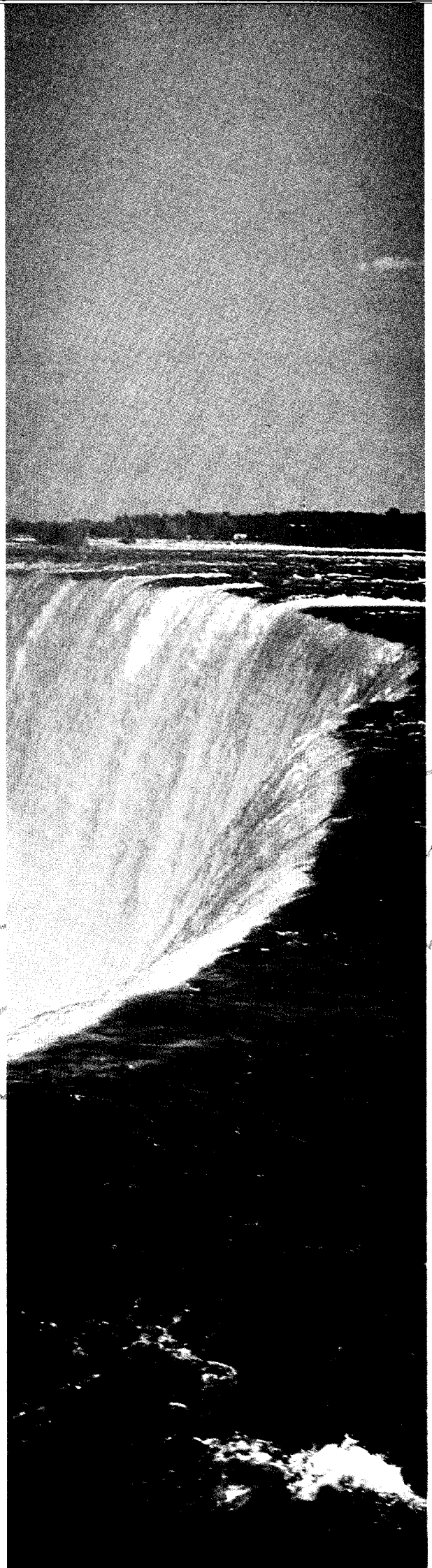


Ultraflux

MESURES PAR ULTRASONS

ULTRASONIC INTERFACE DETECTOR

UF 321-I

USER MANUAL

ULTRASONIC INTERFACE DETECTOR

UF 321-I

TABLE OF CONTENTS

① GENERAL POINTS

- ***1.1 -*** *Purpose of the equipment*
- ***1.2 -*** *Physical principle*
- ***1.3 -*** *Implementing ; operation associated equipment*
- ***1.4 -*** *Operation conditions*

➪ ①- GENERAL POINTS

➪ 1.1 - PURPOSE OF THE EQUIPMENT

By measuring the speed of sound (or celerity), the system enables a continuous follow-up of a liquid's specific gravity as well as the concentration recorded by mixed miscible liquids.

The principle is mainly designed to identify oil products, preferably refined when they are pipelined.

By **interface** is understood the **transition area** of a given product **A** to a second product **B** ; the device is thus known as "**Interface Detector**".

The principle further applies to the measurements performed on the concentration of soluble products (ionizing salts).

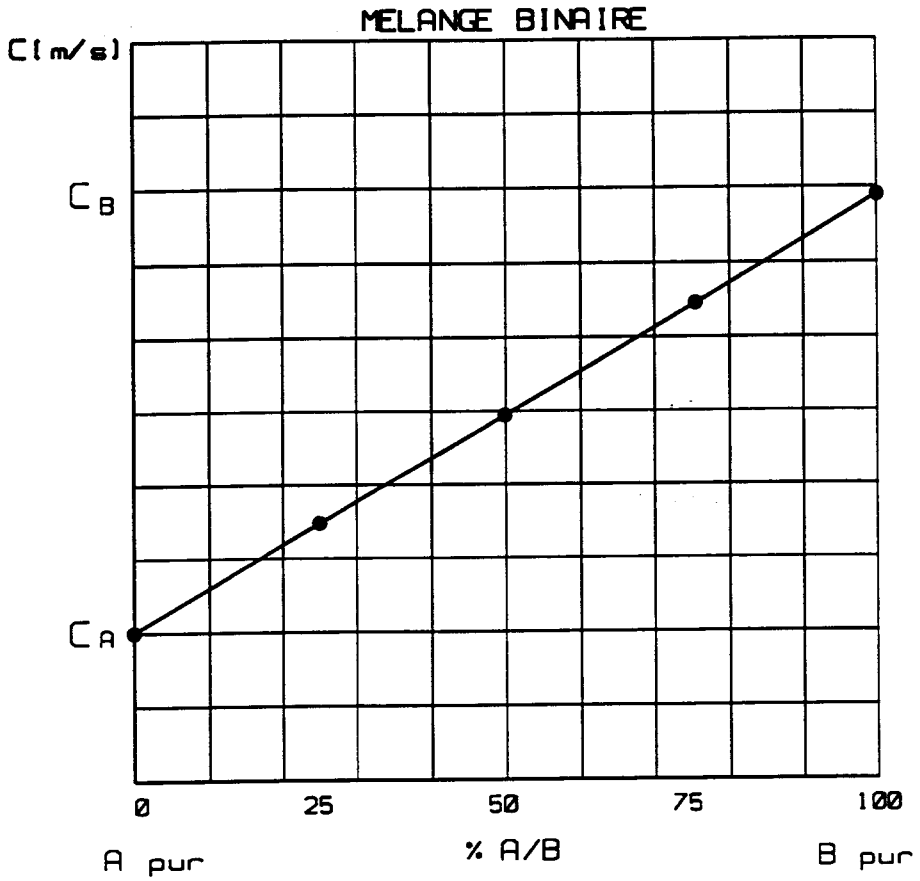
➪ 1.2 - PHYSICAL PRINCIPLE

Even if the **specific gravity** is not directly associated to **sound velocity**, there is nevertheless a linear relationship between both parameters applying to :

- Most binary mixtures,
- For most basic non doped oil products,
- As for other kinds of products, some variations are noted, let's mention for instance, alcohol, water....; same for such intricate products as crude oil, either as leaded or unleaded gasoline, where sound velocity also variates with regards to this law.
  Their respective additives influence compressibility, physical parameter, of major importance in velocity.

The curves and tables hereafter are a clear picture of the relationship just mentioned.

⇨ 1.2.1 - Response with a binary mixture of **A** and **B** products

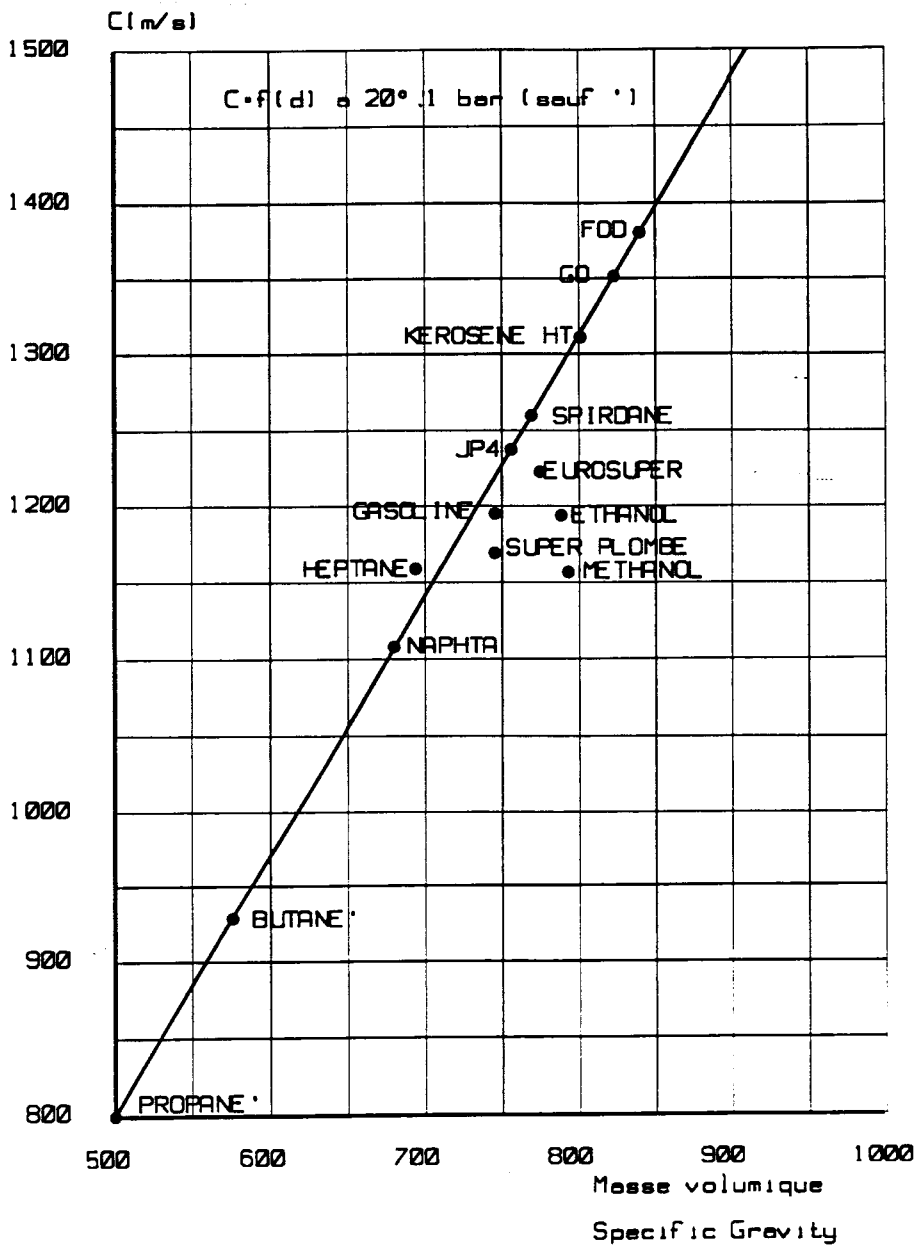


⇨ 1.2.2 - Specific gravity - sound velocity relationship

Typical values at 20°C (± 2°)

Lined up products	S.G (kg/m3)	Sound velocity m/sec	Products	S.G kg/m3	Sound velocity m/sec
Propane	500	800	**Water**	1.000	1.481
Butane	580	920	**Methanol**	790	1.155
Naphta	660	1.110	**Ethanol**	785	1.195
J.P.4	760	1.240	**Benzene**	870	1.305
H.T Kerosene	800	1.310	**Xylene**	860	1.335
G.O	825	1.350	**Eth.Alcohol**	825	1.205
F.O.D	840	1.380			
Spirdane	770	1.260	**Crude oil**	860 - 900	1.340-1.400
Tetranese	775	1.270	**Gasoline**	745	1.190
			Leaded super	745	1.170
			Eurosuper	775	1.220

