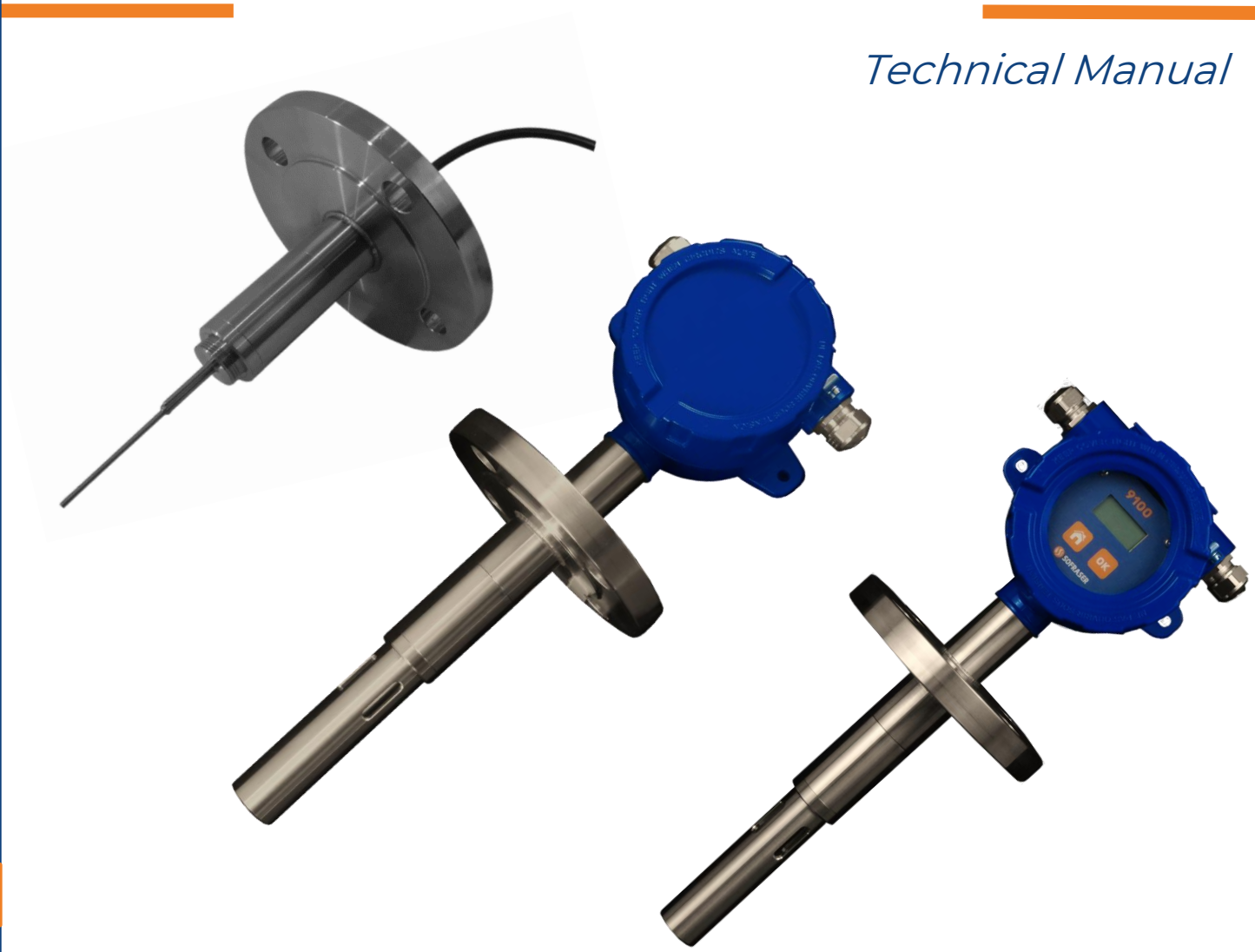
INVI

Technical Manual



Process insertion viscometer

Original version

REF.: 419/0

SOFRASER
Pioneering viscometry since 1972

IMPORTANT

1° READ CAREFULLY THIS MANUAL. THE APPLICATION OF WARRANTY IS SUBJECTED TO STRICT OBSERVANCE OF INSTRUCTIONS.

2° THE OFFSET ADJUSTMENT IN THE AIR MUST BE THE FIRST TASK COMPLETED WHEN THE INVI IS INSTALLED ON ITS MOUTING.

- Clean and dry the vibrating rod of the viscometer in order to make it **neat and dry**;
- Install the sensor on the process and fix it with the screws; these must be tightened at the nominal torque;
- Be sure the process is empty. The **rod must be vibrating in the air**;
- Power on the device and **wait at least 30 minutes**;
- Follow the instructions given in § 2.5 and when applicable in the user manual of the remote electronics device delivered with the equipment.

3° PRACTICAL ADVICES AND IMPORTANT WARNINGS ARE ALSO LISTED IN § 2.3

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1. General presentation

1.1 Principle

The measuring chain is composed of two inseparable elements: the sensor, including its cable when applicable, and its electronic device. The sensor cannot be used with another electronic device because they are matched together as one vibrating system, and vice versa.

The provided viscosity information is relative. In the same fluid and under the same environmental conditions, the information is the same. For two fluids with a different rheological behaviour, the response can be different. Since it is perfectly repeatable, it just needs a different correlation.

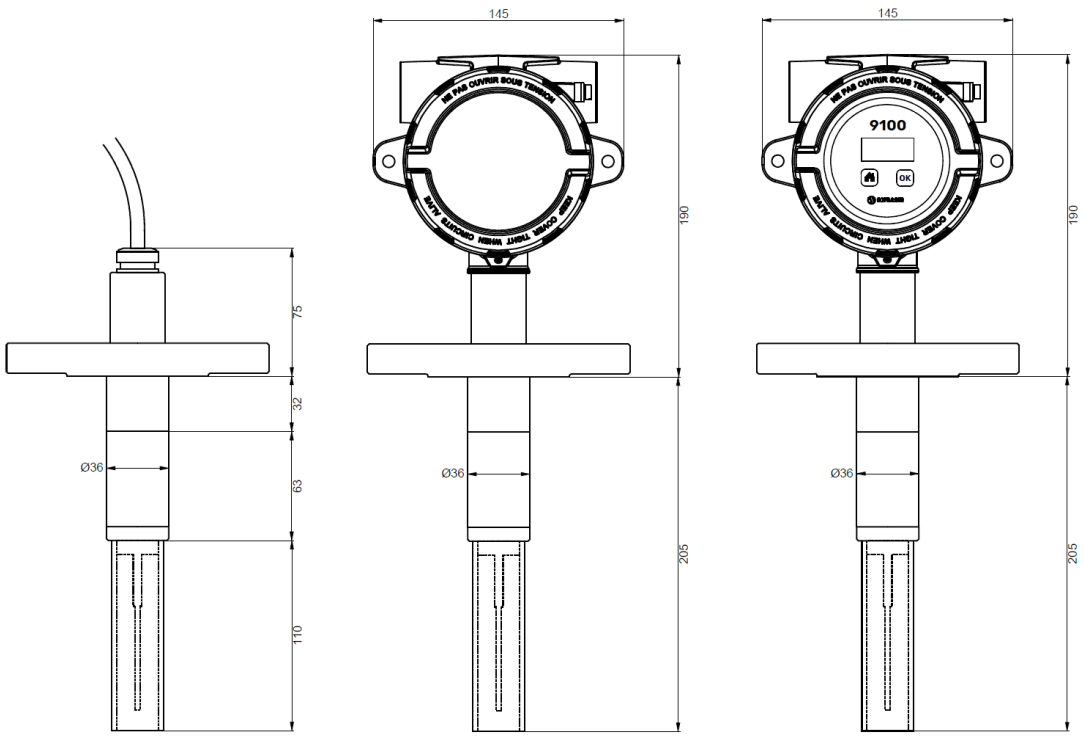
The active part of the sensor is composed of a vibrating rod held in oscillation at resonance frequency (also called tuning-type) by driving magnets. When the rod is immersed into a viscous material, the amplitude of the vibration is dampened. The sensor receiving coil detects the response and the signal is converted to a viscosity value through the electronics device. The factory calibration is performed with certified viscosity standards.

