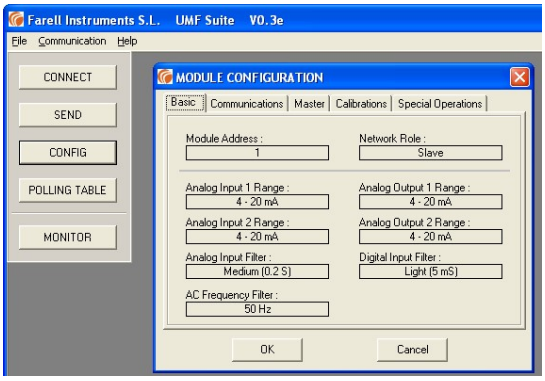
Do a *Connect*. The UMF Suite will identify the module and will open the identification window:



The suite recalls all the module's current configuration and displays some of the main parameters. The module's temperature and supply voltage are also displayed.

Close the window

Select *CONFIG* to open the *Module Configuration* window.

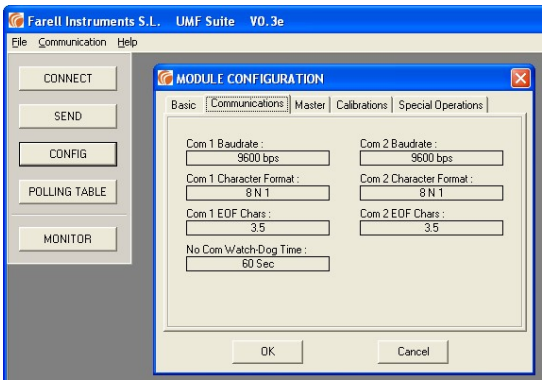


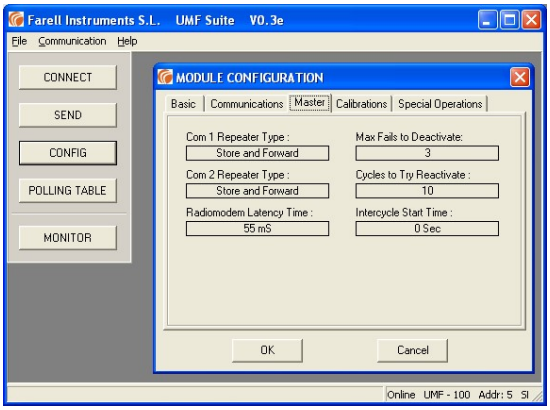
Module Configuration: *Basic*

Module Address: 1 to 32 for Autonomous or Front-End modes and 1 to 255 for other modes
Network Role : Slave, Autonomous Master or Front-End
Analog Input Range: 0-10V; 0-20 mA; 4-20 mA
Analog InputFilter: None, Light, Medium, Strong
Analog Output Range: 0-20 mA; 4-20 mA
Digital input filter: Light; Medium
AC Frequency Filter: 50 Hz; 60 Hz

Module Configuration: *Communications*

Comx Baudrate: (bps): 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
Comx Character Format: Parity: N=none; E=even ; O=odd; M=mark
Comx EOF Chars: (0.5 to 127.5 chars) Silence time corresponding to N characters to detect End Of Frame.
No Com Watch-Dog Time: (0 to 255 Sec) Max time without communication (in any of the ports) before self reset. The value 0 inhibits this function.