➪ *Diagramme with 20°C - 1 bar (except butane and propane)*



Relationship at 20°C

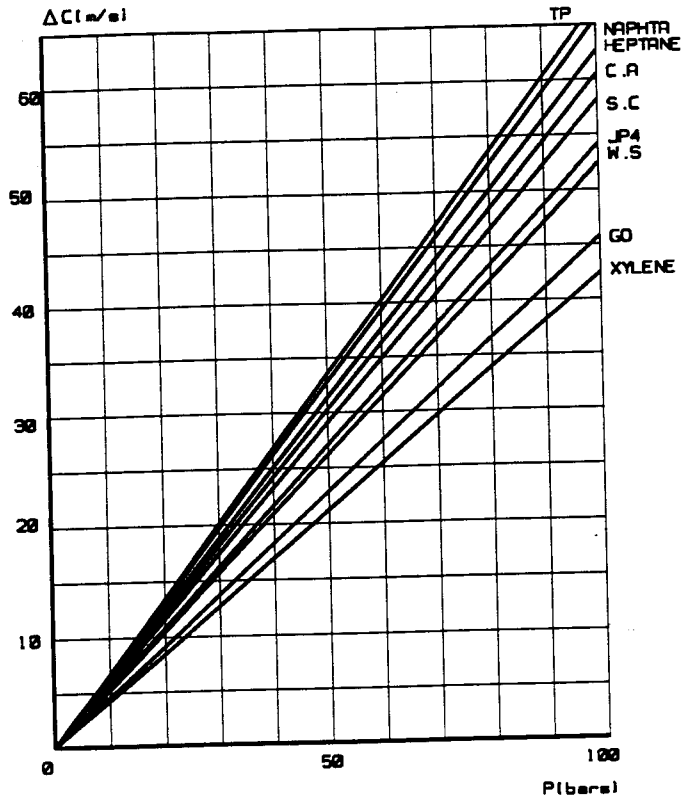
C = 1.707 S.G - 54
m/sec kg/m3

Relationship at 15°C

C = 1.337 S.G - 7
m/sec kg/m3

➪ ***1.2.3 -*** *Effect of pressure on velocity*

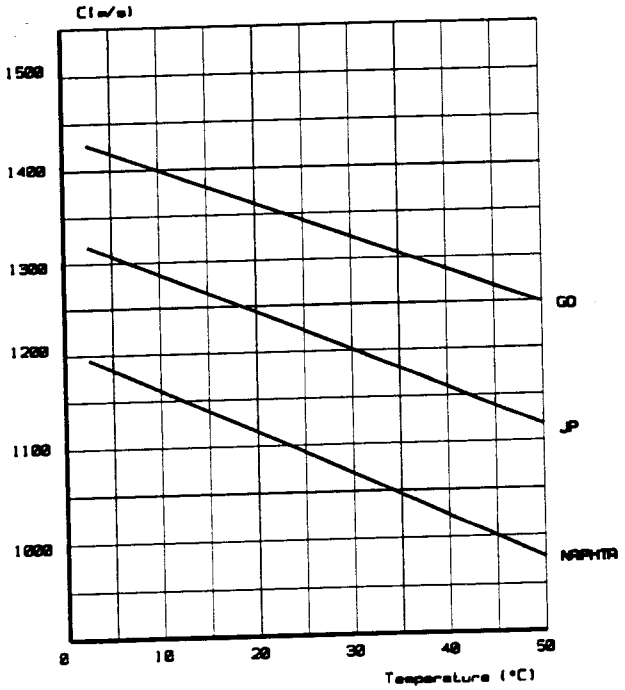
Effect is all the more significant that density is low. The coefficient varies from **+0.4 m/s/bar** for **gas-oil** to **+0.65 m/sec/bar** for **light Naphta**.



Compensation is therefore necessary if pressure varies by over **10 bars**.

⇨ *1.2.4 - Effect of temperature on velocity*

Effect is also all the more important that density is low



Influence factor

$\Delta C/\Delta T$ = -3.7 m/sec/C° for GO
$\Delta C/\Delta T$ = -4.6 m/sec/C° for naphta

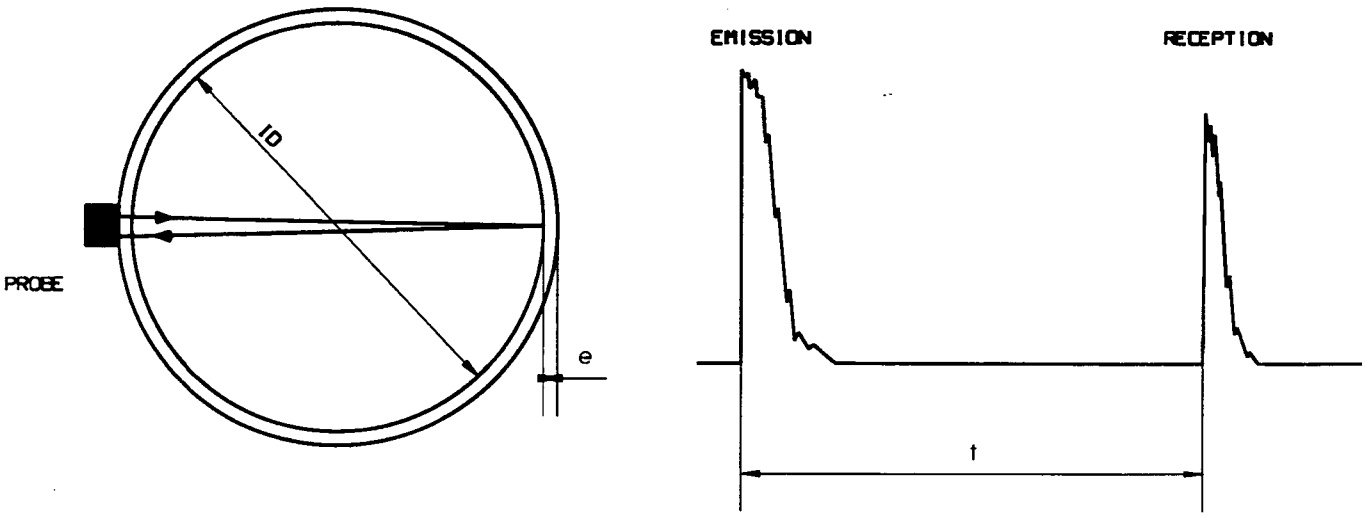
The factor is negative

The need for compensation depends of :

- the **accuracy** aimed at for density
- the **temperature**'s rate of evolution ; let's underline that an interface will not be liable to any mis-identification risks on seasonal temperature difference grounds

⇨ 1.3 - IMPLEMENTING OPERATION ASSOCIATED EQUIPMENT

Sound velocity is generally computed by measuring the **transit time** of an **ultrasonic pulse** (to and back) on a given travel, the latter reference travel being usually a pipe's diameter as it is reputed constant for a given measurement point.



$$t = \text{total time} = t_0 + t_{steel} + t_{product} = t_0 + \frac{2e}{Ca} + \frac{2D}{C}$$

t_0 being the propagation time in the probe itself and
C_a the propagation speed through steel materials

Which results in :

$$C = \frac{t - t_{dead}}{2D}$$

The systems includes :

- an ultrasonic probe (frequency = 1 or 2 MHz)

  . economical model ref. **1524** (LCIE approved)
  . approved model PTB "Ex" SG5 ref. **1457**

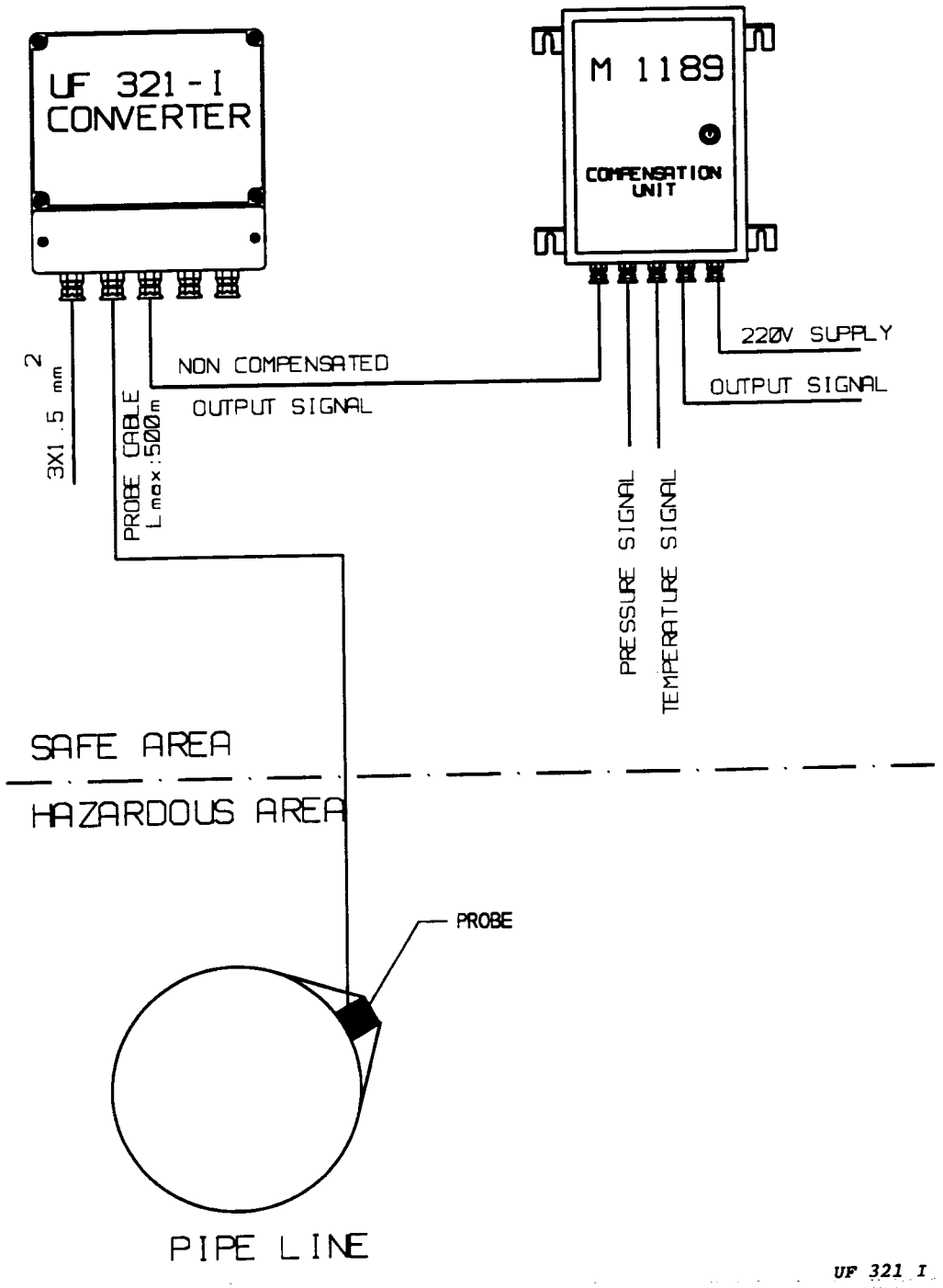
The probe is delivered with a stainless steel attaching strap plus a material for coupling to the pipe

- a shielded connection **cable** (can also be armoured upon request)

  . recommanded model : **100** ohms twinax
  . possible model : **50** or **75** ohms triaxial

- a **converter**, UF 321 I type which dialogues with the probe and returns a scaled but not corrected measurement

- a **correcting unit**, M1189 type, or better, M 1189 **S** type or even **N** type, delivered on option and possibly installed if **Pressure** and **Temperature** influence need to be corrected.