The transducer acquires the coils' voltages and generates various signals. These signals represent the properties being measured. It is also in charge of powering the whole system.

A choice of electronics from embedded transducer to touchscreen PLC/HMI provides process information (viscosity and temperature) through different kinds of output.

1.2 Various versions

Standard design of INVI sensor is manufactured with an ANSI 2" 150 lbs flange for process connection and operation up to 20 bar/290 psi and Insertion length is 205 mm. On request flange size and insertion length can be customized.



A Pt100 class B temperature probe is incorporated in a thermowell on each INVI sensor. The flow damper tube surrounds the vibrating rod.

The viscosity full scale range of each INVI is set according to its end-user application and product specifications. INVI sensor measuring range is set at Sofraser from 0.1 to 10 mPa.s to 100 to 10000 mPas.

3 versions of INVI are available: with remote electronics and with embedded transmitter 9000 or 9100.

On request INVI with remote electronics can be delivered with ATEX or IECEx approval for use in hazardous area.

1.2.1 Classic version (with remote electronics)

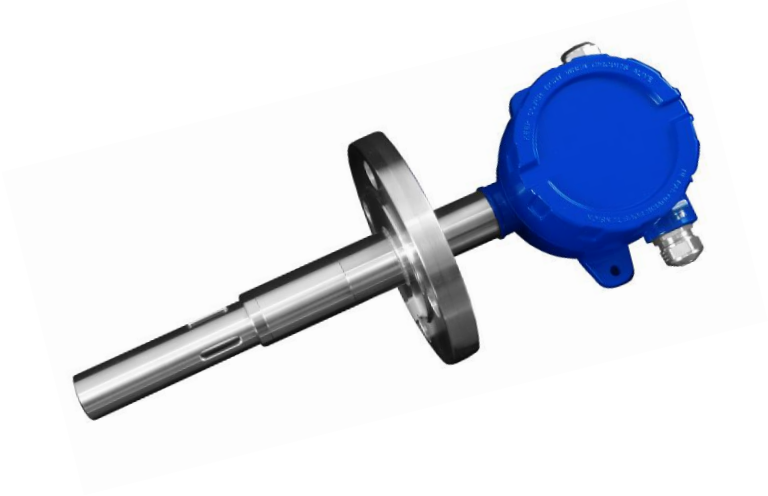
INVI sensor is connected through its cable to one of Sofraser's electronics and benefits from all their features (see list of electronics manuals in Appendix B). Ingress protection of the cable gland is IP66; never release the cable gland and check its tightening.

The Classic version is available with optional ATEX or IECEx 'ia' Exproof approval that allows its installation in Zones 0, 1 and 2 (see § 1.4.2 and Appendix A). The relevant electronics models are the 9100 and 9200 viscosity and temperature transmitters (see Appendix B).

With its remote electronics, the measuring chain is composed of three inseparable elements: the sensor, its cable and the electronic device. The sensor cannot be used with another electronic device because they are matched together as one vibrating system, and vice versa. The cable length should not me modified.

1.2.2 Embedded 9000 blind transmitter version

INVI with embedded 9000 transmitter must be powered with 24VDC. Viscosity and temperature data are forwarded either by the two 4-20mA analog outputs or by the RS485 serial port (see list of electronics manuals in Appendix B).

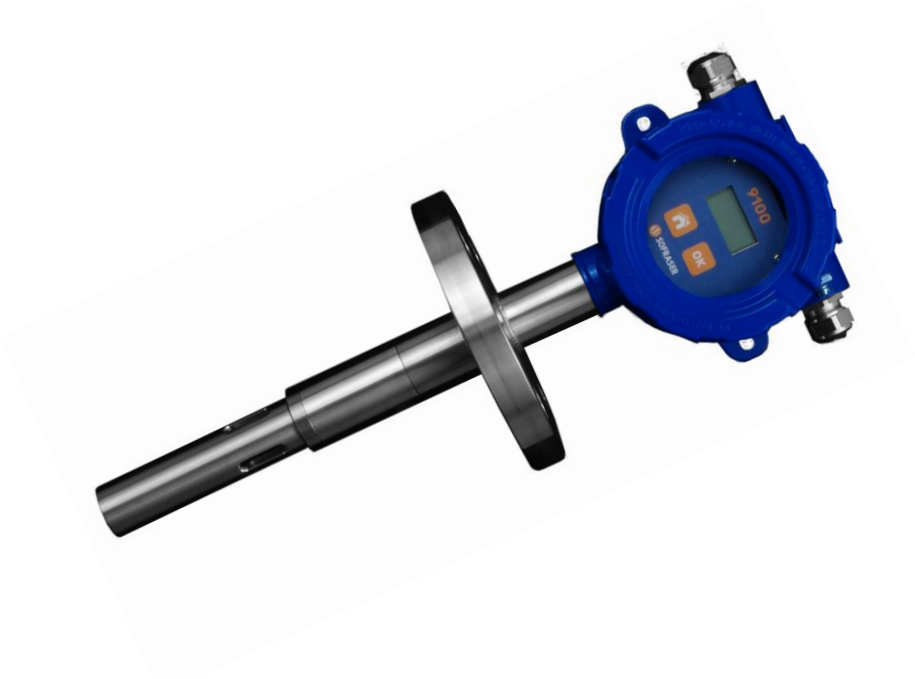


INVI with embedded transmitter is dedicated to use in safe areas. Ingress protection of the electronics enclosure and the two M20 cable glands is IP66. After installation of the cables check the tightening of the cable glands.

During starting up the offset can be adjusted thanks a button. See § 1.3.2 for access to the connector blocks and offset adjustment. Advanced settings are performed with SIS Sofraser Interface Software.

1.2.3 Embedded 9100 display transmitter version

Thanks to its two lines display and two buttons, INVI with display is the All-in-One solution. Starting up and basic settings are performed directly thanks to the buttons and display. Viscosity and



temperature data are displayed continuously and are forwarded by the two 4-20mA analog outputs or by the RS485 serial port.

INVI with embedded transmitter is dedicated to use in safe areas. Ingress protection of the electronics enclosure and the two M20 cable glands is IP66. After installation of the cables check the tightening of the cable glands.

During starting up the offset is adjusted thank to the display and buttons. SIS Sofraser interface software is used for advanced settings.

1.3 Cable wires allocation or wiring

Connecting INVI sensor must be performed by a trained and experienced instrumentation engineer.

1.3.1 Classic version

Hereunder the allocation of the wires of the cable of INVI Classic version.

Wire ID	Colour	item
A B	blue brown	Receiving coil
C D	transparent black	Driving Coil
E F G	red yellow green	Pt100 Temperature probe
N/A	metal	Earth

(*) Applicable to Sofraser standard sensor cable. Wires of special cable may have different colours. Give priority to the Wire ID.

When INVI is delivered with the high temperature cable, the wires at the end of the cable have the following allocations.

