INSTALLATION, OPERATION, CONFIGURATION AND MAINTENANCE MANUAL
January/2024

VVP10-H

HART® VALVE POSITIONER

VIVACE™ Process Instruments

HART® COMMUNICATION FOUNDATION

NOTE

We have reviewed this manual with great care to maintain compliance with the hardware and software versions described herein. However, due to the dynamic development and version upgrades, the possibility of technical deviations cannot be ruled out. We cannot accept any responsibility for the full compliance of this material.

Vivace reserves the right to, without notice, make modifications and improvements of any kind in its products without incurring in any circumstances, the obligation to make those same modifications to products sold previously.

The information in this manual is frequently updated. Therefore, when using a new product, please check the latest version of the manual on the Internet through our website www.vivaceinstruments.com.br/en/, where it can be downloaded.

You are very important for us. We will always be grateful for any suggestions for improvements as well as new ideas, which can be sent to the e-mail: contato@vivaceinstruments.com.br preferably with the title "Suggestions".

SUMMARY

WARNING

It is extremely important that all the safety instructions, installation and operation in this manual are followed faithfully. The manufacturer is not liable for damage or malfunction caused by improper use of this equipment.

It is recommended to strictly following the rules and good practice relating to installation, ensuring correct grounding, noise insulation and good quality cables and connections in order to provide the best performance and durability to the equipment.

Special attention must be considered in relation to installations in hazardous areas, where applicable.

SAFETY PROCEDURES

- *Appoint only skilled people, trained with process and equipment;*
- *Install equipment only in operation compatible areas, with the proper connections and protections;*
- *Use proper safety equipment for any handling device in field;*
- *Turn area power off before equipment installation.*

SYMBOLOGY

Caution - indicates risk or error source

Important Information

General or Specific Risk

Electric Shock Danger

GENERAL INFORMATION

Vivace Process Instruments ensures the operation of this equipment, according to the descriptions contained in its manual, as well as technical characteristics, not guaranteeing its full performance in particular applications.

The operator of this equipment is responsible for observing all aspects of safety and prevention of accidents applicable during the execution of the tasks in this manual.

Failures that might occur in the system, causing damage to property or injury to persons, shall additionally be prevented by external means to a safe outlet for the system.

This equipment must be used only for the purposes and methods proposed in this manual.

1 EQUIPMENT DESCRIPTION

VVP10 HART positioner is part of Vivace Process Instruments HART® family of equipment, designed to work with linear or rotary valve actuators, providing precision and control with high availability and reliability. It allows easy installation and commissioning and is suitable for various types of valves, regardless of the action (single or double) and size.

VVP10 HART features pressure sensor models and end-of-stroke switches (digital input and output) for advanced diagnostics that help to efficiently predict the need for maintenance. The positioner is powered by a 4-20 mA current without polarity, and also has a 4-20 mA output proportional to the measured position.

The configuration uses the HART® 7 communication protocol, already recognized as the most used in the industrial automation world for configuration, calibration, monitoring and diagnostics, and can be performed by any HART® configurator or tool based in EDDL® or FDT/DTM®. The user can configure positioner parameters, as well as perform Auto Travel Calibration, PID Auto Tune, check calibrations, diagnostics and monitoring. It is also possible to configure VVP10 HART via local adjustment using a magnetic tool.

Prioritizing its high performance and robustness, VVP10 HART is designed with the latest electronics and materials technologies, ensuring long-term reliability for systems of any scale.

1.1. BLOCK DIAGRAM

The modularization of VVP10 HART components is described in the block diagram of Figure 1.1.

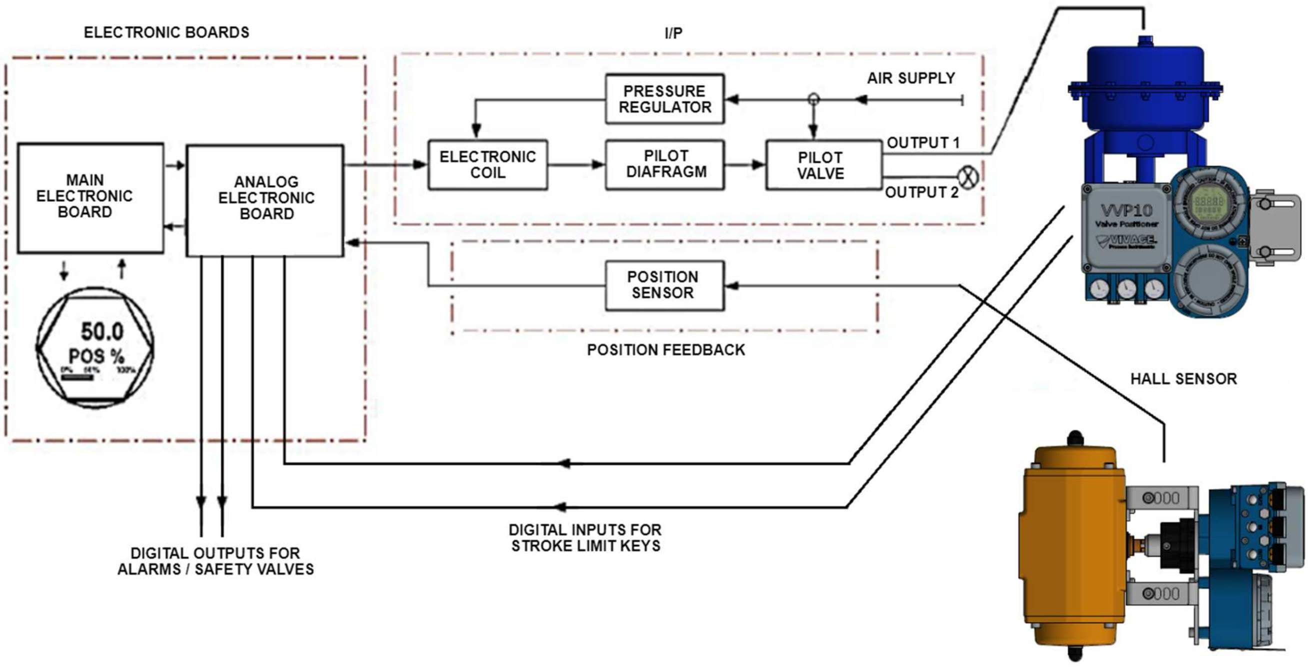


Figure 1.1 – Block diagram for VVP10 HART.

ELECTRONIC BLOCK

The positioner receives a Setpoint signal (SP) via 4-20 mA input loop (or user value, when in disabled mode) and executes a PID control algorithm using Hall sensor's position reading as input.

Hall magnetic sensor signal follows to ADC converter located on the analog electronics board, where it is converted to a digital value and subsequently in position, according to the selected calibration range and unit. Position value (PV) is converted into a 4-20 mA current, proportional to the calibrated range, in the CPU located on the main electronic board.

The PID control generates an output for the analog board that will provide an electric current for the electromagnetic coil to actuate on an I/P module (current/pressure) that will position valve/actuator.

The main board also has a HART® modem that interfaces the microcontroller signals with the HART® line to which the positioner connects.

The display board has the controller block that interfaces LCD with CPU, adapting the messages to be displayed.

The main board CPU can be related to the positioner's brain, executing all time controls, HART® state machine, PID control, diagnostics and transmitters common routines such as configuration, calibration and generation of the digital output value for the current, proportional to the variable PV.

MECHANICAL BLOCK

The positioner is fed through the pneumatic inlet connection by a pressure already directed to the spool valve. The spool valve is nothing more than a 5-way directional valve (input, two outputs and two outlets for these outputs). When used as a single action, we simply close output 2, turning the valve into a 3-way system. See section 2.2 on assembly for single or double actions).

A portion of this input pressure is diverted to an internal regulator, which has the purpose of maintaining a fixed pressure in the I/P module (current/pressure), regardless of the supply pressure applied.

The regulated pressure passes through a restriction orifice, in order to decrease the flow that will reach the nozzle system (I/P module). The nozzle system consists of an electromagnetic coil that receives electric current and generates a magnetic field that attracts a blade. This blade approaches the nozzle when the electric current circulating in the coil has its value increased and moves away when the current value is decreased. This movement allows the pressure present at this point to be varied, since the blade away from the nozzle causes loss of pressure to the atmosphere, reducing the so-called pilot pressure.

The pilot pressure is directed to a diaphragm that acts directly on the spool valve, as opposed to the force of a spring. There is a balance of forces between the pilot pressure in the diaphragm area versus the spring force that positions the spool in different positions, directing the supply pressure to output 1, output 2 or to equilibrium condition (when control is achieved, that is, when it physically reaches the desired position).

There are also two external pressure switches for calibration of the internal regulator and the I/P module, which must remain closed during normal operation of the equipment. See section 2.2 for the item on this calibration.

2 INSTALLATION

RECOMMENDATION

When taking the equipment to the installation location, transfer it in the original packaging. Unpack the equipment at the installation location to avoid damage during transportation.

In the case of a valve/actuator mounted positioner, avoid transporting the assembly by holding the positioner.

RECOMMENDATION

Model and specification of equipment are indicated on identification plate, located at the side part of the housing. Check if supplied specification and model correspond to application requirements.

STORAGE

The following precautions should be observed when storing the equipment, especially for a long period:

(1) Select a storage area that meets the following conditions:

- *a) No direct exposition to rain, water, snow or sunlight.*
- *b) No exposition to vibration and shocks.*
- *c) Normal temperature and humidity (around 20°C / 70°F, 65% RH).*

However, it can also be stored under the following temperature and humidity intervals:

- *Ambient Temperature: -40°C to 85°C (without LCD)* or -30°C to 80°C (with LCD)*
- *Relative Humidity: 5% to 98% RH (@ 40°C)*

(2) For equipment storage, use original factory package (or similar).

(3) If storing an already used Vivace equipment, dry every moist part and clean all connections that was in contact with the process. Keep covers and connections closed and properly protected for its specific application and requirements.

** Only for general use. For explosion proof version, follow product certification requirements.*

INSTALLATION

Close the equipment caps correctly and ensure the correct assembly of the cable press, avoiding clearances between the cable and the cable press that may favor moisture entry.

Close the connections unused, preventing moisture input that can generate low insulation and damage to electronic circuits.

In moisture situations, damage caused to the equipment will NOT be covered by the warranty.

WARNING

All installation procedures must be performed by qualified personnel, following the procedures required by safety regulations. It is recommended that the mechanical installation of the positioner is initially performed on the system to be measured, with the correct positioning of the magnet and support appropriate to the assembly. Then the electrical installation must be carried out, with the power connections and communication with the valve positioner.

2.1. INSTALLATION CONDITIONS

Ambient conditions must be taken into account when installing the positioner, as performance may be affected by poor temperature, vibration or humidity conditions. The temperature directly affects the behavior of some electronic components, so due care must be taken to locate the equipment in order to avoid overexposure to excessive heat.

As the operating principle of the position sensor of the VVP10 HART is magnetic with no mechanical contact, light vibrations should not influence the correct operation of the positioner. However, it is important that there is no large variation of the magnetic field on the position sensor, which can happen if large vibrations in the positioner body are applied. For cases with considerable mechanical vibration, Vivace offers a remote sensor (see section 2.5), which separates positioner body from magnetic sensor, preventing vibrations from interfering with the measurement.

2.2. MECHANICAL ASSEMBLY

VVP10 HART housing has an IP66 protection degree, being immune to water entering its electronic circuit and terminal block, as long as the cable gland (or conduit of the electrical connection) is correctly assembled and sealed with non-hardenable sealant.

The covers should also be tightly closed to prevent moisture from entering, as the threads of the housing are not protected by paint. The electronic circuit is coated with a moisture-proof lacquer, but constant exposures to moisture or corrosive media can compromise its protection and damage the electronic components.

In order to avoid risk of VVP10 HART covers being released unintentionally due to vibration, for example, they can be locked by means of a screw, as shown in figure 2.1.

Figure 2.2 shows the dimensional design of VVP10 HART.

The dimensional drawings related to the magnets can be found in section 2.4.

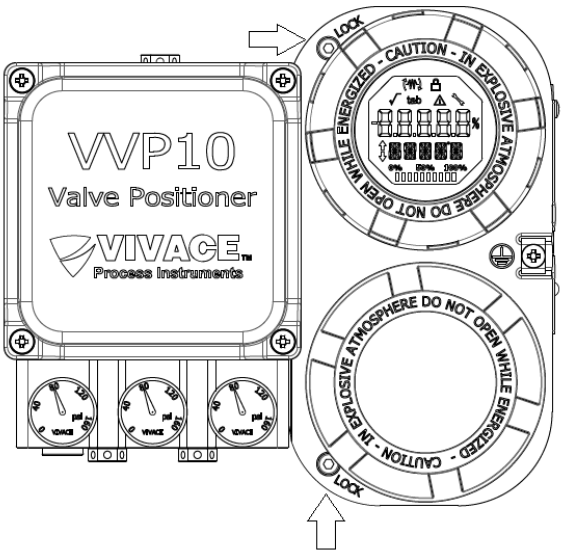


Figure 2.1 – Cover locks.

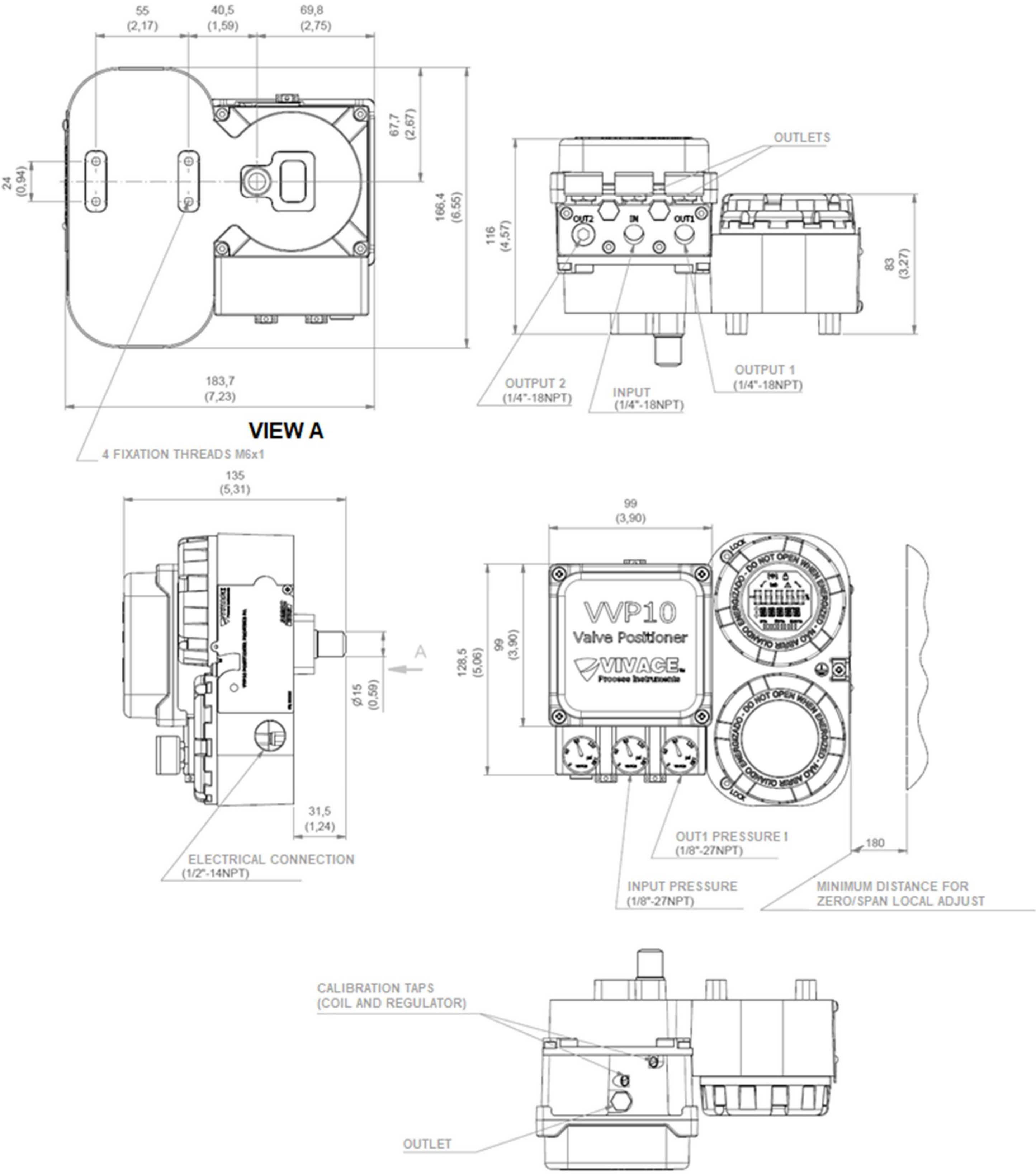


Figure 2.2 – Dimensional drawing for VVP10 HART.

Figure 2.3 identifies the input and output connections for the supply air that will move the positioner. When the positioner is used in a single action set, simply close output 2 using the supplied plug (item 13 in figure 4.1), turning the valve into a 3-way system (figure 2.4).