Let's mention that **separate pressure and temperature probes** lie beyond the usual scope of supply. In fact, they are to express the conditions met at ultrasonic probe location.

The **M 1189** correcting unit and the **UF 321 I** can be separately installed.

⇨ 1.4 - OPERATION CONDITIONS

- Materials to be crossed are to be **transparent to ultrasounds** ; any coating should be cleared upright of the probe ;
- As the probe is **galvanically insulated**, there is no problem with the cathodic protection ;
- The **probe** is to be correctly and permanently **coupled** to the pipe ; we do recommand and further deliver an elastomere material (polyken). As for coupling liquids, greases or glues, they may be resorted to quite exceptionally indeed.
- Once it has been correctly installed, the probe can be definitely **buried** without any harmful effect ;
- **Liquids** to be featured are also to be **transparent to ultrasounds** and therefore homogeneous (there should only be few or best no gas bubbles or suspended particles), miscible and not too viscous (above **50 cst**, consult ***ULTRAFLUX***)
- Standards ruling **hazardous areas** are to be abided by (**intrinsic safety**)
- As concerns areas liable to **storms**, they are to be fitted with **protection modules**

② DESCRIPTION OF THE EQUIPMENT

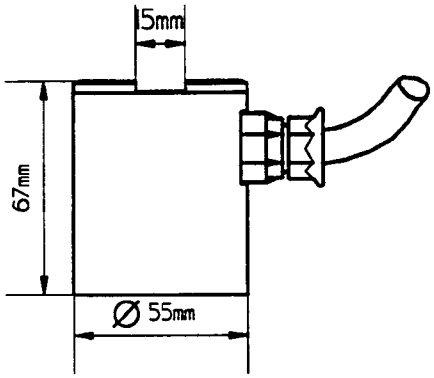
- ***2.1*** - *Overall description of the equipment*
- ***2.2*** - *Functional description*
- ***2.3*** - *General features*

⇨ ②-DESCRIPTION OF THE EQUIPMENT

⇨ 2.1 - OVERALL DESCRIPTION

⇨ 2.1.1 - PROBE (cf probes' data sheets for further details on description)

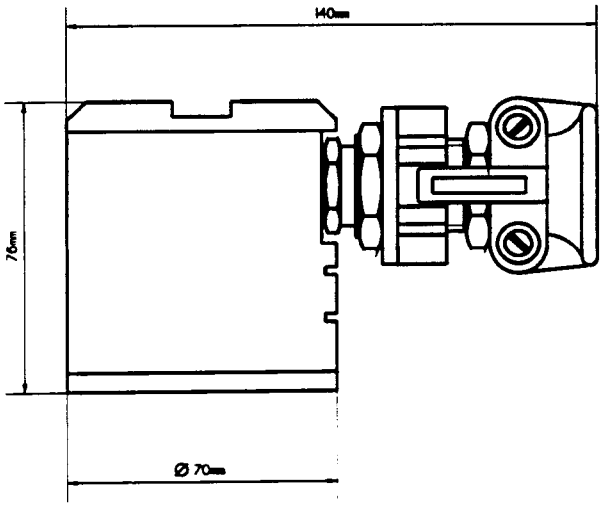
- Simplified probe **ref.1524**



. Approximate weight : 0.6 kg
. screwed or welded connection with potting
. face out of epoxy resin, either flat
or curved to the pipe's outside diameter

- "Ex"s-G5 **Ref. 1457**

. approximate weight : 1.2 kg



. Connection welded with potting

. Epoxy resin face, either flat or curved to the pipe's outside diameter

Nota : For the two above probes, a fixing groove has been specifically designed on the cover for probe to pipe fixing using a stainless steel belt.

- **cable :** IBM type twinaxial cable, or possibly cables armoured by strip steel

. outside diameter : 13 mm
. maximum length : 500 m
. recommanded length : < 300 m

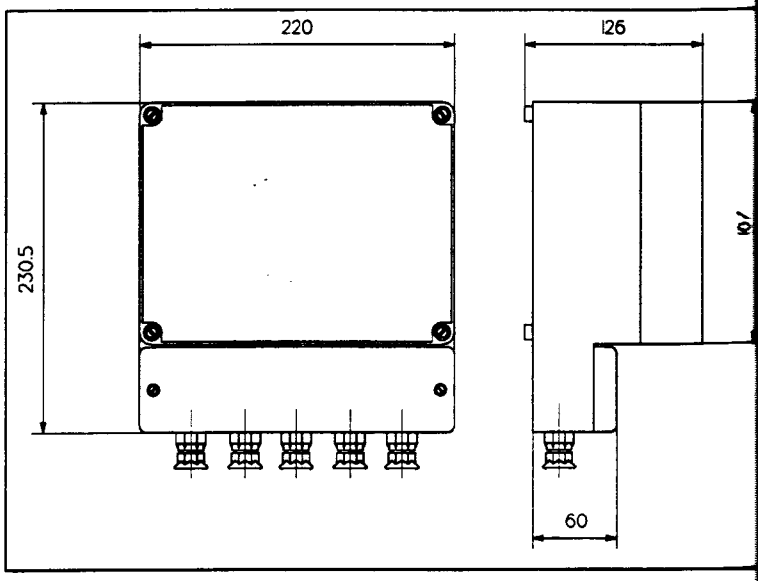
. triaxial (armoured) cable possible

⇨ 2.1.2 - UF 321 I Converter

The **UF 321-I** 's general features are all indicated on the commercial data sheet

- The various existing versions :

* **Standard version** :



. polycarbonate cabinet

. **IP55** water tight enclosure

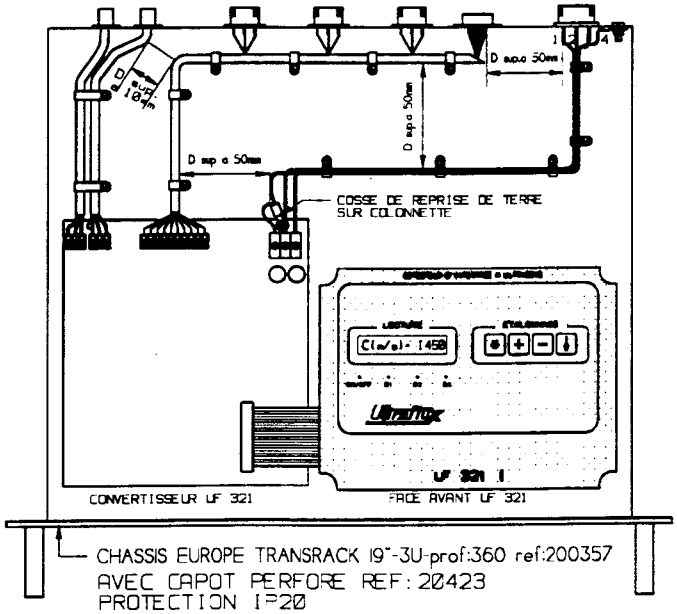
. weight : 2 kg

. **Electronical compartment** covered by a front panel with the **LCD** display, the signal lights and the keypad ; it is protected by a transparent cover

. **terminal block compartment** with gland outputs (runway diameters adapted to the cables selected

. Plus **access to test points** Is, synchro and echo (oscillo)

* **19"-3U'-360 Rack version** :



. IP > 20

. Weight : 5 kg

. Connector outputs

* **Ex-proof Version** : consult ***ULTRAFLUX***

ULTRAFLUX has to make reserves when this mode of protection is associated to intrinsic safety.

- Resources :

. A **4**-key pad plus **LCD** display (**16** digits) with **16** characters for input, modification or consultation of the calibration or measurement parameters as well as for formating output scales.

. Calibration parameters are stored in the **EEPROM** memory

. The device issues :

. a **measurement** as **0-20 mA** or **4-20 mA** current output (control test points)

. a **fault contact** which can be utilized to report the passage of scrapers

. a **threshold** contact

. an **alarm** contact (dC mode : cf hereafter)

. an optional **RS 232** serial output

- Operation modes :

The **3** following measurement modes have been planned for

. **MODE C** : an output, function of sound velocity and therefore density linear. It is the very mode selected with any new installation

. **MODE 1/C** : an output, inversely function of sound velocity. With this mode, the older **M 212** units can be replaced while the older **M 1189** correcting unit is kept.

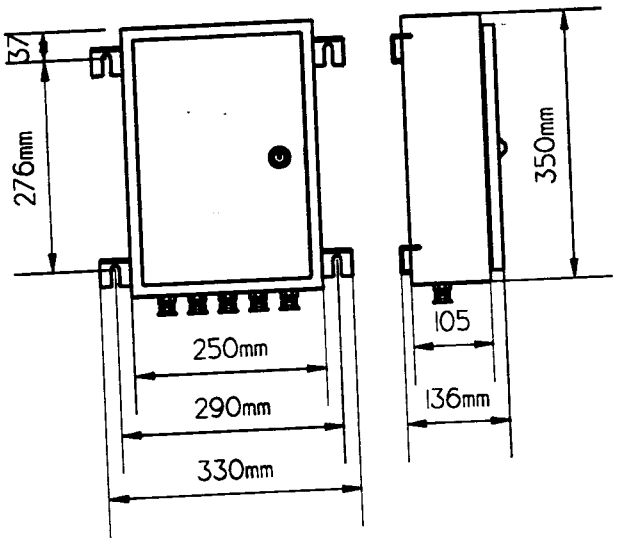
. . **MODE dC** : a differential output (**dC**), which results from the survey by two probes (apart by a distance **L**) of the sound velocity difference. This mode can be used without the correcting unit.

⇨ 2.1.3 - the M 1189 S correcting unit

The first generation correction unit which used to be associated to the older **M 212** device is not part of the present manual.

A separate data sheet will be dedicated to the digital **M 1189 N** correcting unit ; only the **simplified M 1189 S** digital correcting unit is being described here.

- Specifications :



. ***standard version*** :

. standard **IP 55** water tight enclosure

. blind front panel

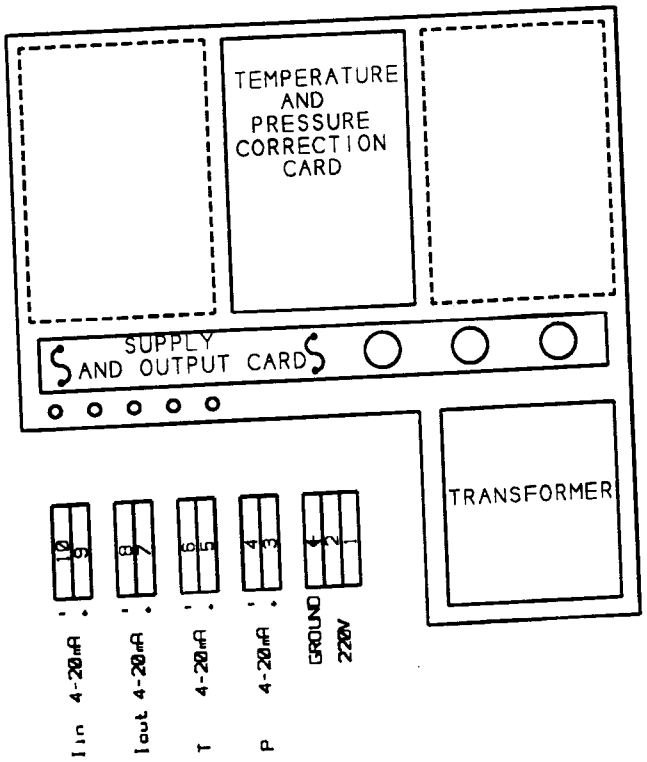
. screw terminal strip

. ϕ 9 gland outputs

. ***optional 19"-3U-360 rack version*** :

. Connector tie-in

. ***optional Exproof version*** :



- Resources :

The **converter** first takes up the input signal from the **UF 321 I,** and then adds to it the correcting factors computed from the pressure and/or temperature data recorded.

