USM-0000020565 / Rev. 00G / FL / nb / September 2011 MNKS001 0.3 (9/11)

Meter with optional cable protection cover

History

Revision	Date	Editor	ECN	Status	Description
Rev. 01/ A	09.11.2006	xxx	50000058026	released	Took over from KOS SAP System
Rev. 00C	November 2007	NB	20092	released	Approval
Rev. 00D	January 2009	ThK	20512	releases	Change cover and footer
Rev. 00E	February 2009	NB	20513	releases	MPU 800 update
Rev. 00F	July 2010	NB	21064	releases	Front page update
Rev. 00G	September 2011	JP	21510	releases	Temperature drop /depressurization

Important

All information and technical specifications in this documentation have been carefully checked and compiled by the author. However, we cannot completely exclude the possibility of errors. **Smith Meter GmbH** is always grateful to be informed of any errors.

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1 INTRODUCTION

This document describes the technical data information, storage, transport and handling, installation, operation and maintenance of the MPU Ultrasonic Gas Flow Meter.

There are currently four versions available, MPU 1200, MPU 800, MPU 600 and MPU 200.
The difference between them is the number of paths. All other parts are identical. The MPU 1200 has 6 paths (12 transducers), MPU 800 has 4 paths (8 transducers), MPU 600 has 3 paths (6 transducers) and the MPU 200 has 1 path (2 transducers). All version use identical electronics with the appropriate number of transducers connected. The MPU 600 is a lower cost version of the MPU 1200 and MPU 800 with slightly lower measurement performance. The MPU 200 is made for applications with lower accuracy requirements.

1.1 Contact Address if Assistance is Required

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1.2 Copyright

1.3 Trademarks

Products listed are trademarks of their respective manufacturers.
Company names listed are trade names of their respective companies.

1.4 Manual Structure and Use

1.4.1 References

The following documents are referred to within this manual:

PRD-0000022520	MPU Transducer Replacement Procedure
DOK-509	MPU Transducer Replacement Procedure (V6- short Transducer) using Retraction Tool
PRD-0000022543	External Data Communication MPU Series B

1.4.2 Abbreviations

Abbreviation	Description
AGA	American Gas Association
AI	Analog Input
AO	Analog Output
D	Diameters
DI	Digital Input
DO	Digital Output
I/O	Input / Output
Kb	Kilo byte
Mb	Mega byte
MPU	Multi-Path Ultrasonic
PC	Personal Computer
PE	Protective Earth
SW	Software
TRT	Transducer Retraction Tool
UACF	Ultrasonic Alternate Current Filter
UAFE	Ultrasonic Analog Front End
UDSP	Ultrasonic Digital Signal Processor
VOS	Velocity Of Sound

2 MAIN DATA FOR OPERATION AND MAINTENANCE

The purpose of this chapter is to give the user, both the single operator and the customer's organization, basic data to ease the planning regarding location, installation, operation and maintenance of the delivered product.

2.1 Purpose of Equipment

The MPU series of ultrasonic flow meters are non-intrusive and transducers are flush mounted to the internal meter body to provide for undisturbed and accurate measurement of gas flow. They are suitable for a wide range of applications in fiscal metering of dry, high pressure, and non-condensing gases, such as:

- Custody transfer of gas onshore and offshore
- Pipeline node bi-directional measurements
- Gas terminals
- Gas mixing stations
- Gas power plants
- Pipeline junctions
- Compressor stations

The MPU 1200 and MPU 800 have fiscal accuracy with 10D straight upstream pipe, and 5D downstream straight pipe.
The MPU 600 has fiscal accuracy with a well developed flow profile, hence long (>20D) upstream straight pipe or in combination with a flow conditioner.
The MPU 200 can not be guaranteed for fiscal accuracy

2.2 Health, Environment and Safety

Precautions must be taken during operation of this equipment to prevent human injury or health problems.

To uphold the human and equipment safety during use and operation of the MPU, the equipment is CE-certified. Refer to Section 2.3.3.

2.2.1 Warnings

If using a crane when lifting the MPU, the certified lifting slings must be wrapped around the meter, or use lifting lugs if available. Lifting and handling must always be performed in accordance with THI-0000020502.

At offshore installations, it is very important to secure the meter during crane handling due to motion on the platform or vessel resulting in pendulum motion of the load.

Do not fasten any lifting slings in the electronic connection box or its bracket.

2.2.2 Hints for installation in hazardous area

All assembly groups which are marked with the ⟨Ex⟩ sign are explosion proof, electrical equipment. This equipment is tested for safety and approved by a notified body.

** Any modifications made by unauthorized people, independent of **
* mechanical or electrical matter, are forbidden *

D a n g e r o f e x p l o s i o n

In case of a malfunction of the electronic board fitted in the flameproof housing only the complete board has to be replaced. Test and repair of the board is only possible in the factory. The installation and replacement of the board is the task of skilled personnel.

General hints:

- The electrical installation has to be compliant with EN 60079-14 and the ordinary electric installation rules.
- To prevent ignition of hazardous atmospheres and to prevent electrical shock, disconnect from supply circuits before opening. Protect the device against unintended power on. Before bringing the device into operation make sure that it is tightly closed.
- The flameproof housing contains one or more of the following threaded entries: ½" NPT. All cable entries, stopping boxes or plugs shall be certified according to the requirements in EN 50018 or IEC 60079-1.
- The flameproof housing contains an internal battery-powered circuit. Do not open the housing unless an area is known to be non-hazardous. To reduce the risk of ignition of hazardous atmospheres, conduit runs must have a sealing fitting connected within 45 cm of the enclosure.
- Before the first power up after installation check that the connected voltage is conform to power rating on the name plate. Not used cable entries have to be closed with certified plugs.
- The wiring has to be made according to the wiring diagrams which are part of this manual.
- Modification of the internal construction of the flameproof and adding additional parts to the electronic are not allowed
- Special precaution must be made when bringing the supplied Laptop / PC into hazardous area. Provide for work permit before bringing the Laptop / PC into restricted area, according the site regulations. A gas detector must be in operation continuously while the Laptop / PC is present in the restricted area. This applies also while it is switched off.
- The ex-relevant data could be found in chapter 2.3.3.

The MPU is manufactured in the following versions:

- IEC/ ATEX - European certification

2.2.3 EC-Type-Examination Certificate

EC-Type-examination Certificate No.	Protection Method
PTB 07 ATEX 1018	Ex d IIC T5 and T4
Nemko 05 ATEX 1244	EEx d IIB T5

CE **Conformance to the EU guideline 89/336/EWG and the ATEX regulation 94/9/EC**

2.2.4 Temperature drop and depressurization

Please be aware that rapid temperature changes may damage the ultrasonic transducers and should be avoided. If the meters are subjected to a temperature change of more than 5 degrees Celsius or 9 degrees Fahrenheit per 5 minutes transducers may be damaged and may have to be replaced. This can also occur under rapid pressure changes like emergency depressurization, therefore, the maximum rate of depressurization is 10 bars per 5 minutes.

CAUTION: Special attention is required to avoid damage to flame paths. See Figure 1 below.

If the flame paths are damaged, the parts must be replaced and **not** repaired.

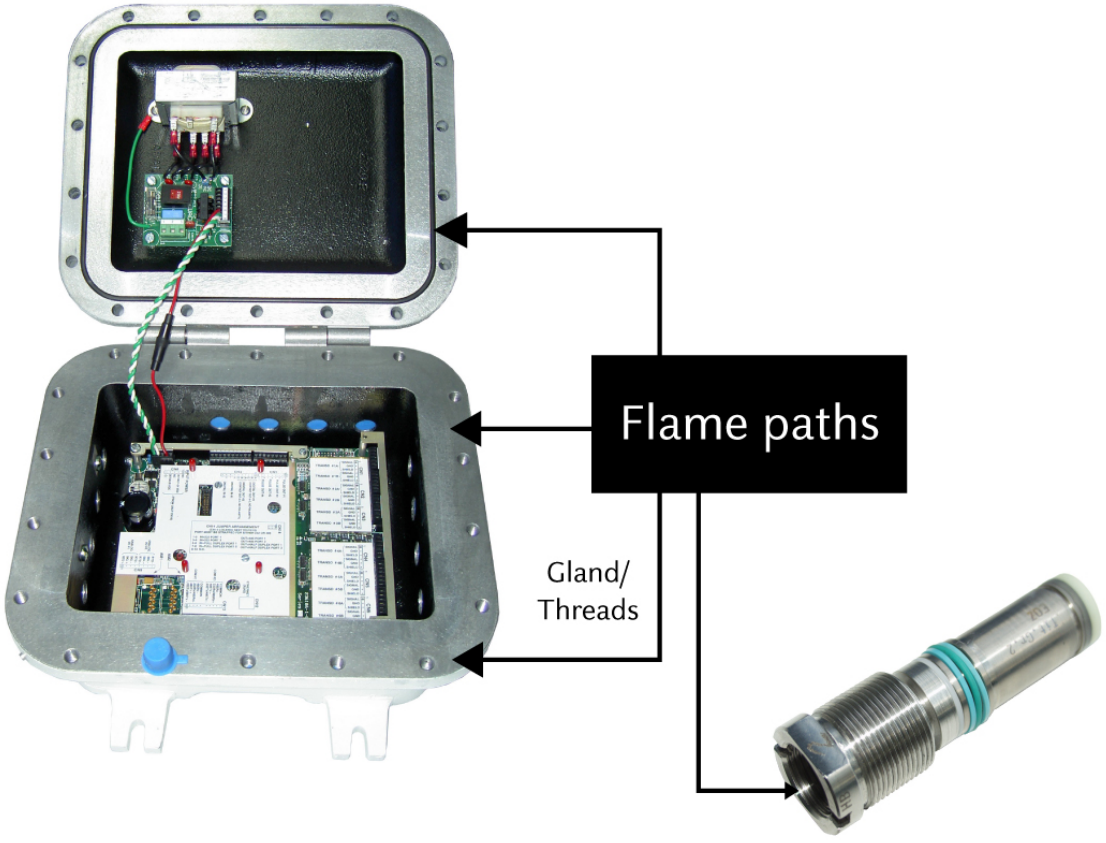


Figure 1 – Flame Paths

2.3 Capacity and Performance

2.3.1 Guarantee

FMC Technologies, Smith Meter GmbH and its subsidiaries assume no responsibility for any errors that may appear in this publication, or for damages arising from the information in it. No information in this publication should be regarded as a warranty made by FMC Technologies, Smith Meter GmbH. The information in this publication may be updated without notice.

The guarantee terms are stipulated in the delivery conditions.

The guarantee on the equipment expires if:

Equipment is damaged during transport, handling, storage or installation where instructions are not followed or due to carelessness.

Service, operation and maintenance are not carried out strictly in accordance with the instructions described in section 7.

Repairs are not carried out by our personnel, or if they are carried out by your staff without our prior written permission and strictly in accordance with the instructions.

Changes are made to the equipment without our prior written permission.

Original MPU parts are not used.

Equipment is used improperly, incorrectly, carelessly or not in line with its nature and/or purpose.

2.3.2 Durability Data

The MPU has the following durability data:

Mean-time-between-failure (estimated figures): 150 000 hours

Mean-time-to-repair: < 2 hours

Equipment lifetime: 25 years

2.3.3 Instrument Data Specifications

Applications

Dry high pressure gases, non-condensing

Operating Pressure range

1-275 bar/ 1 to 3,990 psig
Wider pressure range on request.

Operating flow temperature

-20 ° to 70 °C/ -4 ° to 158 °F

Operating Ambient temperature

-25 ° to 60 °C/ -13 ° to 140 °F

Storage temperature

-20 ° to 70 °C/ -4 ° to 158 °F

Humidity

Up to 95%, non-condensing

Flow Range (typical)

MPU 1200
DN150 – DN400 (6 – 16 in.)*:
0.4 – 30 m/s / 1.3 – 98 ft./sec.
DN450 – DN750 (18 – 30 in.):
0.3 – 26 m/s / 1.0 – 82 ft./sec.
DN800 – DN1300 (32 – 52 in.):
0.2 – 20 m/s / 0.7 – 65 ft./sec.
Larger meter sizes on request

MPU 800
DN150 – DN400 (6 – 16 in.)*:
0.4 – 30 m/s / 1.3 – 98 ft./sec.
DN450 – DN750 (18 – 30 in.):
0.3 – 26 m/s / 1.0 – 82 ft./sec.
DN800 – DN1300 (32 – 52 in.):
0.2 – 20 m/s / 0.7 – 65 ft./sec.
Larger meter sizes on request

MPU 600
DN100 – DN400 (4 – 16 in.)*:
0.4 – 30 m/s / 1.3 – 98 ft./sec.
DN450 – DN750 (18 – 30 in.):
0.3 – 26 m/s / 1.0 – 82 ft./sec.
DN900 (36 in.):
0.2 – 20 m/s / 0.7 – 65 ft./sec.
Larger meter sizes on request

MPU 200
DN100 – DN250 (4 – 10 in.)*:
0.4 – 30 m/s 1.3 – 98 ft./sec.
DN300 – DN400 (12 – 16 in.):
0.3 – 28 m/s / 1.0 – 92 ft./sec.
DN450 – DN600 (18 – 24 in.):
0.3 – 25 m/s / 0.7 – 66 ft./sec.
DN750(30 in.):
0.2 – 20 m/s / 0.7 – 66 ft./sec.
DN900 – DN1300 (36 – 52 in.):
0.2 – 15 m/s / 0.7 – 50 ft./sec.
Larger meter sizes on request

* DN100/ 4” only available as MPU 600 and MPU 200.

Nominal Accuracy

MPU 1200
$Q_{min}<Q<0.05Q_{max}$: ≤ ± 0.5%
With dry calibration:
$0.05Q_{max}<Q<Q_{max}$ ≤ ±0.5% of measured value
With flow calibration:
$0.05Q_{max}<Q<Q_{max}$ ≤ ±0.1% of measured value

MPU 800
$Q_{min}<Q<0.05Q_{max}$: ≤ ± 0.5%
With dry calibration:
$0.05Q_{max}<Q<Q_{max}$ ≤ ±0.5% of measured value
With flow calibration:
$0.05Q_{max}<Q<Q_{max}$ ≤ ±0.1% of measured value

MPU 600
$Q_{min}<Q<0.05Q_{max}$: ≤ ± 0.7%
With dry calibration:
$0.05Q_{max}<Q<Q_{max}$ ≤ ±0.7% of measured value
With flow calibration:
$0.05Q_{max}<Q<Q_{max}$ ≤ ±0.3% of measured value

MPU 200
± 1.5% - 2,5% depending on the application

Repeatability

MPU 1200 and 800
≤±0,1% of measured value
MPU 600
≤±0,15% of measured value
MPU 200
≤±1,5% - 2,5% of measured value

Standard Flange Connections

Typically ANSI B16.5 RF or RTJ face flanges. Other types flange connections available on request.

Spool Piece

Carbon steel or Stainless steel according to relevant regulations and customer's process conditions**.** Other material on request**.**

Transducer

Piezo-electric element, fully encapsulated in Titanium housing

Installation

Typically 10 D upstream straight pipe, 3 D downstream straight pipe. For bi-directional measurement, 10D at both ends.

Hazardous Classification

European type:
Certification Sensor: PTB 07 ATEX 1018
Ex Classification: II 2 G Ex d T5 and T4
ATEX Certification flame proof housing
NEMKO 05 ATEX 1244
II 2 G EEx d IIB T5
North American type:
Ex Classification: Explosion proof, Class 1, Division I, Group C&D
UL/C-UL E23545

Type Approvals

Germany: PTB 7.241 00.03

The Netherlands: NMi B28
Russia: Gosstandart
NO.C.29.004.A No. 10209
Indonesia:
MIGAS 309738.04-DMT/1999
Malaysia: SIRIM
NMC/448/12/4
China: CPA
2002-F235
Complience with AGA-9, ISO 17089 and OIML R-137

CRN Approved

CRN 0F4028.2

DC Input Power to the field mounted electronics

24 VDC +15%/ -10%, 0.5A
Power Inrush: 8 Amps for < 20mS @ 24VDC.
The DC power input circuitry is reverse current protected and fused.
Tested to 20 milliseconds power drop without shutdown. Meter will restart after the return of lost power.

AC Input Power to the field mounted electronics

120/240 VAC continuous, +/- 10%, 12 Watts, 48 to 63 Hz.
Power Inrush: 6 Amps for <20mS @ 120 VAC
Power Inrush: 3 Amps for <20mS @ 240 VAC
The AC circuit is fuse-protected.
Power Interrution Tolerance: Interruption of power greater than 100 milliseconds (typical) will cause an orderly shutdown. Tested to 20 milliseconds drop without shutdown. Meter will restart after the return of lost power.

Electrical Inputs

Digital Inputs
2 digital inputs
Type: High-speed, optically isolated digital input. The input pulse must rise above V (high. min) for a period of time an d then fall below V (low) to be recognized as a pulse.
V (high): 5 VDC minimum to 28 VDC maximum.
V (low): 1 VDC maximum.
Input impedance; 1.8 kΩ.
Frequency range: 0 to 10.0 kHz.
Mode: Single, dual, dual with power sensing, density.
Duty Cycle: 35/65 to 65/35 (on/off)

Analog Input (4-20mA)
Up to 2 analog inputs (maximum number of analog inputs and outputs are 2).
Type: Two-wire, 4-20mA current loop receiver, isolated from ground, programmable as to function.
Span Adjustment: Program adjustable.
Input Burden: 50Ω.
Resolution: One part in 65,536.
Voltage Drop: 2 Volts maximum.
Sampling rate: Software selectable

Analog Input (1-5 VDC)

Up to 2 analog inputs (maximum number of analog inputs and outputs are 2).
Type: Two-wire, 1-5 VDC voltage loop receiver, isolated from ground, programmable as to function.
Span Adjustment: Program adjustable.
Input Burden: 1 mΩ.
Resolution: One part in 65,536.
Sampling rate: One sample/ 300 mSec minimum.

Electrical Outputs

Pulse Output
4 Pulse outputs.
Type: Optically isolated solid-state output. User-selectable pulse units, pulse rates and pulse width/duty cycle.
Volume output selctable for rate and incremental volume.
Single or Dual Quadrature (outputs 90 electrical degrees out of phase) standard?
Polarity: Selectable (Normally Open or Normally Closed
Switch Blocking Voltage (Switch Off): 30VDC maximum.
Load Current (Switch On): 10mA with 0.6 volts drop.
Frequency Range: 0 to 5 kHz.
Duty Cycle: 50/50 (on/off).

Digital Output
2 digital outputs
Type: Optically-isolated solid state output. User-programmable as to function.
Polarity: Programmable (Normally Open or Normally Closed)*.
Switch Blocking Voltage: 30 VDC maximum.
Load Current: 150mA maximum with 0.6 volt drop.
Note: *Power-down normally open.

Analog Output (4-20mA)
Up to 2 analog outputs (maximum number of analog inputs and outputs are 2).
Type: Two-wire, 4-20mA current loop transmitter, isolated from ground, programmable as to function.
Span Adjustment: Program adjustable.
Accuracy: +/-0.025% of range.
Resolution: One part in 65,536.
Voltage Burden: 4 volts maximum.
Maximum Load Resistance: 250Ω.

Analog Output (1-5 VDC)
Up to 2 analog outputs (maximum number of analog inputs and outputs are 2).
Type: Two-wire, 1-5 VDC voltage loop transmitter, isolated from ground, programmable as to function.
Span Adjustment: Program adjustable.
Accuracy: +/-0.025% of range.
Resolution: One part in 65,536.

COMMUNICATION

Ethernet
ANSI/IEEE 802.3 Ethernet channel operating at 10/100 Mbps.
Optical fiber (100Base-FL) or
Twisted pair (10Base-T/ 100Base-T)

Serial
Configuration: Multi-drop network.
Data Rate: Selectable asynchhronous data (Baud) rates of 2400, 4800, 9600 or 19200 bps.
Data Format: One start bit, One stop bit, eight data bits – no parity.
Line Protocol: half duplex, full duplex.
Protocol: MODBUS (RTU)

Ports
Two ports: RS-485 and RS-232.

EIA-232 Port
RS-232 data communication

EIA-485 Port
Operating Half-Duplex (2-wire) or Full Duplex (4-wire).
Multi-drop network for RS-485 data communication. up to 16 Ultrasonic Gas Flowmeters can be connected onto the same Bus/ twisted pair.

2.3.4 Model Code

MPU								-						
	1	2	3	4	5	6	7	8	9	10	11	12	13	Description
Model	1	2												1200 (1) (2)(6)
	0	8												800 (1) (2)
	0	6												600 (1) (2)
	0	2												200 (1) (2)
Certification			U											US model – Explosion Proof certification
			A											European Model – ATEX Certification
			C											European Model – CENELEC Certification
Diameter														Diameter in inches (eg. 06 = 6", 12 = 12")
Flanges						1								150
						2								300
						3								400
						4								600
						5								900
						6								1500
						7								2500
Transducer							S							Standard
							R							Retractable under pressure
Optional interfaces									0					Not required
									F					Fiber optic Ethernet (100Base-FL)
Local display (3)										0				Not required
										D				With Local Display
Analog Input (4)											0			Not required
(E.g. Temperature, Pressure)											1			1 analog input (4-20 mA)
											2			2 analog inputs (4-20 mA)
											3			1 analog input (1-5VDC)
											4			2 analog inputs (1-5VDC)
Analog Output (4)												0		Not required
(E.g. To DCS or indicator)												1		1 analog output (4-20mA)
												2		2 analog outputs (4-20mA)
												3		1 analog output (1-5VDC)
												4		2 analog outputs (1-5VDC)
Additional communication board (5)													0	Not required
													C	With additional communication board

(1) Not available with NMi approval (pending)
(2) Not available with PTB approval (pending)
(3) Required with PTB and NMi approval
(4) Maximum no. of analog I/O ports: 2
(5) Not commercially available yet
(6) Not available in 4"

Standard configuration:

Instrument Input Power:	24 VDC or 120/240VAC
2 digital inputs	High-speed, optically isolated
2 digital outputs	Optically-isolated solid-state output
4 Pulse outputs	Optically-isolated solid-state output (0 – 5kHz) User-programmable pulse units, pulse rates and pulse width/duty cycle. Single or Dual Quadrature.
Ethernet:	Twisted pair (10Base-T / 100Base-T)
Serial:	Two programmable ports, selected from: RS-485 RS-232

A typical maximum and minimum flow rate versus meter dimension is shown in Table 1 Flow rate versus dimension below.

Nominal diameter DN	Size In	Minimum flowrate (typical) m³/h	Maximum flowrate (typical) m³/h	Flow velocity range (typical) m/s	Scale division (typical) m³
100 *	4”	9	650	0.4 - 30	1
150	6”	35	1600	0.4 - 30	1
200	8”	60	3000	0.4 - 30	2
250	10”	90	4500	0.4 - 30	5
300	12”	100	6500	0.4 - 30	5
400	16”	170	11500	0.4 - 30	10
450	18”	220	14500	0.3 - 26	10
500	20”	270	17000	0.3 - 26	10
600	24”	380	25000	0.3 - 26	20
750	30”	400	40000	0.3 - 26	20
900	36”	450	34000	0.2 - 20	20
1050	42”	620	45500	0.2 - 20	20
1200	48”	750	56500	0.2 - 20	30
1300	52”	900	67000	0.2 - 20	30

* Only applicable to MPU 800, MPU 600 and MPU 200

Table 1 – Flow rate versus dimension

2.3.5 Cable Specifications

This section describes recommended technical data for the cables. Customer or location specific requirements for the cables must be checked and followed in addition to these guidelines. Maximum and minimum resistance, capacitance, cable length or other specifications for the signal loop must be checked, ensuring that the cable type chosen keeps the signal loop within its specifications.

It is the customer's responsibility to ensure that these specifications are followed. Please contact supplier for advice if this manual does not contain sufficient information for the specific interfaced apparatus.

	MPU 1200	MPU 800	MPU 600	MPU 200
Cable entries for transducers	12	8	6	2
Cable entries for external cables	4	8	10	14

- All cable entries have ½" NPT threads.
- Transducer cables are factory mounted.
- Cable entries for external cables are plugged.

For EU-model:

- Adapters from ½" NPT threads to M20 threads are included for external cables.
- M20 blind plugs are included for external cable entries.
- All glands, adapters and blind plugs are brass nickel plated or equivalent material, with ATEX certification.
- Cable entries must be in accordance to EN 50018:2000 section 13.1. (EEx d type gland).
- Transducer cable shield is connected to the glands in one end.

For US-model:

- ½" NPT blind plugs are used.
- Transducer cables are MI-cables with integrated glands in each end, with ½" NPT threads. Glands are nickel plated.
- MI-cable shield is connected to the connector marked "shield" (CN1 to CN6 on the UAFE board).
- Cables and blind plugs are minimum certified Explosion proof, Class 1, Division I, Group C&D.

2.3.5.1 Main power, 230/240 , 115/120 VAC

	Specification	Comments
Type of cable	2 core + earth, with armour	Armour may be used as earth connection
Min / max crossectional area	1.5 – 4 mm^2 (18 – 14 AWG)	Check location requirements.
Max. cable length	Not critical	Power requirement is 12W (basic version) and up to 14W (with optical fibre conv.).
Max. resistance	"	"
Cable screen	Collective (armour)	

2.3.5.2 Main power, 24 VDC

	Specification	Comments
Type of cable	2 core + earth, with armour	Armour may be used as protective earth (PE) connection.
Min / max cross-sectional area	Minimum 1.5 mm^2 (18 AWG)	Check location requirements.
Max. cable length	Check resistance in cable, minimum input voltage 22VDC	Power requirement is 12W (basic version) and up to 14W (with optical fibre conv.).
Max. resistance	"	"
Cable screen	Collective (armour)	

2.3.5.3 Instrument Earth cable (IE)

	Specification	Comments
Type of cable	1 core	
Min / max cross-sectional area	Minimum 2.5 mm^2 (16 AWG)	Check location requirements for earth cables.
Max. cable length	Not critical	Usually from closest junction box Check location requirements.

2.3.5.4 Ethernet, twisted pair (10Base-T)

	Specification	Comments
Type of cable	Category 5 cable *) (2 twisted pairs)	Must be twisted the entire length.
Min / max cross-sectional area	Ref. Category 5 cable.	Typical 0.5 mm^2 (24 AWG)
Max. cable length	≅ 100 m (328 ft)	Junction boxes will reduce maximum length.
Cable screen	Collective	

*) Category 5 cable, is defined by the EIA/TIA/ANSI 568 specification. Maximum capacitance of 51 pF/m, typical 43.5pF/m (17 pF/ft, 14.5 pF typical) and characteristic impedance of 100 ohms. Is available as shielded twisted pair (STP) as well as unshielded twisted pair (UTP).

2.3.5.5 Ethernet, fiber Link (10Base-FL)

	Specification	Comments
Type of cable	Multimode 62.5/125µm 4 fibers (2 spare)	
Max. cable length	≅ 1000 m (3280 ft)	The total damping budget must be calculated. Max cable length is dependent on modem in each end, damping in cable and no. of ST-connectors. Use of repeaters will increase maximum cable length.

2.3.5.6 Serial RS-232

	Specification	Comments
Type of cable	3 core	Category 5 cable is recommended for both RS-232.
Min / max cross-sectional area	0.5 – 1 mm^2 (24 – 20 AWG)	Recommended size.
Max. cable length	15 m (50 ft)	Junction boxes will reduce maximum length.
Maximum capacitance	2500pF	Pairwise shielding is recommended.
Cable screen	Collective	

2.3.5.7 Serial RS-485 (2-wire and 4 wire)

	Specification	Comments
Type of cable	Category 5 cable (2 twisted pairs)	Category 5 cable is recommended for RS-485.
Min / max cross-sectional area	0.5 mm^2 (24 AWG)	Recommended size.
Max. cable length	≅ 500 m (1640 ft)	Junction boxes will reduce maximum length.
Cable screen	Collective	Pairwise shielding is recommended.

2.3.5.8 Analog Input/Output

	Specification	Comments
Type of cable	Multicore twisted pair	Cable resistance and capacitance must be checked according to external equipment.*)
Min / max crossectional area	0.5 – 1.5 mm^2 (24 - 18 AWG)	
Max. cable length	50 m (164 ft)	
Cable screen	Collective + pairwise shield	

2.3.5.9 Digital Input/Output

	Specification	Comments
Type of cable	Multicore	Cable resistance and capacitance must be checked according to external equipment.
Min / max crossectional area	0.5 – 1.5 mm^2 (24 - 18 AWG)	
Max. cable length	500 m (1640 ft)	
Cable screen	Collective	

2.3.5.10 Pulse Output

	Specification	Comments
Type of cable	Category 5 cable*) (2 twisted pairs)	Category 5 cable is recommended for both RS-422 and RS-485.
Min / max crossectional area	0.5 mm2 (24 AWG)	Recommended size.
Max. cable length	≅ 500 m (1640 ft)	Junction boxes will reduce maximum length.
Cable screen	Collective	Pairwise shielding is recommended.

*) Category 5 cable, is defined by the EIA/TIA/ANSI 568 specification. Maximum capacitance of 51 pF/m, typical 43.5pF/m (17 pF/ft, 14.5 pF typical) and characteristic impedance of 100 ohms. Is available as shielded twisted pair (STP) as well as unshielded twisted pair (UTP).

2.3.6 Software Interfaces

Communication protocols as Modbus, is described in separate document PRD-0000022543 “External Data Communication MPU Series B”.

2.3.7 Main Connections and Connected Systems

The MPU may be connected to a host computer or delivered with a PC as user interface. Possible interface connections are shown in Figure 2.