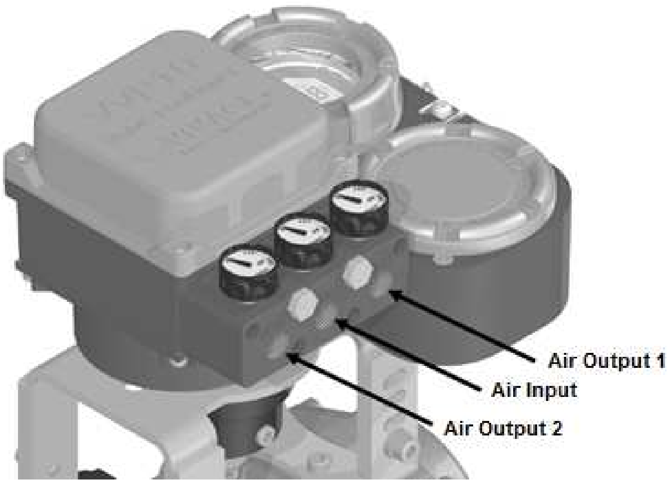


Figure 2.3 – Pneumatic connections for VVP10.

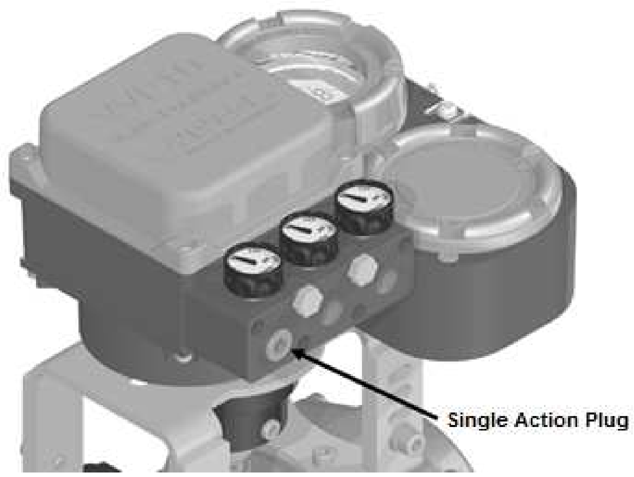


Figure 2.4 – Plug for single action.

WARNING
The default safe position in the case of electric failure will send the entire supply pressure to Output 2 (OUT2). Thus, special attention should be paid to the connection of actuator hoses so the desired action will be achieved on failures.

In addition, the positioner has two pressure plugs on one side (see figure 2.5) to adjust the pilot pressure. Vivace provides the manometer and device specific for this calibration as optional items.

For more information about this procedure, refer to the specific positioner maintenance manual available on the Vivace website.

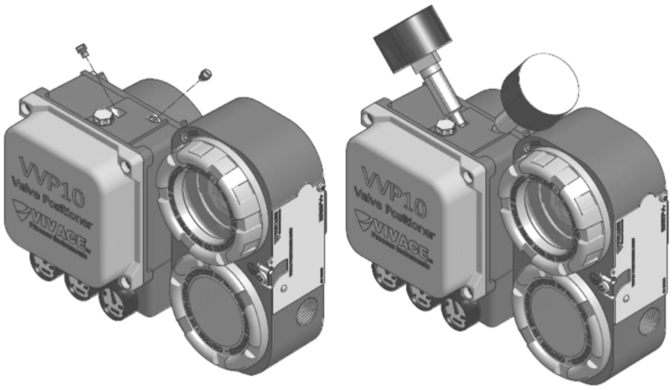


Figure 2.5 – Pneumatic calibration device for VVP10.

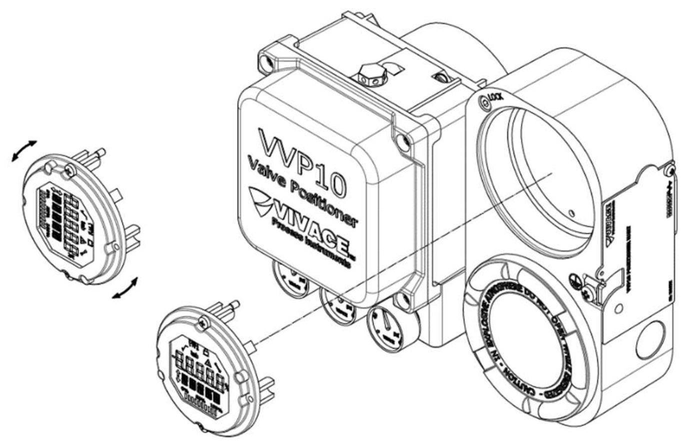


Figure 2.6 –Display LCD 4 x 90° rotation.

VVP10 is a field device that can be installed by means of its own bracket in the actuator of the set to be used (linear or rotary). For details on available brackets, see section 2.6.

VVP10 LCD liquid crystal display can be rotated 4 x 90° so that the display is as accurate as possible for easy viewing. Figure 2.6 illustrates the possible rotation of the LCD of the VVP10.

The installation of VVP10 positioner reference magnet in the desired system should be done first by positioning the magnet in the system so as to allow the sensor to traverse all the useful extension to be measured and aligning the magnet arrow with the positioner arrow on central position (50% of the range) where the sensor will be located (arrow on the bottom of the positioner housing).

WARNING
See section 2.4 for the correct sizing of the magnet. The total extension of the valve stroke must be contained within the magnet course markings for the correct functioning of the positioner.

After magnet positioning, it must be bolted to the assembly to prevent it from moving out of its original position, causing measurement failure. Figure 2.7 exemplifies the installation of VVP10 on a linear motion system magnet, while Figure 2.8 depicts the installation in a rotating motion assembly. Note that there is a necessary spacing to guarantee the performance of the sensor between the lower face of the positioner and the upper face of the magnet (between 2 mm and 4 mm).

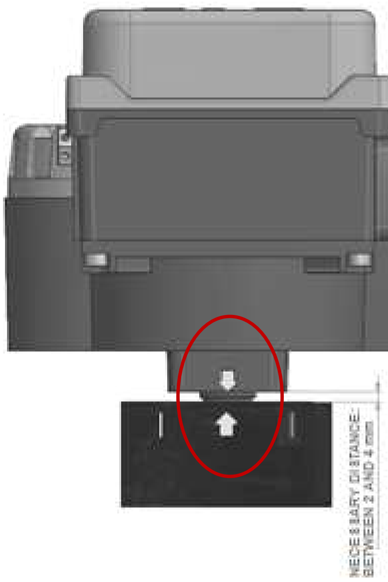


Figure 2.7 – VVP10 with linear magnet.

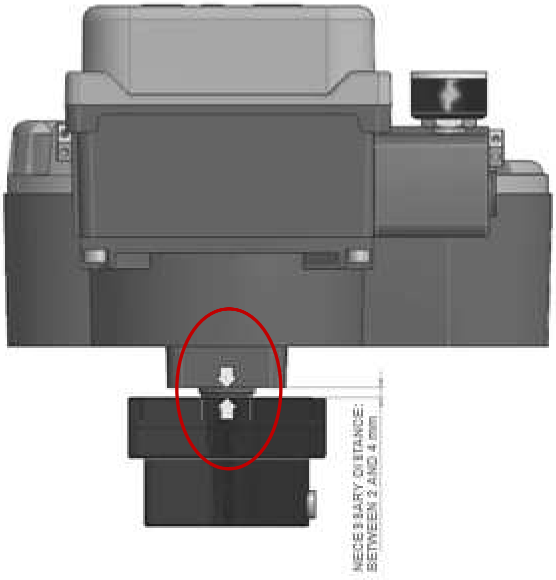


Figure 2.8 – VVP10 with rotative magnet.

Figure 2.9 shows the positioner mounted on linear and rotative valve actuators, detailing the positioning of the magnets on the actuators. For details on the types of magnets and brackets, refer to sections 2.4 and 2.6, respectively.

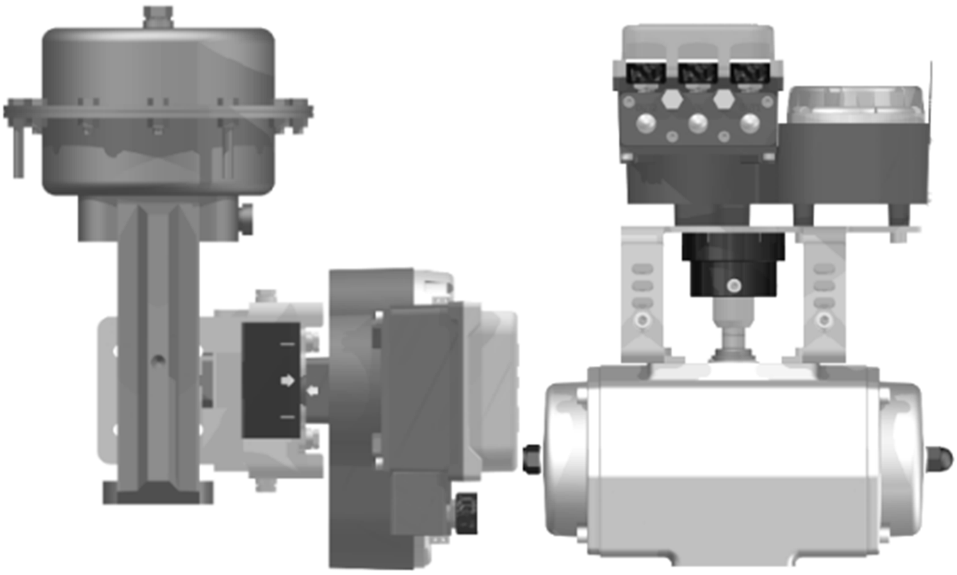


Figure 2.9 – VVP10 on valve actuators with linear and rotative magnets.

2.3. ELECTRICAL CONNECTION

To access the terminal block, remove the blind cover (without display). To do so, loosen the cover locking screw (see figure 2.10) by turning it clockwise.

Figure 2.11 shows power terminals, ground terminals (one internal and one external), plus communication terminals, 4-20 mA current return and tests for standard VVP10 HART. Figure 2.12 shows terminals for digital I/O model (complete).

To power the equipment, it is recommended to use twisted-pair 22 AWG cables. Tables 2.1 and 2.2 describe the functions of the terminals for standard and complete VVP10 HART models, respectively.

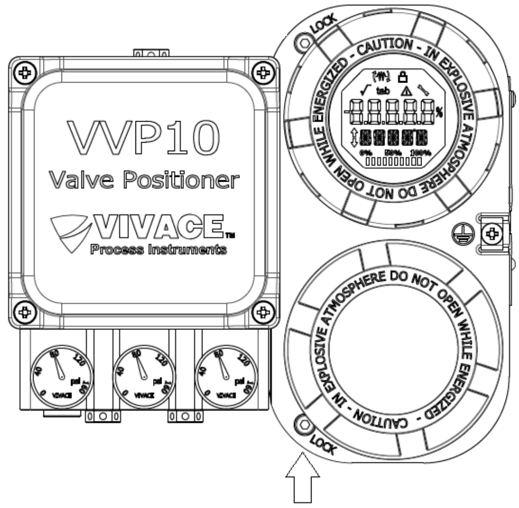


Figure 2.10 – Terminal block cover lock.

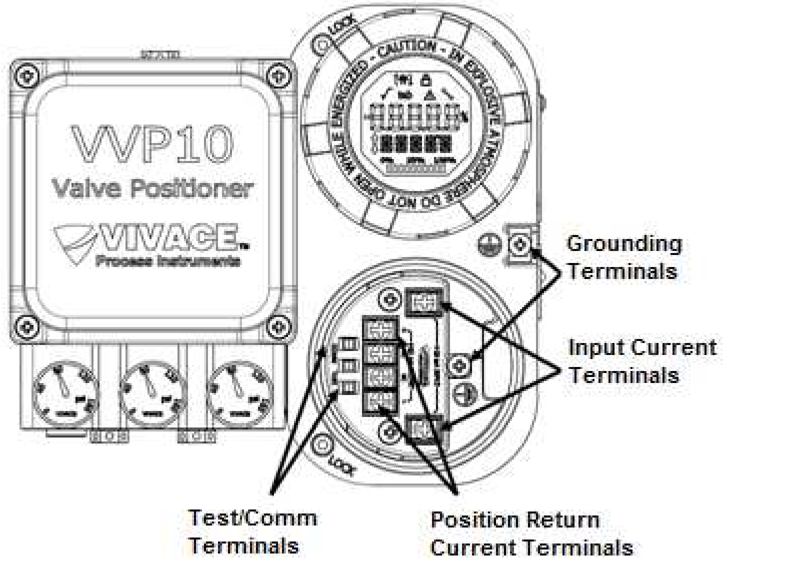


Figure 2.11 – Terminal identification for standard VVP10 HART.

Terminal Description – Standard Model
Power Supply Terminals 4-20 mA INPUT (no polarity)
Position Return Current Terminals 4-20 mA OUTPUT
Grounding Terminals 1 internal and 1 external
Test Terminals - TEST Loop 4-20 mA without circuit opening
Communication Terminals – COMM HART® Configuration

Table 2.1 – Terminal description for standard model.

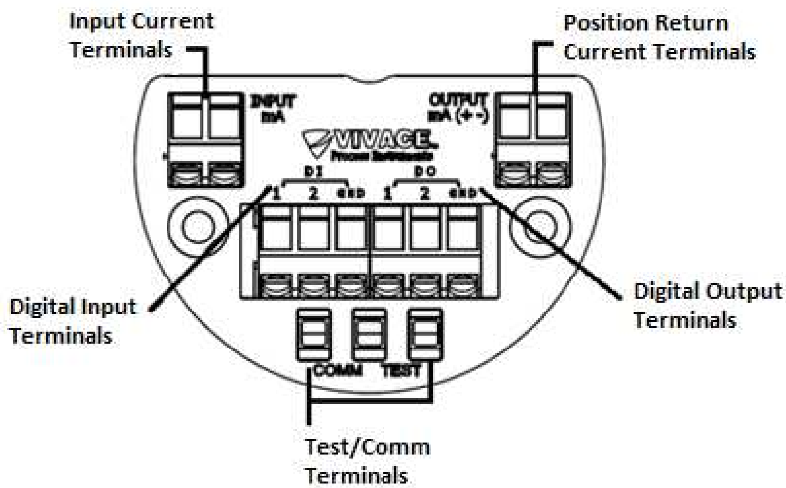
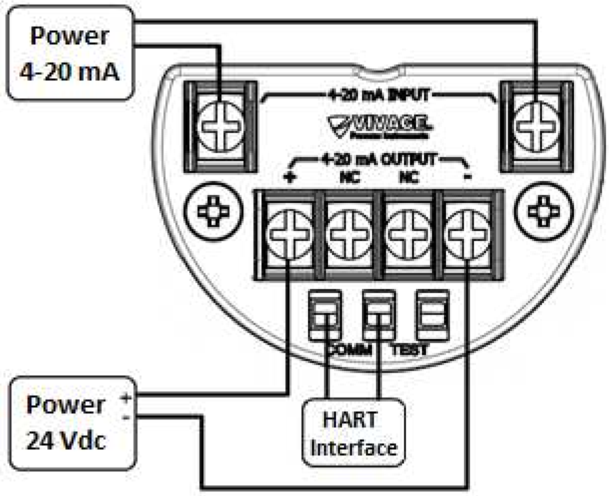


Figure 2.12 – Terminal identification for complete VVP10 HART.

Terminal Description – Complete Model
Power Supply Terminals 4-20 mA INPUT (no polarity)
Position Return Current Terminals 4-20 mA OUTPUT
Digital Input Terminals DI (1 - 2) and Ground (GND)
Digital Output Terminals DO (1 - 2) and Ground (GND)
Test Terminals - TEST Loop 4-20 mA without circuit opening
Communication Terminals – COMM HART® Configuration

Table 2.2 – Terminal description for complete model.

Figures 2.13 and 2.14 ilustrate the electrical connections of power supplies and HART communication for the positioner on standard and complete versions, respectively.



NOTE
All the cables used for connection between VVP10 HART and HART® network must be shielded to avoid interference and noise.

NOTE
It is extremely important to ground the equipment for complete eletromagnetic protection and also to ensure the correct performance on HART network.

Figure 2.13 – Electrical connections for VVP10 HART - standard.

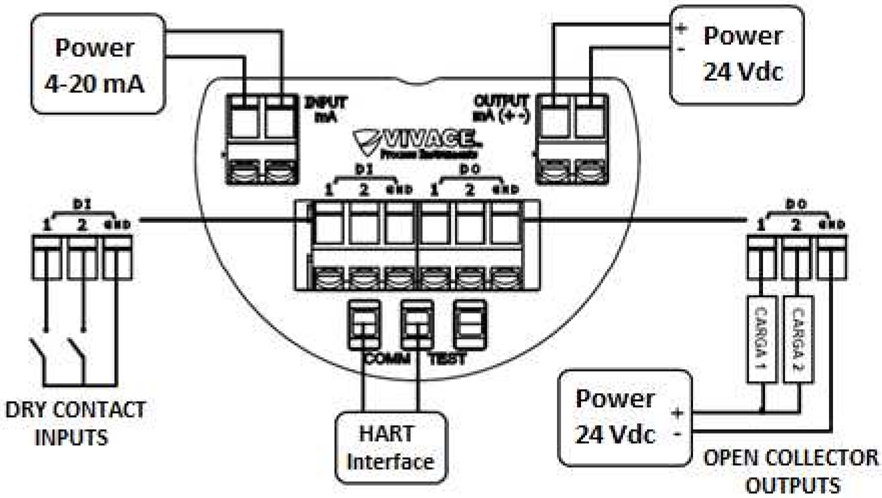


Figure 2.14 – Electrical connections for VVP10 HART - complete.

The conduits through which the power cables of the equipment pass must be mounted in such a way as to prevent water from entering the equipment terminal block. The threads of the conduits must be sealed according to the standards required by the area. The unused electrical connection must be sealed with a suitable plug and seal.

Figure 2.15 shows the correct way to install the conduit to prevent water or other product from entering that could cause damage to the equipment.

