Pietro Fiorentini

Modus

Electronics

TECHNICAL MANUAL

DISCLAIMER

The Manufacturer is by no means liable for the consequences of operations not performed in compliance with this manual.

Pietro Fiorentini

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1 Features

MODUS is a type 1 gas volume converter with two conversion channels[1] with integrated data-logger. For each channel, the impulses from the volume meter, the pressure and the temperature of the gas are acquired and the compressibility factor K and the conversion coefficient C at the reference thermodynamic conditions are calculated.
If not specified as parameter MODUS calculates the heat of combustion Hs.

Communication with the **SAC** takes place via the **GPRS / GSM** network.

Data download, configuration setting and firmware update are possible both remotely and via local connection

An optical interface compliant with CEI EN 62056-21 is available for local communication with the equipment
The human-machine interface consists of a liquid crystal display and a keyboard through which it is possible to navigate through the data presentation menus.

The equipment has the following interface channels towards the field:

3 Pressure inputs (Absolute/relative) from integrated transducers
2 Temperature input from a two wires PT1000 sensor
2 Auxiliary analog inputs with 0÷5 Volt input range
10 Digital inputs
4 Digital outputs
1 RS485 Expansion line

MODUS has been designed to ensure maximum installation versatility and to be powered by a continuous 12VDC power supply via a dedicated **M-POWER** power supply, as well as a battery.

Three different versions are available: **A**, **B**, **T**.

MODUS A is equipped with a GSM/GPRS integrated modem and is battery powered.

MODUS B is not equipped with an integrated modem.
It is designed for the use of the **M-POWER** remote power supply (installed in a safe area) to which it is possible to communicate the acquired data via an RS485 serial line.

MODUS T is equipped with an integrated GSM/GPRS modem (different from the one for **MODUS A**). It is designed for the use of the **M-POWER** remote power supply (installed in a safe area) to which it is possible to communicate the acquired data via an RS485 serial line.

[1] Second conversion channel can only be viewed through the LCD user interface, and are therefore not available local data interface (optical interface, RS485) or remote (GSM / GPRS modem) communication.

1.1 Conversion coefficient

The PTZ corrector performs the acquisition of the pulses emitted by the counter meter and calculates the equivalent cubic meters base conditions according to the formula:

Symbols	Represented quantity	Measuring unit
V_b	Volume at base conditions	m^3
V_m	Volume at measurement conditions	m^3
P	Absolute pressure at measurement conditions	bar
P_b	Absolute pressure at base conditions	bar
T	Temperature at measurement conditions	K
T_b	Temperature at measurement conditions	K
Z	Compressibility factor at measurement conditions	-
Z_b	Compressibility factor at base conditions	-
C	Conversion factor	-

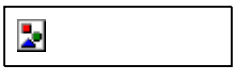
The compressibility factor takes into account the deviation of behaviour between real and ideal gas. The calculation method can be configured.
The flow-meter calculates the Z values according to the following standards:

- UNI EN ISO 12213-2 (AGA8-DC92)
- UNI EN ISO 12213-3 (SGERG88)
- AGA-NX19

The conversion factor is calculated according the formula specified into standard UNI EN ISO 12405-1.

1.2 Energy

The device calculates the energy of gas flown according the standard UNI EN 12405-2:2012.



Symbols	Represented quantity	Measuring unit
V_b	Volume at base conditions	m^3
E	Energy	J
Hs	Superior calorific value	J/m^3

If the compressibility factor configured is AGA8-DC92, the Superior Calorific Value is calculated according the standard UNI EN ISO 6976:2008, otherwise must be configured by user.

The data-logger processes the metric data according to UNI / TS 11291-3 / 4 and makes them available to the central acquisition system (**SAC**) via **GSM / GPRS**.

2 Certifications

2.1 ATEX 2014/34/UE directive

The **MODUS** series is certified according to 2014**/34 / EU (ATEX)** directive both as intrinsically safe equipment for use in applications in potentially explosive atmospheres and as associated equipment.

Certificate: **0425 ATEX 004371 X**

Marking as intrinsically safe equipment:

A version: **II 1 G Ex ia IIA T3 Ga Tamb = -25°C ÷ +60 °C**

B version: **II 1 G Ex ia IIB T3 Ga Tamb = -25°C ÷ +60 °C**

T version: **II 1 G Ex ia IIA T3 Ga Tamb = -25°C ÷ +60 °C**

Marking as associated equipment:

All versions: **II (1) G [Ex ia Ga] IIB**

Versions **MODUS A** and **MODUS T** can only be used with gas from the group IIA while the version **MODUS B** can also be used with gas from the group IIB.

EXPLOSION RISK: Installation must be carried out in compliance with the prescriptions contained in this manual

2.2 MID 2014/32/UE directive

MODUS has been approved **MID** according to EN12405-1:2005+A2:2010.

Certificate: **IT-025-21-MI002-2213**

3 Suitability of the equipment for the installation place

In the case of use in areas with danger of explosion, it must be verified that the type of equipment provided is suitable for the classification of the area and any flammable substances present.

The essential safety requirements against the risk of explosion in classified areas are established by Directive 2014/34 / EU of the European Parliament and of the Council of 26 February 2014 (as regards equipment) and 1999/92 / EC of 16 December 1999 (as regards the plants).
The criteria for the classification of areas with risk of explosion are given by the EN60079-10 standard.
The technical requirements of electrical systems in classified areas are given by the EN60079-14 standard.
The following table shows the legend of the marking for use in a hazardous area:

II 1 G	Equipment for surface systems with the presence of gas or vapours, category 1 suitable for zone 0 and with redundancy for zones 1 and 2
Ex ia	Intrinsically safe equipment, category ia
IIA	Equipment of group IIA suitable for substances (gases) of groups IIA.
IIB	(Version B only) Group IIB equipment suitable for substances (gases) of groups IIB.
T3	Equipment temperature class (maximum surface temperature)
Ga	Equipment protection level
CE	Conformity marking to applicable European directives
Ex	Marking of conformity to 2014/34 / EU directive and related technical standards
0425 ATEX 004371 X	**0425** Number of the laboratory that issued the CE certificate **ATEX** Reference directive **004371** Certificate number. **X** indicates that there are particular conditions of use which are indicated in the manual with safety instructions.
1370	Number of the Notified Body (Bureau Veritas) which carries out the surveillance of the production system.
Tamb	Ambient operating temperature of the equipment

Equipment with temperature class T3 are also suitable for substances with higher temperature class (T2, T1)
The following table shows the legend of the marking for use in a safe area as associated equipment.