Adjustments are workshop performed before delivery ; they are based on the scales first transmitted.

Input or output signals are all represented as **0-20 mA** or **4-20 mA** current loops.

⇨ 2.2 - FUNCTIONAL DESCRIPTION

⇨ 2.2.1 - PROBES

Whichever type has been held back, they consist of a **piezo-electrical ceramic unit**, potted in epoxy resin used both as **matching material** and **dampener**.

Among the range of **frequencies** admitted by intrinsic safety, we, usually hold back the following :

1 or 0.5 MHz	for viscous products
1 or 2 MHz	for slightly viscous products
2 MHz	if the pipe's diameter is < **12"**
1 MHz	if the pipe's diameter is ≥ **12"**

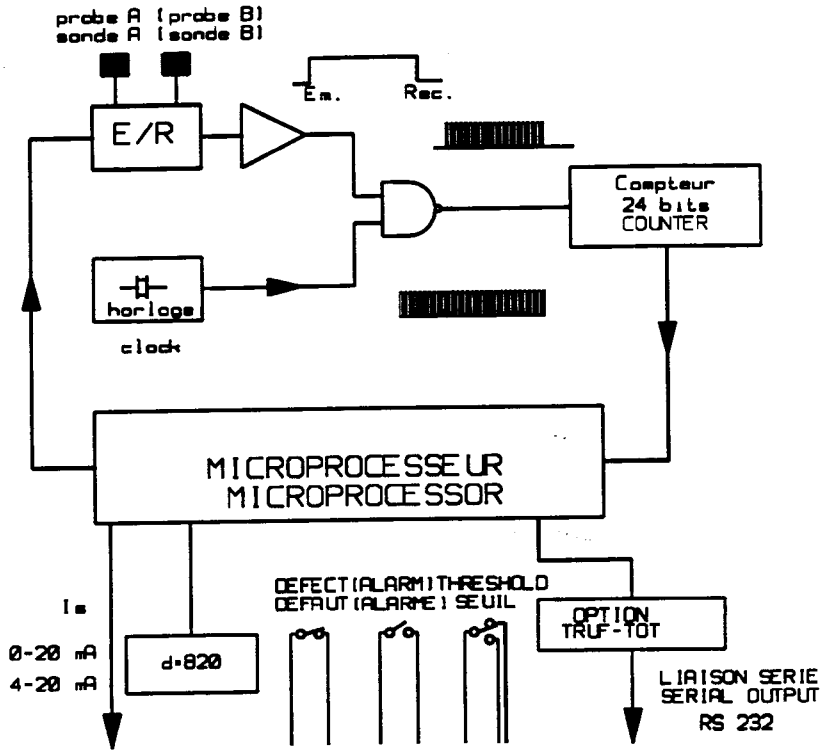
⇨ 2.2.2 - THE UF 321-I CONVERTER

The converter is managed by a **micro-processor** which in turn controls :

- the **pulse signals** to the probe(s)
- the variable **gain amplifier**
- **time measurements** over a high resolution clock
- LCD display
- **Scaling** of the current output
- relay activating

Installation in intrinsically safe areas rules out any intervention of a non skilled agent on the electronic card. This is why the documents describing the electronical part lie beyond the scope of the standard contract.

The synoptic diagramme hereunder shows how the system works :



Once the range of sound velocity (**C**), the pipe's outside diameter, thickness as well as the dead time through the probe have been correctly entered, the **UF 321 I** computes the minimum and maximum transit times, the transit time through the product and then the corresponding sound velocity ; it then makes the following scaling operations :

$$\textbf{Mode C :}\quad \textbf{Is} = \frac{C - C_{min}}{C_{max} - C_{min}} \times \begin{matrix}16\\ \text{ou}\\ 20\end{matrix} + \begin{matrix}4\\ \text{ou}\\ 0\end{matrix}\ \text{mA}$$

$$\textbf{Mode 1/C :}\quad \textbf{Is} = \frac{t - t_{min}}{t_{max} - t_{min}} \times \begin{matrix}16\\ \text{ou}\\ 20\end{matrix} + \begin{matrix}4\\ \text{ou}\\ 0\end{matrix}\ \text{mA}$$

$$\textbf{Mode dC :}\quad \textbf{Is} = \frac{dC - dC_0}{t_{max} - t_{min}} \times \begin{matrix}8\\ \text{ou}\\ 10\end{matrix} + \begin{matrix}12\\ \text{ou}\\ 10\end{matrix}\ \text{mA}$$

With $\mathbf{dC} = C_1 - C_2$ based on two L distant probes

Only at display, does the measured sound velocity correspond to a computed density value.

⇨ 2.2.3 - THE M 1189 S CORRECTING UNIT

For a perfect understanding, see the diagrammes respectively showing the system's two component cards :

- the supply / output amplifier card
- the Pressure and Temperature correction card

- the **input** to the UF 321 I is made over a limiting module ; the latter has been **LCIE** approved - cf System Agreement **N° 87-2003 X** . The 0-20 or 4-20 mA input current is transformed into a voltage ranging from **0** (1) to **5** volts ($\mathbf{R_E}$)

- the **pressure input** signal (0-20 or 4-20 mA) closes down onto a resistance calculated to obtain 10mV/bar ($\mathbf{R_P}$)

- The **temperature input** signal (0-20 or 4-20mA) closes down on to a resistance calculated to obtain 10mV/°C ($\mathbf{R_T}$)

- The various **analogical amplifiers** or multipliers work according to the transfer function

$$\mathbf{Vs} = -1.54 \left[VE - (P - P_0) \times (V_0 - V_E) + \frac{B}{K}(T - T_0) \right]$$

- $\mathbf{P_0}$ is the reference pressure corresponding to an **4ma** pressure signal
- $\mathbf{V_0}$ is to be adjusted proportionally to input scale V_E
- $\mathbf{T_0}$ is the reference temperature
- **K** is to be adjusted proportionally to V_E scale

NB : once adjustments have been performed, $\mathbf{T_0}$ allows adjustment at the end of the 0 or 4 mA of the output scale

- The **supply/output card** rules :

  . the fuse on + and -15 V DC supply (100 mA fuses)

  . the current output amplifier, either 0-20 or 4-20 mA
  $\mathbf{R \leq 400\ \Omega}$

NB : (-) terminals associated to each of the input or output signals are joint to all of them and connected at the zero volt of the correcting unit

The galvanic insulation of either one or several signals will be possible over specific modules, in turn possibly installed on the input/output terminal block.

⇨ 2.3 - GENERAL FEATURES

⇨ 2.3.1 - PROBE

- The transducer is entirely static
- Service temperature : -25/+60°C

⇨ 2.3.2 - UF 321-I

. Ambient temperature :		-10°C to +50°C
. Standard supply	:	220 V AC ±15% - 50/60 Hz optional 24 VDC (16-28V) supply input fuses 630 mA HPC
. Consumption	:	6 VA - 5 Watts
. Output current	:	0-20 mA or 4-20 mA maximum resistive load = 750 Ω galvanic insulation from supply, earthing and probes
. Contacts	:	maximum ratings 0.5 A - 30 V - 3 VA . fault: NO or NC - programmable delay . threshold : reverse contact Rest/Work (W if $C > C_1$) . alarm (dC mode only) - open if $dC > dC_1$
. Resolution	:	0.2 m/sec on LCD display
. Accuracy (C measurement)	:	± 0.2 m/sec on LCD display output current : resolution ±0.1 % of the scale linearity : ± 0.1 % stability over a year : ± 0.1 % of the scale

⇨ 2.3.3 - M 1189 S

- Ambient temperature : -10°C to +50°C
- Standard supply : 220 V AC ±10% - 50/60 Hz

  Consumption 10 VA
  input fuses 100 mA temporized
- Output current : 0-20 mA or 4-20 mA
  other upon request
  maximum resistive load = 400 Ω
- Input impedance : 250 ohms
- P and T input signals : 0-5 / 1-5 / 0-20 / 4-20 mA
- Pressure or temperature ranges can be adapted if the resistance loop (10mV / bar and 10 mV / °C) have been selected beforehand.
- Standard ranges with an optimum compensation :
  Specific gravity : 640-940 / 700-900 / 720-870 kg/m3
  pressure : 0-25 / 0-50 / 0-100 bars
  temperature : -10 - +50°C / 0-50°C / 0-100°C
- Accuracy : copying variation of the input signal :
  0.5 % of the scale
  pressure correction : 2 bars
  temperature correction : 1°C
  stability over a year : ± 0.1 % of the scale
- Linearity : ± 0.5 % of the scale
- Annual stability : 0.2 % of the scale

③ INSTALLATION

- ***3.1*** - *Mechanical installation*
- ***3.2*** - *Electrical installation (connections)*
- ***3.3*** - *Protections*
- ***3.4*** - *Utilization in intrinsically safe areas*

③ INSTALLATION

⇨ 3.1 - MECHANICAL INSTALLATION

⇨ 3.1.1 - PROBE

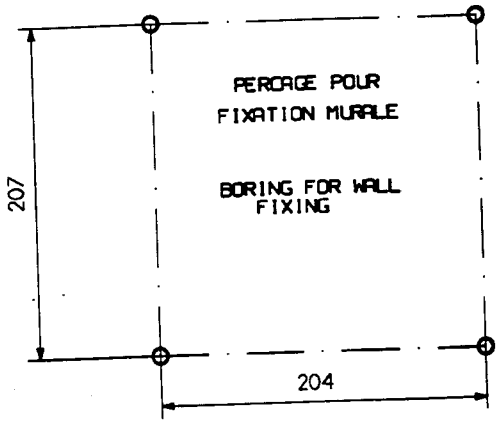
- The probe should first be connected to its respective cable (*cf 3.2.1*)
- Select a section of the pipe with sizes known, straight and not worn oval. Keep apart from weldings (**10cm**)
- Select location by avoiding the vertical axis (deposits can be met in the lower part and gas may always be found at the upper part)
- Remove coating on an area somewhat larger than the probe itself ; it may be kept - make a test beforehand - if it is transparent to ultrasounds (specific coating or paint) ; Clear the surface to have it perfectly smooth
- Prepare the stainless steel belt (or any other fixing system) around the pipe, leaving enough headroom to be able to introduce the probe
- Slightly grease the prepared area as well as the probe's face ; use some mechanical grease (bearing grease or equivalent) adapted to the temperature ; avoid any silicone grease at ambient temperature
- Prepare the coupling film (polyken) by carefully removing the plastic protection sheet
- Then introduce this film between the probe and the pipe at the planned place
- Tighten the attaching belt till the film is squeezed
- Attach the cable to the pipe with a clamp
- Once the operation tests have been performed, the probe can be coated and buried ; but so as to avoid any mechanical lateral strain on the probe, such as ground movements, pressure surges, plan for an overturning or for a local sand filling.