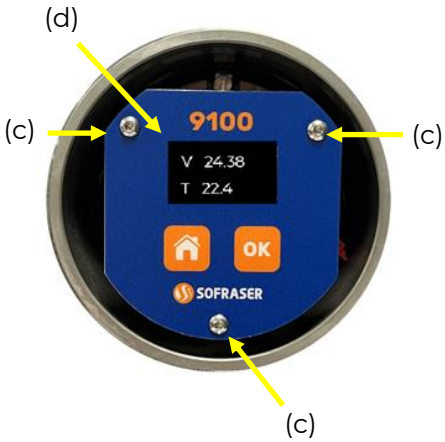
Wire	Color	Item
A B	blue brown	receiving coil
C D	white black	driving coil
E F G	red grey green	Pt100 Temperature probe
N/A	yellow & green	Earth

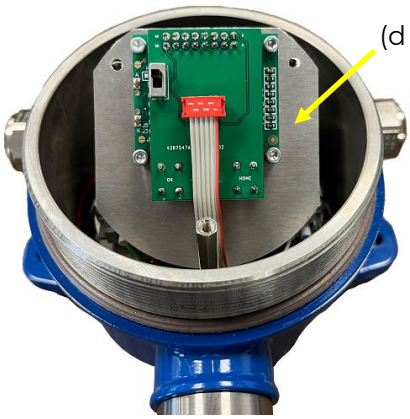
INVI's cable is part of the measuring chain and its type and length should not be modified. The cable of INVI remote must be connected to one of Sofraser's electronics (see Appendix B).

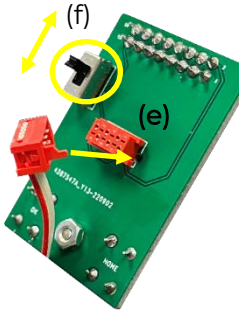
1.3.2 Embedded transmitter versions

Turn off the electronics and release the cover locking screws (a) before removing the cover (b) by unscrewing counter clock wise.

For model with display, unscrew the 3 HEX screws (c), remove and flip the display plate (d), then disconnect (e).

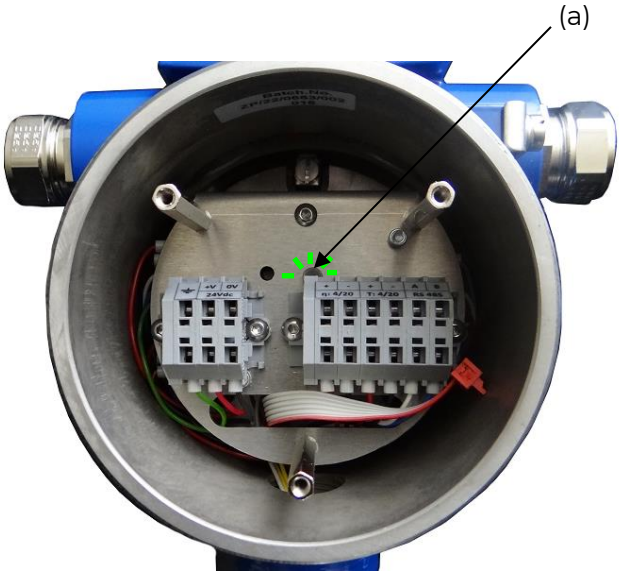






The display is delivered with disabled backlight. The backlight can be enabled thanks to a switch (f) located on the back side of the display. Change the position of the switch to enable or disable the back-light.

Connect power supply, analog outputs and if required RS485 port as per hereunder instructions.



Connector ID # 1	Connector ID # 2	Description
⏚		To be connected to ground earth
24 Vdc +/- 2.4 Vdc	+V	To be connected to external 24VDC stabilized and filtered power supply. Take care of the polarity. Inversion will damage the electronics board.
	0V	
RS 485	A	To be connected to RS485 loop and master device/program. (e.g. Laptop and Sofraser Interface Software SIS).
	B	
η: 4/20	+	Active type, 4-20mA analog output for viscosity. Never connect to an external power supply.
	-	
T: 4/20	+	Active type, 4-20mA analog output for Temperature. Never connect to an external power supply.
	-	

Check wiring and specification of power supply and devices connected to INVI.
Install display board if embedded with display model
Activate power supply; the green control LED (a) is blinking.

1.4 Directives and Standards

1.4.1 European Pressure Equipment Directive and EMC directive

Nominal operating pressure of each INVI sensor is written on the sensor marking plate and its specific notes. Standard INVI sensor is designed for applications up to PN = 20 bar. For information, article 4 paragraph 3 of the PED 2014/68/UE (European Pressure Equipment Directive) is applicable, for a standard INVI sensor, operated up to 20 bar, within the hereunder nominal pipe diameters or reactor volumes.

INVI installed on pipe:

- up to DN=100mm for fluids belonging to Group 1
- up to DN=200mm for fluids belonging to Group 2

INVI installed on reactor:

- up to 10 litters for fluids belonging to Group 1
- up to 500 litters for fluids belonging to Group 2 (no volume limit if operated up to 10 bar).

INVI sensors are CE marked and have been designed and manufactured according to the electrical safety and CEM standards:

- EN 55011
- EN 613216-1
- EN 61000-3-3/4
- EN 61000-4-2/3/4/5/6/8/9/11

1.4.2 ATEX and IECEx intrinsic safety certification

The ATEX and IECEx intrinsic safe certification is only available for the INVI Classic version, with remote electronics. The electronics must be installed in safe are.

1.4.2.1 Marking


II 1G Ex ia IIC T6 to T1 Ga

(*)≤ Tamb≤(*) see tables APPENDIX A

INVI sensors are in agreement with ATEX directive 2014/34/EU and the associated standards EN 60079-0, EN 60079-11, but also with the IEC 60079-0 and the IEC 60079-11.

Be sure the sensor's certification is in accordance to the security level required on your process location: area classification, equipment group, protection method, gas type, temperature codes...

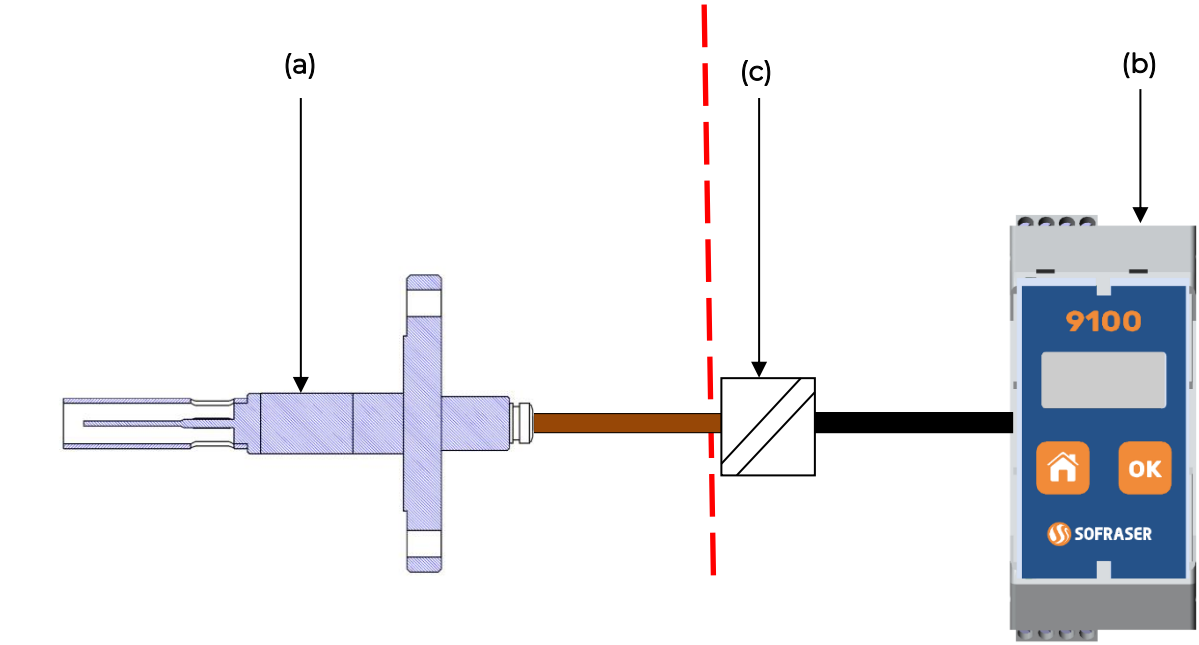
To always keep the maximum security level, the proper functioning and the warranty, do not dismantle the sensor.