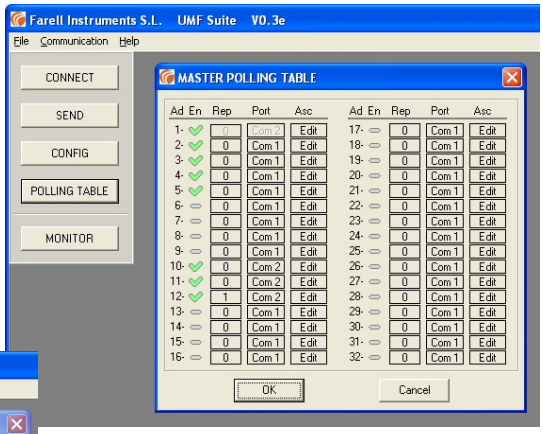
Module Configuration: *Master*

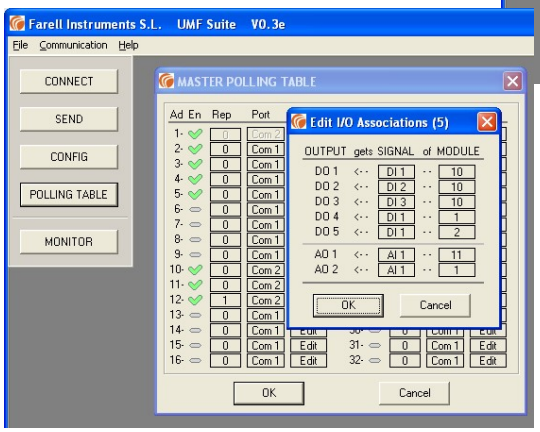
Com1 repeater Type: Type of radio-modem repeaters installed on the radio network (if any): Store&Forward or Back-to-Back
Com2 repeater Type: Not applicable
Radio modem Latency Time: (0 to 255 mS) Frame delay introduced by one radio-modem link. Corresponds to the time that elapses between a character of a frame entering the COM port of a transmitting radio-modem and this same character exiting the COM port of a receiving radio-modem. This is the delay introduced by the radio-modem.
Max Fails to Deactivate: (1 to 7) Max number of consecutive unsuccessful tries to communicate with a slave UMF module. If elapsed, the master signals the slave as 'deactivated module'. The master continues at each pulling cycle sending uni-directional frames to every 'deactivated module', if any. These frames contain the values associated to the outputs of these modules, in case the modules can still listen to the master. No answer from the modules is requested.
Cycles to Try Reactivate: (1 to 15) The master retries bi-directional communication with each 'deactivated module' each *Cycles_to_Try_Reactivate* pulling cycles.
Intercycle Start Time: (0 to 255 Sec): Is the time between the starting of two consecutive pooling cycles on COM1. If 0, a new cycle starts as soon as the previous one has finished. A typical application of this parameter is to reduce the power consumption of remote stations. COM2 pooling (if applicable) is always continuous.

Once the configuration is finished, exit with OK. To send the new configuration to the module it is necessary to do a SEND.

POLLING TABLE: Master Autonomous; Master Front-End; Signal Filter-Isolation-Duplication

The ***Ad column*** identifies by its address the 32 modules allowed in Autonomous or Front-End modes.
En column: To select the installed modules on a Autonomous or Front-End modes
Rep column: (0 to 7) To indicate how many radio-modem repeaters exist between the Autonomous or Front-End master and the module. Only applies if module communicates with COM1 of the master (Com1 selected on Port column).Value 0 if the communication is direct (no radio repeaters).
Port column: To select through which master port the module communicates.
Asc column: To edit to which inputs are associated the outputs of the module.



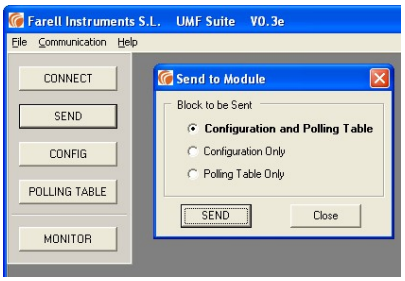


Click ***Edit*** to open the configuring window. For each digital output select the digital input to which it is associated (number of digital input and address of the module). The same for analog outputs.

Once the Polling Table is filled, exit with OK.

To transfer the new Polling Table to the module it is necessary to do a Send.

Do a SEND to open the *Send to Module* window. This window permits to send and store a new Configuration or new Polling Table to a module.



Chose ***Configuration Only*** to send and store a new Configuration.
Chose ***Polling Table Only*** to send and store a new Polling Table.
Chose ***Configuration and Polling Table*** to send and store a new Configuration and new a Polling Table.

Sending a Polling Table to a module configured as slave (*Network Role = Slave*), does not affect its behavior as slave.

Do a SEND and wait until the message ' *Send Operation Completed* ' appears. Do a ***Close***

The module stores the new Configuration and/or Polling Table on flash type memory.

Once a module is configured it is recommendable to identify it for example by sticking an adhesive label containing the configured module address.