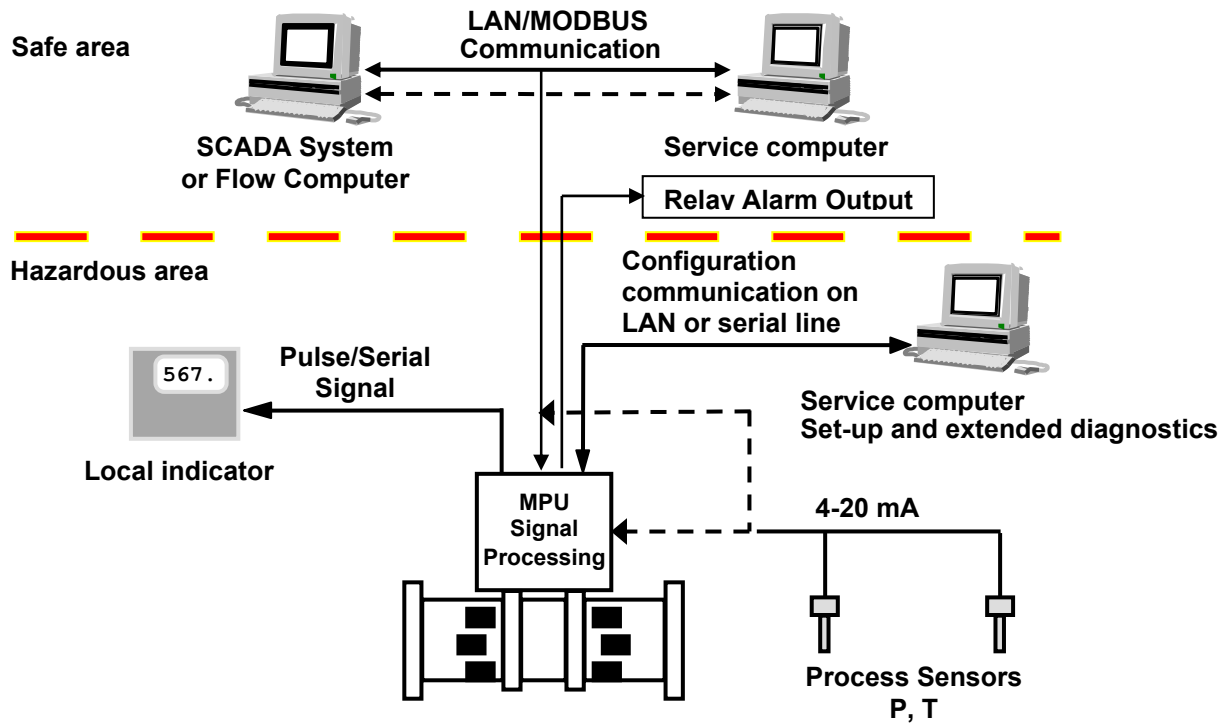


Figure 2 – Main Connections

2.3.8 Weight and Outline Dimensions

MPU Size Pressure Class	4”	6"	8"	10"	12"	16"	20"	24"	30”	36”
ANSI Class 150-600	24,41	29,02	33,46	37,00	39,00	43,31	45,51	53,00	62	72
ANSI Class 900	25,59	29,92	33,86	37,80	39,76	43,70	47,24	53,54	TBA	TBA
ANSI Class 1500	25,59	29,92	33,86	37,80	39,76	43,70	47,24	53,54	TBA	TBA

Table 2 - Typical MPU Dimension A (Inches)

MPU Size Pressure Class	4”	6"	8"	10"	12"	16"	20"	24"	30”	36”
ANSI Class 150-600	620	737	850	940	990	1100	1156	1346	1575	1829
ANSI Class 900	650	760	860	960	1010	1110	1200	1360	TBA	TBA
ANSI Class 1500	650	760	860	960	1010	1110	1200	1360	TBA	TBA

Table 3 – Typical MPU Dimension A (mm)

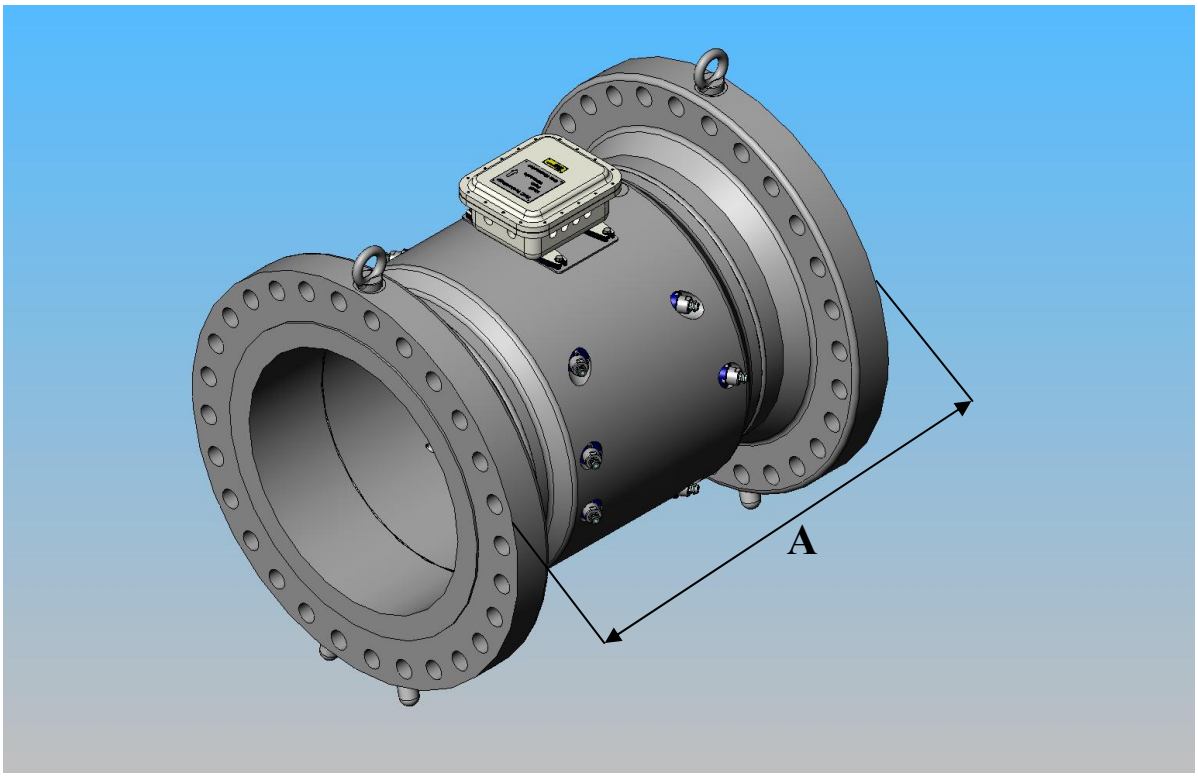


Figure 3 – MPU Face to face dimension

MPU Size *Pressure Class*	4“	6"	8"	10"	12"	16"	20"	24"
ANSI Class 150	321,87	423,29	654,77	672,41	1011,92	1265,45	1671,10	1717,40
ANSI Class 300	341,72	458,56	709,89	749,57	1130,97	1481,51	2109,82	2356,74
ANSI Class 600	374,79	535,72	815,71	947,99	1300,73	1763,70	2493,43	2854,99
ANSI Class 900	425,49	595,25	925,94	1089,08	1499,14	1975,34	2969,63	4195,40
ANSI Class 1500	436,52	705,48	1127,00	1477,10	2231,08	3483,30	5412,35	7855,07

Table 4 – MPU Overall Weights (lbs) (approx.)

MPU Size *Pressure Class*	4“	6"	8"	10"	12"	16"	20"	24"
ANSI Class 150	146	192	297	305	459	574	758	779
ANSI Class 300	155	208	322	340	513	672	957	1069
ANSI Class 600	170	243	370	430	590	800	1131	1295
ANSI Class 900	193	270	420	494	680	896	1347	1903
ANSI Class 1500	198	320	511,2	670	1012	1580	2455	3563

Table 5 – MPU Overall Weights (kgs) (approx.)

3 TECHNICAL DESCRIPTION

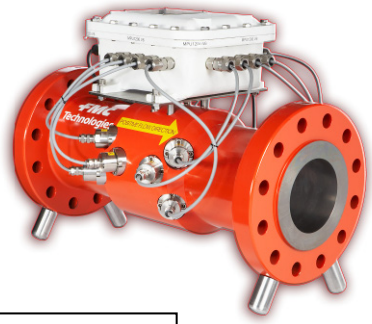
The purpose of this section is to facilitate a better understanding of the different parts of the operating and maintenance instructions. In this way the operator and maintenance personnel are able to easily perform effective faultfinding on a recommended detail level, and exchange or repair damaged components.

3.1 Product Overview

There are currently four versions available, MPU 1200, MPU 800, MPU 600 and MPU 200. The difference between them is the number of paths. All other parts are identical. The MPU 1200 has 6 paths (12 transducers), MPU 800 has 4 paths (8 transducers), MPU 600 has 3 paths (6 transducers) and the MPU 200 has 1 path (2 transducers). All version use identical electronics with the appropiate number of transducers connected. The MPU 800 and 600 is a lower cost version of the MPU 1200 with slightly lower measurement performance. The MPU 200 is made for applications with lower accuracy requirements.

Figure 4 – MPU Product Overview

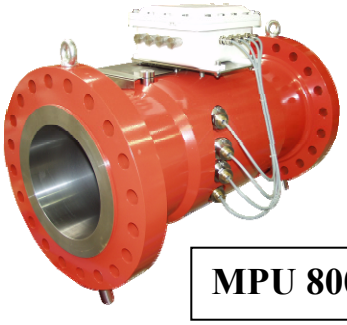
The transducers are flush mounted to the internal meter body to provide for undisturbed and accurate measurement of gas flow.



MPU 1200

The MPU 1200, MPU 800 and MPU 600 are designed to handle the requirements of fiscal metering as a stand alone meter or incorporated into a complete metering station. The MPU series of ultrasonic meters interface easily with field mounted flow computers, distributed control, SCADA systems or you may choose to select our complete metering system.

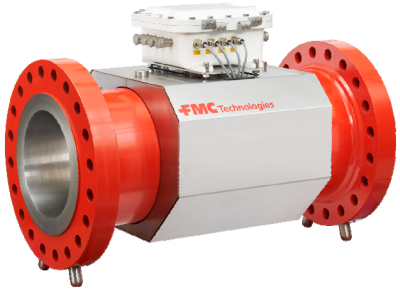
A standard MPU series meter consists of a flanged spool piece with ANSI flanges and body material in Carbon steel. A wide range of dimensions, pressure ratings, special materials and flange types are also available as we design the meter to accommodate your piping scheme.



MPU 800

On the rare occasion that a signal transducer fails, a transducer retraction tool with isolation valves can be delivered providing easy and safe removal of the transducer, if required, without the need for process shut down and meter re-calibration after transducer reinsertion or replacement. The standard version of this tool is capable of operating safely up to 2900 psig/ 200 barg. Higher pressure rating is available on request.

MPU 600



MPU with cover

MPU 200

3.2 The MPU features

- **Up to 60 % cost, space and weight saving** compared to conventional orifice and turbine meter installations.
- **Non-intrusive design** that eliminates pressure drop resulting in highly efficient operation.
- **High accuracy:** 6 or 4 acoustic paths ensure bi-directional flow measurements of high accuracy (MPU 1200 / 800).
- **In line transducer replacement** eliminating the need for shut down.
- **AGA 9 compliance (MPU 1200, MPU 800 and MPU 600).**
- **High turndown ratio.**

3.3 Instrument Design

All electronic parts are located inside the Explosion Proof Enclosure. Cables are connected to the Explosion Proof Enclosure. The field electronics performs all signal processing and calculations.

3.4 Mechanical Design

Meters can be made from dedicated castings, forgings or are fabricated. The attachment of the signal transducer is a flanged design, always in accordance with designated practices.

3.5 Principle of Operation

The MPU series of meters operate on the well-established acoustic transit time principle. The measurement principle is based upon the direction and propagation velocity of an ultrasonic pulse as it is affected by the flowing medium. An ultrasonic pulse propagating with the flow will increase in velocity while an ultrasonic pulse propagating against the flow will decrease in velocity. Turbulence and noise-generated frequencies are filtered by means of a unique signal processing.

The meter measures the transit time of the ultrasonic signal it travels through the gas. The start of the signal transmission and detection of the correct signal is performed by the software.

The signal transducers are non-intrusive and flush mounted ensuring minimum risk of clogging from residues that may be present in the flow. The transducer is fully encapsulated in a titanium housing that is designed to be field replaceable during operation and without the need for process shutdown or flow re-calibration after transducer replacement.

MPU 1200 path configuration:

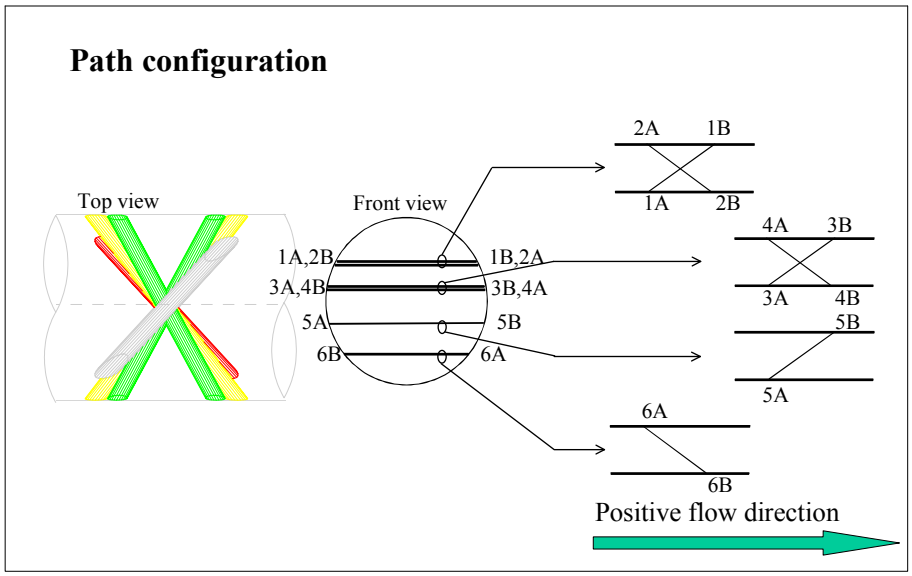


Figure 5 – MPU 1200 path configuration

MPU 800 path configuration:

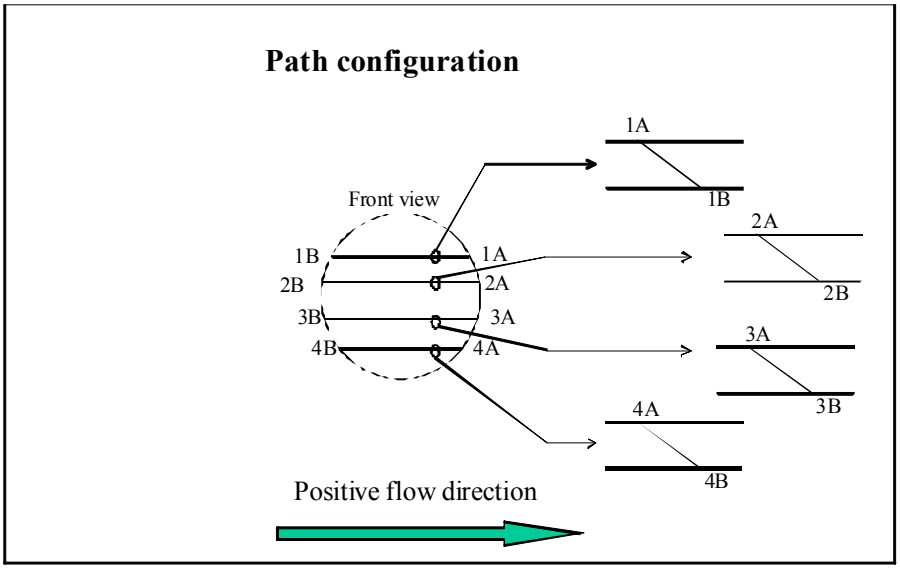


Figure 6 – MPU 800 path configuration

MPU 600 path configuration:

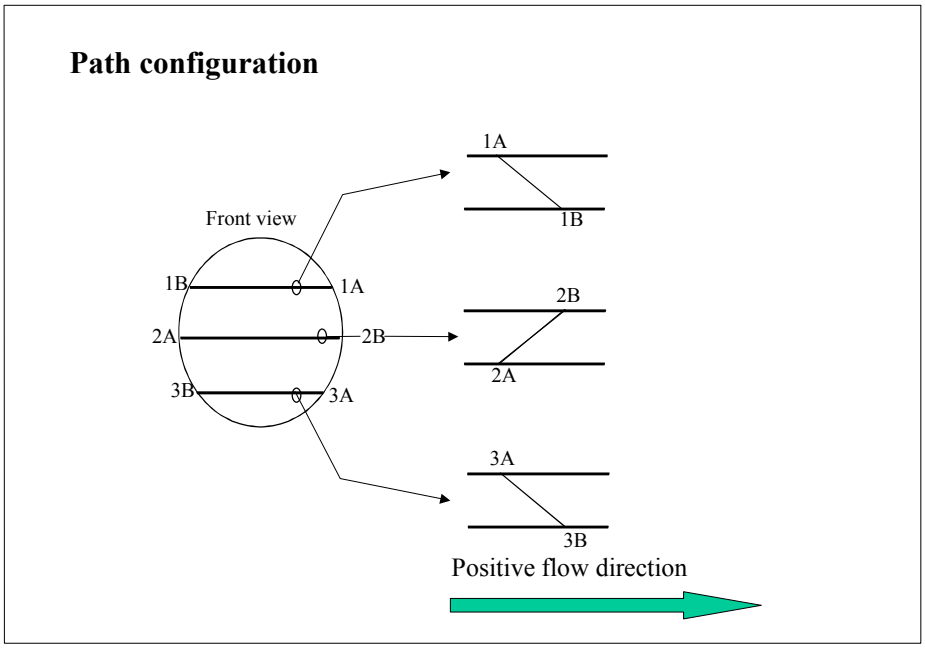


Figure 7 – MPU 600 path configuration

MPU 200 path configuration:

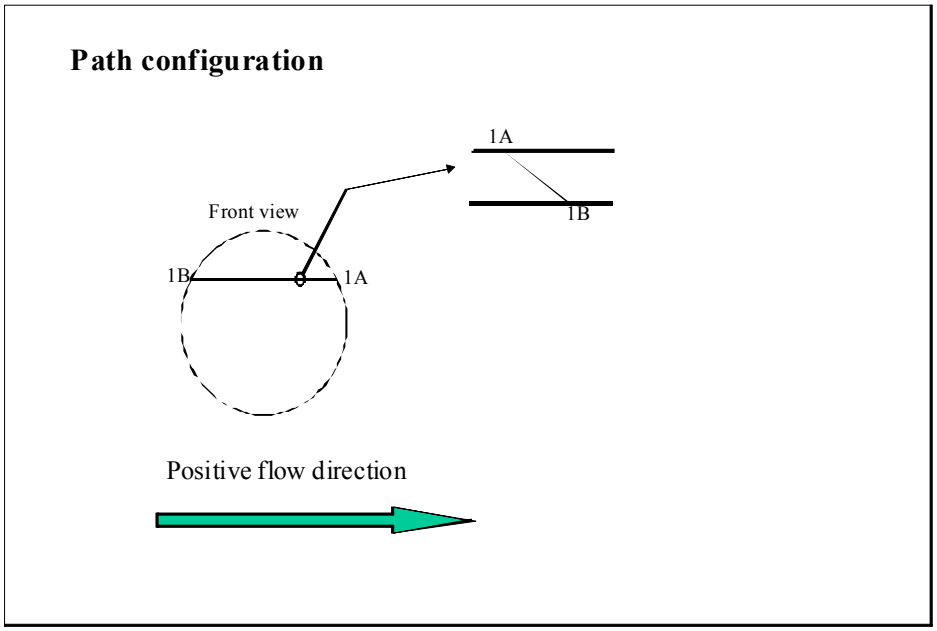


Figure 8 – MPU 200 path configuration

The MPU may be connected to a host computer or delivered with a PC as user interface. When the required parameters have been checked, and if necessary adjusted, the meter may be put into run mode to start measurements. The meter measures continuously, and depending on the number of averaged ultrasonic signals, the flow velocity is updated every 4 - 10 seconds.

The updated flow velocity is stored in the database and is read by the user interface at required intervals. Other measurement values as velocity of sound, flow velocity for each acoustic path, gain for each transducer, percentage number of signals used, line pressure, line temperature and line density etc. are also available in the database. The measured amount of gas may be presented as actual flow velocity or actual volume flow rate. Mass flow rate and standard volume flow rate may be delivered on request, provided that pressure, temperature and density data are available.

The meter's self-diagnostic system gives alarms if a detectable malfunction should occur or maximum deviation limits are exceeded. If a path is malfunctioning, the meter will continue the measurements based on the data from the other paths.

Configuration of the meter can be performed online via the user interface. The next measuring cycle will use the new parameters. The configuration function is password protected.

3.6 Measurement Principle

The following section describes the measurement principle of the MPU.

3.6.1 Transit Time Measurement

To measure gas flow and velocity of sound (VOS), the MPU employs the fact that sound travels faster with the gas flow than against it. Figure 8 below shows a top view of a pipe with gas flow. The gas flow velocity is V, θ is the angle the sound beams make with the pipe wall, A and B are the positions of the transducers and L is the distance between transducer A and B. T_u and T_d are the times of flight up- and downstream respectively. These travel times, together with the geometry of the system, i.e. transducer mounting and pipe diameter, are all that is needed to calculate the gas flow velocity and the velocity of sound for each path.

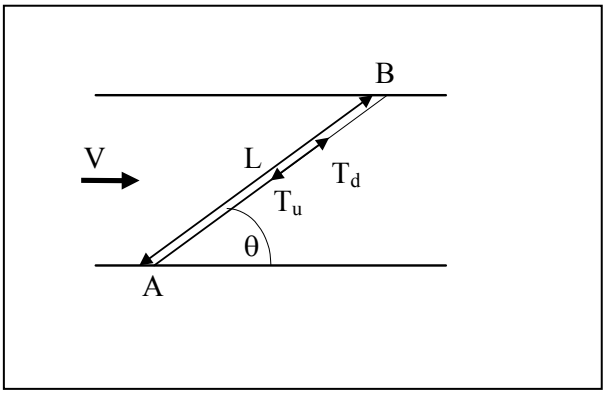


Figure 9 – Top View of path, travel times

The sound will travel slower upstream and faster downstream because of the velocity component of the gas flow in the direction of the sound path. This yield

$$T_d = \frac{L}{c + v\cos(\theta)}$$

and

$$T_u = \frac{L}{c - v\cos(\theta)}$$

where **c** is the velocity of sound in the gas and **v** is the gas flow velocity.

From these equations one can isolate the gas flow velocity and VOS. Thus

$$v = \frac{L}{2\cos(\theta)} \cdot \frac{T_u - T_d}{T_u T_d}$$

and

$$c = \frac{L}{2} \cdot \frac{T_u + T_d}{T_u T_d}.$$

3.6.2 Travel Time Corrections

The signal pulse in the transducers is converted from an electrical signal to an acoustic signal, and back to an electrical signal on the receiver side. The signal is delayed during these conversions, and these transducer delays are measured for each transducer during internal testing. Typical magnitude of the transducer delays is 8-10μs.

3.6.3 Calculate Average Gas Flow Velocity

To calculate the average gas flow velocity over the pipe area, information from all sound paths, including transducer delays, are put into an integration formula.

Figure 9 shows a front view of the pipe, with the placement of the 6 sound paths in the 4 planes for the MPU 1200. The average velocity is given by

$$\bar{v} = \sum_{i=0}^{5} w_i \cdot v_i \quad ,$$

where w_i is the weighting factors and v_i is the average gas flow velocity for each path.

Similar equations are used for the MPU 800, MPU 600 and the MPU 200.

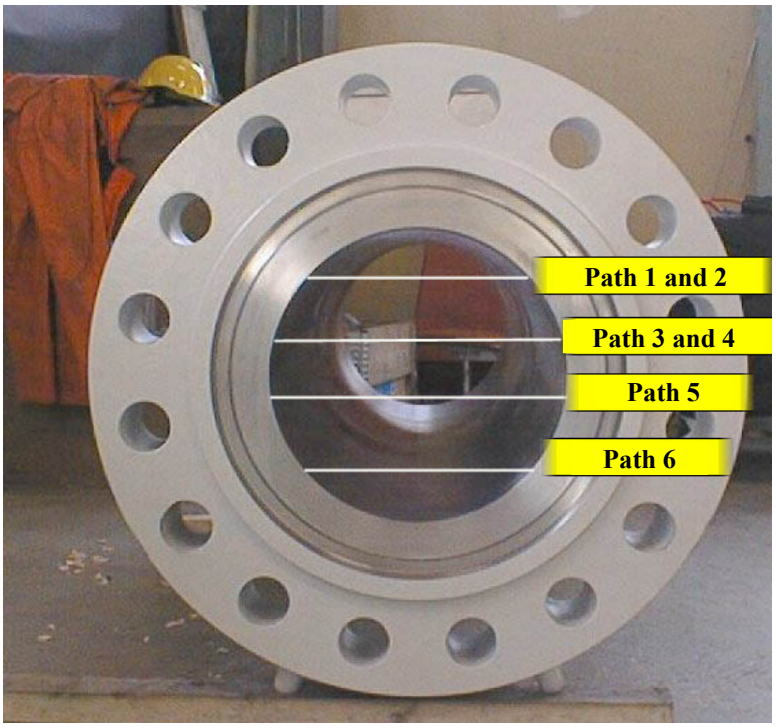
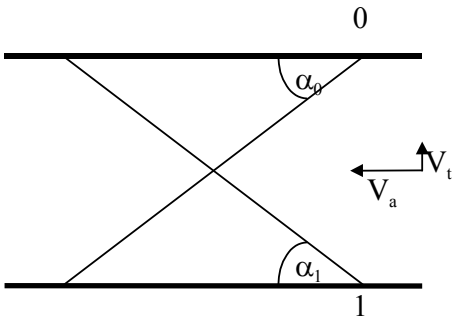


Figure 10 – Front view of pipe, showing internal positions of the paths

For MPU 1200, the two crossing sound paths in the same plane are used to determine the transverse flow components. Figure below shows the top view of the pipe, with axial (V_a) and transverse (V_t) flow indicated.



The information about cross flow and swirl is used to improve the accuracy of the average flow velocity calculation.

Figure 11 – Top View of pipe, with axial and transverse flow indicated

By checking the direction and magnitude of the transverse flow components in the two upper planes, the flow regime can be determined, as shown in picture below.

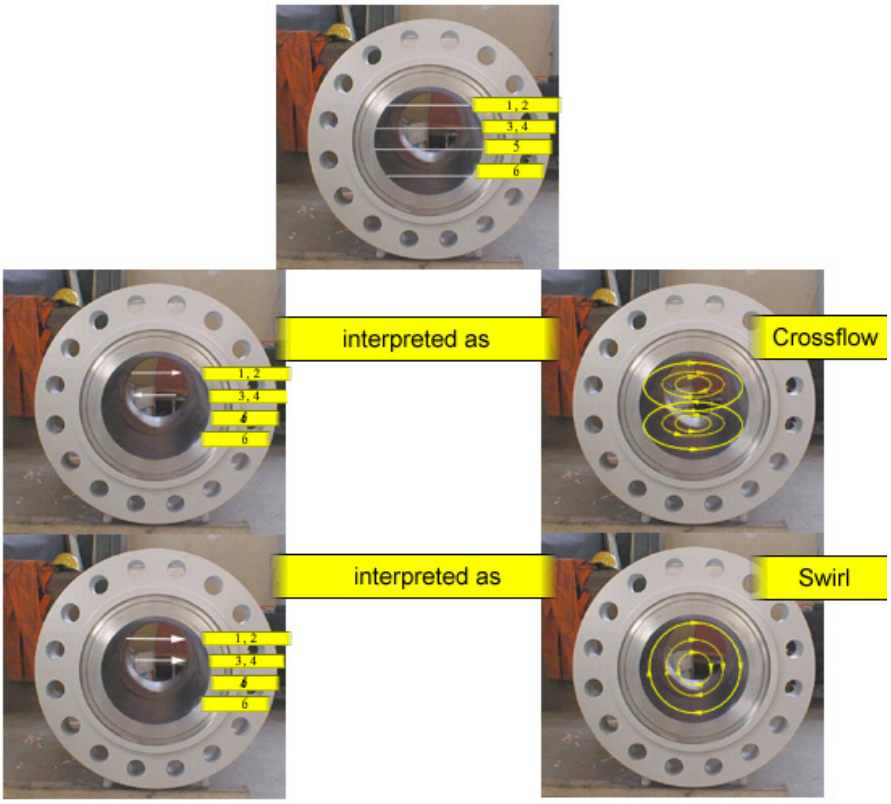


Figure 12 – Front view of pipe, showing flow regimes

The information about cross flow and swirl is used to improve the accuracy of the average flow velocity calculation.

The MPU 800 and MPU 600 will by the path geometry correct for symmetrical swirl, but is more sensitive to crossflow. Therefore a well developed flow profile is required to obtain fiscal accuracy.

The MPU 200 can neither measure or correct for swirl or crossflow.

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4 RECEPTION AND INSTALLATION

The purpose of this section is to provide instructions for reception and installation of the equipment in order to avoid that personnel get exposed to any danger or injury nor damage to the equipment.

4.1 Reception Procedure

When receiving the equipment at site, the following instructions must be followed:

4.1.1 Unpacking and Inspection

NOTE: The equipment is usually transported in a wooden transport box.

A. Unpack the equipment from the wooden box by loosen the roof and walls in the transport box, as shown in the picture below.

Figure 13 – MPU in Transportation Box

B. Inspect the equipment for any sign of damage. Any discovered damage related to the transport of the meter must immediately be reported to supplier and the insurance company being responsible for the transport. All damages must be described and photographed.

NOTE: Dismount the flange protection covers, and inspect the Spools as well.