Check as often as possible that the information indicated on the sensor's identification plate is still visible.

1.4.2.2 Installation in hazardous area

Here is the way to install the INVI remote electronics sensor in a hazardous area.

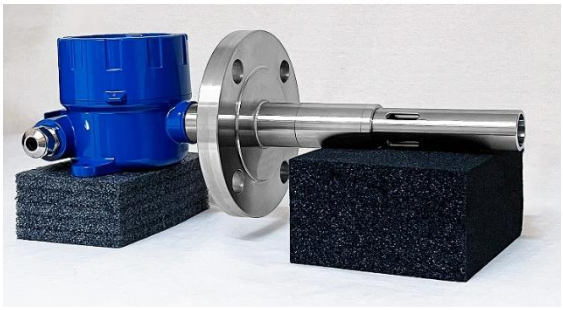
Standard installation for a INVI-SI (a) connected to a Sofraser transducer (b) through intrinsic safe barriers (c), one for each coil plus another for the Pt100 (See Appendix A).



2. Installation

2.1 Checking the equipment after receipt

First and foremost, check the conformity with the ordered equipment. Place the sensor on a soft foam plate.



If Classic version connect it to its remote Sofraser electronics (see list of electronics manuals in Appendix B) and switch it on. The rod shall start vibrating and the viscosity indication shall be zero or close. When touching the rod, the value shall increase.

In case of a subnormal operation occurs, check the power supply, connections, cables; and vibrating rod's shape and condition (no bending, no damages, ...).

If it is not immediately used, store the viscometer in its original packaging that should also be used for transportation. Except during cleaning steps, it is advised keep the flow damper on the INVI in order to secure the vibrating rod.

2.2 Sensor installation

INVI sensor operates in any position, even upside down. Its active part has to be permanently immersed into the fluid (low part of the network or reactor). If the fluid temperature varies widely and fast, choose the upside down or horizontal position, in order to allow proper air convection among the sensor body.

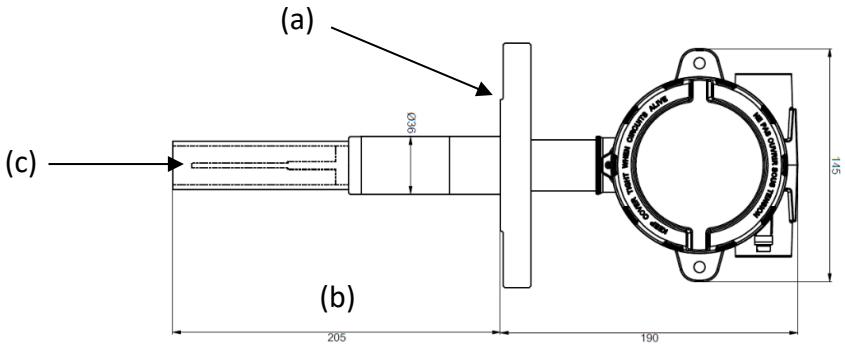
INVI is screwed to the corresponding counter flange installed on the process. Use the screws, torque and seal size and material according to the good practices and your application specifications.

The flanged nozzle dedicated to INVI has to be welded close to the device generating the viscosity variations (heater, mixer, reactor, etc...). Retention, high flow velocities, strong vibrations and high magnetic fields have to be avoided.

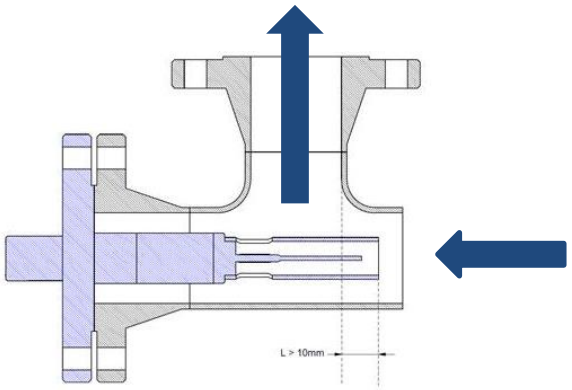
2.2.1 Various mountings and models

In its standard design the INVI sensor is manufactured with an ANSI 2'' 150 lbs flange for process connection and operation up to 20 bar/290 psi, and insertion length is 205 mm.

On request flange type/size/pressure class **(a)** and insertion length **(b)** can be customized. Adaptation is possible from flange size 1'' ½ to 2'' ½ and operating pressure up to PN50/300 lbs. Insertion length can be increased. In normal production cycle, the vibrating rod **(c)** must be continuously and fully immersed in the fluid.



2.2.2 *On pipe angle mounting*



The flange is welded on a right angle straight Tee as indicated in the figure.

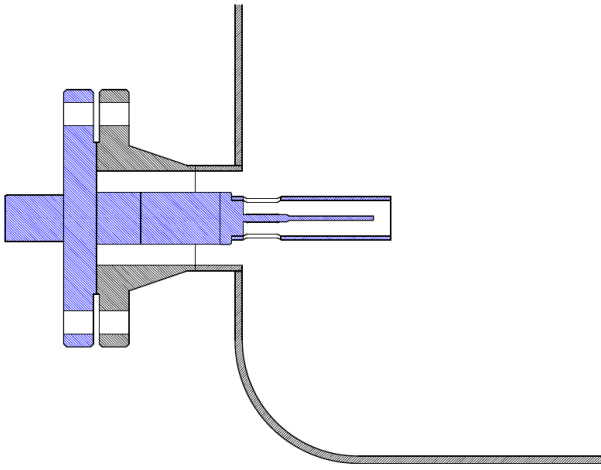
The minimal pipe and Tee diameter is of 1" 1/2.

The vibrating rod, that is the active part located at the end of the insertion probe, must be located at the level of the outlet branch of the tee in order to be immersed in continuously renewed product.

The flow direction is as indicated on the figure. 1 (unless for fibrous fluids where the flow can be inverted and the flow damper removed). **Follow the insertion instruction indicated on drawing.**

Advice: choose a sensor position in order to assure a permanent fluid renewal and to avoid the existence of "dead zones".

2.2.3 *On reactor wall mounting*



The flanged nozzle is best welded on a vertical face of the reactor, at the bottom of the reactor.

The minimal diameter of the nozzle and the flange is of 1" 1/2.

The free area around the vibrating rod has to be at least ∅ 40 and 150mm length.

In order to avoid parasitic vibrations, the reactor wall where the flanged nozzle is welded must be **thicker than 5mm**.

Advice: preferably choose a horizontal position for the rod placement with all the liquid flows turned to the top in order to avoid the apparition of bubbles.

2.2.4 *Other mountings*

For at-line sensor check best use a Sofraser lab stand with corresponding counter flange. Screw the INVI sensor on the lab stand flange.

2.3 Practical advices

2.3.1 Flow damper

Each INVI is delivered with its flow damper (tube) in order to stabilize the flow around the vibrating rod. By default the INVI's flow damper has the short slits through which the fluid renewal is done.

For the highest full scale ranges and when the flow of product through the flow damper must be facilitated the long slits flow damper can be used.

Use of the long and large slits flow damper is possible, for high viscosity products and for the on pipe angle mounting.

It is advised to keep it on the sensor unless the sensor is used in particular conditions. At the time of the assembly on the mounting flange and during transport, it also protects the rod from mishandling. Before installing the INVI on its mounting accessory check that flow damper is firmly screwed on the neck of the INVI sensor.

2.3.2 Tightness

2.3.2.1 Product side

End-user is in charge of supplying the seal between the INVI sensor and the process flange as well as the bolts. Check that the seal material is compatible with your fluid and the operating temperature.