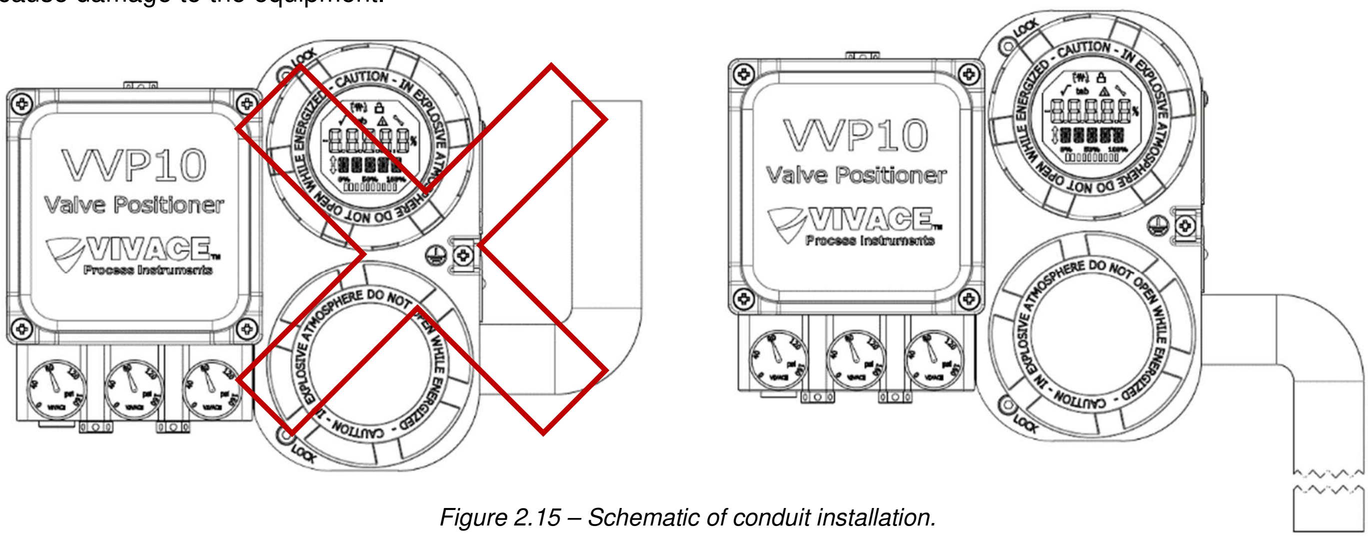


Figure 2.15 – Schematic of conduit installation.

2.4. MAGNET SPECIFICATION

WARNING

Correct magnet dimensioning is a primordial for perfect performance of position measurement, allowing sensor to achieve all system length with the highest magnetic field variation possible.

User must consider installation environment, type of movement (rotative or linear) and amplitude (length), in addition to mounting bracket to be used, among other parameters.

WARNING

A extensão total do curso da válvula deve estar contida dentro das marcações de curso do ímã para o correto funcionamento do posicionador.

Vivace offers the following magnet options for the valve positioner:

ROTATIVE

*Option **0** on Ordering Code*
Used on rotative systems, it has a standard diameter with measurement from 0º to 120º (minimum span of 5º between inferior and superior points).

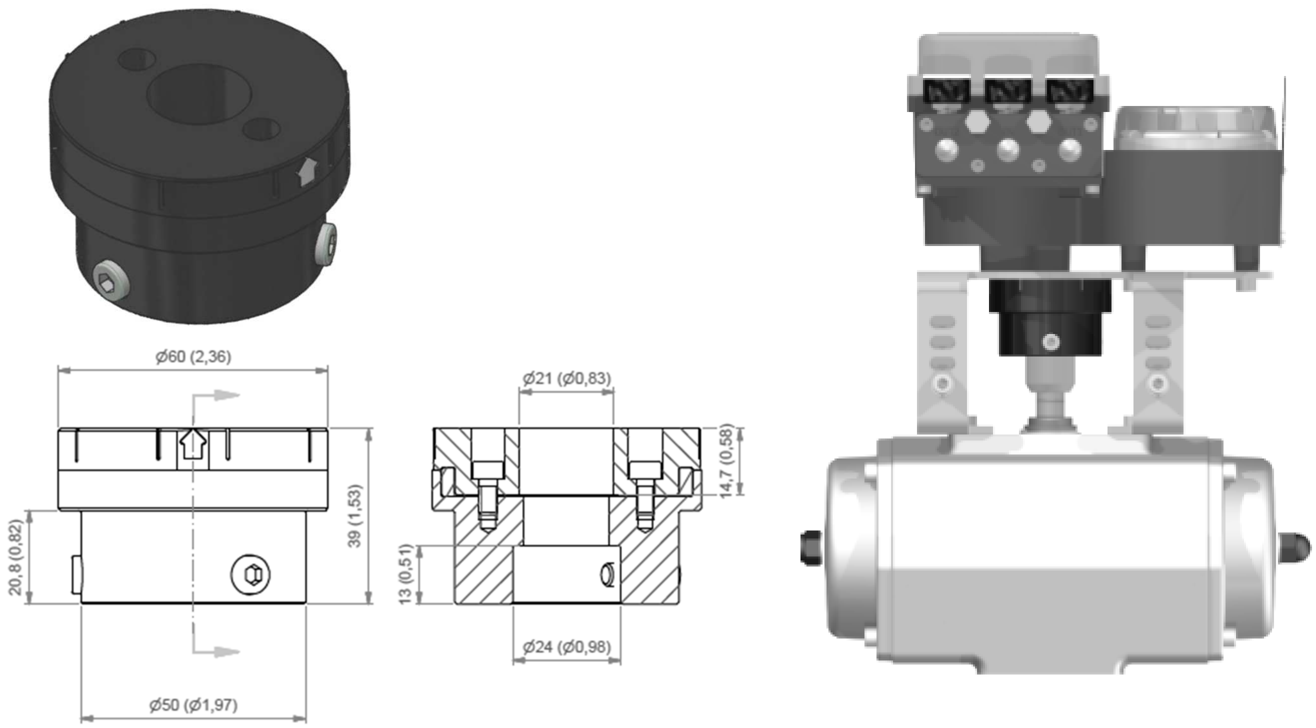


Figure 2.16 – Dimension and assembly of rotative magnet.

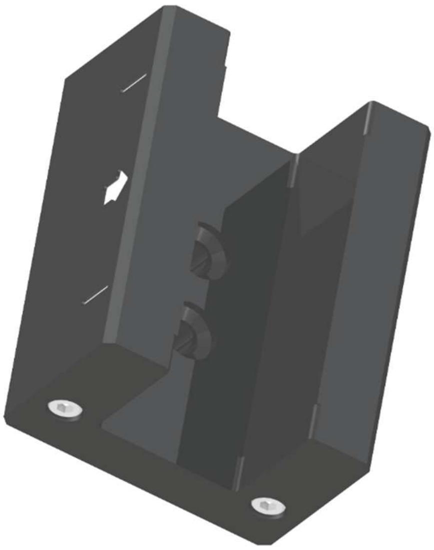
LINEAR

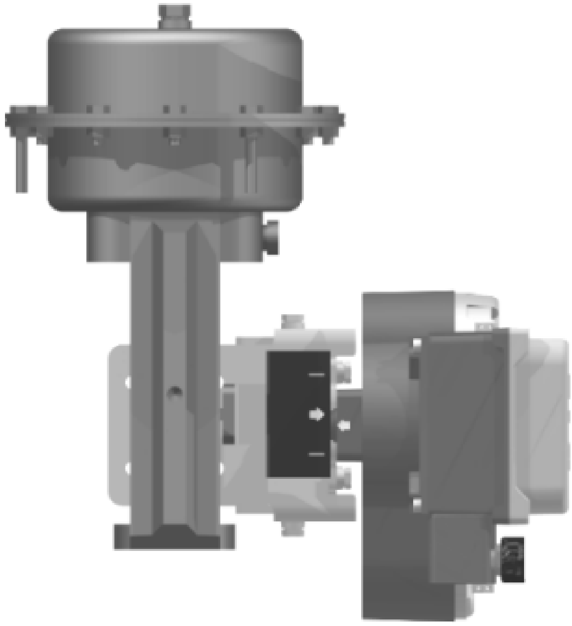
Linear 30
*Option **1** on Ordering Code*
Used on linear systems up to 30 mm, with measurement from 0 to 30 mm (minimum span of 10 mm between inferior and superior points).

Linear 70
*Option **2** on Ordering Code*
Used on linear systems of 30 mm to 70 mm, with measurement from 0 to 70 mm (minimum span of 30 mm between inferior and superior points).

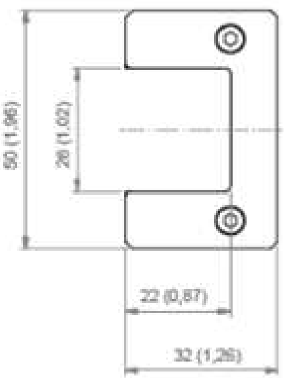
Linear 100
*Option **3** on Ordering Code*
Used on linear systems of 70 mm to 100 mm, with measurement from 0 to 100 mm (minimum span of 70 mm between inferior and superior points).

Linear 150
*Option **4** on Ordering Code*
Used on linear systems of 100 mm to 150 mm, with measurement from 0 to 150 mm (minimum span of 100 mm between inferior and superior points).





DIMENSIONS	A
30mm (1,57")	64mm (2,52")
70mm (2,76")	102mm (4,02")
100mm (3,94")	140mm (5,51")
150mm (5,91")	193mm (7,60")



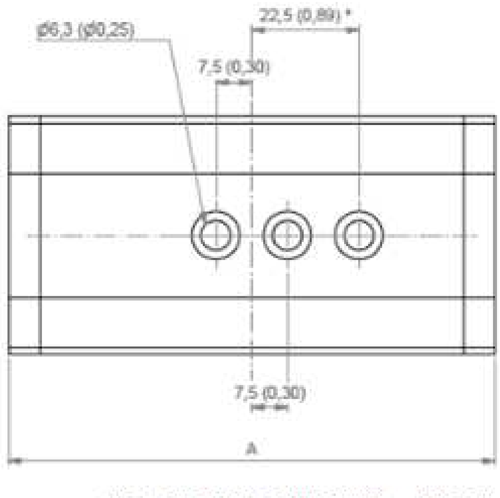
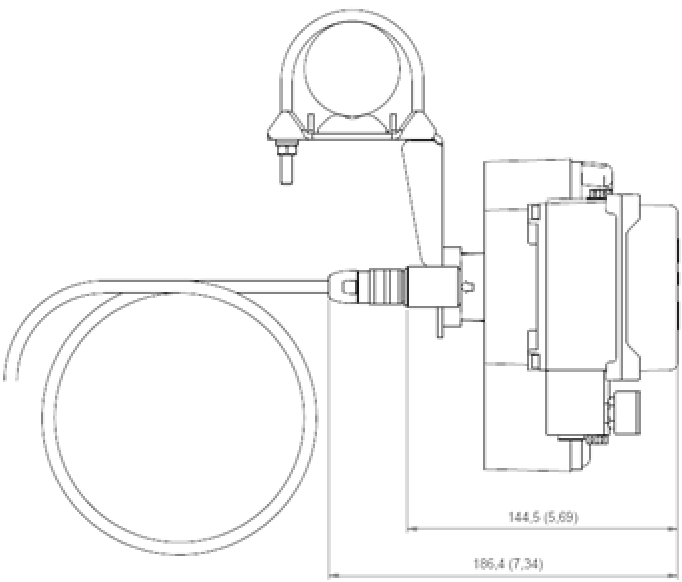


Figure 2.17 – Dimension and assembly of the three linear magnet models.

2.5. REMOTE SENSOR

For applications where excessive vibration or high temperatures (up to 100 ºC) exists on the measuring system or when the positioner can not be installed due to its size, Vivace offers a remote sensor (optional) that works as an extension of the positioner sensor, connected by a cable which has three length options to best adjust device mounting to user process.

Figure 2.18 shows the dimensional drawing of VVP10 HART remote sensor components. At the left we can see the positioner side that receives remote sensor signal, while on the right side we can find the opposite cable side, containing the magnetic sensor already adapted to a fixation support.



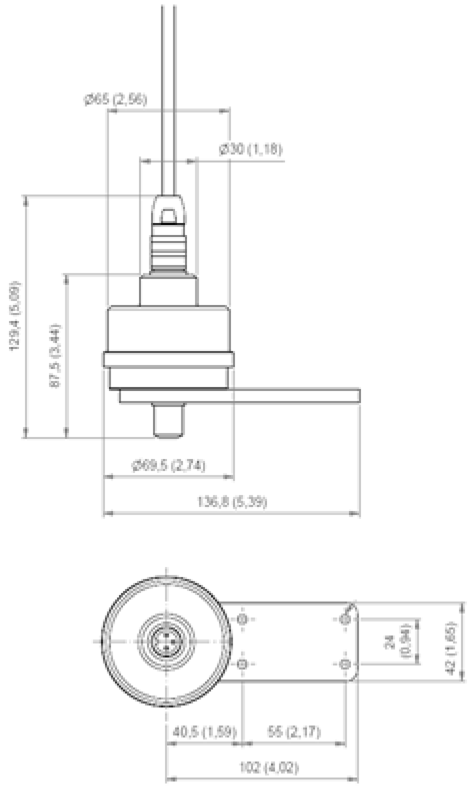
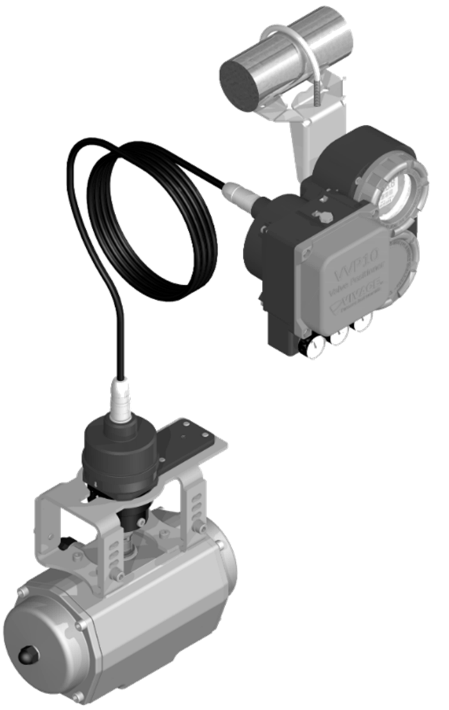


Figure 2.18 – Remote sensor dimensions.



The remote sensor set is composed by three parts:

Sensor
Sensor itself, responsible for receiving the magnetic signal and sending it to positioner as a milivoltage via sensor cable.

Transmission Cable
Signal transmission cable from sensor to positioner input board.

Positioner's Inferior Base
Positioner inferior base prepared for transmission cable connection.

An example of positioner mounting using the remote sensor for a rotative system measuring is shown on figure 2.19.

Figure 2.19 – Remote sensor mounting on VVP10.

2.6. BRACKETS

For applications with linear and rotative magnets in various actuators, Vivace provides compatible brackets, adjusting the positioner to the most diverse combinations.

The following figures detail the available brackets and the positioner installation using them.

LINEAR BRACKET

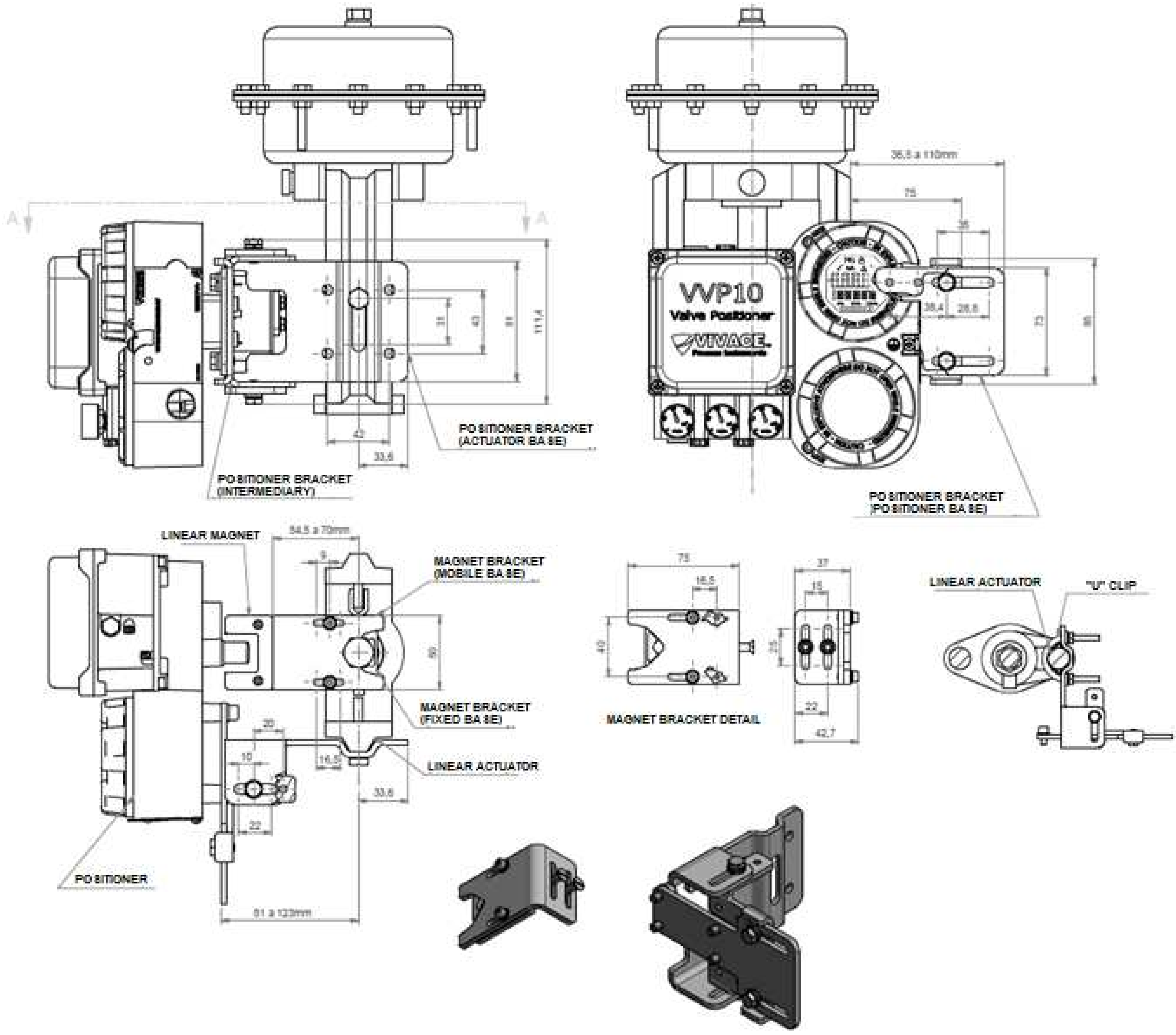


Figure 2.20 – Bracket mounting for linear actuators on VVP10.