II (1) G	Associated equipment of category (1), to be installed in a safe area, for surface installations.
[Ex ia Ga]	Associated equipment of category ia with EPL Ga
IIB	Equipment of group IIB suitable for substances (gases) of groups IIB.
CE	Conformity marking to applicable European directives
Ex	Marking of conformity to 2014/34 / EU directive and related technical standards
0425 ATEX 004371 X	**0425** Number of the laboratory that issued the CE certificate **ATEX** Reference directive **004371** Certificate number. **X** indicates that there are particular conditions of use which are indicated in the manual with safety instructions.
1370	Number of the Notified Body (Bureau Veritas) which carries out the surveillance of the production system.
Tamb	Ambient operating temperature of the equipment

4 Power Supply

4.1 Batteries (MODUS version A)

MODUS A can use different battery models:

BATTERY CODE	FUNCTION	BATTERY TYPE	DESCRIPTION
HP2 – BP	Modem Power supply	Lithium	Standard
LE-BP	CPU Power supply	Lithium	Standard
HP1-BP[2]	Modem Power supply	Lithium	Optional

⚠ The battery packs have been approved by the Notified Body which issued the ATEX type certificate and it is therefore absolutely mandatory to use only the model provided.

EXPLOSION RISK

⚠ Do not short circuit. Do not heat or incinerate. Do not disassemble. Do not immerse in water. Do not recharge.

⚠ Do not use the BU-BP battery pack for the M-LOG PLUS versions A and B. Use exclusively with the T version.

Exhausted batteries contain substances that are hazardous to the environment and are subject to mandatory separate collection: dispose of in accordance with the laws in force to allow for recycling. CER code 160605.

4.1.1 Replacement

⚠ Battery packs must always be replaced in the absence of an explosive atmosphere. Check the operating conditions with suitable instruments before proceeding.

⚠ La Replacing a battery pack involves removing the NON-metrological hardware seals.

⚠ It is not possible to insert two LE-BP batteries permanently

⚠ After replacing a battery, it is necessary to realign the residual autonomy indicators

To minimize the risk of data loss, two **LE - BP** batteries can be temporarily connected together on the **CPU** board. Before extracting the exhausted battery, connect the new one to the free battery connector (**BT2A or BT2B**).
To replace an **HP2 - BP** or **HP1-BP** battery, simply extract the exhausted pack and replace it with a new one.

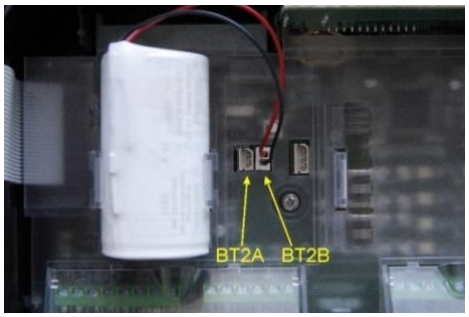


Figure 1: CPU Battery

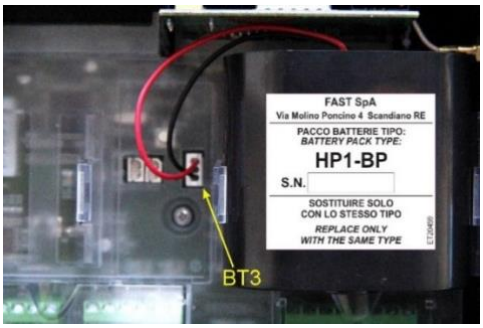


Figure 2: Modem Battery

[2] It is possible to equip the **HP1-BP** equivalent battery as an alternative to the standard **HP2-BP**.

4.2 External power supply (MODUS version T)

EXPLOSION RISK: the installation of the remote power supply must be carried out in accordance with the requirements contained in the **MT342-I M-POWER** User Manual. Never use models other than the one provided.

It is **NOT** allowed to use the external power supply and a battery pack other than **BU-BP** at the same time.

MODUS is powered by an external device, the **M-POWER**.
The remote power supply is available both for solar panel source (**PP** version) and for mains power supply with 12Vdc output (**INS** version).
Both versions are available in the version for DIN rail or wall installation.

Figure 4: M-POWER wall version

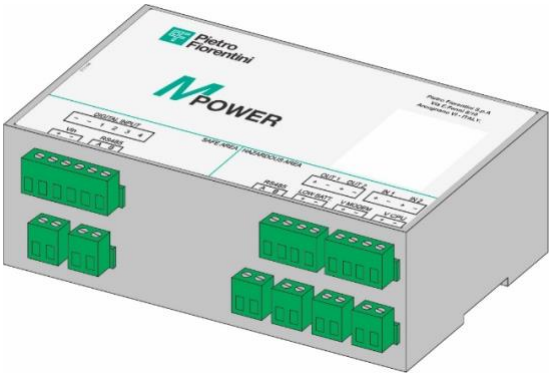


Figure 3: M-POWER DIN rail version

To ensure continuity of service in case of interruption of the primary power source, a backup battery must be considered, the capacity of which must be determined according to the requirements of the specific use case. The backup battery ensures full system functionality during a power failure.

It is possible to use as a secondary backup an optional lithium battery (BU-BP) capable of keeping only the conversion function active in case of the main battery failure
It is **NOT** allowed to simultaneously use the external power supply and a battery pack other than **BU-BP.**

The sizing of the mains power supply, the solar panel controller and the backup batteries must be carried out considering the requirements of the specific application.

5 User's Menu

Under normal operating conditions **MODUS** keeps the display off.
To access the main menu, press the **OK** button.
You can navigate in the menu using the keys ↓ ↑ . the keyallows you to access the submenus if available. The key ← allows you to return to the previous menu.

The menu can only be used to view quantities already configured in the equipment or to force predefined actions. It is not possible to edit the configurations set.

The Flowmeter menu can show in the first line one or both of the following special characters listed below

- **σ** : Metrical sealing temporary unlocked

The metrological release button was pressed. The symbol is shown as long as the display remains lit.