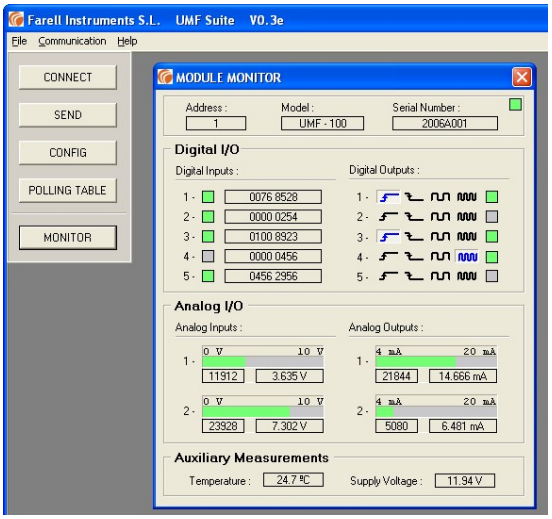
4.2 – MONITOR TEST FUNCTION

This function allows to test a module. The module under test must be connected to the PC with the configuring cable. Make a *CONNECT* and once the module is detected, close window. Then select *MONITOR*.

The *Module Monitor* window will open. A green dot will appear on the top-right side of the window indicating good communication with the module. If not, (a red dot appears):

- Check that the module is configured as Slave *(Network Role = Slave)*. If not, reconfigure it as slave
- Check that the bit rate and character format of the module's COM1 coincide with the ones configured on the PC COM port *(Communication / Port Settings / Bitrate)*.

To achieve maximum refreshing speed of the Module Monitor window choose 115200 bps on COM1 module's port and PC COM port.



Module Monitor window

Digital Inputs: Digital input states. Green indicates activated input .
Counters: Shows counter values. Each counter increments one unit each activation of the corresponding input. Counter values can be modified clicking over it with the right button of the mouse.
Period meter registers: Not displayed
Digital Outputs: Allow to activate, deactivate, slow pulse activate and fast pulse activate, each output. Output state is indicated by color: green indicates activated output (closed contact).
Analog Inputs: Shows:

- The type and range
- Input value displayed on analog bar
- Input in direct numeric value (0 to 32767 decimal) and in real magnitude (V or mA).

Analog Outputs: Shows the configured range and allows to write to outputs. Output values can be written directly clicking the right mouse button over: The display of the numeric value and writing a new one (0 a 32767), the display of the real magnitude (mA) or directly over the analog bar.

Temperature: Internal module's temperature (°C)
Supply Voltage: Supply voltage of the module (V).

Alarms: In case of alarm (fast blinking LED), a red dot appears indicating the cause: Analog input 1 out of range, Analog input 2 out of range, Temperature near or out of limits and Supply voltage out of limits.

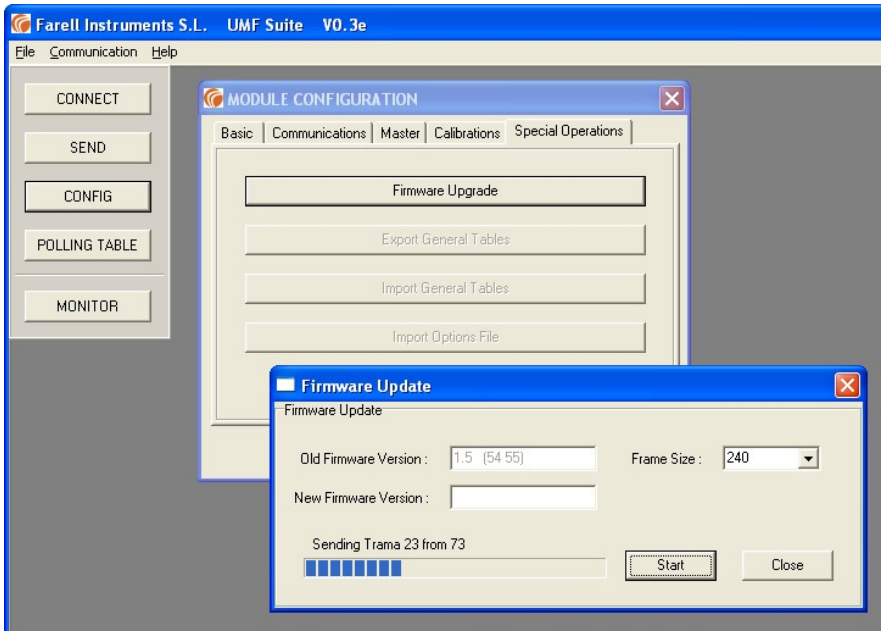
Close window to exit.

Restore the module communication parameters (*Network Role, Com1 Baudrate, Com1 Character Format*) if have been modified for the MONITOR TEST function.