⇨ 3.1.2 - THE UF321 I CONVERTER

- The standard water tight **IP55** enclosure is due to be installed on a wall or on a panel

. Fixing marks :

Fixing by **4** screws in lodgings at cabinet's **4** corners



If the cabinet is due to be installed outside, and, moreover in a region with severe climatic conditions, it is highly recommanded to have the cabinet protected in a second larger cabinet (double envelope), or else, in an electrical possibly thermostated cabinet. The volume thus leaves enough headroom for such protection modules as circuit-breakers, lightning suppressors..

- the **optional** rack mounted enclosure can be fitted with telescopic sliding equipment, adapted to specific frames

⇨ 3.1.3 - THE M1189S CORRECTING UNIT

- It can be installed just as the **UF 321 I** converter
- It is generally housed in an electrical room where Pressure and Temperature signals are already available, and, where therefore measurement exploitation receivers are quite near.
- It can also be logded close to the **UF 321 I** :
  - . either in the cabinet specifically planned for,
  - . or on the same rack,

⇨ 3.2 - ELECTRICAL INSTALLATION

⇨ 3.2.1 - THE PROBE

- If the cable is overmoulded to the probe, it can run directly to the converter ; be nevertheless careful of selecting the runways left to intrinsic safety signals, if the latter type protection has been withheld.

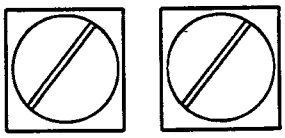
- If connection is made over the probe's screw terminal, remove the cover, let the cable in through the gland, connect the two twisted ends of the twinax cable (or the central coaxial cable), to the two terminals of the probe ; then tighten the gland and last close down the probe's cover by greasing the face. Have the cable run as previously indicated.

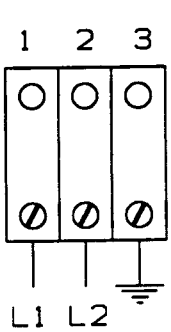
Nota : Prefer an overmoulded connection if the probe is due to be buried.

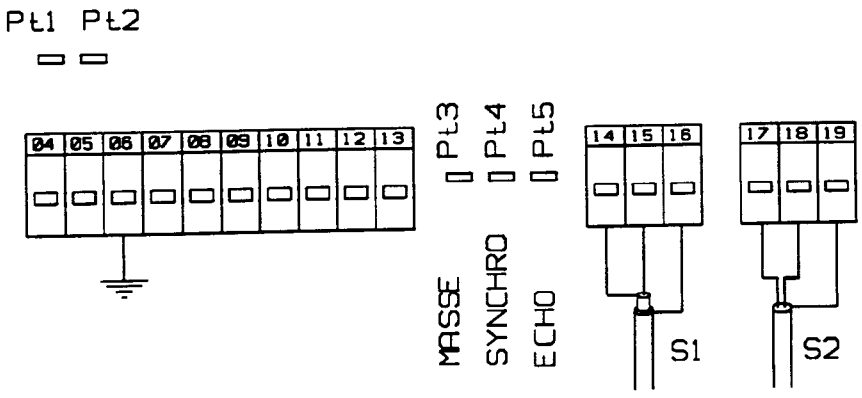
⇨ 3.2.2 - THE UF321I CONVERTER

- The water tight standard enclosure :

. Have the cables run through the glands ; connect them as indicated herebelow :







CABLES SONDE : TRIAXIAL ou BIFILAIRE

- Supply : AC : 1 Phase ; 2 Neutral
  DC : 1 (+) ; 2 (-)
  Earth: 3

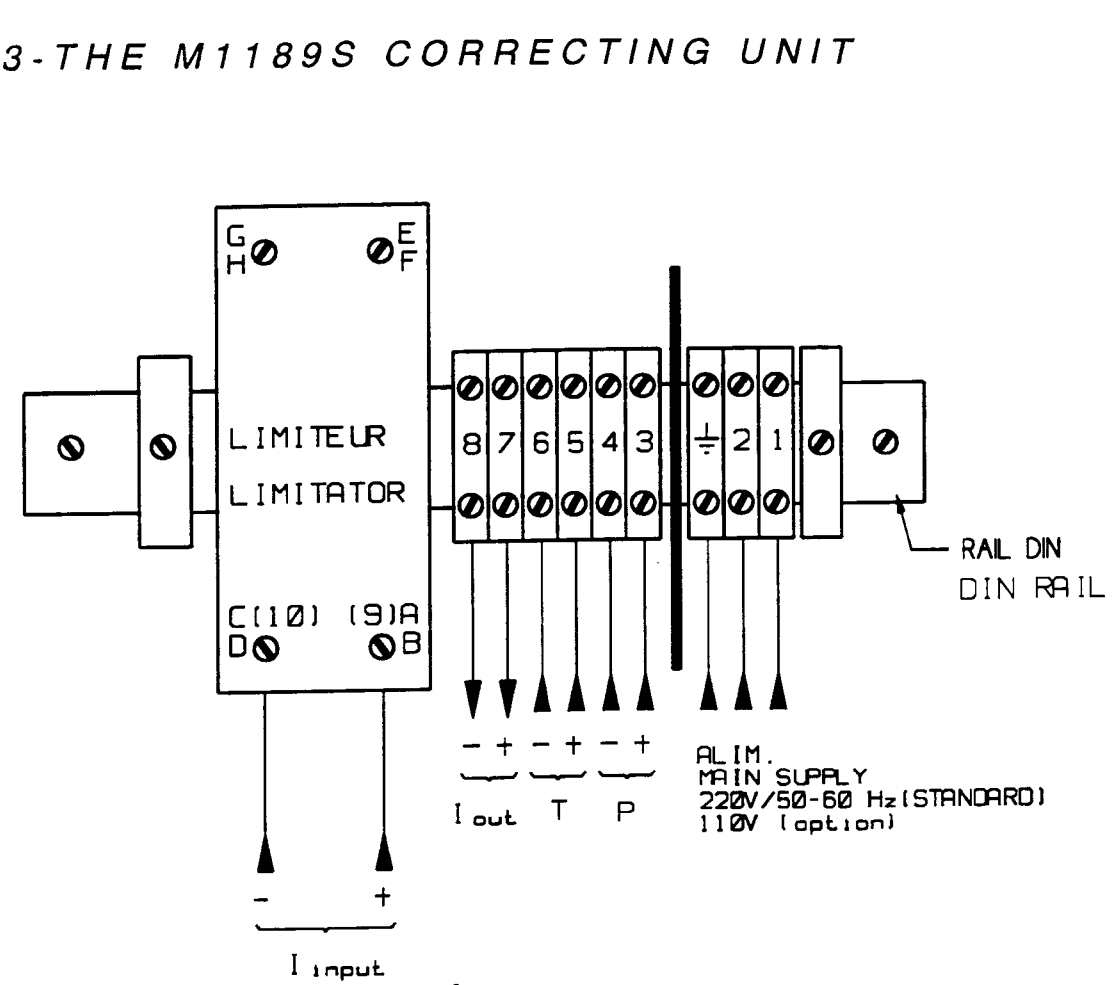
  Nota: *Given comsumption, use some cable of the 3 x 1.5 mm2 type*

- Measurement output signal : 4 (+), 5(-) ; current type signal
  Receiver : R < 750 Ω
- Fault contact : 7.8 Normally closed or open
- Threshold contact : 11 (common) ; 12 (rest) ; 13 (work)
- Alarm contact : 9.10 (only with **dC** menu)
- Probe (C and 1/C modes) = S1 : 14 (-) ; 15 (+) ; 16 (external armour)
- Probes (dC mode) :
  S1 = upstream probe : 14 (-) ; 15 (+) ; 16 ( ) external armour
  S2 = downstream probe : 17 (-) ; 18 (+) ; 19 ( ) external armour

  Nota : *the reference potential (earth) is connected inside between terminals 3, 6, 16 and 19*

- **The rack optional enclosure** : (cf our diagramme n°321-R-00)

⇨ 3.2.3 - THE M1189S CORRECTING UNIT



⇨ 3.3 - PROTECTIONS

Standard versions of these devices include peak suppressing systems, of the GeMOV, TRANSYL types or else resistive limiters, as well as fuses of specifically adapted size and speed ; they are designed to protect the electronical circuits from any electrical induction effect.

As some sites are particularly liable to major energy inductions (lightning, overvoltages...), they should be carefully safeguarded by appropriate modules. If ***ULTRAFLUX*** can supply such modules, they are generally charged to the customer or to his representative (installator...).

Are therefore included :

- the UF 321 I - M 1189 S connection
- the power supply
- and the Pressure and Temperature inputs at lowest level

⇨ 3.4 - UTILIZATION IN HAZARDOUS AREAS

- The UF 321 I can be used in intrinsic safe areas. In fact, the device abides by the **CENELEC** standards and has been EEX ia IIB approved by the French **LCIE** (Central Laboratory for Electrical Industries) - reference number : **92.C.6040 X**
- Only the **probe** is due to be installed in **hazardous area** .
- Have cable(s) and output signals run through a way specifically reserved to intrinsic safety.
- The input module to the M 1189 S is considered as a separation barrier for any downstream connected circuit.
- In the certificate are defined the limits or particular cautions to be taken. Beware of the equipotential feature of sites.

④ START UP

- ***4.1*** - *Precautions*
- ***4.2*** - *Programming and adjusting the UF 321 I*
- ***4.3*** - *Adjusting the M 1189 S*
- ***4.4*** - *Examples*
- ***4.5*** - *Control operations*

➪ 4.1 - PRECAUTIONS

The installation should be performed according to the rule book, and should abide by the particular instructions just indicated before.

Both the UF 321 I converter itself and the M 1189 S correcting unit have not been fitted with an **ON/OFF** switch. Fuses however can be used as circuit-breakers ; they are respectively located :

- in the electronical compartment of the UF 321-I converter (behind the front panel)
- next to the M 1189 S terminal

Check the supply voltage available and eventually energize

Check the display on the converter's front panel

➪ 4.2 - PROGRAMMING AND ADJUSTING THE UF 321 I

Any correct measurement can only be obtained if the device has been properly calibrated beforehand with regards to the application aimed at. **Adjustments** are performed using the keypad and the LCD display and does not require any additional equipment.

Calibration parameters are stored in the **EEPROM** memory (the latter can be modified but is not volatile). Once it is powered on, the device is operated using the parameters resulting of workshop adjustments or from the latest modification.