C. Mount the covers back on before lifting the equipment to installation site.

D. Lift and handle the MPU in accordance with THI-0000020502.

4.1.2 Identification and Marking

In order to perform correct installation, it is important that the correct ultrasonic meter and its ultrasonic signal paths are identified.

Item	Marking
Spool piece	– Serial number of the MPU.
Adapter / Spool piece	– Transducer position number. See Figure 14 to 17- Transducer and Electronic marking.
Electronics enclosure	Name plates with: – Serial number of the MPU. – Tag. No. according to customer requirements. – Electrical classification – Operational conditions. – Spool piece data.
Transducer	– Serial number of the transducer (not visible while mounted).
Transducer Cable	– Marked with Number 1 and 2 on the strands

The transducers show the transducer serial number, the Heat No and PTB EX classification.. The cross-reference between the transducer serial number and the transducer position number is found in the calibration report.

Table 6 – Transducers marking

Transducer number	Adapter number	Electronic number	Cable connection in electronics enclosure
1A	Position 1A	1A	TRANSD 1A
1B	Position 1B	1B	TRANSD 1B
2A	Position 2A	2A	TRANSD 2A
2B	Position 2B	2B	TRANSD 2B
3A	Position 3A	3A	TRANSD 3A
3B	Position 3B	3B	TRANSD 3B
4A	Position 4A	4A	TRANSD 4A
4B	Position 4B	4B	TRANSD 4B
5A	Position 5A	5A	TRANSD 5A
5B	Position 5B	5B	TRANSD 5B
6A	Position 6A	6A	TRANSD 6A
6B	Position 6B	6B	TRANSD 6B

Figure 14 – Transducer and Electronic marking (MPU 1200)

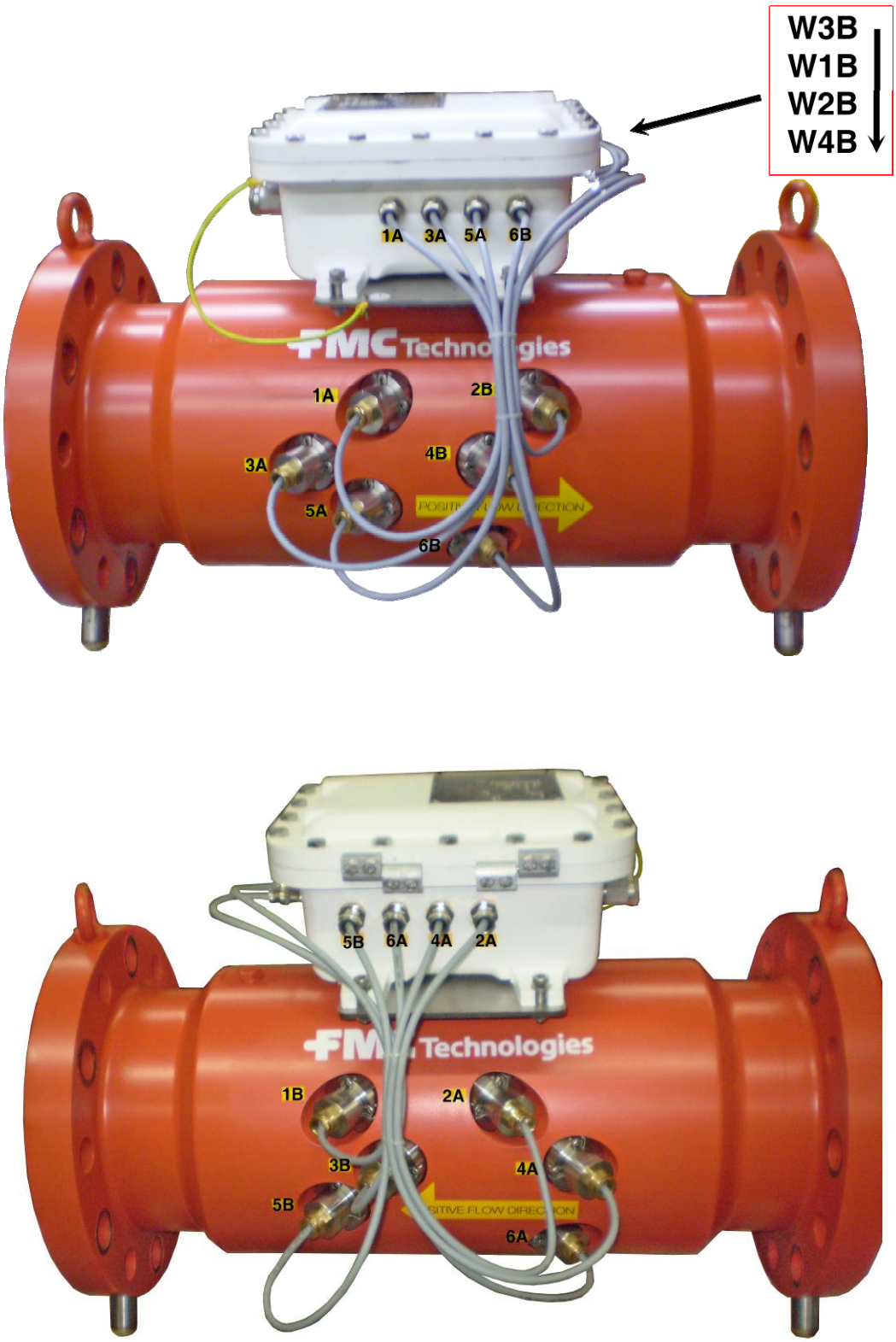

Figure 15 – Transducer and Electronic marking (4” until 10” MPU 800)

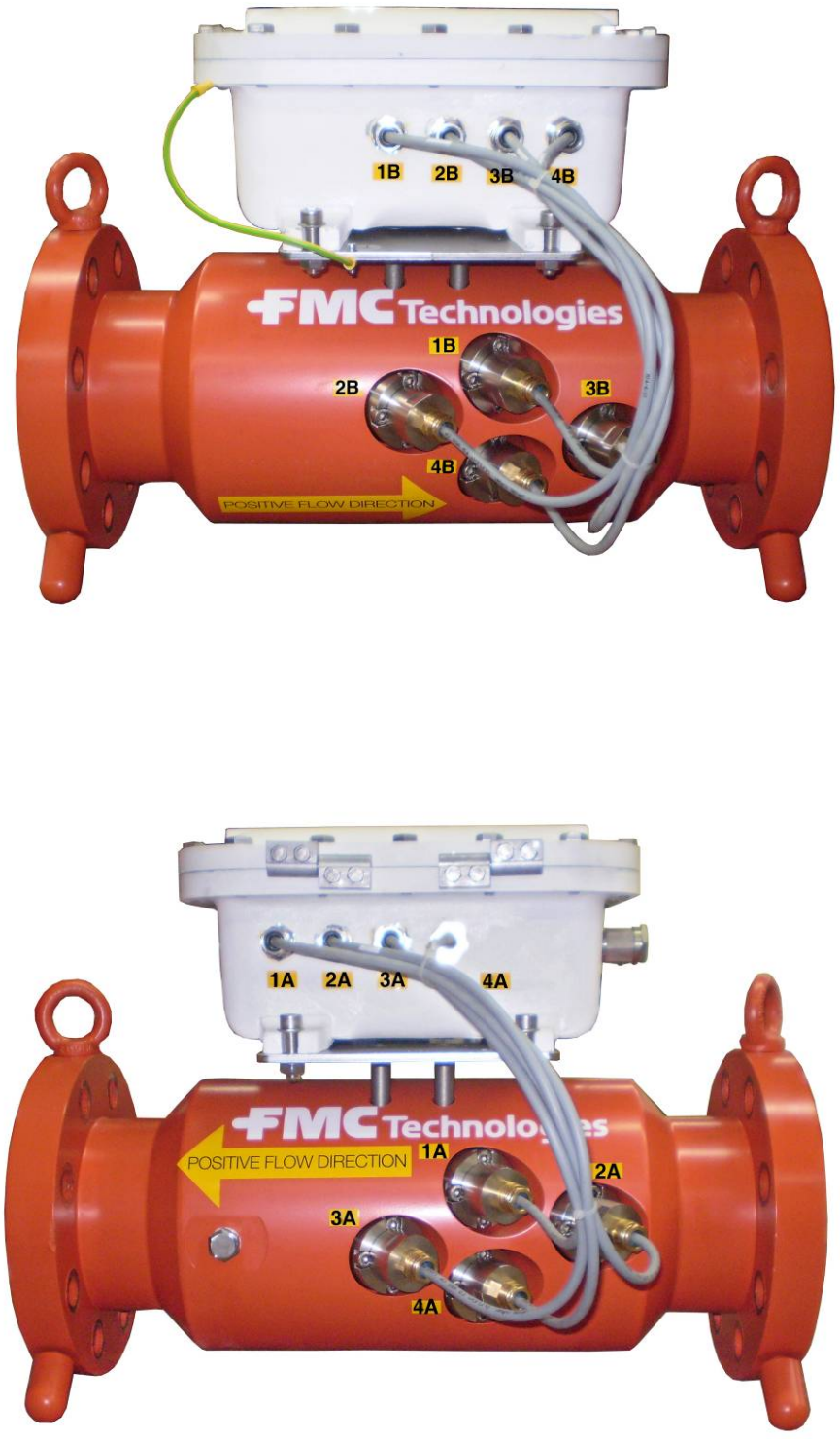

Figure 16 – Transducer and Electronic marking (at 12” MPU 800)

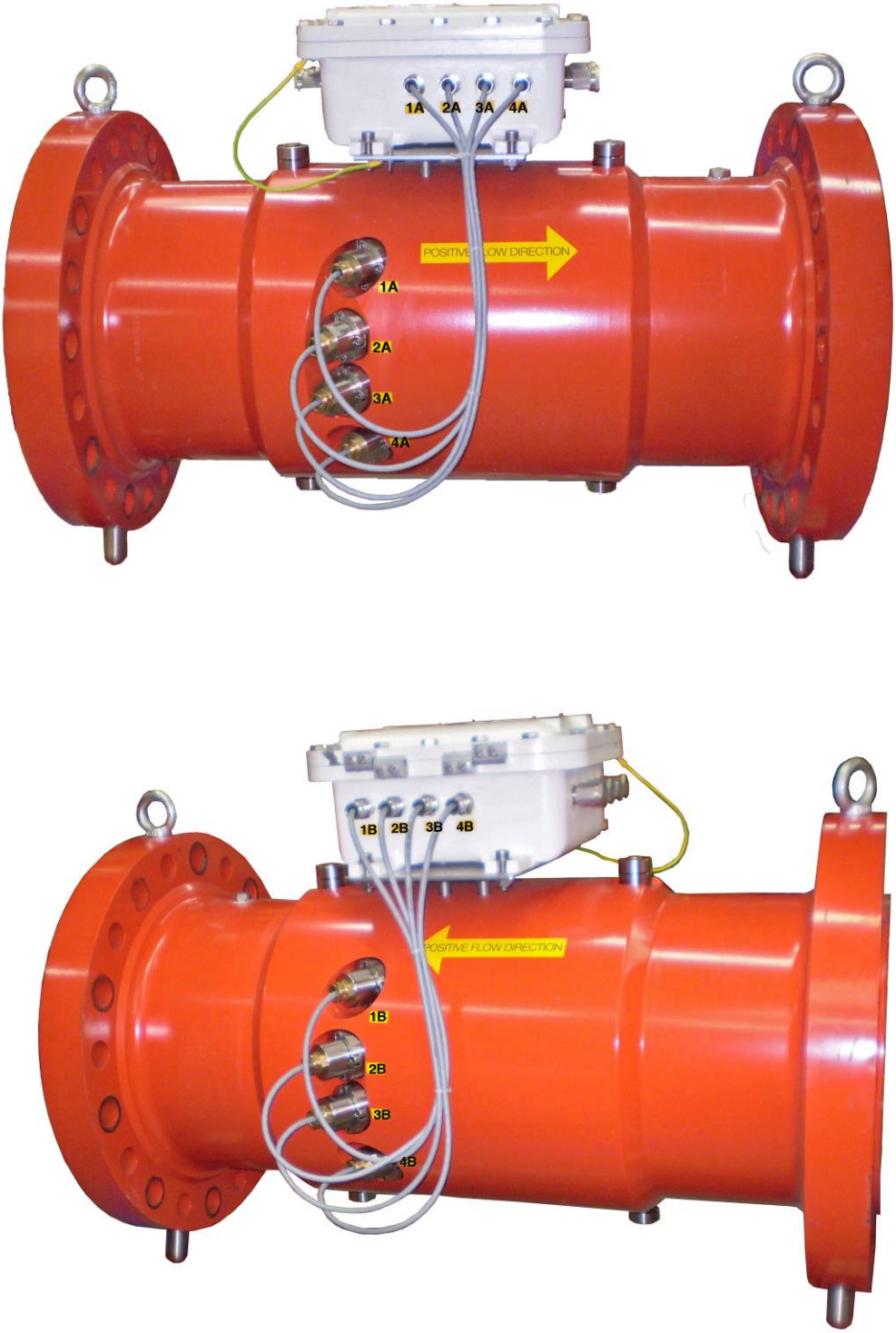

Figure 17 – Transducer and Electronic marking (MPU 600)

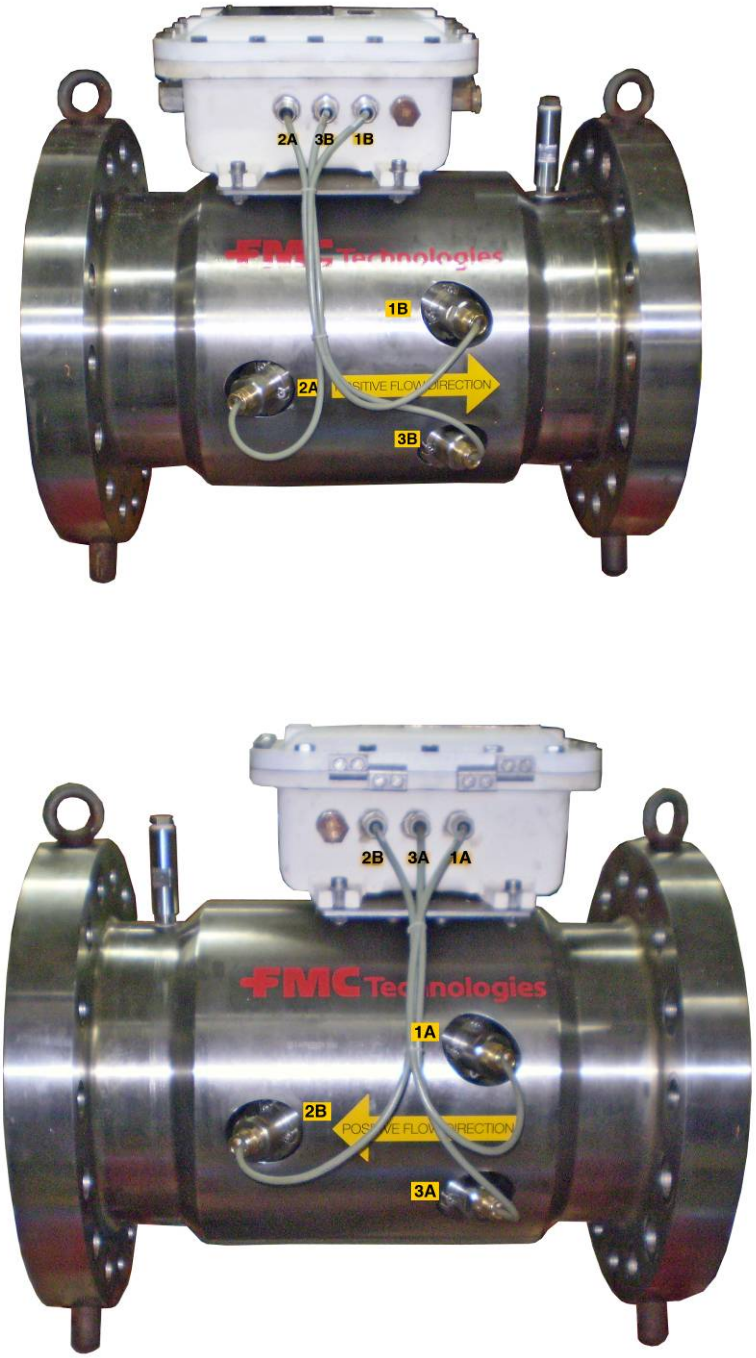

Figure 14 – 17 shows the transducer positions and where the transducer cables enter the electronics enclosure. The large arrow illustrates positive flow direction.

4.2 Installation Procedure

4.2.1 Pre-Installation Procedures

4.2.1.1 Installation Requirements

Usually the installation requirements are determined during the project engineering phase, before the actual installation. However, sometimes the meter may be moved or additional equipment added at a later stage, so always make sure the following requirements are fulfilled. Any deviations from this must be agreed by supplier prior to installation, in writing.

- Minimum 10D upstream straight pipe. Minimum 3D downstream straight pipe. For bi-directional measurements, Minimum 10D at both ends. May be less if flow-straightener is installed, advised by supplier in each case.
- If the MPU TRT transducer retraction tool is to be used, at least 2 meters of space on both sides of the MPU is required. 2 meters of space is also required on both sides of the piping 1 meter upstream and 1 meter downstream of the MPU.
- For one upstream bend configuration, a flow straightener is usually not required. Please contact supplier for advice.
- For multiple upstream bend configurations, a flow straightener may be required. Please contact supplier for advice.
- According to customer requirements, insulation to maintain a stable gas temperature may be done.

4.2.1.2 Mechanical Inspection

Preferably, the original protection covers should still be intact. These may now be removed. Before the spool piece is mounted in the pipeline the following must be controlled:

- The inside surface must be clean and dry. Use rags or similar to remove preservative. Make sure no preservative is left in the transducer ports, as this may affect the measurements.
- Check the flanges for damage. There must not be any damage to the gasket surfaces.
- Make sure that there is no damage to the meter, check the electronics enclosure, cable glands, transducer cables, transducer end covers etc.
- Check that the positive flow direction indicated on the name plate is in the same direction as the defined positive flow direction of the site.
- Use the correct type of flange gaskets, and make sure there is no damage to the gaskets.

The support legs are threaded and may be removed after installation. They should be stored and remounted before possible removal of the meter.

4.2.2 Installation of the Spool Piece

In most cases the spool piece is to be installed at a predetermined location in the piping system. The size, material and flange type of the spool piece is manufactured to comply with the existing piping. The size and type of bolts and gaskets must comply with the piping specifications. It is a condition for the installation that general knowledge about how to install pipe work is held by the dedicated professionals.

NOTE: Lifting lugs should be removed after installation in order not to be used if the MPU is to be removed after years in operation.

4.2.2.1 Equipment and Tools required

The following tools and equipment are necessary to perform a safe and correct installation of the spool piece:

- Crane or forklift
- Certified lifting slings
- Hydraulic tools for correct torque of the bolts
- Rags for cleaning of inside surface
- Necessary gasket lubricant
- Bolt lubricant

The size of some of the tools will depend on the flange type and size.
Check weight and pressure rating on the spool piece to get suitable equipment.

A. Use a forklift or a crane to place the meter in its position in the pipeline.
B. While a few bolts are fastened on both sides, check that the gaskets have entered correctly.
C. Enter the remaining bolts.
D. Use the hydraulic tools and set the torque according to the pressure rating of the flanges.
E. Pressurise the pipeline and check for leakage.

4.2.3 Cabling Overview

The MPU electronics is mounted in an explosion proof enclosure. The enclosure is placed on top of the flow meter body. The electronic unit performs all signal processing and calculations, and communicates flow rates as well as diagnostics data to customer specified Host systems. The required cabling between the electronics and the control room is one communication cable and one power cable. The maximum distance between the meter and the control room is only limited by selected type of communication interface.

A picture of the electronics enclosure is shown in Figure 18.

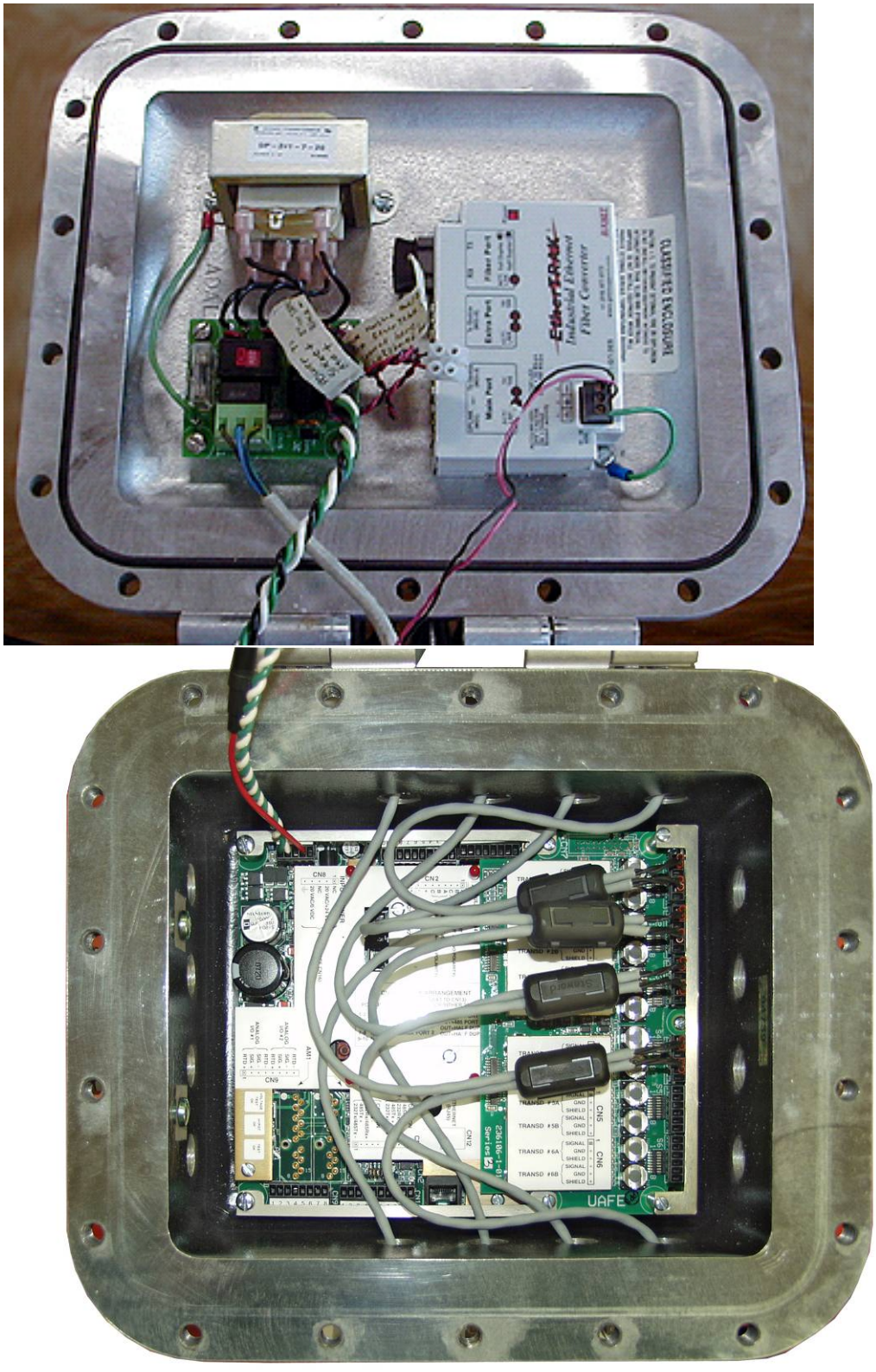

Figure 18 – MPU Electronics

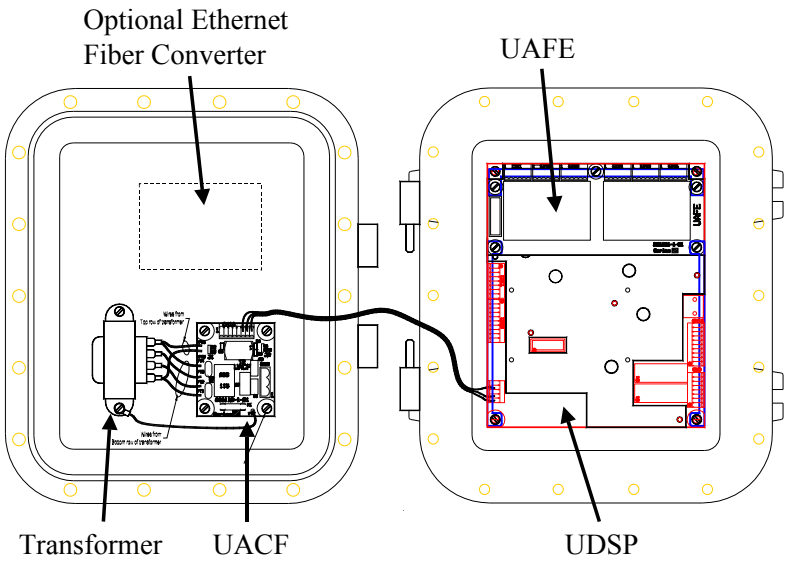

Figure 19 – MPU Electronics overview

4.2.3.1 Power supply

CAUTION: Make sure correct switch and jumper settings are applied to the UACF board.

Both AC and DC power can be applied depending on the UACF board setup.

Power	Rating
AC power input range	115/230 VAC +/-10%, 12 Watts, 48 to 63 Hz
DC power input range	24 VDC +/- 15%, 0.5 A

AC input power setup:

1. Set jumper J1 between pin 1 and 2 for AC input power.
2. Select AC input voltage level (115 or 230 VAC) with switch SW1.
3. Connect input power cable to connector CN15.

AC input wire	Terminal
L1	CN15-1
L2/N	CN15-2
Earth	CN15-3

DC input power setup:

1. Set jumper J1 between pin 2 and 3 for DC input power.
2. Connect input power cable to connector CN16.

DC input wire	Terminal
24 VDC (+)	CN16-1
0 VDC (-)	CN16-2

See Figure 57 for external wiring connection details.

4.2.3.2 Transducer wiring

The Transducer wiring is factory mounted.

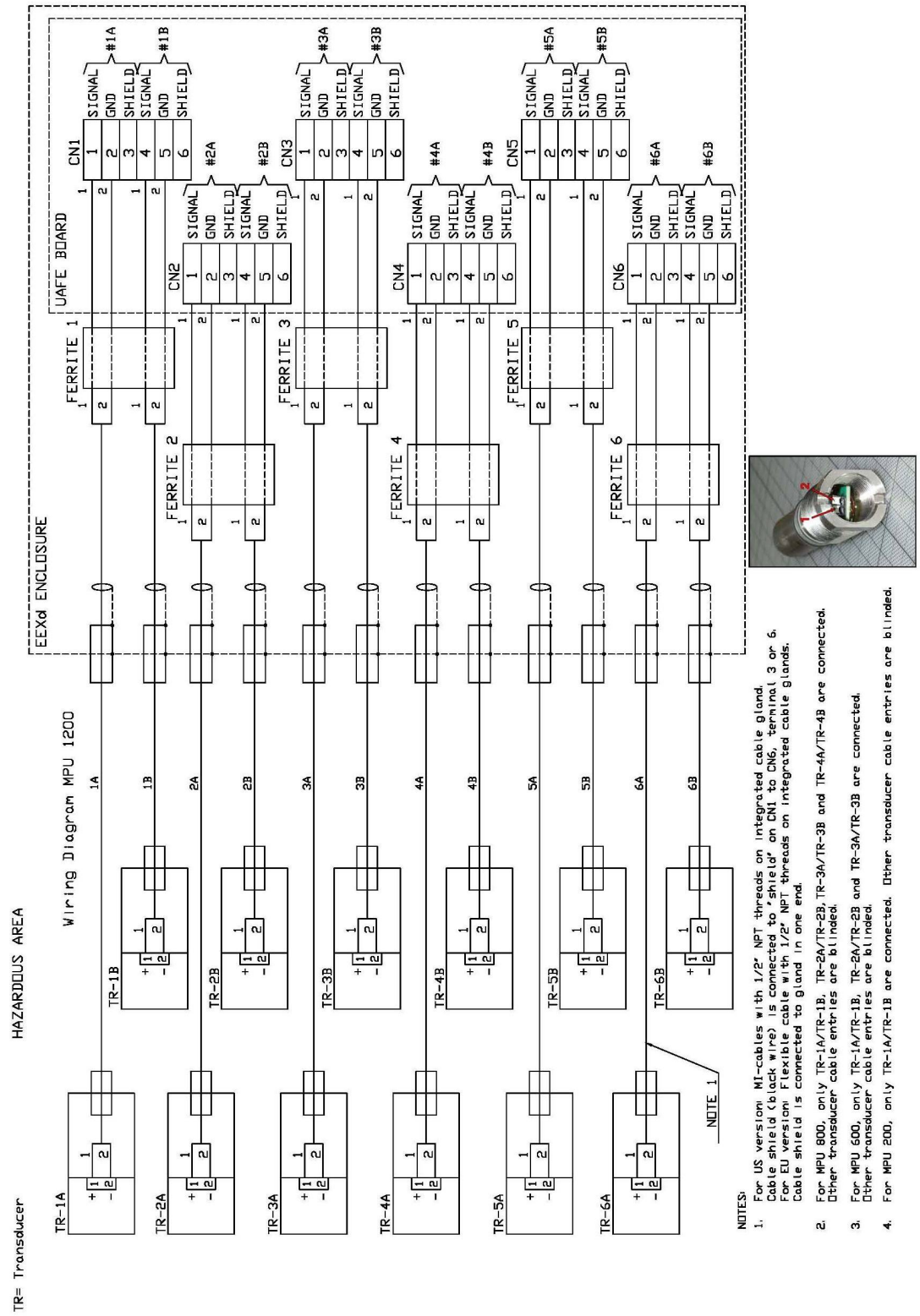

Figure 20 – Transducer wiring

4.2.3.3 Communication

Various communication ports are available, see details in Figure 21. Correct jumper setting on CN14 is required for serial communication. Analog I/O is optional, and requires Analog Input and/ or Analog Output modules to be mounted.