4.3 – FIRMWARE UPDATE

This function allows to update the module's firmware. Act the same way as if you where configuring the module. In ***CONFIG*** select ***Special Operations*** and then ***Firmware Upgrade***. A window will open to allow selecting the new firmware file to download. The file name must be similar to '***UMF-100_COM1_V1.5_5455.hbk***'. Note that the file extension must be ***hbk***. Keep the ***Frame Size*** to 240.

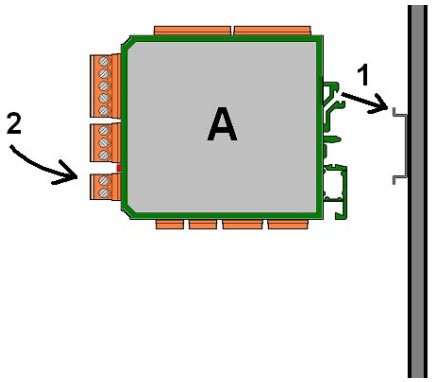
Then pulse ***Start***. A bar will open indicating the state of the transfer. When finished the indication ***UPDATE COMPLETED*** will appear. Do a ***Close*** to exit.



5 – DIN RAIL INSTALLATION

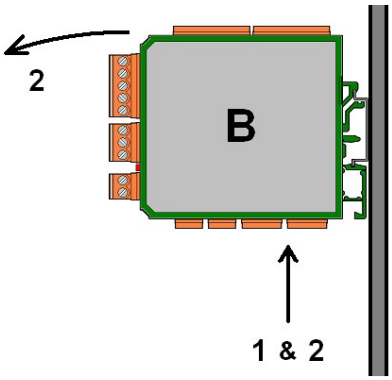
Inserting a module:

1. Place the top hanging clip on the back of the module over the top of the DIN carrier rail
2. Push the lower part of the front of the module to insert the bottom hanging clip on the back of the module into the DIN carrier rail



Removing a module:

1. Push up the module from its bottom side
2. Maintaining the push, pull out from the upper part of the front of the module to remove the top hanging clip from the DIN carrier rail



6 – TECHNICAL SPECIFICATIONS

5 DIGITAL INPUTS, GROUP ISOLATED (5 DI)

Type	Voltage operated. Positive or negative common
Input state	OFF: Input voltage < 2 Vdc ON: Input voltage from 9.0 Vdc to 28 Vdc
Input current	Input voltage related: 1.5 mA at 12 Vdc and 3 mA at 24 Vdc
Filtering	Selectable. 3 modes: *Light*, medium 50 Hz and *Medium* 60 Hz
Minimum state length	5 mS (light); 20 mS (medium 50 Hz); 16.6 mS (medium 60 Hz)
Transient protection	By fast diodes
Isolation	Group isolated (3750V)

5 COUNTERS & PERIODMETERS (5 CPI)

Counters/Operations

Type	8 digits. Each counter is associated to a digital input
Increment	One unit each OFF/ON transition of the related input
Range	From 0 to 99999999 and rollover to 0
Max frequency	100 pulses/S (light); 25 p/S (medium 50 Hz); 30 p/S (medium 60 Hz)

Flow Rate or Power

Type	Measures flow rate or power. Simultaneous with counting function
Measurements	Are made at OFF/ON transitions of digital inputs (pulses)
Measurement range	
Old Mode:	Continuous from 100 pulses/Sec to 1 pulse every 22 minutes
New Mode (V>=3.0):	Continuous from 9.1 pulses/Sec to 1 pulse every 10 minutes
Accuracy	Better than 0.8 % of the measured period in the worst case (fastest pulses)

Operating time (V>=3.0)

Type	Accumulated time of an active input (minutes). 8 digits. (Internal resolution: ¼ sec)

- *All counter registers (Counter/Operations and Operating time) will be saved on a power outage and automatically restored. Saving operation is no battery based.*

5 DIGITAL OUTPUTS, GROUP ISOLATED (5 DO)

Type	N.O. type contact. Static relay (no bouncing)
Max operating voltage	50 Vdc or 35 Vac
Max continuous current	150 mA
Peak current (10 mS)	300 mA
Internal contact resistance	8 Ω max when closed
Max leakage current	1 μA (open contact)
Transient protection	By fast diodes
Isolation	Group isolated (1500V)