Check that the maximum operating pressure of your process is within the nominal pressure indicated on the marking plate of your INVI sensor.

Tightness of the insertion probe of the INVI sensor is achieved thanks to 2 FEP coated Viton O-ring seals. Check that they are compatible with your fluid and operating temperature.

After installation, proceed to the pressure proofing (limited to 150 % of the rated pressure of your INVI sensor).

2.3.2.2 Ambiant air side

The INVI sensor is rated IP66. Nevertheless, for long term use it should be operated in IP63 conditions. Cable gland should never be **loosened** or **dismantled**.

2.3.3 Fluid homogeneity

The INVI is fully compatible with biphasic fluids, gas emulsions and solid suspensions. There is no impact with particles size up to 1 mm; larger particles could disturb the measurement and/or damage the sensor.

Presence of bubbles in the fluid doesn't disturb significantly the INVI as long as the concentration and diameter don't affect the properties of the centimetric diameter size of the volume taken into account by the measures.

It is strongly recommended to carry out the measurement on a homogenized fluid so that the measurement is representative of the fluid.

2.3.4 Chemical compatibility

Check that Material Of Construction (MOC) of your INVI sensor is compatible with your fluid and the operating temperature.

For information, the standard MOC of the wetted parts of the INVI sensor is 316L stainless steel and the tightness of the insertion probe is achieved thanks to 2 FEP coated Viton O-ring seals. Check that they are compatible with your fluid and operating temperature.

The sheath of the standard cable of the INVI remote sensor is in PVC material and the cable gland(s) is/are in chrome-plated brass.

2.3.5 Temperature compatibility

For each INVI the maximum operating temperature on process/fluid and on ambient air sides are indicated on its marking plate and specific notes.

Standard minimal temperatures for the product/fluid and for the ambient air are 0°C.

2.3.5.1 Classic version

The maximum temperature of your process/fluid and the temperature of the ambient air must be lower than the “Max. Temp.” value indicated on the marking plate. The information is also available on the INVI’s specific notes.

Standard value of “Max. Temp.” is 100°C.

“Max. Temp.” value may be limited by Exproof temperature marking (see Appendix A)

2.3.5.2 Embedded versions

Temperature on process/fluid side must remain below “Tproduct max” value and ambient temperature around the cable gland and embedded electronics enclosure must remain below “Tamb max” value.

For embedded 9000 electronics without display the standard value for “Tproduct max” is 100°C and for “Tamb max” is 50°C.

For embedded 9100 electronics with display the standard value for “Tproduct max” is 80°C and for “Tamb max” is 50°C.

2.3.6 Pressure compatibility

During normal operation, do not exceed the INVI sensor rated pressure. For each INVI sensor the information is available on its marking plate and specific notes.

2.3.7 Sensor handling

Do not drop nor knock the INVI sensor.

Knocking the rod will have an effect on the factory calibration. It can be corrected on site.

Bending may block the vibration of the rod and require factory maintenance.

In the case it is necessary to work without the flow damper, the mounting of the INVI sensor must be made with precaution, in order to avoid knocking or bending the vibrating rod.

Same precaution must be followed when removing the INVI sensor from its mounting accessory. As soon as the sensor is removed, screw immediately its flow damper tube in order the secure the rod.

In any case when moving or shipping don’t forget to install back the flow damper in order to secure the rod.

Don’t knock, pinch, crush, twist or bend the cable. Its minimum bending radius is 100 mm. Don’t modify the length of the cable; modification may impact the response of the viscometer.

Protect the INVI sensor against mechanical damages due to impact, pinching, crushing, twisting and bending that aren’t covered by the warranty

2.3.8 Mounting screws/bolts

By default the screws/bolts for installing the INVI sensor on the flange installed on the user's process aren't supplied by Sofraser. Please refer to the Standard document of the flange for screws/bolts size and specifications.

2.3.9 Grounding and wiring

The INVI sensor and the electronics devices must be connected to a good earth ground at same voltage level.

INVI remote model must be connected to the earth ground thanks to the threaded rod located on the outer surface of the mounting flange.

2.4 Checking the equipment when placed in the process line

For INVI with remote electronics, please refer to the relevant electronics manual (see list of manuals in Appendix B)

Before starting the process, check that the viscosity information is stable (vibrating rod in the air). If not, check first the strength of the sensor fitting. Otherwise rotate the sensor of 90° (4 possible positions). Choose the position where the information is the most stable. Locate this position in order to restore it when the sensor is removed and reinstalled.

Adjust the mounting offset, at room temperature. The rod is vibrating in the air.

2.5 Offset adjustment in air

The offset of the raw signal must be performed before utilization and introducing fluid in the process. This is a mandatory step to ensure the reliability of the measure.

The clean and dry rod must vibrate in the air since at least half an hour before the offset adjustment is carried out, in order to warrant the homogeneity and the stability of the INVI temperature on its mounting accessory (best at ambient temperature). Refer to the manual of the electronics for the detailed instructions.

The amplitude, corrected with an offset, is shifted so that the viscosity value is 0.00 cP.

When offset is confirmed, write it down as well as the raw values (see electronics manual) in the follow up file of your instrument.

2.5.1 Classic version

Detailed instructions for adjusting automatically the offset of the raw signal in the air is described in the user manual of the remote electronics (see list of manuals in Appendix B)

2.5.2 Embedded 9000 blind transmitter version

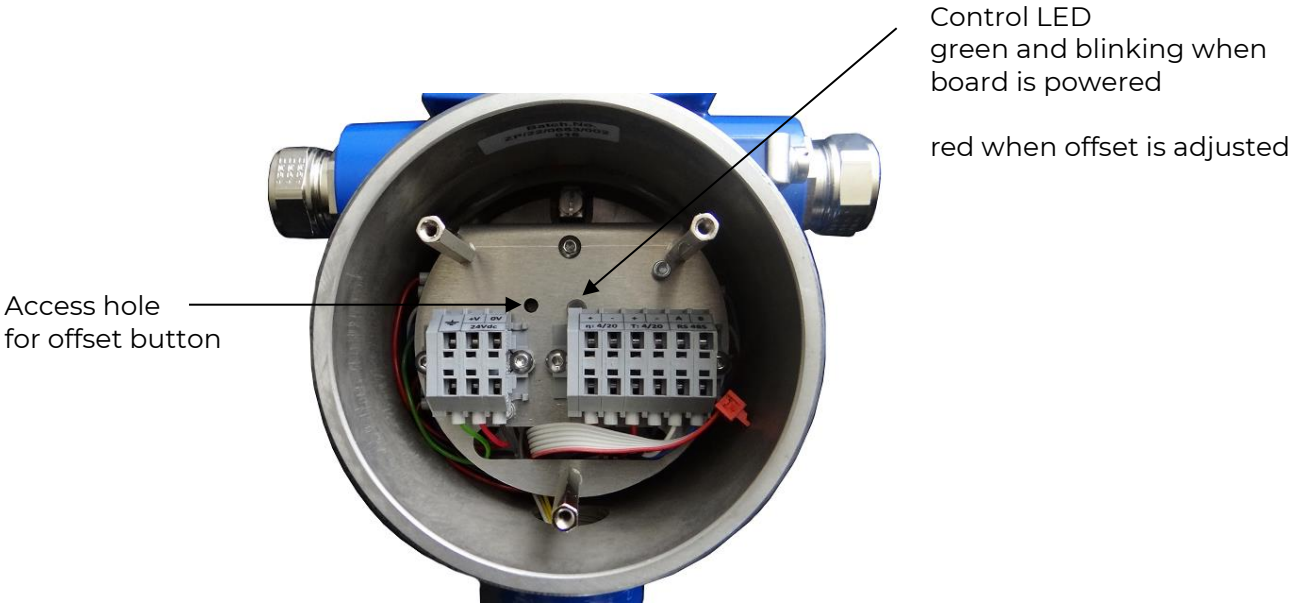
The offset of the raw signal in the air is adjusted thanks to a button located behind the connector blocks and the control LED (refer to § 1.3.2 to access).