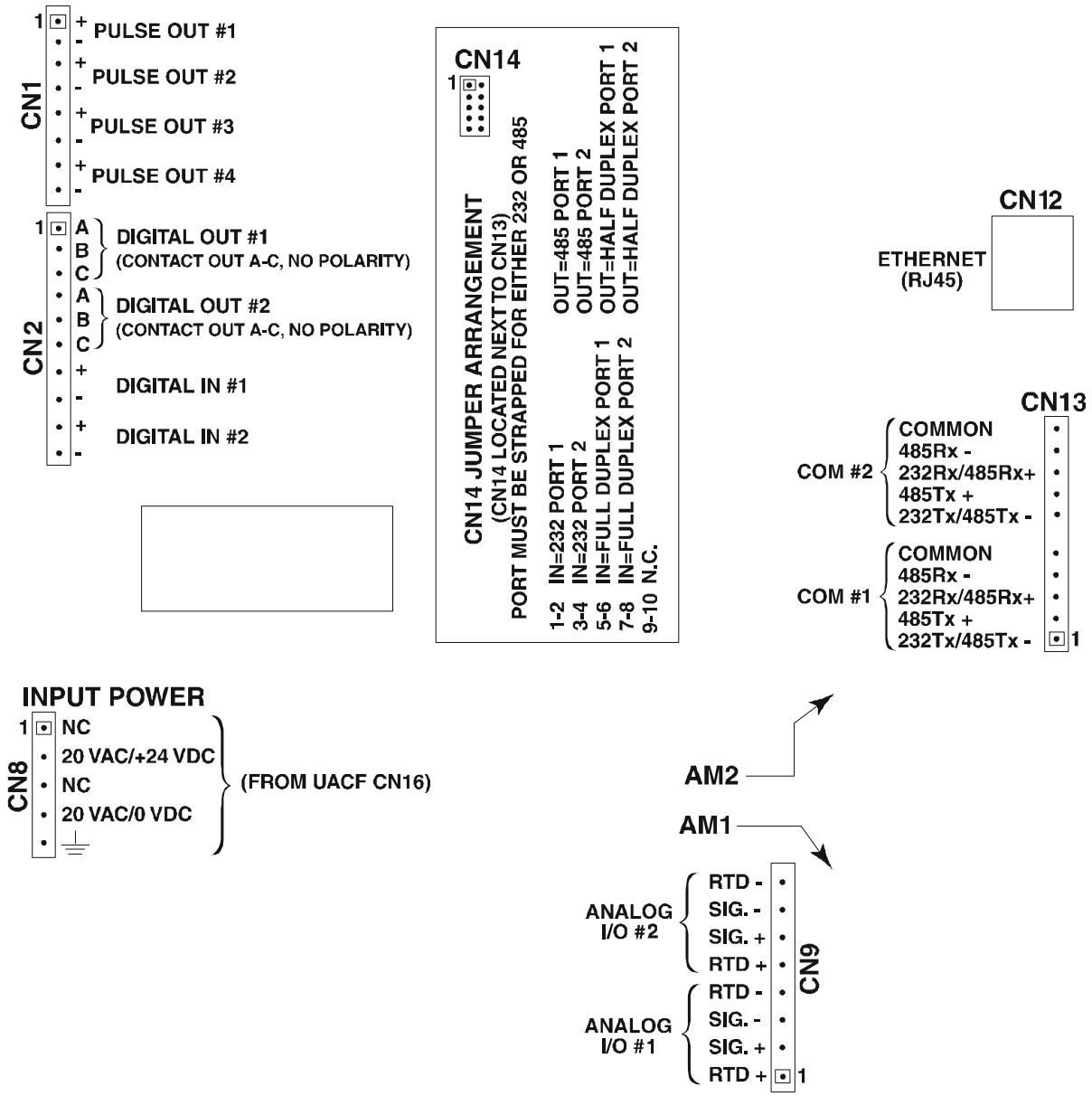

Figure 21 – UDSP board terminals

4.2.4 Installation of Cables

Due to customer or location specific requirements, the cables for communication and power supply lines are usually not a part of the delivery. However, the technical specifications for the cables **MUST** be followed. Prior to the installation, these requirements must be checked.

The number of and types of cables are dependent on which version or options that are delivered. A set of wiring diagrams are available covering the different options. Project specific wiring diagrams may also be available. The various cable requirements for the available options are described in Section 1.4.5.

Cable installation and connection must be done by professionals with the required skills and certificates.

DO NOT SWITCH POWER ON until the installation is checked and approved by supplier. Any damage caused by unauthorised operation will void the warranty.

CAUTION: The cable installation must be performed according to the relevant cabling lists and/or connection diagrams.

Equipment Required:
– Conventional hand tools for cable installation.
– If a fiber optic cable is a part of the delivery, special tools for connecting ST-connectors are required.

CAUTION: To prevent ignition of hazardous atmospheres, disconnect from supply circuit before opening, keep tightly closed when circuits are in operation.

WARNING: Contains internal battery-powered circuit. In order to prevent ignition of hazardous atmospheres, do not open enclosure unless area is known to be non-hazardous.

4.2.4.1 ATEX Requirements (European Versions)

Installation shall be in accordance with section 1.06 of Annex II of Directive 94/9/EC (ATEX Directive).

Cable entry must be in accordance to EN 50018:2000, section 13.1. For systems utilizing cable glands, the gland or thread adaptor must be EEx d certified. The cable end must be securely installed, and depending on the cable type, be properly protected from mechanical damage.

Conduit Entry must be in accordance to EN 50018:2000, section 13.2. For systems utilizing conduit, an EEx d certified sending device must be used immediately at the entrance of the enclosure.

Any unused entry must be suitably blocked with an EEx d certified plug.

4.2.4.2 Cable Installation Check List

A. All cables to and from the MPU are connected to dedicated terminals in the electronic enclosure.

B. Check that the connection of armour and screens are done according to the drawings and relevant specifications. General descriptions for installation of the various power or signal types are shown below. Keep in mind various types of cable glands and how these should be installed.

C. The cable must be installed on cable trays or in pipes, protected against mechanical damage.

D. The external cables are entered into the Ex d enclosure, and relevant regulations for such installation must be followed. Keep in mind minimum segregation between power and signal cables.

E. Be aware of the minimum bending radius of the cable. The bending radius for a multicore cable is normally 6 times the diameter, but may vary so cable specifications must be checked.

F. Make sure that the earthing system is maintained. The Protective Earth (PE) bars have to be connected to the main earth system.

G. Make sure that the Cortech or similar is removed from the connection box before power is switched on.

H. All cable armour or cable shield connections should be as short as possible, reduce “pigtails” to a minimum.

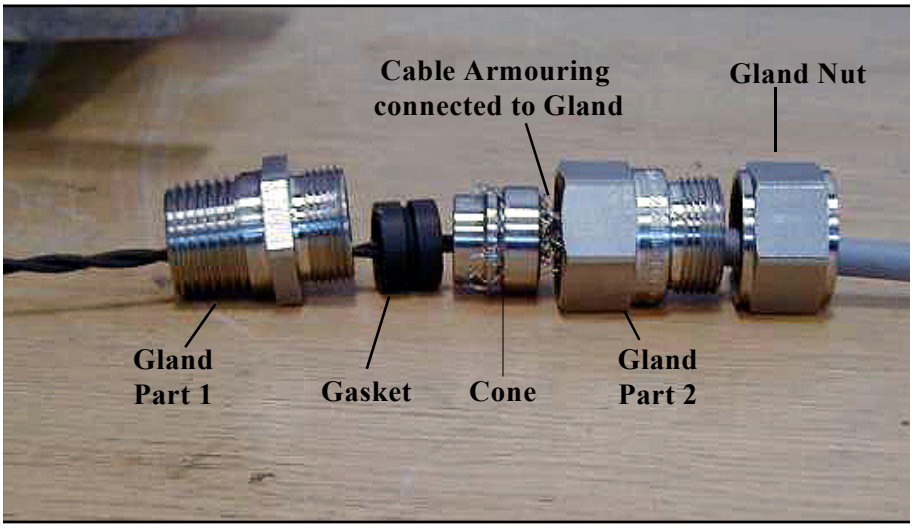

Figure 22 – Example of EEx d Cable Gland Connection (European Model)

4.2.4.3 Loop Check

Loop checks of cables are usually done to ensure that the cable connections have been done correctly. The loop test should be performed according to relevant loop check schemes and procedures.

A. To ensure correct result of the loop check the wires at both ends must be disconnected.

B. The loop check should cover as much of the signal loop as possible, preferably from terminations at the MPU to terminations in the control room.

C. Usually a Multimeter with resistance measurement is sufficient for the loop check.

D. In some cases plant specifications require a megger-test. It is extremely important that the wires are disconnected from the electronics before the megger is used.

CAUTION: MEGGER BLOWS ELECTRONICS!

E. After the loop test, it is important that the wires are reconnected correctly and properly.

4.2.4.4 Power Cables

This installation method covers cables for the following signals:

Signal type	Ref. cable specification
24VDC power cable	Section 0
120/240VAC power cable	Section 0

- The armour of the cable shall be connected to the PE-bars both in the electronic enclosure and in the control room.
- If a PE-core is included in the cable, this shall be connected directly to the PE-bar.
- The armour is connected to the cable gland.

4.2.4.5 Communication and Analogue I/O Cables

This installation method covers cables for the following signals:

Signal type	Ref. cable specification
Ethernet TCP/IP with twisted pair	Section 0
RS-232	Section 0
RS-422 / RS-485	Section 0
Analogue Input / output	Section 0
Pulse output	Section 0

- The armour of the cable must be connected to the PE-bar. The armour is connected to the cable gland.
- If a cable with pairwise shield is selected, the pairwise shield must be connected to the IE-bar in one end. For cables between the control room and the MPU, the shield should be connected in the control room. For cables between the MPU and external instrumentation, the shield should be connected at the MPU.
- Each signal with reference (zero volt) shall be run in the same twisted pair.

4.2.4.6 Digital I/O Cables

This installation method covers cables for the following signals:

Signal type	Ref. cable specification
Digital input / output (relays and pulses)	Section 0

- The armour of the cable shall be connected to the PE-bar. Then the armour is connected to the cable gland.

4.2.4.7 Fibre Optical Cables

This installation method covers cables for the following signals:

Signal type	Ref. cable specification
Ethernet TCP/IP with optical fiber	Section 0

The cable installation should be performed according to the relevant cabling lists and/or interconnection diagrams.

- ST-connectors are used to connect the optical fibre cable to the MPU. A female ST-connector must be mounted to this cable end. A ST-connector or similar must be mounted in the control room end too. The connectors may be pre-mounted, or special tools must be available for mounting these. Note: If the ST-connector is pre-mounted, make sure that it is possible to feed the ST-connector through the cable gland.
- The cable must be installed on cable trays or in pipes, protected against mechanical damage.
- Be aware of the minimum bending radius of the cable. The bending radius for a multicore cable is normally 6 times the diameter. However, the minimum bending radius for a fiber optical cable may vary from this, and must be checked in each case.

The maximum number of cable connections for one fibre signal is given by the total power budget. This is dependent on the type of cable, length of cable, type of transmitter and receiver in both ends, use of repeaters and number of connections.

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5 OPERATION

The purpose of this section is to give the operator easy access to right information regarding start-up and normal operation of the MPU.

5.1 Basic Information to Operator

5.1.1 Operating Area and Manoeuvring Gear

The complete MPU control system is placed in an explosion proof enclosure located on the spool piece. Operators interface is usually made through the Host system, which is communicating with the MPU.

5.1.2 Skill Requirement

To operate the MPU it is required that the operator has participated in an operation course.

5.1.3 Elements of Risk

The MPU has password protection against change of critical parameters.

NOTE: If any values are changed without updating the database backup-file, these must be noted in a logbook or similar in case the electronics must be replaced.

CAUTION: Hot work permit is required for opening the electronic enclosure.

5.2 Pre-operation

5.2.1 Purpose

The purpose of the operating procedure is to detail the following:

- Normal start-up
- Configuration and operation of the meter
- Alarm list and a list of available data

5.2.2 Equipment Required

PC Hardware:

Minimum requirements:

- Ethernet network interface.
- Alternatively RS 485/232 interface

PC Software:

- For WinScreen communication:
  - PC with Windows 98, 2000, NT, XP or Vista operating system
  - MPU WinScreen software

5.2.3 PC Configurations

NOTE: Supplier can assist configuration of customer's PC during commissioning. Alternatively a PC can be supplied with the correct software and set-up as a part of the delivery.

If the Ethernet communication with the WinScreen program is used, the PC has to be set up correctly. Twisted pair Ethernet speed can be 10 Mb/s or 100 Mb/s. Fiberoptic Ethernet speed must be 100 Mb/s.

From the **Start** menu on your PC:

A. Select Settings - Control Panel - Network.

B. Select TCP/IP protocol - Properties.

C. Set a fixed IP address (Specify IP address) and set an address in the same group as the flow meters, for example 128.1.221.111.

D. Set subnet mask 255.255.0.0. The two first digits, in this case 128.1, must be identical for the MPU and the PC. If no numbers are identical, the subnet mask must be set to 0.0.0.0.

E. NOTE: Each IP address must be unique, i.e. no units connected to the same network can have the same IP-address.

5.2.4 Check list prior to power on

Before switching the meter power on, check the following:

Checkpoints
All electrical connections are correct.
Cortech or similar is removed from connection boxes.
Power supply is of the required type.
Permission is given by the site authorities.

5.2.5 Start flow measurement

Apply power. The MPU will start measurements automatically, after the boot sequense is completed. This takes approximately 30 seconds. Measurement data will then be available through the Host system, or through the WinScreen program. For user instruction on the Host system, see dedicated manual(s).

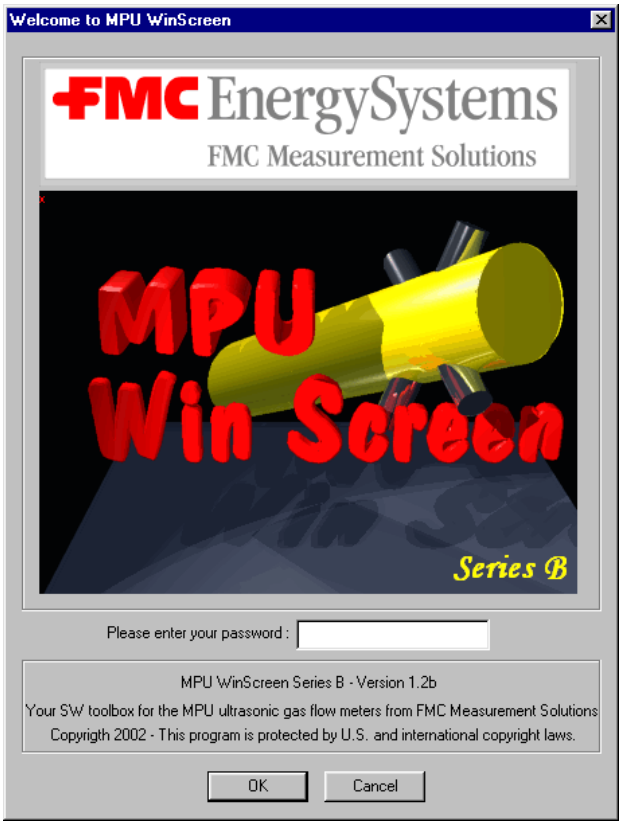
5.3 Operating Procedures

5.3.1 Install and start the WinScreen program

Install WinScreen Series B program by running the installation file “Winscreen Series B Setup.exe”. Follow the instruction on screen. Use serial no. as given on the floppy or certificate.

After installation is finished, there will be a shortcut on the desktop and in the “START” menu on the PC. Installation is only done by the first time.

Start the WinScreen Series B program.. The dialog box as shown in figure below will appear. Select security level “HIGH”.



WinScreen has three security levels, shown in the table below.

Password	Level
Low	Low (Customers, changes not possible)
High	High (Customers, changes possible)
####	Super-user (FMC Service personnel)

Clicking “Cancel” will result in Security Level Low.

Down in the right corner of the program the selected security level is shown.

The difference between these levels is mainly affecting the diagnostic tools, and possibilities to make changes in the meter set-up.

It is recommended that the operator change the password to make sure that unauthorised personnel not can change parameters by entering the default password.

5.3.1.1 Change Password

To change the password in WinScreen:

1. Select “Security” from the main menu.
2. Select “Change Password” from the drop-down list.

3. The following picture will appear.

1. In the section “Old Password” type in the old password “High”.
2. Type a new password in the section “New Password”.
3. Retype the new password in the column “Retype password”.
4. Click OK.

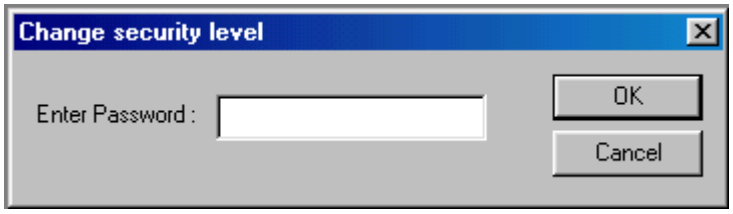
NOTE: Remember to take note of the new password, and store it in a safe place

5.3.1.2 Change Security Level

To change the password in WinScreen:

1. Select “Security” from the main menu.
2. Select “Change Security Level” from the drop-down list.

3. The following picture will appear.



4. Type the password for a higher or lower level and click OK.

NOTE: It is highly recommended that the security level normally is set to Low. Only change the security level to high if necessary to change parameters or measurement modes, and return to Low immediately after.

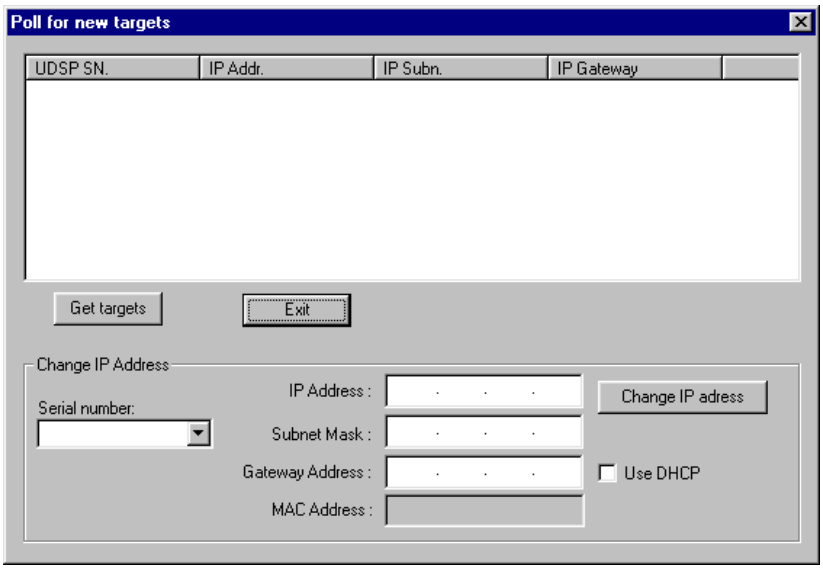
5.3.1.3 Connecting to the Ultrasonic Meter

To communicate with the meter, establish an IP-address and a name that belongs to the meter. The meter has a specified IP-address. The IP-address and name of the meter must be defined in the Host-file on the PC.

The WinScreen software has the ability to find the IP-address of any MPU flow meters (Series B) connected on the same local area network (LAN) as the PC.

To search for MPU flow meters on the LAN:

1. Select “Tools” from the main menu.
2. Select “Poll for new targets” from the drop-down list.
3. Click on the “Get targets” button. Connected MPUs will respond with their IP-address listed in the blank window.

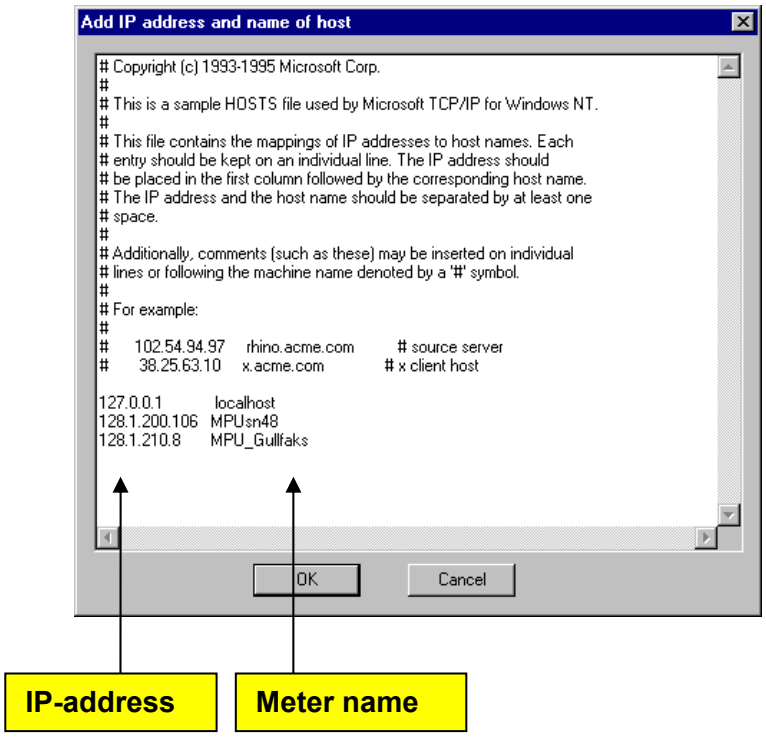


For editing the Host file, do the following steps:

1. Click on the soft key “Define a new target” in the picture shown below.

2. Then the Host file appears and can be updated with correct IP-address and name of the meter.

<u>Note:</u> Use the space key, not the TAB-key for spacing.



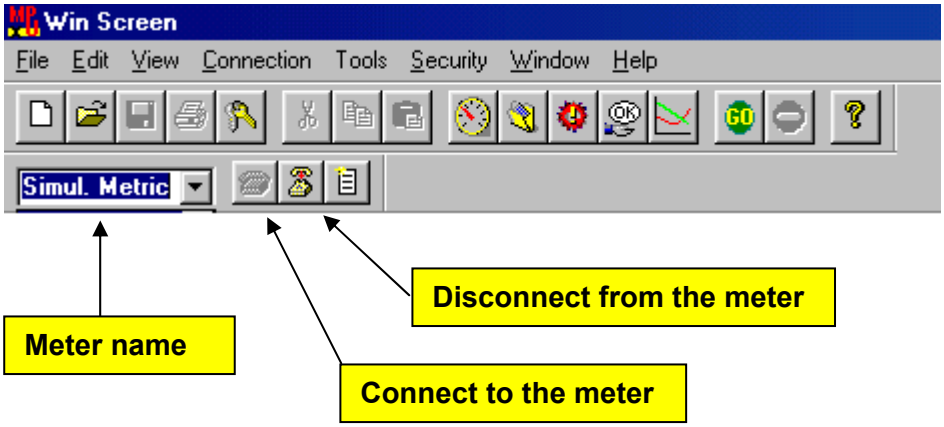
Services file

Editing of the services file on the PC is not required.

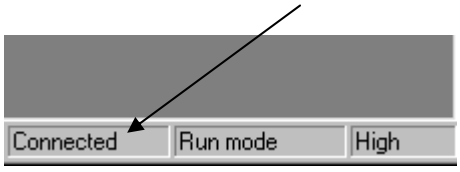
5.3.2 Establish communication with Ethernet link

This section describes how to establish data communication with an Ethernet physical connection (twisted pair cable or fiber-optic cable) between the flow meter and the PC.

The given meter host name (as specified in the Host file) must be written into the picture shown below, or picked from the pull-down menu. This is necessary for the WinScreen program to communicate with the meter. Click the connect button as shown below to connect to the meter.



A field in the bottom of the WinScreen program shows if the meter is connected or not.



5.3.3 Establish communication with serial link

This section describes how to establish serial data communication with the flow meter.

The MPU Series B flow meters feature two serial communication ports referred to as Port 1 (COM #1) and Port 2 (COM #2). The serial port terminals are accessed on connector CN13 on the UDSP board. See Figure 51 for hookup details. Hookup examples are listed in the Appendix section.

The two communication ports can be configured individually for RS-232, 2-wire RS-485 (Half Duplex) or 4-wire RS-485 (Full Duplex / RS-422).

Both ports support the Modbus-RTU communication protocol.

The hardware configuration of the serial ports is done with jumper settings on CN14 on the UDSP board as shown in Figure 19.

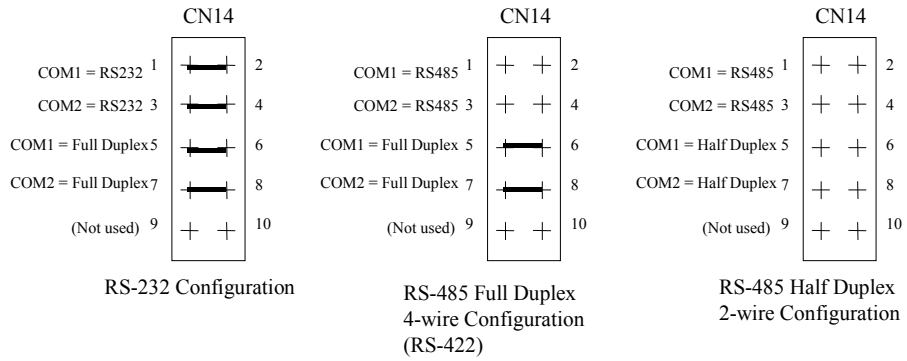


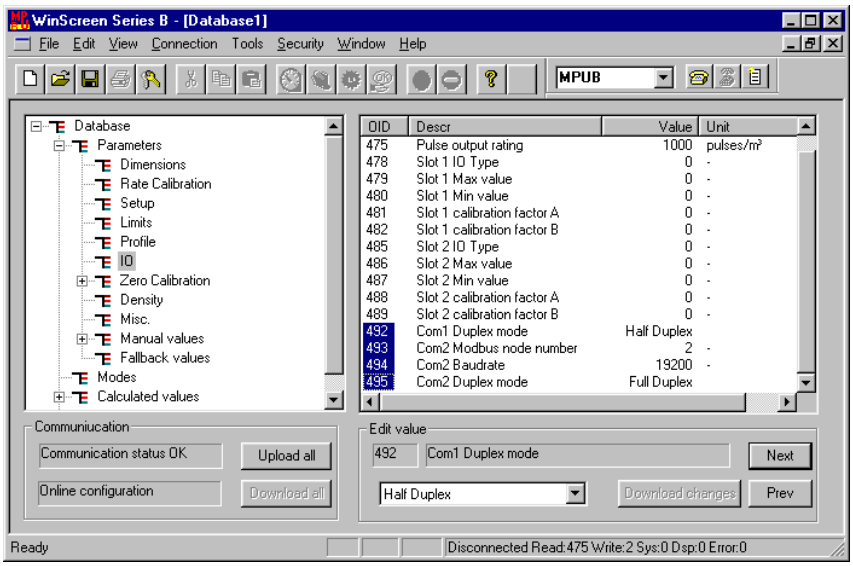
Figure 23 – Serial Port Hardware Configuration

CAUTION: Erroneous combination of jumper settings and communication wiring may damage the serial ports.

Software configuration of the serial ports is done with the WinScreen program running on a PC with Ethernet connection to the MPU.

Database object number	Description
492	Port 1 Duplex Mode
493	Port 2 ModBus Node number
494	Port 2 Baud Rate
495	Port 2 Duplex Mode

Table 7 – Serial Port Software Configuration



Parameter	Port 1	Port 2
Baud rate	9600 (Fixed)	SW configurable 9600 / 19200 (Default 9600)
Parity	None	None
Data bits	8	8
Stop bits	1	1
Modbus node number	1 (Fixed)	SW configurable (Default 1)
Half / full duplex	HW and SW configuration required	HW and SW configuration required

Table 8 – Serial Port Communication Parameter Settings

For communication with WinScreen on a PC, the Series B WinScreen program features both integrated Ethernet and serial communication modes. Either RS-232 or RS-485 can be used to communicate. Since the PC has an RS-232 interface, the use of RS-485 due to longer cable lengths will require a converter.

5.3.4 RS-232 Serial Link Configuration

1. Configure the CN14 jumper settings on the UDSP board for RS-232 full duplex communication as shown in Figure 19.
2. Connect a 3-wire serial cable to either Port 1 (COM #1) or Port 2 (COM #2) as shown in Figure 20.
3. Set software configuration parameters as described in section 1.15.3.

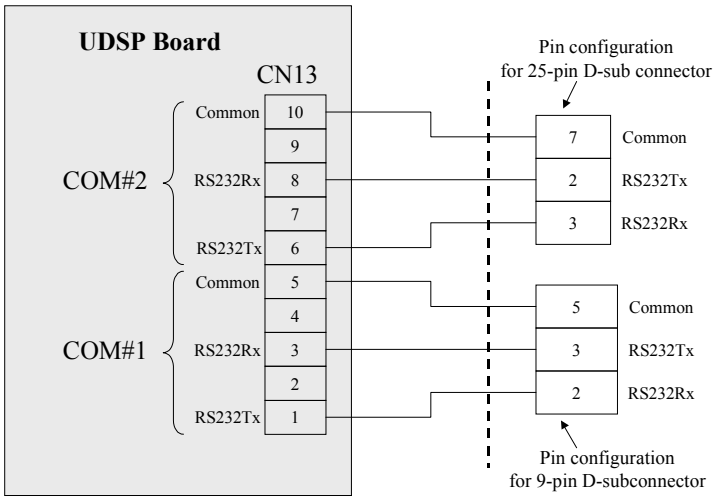


Figure 24 – RS-232 Serial Communication Wiring

5.3.4.1 RS-232 Serial Link with WinScreen on PC

1. Connect a 3-wire serial cable between the MPU and the PC as shown in Figure 20. Use either Port 1 or Port 2 on the MPU.
2. Open WinScreen via Ethernet network connection. Set appropriate COM port to Full Duplex mode under the IO tab in the Database Configuration menu, OID 492 or 495.
3. Close down the WinScreen program.
4. Reset the power on the meter.
5. Open WinScreen. Select "/com1" in the meter name pull down menu to select COM1 serial port on the PC and connect to the MPU by pressing the "Connect" button.