ROTATIVE BRACKET

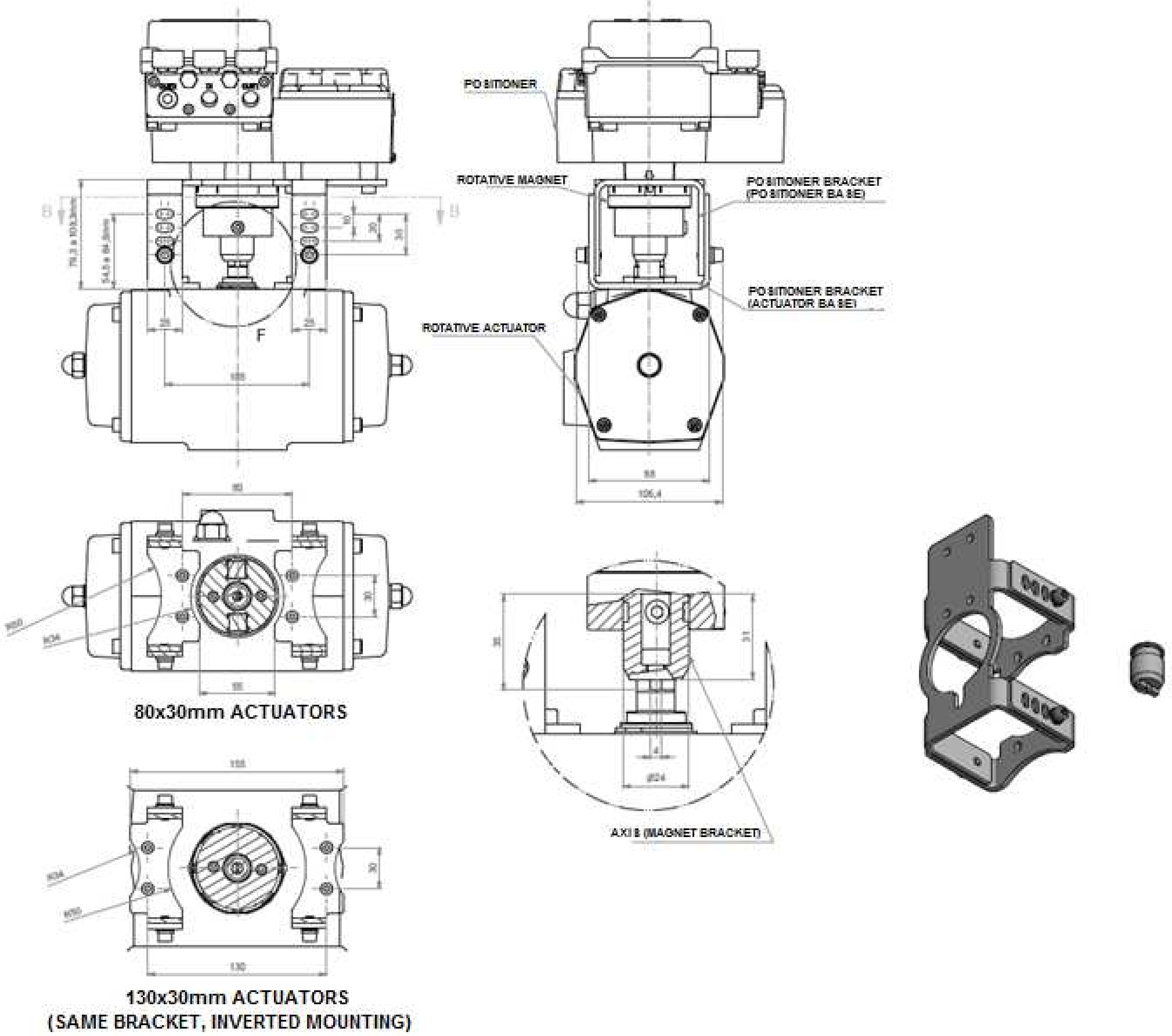
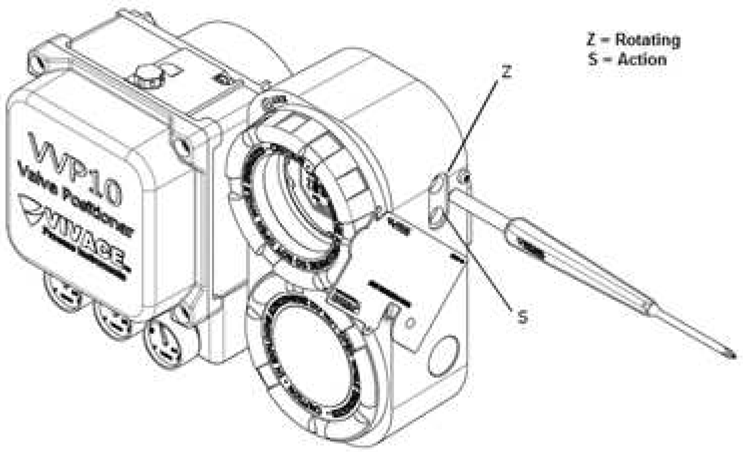


Figure 2.21 – Bracket mounting for rotative actuators on VVP10.

3 CONFIGURATION

Configuration of VVP10 HART valve positioner can be done with a HART® programmer or with EDDL and FDT/DTM-based tools. User can use a tablet, Android smartphone, HART® 375, 475, PC programmer via FDT/DTM tools or a PALM. Another way to configure the VVP10 HART is through local adjustment using a Vivace magnetic key.

3.1. LOCAL CONFIGURATION



The equipment local configuration is executed by using Vivace's magnetic screwdriver on Z and S orifices, located at housing superior side, under identification plate. Orifice Z starts local configuration and changes the field to be configured. Orifice S is responsible for changing and saving the new value on the selected field. Saving after LCD value changing is automatic.

Figure 3.1 shows orifices Z and S for local configuration, stamped on device housing, and their functions on magnetic screwdriver actuation.

Figure 3.1 – Z and S orifices and magnetic screwdriver.

Insert the magnetic screwdriver on *Zero* orifice (Z). icon appears to indicate that device has recognized the screwdriver action. Keep the magnetic screwdriver inside until "LOCAL ADJST" message is shown on display, then remove it for 3 seconds. Insert the magnetic screwdriver into Z orifice again, so user can navigate through local adjust parameters.

Table 3.1 indicates actions executed by magnetic screwdriver when inserted on Z and S orifices.

Orifice	Action
Z	Select configuration tree function
S	Act on selected function

Table 3.1 – Z and S orifices actions.

Some parameters show the icon to allow user configuration on it by inserting the magnetic screwdriver into *Span* orifice (S). In case the parameter has pre-defined values, those will be rotate on display, while the magnetic screwdriver remains into *Span* orifice (S).

In the case of a numeric parameter, this field will enter edit mode and the decimal point will begin to blink shifting to the left. When entering Z orifice, the least significant digit (on the right) will begin to blink, indicating it is ready for editing. When entering the key in S, user can increment this digit, varying from 0 to 9.

After editing the least significant digit, user must enter the key in Z so that the next digit (on the left) starts blinking, allowing its edition. User can edit each digit independently, until the most significant digit (5th digit left) is configured. After the 5th digit is edited, the numeric value signal can be edited with the key in S.

During each step, if the user removes the magnetic key from the local adjustment holes, editing will be completed and configured value will be saved to the device.

If the configured value is not acceptable by that device parameter (invalid value), it will be returned to the last valid value before edition. Depending on the parameter, some values can be shown on numerical or alphanumerical fields, adjusting the best option view to user.

With the magnetic screwdriver out of Z and S orifices, device will leave local adjust mode after some seconds and monitoring mode will be shown.

CONFIGURATION RESTORE
If the user needs the complete factory restoration of positioner parameters (including current and pressure sensor calibrations), they should insert two magnetic screwdrivers (one in each hole - Z and S) in local adjustment and restart the equipment, awaiting numerical counting until the word "donE" is shown on display. After that, simply reconfigure it with the desired values for the application. ****Vivace provides only one screwdriver for device. Second unit is sold separately.***

3.2. JUMPER CONFIGURATION FOR LOCAL ADJUST AND WRITE PROTECTION

VVP10 HART has two jumpers on its main board to protect data writing (WP1) and also enabling/disabling local adjust (ADJL1). Figure 3.2 presents those jumpers.

WP1	Write Protection
	Enabled
	Disabled

ADJL1	Local Adjust
	Enabled
	Disabled

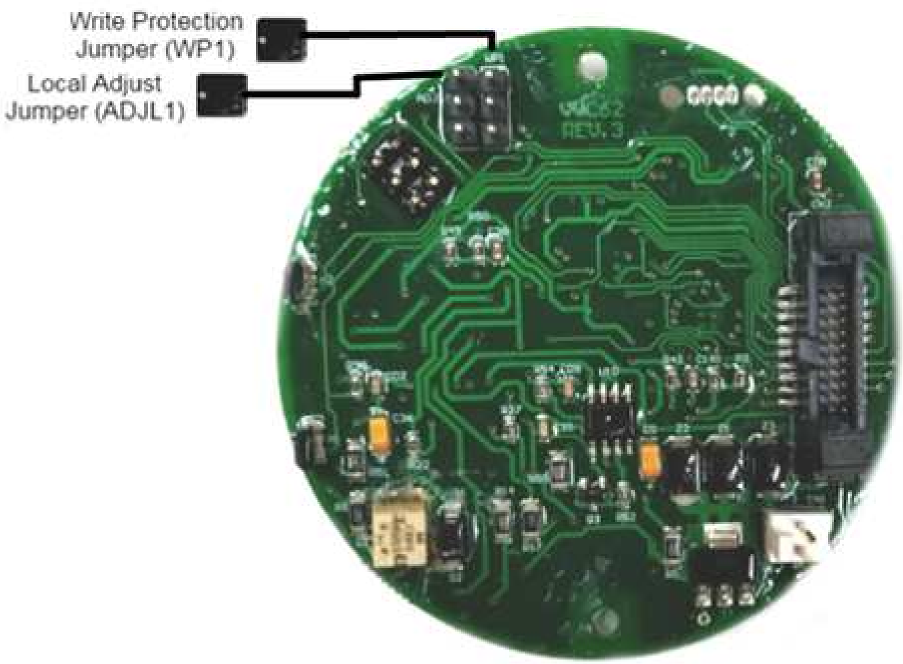


Figure 3.2 – Jumpers WP1 and ADJL1 on VVP10 HART main board.

NOTE
*Default selection for these jumpers is Write Protection **DISABLED** and Local Adjust **ENABLED.***

3.3. LIQUID CRYSTAL DISPLAY (LCD)

Main information related to positioner are indicated on its liquid crystal display (LCD). Figure 3.3 shows the LCD with all its indication fields. Numerical field has 5 digits and is used mainly for monitored variable indication. Alphanumerical field indicates which variable is being monitored, units or auxiliary messages. Each indication icon use is described on table 3.2.

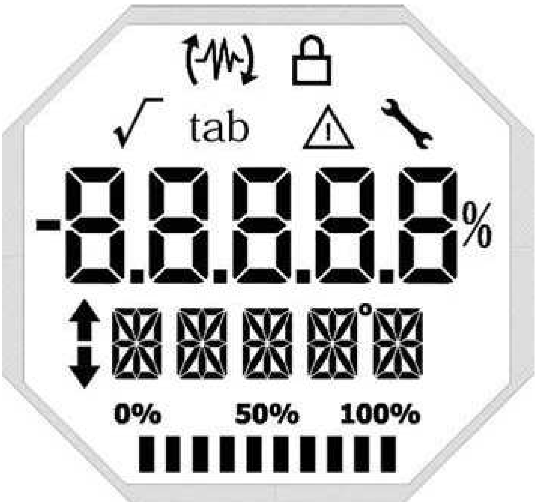


Figure 3.3 – LCD fields and icons.

Symbol	Description
	Sending communication.
	Receiving communication.
	Write protection enabled.
√	Square root function enabled.
tab	Characterization table enabled.
⚠	Diagnostic occurrence.
	Recommended maintenance.
⬆	Increment values in local adjust.
⬇	Decrement values in local adjust.
°	Degree symbol for temperature units.
0% 50% 100%	Bargraph to indicate measured variable range.

Table 3.2 – LCD icon description.

3.4. HART® PROGRAMMER

Configuration of the equipment can be done by means of a HART® compatible programmer. Vivace offers VCI10-H (USB, Android or Bluetooth HART®) interfaces as a solution for identifying, configuring and monitoring HART® line devices.

Figures 3.4 and 3.5 illustrate the use of the VCI10-UH USB interface with a personal computer that has installed HART® configurator software. In figure 3.4, the interface is installed in parallel with the equipment's 4-20 mA current source. In Figure 3.5, the interface is also used to power the positioner (supplying 3.9 mA), requiring no external current source.

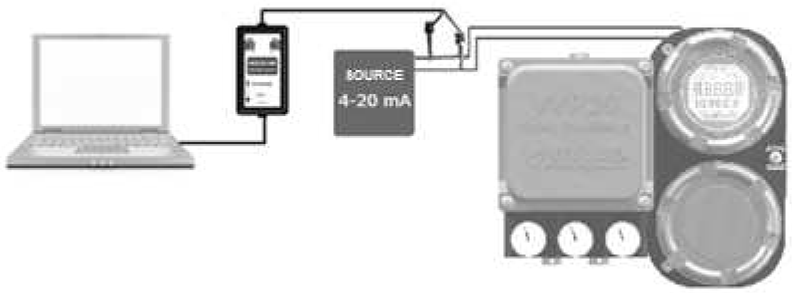


Figure 3.4 - Wiring diagram of VCI10-UH interface to VVP10 HART with external power supply.

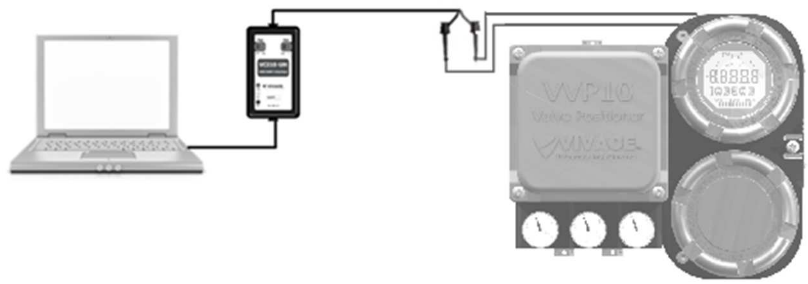


Figure 3.5 - Connection diagram of the VCI10-UH interface feeding the VVP10 HART.

3.5. LOCAL ADJUST CONFIGURATION TREE

Figure 3.6 shows the fields available for local configuration of the positioner and the sequence in which they are provided by the actuation of the magnetic key in the hole Z.