➪ 4.2.1 - UTILIZING THE KEYPAD

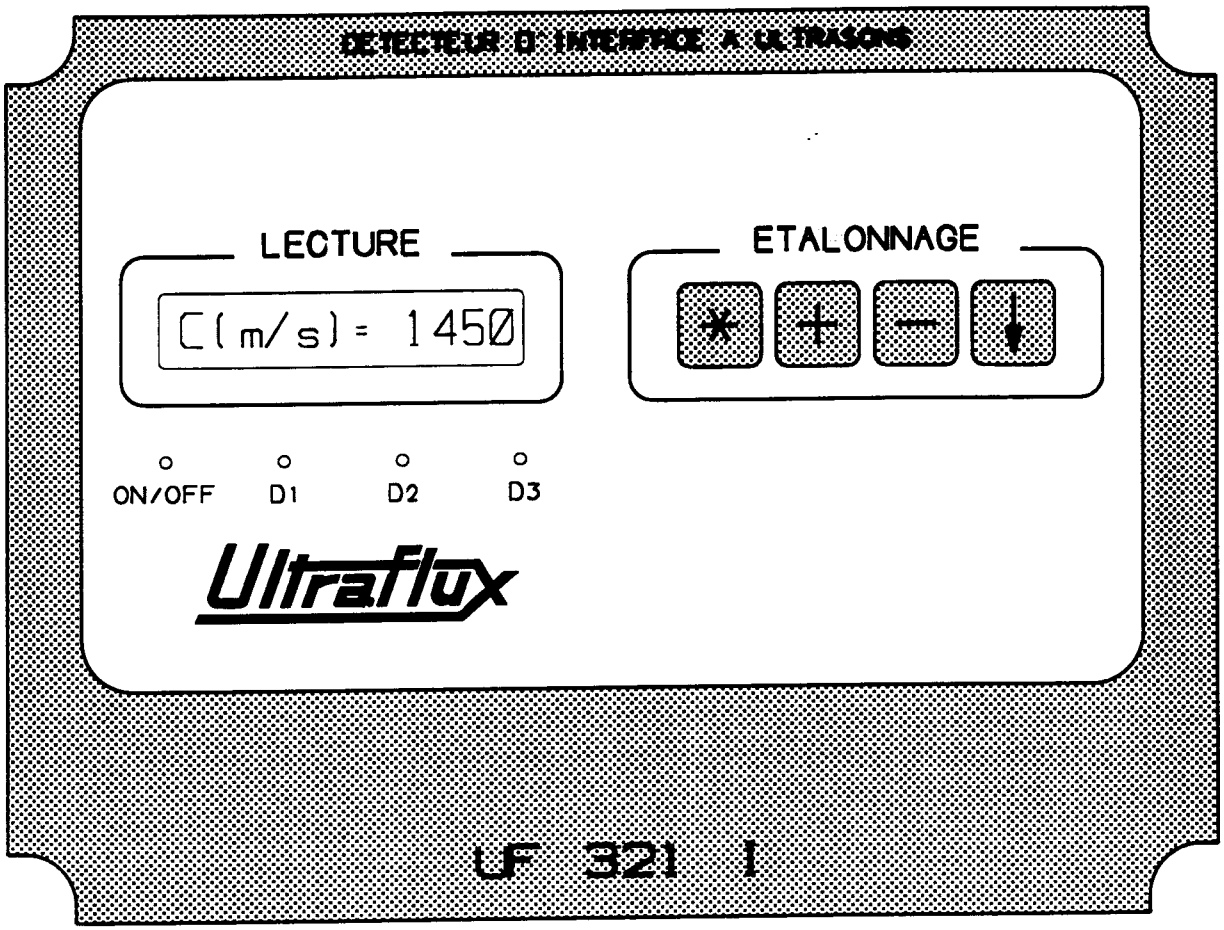
The keypad is made up of 4 keys :

[*] *Re-initiates measurement* according to the memory available parameters ; it can be used at any time (caution when the device is in measurement mode)

[+] *Increases* the value of the displayed parameters or displays the proposed options

[-] *Decreases* the value of the displayed parameters or displays the proposed options

[⇓] *Validates* the displayed parameter and displays the following parameter


DETECTEUR D'INTERFACE A ULTRASONS
LECTURE
C(m/s)= 1450
ETALONNAGE
*
+
−
ON/OFF
D1
D2
D3
Ultraflux
UF 321 I

⇨ 4.2.2 - MENUS PROPOSED (4)

- The **priority** menu is reputed to be dedicated to operation and thus to measurement. It follows any energizing action or appears each time **[*]** is pressed

- A **configuration** menu enables to :

  . select the language used for dialogue - either French (**Fr**) or english (**En**)

  . select the operation mode :

  * the **1/C** mode is to be considered if the UF 321 I replaces the older non linearized M 212 converter

  * the **C** mode is a preferential mode for measurements linked to density or concentration

  * the **dC** mode is a particular alarm mode for product interface detection using two probes

  . select display values requested when in measurement mode :

  * either sound velocity (mode C and 1/C) = C

  * or the computed specific gravity (mode C and 1/C) = SG

  In dC mode however, dC display has priority

➲ Access to the above menu : keep **[-]** pressed, and, at the same time, press [*] during about a second and finally release **[-]**

- A **calibration** menu - configuration being predefined - enables access to geometrical and scaling data as well as treatment of signals:

➲ Access to the above menu : keep **[⇓]** pressed, and at, the same time, press [*] during about a second and finally release **[⇓]**

- A **control** menu - access to it has no effect on measurement

➲ Access to the above menu : as the UF 321 I converter is in operation menu and is displaying a reputedly priority value, press [⇓] till the required parameter is displayed

- the above menu enables to display :

  . sound velocity (C1)
  . the percentage of measurement rejected values (% REJECTS)
  . the gain(s) - (GAIN %) - (GAIN 2%)
  . the specific gravity (SG) if selected in the configuration menu

➪ *4.2.3 - CALIBRATING THE UF 321-I*

Upon delivery, the device has already been calibrated by ***ULTRAFLUX***

- Let's consider the configuration hereunder : [* ; -]

LANG ?	(En)	+ [⇓]
MODE ?	(1/C ; dC)	+ [⇓]
DISPLAY ?	S.G (C)	[* ; ⇓]

- Calibration : [* ; ⇓]

O.D (mm) ?

Pipe's outside diameter
can be calibrated from 0 to 6.500,0 mm

[± ⇓]

Th (mm) ?

Thickness of the pipe
can be calibrated from 0 to 6.500,0 mm
The material is supposed to be steel. If not, apply the factor derived from the ratio of sound velocities through materials

[± ⇓]

T_0 (NS) ?

Dead time through the probe (go plus return time)
can be calibrated from 0 to 6.500,0 µsec
Usual values : standard face 3mm = 3.0 µsec
thick face 6mm = 6.0 µsec

[± ⇓]

OUTPUT ?:

Current output standard 4-20 or 0-20 mA

[+ ⇓]

Cmin (m/s) ?

Sound velocity corresponding to lowest density
can be calibrated from 0 to 6.500,0 m/sec

[± ⇓]

Cmax (m/s) ?

Sound velocity corresponding to highest density
can be calibrated from 0 to 6.500,0 m/sec

[± ⇓]

SG (kg/m3) ?

Specific gravity corresponding to sound velocity Cmin
can be calibrated from 0 to 6.500,0 kg/m3

[± ⇓]

SG (kg/m3) ?

Specific gravity corresponding to sound velocity Cmax
can be calibrated from 0 to 6.500,0 kg/m3

[± ⇓]

Damp (s) ?

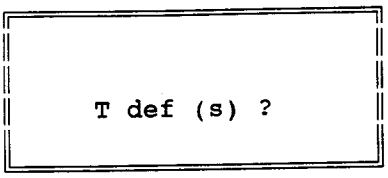
Measurement damping in seconds, at display and
current output
can be calibrated from 0 to 3.600 sec

[± ⇓]

(Def;sw) ?

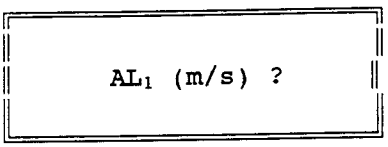
Rest state of defect transmission relay
(echo loss, scraper, sphere)
N.C : normally closed or NO: normally opened

[+ ⇓]



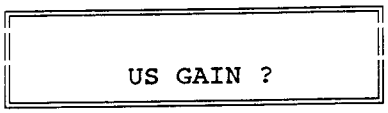
Memorization of defect relay.
Changes mode as soon as defect appears.
Returns to "rest" mode when time is through
Can be calibrated from 0 to 3.600 sec.

[± ⇓]



Value of sound velocity inducing mode change
of threshold relay
can be calibrated from 0 to 6500.0 m/sec

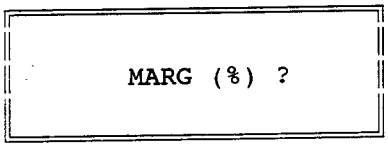
[± ⇓]



AUTO or MANUAL ?
Manages the reception amplifier of ultrasonic signals

[+ ⇓]

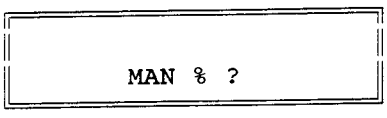
****** *IF AUTO* ******



Over-amplification proportionally to signal loss level
(Echo loss)
can be calibrated from 0 to 100 %

[± ⇓]

****** *IF MANUAL* ******



Gain consign for reception amplifier
Can be calibrated from 0 to 100 %

[± ⇓]

End of calibration stage and automatic switch to operation menu

NB : Variations to calibration:

1) With the **1/C** mode selected in the configuration menu, the parameters listed as per calibration are similar.

2) With the **dC** mode selected in the configuration menu, the calibration menu further includes the following parameters :

dC (m/s) ?	Maximum variation in sound velocity by probe 1 (upstream) and probe 2 (downstream) Can be calibrated from -3.200 to +3.200 m/sec
dC ϕ (m/s) ?	Initial variation beyond any interface coming of a geometrical difference upstraight of probes 1 and 2 Can be calibrated from -3.200 to +3.200 m/sec
Al.2 (m/s) ?	Value of alarm on dC value can be calibrated from 0 to +3.200 m/sec ABSOLUTE VALUE
US GAIN 2 (m/s) ?	Amplification of S1 upstream probe signal managed by US1 GAIN Amplification of S2 downstream probe signal managed by US2 GAIN Similar calibration (AUTO ; MANUAL)

⇨ 4.3 - STARTING AN M1189S CORRECTING UNIT

Important ! *The UF 321 I is to be first configurated in C Mode*

⇨ 4.3.1 - SIMPLIFIED PROCEDURE

ULTRAFLUX pre-adjust the M 1189 S correcting unit in compliance with the scaling specifications as required by the customer, i.e :

- the standard for input/output signals (0-20 / 4-20 mA...)
- the required density scale
- the correction ranges admitted for pressure or temperature

Start-up should therefore occur as described hereunder and without any prior site adjustment :

- Check for the presence and polarity of the output signals such as :
  - . signal from the UF 321 I (I_E)
  - . pressure signal (if planned for) (I_P)
  - . temperature signal (if planned for)(I_T)
- Check the output circuit ; impedance of the loop is limited to 400 ohms in standard 20 mA version (I_S)
- Check supply voltage and energize

The **output** signal (I_S) is a picture of the input signal (I_E) coming from the UF 321 I, although corrected of any temperature or pressure effect

Also possibly check the **correction** factors by simulating a pressure or temperature variation on the mere electrical signals (I_P, I_T) :