Air is used as reference fluid in order to adjust the amplitude during the installation.

The offset adjustment must be done for each new installation of the sensor on the process.

BEFORE STARTING THE PROCESS, IT IS VERY IMPORTANT TO PROCEED TO THE OFFSET ADJUSTMENT IN AIR.

1. Be sure the process is empty. The sensor must vibrate in air, the rod is clean and dry.
2. Install the sensor on the process and fix it firmly
3. Power on the device, the green control LED is blinking. Wait 30 minutes and proceed to the offset.
4. Adjust the offset by using the internal button located 1 cm behind the plate on which the connectors are fixed. Push continuously the OFFSET button and when the red control LED lights on, release the button. The offset is done.



WARNING: Carefully and properly close the IP66 enclosure when the operation has been done.

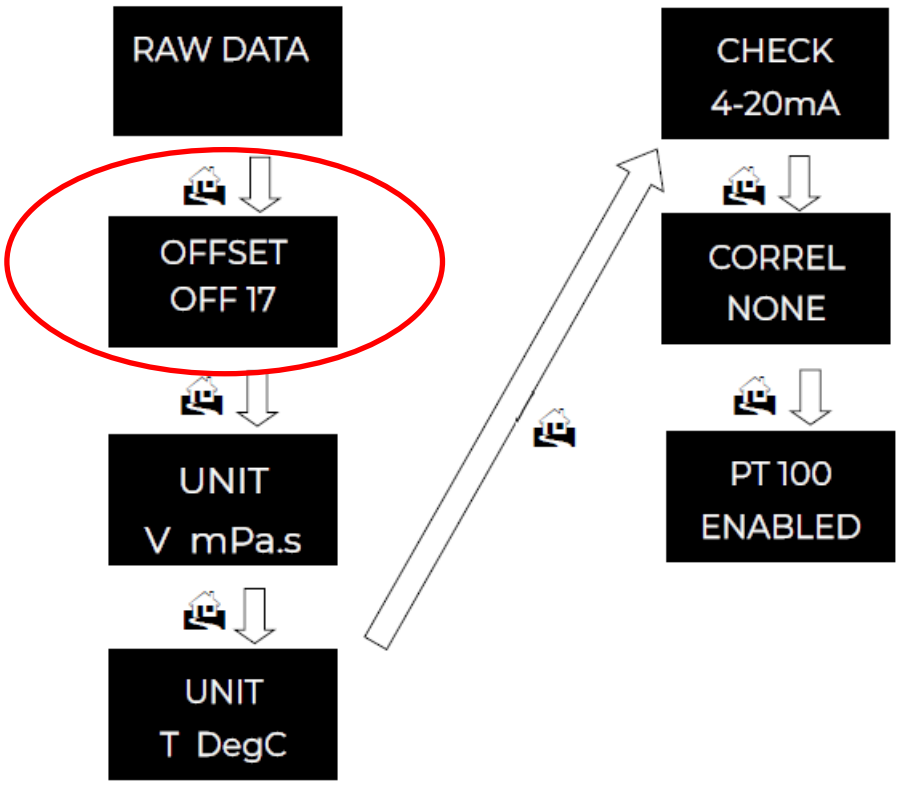
Notes:

- The viscosity signal delivered to the outputs of the electronics device is calculated by using the corrected amplitude of the rod. If the offset is done in a wrong way or has been forgotten, the viscosity value will be false.
- The user should wait at least one minute between two zero adjustments, in order to get accurate signals and calculations.

2.5.3 Embedded 9100 display transmitter version

The offset of the raw signal in the air is adjusted thanks to the embedded display and the two buttons (refer to § 1.3.2 to access).

The main screen is displaying the viscosity and if activated the temperature. By pressing the "**Home"** button (small house icon), we get access to the seven different menus proposed by the transmitter. We can browse from one to the other with the help of **Home**. To enter into a menu, press **OK**.



Refer to technical manual of 9100 DIN rail transmitter reference 423 chapter 3 for detailed instruction for setting the offset in the air.

If both **Home** and **OK** buttons are pressed simultaneously, the 9100 display will move back to the main screen showing the viscosity and the temperature.

3. Operation and calibration

3.1 INVI utilization

Be sure that the offset in the air has been performed before introducing the fluid in the process. Refer to the electronics manual for display, advanced data processing and output features.

3.2 Reference point

When possible, note the viscosity information and raw values when a cleaning or rinsing solution is flowing.

Beside of the condition “in the air”, this can be used as reference for some periodic controls of the equipment. The operation must be done each time in the same conditions (rod in the air, or in the cleaning solution). Such a control can be assimilated to a self-checking. If the original calibration has been modified, the reference values will of course be those obtained with the new calibration.

3.3 Periodic checking

Conformity to regulations relative to Quality Insurance implicates a periodic control of the measuring equipment used in the manufacturing operations, taking in consideration (or correcting) their drift in time.

It is proved that this equipment drift is negligible. However, it is good to check their aspect and their response once a year, at the same time as the other process equipment. A quick control is possible from time to time, if the sensor active part is in air, or immersed in a cleaning or rinsing solution. As long as these values stay similar, we can say that the sensor operation is right among its whole range (if no intermediate re-programming occurred).

3.4 Modification of the previous calibration

The paired transducer has been programmed in order to perfectly answer to the customer’s needs. These settings are noted in the factory “specific notes and manufacturing parameters” pages that are delivered with the documentation. The factory calibration is performed with certified viscosity standards (Newtonian mineral oils). In normal conditions, there is almost no drift of the calibration. Nevertheless, the need for calibration update isn’t abnormal.

At first, be sure that the modification is necessary, and not consecutive of a non-coherent comparative information (different measuring conditions, bad standards, inaccurate or wrong laboratory measurements ...). The initial calibration parameters are protected and can only be modified at SOFRASER. For any modification, check in the electronics manual if this operation is allowed or contact your distributor.

Calibration update at SOFRASER workshop is the first solution. Please contact your distributor or SOFRASER after sales team.

Calibration can be checked and updated in process conditions. Run your process in steady state conditions, record viscometer reading, take a sample and determine its viscosity with your reference method at the process temperature, compare and, if necessary, adjust the viscometer’s response thanks to the correlation / correction feature of the electronics.

Third method is to control the response at-line by using the on lab stand method and Newtonian mineral type oils.

Similar control and adjustment can be performed for the incorporated temperature probe thanks to the Pt100 calibration features (see electronics manual).

3.5 RS Frame and Protocol

Goal: read viscosity and Pt100 values using RS-485 communication

S: send from the console to the board
R: response from the board to the console
Viscosity: viscosity in the unit displayed on the 9100 screen (mPa.s or Pa.s)
Pt100: value in the unit displayed on the 9100 screen (°C or °F) of the temperature read by the probe when there is one

COM port characteristics:

Speed: 9600 bits/s Number of bits: 8 Parity: none Stop bit: 1

Generic frame format (all the data in the frames are in Hexadecimal)

S = SN 04 XX XX YY YY <CRC-16>
R = SN 04 AA {DATA} <CRC-16>

SN: slave number
04: reading function
XX XX: starting point for the addresses to be read
YY YY: number of words to be read
AA: read bytes number
DATA: content of all the asked addresses
<CRC-16>: checksum Modbus RTU on 16 bits (can be automatic if PLC or software is compatible)

NB: 1 word = 2 bytes

List of addresses:

Data to read	Address in Hexadecimal	Number of words	Multiplied factor of the data received	Frame to send with a unit at slave address 01
Viscosity *(in cP, P mPa.s or Pa.s)*	0x 00 14	2 words 4 bytes (UINT_32)	10,000 or 1,000,000 (see table below)	01 04 00 14 00 02 31 CF
Temperature *(in °C or °F)*	0x 00 12	2 words 4 bytes (INT_32)	100,000	01 04 00 12 00 02 D1 CE

The viscosity value read through the RS-485 is the viscosity displayed on the 9100 main screen multiplied by a factor which depends of the viscosity range of the unit.