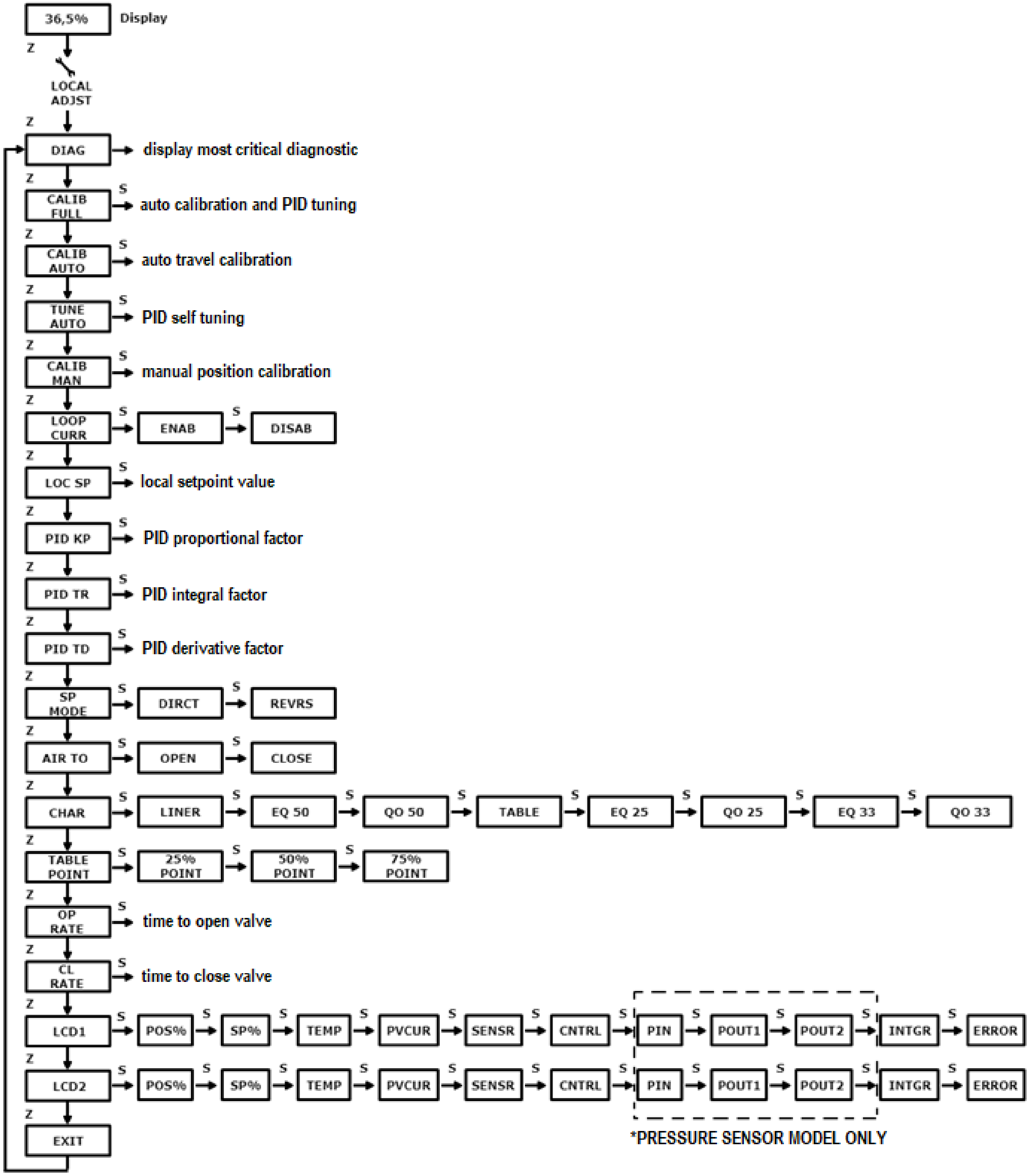


Figure 3.6 – Local adjust programming tree.

3.6. HART CONFIGURATOR PROGRAMMING TREE

The programming tree is a tree-shaped structure with a menu of all available software features, as shown in figure 3.7. To configure the positioner online, make sure it is correctly installed with the correct 4-20 mA current source in the power supply.

INFORMATION

The main information about the positioner can be accessed here.

***Device* -** The main device information is found here, such as: Tag, Description, Address, Manufacturer, Device Type, Device Profile, HART® Revision, Software Version and Order Code.

***Sensor* -** Here is the main position sensor information: Position Mode, Magnet Type, Actuator Type and Air Configuration (open or close).

CONFIGURATION

Here the positioner is configured in relation to the variables of communication, sensor operation and temperature reading.

***Hart* -** In this directory user can configure the parameters of address, current mode, number of preambles and write protection, all related to HART communication.

***Specific* -** In this directory, user can configure positioner's position, temperature and pressure sensors (when available), in addition to position and PID tuning adjustments, LCD display variables and characterization curve points. For a detailed description of the parameters of this menu, refer to section 3.7.

***Range* -** In this directory user can configure the Setpoint range in current mode (4-20 mA) and safety fault.

TRIM

In this directory user can adjust the position sensor (calibration of the user's lower and upper points), the input and output currents (4 mA and 20 mA), temperature and input/output pressures sensors (when available). Figure 3.11 shows the connection of the multimeter with the positioner to the output current trim. See item 3.8 below for more details.

MAINTENANCE

In this directory user can either restart the device by software or restore the factory default settings of the positioner.

OBSERVE

In this directory, the values of the Input Current, PV%, PV (Position), SV (Setpoint), TV (Temperature) and QV (Output Current) are monitored.

DIAGNOSIS

In this directory user can configure and view the diagnostics of the equipment.

General Equipment Status - Informs if there is any problem or alert related to communication or general sensor status and calculated values.

- *Sensor Not Detected*
- *No Motion/Air Supply*
- *Current Failure*
- *PID Control Deviation*
- *Reversal Limit*
- *Stroke Limit*
- *Mileage Limit*
- *Deviation Limit*
- *Pressure Limit Exceeded*
- *Temperature Limit Exceeded*
- *Partial Stroke Test Status (see section 3.9)*
- *Malfunction*
- *Fixed Current*
- *PV Out of Operating Limit*
- *Temperature Out of Operating Limit*
- *Pressure Out of Operating Limit*
- *Saturated Current*

***Change Counter* -** Informs the change counters for each of the following positioner parameters. User can also reset the counters in this directory.

- *Setpoint Mode*
- *Input Current Range*
- *Actuator Type*
- *Magnet Type*
- *Input Air Configuration*
- *Lower Position Trim*
- *Upper Position Trim*
- *Characterization Function*
- *Characterization Table*
- *Software Writing Protection*
- *LCD Display Variables*
- *Temperature Unit*
- *Security Failure*
- *HART Polling Address*
- *Auto Calibrations/PID Tuning*
- *PID Factor*
- *PID Enable/Disable and Deadband*
- *Setpoint Limits*
- *Loop Current Enable/Disable*
- *Setpoint Rate Open/Close*
- *Setpoint Cutoff*

***Position Diagnostics* -** Enables/disables, configures and reports the Diagnostics of Reversals, Strokes, Mileage and Position Histogram. For details on each of these diagnostics, see section 3.9 of this manual.
In addition, it performs the Actuator Opening and Closing Test procedures (for calculation of opening/closing times), Partial Stroke Test (PST) and Full Stroke Test (FST). For details on each of these procedures, see section 3.9 of this manual.

***Temperature* -** Informs the maximum and minimum temperature values recorded by the positioner during its operation, according to the user calibration. In addition, it monitors the temperature according to the user-configured work limits, offering occurrence counter and limit exceeded persistent alarm, also configurable.

Pressure - Inform the maximum and minimum input pressure values recorded by the positioner during its operation, according to the user calibration. In addition, it monitors the input pressure according to the user-configured work limits, offering occurrence counter and exceeded limit persistent alarm, also configurable.
**This directory is only available for models with installed pressure sensors.*

***Digital I/O* –** Configures the position limits for activating digital outputs (lower and upper), the actuation of the digital outputs (in relation to inputs or position limits) and enables/disables the alarms for digital inputs and outputs. See following section 3.10 for more information.
**This menu is only available for complete model.*

***HART Communication* –** It informs the number of communication packets received by the equipment (*RX*), as well as those answered by it (*TX*), displaying the communication loss rate per hour (*Loss/h*). It also informs the total operating time of the equipment since the last default restoration (*Restore Default*).

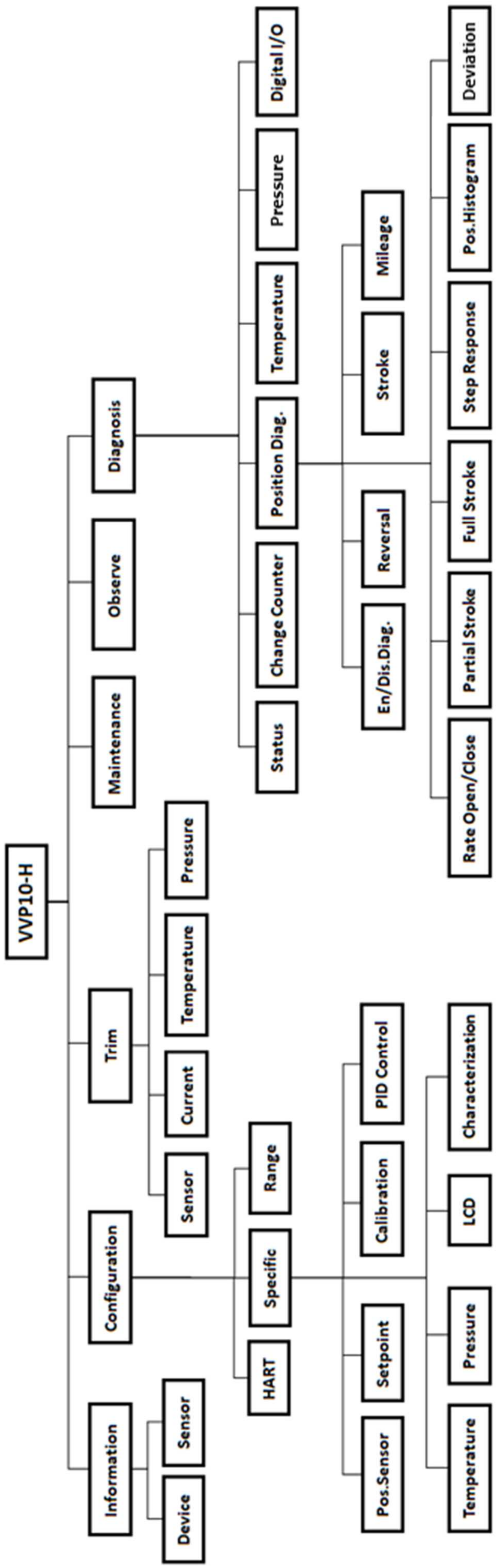


Figure 3.7 – VVP10 HART programming tree.

3.7. CONTROL CONFIGURATION

VVP10 HART allows user to flexibly configure positioner control by changing magnet and sensor assembly measurement modes, characterizing Setpoint, performing automatic calibrations and fine adjustments on PID control parameters.

This section is intended for detailing each of these functions available to the user.

POSITION SENSOR

User can configure position measurement using the following parameters.

Magnet Type
It can be configured as Linear or Rotary, only for system information to the user.

Actuator Type
It can be configured as Single or Dual, indicating the actuator type of actuator, only for system information to the user. For models with pressure sensors, this parameter will indicate which pressure to use in FST and PST diagnostics (see section 3.9), being the pressure from output 1 (*POUT1*) for single action and the differential of output pressures (*POUT2 - POUT1*) for double action.

NOTE
Parameters Magnet Type *and* Actuator Type *are informative only, not influencing on PID control.*

Air To Action
It can be set to Open (100% Open) or Close (100% Closed), indicating the actuation of the actuator, according to the action of the supply air in the positioner (depending on pneumatic connections installation).

Open: the action of the air in the positioner (increase of PV%) causes actuator to open.

Close: the action of the air in the positioner (increase of the PV%) causes actuator to close.

WARNING
For single action actuators (with spring force return), positioner's output 1 (OUT1) should always be used, in order to ensure the closure of the system by security in case of electrical failure.

SETPOINT

User can characterize Setpoint value through the following parameters.

Loop Current Mode
It can be set to Enabled or Disabled.
This parameter is available on the "HART" menu as it is a configuration common to all equipment that has this communication protocol.

Enabled: Setpoint will follow the 4-20 mA current of the positioner's power supply (in the percentage of the operation range configured in *"Range"* menu), considering the user Setpoint settings (*Setpoint Mode, Setpoint Limits* and *Setpoint Cutoff*).
For example, considering the complete operation range 4 to 20 mA, Input Current = 8 mA (25% of current range) will cause a 25% Setpoint.

Disabled: Setpoint will follow the manual value configured by user in the *Local Setpoint* parameter, without considering user Setpoint settings (*Setpoint Mode, Setpoint Limits* and *Setpoint Cutoff*).

Local Setpoint

It sets the Setpoint value manually when Loop Current Mode is Disabled.

WARNING

When Loop Current Mode is disabled, Setpoint starts to follow parameter Local Setpoint *directly, not considering any other Setpoint configuration.*

Setpoint Mode

It can be set to Direct or Reverse, directly affecting the Setpoint.

Direct: Setpoint follows the 4-20 mA input directly.
For example, 8 mA input (25% of current range 4-20 mA) will cause a 25% Setpoint.

Reverse: Setpoint follows the 4-20 mA input in reverse *(SP% = 100% - Curr%).*
For example, 8 mA input (25% of current range 4-20 mA) will cause a Setpoint of 100% - 25% = 75%.
Figure 3.8 exemplifies the linear behavior of both modes, affecting the Setpoint either directly or in reverse.

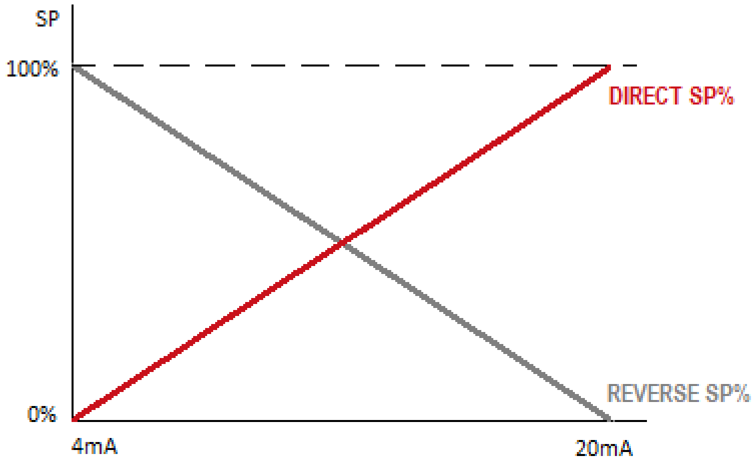


Figure 3.8 – Behaviour of direct and reverse Setpoint modes.

Setpoint Limit

It limits the Setpoint value after Setpoint Mode (see above). It has independent settings for Upper and Lower Limits.
For example: SP = 0% (after Setpoint Mode) with SP Low Limit with 10% will force the Setpoint to 10%. SP = 100% (after Setpoint Mode) with SP High Limit with 95% will force the Setpoint to 95%.
Figure 3.9 exemplifies (in red) the Setpoint values that are disregarded by the configuration of Current Limits.

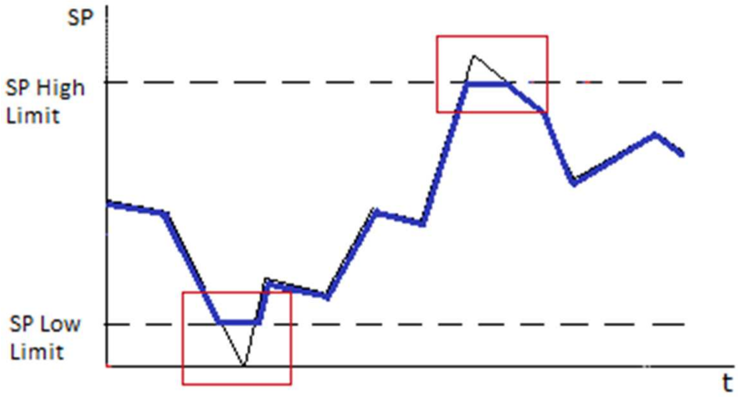


Figure 3.9 - Example of how Setpoint Limits work.

Setpoint Cutoff

Configures cutting values for Setpoint after applying its limits (see above). It has independent Upper and Lower Cutoffs. Any input Setpoint value that exceeds cut values will force a new SP = 100% (upper cut) or SP = 0% (lower cut).
For example: SP Low Cutoff = 1%. When SP < 1% (after Setpoint Limits) will be forced to 0% and will remain in this value until the new input SP rises to a value above the Lower Cutoff value plus 0.5% (in this case, when it is higher than 1.5%). SP High Cutoff = 95%. When SP > 95% (after Setpoint Limits) will be forced to 100% and will remain in this value until the new input SP descends to a value below the Upper Cutoff value less 0.5% (in this case, when it is less than 94.5%).
Figure 3.10 exemplifies Setpoint behavior according to Setpoint cutting zones.

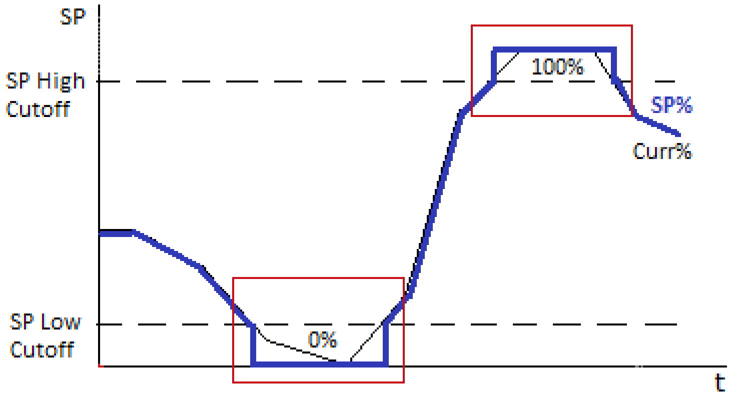


Figure 3.10 – Example of how Setpoint Cutoff works.

Rate Open/Close

It sets the opening and closing time of the actuator to slow down the system.

The open rate will be given by R_{open} = 100% / t_{open}, provided that t_{open} is higher than the value found in the Auto Calibration procedure (in seconds).

The closing rate will be given by R_{close} = 100% / t_{close}, provided that t_{close} is higher than the value found in the Auto Calibration procedure (in seconds).

WARNING
These times will be automatically changed to the maximum system performance (lowest value possible) when the Auto Calibration or Opening/Closing Test procedures are performed.

CHARACTERIZATION CURVES

This directory (*Specific/Characterization*) allows user to configure the Setpoint according to a pre-established system flow characterization function or following a specific table of up to 16 points. The pre-established characterization functions are described below.

Linear

This function characterizes the output directly proportional to the Setpoint input signal (either by the input current or local mode).