See Figure 36 for detailed hook-up example.

5.3.4.2 RS-485 4-wire Full Duplex Configuration

The full duplex RS-485 communication is often referred to as RS-422.

1. Configure the CN14 jumper settings on the UDSP board for RS-485 full duplex communication as shown in Figure 19.
2. Connect the RS-485 wires (4) to either Port 1 or Port 2 on CN13 on the UDSP as shown in Figure 21. A 100 Ω resistor must be connected between terminals 3 and 4 (Port 1) or between terminals 8 and 9 (Port 2) as indicated.
3. Set software configuration parameters as described in section 1.15.3.

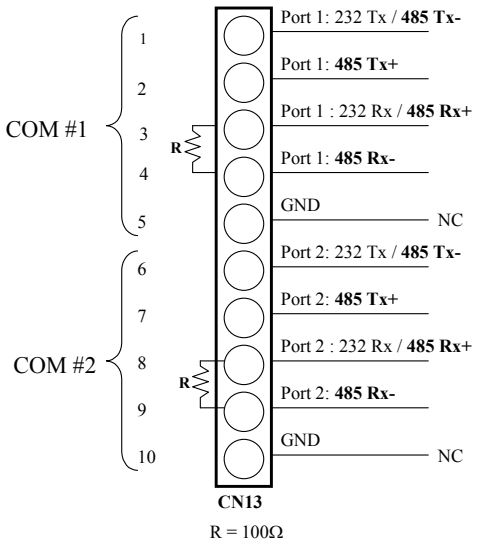


Figure 25 – RS-485 Full Duplex Serial Communication Wiring

5.3.4.3 RS-485 Full Duplex Serial Link with WinScreen on PC

1. Connect a 4-wire serial cable to the MPU as shown in Figure 21. Use either Port 1 or Port 2 on the MPU.
2. Convert the RS-485 communication to RS-232 communication by means of an RS485/RS232 converter and connect the RS-232 serial link to the PC.
3. Open WinScreen via Ethernet network connection. Set appropriate COM port to Full Duplex mode under the IO tab in the Database Configuration menu, OID 492 or 495.
4. Close down the WinScreen program.
5. Reset the power on the meter.
6. Open WinScreen. Select “/com1” in the meter name pull down menu to select COM1 serial port on the PC and connect to the MPU by pressing the “Connect” button.

See Figure 39 for detailed hook-up example.

5.3.4.4 RS-485 2-wire Half Duplex Configuration

The half duplex RS-485 communication is a 2-wire serial connection.

1. Configure the CN14 jumper settings on the UDSP board for RS-485 half duplex communication as shown in Figure 19.
2. Jumper terminals on CN13 as shown in Figure 22.
3. Connect the RS-485 wires (2) to either Port 1 (terminals 1 and 2) or Port 2 (terminals 6 and 7) on CN13 on the UDSP as shown in Figure 22.
4. Set software configuration parameters as described in section 1.15.3.

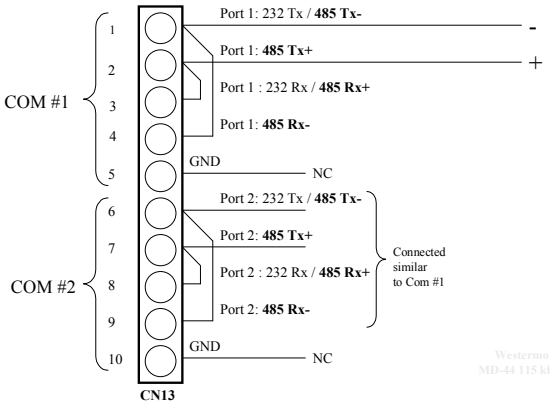


Figure 26 – RS-485 Half Duplex Serial Communication Wiring

5.3.4.5 RS-485 Half Duplex Serial Link with WinScreen on PC

1. Connect a 2-wire serial cable to the MPU as shown in Figure 22. Use either Port 1 or Port 2 on the MPU.
2. Convert the RS-485 communication to RS-232 communication by means of an RS485/RS232 converter and connect the RS-232 serial link to the PC.
3. Open WinScreen via Ethernet network connection. Set appropriate COM port to Half Duplex mode under the IO tab in the Database Configuration menu, OID 492 or 495.
4. Close down the WinScreen program.
5. Reset the power on the meter.
6. Open WinScreen. Select “/com1” in the meter name pull down menu to select COM1 serial port on the PC and connect to the MPU by pressing the “Connect” button.

See Figure 42 for detailed hook-up example.

5.3.4.6 Run WinScreen against PC Simulator

For demonstration or training purposes, the WinScreen program can be run against either the included Simulator or with manually inputted values. To use the Simulator, select “Simulator” from the meter name pull-down menu and connect. The data generated is random in nature, and will cycle through all the modes of the meter. Units are selected by setting “Unit mode” to either Metric or US under the Modes tab in the Database Configuration menu.

To use manually inputted values, set “Enable Manual Values” to “ON” under the Modes tab in the Database Configuration screen. Then, in the “Manual Values” section of the “Parameters” tab, enter the desired measurement data. All values shown on the Measurement Values screen except Accumulated Totals can be manually manipulated.

5.3.4.7 Trouble Shooting – Ethernet

If no contact to the MPU is obtained:

- Check that the power on the MPU is switched on.
- Check that the IP address of the meter is correct.
- Check that the subnet mask and IP address of the PC comply.
- Make sure that communication cables are connected.
- Try to ping the MPU. Write “ping” + applicable “IP address” in a DOS window.
- If reply:
  - Check Host-file (Use “Tab” instead of “space” between address and name or vica versa). If “tab” does not work, use “Ctrl-Tab”.
- If no reply:
  - Check communication cables.

5.3.5 Operating the MPU WinScreen program

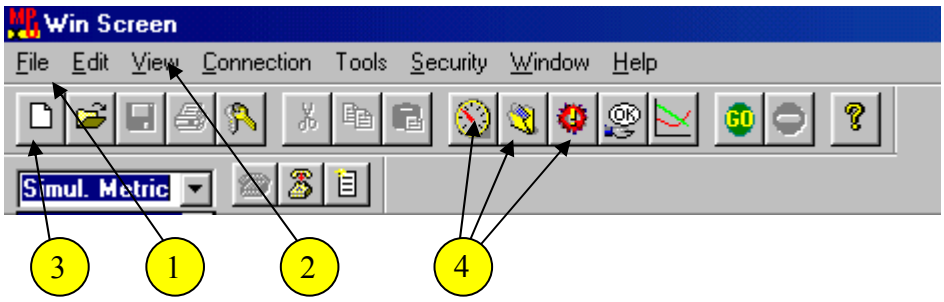
5.3.5.1 Menu Overview

The MPU WinScreen software contains 9 applications. The five last options are diagnostic tools.

1. Measured values
2. Database configuration
3. Log
4. Database report
5. Diagnostic
6. Parameters
7. Analyser
8. Calibration
9. Electronic Test Report

All applications are located in more than one place in the menu system. These are shown in the picture below.

1. *File* Menu under New
2. *View* Menu
3. *New* in the soft key menu
4. In the soft key menu



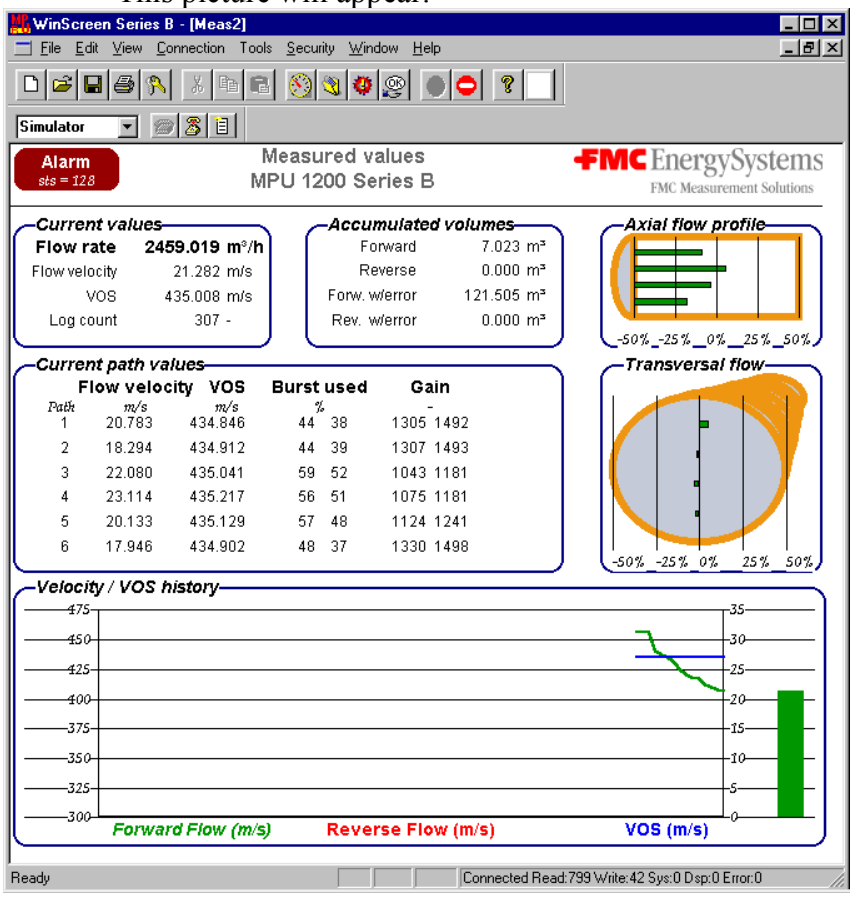
The New Menu option will be used in the following sections. These applications are available by clicking OK when the desired option is selected.

5.3.5.2 Measured Values


Soft key

To inspect the actual measurements the Measured Values window can be selected in the New menu (or the shown soft key).

This picture will appear:



This Measured Values picture contains a summary of important information, below is a short explanation. Units can be Metric or Imperial.

Alarm Window (top left)

- Green colour – no alarm, Red colour – active alarm, Yellow colour - inactive, but not acknowledged alarm
- Alarm Status Word, coded number indicating type of error. (sts = 0 indicates no error.)
- Available on Serial and Ethernet communication
- A detailed description of alarm functions is listed in the Maintenance section.

Current Values

- Flow rate - Total calculated volume flow rate.
- Flow velocity - Showing the weighed average flow velocity for all 6 paths. Used to calculate actual volume flow rate.
- VOS (velocity of sound) - The average Velocity of Sound for the 6 paths.
- Sign indicating the direction of the flow (positive or negative flow direction).

Accumulated Volumes

- Total accumulated volumes - Forward, reverse, forward with error and reverse with error (The volume is accumulated in separate registers if the MPU is operating with a critical error).

Current Path Values

- Flow velocity - The flow velocity variation between the paths should be according to expected flow profile. For a well developed flow profile the flow velocity for the paths 3A/3B, 4A/4B and 5A/5B (the two mid layers) should be approximately 0.5-2 m/s higher than the flow velocity for the paths 1A/1B, 2A/2B and 6A/6B (the upper and lower layers).
- VOS - The velocity of sound variation between the paths should not exceed 1 m/s
- Bursts used - Number of bursts (in percent) used to calculate the path velocity is usually above 90%, may be lower at high velocity. If the value is below 50%, special attention is needed to check that flow velocities and velocity of sound measurements for each path are correct.
- Gain - This shows the receiver gain for each transducer. The gain is a number in the range 0 – 4000. The gain is adjusted automatically to achieve required signal amplitude. The value is dependent on meter size, operational pressure and flow velocity. Typically in the range 300 – 1500. Individual variations due to different path lengths and turbulence levels are expected.

Axial Flow Profile

- The Axial Flow view shows the longitudinal flow profile. Green bars indicate forward flow, red bars reverse flow. The numbers represent the percentage above or below the average total flow velocity.

Transversal Flow

- The Transverse Flow window indicates swirl or crossflow. The bars indicate the direction of the swirl and the numbers the magnitude of the swirl as a percentage of the average total flow velocity. For example, for 10 m/s total average flow velocity, a green bar at 25% represents a clockwise swirl with a velocity of 2.5 m/s.

Velocity / VOS History

- Showing a Trend curve of Mean velocity and Mean VOS variations over the last period of time. A Green line indicates positive flow. A Red line indicates negative flow. The scale is to the right. The bar to the right (Green or Red respectively) shows the current actual Mean velocity.
- The Blue line indicates VOS. The scale is to the left.

5.3.6 Alarms and Self-diagnostics

To ensure correct and reliable measuring values, the meter is supplied with a self-diagnostic feature. Important values are checked against maximum allowed variations and extreme values in order to detect a malfunction in the meter.

In case of malfunction of transducer pairs, the meter will automatically reject the measuring values from these pairs. The total flow will be calculated based on the other acoustic paths, while alarms are activated showing malfunction detected. The accumulated volume flow will be stored in the normal accumulated volume register, as well as in an error accumulated volume register, to keep track on how much of the accumulated volume might be inaccurate.

The alarms can be monitored using the alarm list of the Host system, or by the Historic or Active Alarm Logs as described above.

Alarm limits can be adjusted due to operational and installation specific conditions. Supplier normally does this during commissioning.

The alarm limits can be adjusted at a later stage. The database object number for respective alarm limits are listed in the database, and can be found by searching the database or referring to delivery specific documentation.

CAUTION: This will influence the functionality of the meter, and must be done by authorized personnel only, in accordance with supplier's recommendations.

5.3.6.1 Active Alarm Log

Alarm logs are divided into two levels; Active Alarm Log and Historical Alarm Log. The Active Alarm log shows only the alarms which are active and not acknowledged. The alarm is acknowledged by pressing the Ctrl-A-buttons. This screen is selected from the main menu.

5.3.6.2 Historical Alarm Log

The Historical Alarm Log shows all alarms that have been raised. This screen is selected from the main menu. The Historical Alarm Log contains up to 200 alarms.

5.3.6.3 Checksum error alarm

The MPU internal database is corrupt.

5.3.6.4 Internal calculation failure alarm

The MPU internal calculations have failed.

5.3.6.5 Velocity of sound deviation alarm

This alarm is activated if the measured velocity of sound for one of the paths deviates more than a specified limit (Max. VOS variation) from the median of the six measured velocity of sound values. The limit is set during commissioning.

The alarm limit may be adjusted. This alarm is used to monitor whether each path is measuring the correct transit time or not. Acceptable variation of the velocity of sound will vary with the size of the meter and operational conditions (normal temperature variations within the cross section of the pipe etc.).

5.3.6.6 Flow speed deviation alarm

This alarm is activated if the measured flow velocity for one of the paths deviates more than a specified limit (Max. flow-vel variation) from the median of the flow velocities of the center paths or the upper/lower paths. This is due to an expected flow profile where the center paths measure higher flow velocities than the upper/lower paths. The limit is set during commissioning.

The alarm limit may be adjusted. This alarm is used to monitor if all path velocities form an expected flow profile. With complex upstream pipe configurations alarm limits may be increased.

5.3.6.7 High flow alarm

This alarm is activated if the calculated mean flow is exceeding the defined minimum or maximum limits. The limit is set during commissioning.

The alarm limit may be adjusted.

5.3.6.8 Gain deviation alarm

This alarm is activated if the automatically adjusted gain level for one of the paths deviates more than a specified limit (Max allowed gain deviation Group n) from the median of the 12 adjusted gain levels. The limit is set during commissioning.

The alarm limit may be adjusted. This alarm is used to monitor the system. The gain values should be within the same area, as transducers, electronics and operational conditions are very similar. If one path is trigging the gain deviation alarm, this may be an indication of a fault with transducers, cables, electronics, software or configuration.

5.3.6.9 Transducer failure alarm

Transducer failure is triggered if a “serious malfunction” is detected. The meter is still firing on the defect acoustic path, and the measuring result is checked. The path is automatically put back into operation if the measurements are acceptable. However, the reason for the alarm must be investigated and corrective actions must be taken.

5.3.6.10 Hardware error alarm

This alarm indicates internal MPU electronics failure.

5.3.7 Transducer failure – correction algorithms

5.3.7.1 Reduced accuracy with respect to transducer failure

The reduction in accuracy caused by transducer failure, and thereby path dropout, is dependent on a numerous set of parameters. Various types of initial setup, diagnostics and compensations are built into the MPU to make the best possible performance during different combinations of transducer failures and operational conditions.

Important parameters are:

- Flow velocity
- Complexity of flow profile
- Number of simultaneous transducer failures
- The location of the failed transducer

5.3.7.2 Dynamic flow profile monitoring

The MPU is continuously monitoring the flow profile for self-diagnostics purpose.

The flow velocity profile is expressed as a set of normalised profile factors using the average measurement of paths 3 and 4 as the reference. The profile factors will remain relatively constant over the operating range of the flow meter, assuming no changes to the upstream pipe configuration.

Example:

Path	Flow Velocity (m/s)	Profile Factor
1	8.1	0.81
2	8.2	0.82
3	9.9	0.99
4	10.1	1.01
5	9.8	0.98
6	8.0	0.80

Average of path 3 and 4 = 10.0 m/s

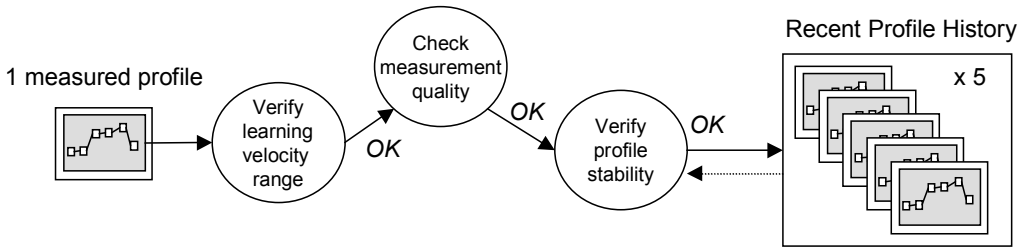
The MPU compares the measured flow profile against a pre-recorded “learned” profile. If the measured profile does not fit to the learned profile within certain acceptance limits, the deviating path velocities will be corrected based on the learned flow profile.

As the learned profile is updated under operation, the estimate of a path velocity will be correct even if the flow profile should change, due to for example change in position for an upstream flow control valve. If the flow profile changes while one path is substituted, this may lead to increased uncertainty, as new profiles will not be learned with failing paths. In special cases it is possible to set up the meter to learn different flow profiles for low, middle and high flow velocity ranges.

5.3.7.3 Profile learning

A "true" flow profile is automatically learned by the MPU and stored as a set of learned profile factors. Automatic adjustment of the learned profile factors is performed based on several profile quality checks.

The flow profile learning process is illustrated in the figure below.



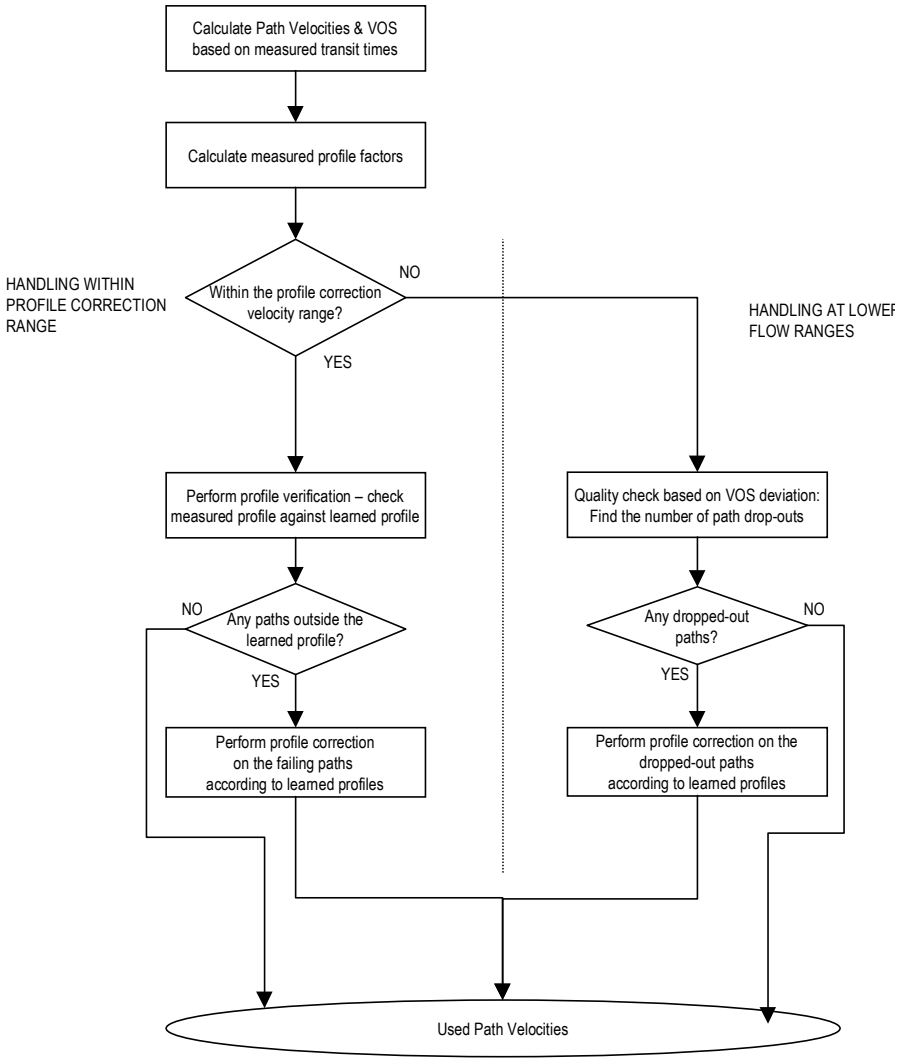
The flow profile learning needs to go through a three-stage approval:

1. *Verify learning velocity range* – The measured flow velocity must be within the specified "learning range", normally from 5 to 15 m/s (16 to 50 ft/sec).
2. *Check measurement quality* – The Bursts Used quality indicator must be above specified limit (normally 60%) for each transducer and the measured Velocity of Sound for each path must be within specified limits (VOS profile limits).
3. *Verify profile stability* – The flow profile must be similar to the set of profiles already stored in the *Recent Profile History*. This ensures stable conditions before new profile factors are accepted.

If these checks succeed, the measured profile is added to the *Recent Profile History*. The learned profile factors will be the average of the 5 sets in the *Recent Profile History*. The learned profile factors will be updated at maximum every 5th cycle.

5.3.7.4 Flow measurement with profile check

When flow velocities and velocities of sound have been measured for each path, the results are checked in accordance with the flow chart below.



For low flow velocities, typically below 5 m/s (16 ft/sec), the profile check algorithm can not be used as the flow profile is no longer independent of the flow velocity. Therefore a separate algorithm is made to check for erroneous path velocity measurements in the lower velocity range. This is illustrated in the flow chart.

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6 MAINTENANCE

The purpose of this section is to give the user applicable information regarding maintenance of the MPU, to maintain the guaranty requirements arranged. In addition, to make sure that the user can perform replacement and repair safe and quickly on his own, is all replacement/repair procedures that is relevant for the equipment presented in this section.

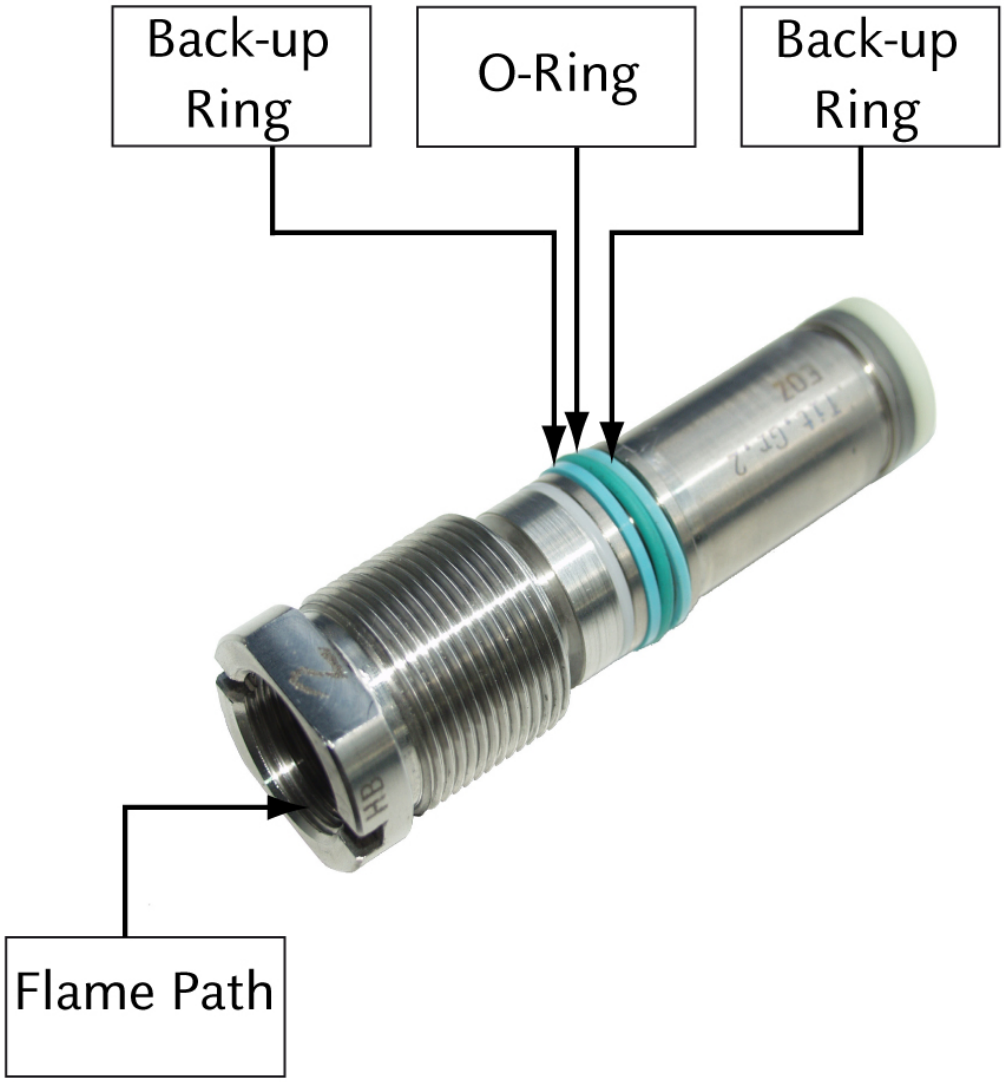
6.1 Periodical Inspection and Maintenance

As long as the meter is in operation, major faults will be revealed by the alarm system. Inspection and maintenance of the meter during storage is described in Section 1.18.1.

6.1.1 Inspection every 3rd month

1. Check that there is no mechanical damage to the Spool piece, Transducer Covers or Electronics Enclosure leading to malfunction, leakage or corrosion.
2. Check that there is no damage to Transducer Cables or the external cables with cable glands.

6.1.2 Replacement of O-rings and Backup-rings



O-rings facing the natural gas are made of Viton. The O-ring manufacturers do not specify any exact lifetime of the O-rings, but during normal operation (continuously pressurised and untouched) the o-rings will last for several years. However, to be on the safe side it is strongly advisable to:

- Change all O-rings and Backup-rings during revision stops.
- Change all O-rings and Backup-rings if the meter has been depressurised for a long time.
- Change O-rings and Backup-rings in case of transducer exchange.

  O-rings of material Nitril, NBR and Vitron can be stored for 10 to 15 years without reduction of quality. This depends on storage in air tight plastic bags in environment of low humidity and not subjected to sunlight. The ambient temperature must be between +5°C and +20/25°C.

6.2 Troubleshooting and Replacement of Parts

CAUTION: Trouble shooting and replacement outside of what is described in this manual, require special skills.

Any replacement of parts must only be performed by personnel with the required knowledge.

Maintenance courses from the manufacturer are available, held at supplier's or customer's location. Required documentation and manuals are a part of the course.

Supplier's service department is available for call-outs on short notice, but it is recommended to sign a service agreement with the supplier, ensuring the necessary support at all times.

Remote trouble shooting via modem is possible if the system is prepared for this. It will be specially integrated for each customer.

6.2.1 Self diagnostics features

A logging feature for internal self-diagnostics messaging is built into the MPU flow meter.

The messages are separated into five different categories:

- Active alarm log
- Historical alarm log
- Event log
- Operator change log
- Error log


Soft key

The various logs can be inspected with the MPU WinScreen program by opening the Log window in the New menu (or the shown soft key).

Active alarms are also displayed as an Alarm Status Word, a number representing one or several combinations of eigth different alarm types.

Detailed descriptions are listed below.

6.2.1.1 Alarm status word

The alarm status word is a binary bit coded number displayed in decimal format. Each bit represents a pre-defined alarm situation. The bit is set to ”1” (”high”) when the associated error situation is active. The Alarm Status Word can be transmitted with external communication links to supervisory computer systems.