- **β** : Volume conversion stopped

Volume conversion is inhibited. The reasons can be different: pressure out of range, temperature out of range, wrong gas parameters etc

FLOWMETER ↵						
↓	**Vb 1**					*Volume Counter at base conditions– channel 1*
↓	**Vm 1**					*Volume Counter at measurement conditions– channel 1*
↓	**Ve 1**					*Volume Counter at measurement conditions when conversion is stopped – channel 1*
↓	**Energy 1**					*Energy counter– channel 1*
↓	**Vb2**					*Volume Counter at base conditions– channel 2*
↓	**Vm 2**					*Volume Counter at measurement conditions– channel 2*
↓	**Ve 2**					*Volume Counter at measurement conditions when conversion is stopped – channel 2*
↓	**Energy 2**					*Energy counter– channel 2*
↓	**Measures**	→	**Press. 1**			*Absolute pressure at the measurement conditions– channel 1*
		↓	**Temp. 1**			*Absolute temperature at measurement conditions– channel 1*
		↓	**Zb/Z 1**			*Gas compression factor at the measurement conditions– channel 1*
		↓	**Zb 1**			*Gas compression factor at base conditions– channel 1*
		↓	**C 1**			*Volume conversion factor– channel 1*
		↓	**Press. 2**			*Absolute pressure at the measurement conditions– channel 2*
		↓	**Temp. 2**			*Absolute temperature at measurement conditions– channel 2*
		↓	**Zb/Z 2**			*Gas compression factor at the measurement conditions– channel 2*
		↓	**Zb 2**			*Gas compression factor at base conditions– channel 2*
		↓	**C 2**			*Volume conversion factor– channel 2*
↓	**Parameters**	→	**Channel 1**	→	**Composition**	*See table 2*
		↓	**Channel 2**	→	**Composition**	*See table 2*
↓	**State**	→	**Diagn.**			*See table 3*
		↓	**Alarms**			*Display of any active alarms*
		↓	**Residual Battery**			*Percentage of residual flowmeter battery*
		↓	**Contat. Att.**			*Display of weight and pulse divider*
↓	**Sistema**	→	**S/N Conv.**			*Display of the flowmeter serial number*
		↓	**S/N Press. 1**			*Display of the serial number of the pressure transducer– channel 1*
		↓	**S/N Temp. 1**			*Display of the serial number of the temperature transducer– channel 1*

		↓	**S/N Press. 2**			*Display of the serial number of the pressure transducer– channel 2*
		↓	**S/N Temp. 2**			*Display of the serial number of the temperature transducer– channel 2*
		↓	**Vers. FW**			*Firmware version*
		↓	**Crc FW**			*Display of the flowmeter firmware CRC*
↓	**Events Buffer**	→	**In queue**	→	**Events List**	*Number and list of events with datecode*
		↓	**Abs Counter**			*Absolute Event counter*
		↓	**Reset**			*See chapter "Machine reset"*
↓	**Date & Time**	→				*Display of the current date and time*

Table 1: Flowmeter Menu

Pb	*Reference pressure*
Tb	*Reference temperature*
Tcb	*PCS combustion temperature*
Tpcs	*Reference temperature of the PCS measurement*
HS	*Higher Caloric Power*
CO2	*Current CO2 concentration*
H2	*Current H2 concentration*
N2	*Current N2 (Nitrogen) concentration*
CH4	*Current CH4 (Methane) concentration*
C2H6	*Current C2H6 (Ethane) concentration*
C3H8	*Current C3H8 (Propane) concentration*
H20	*Current H2O (water) concentration*
H2S	*Current H2S (Hydrogen sulfide) concentration*
CO	*Current CO (carbon monoxide) concentration*
O2	*Current O2 (Oxygen) concentration*
iC4	*Current Isobutan concentration*
nC4	*Current Neobutan concentration*
iC5	*Current Isopentane concentration*
nC5	*Current neopentane concentration*
nC6	*Current Neo-C6 concentration*
nC7	*Current Neo-C7 concentration*
nC8	*Current Neo-C8 concentration*
nC9	*Current Neo-C9 concentration*
nC10	*Current Neo-C10 concentration*
He	*Current helium concentration*
Ar	*Current Argon concentration*

Table 2: Gaz composition and conversion parameters

NOT CONFIGURED	Factory condition. The machine is **NOT** operational.
CALIBRATION	Non-operating machine update functions can be performed
NORMAL	Standard operating condition
MAINTENANCE	The equipment is operational but does not store data or events

Table 3: Possible states for the flowmeter section

DATALOGGER ↵				
↓ **Id (PDR)**				Redelivery point identifier
↓ **Per. Fatt.**	→ **Current**	→ **ID PT**		Rate plan identifier
		↓ **Vb**		Cubic meters counter at standard conditions
		↓ **Vb F1**		Cubic meters counter at standard conditions F1
		↓ **Vb F2**		Cubic meters counter at standard conditions F2
		↓ **Vb F3**		Cubic meters counter at standard conditions F3
		↓ **Vm**		Cubic meters counter at the measurement conditions
		↓ **Vm F1**		Cubic meters counter at the measurement conditions F1
		↓ **Vm F2**		Cubic meters counter at the measurement conditions F2
		↓ **Vm F3**		Cubic meters counter at the measurement conditions F3
		↓ **Vme**		Cubic meters counter in error
		↓ **Vme F1**		Cubic meters counter in error F1
		↓ **Vme F2**		Cubic meters counter in error F2
		↓ **Vme F3**		Cubic meters counter in error F3
	→ **Previous**	→ **ID PT**		Rate plan identifier
		↓ **Reason**		Reason for period closure - see table 6
		↓ **Vb**		Cubic meters counter at standard conditions
		↓ **Vb F1**		Cubic meters counter at standard conditions F1
		↓ **Vb F2**		Cubic meters counter at standard conditions F2
		↓ **Vb F3**		Cubic meters counter at standard conditions F3
		↓ **Vm**		Cubic meters counter at the measurement conditions
		↓ **Vm F1**		Cubic meters counter at the measurement conditions F1
		↓ **Vm F2**		Cubic meters counter at the measurement conditions F2
		↓ **Vm F3**		Cubic meters counter at the measurement conditions F3
		↓ **Vme**		Cubic meters counter in error
		↓ **Vme F1**		Cubic meters counter in error F1
		↓ **Vme F2**		Cubic meters counter in error F2
		↓ **Vme F3**		Cubic meters counter in error F3
↓ **Matr. Cont.**	→			Mechanical counter serial number
↓ **Modem**	→ **Call SAC**			Force call to the configured remote management centre
	↓ **SMS Test SAC**			Force sending test SMS
	↓ **Turn on GSM Data**			Force power on modem in GSM data mode
	↓ **Turn on GPRS**			Force modem power on in GPRS data mode
	↓ **Gprs DCE IP**			Displays the last IP assigned by the network
	↓ **GSM Field**			Displays the intensity of the GSM field
	↓ **Local echo modem**			Enable modem echo on local serial port
	↓ **Last connection**			Date and time of the last connection occurred
	Message SAC	→		
		↓ **P0**		Text message from SAC profile 0
		↓ **P1**		Text message from SAC profile 1
		↓ **P2**		Text message from SAC profile 2
		↓ **P3**		Text message from SAC profile 3
		↓ **P4**		Text message from SAC profile 4

Table 4: Datalogger menu

5.1 Diagnostic

The diagnostic information shown on the display reports the status of each diagnostic bit in hexadecimal format. Each bit equal to 1 indicates a specific anomaly.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
0 - 4				**0 - F**				**0**				**0**				**0 - 2**				**0 - 3**				**0 - F**				**0 - E**			
VISUALIZZAZIONE A DISPLAY																															