- when I_P drops with I_E and I_T constant, I_S on the other hand increases

  . Variation : 1 bar : Δ S.G = 0.25 to 0.35
  for usual oil products

- when I_T drops with I_E and I_P constant, I_S on the other hand decreases

  . Variation : 1 °C : Δ S.G = 2.1 to 2.7
  for usual oil products

Nota : the given variation includes the density's true variation added to the variation caused by sound velocity so as to bring down measurement to standardized Pressure and Temperature conditions (P_0 ; T_0)

⇨ *4.3.2 - COMPLETE ADJUSTMENT OF AN M 1189 S*

- Required equipment : **2** to **3** current sources plus a multimeter

- **To adjust the output current :**

  . Remove the correction card and replace it by a standard gain card (**gain : -1.5**) ; if not, Pressure and Temperature inputs will have to be simulated, given : $P = P_O$ and $T = T_0$)

  . Successively perform the following :

  * output load = 0 ohm

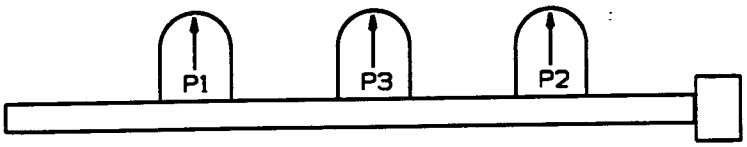
  I_E = 0 mA ➠ I_S = 0 mA
  Output card adjusted by P_3

  I_E = 20 mA ➠ I_S = 20 mA
  Output card adjusted by P_2

* output load = 330 ohms

I_E = 20 mA ➡ I_S = 20 mA
Output card adjusted by P_1

Seen from above :



- **Adjusting the correction card :**

  . The input resistance of the Pressure signal has to be calculated to obtain **10 mV/bar**

  example : range : 0-100 bars / 0-20 mA → $R_P = 50\ \Omega$
  " " / 4-20 mA → $R_P = 62\ \Omega$

  . The input resistance of the Temperature signal has to be calculated to obtain **10 mV/°C**

  example : range : 0-50°C / 0-20 mA → $R_T = 25\ \Omega$
  0-50°C / 4-20 mA → $R_T = 31\ \Omega$

  . The input resistance of the speed of sound input (321 I) has to be calculated to obtain **5** volts at full scale, i. e 250 Ω with 0-20 or 4-20 mA

  . Simulate $P = P_0$ (1 bar absolute), i.e $I_P = 0$ or 4 mA ;
  Adjust potentiometer P_1 to obtain **0** volt at test point TP1

  . Simulate $T = T_0$ (15 °C), i.e I_T = 8.8 mA given a 0-50°C /4-20mA scale
  Adjust potentiometer P_2 to obtain **0** volt at test point TP2

- Adjust voltage V_0 (TP5), according to the range of densities and to the scale selected and more particularly :

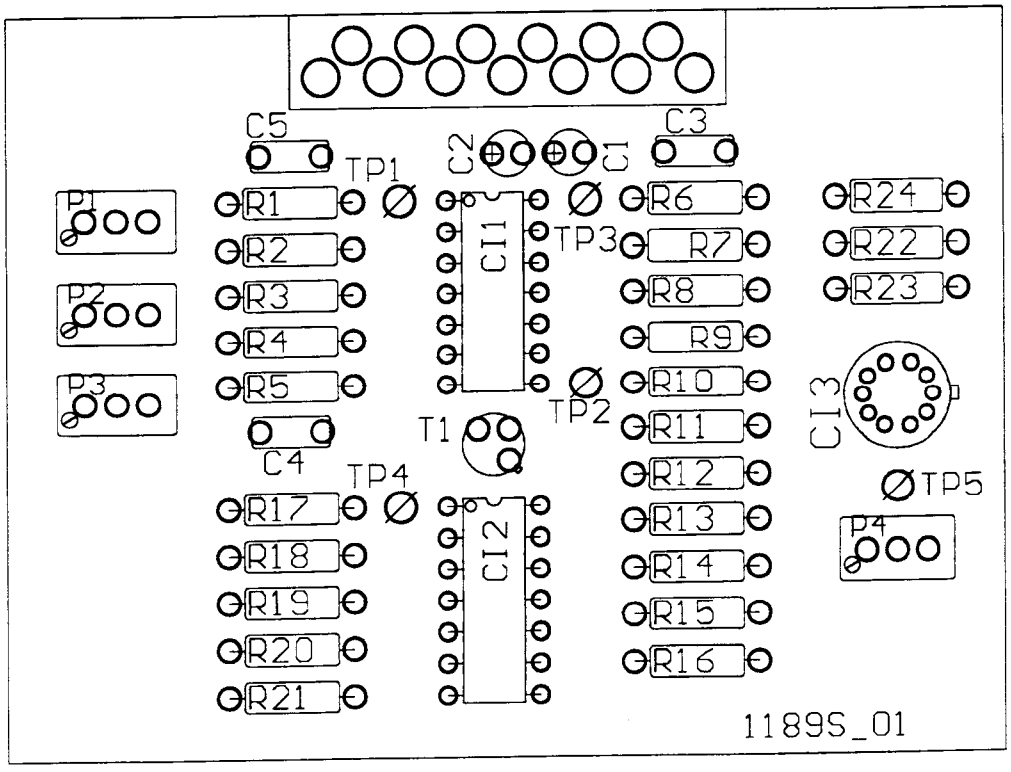
I_S = 0-20 mA	/	**MV** = 640-940	→	V_0 = 6.15 volts
I_S = 4-20 mA	/	**MV** = 640-940	→	V_0 = 5.76 volts
I_S = 0-20 mA	/	**MV** = 700-900	→	V_0 = 7.58 volts
I_S = 4-20 mA	/	**MV** = 700-900	→	V_0 = 7.29 volts
I_S = 0-20 mA	/	**MV** = 720-870	→	V_0 = 10.16 volts
I_S = 4-20 mA	/	**MV** = 720-870	→	V_0 = 8.95 volts

If another range has to be selected, then consult ***ULTRAFLUX***

- To adjust V_T (TP3), simulate : $V_E = 0$ (I_E = 0mA)

$T - T_0$ = 20°C ex : I_T = 15.2 mA scale being 4-20 mA / 0-50°C
Adjust P_3 accordingly, first to the range of densities and then to the scale selected, i.e :

IF 0-20 mA scale	/	**MV** = 640-940	→	V_T = 0.860 volts
If 4-20 mA scale	/	**MV** = 640-940	→	V_T = 0.680 volts
If 0-20 mA scale	/	**MV** = 700-900	→	V_T = 1.29 volts
If 4-20 mA scale	/	**MV** = 700-900	→	V_T = 1.032 volts
If 0-20 mA scale	/	**MV** = 720-870	→	V_T = 1.72 volts
If 4-20 mA scale	/	**MV** = 720-870	→	V_T = 1.38 volts



- Restore the final wiring ; the output current is then to indicate the expected measurement value.

  If the latter is slightly shifted, it can be corrected by adjusting potentiometer **P2** (T_0)

⇨ *4.3.3 - PUTTING ONE OF THE P AND T INPUTS OUT OF SERVICE*

To have one of the Pressure and Temperature inputs out of service, make the necessary adjustments on **P1** (P_0) or **P2** (T_0) till you get voltage null at test points **TP1** or **TP2** ; the corresponding correction factor will therefore also become null.

⇨ 4.4 - SOME START UP EXAMPLES:

. **Given a steel pipe transporting refined oil products :**

- . Outside ϕ : 12"3/4 = 323.8 mm
- . Thickness : 3/8" = 9.52 mm
- . S.G range : = 700 to 900 kg/m^3
- . Output signal : = 4-20 mA
- . Output signal is only corrected by pressure :
  - . pressure range = 0-50 bars
  - . pressure signal = 4-20 mA
- . Equipment installed : = Probe ref.1524 F1 + UF 321 I + M 1189 S
- . The equipment is already connected and energized

⇨ 4.4.1 - CALIBRATING THE UF 321 I

***** *CONFIGURATION MENU* ***** [-] [*]

LANG ? En

MODE ? C

DISPLAY ? SG (C)

***** CALIBRATION MENU *****

[⇓] [*]

O.D (mm) ? 323.8
Th (mm) ? 9.5
TO (µs) ? 3.0
OUTPUT ? 4-20 mA
Cmin (m/s) ? 1160.0
Cmax (m/s) ? 1493.3
sg (kg/m3) ? 700
SG (kg/m3) ? 900
Damp (s) ? 5
Def.Sw ? N.C
T def. (s) ? 20
Al_1 (m/s) ? 1.300
US GAIN ? AUTO
MARG (%) ? 30

[⇓] [*]

***** MEASUREMENT MENU *****

⇨ 4.4.2 - ADJUSTING THE M 1189 S CORRECTING UNIT

. Given a pressure signal	I_P	=	12 mA (25 bars)
. Given a signal from the UF 321 I	I_E	=	12.8 mA

. Adjust **P2** (T_0) to obtain = $V_{PT2} = 0V$

. Measurement of output signal = $I_S = 12.2$ mA
i.e SG = 802.5

. True density = 800 kg/m^3

- **Causes of variation** : **1-** pipe sizes ?

2- product temperature else than 15°C

3- product not located on the theoretical law admitted

- **Answers to :** cause **1** : Review UF 321 I calibration

cause **2** : Adjust **P2** on the M 1189

cause **3** : Wait for a product reputedly in accordance to theoretical law before correcting either adjustment

⇨ 4.4.3 - INSTALLATION WITHOUT THE M 1189 S

Should an installation be without the M 1189 S correcting unit, both an average pressure and temperature value can be considered by altering the SG / sound velocity correspondance.

EXAMPLE :

. Average temperature	:	20°C ($\Delta T = 5°C$)
. Average pressure	:	20 bars ($\Delta P = 20$ bars)

- Sound velocity is therefore corrected to :

$\Delta C = \Delta C/°C \times 5 + \Delta C/bar \times 20$

So for an **S.G** of **700** kg/m3 :

$\Delta C = -4.44 \times 5 + 0.62 \times 20 = -9.8$ m/sec

and therefore : **Cmin** = 1.160 - 9.8 = 1.150.2 m/sec

or with an **S.G** of **900** kg/m3 :

$\Delta C = -3.38 \times 5 + 0.304 \times 20 = 10.8$ m/sec

and therefore :

Cmax = 1.493 - 10.8 = 1.182.2 m/sec

- Have **Cmin** and **Cmax** calibrated on the basis of the upper calculated values.