Bit	Alarm description
0 (LSB)	Checksum Error. The MPU internal database is corrupt
1	Internal Calculation Failure alarms
2	Velocity of Sound Deviation alarms. Indicates that the calculated VOS of one or more paths deviates to much from the average
3	Flow Speed Deviation alarms. Indicates that the calculated velocity of one or more paths deviate to much from the average
4	High Flow alarms. The calculated flow velocity is outside the operating range of the MPU
5	Gain Deviation alarms. Gain on one path differs from gain value on other transducers.
6	Transducer Failure alarm. High Gain alarm or low Burst % alarm. A measured gain or burst percentage value is outside specified limit.
7(MSB)	Hardware Error. Internal failure in the MPU electronics

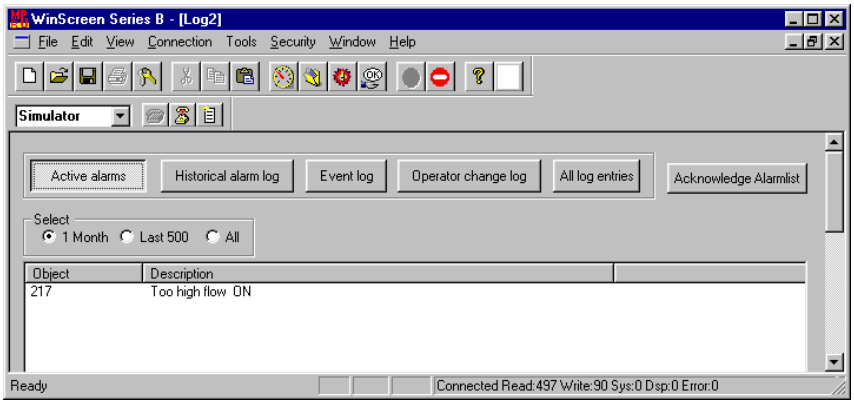
Examples:

sts = 0	No bits set. No alarms.
sts = 4	Bit 2 set ”high”. Velocity of Sound Deviation alarm active.
sts = 68	Bits 2 and 6 set ”high”. Velocity of Sound Deviation alarm and Transducer Failure alarm active.

6.2.1.2 Active alarm log

Alarm logs are divided into two levels; Active Alarm Log and Historical Alarm Log.

The Active Alarm log shows only the alarms that are active and not acknowledged. Alarms are acknowledged by clicking on the Acknowledge Alarm List button.



The first column called Pri (Priority) shows the priority of the alarm, Critical, General, Event or None.

C = Critical alarm

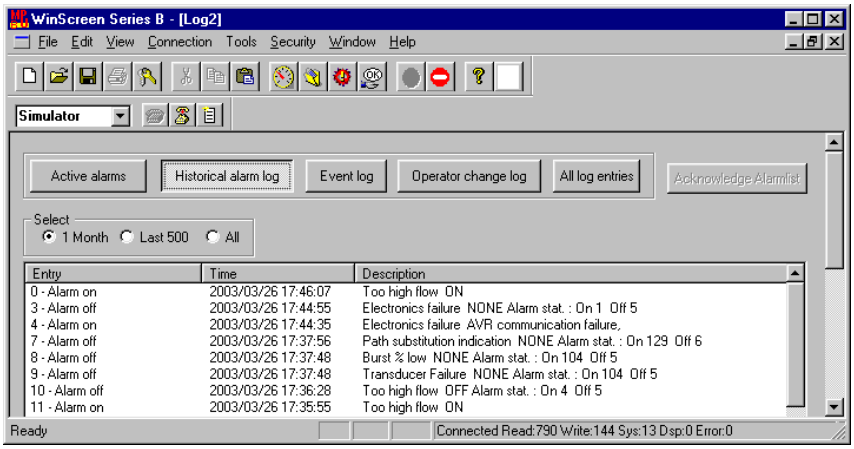
G = General alarm

E = Event

N = None

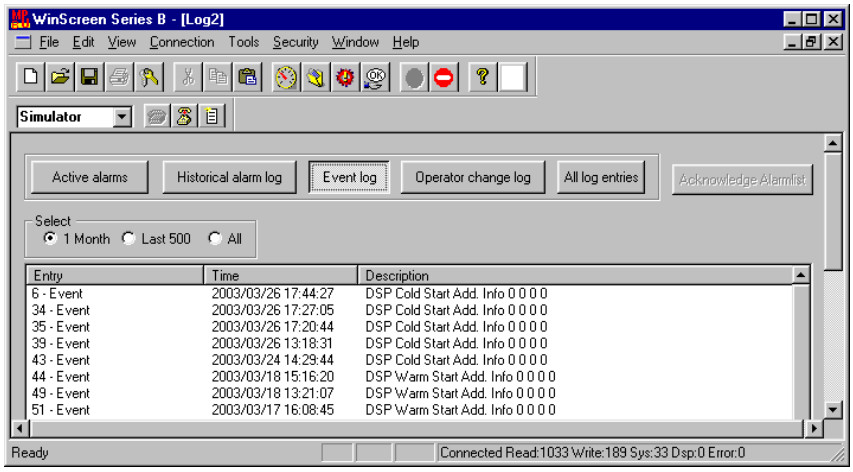
6.2.1.3 Historical alarm log

The Historical Alarm Log shows all alarms that have been raised. The Historical Alarms Log contains up to 200 alarms.



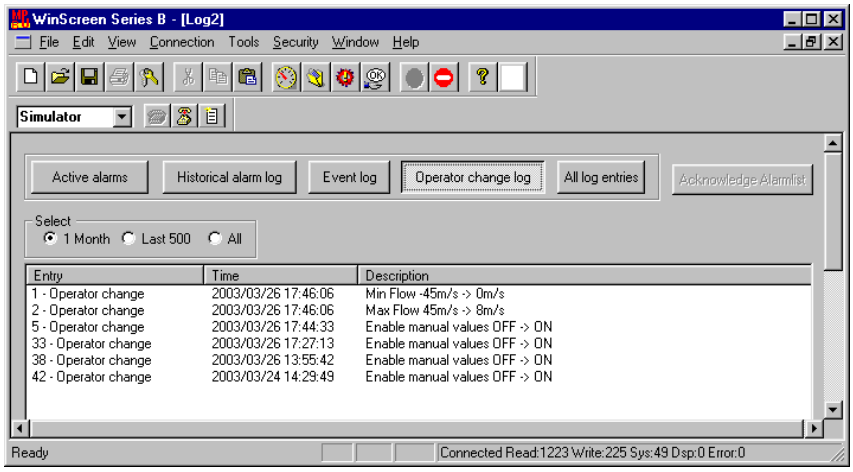
6.2.1.4 Event log

Change of security level is automatically logged as an event. Security level must be set in order to make changes that can influence the gas flow measurements.



6.2.1.5 Operator change log

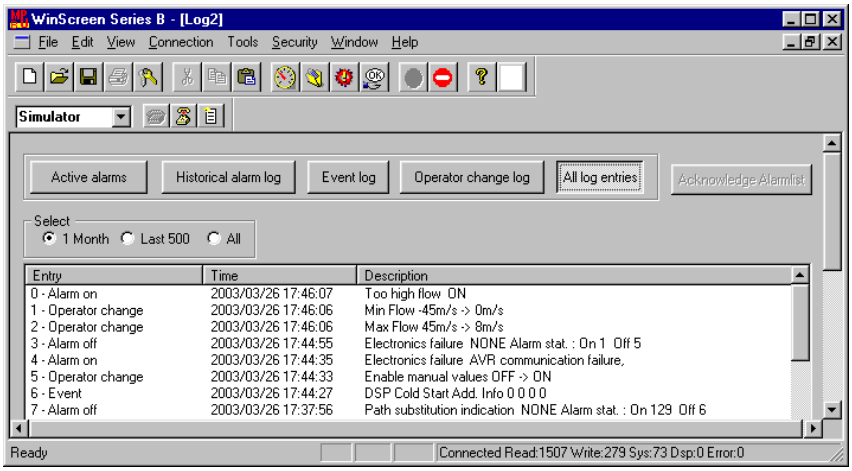
Changes made to operate modes or parameters by the operator that may influence the gas flow measurement are recorded automatically.



6.2.1.6 All log entries

This option enables display of all log entries:

- Active alarm log entries
- Historical alarm log entries
- Event log entries
- Operator change log entries



6.2.2 Malfunction or errors during operation

Failure Description	Probable Cause	Corrective Action
No communication	• Lost or poor physical connection on communications cable • Power failure • Electronics failure	• Check wiring and connections • Check supply power • Check power board (UACF) switch settings • Cycle power • Replace the UDSP board
Suspicious flow measurement	• Incorrect transit time measurement caused by lost or disturbed ultrasonic signals • Lost or poor transducer connection • Operating conditions exceeding meter specification • Transducer failure	• Check internal alarm list • Check termination of transducer cables • Check for recent changes in operation condition and reconfigure the flow meter if necessary • Inspect transducer(s) and replace if necessary

Table 9 – Troubleshooting overview

6.2.3 Troubleshooting diagrams

The diagrams shown on the succeeding pages may be useful in the following cases:

- No output from the meter to the host computer
- Suspicious measurements from the meter

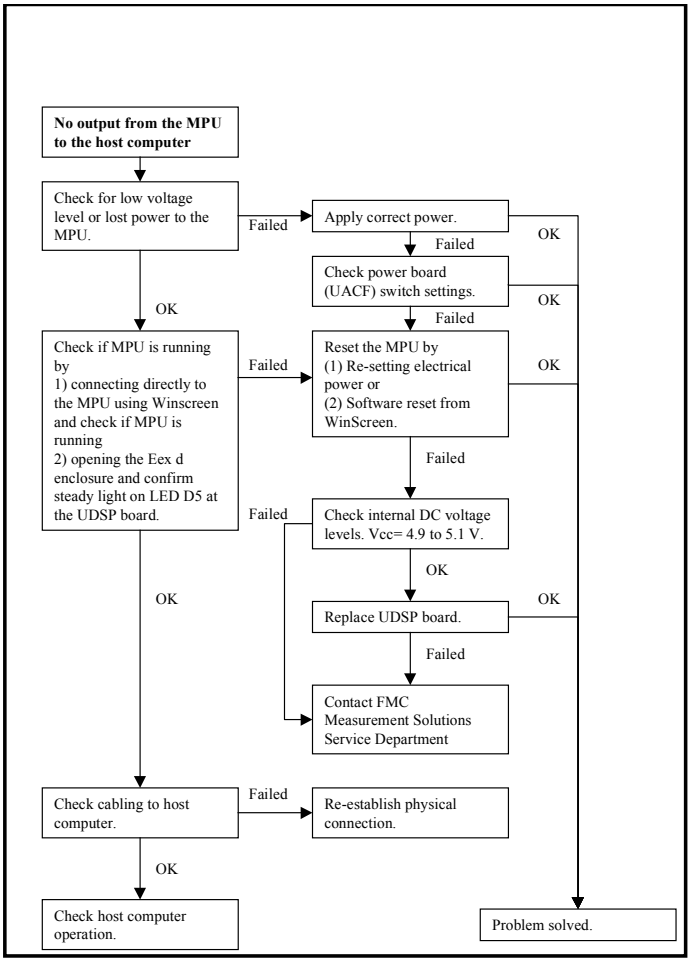


Figure 27 – No output from the MPU (Communication failure)

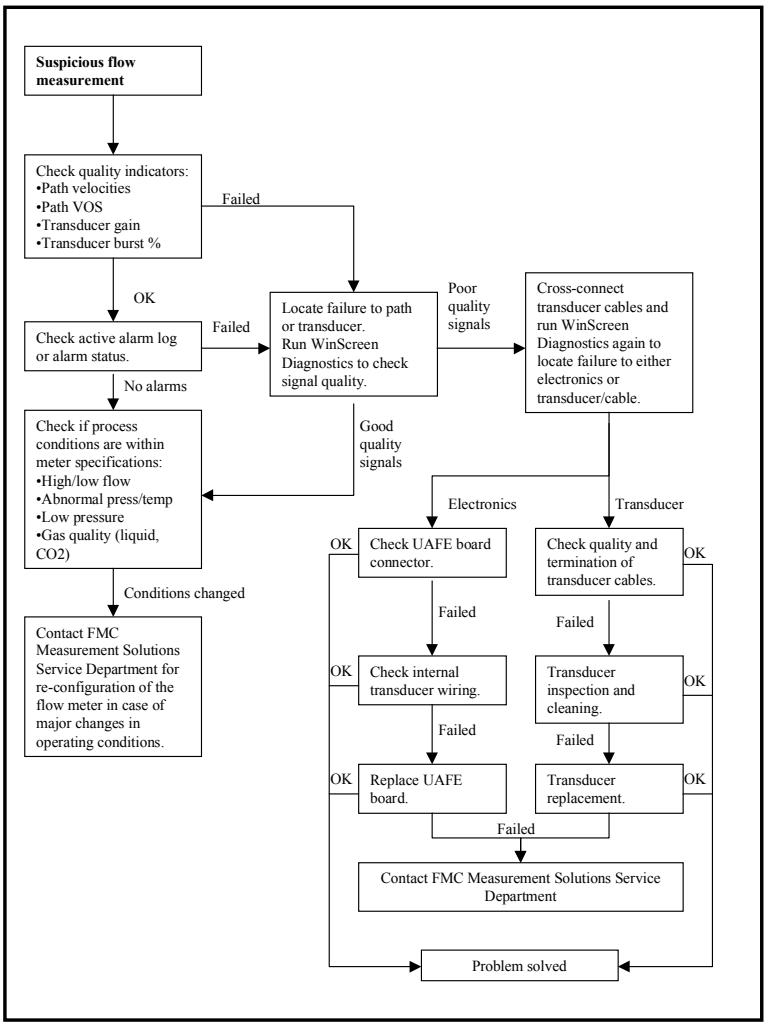


Figure 28 – Suspicious Flow Measurement

6.2.4 LEDs Overview

During start-up and normal operation some LEDs on the UDSP board are visible, see Figure 29.

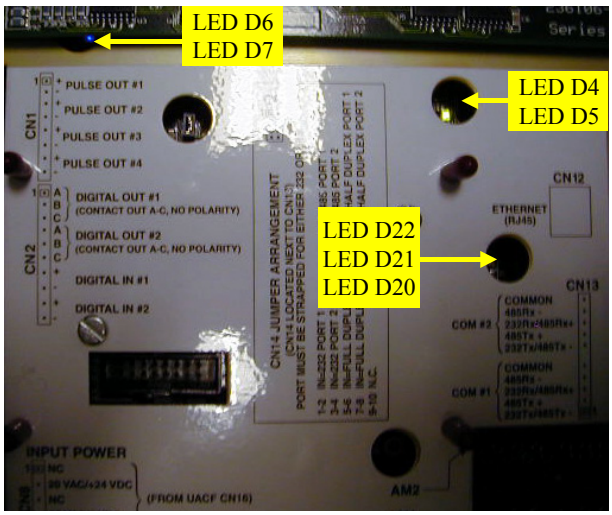


Figure 29 – Visible LEDs on the UDSP board

Start–up

During start-up the following LED behaviour should be observed:

1. All visible LEDs flash for a short moment.
2. **Red LED D7** and **Green LED D5** lights for approximate 5 seconds.
3. **Red LED D7** is turned off, while **Green LED D5** starts flashing for approximate 4 seconds. This is the DSP being booted by the DSP.
4. **Green LED D5** stops flashing after booting is complete, and will light steady.
5. **Red LED D7** starts flashing.

Normal operation

During normal operation the following LED behaviour should be observed:

1. **Red LED D7**, **Green LED D5** and **Yellow LED D21** light steady.
2. **Green LED D20** indicates contact with Ethernet. LED flashes during traffic on the Ethernet.

6.2.5 Fuses Locations

There are two fuses connected to the electronics inside the electronics enclosure, see Figure 51.

F1	250 VAC, 200 mA, Slow Blow Fuse
F2	250 VAC, 1 A, Slow Blow Fuse

Fuse F1 is connected to the AC Input Power, while F2 is connected to the DC Input Power.

- To replace fuse F1, lift up the proctective cap.
- To replace fuse F2, unscrew the receptacle as shown in Figure 51.

6.2.6 Replacement of Electronics Board

A. Turn off power to the meter.

B. Open up the Exd enclosure lid.

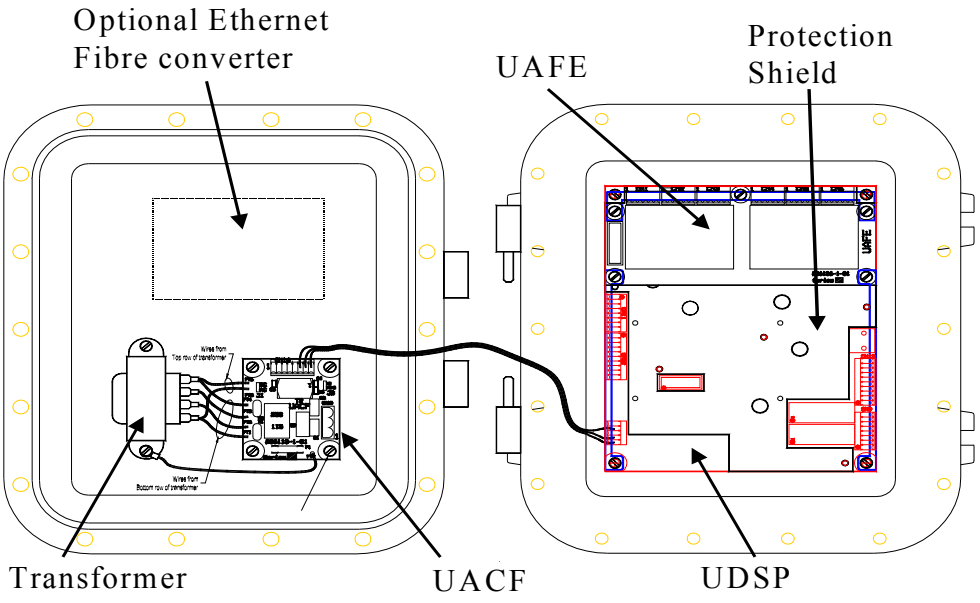


Figure 30 – Electronics board locations

Electronics Board	Cables to disconnect	Connector
UAFE	Transducer cables	CN1 through CN6
UDSP	All	All

6.2.6.1 Replacement of UAFE (analog front end) board

A. Remove the transducer connector hold-down bracket.

B. Remove the six transducer cable connectors CN1 through CN6.

C. Losen the five screws on the UAFE board with a screwdriver and pull out the UAFE board gently.

D. Repeat the procedure in reverse order to insert a new board.

6.2.6.2 Replacement of UDSP (digital signal processing) board

A. Remove the transducer connector hold-down bracket.

B. Remove the applicable cable connectors.

C. Losen the four screws on the UDSP board with a screwdriver and lift the UDSP board gently.

D. Remove all connectors plugged on to the UDSP board.

E. Losen the four screws on the UDSP board with a screwdriver and pull out the UDSP board gently.

F. Repeat the procedure in reverse order to insert a new board.

6.2.6.3 Replacing complete electronics (UAFE and UDSP board)

A. Remove the transducer connector hold-down bracket.

B. Remove the six transducer cable connectors CN1 through CN6.

C. Remove all connectors plugged on to the UDSP board.

D. Losen the four screws on the UDSP board with a screwdriver and pull out the UDSP board gently. (The UAFE board is attached to the UDSP board.)

E. Repeat the procedure in reverse order to insert new electronics.

6.2.7 Software configuration

A. Replacement of UAFE board does not require any software re-configuration.

B. Replacement of UDSP board requires:
- Re-loading of software file
- Re-loading of database file (parameters)
- Entering appropriate IP network address for Ethernet communication

6.2.8 Replacement of Transducers

Replacement of Transducers is described in PRD-0000022520 “MPU Transducer Replacement Procedure Series B” without pressure and

DOK-509 “MPU Transducer Replacement Procedure Using Transducer Retraction Tool” under pressure.

An external pressure connection is required for pressure balancing during operation of the Transducer Retraction Tool. A pressure balance hose according to Part Number 870027043 is required. On site it’s required a pressure tap with valve, in maximum distance of 7m from each the ultrasonic meter.

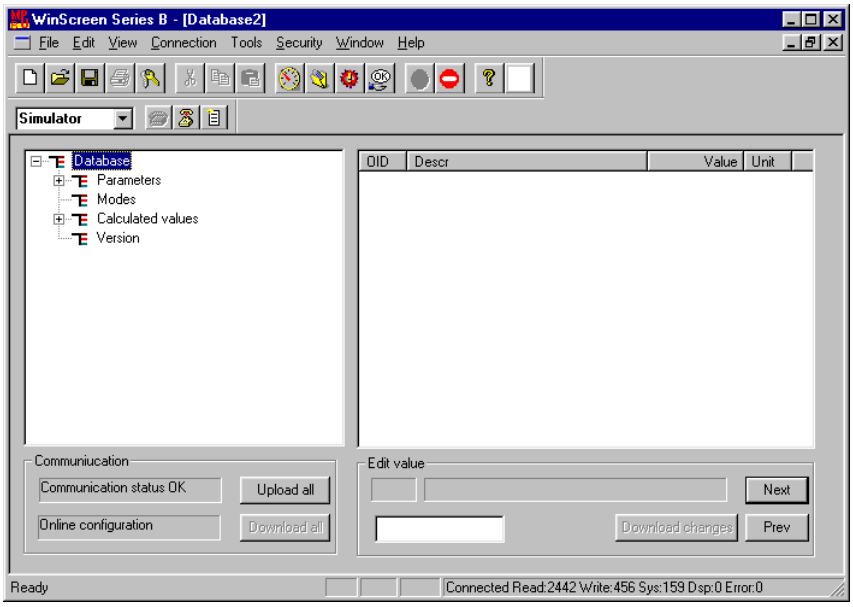
6.2.9 Database Configuration

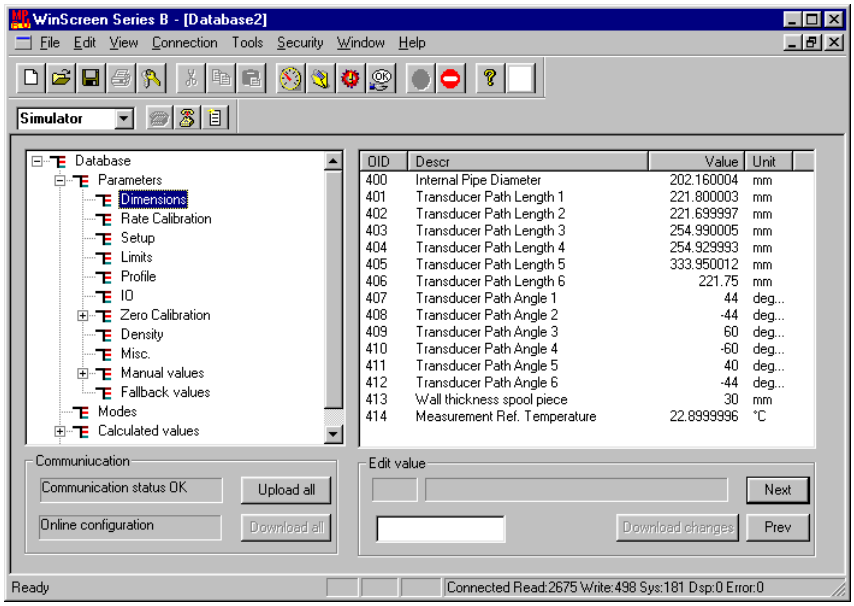
The first time this PC with this WinScreen program is connected to this MPU, or there have been software upgrades, the database structures in the WinSceen program and the MPU must be synchronized. This is done by entering the Tools menu and selecting the ”Synchronize data base structure with MPU”.


Soft key

To inspect the database the Database Configuration window can be selected in the New menu (or the shown soft key).

The first picture below shows the first window that appears after selecting Database Configuration in the New menu. To go further into the database just click on the plus sign in front of the desired choice. This is shown in the second picture below.





It is divided into three main groups - Parameters, Modes, Calculated Values and Version. The main groups may have more levels of information. The main groups are shown below.

Parameters

- Dimensions
- Rate Calibration
- Setup
- Limits
- Profile
- IO
- Zero Calibration
- Density
- Misc
- Manual Values
- Fallback Values

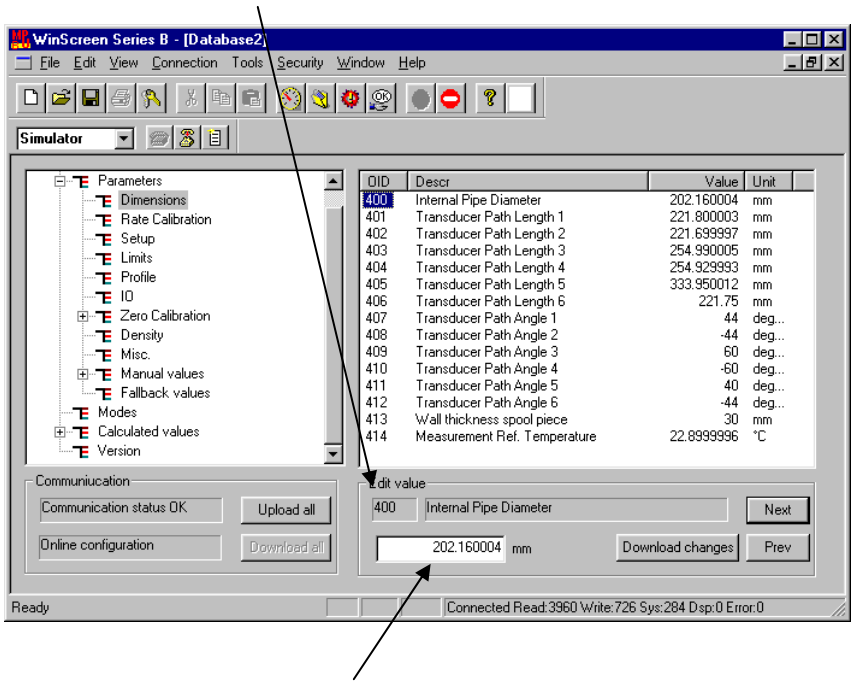
Calculated Values

- Measurements
- Errors
- Density
- Profile
- Status
- Misc.

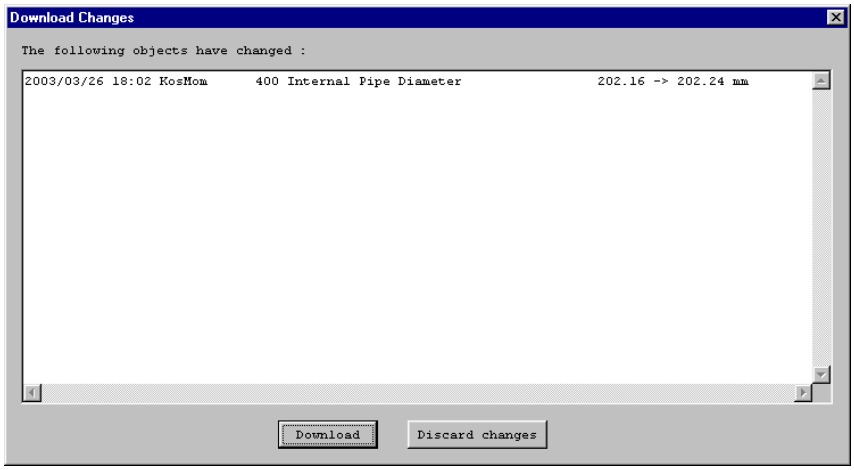
6.2.10 Change parameters

The correct security level must be entered to access this function.

- Select the parameter to be changed by clicking on it with the cursor. This parameter will now be shown in the Edit value window, the present value and name appear.

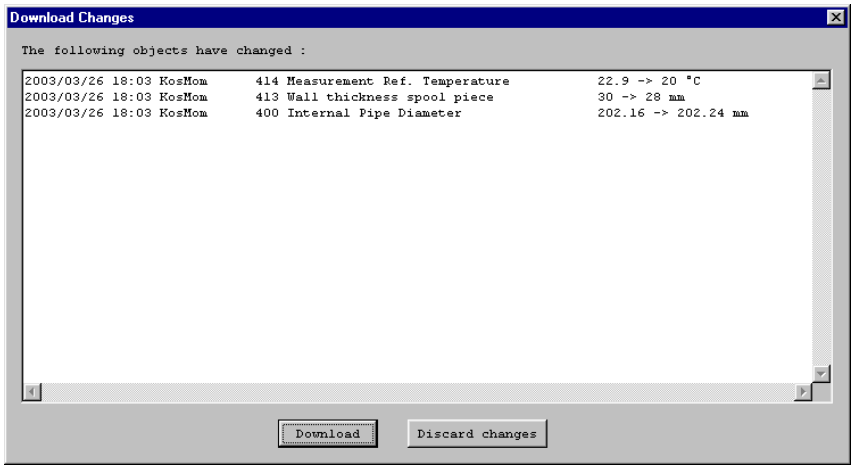


- Type in the new value
- The choice Download Changes becomes available. Click on it and a new window will appear. This window is shown below.



This window shows the old and new values. The change can now be downloaded or discarded. This information will be stored in the Operator Change Log.

It is possible to change more than one value in one download operation. Click on the next parameter and then go to the Download button.



6.2.11 Database Report


Soft key

All relevant data stored in the database can be uploaded by opening the Database Report window in the New menu (or the shown soft key). Database reports can then be printed or stored as a file.