FUNCTION	BIT	FUNCTION	BIT	FUNCTION	BIT	FUNCTION	BIT
GENERAL ALARM	1	RISERVATO	9	RISERVATO	17	CONVERSION STOPPED	25
STATUS NOT NORMAL	2	RISERVATO	10	RISERVATO	18	UNALIGNED CLOCK	26
PRESSURE ERROR	3	RISERVATO	11	RISERVATO	19	EVENT QUEUE FULL	27
TEMPERATURE ERROR	4	RISERVATO	12	RISERVATO	20	TAMPER ALARM	28
ERR. Z CALCULATION	5	RISERVATO	13	RISERVATO	21	GENERIC ALARM	29
ERR. CONFIGURATION	6	RISERVATO	14	Q OUT OF RANGE	22	EVENT QUEUE 90%	30
PRESS. UNCALIBRATED	7	RISERVATO	15	PRESS. OUT OF RANGE	23	LOW BATTERY	31
TEMP. UNCALIBRATED	8	RISERVATO	16	TEMP. OUT OF RANGE	24	RESERVED	32

Table 4: Flowmeter diagnostic section

5.2 Events

N	DISPLAY	DESCRIPTION	N	DISPLAY	DESCRIPTION
1	GENERIC	Generic Event	14	PROG.DST	Changed DST Setting.
2	OUT OF LIMIT	Out Of Limit	15	EVT FULL	Event Queue Full
3	OUT OF RANGE	Out Of Range	16	CONF BILLING	Changed Billing Period
4	MOD. PARAM.	Modified CTR Object	17	START BILLING	Start New Billing Period
5	FAILURE	Generic Failure	18	CONF SW	New Firmware Downloaded
6	NO SUPPLY	No 230V	19	START SW	New Firmware Active
7	LOW BATT	Low Battery	20	REBOOT	Reboot
8	MOD. DATE	Date and Time Mod.	21	STATUS NOR.	Status Changed to NORMAL
9	CALC ERROR	Calculation Error	22	STATUS UNCO	Status Changed to UNCONFIGURED
10	RESET MEM	Factory Reset	23	STATUS MNT	Status Changed to MAINTENANCE
11	UNLOCKED SEAL	Unlocked Software Seal	24	SEAL MOD.	Password Changed
12	SYNC ERR.	Date or Time Error	25	BATT.REPL.	Battery Replaced
13	EVT RESET	Event Queue Reset			

Table 6: Events

5.3 Reasons for closing previous billing period

Code	Description
1	Changed provider
2	New contract
3	New user
4	Changer distributor
5	End of billing period
6	New billing period

Table 7: Reasons for closing billing period

5.4 Factory Reset

It is possible to restore the RTU to its original factory conditions.

1. Disconnect the LE – BP battery pack;
2. Wait for 5 seconds;
3. Holding down the keys ↓ ↑ Reconnect the battery pack; wait for the message **RESET HW** to appear on the display;
4. Wait for the RTU to restart.

6 Installation

It is NOT sufficient for a device to be intrinsically safe for it to be connected to associated equipment. It is necessary that a qualified technician or a body in charge proceed with the verification of the system and issue of suitable certification proving the compatibility between the electrical safety parameters possessed by both devices.
The essential safety requirements against the risk of explosion in classified areas are established by the European Directives 2014/34 / EU of 26 February 2014 (for equipment) and 1999/92 / EC of 16 December 1999 (for plants).
The criteria for the classification of areas with risk of explosion are given by the EN60079-10 standard.
The technical requirements of electrical systems in classified areas are given by the EN60079-14 standard.

6.1 MODUS clamps

The replacement of the pressure or temperature transducer is not allowed.

Opening the lid removes the metric seals.

Refer to chapter 8 for the characteristic parameters of intrinsically safe circuits.

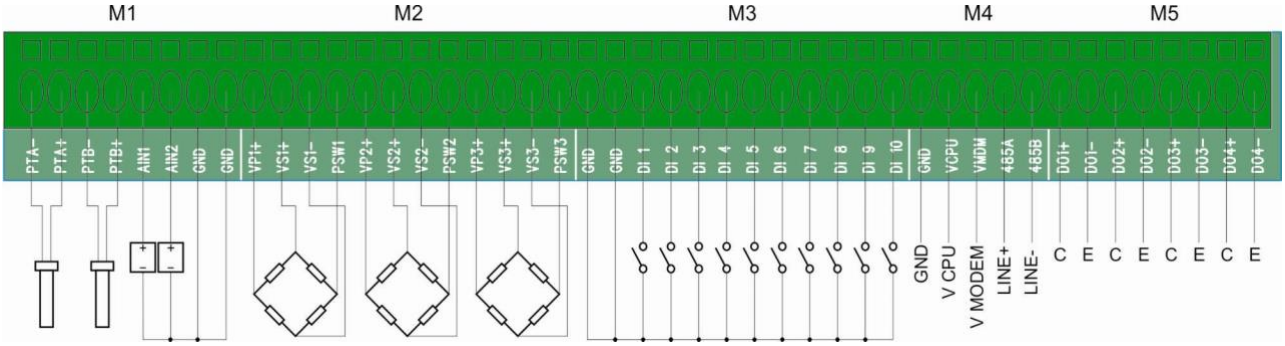


Figure 5: MODUS clamps

Auxiliary inputs AIN1, AIN2 accept analog signals from galvanically isolated instruments. Refer to Chapter 8 for safety parameters for electrical coordination.
The digital inputs from number 1 to number 8 provide for the application of a voltage-free signal, inputs DI9 and DI10 can also accept a voltage signal.
The RS485 expansion line can be used for connection to a galvanically isolated equipment.
The digital outputs provide four open collector channels. The devices to which the connection is made must be galvanically isolated.

Clamp.	DEN.	FUNCTION	Clamp.	DEN.	FUNCTION	Clamp.	DEN.	FUNCTION
M3	GND	Ground	M4	GND	Ground	M3	DO1+	Digital Output 1 - positive
	GND	Ground		V CPU	CPU Power Supply		DO1-	Digital Output 1 – negative
	DI1	Digital Input 1		V MDM	GSM Modem Power Supply		DO2+	Digital Output 2 - positive
	DI2	Digital Input 2		485 +	RS485 LINE+		DO2-	Digital Output 2 - negative
	DI3	Digital Input 3		485 -	RS485 LINE-		DO3+	Digital Output 3 - positive
	DI4	Digital Input 4					DO3-	Digital Output 3 - negative
	DI5	Digital Input 5					DO4+	Digital Output 4 - positive
	DI6	Digital Input 6					DO4-	Digital Output 4 - negative
	DI7	Digital Input 7						
	DI8	Digital Input 8						
	DI9	Digital Input 9						
	DI10	Digital Input 10						

Table 8: Description of the available clamps

6.2 Prescaler

Clamps DI9 and DI10 (M3-11, M3-12) have two independent prescalers that can be enabled via selector LK3 and LK2 respectively.
In this mode the frequency of the input pulses is divided by a configurable factor from 8 to 4096, this allows to extend the range of input pulse frequencies up to 12KHz.
The prescalers are configured by the LK4 and LK5 selectors; the available options are shown in Tables 9 and 10.