Therefore, the viscosity read through the RS-485 has to be divided by a factor in function of its full-scale range and which is indicated in the table below:

Full scale range	Multiplied factor
0 to 4,000 mPa.s	1,000,000
4,001 to 10,000 mPa.s	10,000

Example 1: to read the viscosity of a unit which has a slave address 01 (01 in Hexadecimal), with a full-scale range of 100 mPa.s and which measures a viscosity of 67.65 mPa.s

S = 01 04 00 14 00 02 31 CF
R = 01 04 04 04 08 4F 18 4F 4C

01: slave number of the viscometer in Hexadecimal
04: reading function
00 14: viscosity address
00 02: number of words
31 CF: checksum of sending frame
04: number of bytes read
04 08 4F 18: viscosity value in Hexadecimal which is converted to 67,653,400 in Decimal and this value has to be divided by 1,000,000 (because range is below 4,001 mPa.s) so the viscosity is 67.65 mPa.s
4F 4C: checksum of receiving frame

Example 2: to read the viscosity of a unit which has a slave address 01 (01 in Hexadecimal), with a full-scale range of 10,000 mPa.s and which measures a viscosity of 3,495.2 mPa.s

S = 01 04 00 14 00 02 31 CF
R = 01 04 04 02 15 54 DC D4 A1

01: slave number of the viscometer in Hexadecimal
04: reading function
00 14: viscosity address
00 02: number of words
31 CF: checksum of sending frame
04: number of bytes read
02 15 54 DC: viscosity value in Hexadecimal which is converted to 34,952,412 in Decimal and this value has to be divided by 10,000 (because range is between 4,001 and 40,000 mPa.s) so the viscosity is 3,495.2 mPa.s
D4 A1: checksum of receiving frame

Example 3: to read the temperature of a unit which has a slave address 01 (01 in Hexadecimal), which measures a temperature of 25.92 °C

S = 01 04 00 12 00 02 D1 CE
R = 01 04 04 00 27 8C FE AE CF

01: slave number of the viscometer in Hexadecimal
04: reading function
00 12: temperature address
00 02: number of words
D1 CE: checksum of sending frame
04: number of bytes read
00 27 8C FE: temperature value in Hexadecimal which is converted to 2,591,998 in Decimal and this value has to be divided by 100,000 (always the same factor) so the temperature is 25.92 °C
AE CF: checksum of receiving frame

3.6 SIS Sofraser Interface Software

SIS is an optional accessory and is not included in standard with INVI.

It allows the communication between the embedded 9000/9100 electronics board and a computer in order to make some data logging or to set some parameters including the correlation function. Refer to 9100 transmitter technical manual reference 419 – Chapter 5 – Sofraser Interface Software for details.

4.Maintenance

4.1 Periodic maintenance

INVI sensor has no moving parts and can be operated without maintenance in some specific conditions.

Nevertheless, SOFRASER advises to check the INVI sensor once a year.

Each end user can reduce or increase this period of time according to his policy and specific operation conditions.

The check can be done by end user, SOFRASER distributor or SOFRASER after sales workshop.

SOFRASER advises to proceed to hereunder check:

Check	Expected	Action in case of not expected status
Visual inspection of cable (for Classic version)	No damages, no cut, no twist, …	Stop the viscometer, especially if used in Ex area, and send the unit back to SOFRASER for maintenance of the cable
Sensor and electronics serial numbers (for Classic version)	INVI sensor and remote electronics have the same serial number	Investigate why INVI sensor is used with electronics that hasn't the same serial number. Unless there is an explained reason find the electronics that has been matched with sensor by SOFRASER
Visual inspection of the cable gland(s)	No damages, no broken parts, no dismounted parts, not loose, the cable(s) is (are) securely held by the cable gland(s), …	Stop the viscometer, especially if used in Ex area, and send the unit back to SOFRASER for maintenance of the cable gland
Visual inspection of the marking plate	Presence of the marking plate, readable serial number, Ex classification, maximum operating conditions and consistency with process conditions	Refer to delivery note and specific notes if information aren't readable.
Visual inspection of the cover of the transmitter head (embedded transmitter versions)	Presence of the locking screw, cover well screwed on the head, no damage on the window (embedded with display model), absence of humidity, liquid, dust inside the head	In case of damage or failure send the unit back to SOFRASER for maintenance
Visual inspection of the inside of the transmitter head (embedded transmitter versions)	absence of humidity, liquid, dust inside the head	In case of damage or failure send the unit back to SOFRASER for maintenance

Remove the INVI from its mounting accessory. Take care and warrant the absence of pressure, hazardous chemicals, excessive temperature..., before releasing the mounting screws. Check that INVI has been installed with its flow damper. If not and in case of doubt take much care to not knock nor bend the rod while removing INVI from its mounting accessory.

Remove the flow damper. Take much care to not damage, bend or knock the rod. Do not insert tool in the slots of flow damper in order to release the flow damper. Use appropriate solvent to dissolve eventual traces of product.

- Clean the vibrating rod.
- Take much care to not damage, knock or bend the rod.
- Use appropriate solvent to dissolve and remove product.
- Do not use tools like hard brushes to clean the rod.

Check	Expected	Action in case of not expected status
Visual inspection of the insertion probe	The 4 parts that make up the insertion probe must be well assembled together.	If required tighten the flow damper by screwing. If not effective and if other parts are not well assembled, do not re-install the INVI and the process and contact your distributor or Sofraser
Visual inspection of the vibrating rod	Vibrating rod must be straight (not bent) The larger diameter part (5mm) of the rod must not show any impact. No damage or attacks on optional coating	Contact your distributor or Sofraser Contact your distributor or Sofraser Check the compatibility of MOC and/or coating with your fluids and process conditions. Contact your Distributor or Sofraser.
Tweak gently the end of the vibrating rod with one of your fingers	Diapason type noise that disappears after a hand of seconds. Sound must not be deaf and brief.	Contact your distributor or Sofraser
Check the response of the viscometer (see chapter 3.2)	Absence of shift of response since last check or acceptable shift.	See chapter 3.3

Clean and dry the inside of your mounting accessory before installing the INVI back on your process and setting the offset in the air.

4.2 Troubleshooting

Troubles are mainly detected thanks to the display and the raw data. (See APPENDIX B for the references of specific manual of the electronics matched with your INVI sensor).

In case of subnormal operation, check the following points:

- Electrical connections (connectors, cables, power supply…)
  See chapter 1.3 and status of the power supply control LED for embedded electronics (see chapter 1.3.2).

- Remove the sensor from the process and clean it

- Check that the vibrating rod is not bent
  When powered on, check with the finger there is a vibration at the end of the rod. At this moment, the viscosity information (displayed on the electronics device and/or on current and RS485 outputs) has to increase.
  If abnormal measurements and the raw signals cannot be explained, please contact Sofraser or the Sofraser distributor in charge.

4.3 Return instructions

Please contact your distributor or SOFRASER and ask for the Return Materials Authorization form. Complete viscometer must be sent back in its original packaging, with filled RMA form and decontamination statement.