This report contains all relevant data used in the Ultrasonic meter, it is basically a printout of all the parameters in the database. It contains the following information:

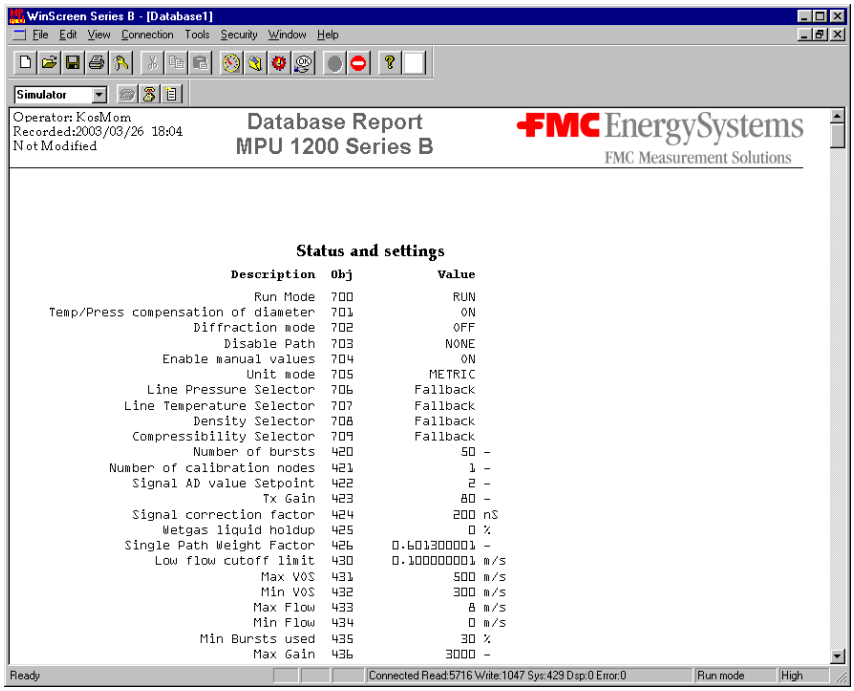
- Status and settings
- Dimensions and profile diagnostics settings
- Calibration parameters
- Manual values and fallback values
- Current measurements
- Active alarm log
- Historical alarm log
- Operator change log
- Event log

6.2.11.1 Print Database Report


Soft key

The Database Report can be printed out from the file menu in the program, or by using the soft key.

See example of a Database Report below.



In the top of this report there is information regarding who the operator is, time and date when the report was generated and if the report is modified or not. The text “Not Modified” will change to “Modified” if any changes are made to the database after being uploaded from the MPU. This means that a “Not Modified” database report can be used as a documentation of the database content at a given moment.

6.2.11.2 Save Database Report

The report can also be stored as a file (filename.db). Use the **save** soft key or menu selection. The database report file can be opened later for inspection and printing.

6.2.11.3 Open Database Report

The stored database report file (filename.db) can be opened by using the **open** soft key or menu selection. Both the “Database Configuration” – (type of window with tree-structure) and the “Database Report” will be opened, and the data can be inspected in both.

6.3 Storage and Preservation of the MPU and Spare Parts

6.3.1 SHORT term storage - up to one month

Depending on where the meter is stored, indoors or outdoors, precautions should be taken to preserve the meter during storage. Even for outdoor storage less than a day, precautions are required.

- When the meter is delivered, it is protected by protection covers. Inspect them for damage, and keep them on during storage.
- For outdoor storage, protect the flanges and inner pipe with Cortech or similar to prevent corrosion (unless the spool is made of non-corrosive material). For indoor storage in room temperature and low humidity, this is not necessary. Make sure that the transducer fronts and o-rings inside the spool piece are not subjected to any solvents which may lead to damage.
- Mount protection covers on the flanges, to prevent mechanical damage.
- Place the meter in such a way that it is not subject to damage caused by handling of other equipment.
- If outdoor storage, plug all cable glands and check that the electronics enclosure is properly closed. This is very important to prevent water ingress.
- Make sure the ambient temperature and humidity is within the meter's specifications (see Section 1.4.3) at all times.
- Make sure that the meter is properly placed and secured against tilting. Provide necessary supports.

6.3.2 LONG term storage - more than one month

Precautions must always be taken to preserve the meter during storage. The preservations must be checked every third month. Precautions are the same as for short term storage, with the following additions:

- Flanges and inner pipe must be protected with Cortech or similar to prevent corrosion (unless the spool is made of non-corrosive material). Make sure that the transducer fronts and O-rings inside the Spool piece are not subjected to any solvents which may lead to damage.

NOTE: If the meter has been subject to long term storage, all O-rings and Backup-rings have to be checked and if necessary changed.

6.3.3 Preservation

For preservation of the meter, the following is required:

- Cortech or similar to prevent corrosion.
- Covers for the flanges, to protect against mechanical damage.
- Necessary supports and extra covers to secure against damage caused by handling of other equipment.

6.4 Instructions for Packing and Transport

NOTE: The equipment must always be transported in a transportation box.

A. Mount the protection covers on the spool flanges before lifting the equipment into the box.

B. Visually inspect the MPU. Any damage must be reported immediately. The damage must be described and photographed.

C. Lift the equipment into the transportation box, as shown in the picture below.

Figure 31 – MPU in Transportation Box

NOTE: Lift and handle the MPU in accordance with the Lifting and Handling procedure, THI-0000020502.

7 SPARE PARTS

The purpose of this section is to give the user possibility to identify spare parts and order them from the supplier.

	ELEKTRONIK BOX	
Pos.	**Part Number**	**Description**
1	644622445	Transformer (AC)
2	65-900001	Optical Ethernet Fiber converter (Optional)
3	236110-101	UACF board (Power Supply Front End Board)
4	236108-101	UDSP board (Digital Signal Processor board)
5	870016010	UAFE board (Analog Front End board)
6	235553101	Analog input module, current (4-20mA)
6	235559101	Analog input module, voltage (0-5V)
6	235565101	Analog output module, current (4-20mA)
6	235568101	Analog output module, voltage (0-5V)

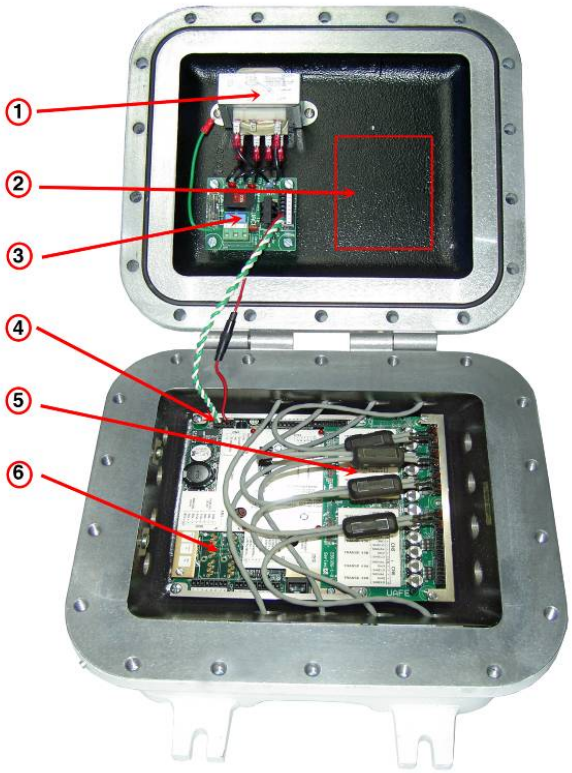


Figure 32 - Electronic Box

	TRANSDUCER	
Pos.	**Part Number**	**Description**
1	-	Transducer, calibrated to operational conditions (must order pairs) - ATEX
1.1	870007020	Transducer Assembly
1.2	870007028	Transducer Assembly – w/o ML
1.3	870007030	Transducer Assembly – CL1500
1.4	870007037	Transducer Assembly – High Pressure
2	870007018	Adapter
3	870007010	Cover
4	200004260	M8 x 25 Head Cap Screw
5	200010961	O-Ring 18,77 x 1,78
6	200012096	Backup Ring 19,4 x 22 x 1,2
7	200007501	O-Ring 59 x 2
8	6000006	O-Ring 27 x 2,5
9	-	Transducer cable – European type
9.1	870016004	4” – 6”
9.2	870016026	8” – 10 “
9.3	870016017	12” – 14”
9.4	870016007	16” – 18”
9.5	870016008	20” – 22“
9.6	870016018	24” – 26”
9.7	870016009	28” – 30”
9.8	870016019	32” – 34”
9.9	870016020	36” – 38”
9.10	870016021	40” – 42”
9.11	870016022	44” – 46”
9.12	870016023	48” – 50”

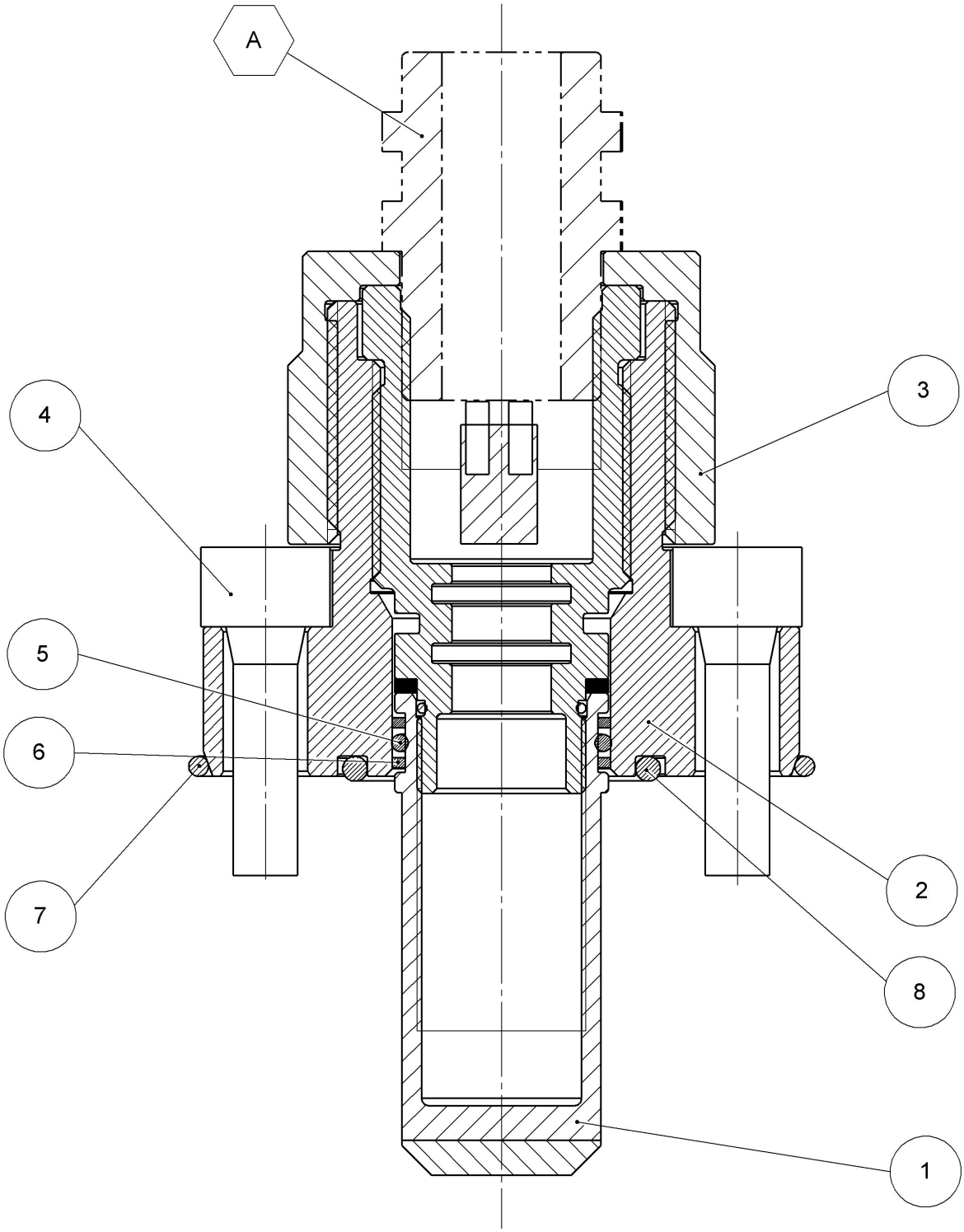


Figure 33 – Transducer

Some spare parts for the MPU may be specific for each project or delivery. Refer to the project specific spare parts list.

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8 HANDLING AND TRANSPORTATION

The purpose of this section is to provide instructions for handling and transportation in order to avoid that personnel get exposed to any danger or injury nor damage to the equipment.

CAUTION: In order to safely install the meter without any damage, it must be handled with great care. The below precautions and instructions must be followed.

For further information regarding lifting and transportation instructions, see THI-0000020502 “MPU Transport and Handling Instructions.

8.1 Spool Piece

Lifting lugs are dimensioned for the weight of the MPU only, not including blind flanges or liquid for test purpose.

If using a crane, the certified lifting slings must be wrapped around the meter, or use lifting lugs if available. Lifting and handling must always be performed in accordance with THI-0000020502.

At offshore installations it is very important to secure the meter during crane handling, due to motion on the platform or vessel resulting in pendulum motion of the load.

Do not fasten any lifting slings in the electronic connection box or its bracket.

CAUTION: The meter must not be subject to impacts. Transducer end covers, transducer cables, the electronic connection box and the flanges are especially exposed to damage.

CAUTION: If the lifting slings are fastened around the meter body, make sure that the meter isn’t tilted and that the electronic connection box, transducer covers or transducer cables aren’t damaged.

CAUTION: The flanges are protected with covers. Keep these on as long as possible before the meter is installed in the pipeline.

CAUTION: Make sure the ambient temperature and humidity are within the meter specifications (see section 1.4) at all times.

CAUTION: Make sure that the meter is sufficiently protected in case other work, which may damage the meter, is performed nearby. E.g. in case of welding, painting, cutting tools usage etc.

A. The meter is delivered with flange protection covers. The covers should be removed as close to the final installation point as possible. The meter must not under any circumstances be subject to impacts. Transducer covers, transducer cables, the electronics enclosure and the flanges are most subject to damage.

B. At offshore installations it is especially important to keep the protection covers intact during crane handling, due to motion on the platform/vessel resulting in pendulum motion of the load.

C. While the protection covers are intact, the meter may be handled by a forklift or similar, or by crane using certified slings correctly. Make sure that the lifting slings are fastened in such a way that the spool piece is unable to slide or tilt. Use lifting lugs if mounted (make sure that they are certified, and not damaged by wear and tear). While the meter is put down, check the foundation and the support legs at the meter, and make sure the meter will not tilt while lifting slings are released. This may cause damage to the meter.

D. Do not fasten any lifting slings in the electronics enclosure or its bracket.

E. If the lifting slings are placed around the meter body, make sure that the electronics enclosure not is damaged and that the meter is secured from tilting.

F. Make sure the ambient temperature and humidity is within the meter's specifications (see Section 1.4.3) at all times.

If the meter for some reason is removed from the pipeline, it should be properly protected against mechanical damage during handling and transportation. Depending on the pipe material, the meter must be properly protected against corrosion by means of Cortech or similar.

9 Appendix

9.1 Wiring Examples

9.1.1 Power Supply – AC

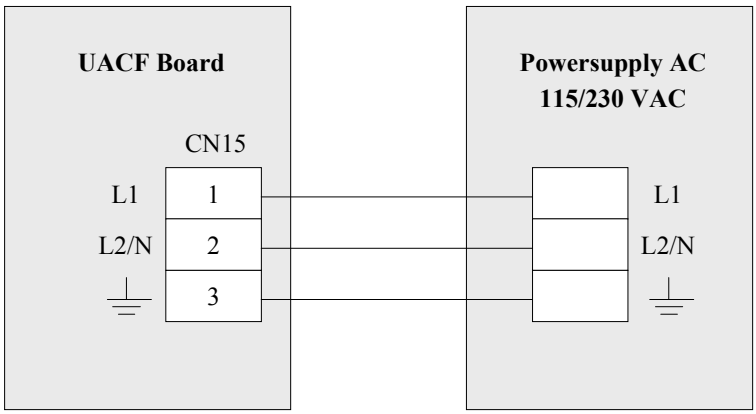


Figure 34 – Wiring Power Supply AC

Jumper and switch setting must be in accordance with chapter 0.

9.1.2 Power Supply – DC

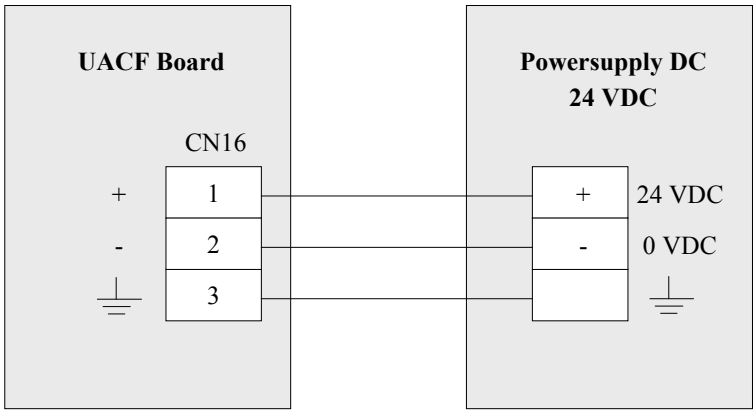


Figure 35 – Wiring Power Supply DC

Jumper and switch setting must be in accordance with chapter 4.2.3.1

9.1.3 Ethernet – twisted pair

9.1.3.1 Straight through

For communication via HUB or Switch:

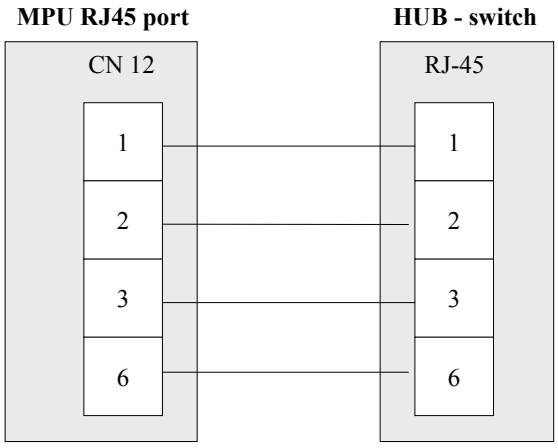


Figure 36 – Ethernet twisted pair - straight through

9.1.3.2 Cross-over cable

For communication directly to e.g. PC:

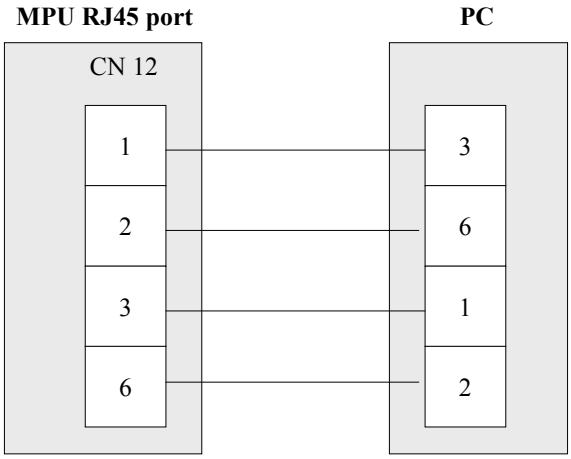


Figure 37 – Ethernet twisted pair - cross-over cable

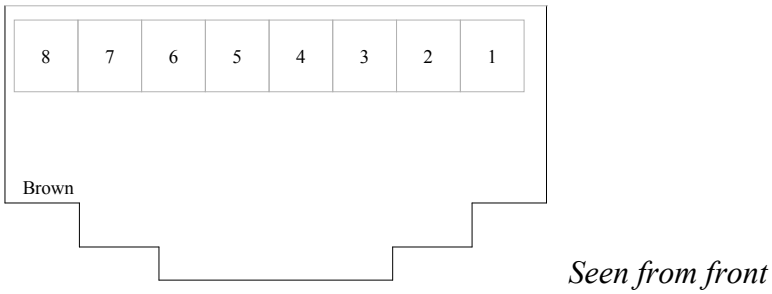


Figure 38 – Pin configuration in RJ45 plug

Straight Through Cable Wiring	
RJ-45 Pin #	***Color (both sides same)***
Pin 1	White with Orange
Pin 2	Orange
Pin 3	White with Green
Pin 4	Blue
Pin 5	White with Blue
Pin 6	Green
Pin 7	White with Brown
Pin 8	Brown

Table 10 – Colour Code Ethernet Straight Through Cable

Cross-over Cable Wiring		
RJ-45 Pin #	***1 end Color***	***2 end Color***
Pin 1	White with Orange	White with Green
Pin 2	Orange	Green
Pin 3	White with Green	White with Orange
Pin 4	Blue	Blue
Pin 5	White with Blue	White with Blue
Pin 6	Green	Orange
Pin 7	White with Brown	White with Brown
Pin 8	Brown	Brown

Table 11 – Colour Code Ethernet Cross-over Cable

9.1.4 Ethernet – Optical fibre

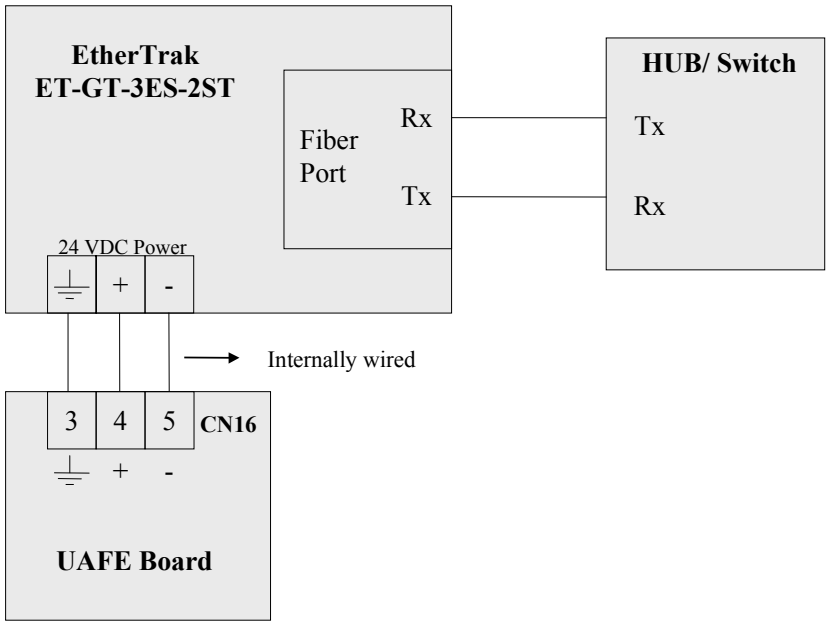


Figure 39 – Wiring Ethernet Optical Fibre

The Sixnet EtherTRAK Industrial Ethernet Switch has communication LEDs on each port and a power LED, as described in Table 12 and Figure 34.

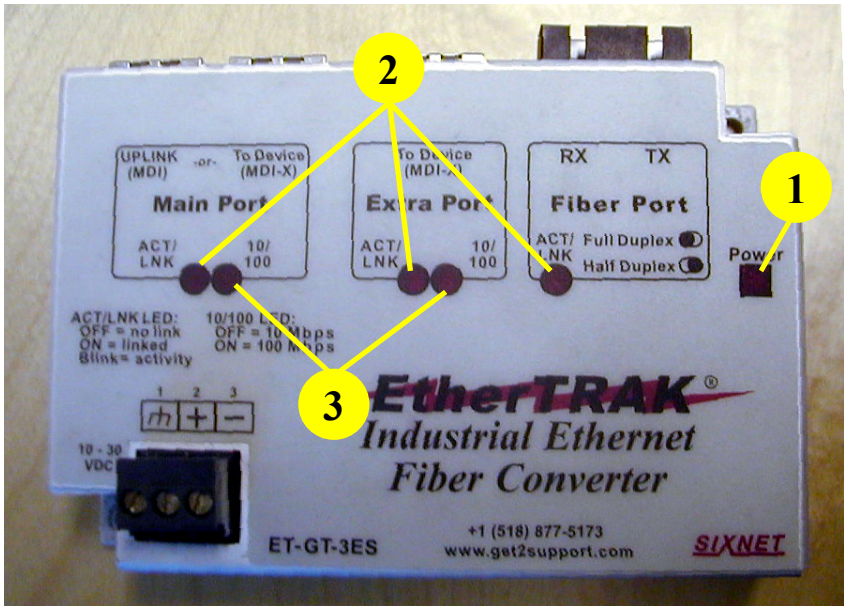


Figure 40 – EtherTRAK Industrial Ethernet Switch

Pos. no.	Name	Description
1	Power LED	This LED will be on solid when proper power has been applied to the unit.
2	ACT/LNK LEDs	The activity (ACT) and link (LNK) indication is combined into one LED (labeled “ACT/LNK” or“A”) on the EtherTRAK Industrial Ethernet Switches. There is one of these LEDs per port. The ACT/LNK LED will be ON solid when you have made a proper connection. ▪ **OFF** – This would indicate that there is not a proper Ethernet connection (Link) between the port and another Ethernet device. Make sure the proper cable type is in use and that it has been plugged securely into the ports at both ends. See section 5 for proper Ethernet cabling. ▪ **ON Solid (not flashing)** – This would indicate that there is a proper Ethernet connection (Link) between the port and another Ethernet device, but no communications activity is detected. ▪ **Flashing** - This would indicate that there is a proper Ethernet connection (Link) between the port and another Ethernet device, and that there is communications activity.
3	10/100 LEDs	This LED indicates what speed of communications is detected on the port. There is one of these LEDs per RJ45 port and it is labeled “ S”. (The fiber optic port does not have one of these LEDs because its speed is fixed at 100 Mbps.) (Mbps = Megabits per Second) ▪ **OFF** – A 10 Mbps (10BaseT) connection is detected. ▪ **ON** – A 100 Mbps (100BaseTx) connection is detected.

Table 12 – Sixnet EtherTRAK Fiber Converter LED descriptions

9.1.5 Serial communication – RS-232

The MPU uses only 3 wires for the RS-232 serial communication.

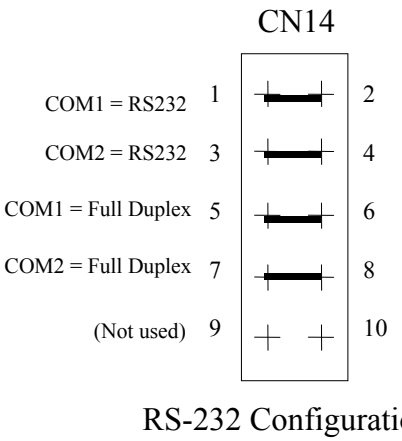


Figure 41 – CN14 jumper setting for RS232

9.1.5.1 Example of RS-232 communication with PC (WinScreen)

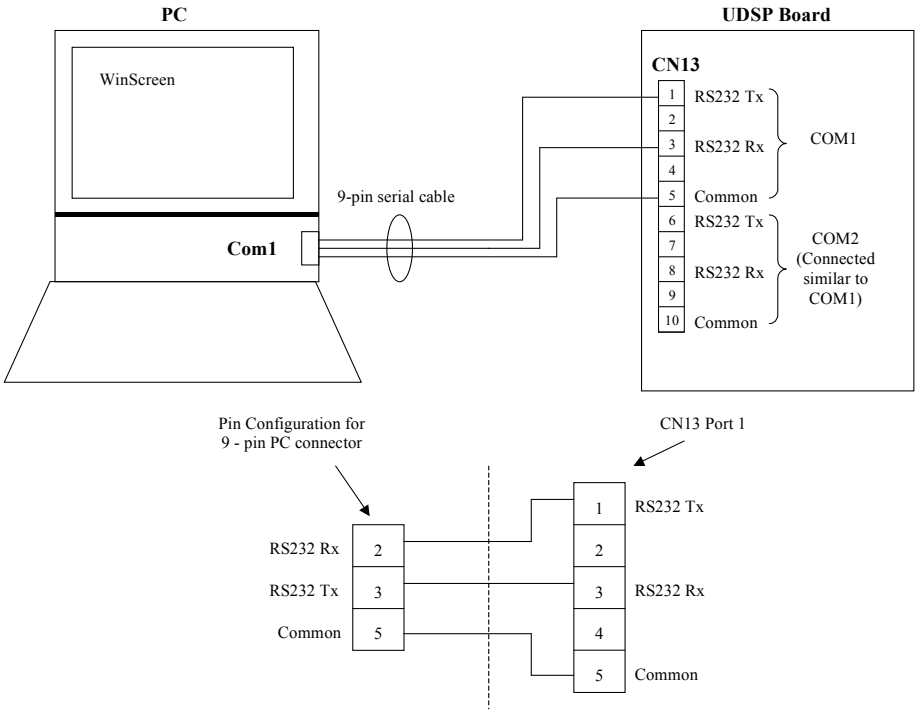
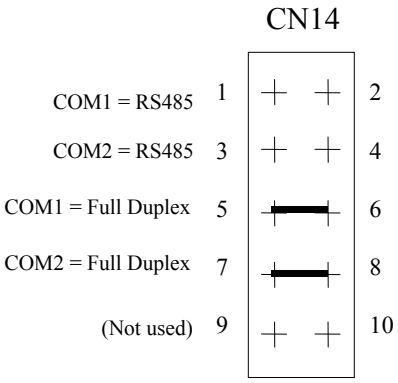


Figure 42 – RS-232 serial communication with PC

9.1.6 Serial Communication – RS 485 Full Duplex

4-wire RS 485 communication (full duplex) is also called RS422. Usually an RS-485/RS-232 converter is used to connect the signal to a PC or a flow computer.



RS-485 Full Duplex
4-wire Configuration
(RS-422)

Figure 43 – CN14 jumper settings for RS485 full duplex

9.1.6.1 Example based on Westermo MD 44 converter and a PC

The DIP switch settings for Westermo MD-44 converter should be as shown in Figure 38.