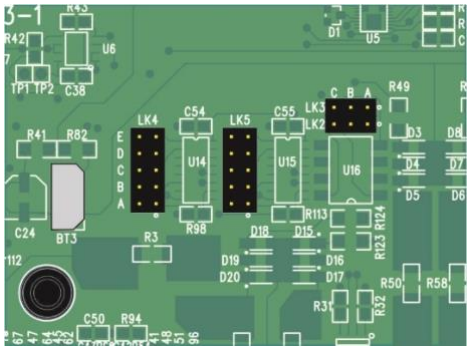


Figure 6: Selectors for enabling and configuring the prescalers for digital inputs DI9 and DI10

LK3	LK5	Prescaler	Frequency Max
A-B	-	-	3 Hz
B-C	A	1	3 Hz
	B	8	24 Hz
	C	64	192 Hz
	D	512	1.5 KHz
	E	4096	5 KHz

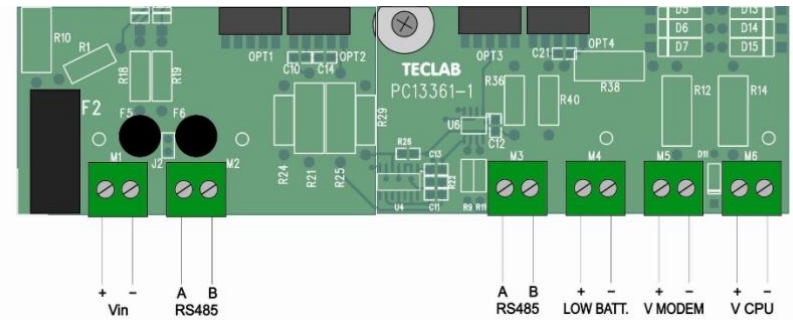
Table 9 - DI9 Configuration

LK2	LK4	Prescaler	Frequency Max
A-B	-	-	3 Hz
B-C	A	1	3 Hz
	B	8	24 Hz
	C	64	192 Hz
	D	512	1.5 KHz
	E	4096	5 KHz

Table 10 - DI10 Configuration

6.3 M-Power Clamps

6.3.1 Main Board



CLAMP.	DEN.	FUNCTION
M1	Vin+	Power Supply Input - Positive
	Vin-	Power Supply Input - Negative
M2	RS485 A	RS485 EXPANSION LINE+
	RS485 B	RS485 EXPANSION LINE-
M3	RS485 A	RS485 LINE+
	RS485 B	RS485 LINE-
M4	LOW BATT +	Low battery Digital Output – Positive
	LOW BATT -	Low battery Digital Output - Negative
M5	V MODEM+	Modem Power Supply Output - Positive
	V MODEM-	Modem Power Supply Output - Negative
M6	V CPU+	CPU Power Supply Output - Positive
	V CPU-	CPU Power Supply Output - Negative

Table 11: M-Power Clamps

6.3.2 Namur inputs expansion

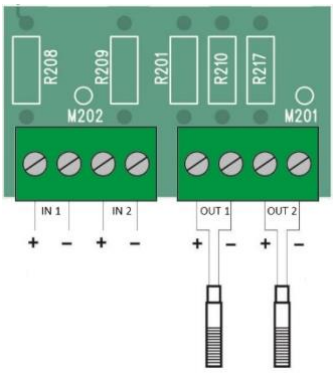


Figure 8:5 NAMUR inputs expansion

CLAMP.	DEN.	FUNCTION
M201	OUT1+	Transducer connection NAMUR 1 - positive
	OUT1-	Transducer connection NAMUR 1 - negative
	OUT2+	Transducer connection NAMUR 2 - positive
	OUT2-	Transducer connection NAMUR 2 - negative
M202	IN1+	Repetition NAMUR 1 – positive
	IN1-	Repetition NAMUR 1 – negative
	IN2+	Repetition NAMUR 2 – positive
	IN2-	Repetition NAMUR 3 - negative

Table 12:Namur Clamp

6.3.3 Digital/Analog inputs expansion

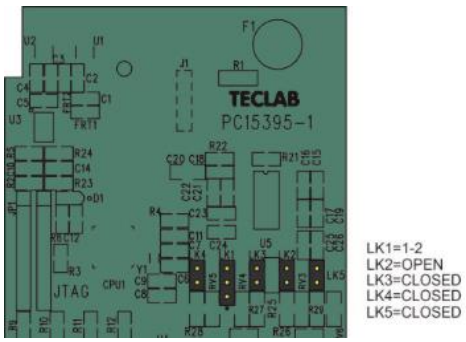
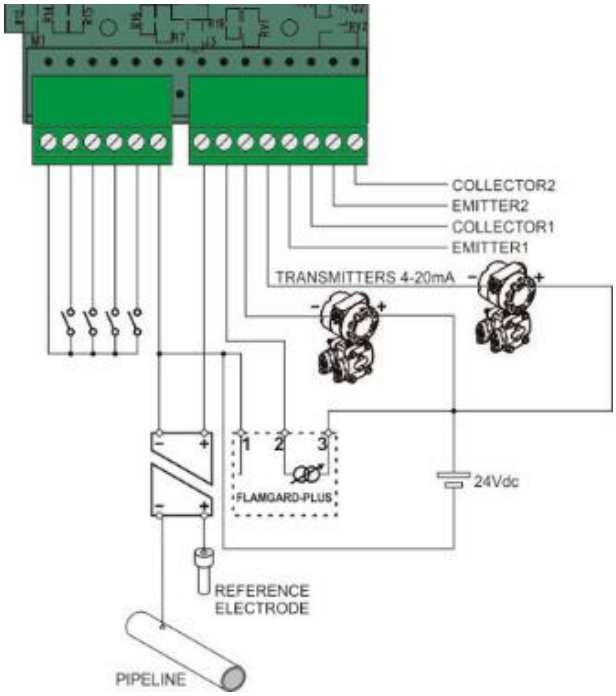


Figure 9:6 Exapansion I/O

LINK	POS.	FUNCTION
LK1	1 – 2	AIN3 +-5V FS o 4-20mA (LK3)
	2 – 3	AIN3 0 +- 20V FS
	Open	AIN3 Open
LK2	Open	AIN0 Voltage
	Closed	AIN0 Current
LK3	Open	AIN3 Voltage
	Closed	AIN3 Current
LK4	Open	AIN2 Voltage
	Closed	AIN2 Current
LK5	Open	AIN1 Voltage
	Closed	AIN1 Current