Equal Percentage (EQ)

This function characterizes the output according to a percentage increment in the flow over its previous value. This percentage can be 25%, 33% or 50%, which causes a logarithmic curve as shown in the following figure.

Quick Open (QO)

This function characterizes the output according to a high increase in the flow, also in percentage (25%, 33% or 50%) on a small variation in the input signal, which causes a logarithmic curve as shown in the following figure.

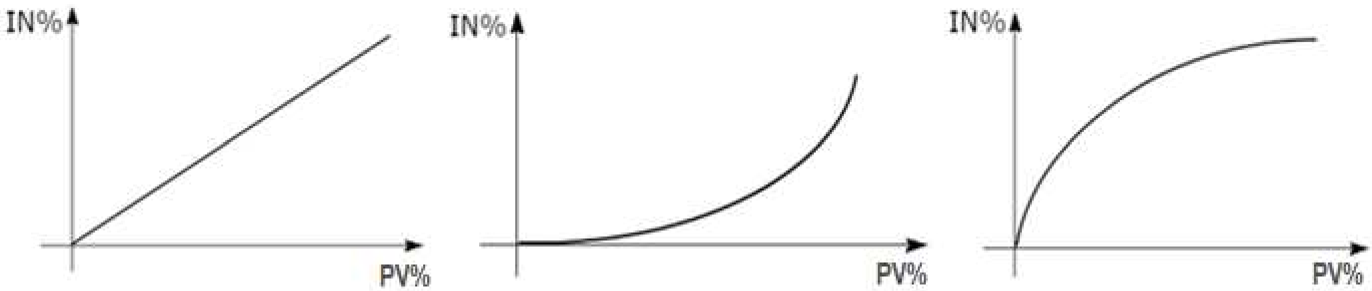


Figure 3.11 – Linear, equal percentage and quick opening functions for Setpoint characterization (respectively).

User Table

Used in measurements that require custom output. VVP10 HART has a user table with 16 points with input and output as a percentage (depending on the input signal).

The user must configure at least two points in the table. The points will define the characterization curve to be used for the calculation of the Setpoint that will be sent to the PID control.

It is recommended to select equally distributed dots over the desired band or over a part of the band where better precision is required. The table should be monotonically increasing, ie all points in the growing order of x, as in the example in figure 3.12.

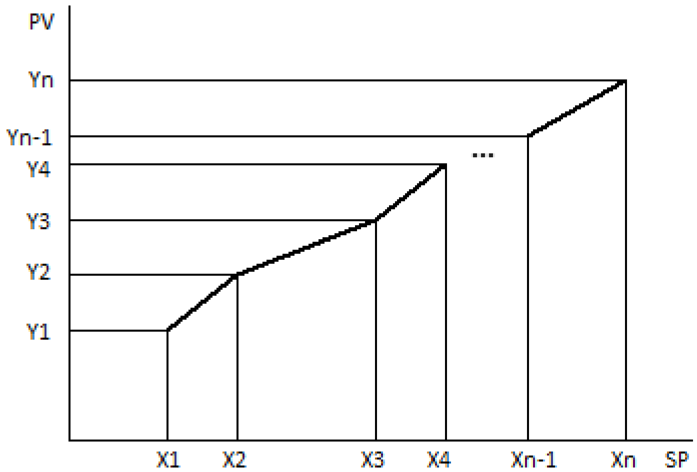


Figure 3.12 – Setpoint characterization user table.

User Table Configuration using Local Adjust

The user can configure the table points using the local adjustment (*Table Point* option) for five predefined points: 0%, 25%, 50%, 75%and 100%.

0% and 100% points are automatically associated with previously calibrated position extremes (see the following section on "Calibration"). Therefore, the user can configure the desired points to 25%, 50% and 75%, completing the five -point table.

To do this, the following procedure should be followed.

1. Access the Table Point option on local adjustment and insert the magnetic key into S;
2. After displaying the "25% Point" message on display, remove the adjustment screwdriver and position the valve manually in the desired position (suggests small increments/decrements in the Setpoint current);
3. After the desired positioning of the valve, insert the magnetic screwdriver into Z until the message "25% OK" is displayed;
4. Insert the magnetic screwdriver into S for configuring the next point;
5. Repeat items from 2 to 4 to configure points 50% and 75%;
6. After configuring all the three points, insert the magnetic screwdriver into S to finish the process.

WARNING
This procedure only configures the User Table points. *To activate the table operation, you must change the configuration of the Characterization Curve parameter (*Characterization*) to Table.*

CALIBRATION AND PID TUNING

This directory (*Specific/Calibration*) has procedures for calibrating the system positioning (automatic or manual), as well as automatic tuning of the PID control.

WARNING
During these procedures system will perform several opening and closing movements, it is recommended that the process be prepared for this behavior.

Auto Travel Calibration

It performs the automatic adjustment procedure of the 0% and 100% position sensor references.

It also calculates the opening times (0% to 100%) and closing (100% to 0%) with maximum actuator performance (according to the applied pressure). Figure 3.13 shows procedure steps.

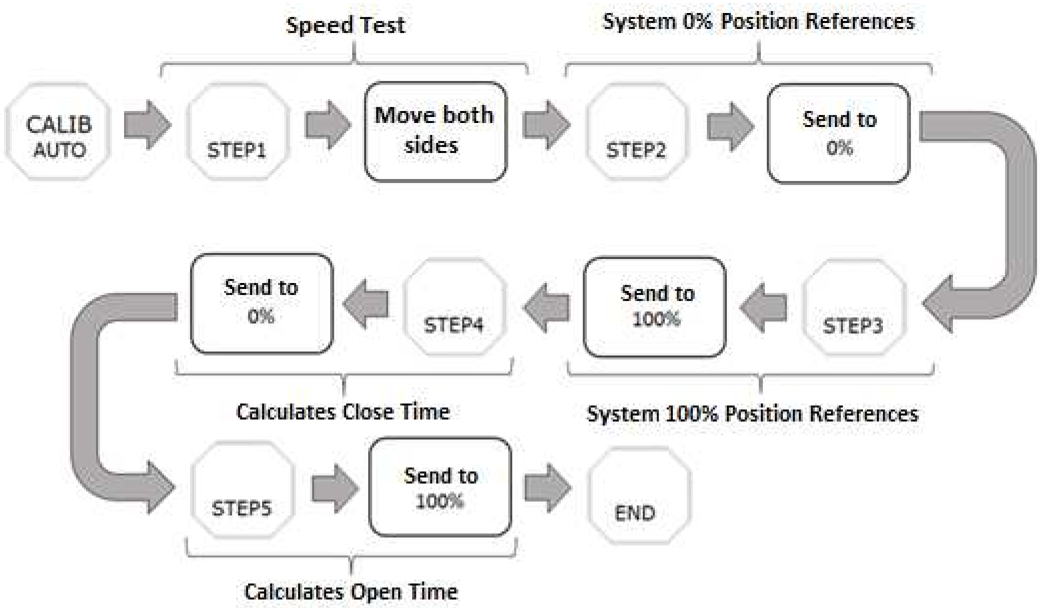


Figure 3.13 – Diagram for position automatic calibration.

Auto Tuning

It performs the automatic tuning procedure for PID control, calculating the optimized values of Proportional (Kp), Integral (Tr) and Derivative (Td) parameters through data collected in repeated oscillations of the system (according to the applied pressure). Figure 3.14 shows procedure steps.

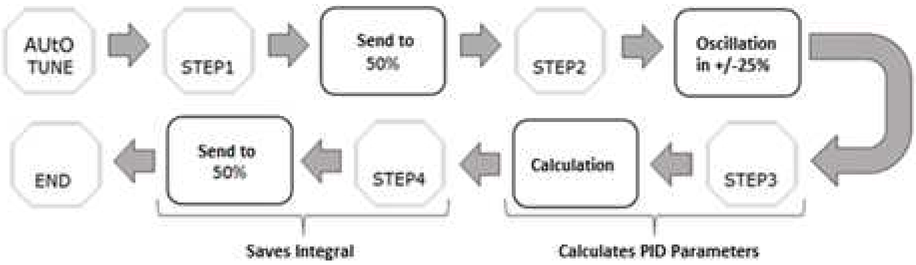


Figure 3.14 – Diagram for PID control auto tuning.

Full Auto Calibration

It performs the automatic position sensor calibration and PID control tuning procedures sequentially. For details on each of these procedures, see the above items. Figure 3.15 shows procedure steps.

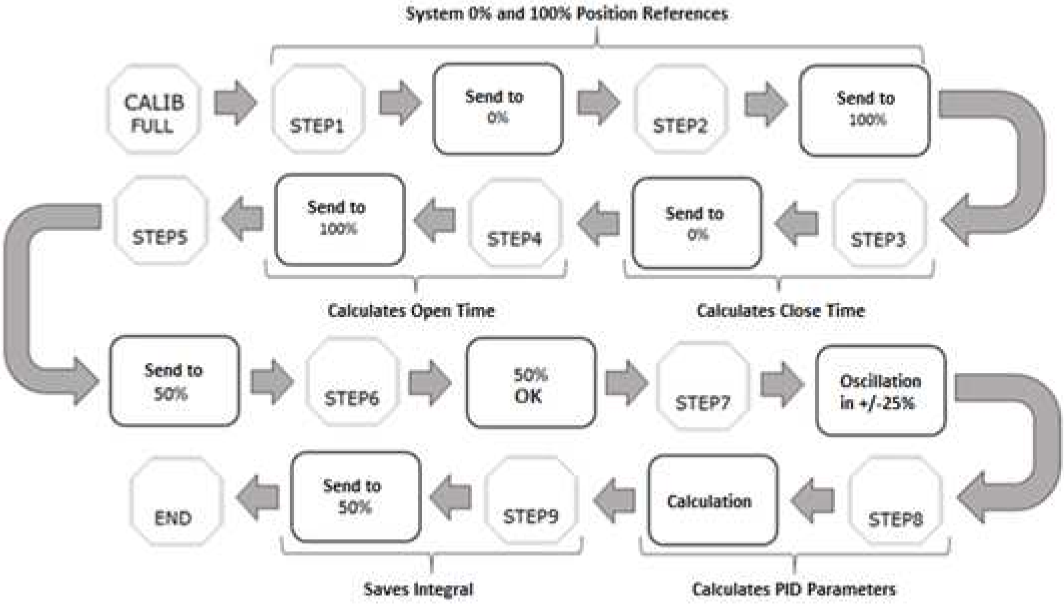


Figure 3.15 – Diagram for full calibration.

Manual Travel Calibration

It performs the manual procedure for adjusting the 0% and 100% position sensor references. Figure 3.16 shows procedure steps.

WARNING
This procedure depends on the user's confirmation regarding the positioning of the system at the ends of the valve, ensuring that the calibration is performed successfully. In the case of local adjustment, the display will indicate "wait" so user wait for valve settling, and then actuate the magnetic key in the Span (S) hole.

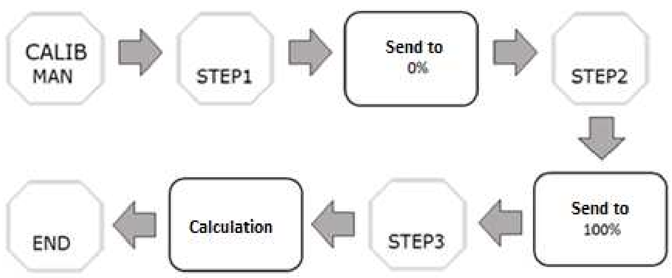


Figure 3.16 – Diagram for position manual calibration.

PID CONTROL

This directory (*Specific/PID Control*) allows user to freely configure the parameters of the PID control, for fine control tuning.

Proportional Factor Kp (*PID Kp*)
It sets the proportional parameter of the control, also called gain, responsible for control speed, in relation to the error (SP% - PV%).
A very low Kp value will result in a slow control, while a very high Kp value will result in oscillation of the system around Setpoint.

Integral Factor Tr (*PID Tr*)
It sets the integral parameter of the control, responsible for the search of the Setpoint in a smooth and gradual way, ensuring an accurate approximation of the desired position.
This factor is used only when the error is relatively low, resulting from proportional and derivative actions, and its action is inversely proportional to its value.
A very low value of Tr will result in a quick integration of error search, which can cause oscillation. A very high value of Tr will result in very slow and inefficient integration.

Derivative Factor Td (*PID Td*)
It sets the derivative parameter of the control, responsible for controlling the oscillation around the Setpoint, resulting from the proportional action.
A very low value of Td will result in ineffectiveness of the derivative action, allowing the system to oscillate. A very high value of Td will result in an initial brake on the integral action, but later oscillation around the Setpoint.

PID Deadband
It sets the maximum allowed error before the PID control is activated. The default value for this parameter is zero, leaving the control always active.

HINT
Auto Tuning calculates parameters that will sufficiently meet the control in most situations. If you need to change the parameters manually, try to change the Td parameter proportionally to the KP parameter change.

WARNING
If the user changes the PID control parameters incorrectly and does not record the previously calculated values, simply perform the Auto Tuning procedure.

3.8. CALIBRATION

VVP10 HART allows user to calibrate several variables according to their own measurement standards to suit their system perfectly. The variables that can be calibrated with their respective procedures are described below.

POSITION

It allows user to take advantage of the largest possible range of the measurement system by the magnetic sensor related to the physical limits of the valve, by performing previously explained procedures: Automatic Travel Calibration or Manual Travel Calibration. Both procedures can be found in the *Specific/Calibration* directory and will perform both lower and upper position calibrations, based on the physical limits (valve seating).

If user wishes to calibrate those positions outside valve's physical location, the Trim (*Lower Position Trim* and *Upper Position Trim*) functions must be used. Those can be found under *Trim/Sensor* directory.

For lower position, user must perform the *Lower Position Trim* function, where the positioner will send the actuator to the previously calibrated lower position. From there, via configurator, user must position system in the desired position, entering the step to be given by the positioner (on display or HART monitoring), since it is lower thano 10%.
For example, with the valve in 0%, execute Lower Position Trim, sending the value (-5%). The valve will go to 5% and the user can confirm the new position, which will become the new 0% (lower reference) of the stroke course.

For the upper position, the process is repeated, only changing reference from lower to upper.
For example, with the valve in 100%, execute Upper Position Trim, sending the value (105%). The valve will go to 95% and the user can confirm the new position, which will become the new 100% (upper reference) of the stroke course.

WARNING

With these two calibrations, the positioner will have its references of 0% and 100% for changed system positioning, in relation to the physical valve settlement limits.

If the user wants to return to the calibration of the system settlement positions, simply perform the automatic position calibration again.

CURRENT

The positioner has two calibrations for 4-20 mA current: the return current from control position and the input loop current. Calibrations are independent and work differently. Both can be found under *Trim/Current* directory.

Calibration of the position return current functions as the calibration common to the transmitters, but with HART® commands specific for the positioner. The positioner also provides specific commands to execute methods that automatically set the output current to 4 mA and 20 mA according to the calibration point to be executed (zero or span, respectively).

After generating the fixed current through the positioner, with an ammeter connected in series (see figure 3.17), user can check the actual current generated and send it by means of HART® commands to the equipment, which will perform the internal calibration and generate the corrected current, allowing user to see the new current in the connected ammeter, automatically.

The calibration of loop current works with standard HART® commands and routines, since the positioner will only perform the adjustment of the measurement being carried out on the input current (with the help of an ammeter - figure 3.18) so that user is sure of the correct current supplied to the positioner.

Both procedures can be repeated as many times as the user deems necessary, until the currents are perfectly calibrated at both ends (4 mA and 20 mA).

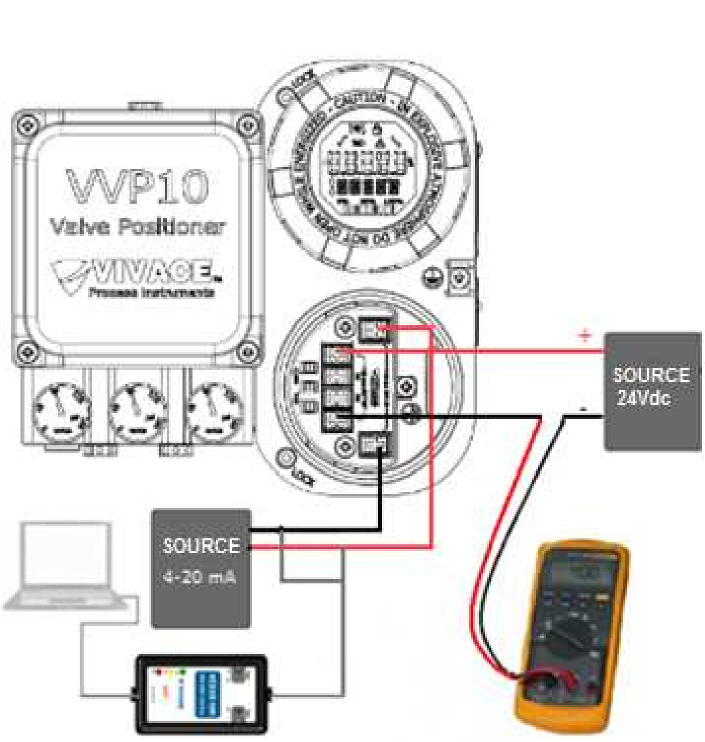


Figure 3.17 – Assembly for position return current trim.