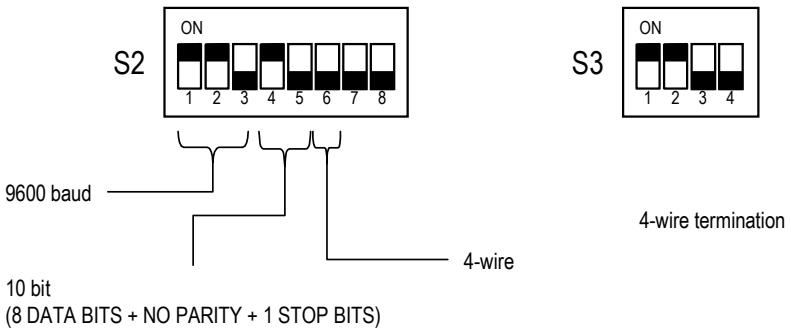


Figure 44 – DIP switch settings for Westermo MD-44, RS485 full duplex

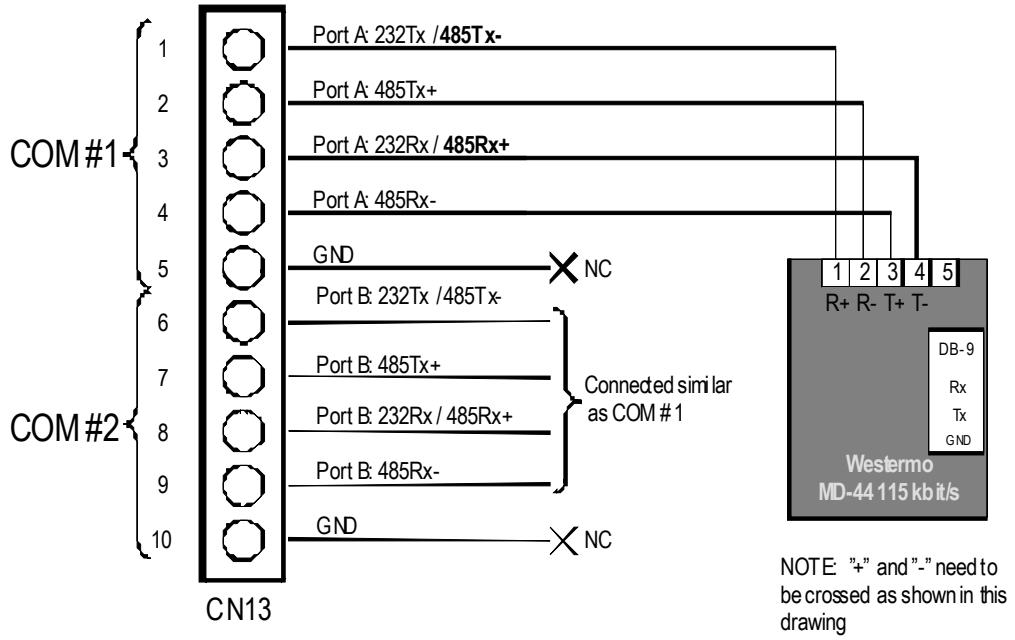


Figure 45 – Westermo MPU Wiring Diagram, RS485 full duplex

9.1.7 Serial Communication – RS485 Half Duplex

Half duplex is 2-wire RS485 communication. Usually an RS-485/RS-232 converter is used to connect the signal to a PC or a flow computer.

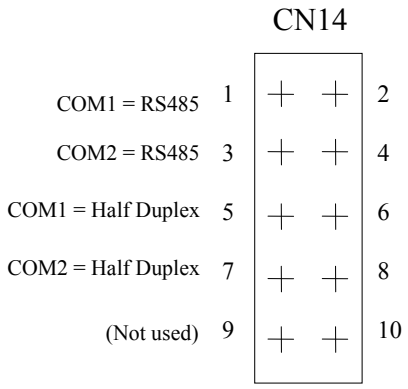


Figure 46 – CN14 jumper settings for RS485 - half duplex

9.1.7.1 Example based on Westermo MD 44 converter and a PC

The DIP switch settings for Westermo MD-44 converter should be as shown in Figure 41.

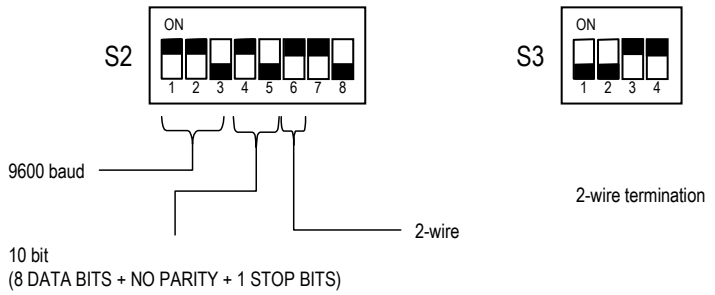


Figure 47 – DIP switch settings for Westermo MD-44, RS485 half duplex

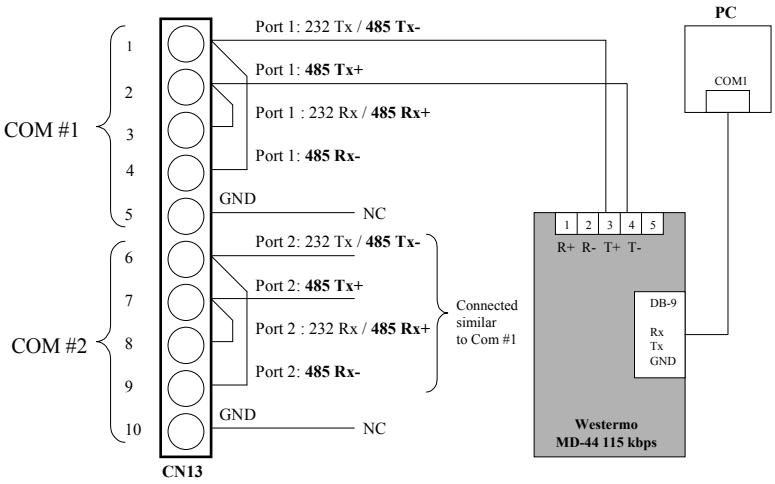
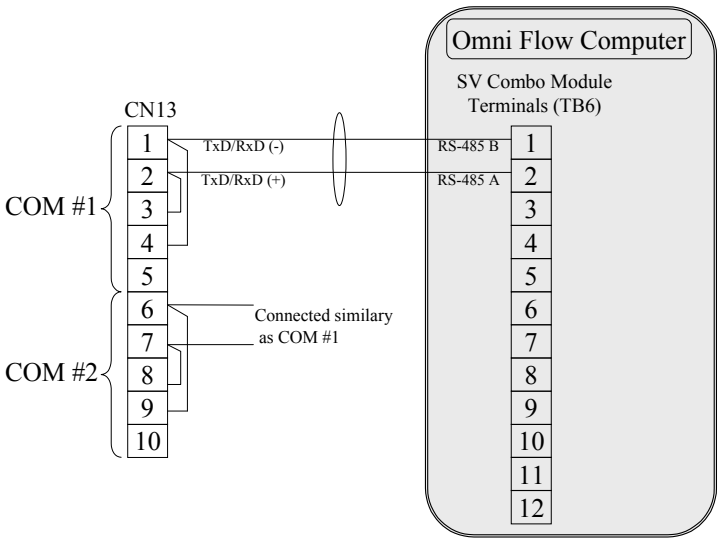


Figure 48 – Westermo MPU Wiring Diagram, RS485 half duplex

9.1.7.2 Example based on OMNI flow computer



9.1.8 Pulse Output

The pulse outputs can in principle be looked at as low resistant relays, where the relay coil is powered by the MPU and the relay contacts are powered by the external unit (flow computer). Note that polarity is important as it is open collector outputs.

The voltage over the relay contacts can be maximum 30VDC, i.e. according to the flow computer requirements (e.g. 5VDC, 12VDC 24VDC). Maximum current in the loop is 10mA (with 0.6V drop). Voltage level and resistance of the signal loop must be designed accordingly.

Pulse 1	Positive direction
Pulse 2	Positive direction 90 degrees phase shift of pulse 1
Pulse 3	Negative direction
Pulse 4	Positive direction 90 degrees phase shift of pulse 3

Figure 43 shows an example of how to wire the pulse module. There are similar connections for pulse 3 and pulse 4.

Pulse Wiring example 1

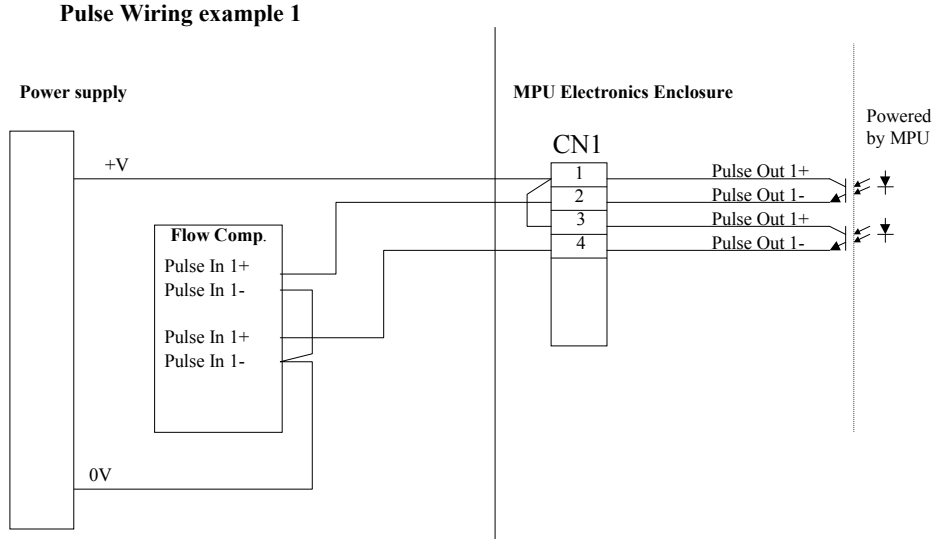


Figure 49 – Pulse Wiring - Example 1

Pulse Wiring example 2

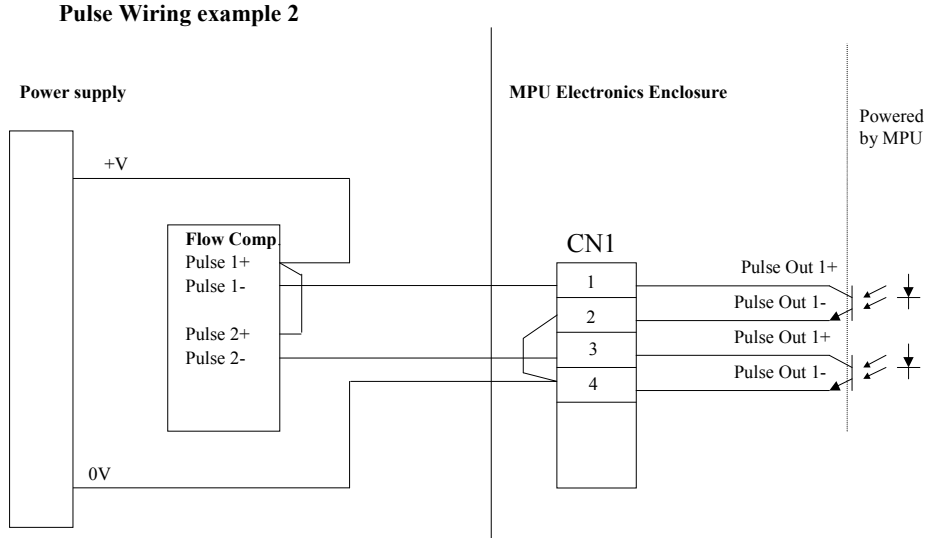


Figure 50 – Pulse Wiring - Example 2

9.1.9 Digital Output

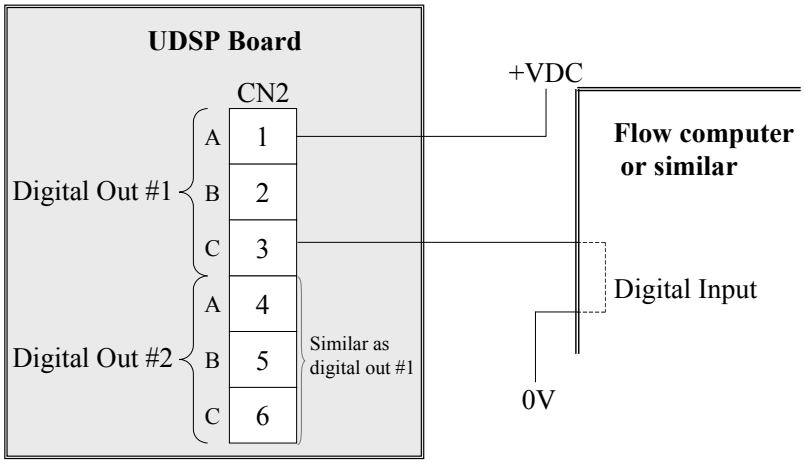


Figure 51 – Wiring Diagram - Digital Output

The digital output is an optically isolated solid state output. Maximum voltage is 30 VDC.

9.1.10 Digital Input

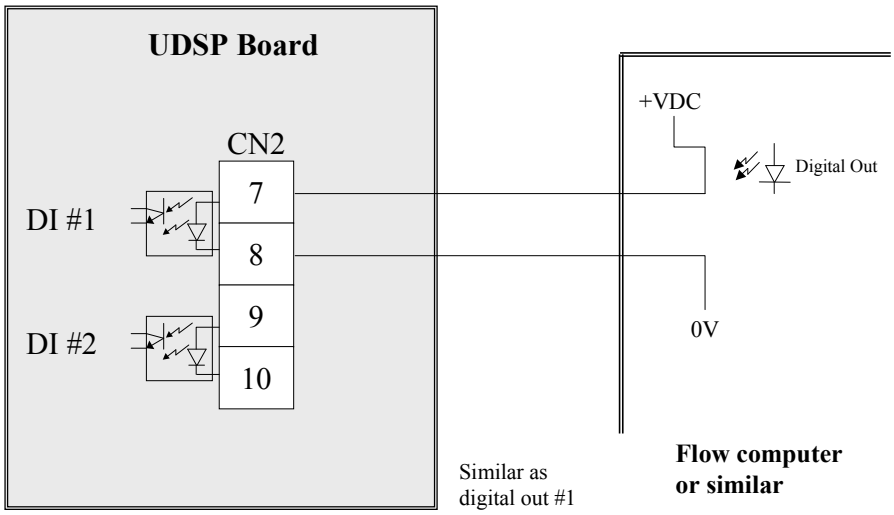


Figure 52 – Wiring Diagram - Digital Input

High speed, optically isolated digital input

V (high):	5-28 VDC
V (low):	Less than 1VDC
Input Impedance:	48 kΩ

9.1.11 Analog Output

9.1.11.1 Analog Output 4-20 mA

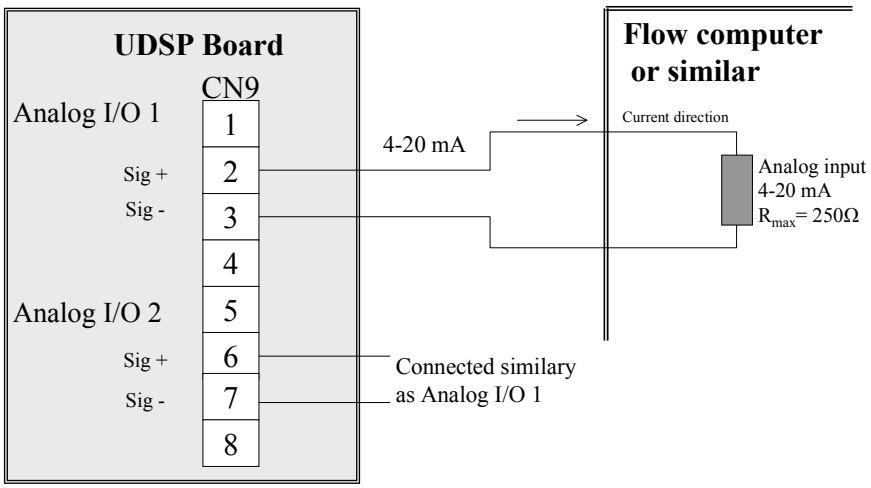


Figure 53 – Wiring Analog Output - 4-20 mA

Analog output module, type 4-20 mA, must be mounted in the used slot.

9.1.11.2 Analog Ouput 1-5 V

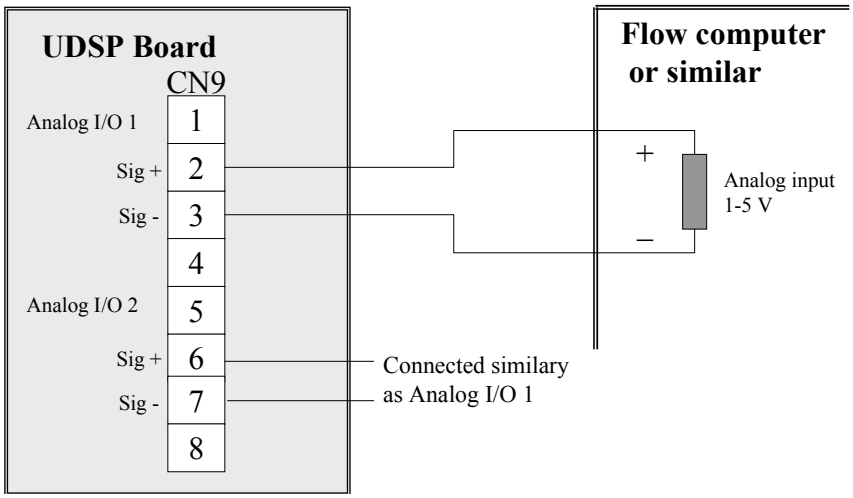


Figure 54 – Wiring Analog Output - 1-5 V

Analog output module, type 1-5 V, must be mounted in the used slot.

9.1.12 Analog Input

9.1.12.1 Analog Input 4-20 mA

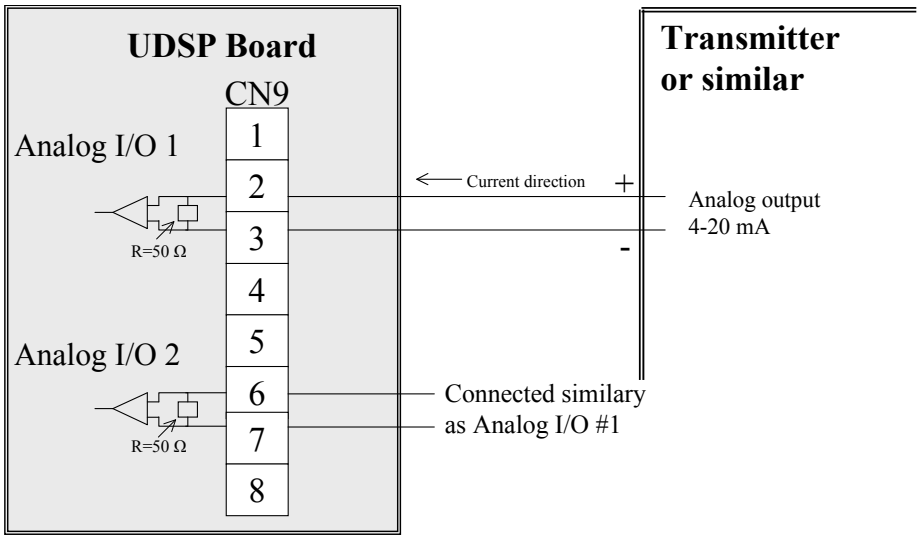


Figure 55 – Analog Input - 4-20 mA

Analog Input module, type 4-20 mA, must be mounted in the used slot.

9.1.12.2 Analog Input 1-5 VDC

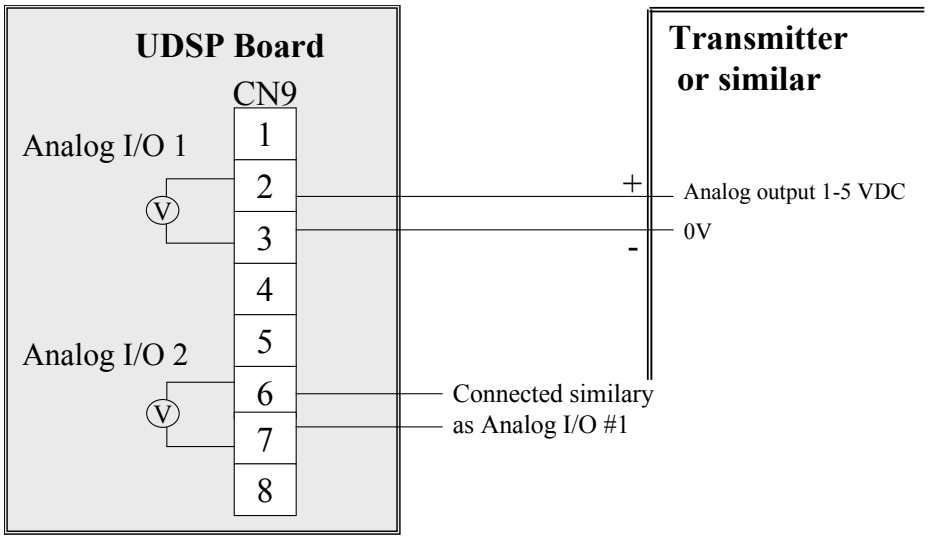


Figure 56 – Analog Input - 1-5 VDC

Analog Input module, type 1-5 VDC, must be mounted in the used slot.

9.2 External Wiring Connections

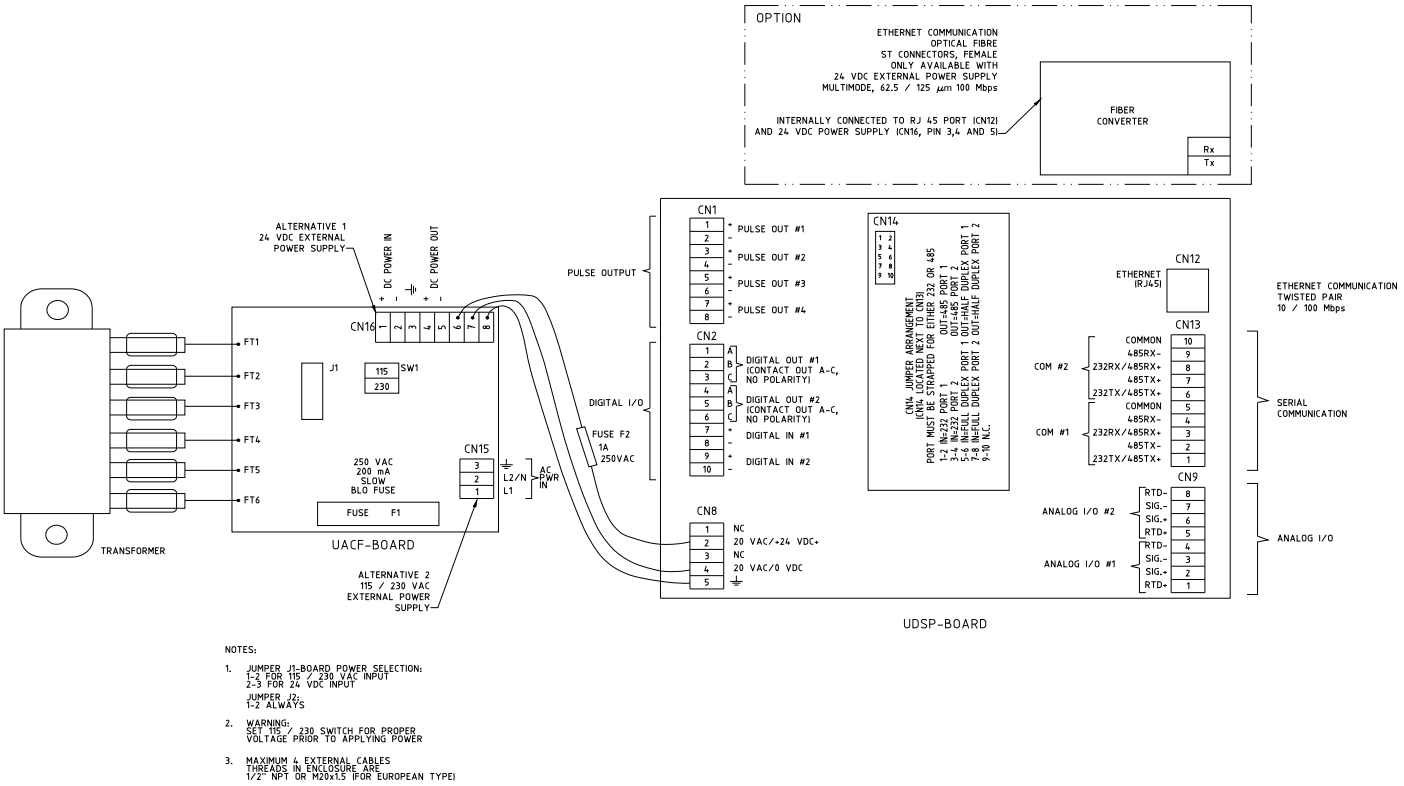


Figure 57 – MPU Series B External Wiring Diagram

9.3 Declaration of Conformity

FMC Technologies
Smith Meter Inc
1602 Wagner Avenue
Erie, PA 16510

Phone: (814) 898-5000
Fax: (814) 899-9349

EC Declaration of Conformity

This is to declare, in accordance with Directive 94/9/EC, that the following product(s) are designed and manufactured in accordance with Annex II of Directive 94/9/EC.
The manufacturer attests on their own responsibility that the apparatus has been constructed in accordance with the principles of good engineering in safety matters, and that any routine verification and test required by Clause 24 of EN 50014:1997 has been successfully completed.

Manufacturer:
FMC Technologies Measurement Solutions Inc. (Smith Meter)

Manufacturer's Address:
1602 Wagner Ave
Erie, Pennsylvania 16510
USA

Product Description:
Ultrasonic Interface (USI) for use in potentially explosive atmospheres

EEx d IIB T6 Tamb -60° C to +60° C, CE 0539 Ex II 2 G

Product Name:
USI Ultrasonic Interface
Models USI-G and USI-L

Certifying Agency for Quality Assurance Notification:
UL International DEMKO A/S (0539)
Lyskaer 8, P.O. Box 514,
DK-2730, Herlev, Denmark
Telephone +45 44856565
04 ATEX Q132684

Certifying Agency for Essential Health and Safety Requirements only:
Nemko AS (0470)
Gaustadalleèn 30, N-0373 Oslo
PO Box 73, Blindern, N-0314 Oslo
Norway
Telephone: +47 22 96 03 30
NEMKO 05 ATEX 1244

This Declaration is based on compliance with the following standards:
Essential Health and Safety Requirements:
EN 50014: June 1997 E +A1-A2: 1999
Electrical apparatus for potentially explosive atmospheres - General requirements

EN 50018: November 2000: + A1: 2002
Electrical apparatus for potentially explosive atmospheres - Flameproof enclosures'd'

EN 60529: 1992
Degrees of protection provided by enclosures (IP code)

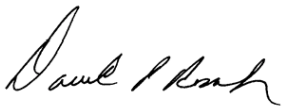
EMC compliance:
(by Council Directive 89/336/EEC, 91/263/EEC, 92/31/EEC, 93/68/EEC and 93/97/EEC)
Electromagnetic Emissions:

EN 50081-1:92 EMC Generic Emission Standards Class B
EN 55022:98 A2 ITE - Radio Disturbance Characteristics - Limits and Methods of Measurement
EN 61000-3-2:01 Limits for Harmonic Current Emissions
EN 61000-3-3:95 A2 Limitations of Voltage Fluctuations and Flicker
Electromagnetic Immunity:
EN 61000-6-2:01 Generic Immunity Standards Industrial Environments
EN 61000-4-2:95 A2 Electrostatic Discharges (ESD)
EN 61000-4-3:02 A1 Radiated Electromagnetic Field
EN 61000-4-4:95 A2 Electrical Fast Transient (Burst)
EN 61000-4-5:95 Electrical High Energy Pulses (Surge)
EN 61000-4-6:96 Immunity to Conducted Disturbances
EN 61000-4-8:94 A1 Power Frequency Magnetic Field Immunity Test
EN 61000-4-11:94 A1 Voltage Dips, Short Interruptions, and Variations

Supplementary Information:

European Contact:
Smith Meter GmbH
Regentstrasse 1
25474 Ellerbek Germany
Telephone +49 0 4101 304 0

For and on behalf of Smith Meter Inc.,



December 14, 2005

David P. Resch
Engineering Manager

FMC Technologies

Smith Meter GmbH
Ellerbek, Germany

EG - Konformitätserklärung

EC - Declaration of Conformity

im Sinne der EG-Richtlinie über explosionsgeschützte Geräte
nach 94/9/EG (ATEX)
as defined by non-electrical explosion protected Equipment Directive 94/9/EC

Der Hersteller / *The Manufacturer*

Smith Meter GmbH, Regentstraße 1, D-25474 Ellerbek

erklärt hiermit, dass das (die) explosionsgeschützte(n) Gerät(e)
herewith we declare, that the explosion protected Equipment

Produktbezeichnung: ***Product:***	**Zündschutzart:** ***Type of protection:***	**EG – Baumusterbescheinigung*** ***EC – Type Test Approval***
Device: Ultra-Short Transducer, Type: US-…	Ex II 2 G Ex d IIC T5 / T4	PTB 07 ATEX 1018

*einschließlich aller Ergänzungen / *including all supplements*

in der gelieferten Ausführung den folgenden Sicherheitsanforderungen entspricht (entsprechen):
Corresponds to following safety requirements in the delivered implementation:

Grundlegende Normen / CENELEC: ..... EN 60 079-0: 2004, EN 60 079-1: 2004
Basic norms:

Angewandte harmonisierte Normen, insbesondere:.....
Applied harmonized standards, in particular:

Andere angewandte Bestimmungen / EG-Richtlinien:.....
Other applied appointments / EC-Directives:

Benannte Stelle / Produktionsüberwachung:.....Physikalisch-Technische Bundesanstalt
Notified Body Production control PTB 99 ATEX Q001; CE 0102

Prüfungen/Überwachung/Kontrollen während der Fertigung:.....Hersteller
Examination/inspection/tests during manufacturing: *Manufacturer*

Die zugehörige Betriebsanleitung enthält wichtige sicherheitstechnische Hinweise und Vorschriften für die Aufstellung, Inbetriebnahme Wartung und Instandhaltung der (s) Gerät(es).
The appropriate operator's manual contains important safety technical notes and regulations for the installation, placing into operation, maintenance and maintenance of the equipment.

Ort und Datum: Ellerbek, den 13.09.2011
Location and date

Geschäftsführer _____
General Manager *(F.Jönsson)*

No. of document: KEel 090

page 1 of 1

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Measurement Products and Equipment:
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