2 ANALOG INPUTS, INDIVIDUALLY ISOLATED (2 AI)

Type and range	0-20 mA ; 4-20 mA; 0-10 V. Independent terminals for each input range mA and V
Resolution	≥ 12 bits (depending on selected input filter)
Accuracy (25 °C)	± 0.05 % FS
Typical temperature drift	± 0.003 % FS / °C
Auto-zero function	For I < 28 μA (range 0-20 mA) and for V < 14 mV (range 0-10 V)
Rejection filter	50 Hz or 60 Hz, selectable
Digital input filter	Mean value 'sliding window type'. Selectable: *None*; *Light* (83-100mS); *Medium*(166-200mS); *Strong*(660-800mS) (sliding window time, with rejection filter 50Hz-60Hz respectively)
Conversion speed	14 conv / Sec (each input)
Input impedance	28.7 Ω ± 1% (mA input) ; 51.7 KΩ ± 1% (V input)
Transient protection	By fast diodes
Isolation	Each analog input individually isolated (350V)

2 ANALOG INTERNAL MEASUREMENTS (2 AIM)

Internal module temperature	Range: - 30 °C to + 80 °C (-22 °F to +176 °F)
Supply voltage (Vsupply)	Range: 7.5 Vdc to 28Vdc

2 ANALOG OUTPUTS (2 AO)

Type and range	0-20 mA ; 4-20 mA
Resolution	12 bits
Accuracy (25 °C)	Range 4-20 mA: ± 0,05 % FS Range 0-20 mA: ± 0,05 % FS from 0.3 to 20mA ± 1,5% FS from 0.0 to 0.3 mA
Typical temperature drift	± 0.003 % FS / °C
Max load resistance	Rload max (Ω) = 50 (Vsupply – 5.5) *(ex.: 325 Ω at 12 V)*
Maximum load inductance	1 mH
Conversion speed	> 100 conv / Sec
Transient protection	By fast diodes

5 WORKING MODES

- ❑ Slave ModBus RTU
- ❑ Autonomous Signal Transfer (radio and/or cable link)
- ❑ Front-End
- ❑ RS-232/RS-485 Intelligent Converter
- ❑ Filtering / Isolation / Replication / Conversion of Digital and Analog Signals

COM1 and COM2 ports

Com1:	RS-232 type
Com2:	RS-485 type, with intelligent and automatic RX/TX control
Baud rate (bps):	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

Character format (ModBus, Autonomous and Front-End modes): 8N1, 8E1, 8O1, 8M1, 8S1, 8N2
Character format (RS-232/RS-485 converter mode): 8N1, 8E1, 8O1, 8M1, 8S1, 8N2, 7E1, 7O1, 7M1, 7S1, 7N2, 7E2, 7O2, 7M2 and 7S2

Transient protection	By fast diodes

POWER SUPPLY

Supply voltage (Vsupply)	9.0 Vdc to 28Vdc
Transient protection	By fast diodes
Reverse polarity	Protected by series diode
Typical current consumption	35 mA + 3.5 mA for each activated digital output + 20 mA for each FS analog output + 3 mA for each employed COM port

ALARMS

- ○ Supply voltage out of limits; Temperature out of limits; Analog input 1 or 2 out of range
- ○ Alarm state is signaled by fast blinking of the LED. Alarm cause can be found with UMF Suite or by reading the alarms ModBus register

PHYSICAL

Dimensions (WxHxD)	23 x 114 x 118 mm (0.9 x 4.48 x 4.65 inch)
Weight	< 100 g (0.22 lb)
Material	Polyamide PA66 (UL94V-0)
Mounting	DIN rail EN 50022

ENVIRONMENTAL

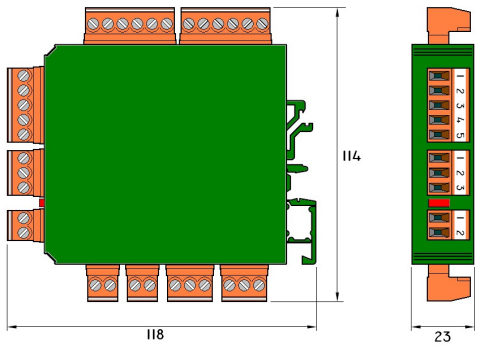
Ambient Temperature:	-30 °C to +70 °C (-22 °F to +158 °F)
Humidity:	Maximum relative humidity 90% for temperatures up to +45 °C decreasing linearly to 50% at +70 °C

CERTIFICATIONS

CE compliant
prETSI EN 301 339(97)
UNE EN 60950

OPTIONS

NV OPTION: Saves pulse counter values during power supply failures. (> 50 years). No internal battery.



All dimensions in mm