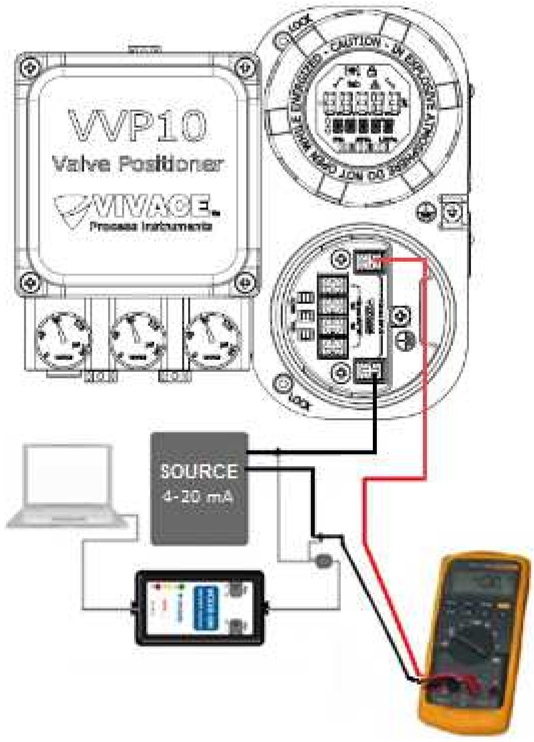


Figure 3.18 – Assembly for loop current trim.

PRESSURE

WARNING

Pressure calibration will be available only for positioner models with installed pressure sensors. Verify the Ordering Code for this characteristc (section 6.2).

Pressure calibration is available for Input, Output 1 and Output 2 pressure sensors. Individually, user must apply the lower and upper pressure references for each of the sensors. The following procedure exemplifies these calibrations found under *Trim/Pressure* directory.

First, user must remove all the supply pressure (which will also cause zero pressure at the outputs) and perform the lower pressure calibration on the three sensors, informing the value (in this case, zero).

Subsequently, he must apply the working feed pressure (eg. 30 psi) and calibrate the input sensor with this value.

With the position at 0%, all air from air supply will be sent to output 2. User will then be able to calibrate this sensor with the same input value. By changing the control position to 100%, all of the air from the air supply is being sent to output 1. User can then calibrate this sensor to the same input value.

This process can be repeated as many times as the user finds necessary, until the sensor pressures are perfectly calibrated at the lower and upper points.

TEMPERATURE

The temperature calibration is the simplest one offered by the positioner, where user only sends the value of the ambient temperature measured by some external thermometer. The equipment automatically adjusts the internal temperature measurement based on the value sent by the user.

This process can be repeated as many times as the user deems necessary, until the temperature is perfectly calibrated. Temperature calibration can be found under *Trim/Temperature* directory.

3.9. DIAGNOSIS

VVP10 HART has several diagnostics (*Diagnosis* directory) to assist in the predictive maintenance of the actuator/valve system. By setting the parameters according to the specific application, user can count on a series of indicators that will aid in the decision to execute the necessary maintenance in the system.

Diagnoses are displayed in the form of event counters, specific graphics and operating times, offering user configurable limits for alarm generation.

Sensor status display and alarm measurements serve to alert the user about any abnormalities in system behavior. These alarms indicate common failures to HART® protocol equipment or valve positioner - specific to each diagnostic, as described below.

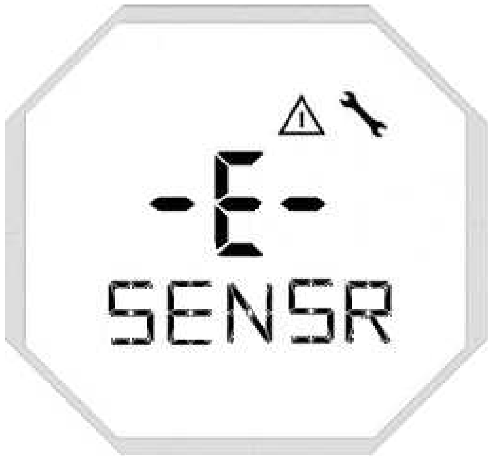


Figure 3.19 – Indication of sensor error on VVP10 HART.

STATUS

HART® Common Alarms
Alarms defined by the communication standard in general for all equipment.

Alarm	Description
PV OUT OF LIMITS	The primary variable is outside normal limits (-1.25% and 103.125%).
NON-PV OUT OF LIMITS	A variable other than primary has a value outside normal range. For VVP10 HART this variable could be the temperature or the input pressure.
MORE STATUS AVAILABLE	Indicates that equipment-specific alarms are active.
COLD START	There was a restart of the equipment.
CONFIGURATION CHANGED	Some parameter of the equipment has been configured.
DEVICE MALFUNCTION	Some important positioner variable is malfunctioning. Check possible causes on *Critical Alarms*, below.

Critical Alarms
In the occurrence of any of those alarms, the maintenance and diagnostic alert icons will be displayed on LCD.

Alarm	Description
SENSOR NOT DETECTED	The position sensor is not sending data to A/D converter. It may indicate sensor breaking or problem in its connection. In the occurrence of this alarm, the message "-E- SENSR" will be displayed on LCD (figure 3.19).
NO MOVEMENT / LOW AIR SUPPLY	The system is not responding to positioner control. It may indicate actuator/valve stuckness or low pressure on air supply.
LOOP CURRENT FAILURE	There is no sufficient supply current (loop). The positioner input current is insufficient for the correct operation of the PID control. Check the 4-20 mA loop current source.

Non-Persistent Predictive Alarms

Non-persistent alarms that indicate system changes, beyond acceptable values configured by user. When the problem is solved, alarm will be automatically deactivated.

Alarm	Description
CONTROL DEVIATION ALERT	There is a deviation in the PID control beyond configured error and time values. It could indicate a stuck valve or problem with the supply air. For more information about this diagnosis, see the Deviation item in this section.
PRESSURE OUT OF RANGE	The supply pressure (PIN) value is beyond the configured limits. For more information about this diagnosis, see the Inlet Pressure item in this section.
TEMPERATURE OUT OF RANGE	The temperature value measured by the positioner is beyond the configured limits. For more information about this diagnosis, see the Temperature item in this section.
LOW CURRENT ALERT	The supply current (loop) is suboptimal (3.8 mA minimum). The positioner will continue to function normally up to a current of 3.6 mA. Check the 4-20 mA loop current source.

Persistent Predictive Alarms

Persistent alarms that indicate system changes, beyond acceptable values configured by user. When the problem is solved, alarm will remain active until user resets it.

Alarm	Description
REVERSAL LIMIT ALERT	The reversal counter has exceeded the configured limit. For more information about this diagnosis, see the Reversal item in this section.
STROKE LIMIT ALERT	Thel stroke counter exceeded the configured limit. For more information about this diagnosis, see the Stroke item in this section.
MILEAGE LIMIT ALERT	The mileage counter has exceeded the configured limit. For more information about this diagnosis, see the Mileage item in this section.
DEVIATION LIMIT ALERT	Deviation counter exceeded the configured limit. For more information about this diagnosis, see the Deviation item in this section.
PRESSURE LIMIT ALERT	The supply pressure alert counter has exceeded the configured limit. For more information about this diagnosis, see the Pressure item in this section.
TEMPERATURE LIMIT ALERT	The temperature alert counter has exceeded the configured limit. For more information about this diagnosis, see the Temperature item in this section.

WARNING
The PRESSURE OUT OF RANGE and PRESSURE LIMIT ALERT alarms are available only on positioner models containing pressure sensors. *Verify product Ordering Code for this characteristic (section 6.2).*

Discrete Input/Output Alarms

Alarms for indicating the activation of the channels of discrete inputs and outputs. For more information on this functionality, see the item Discrete Input/Output (Digital I/O), in this section.

Alarm	Description
DIG. INPUT LOW ALERT	The inferior digital input (*DI1*) is active.
DIG. INPUT HIGH ALERT	The superior digital input (*DI2*) is active.
DIG. OUTPUT LOW ALERT	The inferior digital output (*DO1*) is active.
DIG. OUTPUT HIGH ALERT	The superior digital output (*DO2*) is active.

WARNING

Discrete Input and Output alarms are available only for discrete or full models of the positioner. Check the Ordering Code for this feature (section 6.2).

Procedure Running Alarms

Alarms that indicate calibration procedure or positioner performance testing. Upon completion of the procedure, the alarm will be automatically disabled.

Alarm	Description
FULL AUTO CALIBRATION	The complete automatic positioning procedure is being performed. For more information on this procedure, see the Full Auto Calibration item in section 3.7.
AUTO TRAVEL CALIBRATION	The automatic position calibration procedure is being performed. For more information on this procedure, see the Auto Travel Calibration Automatic Calibration item in section 3.7.
AUTO TUNING	The PID control auto tuning procedure is being performed. For more information on this procedure, see the PID Auto Tuning item in section 3.7.
MANUAL TRAVEL CALIBRATION	The manual position calibration procedure is being performed. For more information on this procedure, see the Manual Calibration Manual Calibration item in section 3.7.
VALVE OPEN / CLOSE TEST	The valve opening and closing test is being performed. For more information on this procedure, see the Valve Open/Close Test item in this section.
FULL STROKE TEST	The valve signature test is being performed. For more information on this procedure, see the Full Stroke Test item in this section.
PARTIAL STROKE TEST	The valve partial movement test is being performed. For more information on this procedure, see the Partial Stroke Test item in this section.
STEP RESPONSE TEST	The step response test is being performed. For more information on this procedure, see the Step Response Test item in this section.

WARNING

During the execution af any of the procedures, the positioner will NOT accept any write command, either by HART configurator – answering "Busy" – or local adjustment.

Test Error Alarms

Persistent alarms that indicate errors in performing procedures in order to invalidate the parameters obtained. For more information about the procedures, see the respective items, in this section.

Alarm	Description
PST ABORTED	The valve partial movement test has been canceled as the initial conditions did not correspond to the configured. Check the test configuration.
PST TIMEOUT	The valve partial movement test has not been finalized within the time provided for in its configuration. Check the test configuration.
PST SP CHANGED ALERT	The valve partial movement test was aborted for safety due to the change in the positioner's control Setpoint.
PST BREAKOUT ALERT	The valve did not move within the time provided for in the valve partial movement test. Check the test configuration.
FST ERROR	The valve signature test was not completed correctly. Possible stuckness or low supply pressure.
STEP RESPONSE ERROR	The PID control of the position did not respond to the steps scheduled in the step response test. Check the PID tune.
OPEN / CLOSE TEST ERROR	The complete opening and closing test of the system was not completed correctly. Possible stuckness or low supply pressure.
AUTO CALIB / TUNING ERROR	Error during automatic position calibration and/or control auto tuning. Possible stuckness or low supply pressure.

Local Adjust Alarms

The first field of local adjustment displays the status of the equipment, prioritizing the most critical alarm, informing a code, according to the following table.

Status	Type	Alarm
---	-	Sem alarmes.
E-01	*ERROR*	*SENSOR NOT DETECTED*
E-02	*ERROR*	*NO MOVEMENT / LOW AIR SUPPLY*
E-03	*ERROR*	*LOOP CURRENT FAILURE*
A-01	*ALERT*	*LOW CURRENT ALERT*
A-02	*ALERT*	*TEMPERATURE OUT OF RANGE*
A-03	*ALERT*	*PRESSURE OUT OF RANGE*
A-04	*ALERT*	*REVERSAL LIMIT ALERT*
A-05	*ALERT*	*MILEAGE LIMIT ALERT*
A-06	*ALERT*	*STROKE LIMIT ALERT*
A-07	*ALERT*	*PRESSURE LIMIT ALERT*
A-08	*ALERT*	*DEVIATION LIMIT ALERT*
A-09	*ALERT*	*TEMPERATURE LIMIT ALERT*

Status	Type	Alarm
A-10	*ALERT*	*PST ABORTED*
A-11	*ALERT*	*PST TIMEOUT*
A-12	*ALERT*	*PST SP CHANGED ALERT*
A-13	*ALERT*	*PST BREAKOUT ALERT*
A-14	*ALERT*	*STEP RESPONSE ERROR*
A-15	*ALERT*	*OPEN / CLOSE TEST ERROR*
A-16	*ALERT*	*AUTO CALIB / TUNING ERROR*
A-17	*ALERT*	*FST ERROR*
A-18	*ALERT*	*DIG. INPUT LOW ALERT*
A-19	*ALERT*	*DIG. INPUT HIGH ALERT*
A-20	*ALERT*	*DIG. OUTPUT LOW ALERT*
A-21	*ALERT*	*DIG. OUTPUT HIGH ALERT*
A-22	*ALERT*	*CONTROL DEVIATION ALERT*

WARNING
For a detailed description on each diagnostic, check the previous tables.

PREDICTIVE DIAGNOSTICS OF POSITION

Reversal

Diagnostic for verification of course transitions from the control system. With each reversal of sense of the movement, a counter is increased. The reversal is accounted for when the valve reverses its direction with a moving above *Reversal Deadband*, configured by the user between 0% and 20%.

In addition, the user can configure the maximum value to the counter (*Reversal Counter Limit*) in order to generate an alarm (*Reversal Limit Alert*) when it is exceeded. This alarm is persistent, forcing the user to deactivate it manually after verifying the cause of the reversal alert.

With proper knowledge of the process, the user can configure the counter limit to an expected value of motion reversals for a certain period (with a certain tolerance to avoid false alarms).

HINT

The Reversal diagnosis is used to identify unwanted fluctuations in the system and may indicate error in PID control tune or friction problems that disturb the correct modulation of the system.

In the chart of Figure 3.20, considering variations d1 and d2, where d1 < *Reversal Deadband* and d2 > *Reversal Deadband*, the reversal counter will be increased only in reversal of direction in d2, ignoring the small d1 reversal, because it is less than minimum value of dead zone configured.

Example 1: Considering Reversal Deadband = 1% and PV = 0%. If the valve goes to 25% and then to 23.9%, the counter will be increased as it will have changed direction beyond 1%. If the valve went to 25% and then to 24.1%, the counter would not be increased as it would not have left the deadband of 1% of the reversal.

Example 2: Considering Reversal Deadband = 1% and PV = 100%. If the valve travels the sequence 50%, 55%, 45% and 45.5%, the counter will be increased twice (50% to 55% and 55% to 45%). Note that the movement from 45% to 45.5%, despite being in reverse to the previous one, will not be considered a reversal, as it does not exceed the deadband configured.

The diagnosis also has Operation Time count, informing how long it has been active since the last reset of diagnosis. On restarting, counter, operation time and alarm are reset.

Default values for Reversal parameters are *Reversal Deadband = 1%* and *Reversal Counter Limit = 1000*.

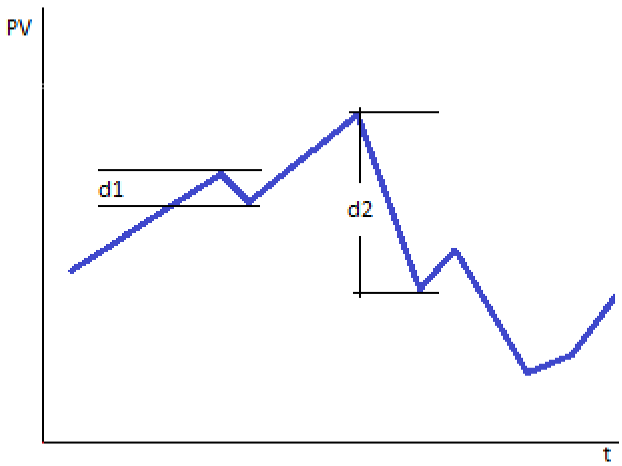


Figure 3.20 – Example of reversal occurrence.

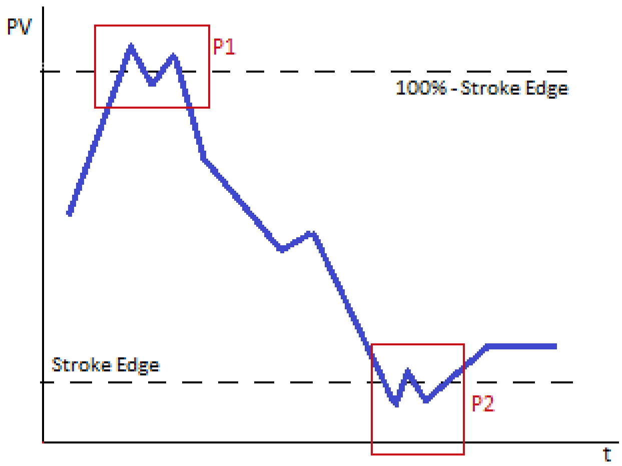


Figure 3.21 – Example of strokes occurrence.

Stroke

Diagnosis to verify position at the end of the valve course. With each entrance to the end of the course, a counter is increased. The end of the course regions are the ends of the system, configured by the user via *Stroke Edge* parameter (between 0% and 20%), and is therefore considered by the positioner as *Stroke Edge*, to the lower region, and (100% - *Stroke Edge*), to the upper region.

Furthermore, the user can configure the maximum value for the counter (*Stroke Counter Limit*), in order to generate an alarm (*Stroke Limit Alert*) when it is exceeded. This alarm is persistent, forcing the user to manually deactivate it, after verifying the cause of the extremity position alert.

With the proper knowledge of the process, the user will be able to configure the counter limit to an expected value of strokes at the end of the course during a certain period (with a certain tolerance, in order to avoid false alarms).

HINT

The Stroke diagnosis is used to identify total openings and closings of the system, allowing the user to control the frequency in which these events occur and if they are occurring in situations where they should not occur.

In the graph of figure 3.21, the stroke counter will be incremented in the P1 and P2 regions, considering the values of the ends in the black horizontal lines. Note that the counter will not be incremented more than once, as long as the variation at the ends does not exceed 1% (*Stroke Edge* + 1%).