⇨ 4.5 - CONTROLLING START - UP

⇨ 4.5.1 -

Some of the points brought up are an integral part of the preceeding chapters **4.3 and 4.4**

⇨ 4.5.2 -

The UF 321 **I** holds a **control menu** which can be accessed to over the measurement menu by keeping [⇓] pressed till the required message is displayed

These are the information available :

- sound velocity measurement (C / m/s)
- the percentage of rejected measurements (% rejected), which should in fact be as lowest as possible.
- the value of the amplification gain (Gain %) ; gain is all that lower that the signal obtained by the probe is high. In AUTO mode however, gain can not be reduced under the programmed margin (cf hereafter)

⇨ 4.5.3 - CONTROL OPERATIONS USING THE OSCILLOSCOPE

Some more technical control operations can only be performed using an oscilloscope. Let's mention that the UF 321 I includes **three test points** - which can be accessed to through the terminal block compartment - for connecting probes of an oscilloscope (probes x1 or x10), and more particularly :

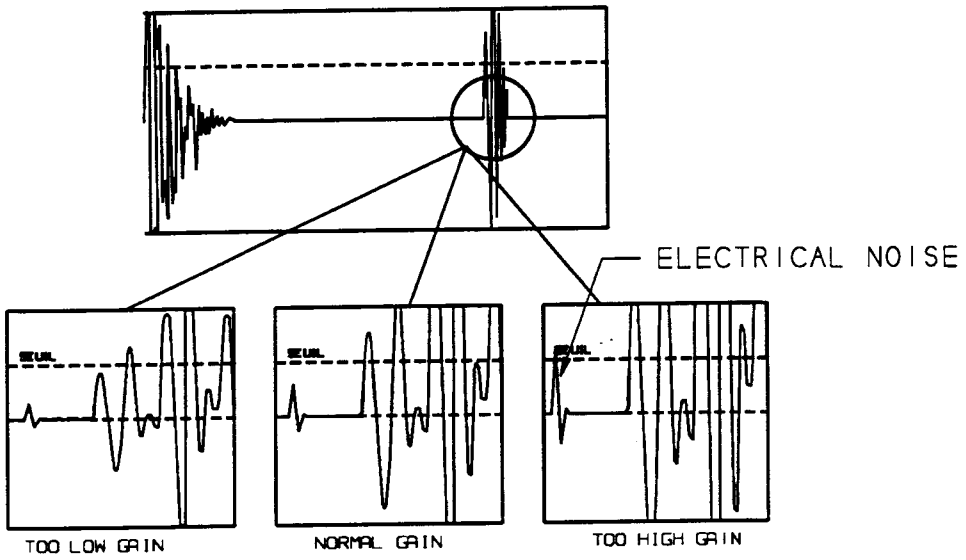
. * on the left side : the 0 volt

* in the middle : the synchronization signal (SYN)

* on the right side : the acoustic signal, amplified (ECHO)

- As the synchronization signal records a 5 volt level, select the downward front (-)

- The echo signal has the following shape :



- **Noise** following the emission time comes from :

  . the probe's own noise (negligible)
  . the successive echoes through the pipe's thickness
  . the closeness to any welding
  . surface waves

  Nota : Noise may be a hindrance if the pipe's diameter is too small (2 to 3")

- **The shape of the echo** is influenced by :

  . which frequency has been selected for the probe
  . the pipe's thickness (path combinations)

- As a consequence, **gain** should be adjusted in order to have :

  . noise signal not interfering with the echo signal
  . measurements perfectly carried out as soon as echo starts (varying)

The diagramme herabove is a clear description of the successive stages of control

- In *Manual Gain Calibration*, act on the gain percentage (%) from 0 to 100 %

- In *AUTO GAIN calibration*, act on the amplification margin (Margin %), which refers to the echo loss level.

⇨ 4.5.4 - CONTROL OPERATIONS USING THE UF 501 ECHO SIMULATOR

The said ***ULTRAFLUX*** equipment is used to simulate an echo and control any delay (displayed in μsec).

- Connect the coaxial cable supplied to the probe input on the UF 321 I to one of the 2 outputs of the simulator (S_1 upstream ; S_2 downstream)

  . with switch on P.E, signal on S_1 has a delay of $t + \Delta t$, and signal on S_2 has a delay of t

  . with switch on zero, same delay t on S_1 and S_2

- Energize the simulator

- Display any echo delay time t (or $t + \Delta t$), calculated according to the pipe's diameter, its thickness and the velocity of sound to be simulated (C) :

$$t = t_0 + t_{steel} + t_{product}$$

Let's take for instance a pipe :

. 12" 3/4 - Thickness : 3/8 (9.52 mm)

. outside diameter : 323.8 mm

. inside diameter : 304.8 mm

. simulated sound velocity : 1.250 m/sec

$$t = 3\,\mu s + \frac{2 \times 0.00952}{5.800} \times 10^6 \mu s + \frac{2 \times 0.3048}{1.250} \times 10^6 \mu s$$

$t = 494\,\mu s$ $\qquad$ $C = 1.247$

- Then control the measurement displayed and emitted by the UF 321 I

④ - MAINTENANCE

- ***1 -*** *Spare parts and accessories*
- ***2 -*** *Preventive maintenance*
- ***3 -*** *Repairing*

⇨ 5.1 - SPARE PARTS AND ACCESSORIES

- **Spare sparts to the probe :**

. According to its **MTBF**, probes are due to last over 10 years in normal utilization conditions. They can nevertheless undergo some mechanical shock or else which can be destructive.

. Probes include no interchangeable parts which help maintenance operations

. We therefore recommand one spare probe for **10** in operation. If the probes used are curved to the pipe's diameter, the spare probe can then be delivered flat, with no effect on operation.

. Probe references : **1457** F1 or F2 + cable

1524 F1 or F2 + cable

- **the UF 321 I converter :**

. Skilled technicians can secure maintenance of the device, knowing that most active electronical components (I.C) are support mounted. In this case, and, if required, does *ULTRAFLUX* propose a component maintenance kit.

. Otherwise, we do recommand :

* a UF 321 I specific electronical card
* an equipped front panel

- **the M 1189 S correcting unit :** as above :

* spare component kit
* supply + output card N°**1189**
* P and T correction card N°**1189 S-01**

- **Accessories useful to maintenance :**

  . a 20 MHz bandwith analogical oscilloscope
  (out of ***ULTRAFLUX*** saling scope)

  . a multimeter - 2.000 points minimum
  (out of ***ULTRAFLUX*** saling scope)

  . one or two 4-20 mA current sources
  (out of ***ULTRAFLUX*** saling scope)
  Nota : only for the M 1189 S correcting unit

  . a **UF 501** echo simulator
  (can be bought at ***ULTRAFLUX***)

⇨ 5.2 - PREVENTIVE MAINTENANCE

- The probe requires no maintenance if it has been properly installed with the coupling film.

- The echo level is recommanded to be controlled each year (value of the Automatic gain or oscilloscope observation) on the UF 321 I so as to check for any deterioration or dirtying of the pipe.

- Once a year, also check that **input** and **output** currents remain in keeping with the values they stand for (**C, P, T, SG**)

⇨ 5.3 - REPAIR AND DIAGNOSTIC

⇨ 5.3.1 - THE PROBE

It can not be repaired. In case of defect, have it exchanged

⇨ 5.3.2 - THE UF 321 I CONVERTER

In normal operating conditions (Measurement or control) :

- The **ON/OFF** green light should be lit (it goes out when passing to the configuration or calibration menus)
- **D1** defect light should be out
- Measurement should be renewed every **0.5** sec or so
- Otherwise, make a diagnostic and try to remedy to the defect as follows :

SYMPTOM	PROBABLE REASON	ACTION
ON/OFF LIGHT is off	Supply ? Fuses ?	Control voltage Replace fuse in the electronic compartment
	Internal connection cable of front panel	Check connections
No display	Make a reset	Check front panel
echo loss message permanent ECHOS < 30% (no measurement possible)	- empty pipe or gas pocket	- check that pipe is full and pressure conditions
	- probe connection interrupted	- check
	- probes uncorrectly installed or faulty (coupling, location)	- resume installation and control procedure
	- incorrect entry of geometry and sound velocity range	- enter the right parameters
	- gain programming too weak	- Pass to AUTO gain mode MARGIN > 10%
	- emitting/reception circuit breakdown	- oscilloscope control or change cards Consult ULTRAFLUX
"ECHO LOSS" appears from time to time	- gas pocket or bubbles in the flow - echo too weak	- Measurement set back to zero once 20 successive and faulty cycles are through

SYMPTOM	PROBABLE REASON	ACTION
D1 is permanently lit (defect) without ECHO LOSS message over 30% measurements rejected	- Programming wrong - Gain too large - Electronical defect	- Correct - Reduce gain or margin - Consult ULTRAFLUX
D1 is lit from time to time	- Rejects > 30%	- NO major consequence if normal conditions restored within 20 successive cycles
A few % is rejected	- Interferences	- Check earth potential - Disconnect shield of probe . cable ; check if it is better - Control origin of interferences using the oscilloscope - Act on gain
Current output does not correspond to scaled displayed value	- Loop impedance too high - output circuits faulty	- R < 750 Ω - Consult ULTRAFLUX or or approved representative
The UF 321 I does not display the required measurement	- Faulty calibration - physical features of liquid differ from the ones held back at calibration (C,d,P,T)	

⇨ 5.3.3 - THE M 1189 S CORRECTING UNIT

In case of fault on the corrected measurement emitted by the device, check the following successive points :

- Check for supply voltage
- Check the supply circuit fuse ; replace it if faulty
- Check the secondary voltages (*cf figure at § 4.3*) +15 and -15 Volts, ± 0.5 V
  If faulty, check the fuses on the supply card, vertically .....
- Check the polarity of input signals
- Check gain or transfer function for each part or module :

  . input module : 0-20 mA
  conversion from 0 to +5 Volts

  . correction card : input 0 to +5 Volts
  output 0 to -7.50 volts

  . output current : input 0 to -7.50 Volts
  output 0 to 20 mA

  So as to be able to locate the fault.

- If a fault has been detected and if as a matter of fact repair turns out rather difficult, swap the module implied

⇨ 6 - OPTIONS

⇨ **6.1** - Special applications can be carrried out with prior ***ULTRAFLUX*** agreement. It will give rise to a special document

⇨ **6.2** - To the UF 321 I can be associated a continuous supply (16 to 60 volts). It is borne to 28 V in intrinsically safe areas though.

⇨ **6.3** - Measurements from the UF 321 I can be transmitted over an RS 232, 422 or 485 output

YOUR COMMENTS

You have just read our user manual. We would highly appreciate your helping us in improving both its quality and handiness. Therefore we shall welcome your comments and suggestions.

1) Title of the manual : _____

2) How did you evaluate this manual ?

	Good	Average	Poor
a) Handiness (organization)	❑	❑	❑
b) Accuracy of information	❑	❑	❑
c) Exhaustivity of information	❑	❑	❑
d) Practical usefulness of examples	❑	❑	❑
e) Adapted to your technical skills	❑	❑	❑
f) General appreciation	❑	❑	❑

3) Since how long have you been testing this type of equipment ? < 1 year ❑ > 1 year ❑

4) Did you find any mistake in the manual ? If yes, please indicate the page number(s) and paragraph or just mark the pages concerned and return them along with the questionnaire.

	Page	Paragraph
a) Information false _____	_____	_____
_____	_____	_____
_____	_____	_____
b) Information missing _____	_____	_____
_____	_____	_____
_____	_____	_____
c) Was difficult to understand _____	_____	_____
_____	_____	_____
_____	_____	_____

5) Do you have any suggestions to improve the manual ?

_____

_____

M. _____ Telephone _____ Fax _____

Company _____ Dept _____

Address _____

Postal code _____ Town _____

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Thank you for having completed the questionnaire and returning it to :

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