Table 13: Analog/Digital inputs expansion Link configuration

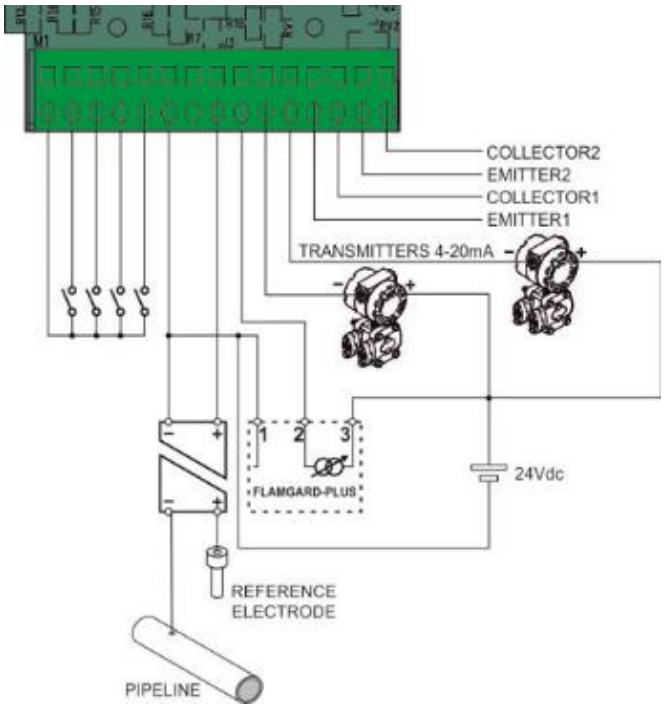
DIN RAIL M-POWER INPUTS



CLAMP	DEN	FUNCTION
M1A	GND	Ground
	DI1	Digital input 1
	DI2	Digital input 2
	DI3	Digital input 3
	DI4	Digital input 4
	GND	Ground
M1B	AIN1	Analog input 1
	AIN2	Analog input 2
	AIN3	Analog input 3
	AIN4	Analog input 4
	DO1+	Digital output 1 – positive
	DO1-	Digital output 1 – negative
	DO2+	Digital output 2 – positive
	DO2-	Digital output 2 – negative

Table 13: DIN RAIL inputs

IP 67 M-POWER INPUTS



CLAMP.	DEN	FUNCTION
M1	GND	Ground
	DI1	Digital input 1
	DI2	Digital input 2
	DI3	Digital input 3
	DI4	Digital input 4
	GND	Ground
	GND	Ground
	AIN1	Analog input 1
	AIN2	Analog input 2
	AIN3	Analog input 3
	AIN4	Analog input 4
	DO1+	Digital output 1 – positive
	DO1-	Digital output 1 – negative
	DO2+	Digital output 2 – positive
	DO2-	Digital output 2 – negative

Table 14: IP 67 inputs

6.4 Correction channels

MODUS has two independent correction channels PTZ1 and PTZ2.
The PTZ2 channel has a prescaler for extending the frequency range of the impulse arriving from the counter.
The following table shows the wiring and configuration diagram of the two channels. The number and characteristics of the correction channels actually available depend on the order code used to purchase the specific machine.

Channel	Clamps			Prescaler		Max Frequency
	Pressure M2	Temperature M1	Pulse M3	Activation LK2	Configuration LK4	
PTZ 1	VP1+ VS1+ VS1- PSW1	PTA+ PTA-	D1 GND	-	-	3 Hz
PTZ 2	VP2+ VS2+ VS2- PSW2	PTB+ PTB-	D10 GND	A-B	-	3 Hz
				B-C	A	3 Hz
					B	24 Hz
					C	192 Hz
					D	1.5 KHz
					E	5 KHz

6.5 Metrological unlock Button

The Metrological unlock button is accessed removing main cover, protected by Metrological seals.
After pressing Metrological Unlock Button the software Metrological seals are unlocked and Metrological parameters can be modified. The software Metrological seals return to locked status when display switch off after 30 seconds of keyboard activity.
During the period the Metrological seals are unlocked the display shows symbol **σ** as first character of first line

When the Metrological seal is unlocked the following parameters, can be modified:

- Vm – Volume at measure conditions
- Vb – Volume at base conditions
- Ve – Volume in error conditions
- Energy
- Pulse configuration
- Device Status
- Erase Events Queue

The activation and deactivation of the metrological unlock and the modification of the parameters are recorded as events.

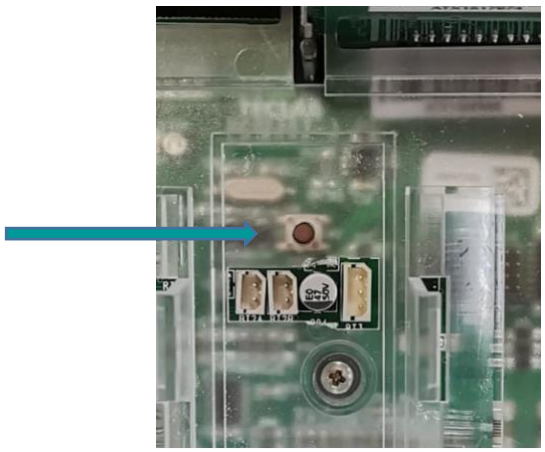


Figure 9 – Metrological unlock Button

7 Metrological sealing

Sealing takes place by affixing two different types of seals: type A seals (adhesives), type B seals (lead). Type A seals protect:

- The programming button, which is pressed to reprogram some parameters of metrological significance (sealing A-1, figure 10)
- Motherboard and components (sealing A-2, figure 10)
- Clamps (sealing A-3 e A-4, figure 10)

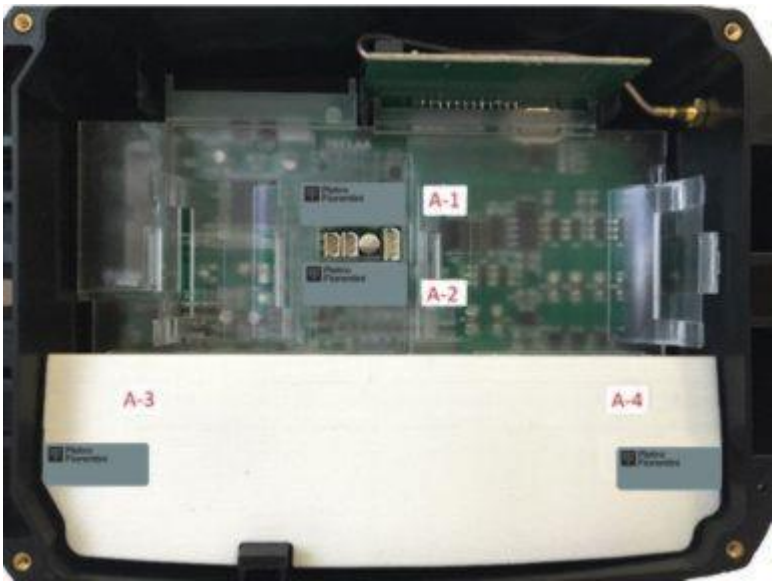


Figure 10: Type A sealings within the MODUS

Type B sealings protect:

- The connection of pressure transducer / transducers to the system (sealing B-1, figure 11)
- The connection of temperature transducer / transducers to the system (sealing B-2, figure 12)
- The connection between the device and the volume counter (sealing B-3, figure 13)
- The lid of **M-Power**, if available (sealing B-4, figure 14)

The change of the metrological parameters of the device is protected by a programming button (PROG, see par. *"Metrological Unlock Button"*), when pressed allows you to reprogram some parameters of metrological relevance.

Figure 11: Type B sealing for pressure transducer

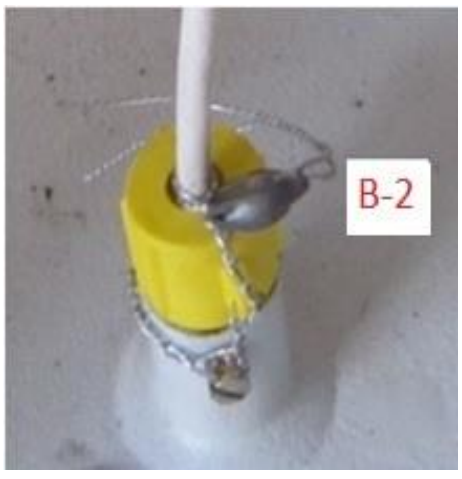


Figure 12: Type B sealing for temperature transducer

Figure 13: Type B sealing for pulse acquisition

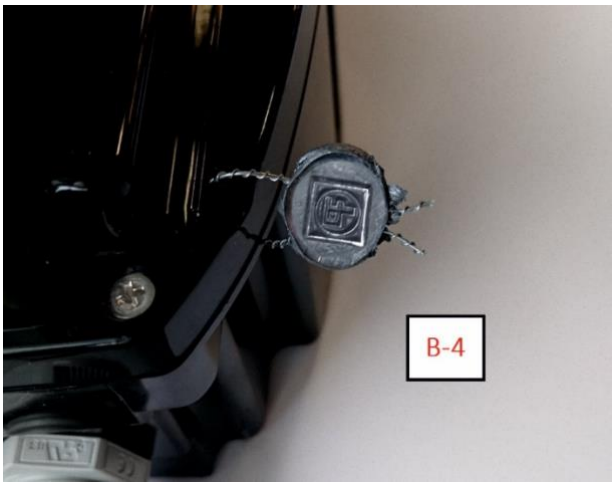


Figure 14: Type B sealing for MPOWER lid

7.1.1 Metrological Software sealings

The device provides programming of meteorologically relevant parameters through the optical interface, which access is restricted by a password and can only be accessed by authorized personnel.

Implemented as requested by the point 6.1.3 of the EN 12405-1:2005 + A2:2010:

1. Restricted access by Password (Changeable);
2. Registration, with date and time, of at least the last intervention carried out;
3. Possibility to access the events recorded in the memory. The events are shown on the display with the following sequence:

    - Press the key 'OK' to turn on the display;
    - Press again the key 'OK' to enter the menu;
    - Scroll through the menu items using the 'DOWN ARROW' key until selecting 'Event Log';
    - Press the key 'OK' to get in the menu 'Events Buffer'.

The device is equipped with software seals required by the protocol UNI EN 12213.

7.2 Non metrological sealings

A non-metrological seal is provided on the MODUS lid to protect it from unauthorized opening. The figure below shows an example of sealing:

Figure 15: Non-metrological hardware seal on the MODUS lid

8 Identification

MODUS is identified by a front plate on which are reported:

CE Marking
ATEX Certificate number
Version (A, B, T)
Protection mode identification string
Serial number
Year of production

9 Maintenance

There are no scheduled maintenance operations.

WARNING: DANGER OF ELECTROSTATIC DISCHARGE

In order to prevent the accumulation of electrostatic charges on the equipment, appropriate procedures must be adopted during installation, maintenance and use.

10 Verification

All verification and / or maintenance operations must be carried out according to the criteria of the European standard EN60079-17.

Pietro Fiorentini

11 Technical specifications

CARATTERISTICHE MECCANICHE	MIN	TIP	MAX
Casing Dimensions (L X H X P)		210X150X80 mm	
Pressure Sensors Dimensions (L X H X P)		62 X 28 X 28 mm	
Pressure Sensors Dimensions – headroom (L)		50 mm	
IP Protection		65 / 66 / 67	
ENVIRONMENT	**MIN**	**TIP**	**MAX**
Operating temperature	-25°C		+60°C
Mechanical/Electromagnetic Class		M2/E2	
ELECTRICAL	**MIN**	**TIP**	**MAX**
Battery life – HP1-BP[3]		5 years	
Battery life – LE – BP (pressure sampling period 30s)		5 years	
LOCAL OPTICAL INTERFACE		EN 62056-21 (ZVEI)	
Speed, data bits, parity, stop bit		9600,8,n,1	
REMOTE COMMUNICATION			
Communication technologies		GSM data, GSM SMS, GPRS	
Connection Type		Scheduled Call; Configuration; Download Archive and Current Data, Clock Set.	
Firmware update		Local or Remote. CRC32 Protection	
ANALOG INPUTS	**MIN**	**TIP**	**MAX**
Available channels		7	
Type		3 x Piezoresistive 2 x Voltage / Current (0÷5V, 4/20mA configurable) 2 x Temperature	
Resolution		16 bits	
Pressure transducer working range (Bar)[4]	0.8		2
	0.8		3.5
	0.8		10
	1		20
	1		24
	6		80
Pressure transducer working range (Celsius)[2]	-25		+60
DIGITAL INPUTS - COUNTERS	**MIN**	**TIP**	**MAX**
Available			10
Flow Rate inputs			2
Frequency (channels D1-D2-D3-D4-D5-D6-D7-D8)	0		3 Hz
Frequency (channels D9-D10)			5 KHz[5]
Power supply voltage[6]		3 V	3 V
Current			3 mA
Type		Relay Contact	
DIGITAL OUTPUTS	**MIN**	**TIP**	**MAX**
Available			4
Vout			15V
Insulation		1500 Vac	
Type		Open collector npn	
FUNCTIONAL			
Channels PTZ MID		2	
Compressibility calculation		UNI EN ISO 12213-2 (AGA8-DC92)	
		UNI EN ISO 12213-3 (SGERG-88)	
		AGA NX-19	
Conversion coefficient calculation		UNI EN 12405-1	
Energy calculation		UNI EN 12405-2	
Calculation of higher calorific value [7]		UNI EN ISO 6976:2008	

[3] Referred to standard operating conditions: 1 GPRS data connection per day; 1 alarm call per month.
[4] MID certified fields. Other fields are available without metric certification.
[5] With prescaler configured at 4096.
[6] Internally generated. Do not connect external voltage generators.
[7] If the compressibility calculation is set according to AGA8-DC92.