4.4 End of life

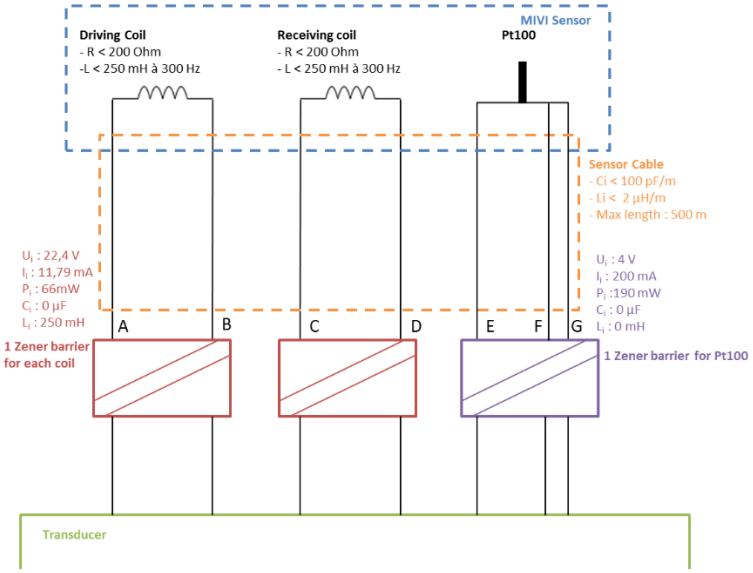
INVI sensor is designed for 24/7 utilization.

At its end of life INVI sensor can be dismantled and each part can be recycled. SOFRASER advises to send the equipment back to its workshop. SOFRASER will dismantle the sensor and reuse or send the parts to the relevant recycling channels.

Appendix A: SPECIFIC CONDITIONS OF USE FOR ATEX AND IECEx INVI sensor

This chapter is applicable only to INVI Classic version (see § 1.2.1).
Hereunder an extract of the applicable EU type examination certificate LCIE 15 ATEX 3034 X.

Intrinsically Safe installation



Other specific conditions:

The equipment can be only connected to intrinsically safe certified associate equipment. These combinations must be compatible as regards with the intrinsic safety rules (see electrical parameters).

Approval's ambient temperature limits:

- Sensor body: -40°C to +300°C

- Cable: -40°C to +100°C

Cable length must be defined in such a way that total capacitance of sensor and cable does not exceed the maximum permitted capacitance of certified power supply.

To avoid the effects of process temperature and other thermal effects, care shall be taken to ensure that the temperature at sensor body and cable parts does not exceed assigned ambient temperature range.

The temperature classification depends on the ambient temperature as follows:

Temperature class	Ambiant temperature	
	With Pt100 sensor (INVI-T)	Without Pt100 sensor (INVI-0)
T6	-40°C ≤ Tamb ≤ +35°C	-40°C ≤ Tamb ≤ +65°C
T5	-40°C ≤ Tamb ≤ +50°C	-40°C ≤ Tamb ≤ +80°C
T4	-40°C ≤ Tamb ≤ +85°C	-40°C ≤ Tamb ≤ +115°C
T3	-40°C ≤ Tamb ≤ +150°C	-40°C ≤ Tamb ≤ +180°C
T2	-40°C ≤ Tamb ≤ +245°C	-40°C ≤ Tamb ≤ +275°C
T1	-40°C ≤ Tamb ≤ +300°C	-40°C ≤ Tamb ≤ +300°C

EXAMPLE of link with marking plate specific information, and wording

Example for an INVI-T sensor Ex ia IIC T3 Ga

Sensor body = from vibrating rod to process connection flange:

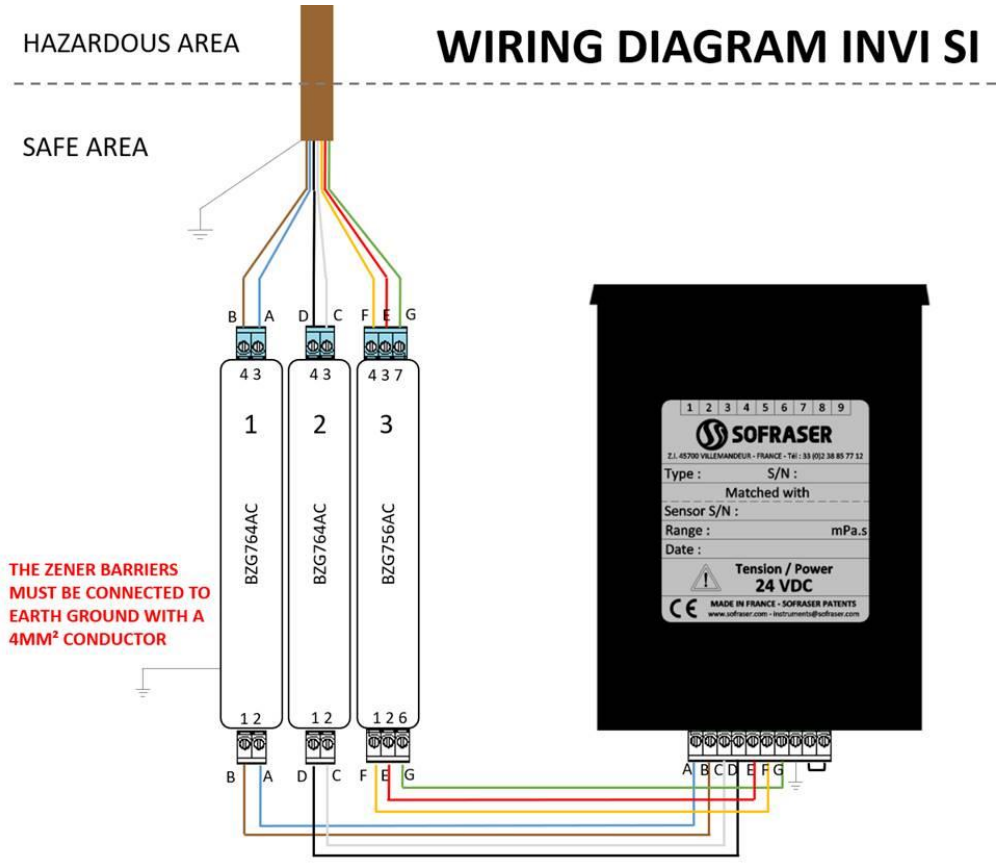
the ambient temperature (product/fluid temperature) must remain within the range “0 °C < T amb. > 150 °C”.

Cable = cable gland + sensor cable:

the ambient temperature (ambient air temperature) must remain below “Cable Ent. Max Temp.: 100 °C”.

INVI-T Viscometer	
Type: MIVI-SI	
SOFRASER - 45700 Villemandeur - FRANCE	
LCIE 15 ATEX 3034X CE 0081 Ex II 1G	
IECEx LCIE 15.0031X Ex ia IIC T3 Ga	
S/N: 1234	Date: 01/01/2023
0°C < T amb. < 150°C	Max Press.: 20 bar
Coils : Ui: 22.4V - Ii: 11.79mA - Pi: 66mW - Li: 250mH - Ci: 0µF Pt100 : Ui: 4V - Ii: 200mA - Pi: 190mW - Li: 0mH - Ci: 0µF Cable : Lcable: 2µH/m - Ccable: 100pF/m	
Cable Entr. Max Temp. : 100°C	
WARNING - DO NOT OPEN - Sofraser Patents	

EXAMPLE of wiring with a 9200 transmitter:



According to cable model the color of the wires may change. Give priority to the wires marking. Refer to the relevant electronics manual.

Appendix B: LIST OF OTHER SOFRASER DOCUMENTS

Manual ref. 381 – 9000 transducer (for Classic version)

Manual ref. 418 – 9100 transmitter (for Classic version and for Embedded 9100 display transmitter version)

Manual ref. 380 – 9200 transmitter (for Classic version)

Manual ref. 390 – 9510 processor (for Classic version)

Manual ref. 396 – 9710 processor (for Classic version)

Contact your distributor or Sofraser with the serial number of your viscometer for relevant version of the document(s).