11.1 I/O characteristic parameters

Digital Inputs 1-8										
Parameter	**Uo**	**Io**	**Po**	**Ui**	**Ii**	**Pi**	**Co**	**Lo**	**Ci**	**Li**
Value (Ver. A)	6 V	6,5mA	10mW	6 V	N.A.	N.A.	10µF	47µH	Nota 1	5µH
Value (Ver. B)	6 V	6,5mA	10mW	6 V	N.A.	N.A.	10µF	47µH	Nota 1	2,5µH
Value (Ver. T)	6 V	6,5mA	10mW	6 V	N.A.	N.A.	10µF	47µH	Nota 1	50nH
Digital Inputs 9-10										
Value (Ver. A)	6 V	6,5mA	10mW	15 V	N.A.	N.A.	10µF	47µH	Nota 1	5µH
Value (Ver. B)	6 V	6,5mA	10mW	15 V	N.A.	N.A.	10µF	47µH	Nota 1	2,5µH
Value (Ver. T)	6 V	6,5mA	10mW	15 V	N.A.	N.A.	10µF	47µH	Nota 1	50nH
Digital Outputs										
Parameter	**Uo**	**Io**	**Po**	**Ui**	**Ii**	**Pi**	**Co**	**Lo**	**Ci**	**Li**
Value (Ver. A)	6 V	6,5mA	10mW	15V	N.A.	N.A.	10µF	47µH	Nota 1	5µH
Value (Ver. B)	6 V	6,5mA	10mW	15V	N.A.	N.A.	10µF	47µH	Nota 1	2,5µH
Value (Ver. T)	6 V	6,5mA	10mW	15V	N.A.	N.A.	10µF	47µH	Nota 1	50nH

Inputs for Analog pressure sensor (1)										
Parameter	**Uo**	**Io**	**Po**	**Ui**	**Ii**	**Pi**	**Co**	**Lo**	**Ci**	**Li**
Value	6 V	222mA	333mW	N.A.	N.A.	N.A.	10µF	47µH	N.A.	N.A.

Auxiliary Analog inputs 0-5V										
Parameter	**Uo**	**Io**	**Po**	**Ui**	**Ii**	**Pi**	**Co**	**Lo**	**Ci**	**Li**
Value (Ver. A)	6 V	1mA	6mW	6 V	N.A.	N.A.	10µF	47µH	450µF	5µH
Value (Ver. B)	6 V	1mA	6mW	6 V	N.A.	N.A.	10µF	47µH	85µF	2,5µH
Value (Ver. T)	6 V	1mA	6mW	6 V	N.A.	N.A.	10µF	47µH	450µF	50nH

Input for temperature sensor										
Parameter	**Uo**	**Io**	**Po**	**Ui**	**Ii**	**Pi**	**Co**	**Lo**	**Ci**	**Li**
Value	6 V	26mA	39mW	N.A.	N.A.	N.A.	10µF	47µH	N.A.	N.A.

RS485 Serial Expansion Line										
Parameter	**Uo**	**Io**	**Po**	**Ui**	**Ii**	**Pi**	**Co**	**Lo**	**Ci**	**Li**
Value (Ver. A)	6 V	6,5mA	10mW	6V	N.A.	N.A.	180 µF	200µH	450µF	5µH
Value (Ver. B)	6 V	6,5mA	10mW	6V	N.A.	N.A.	500 µF	200µH	85µF	2,5µH
Value (Ver. T)	6 V	6,5mA	10mW	6V	N.A.	N.A.	180 µF	200µH	450µF	50nH

(1) The following transducer models can be connected to these channels:
STS TD GAS, STS TM EX
GEMS 563966, GEMS 564280
TECLAB GSE-03, TECLAB TL01, TECLAB GSE/03/1
FAST GSE-03, FAST TL01, FAST GSE/03/1
Or any ATEX certified transducer with characteristic parameters compatible with the values shown in the table.

Note 1:
The capacity Ci that **MODUS** presents externally is a function of the applied voltage Ui: the considerations that led to these values are described in the technical note filed with the Notified Body that issued the type certificate.
The following two tables show the Ci values as a function of the applied voltage:

Voltage V	Version A and T Ci (µF)
8,7	450
9	225
10	45
11	27
12	16,2
13	10.2
14	7,66
15	6,3

Table 11-18

Voltage V	Version B Ci (µF)
6	85
7	25,8
8	8,5
9	3,4
10	1,86
11	1,18
12	0,77
13	0,53
14	0,4
15	0,31

Table 11-19

11.2 Power supply line characteristic parameters

11.2.1 External Battery – A version

if you decide to power the modem section of **MODUS** version A with an external battery pack, the following characteristic parameters must be taken into consideration:

Parameter	Uo	Io	Po	Ui	Ii	Pi	Co	Lo	Ci	Li
Value	NA	NA	NA	5,9V	3,9A	5,76W	NA	NA	880 µF	5µH

Table 11-1

11.2.2 External power supply using M-POWER – T version

MODUS T version can be powered by the M-Power remote power supply.

In this version the modem must be exclusively of the SE13358 type and cannot be replaced in any way by another type of modem, also the radio module CANNOT be installed.

Characteristic parameters of the CPU power supply line:

Parameter	Uo	Io	Po	Ui	Ii	Pi	Co	Lo	Ci	Li
Value	NA	NA	NA	5,9V	0,6A	N.A	NA	NA	880 µF	50nH

Table 11-2

Characteristic parameters of the MODEM power supply line:

Parameter	Uo	Io	Po	Ui	Ii	Pi	Co	Lo	Ci	Li
Value	NA	NA	NA	5,9V	3,9A	5,76W	NA	NA	880 µF	50nH

Table 11-3

can be equipped with a BU-BP battery capable of supporting the power supply of the CPU in the event of a main power supply failure. It is not allowed to use the BU-BP buffer battery in versions A and B. Use only the battery model indicated.

12 Disposal

Exhausted batteries contain substances that are hazardous to the environment and are subject to mandatory separate collection. **CER 160605.**

The equipment must be disposed of in accordance with current regulations. **CER 160216**