Example 1: Assuming Stroke Edge = 5% and PV = 50%. When the valve goes to 0%, the counter is incremented. If the valve goes to 5.5% and returns to 0%, the counter will not be incremented, as the valve has not left the 1% deadband above the Stroke Edge value. Therefore, only after exceeding 6% and returning to a position below 5% will the counter be incremented again.

Example 2: Considering Stroke Edge = 5% and PV = 50%. When the valve goes to 100%, the counter is incremented. If the valve goes to 94.5% and returns to 100%, the counter will not be incremented, as the valve has not left the 1% deadband above the Stroke Edge value (100% - 5% - 1% = 94%). Therefore, only after exceeding 94% and returning to a position above 95% will the counter be incremented again.

The diagnostics also has an Operation Time count, informing how long it has been active since the last reset of the diagnostics. On restarting, counter, operation time and alarm are reset.

The default values for Stroke parameters are *Stroke Edge = 1%* and *Stroke Counter Limit = 1000*.

Mileage

Diagnosis to count the total valve displacement. All movement performed above a minimum value defined by the user (*Milleage Deadband*, between 0% and 20%) is added to the *Mileage Value* sum.

HINT

The diagnosis of Mileage is used for predictive stop schedule in the valve, considering its total displacement and operating time from the last maintenance. Thus, the Mileage DeadBand parameter must be configured with a value that ignores minimal control system fluctuations.

Furthermore, the user can configure the maximum value for the sum (*Mileage Limit*), in order to generate an alarm (*Mileage Limit Alert*) when it is exceeded. This alarm is persistent, forcing the user to manually deactivate it, after verifying the cause of the displacement alert.

With the proper knowledge of the process, the user will be able to configure the sum limit to an expected value of displacement during a certain period (with a certain tolerance, in order to avoid false alarms).

In the chart of figure 3.22, the variation located within the range d1 will not be considered, with d1 being the variation deadband (*Mileage Deadband*). Once the displacement exceeds this value (up or down), the displacement sum will be incremented by this difference.

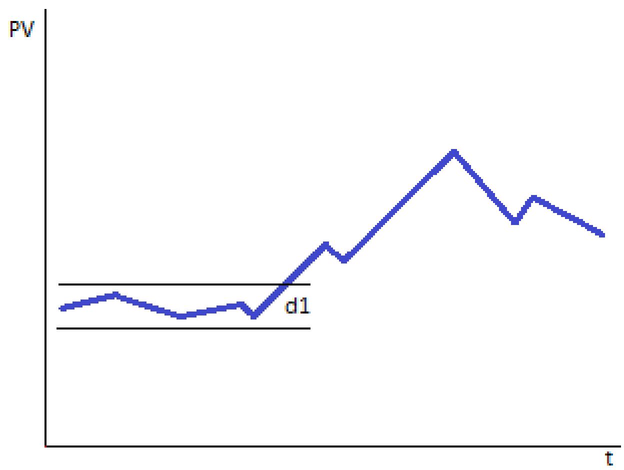


Figure 3.22 – Mileage sum example.

Example 1: Assuming Mileage Deadband = 1% and PV = 50%. When the valve goes to 45%, the sum will be incremented by 5%. If the valve returns to 50%, the sum will be increased again by 5%.

Example 2: Considering Mileage Deadband = 1% and PV = 50%. When the valve goes to 49.1%, the sum will not be incremented as the displacement will not have exceeded the deadband value. If, in the sequence, the valve goes to 48%, the sum will be increased by 2%.

The diagnostics also has an Operation Time count, informing how long it has been active since the last reset of the diagnostics. On restarting, mileage value, operating time and alarm are reset.

The default values for the Mileage parameters are *Mileage Deadband = 1%* and *Mileage Limit = 1000*.

Deviation

Diagnostics to check for excessive deviation in the PID control. Deviation is characterized by an error greater than *Deviation Deadband* for a time greater than *Deviation Time*. With each new deviation, a counter is incremented. After the deviation count, if the error in the PID control becomes less than the value configured by the user in *Deviation Deadband*, the deviation state is turned off, the time reference is reset and a new verification is started.

The user can configure the maximum value for the counter (*Deviation Counter Limit*), in order to generate an alarm (*Deviation Limit Alert*) when it is exceeded. This alarm is persistent, forcing the user to manually deactivate it, after verifying the cause of the deviation alert.

With the proper knowledge of the process, the user will be able to configure the counter limit to an expected value of deviations during a certain period (with a certain tolerance, in order to avoid false alarms).

HINT
The Deviation diagnostic is used to identify problems directly related to valve position control. It may indicate an error in the PID control tuning or friction problems that disturb the correct modulation of the system.

In the chart of figure 3.23, the deviation starts at time T_1, as soon as the error (*SP – PV*) becomes greater than the *Deviation Deadband* parameter. The error remains above the value configured for the deviation for a time longer than the *Deviation Time*, counting the deviation in the counter at time T_2 and activating the non-persistent alarm *Control Deviation Alert*.

Example 1: Considering Deviation Deadband = 5% and Deviation Time = 10s. With SP = 50% and PV = 50% there is no control deviation. Assuming that the Setpoint is changed to SP = 60% and that the PV remains at PV = 50%, the error becomes 10% and the deviation verification time count starts. Note that at this time the deviation is not yet accounted for. If the error is not less than 5% for 10 seconds, the deviation is characterized, and the counter is incremented. After the deviation occurs, a new deviation will only be counted if the error is less than 5% at some point and the process is repeated.

Example 2: Considering the same initial conditions as in Example 1, without control deviation (SP = PV = 50%). Assuming that the Setpoint is changed in order to create an error greater than the Deviation Deadband, the deviation time count starts. At T = 9s of the deviation time count, the Setpoint returns to SP = 50%. At this moment, the deviation count is reset and, if the error rises again, the count will be restarted from T = 0s, ignoring the previous nine seconds.

The diagnostics also has an Operation Time count, informing how long it has been active since the last reset of the diagnostics. On restarting, counter, operation time and alarms are reset.

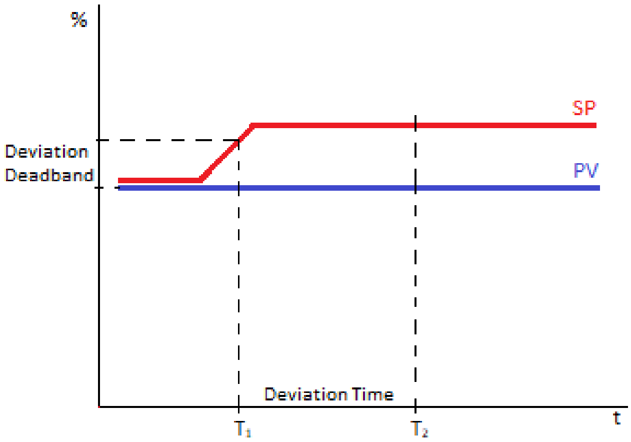


Figure 3.23 – Example of PID control deviation.

The default values for the Deviation parameters are *Deviation Deadband = 5%, Deviation Time = 10s* and *Deviation Counter Limit = 1000*.

Position Histogram

Diagnosis that provides the user with a history of the positions traveled by the valve during its operating period. It enables the visualization of a graph (via DTM or another configurator that offers graphs) with the percentages of time in each of the 5% ranges of the valve travel.

NOTE

The first point on the graph indicates the percentage of time the valve was fully closed (PV=0%), while the last point indicates the percentage of time the valve was fully open (PV=100%) – considering the installation to Open (AirTo Open).

The Histogram does not require any configuration and does not have any alarms, being a system behavior monitoring diagnostic for user analysis and comparisons.

Figure 3.24 shows an example of a graph of the history of the positions traveled by a valve during its operation. Note that the control was about 80% of the time between 40% and 60%, plus about 20% of the time with PV=0% - indicating possible valve closure for maintenance, for example.

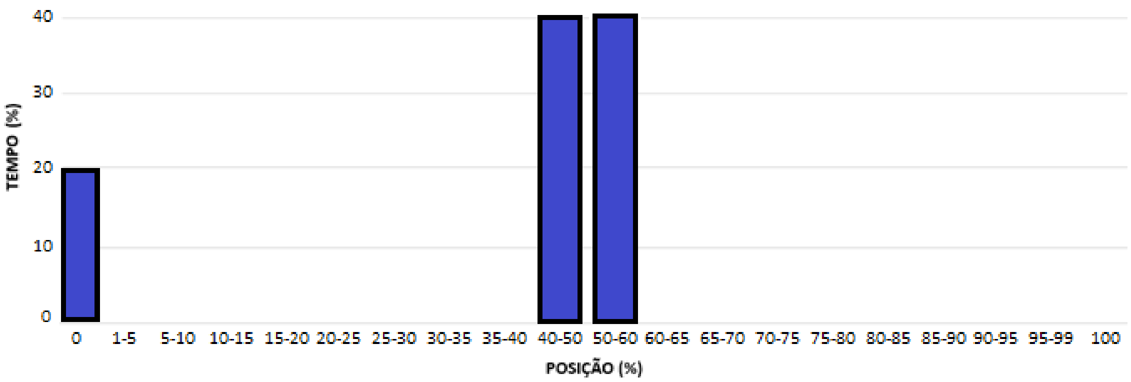


Figure 3.24 – Example of graph for valve position history.

The diagnostics has an Operation Time count, informing how long it has been active since the diagnostics was last reset (reset). On restart, operating time and graph points are reset to zero.

Valve Signature Test (Full Stroke Test)

Test that verifies the performance of the system throughout its excursion, varying the Setpoint from 0% to 100% and returning to 0%, in a period configured by the user through the *FST Stroke Time* parameter, performing Position, Setpoint and Output Pressure readings (for models with pressure sensors) that can be archived.

This test is also known as Valve Signature because it maps the possible sticking points of the system at a given point, recording the complete valve performance profile for future comparisons.

The default runtime per cycle setting is thirty seconds (30s) and can be changed to 60s, 90s, 120s or 180s. At the end of the test, if performed successfully, the system Hysteresis value (difference between the opening and closing performances of the system) is displayed, together with the point of occurrence. If the execution fails, the system total stuckness alarm (*No Movement / Low Air Supply*) will be activated.

In the graph of figure 3.25 is an example of a curve of a single action system (spring return) after the Valve Signature. Note that there is a point P1 that indicates an increase in pressure, in order to maintain the Position following the Setpoint, followed by the normalization of the curve, forming a “bump”. This condition indicates punctual friction of the system, since the linear pressure was not enough to move the valve in that position, causing oscillation in the opening and closing curves (*Pressure x Position*).

Note in figure 3.26 that, even for models that do not have pressure sensors installed, the friction of the system can be analyzed by the opening (blue) and closing (red) curves of the test at the same point P1 - *when the pressure sensors are not available, the Valve Signature graph is plotted as Position x Setpoint.*

Also, note that there is a gap between the upper and lower pressure curve, the system hysteresis (H). The higher its value, the greater the difference between the opening and closing pressures for the same point in the system, which is not desirable, suggesting maintenance. The beginning and end points of the curves indicate the valve seating, with maximum and minimum pressures.

If the system is double acting, the only graphic change will be in the pressure curve, which will portray the difference between OUT2 and OUT1 output pressures, resulting in a more horizontal curve. However, the hysteresis and settling characteristics will be observed in the same way.

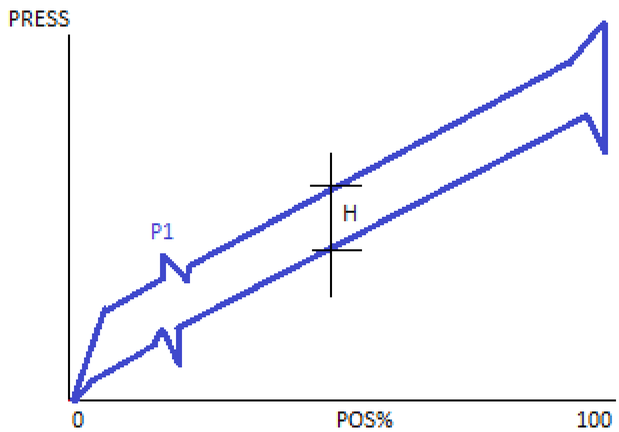


Figure 3.25 – Example of FST in a single action system for a model with pressure sensors.

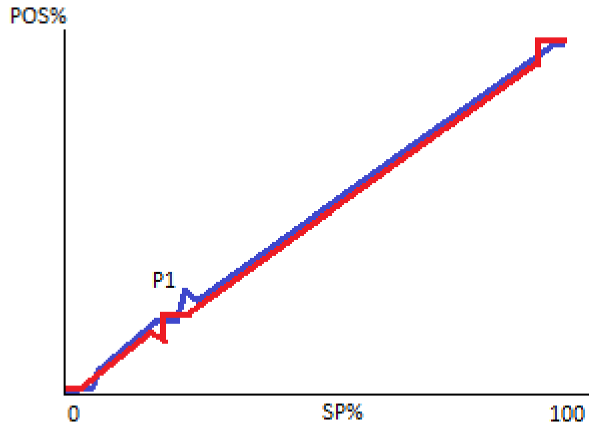


Figure 3.26 – Example of FST in single action system for a model without pressure sensors.

The test stores all measured Setpoint, Position and Output Pressure points (for compatible models), allowing the user to save the complete graph in a personal file for future comparison.

HINT
Use the Valve Signature test right after valve maintenance and good tuning of the PID parameters in order to obtain an optimal reference graph. Periodically, to analyze the need for maintenance, perform the test again and compare the graph of the new data obtained with the ideal reference recorded previously. Analyze the Hysteresis of the system and look for points of friction/stuckness, as exemplified above.

Partial Stroke Test

Test that verifies the performance in safety systems, where the actuator/valve set remains fully open or closed most of the working time, which may cause stuckness in the seating. Thus, the test performs a partial opening or closing (configured by the user) to ensure that the system is responding as expected.

It is similar to Valve Signature, with the difference that it does not completely open or close the system, requiring several configurations by the user. These settings are described below.

Parameter	Description
PST Type	Sets the test movement type, opening or closing. If the system is not positioned according to this configuration at the beginning of the test, it will be aborted and the *PST Aborted* status will be activated.
PST Offset	Sets the test offset (in percentage) – 5% minimum.
PST Pause	Sets the time (in seconds) to wait between the end of opening and the beginning of closing in the test.
PST Timeout	Configures the maximum time for performing the complete test. If the test exceeds this time, it will be canceled and the *PST Timeout* status will be activated.
PST Breakout Limit	Sets the maximum time for valve initial movement (*Breakout*). If this time is exceeded, the test will be canceled and the *PST Breakout* status will be activated.
PST Cycle Time	It configures the period (in hours) for the automatic execution of the test. Set this parameter to zero to perform the test manually only. A performed tests counter (*PST Execution Counter*) and a test failure counter (*PST Failure Counter*) are recorded with each new test.

In addition to the previously mentioned statuses for the PST, there is also the *PST SP Changed* status, which indicates a change in the Setpoint during the test (which will affect the control desired by the user) and, consequently, priority in relation to the test. In this case, the test will also be aborted.

In the graphs of the following figures, we have the example of a curve in a double acting system after the *Partial Stroke Test* for opening a safety valve (*PST Type = 'Opening'*).

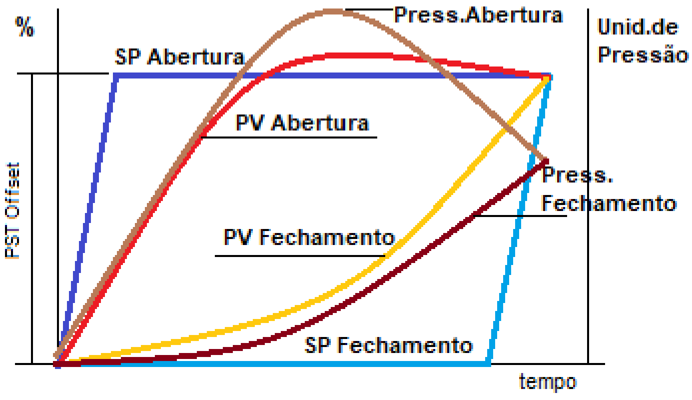


Figure 3.27 – Example of PST ins a double action system for a modelo with pressure sensors.

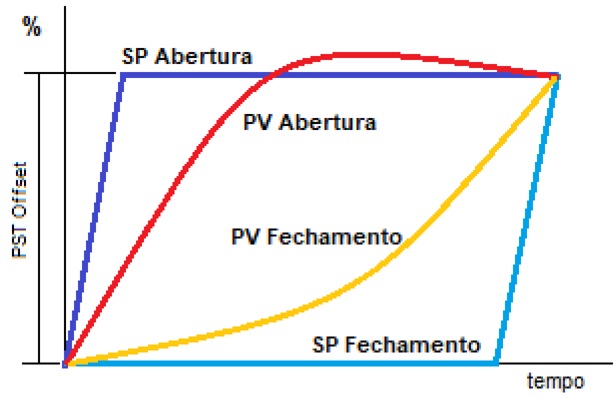


Figure 3.28 – Example of PST in a double action system for a model without pressure sensors.

The test stores all Setpoint, Position and Output Pressure (for compatible models) points measured, enabling the user to save in the personal file the full graph for future comparison.

Step Response Test

Test that checks PID control performance when applying steps set by the user to Setpoint and analyze the system response. It is performed by the positioner himself, regardless of being connected to some monitoring system. The user can configure up to ten independent steps as described below.

Parameter	Description
Number of Steps	It configures the number of Setpoint steps to be simulated during the test (from 1 to 10). The test starts at step one and goes to the last step configured in this parameter, when it ends.
Start Position	It configures the starting position of that step (in percentage).
Stop Position	It configures the final position of that step (in percentage).
Delay	It configures the waiting time (up to 60s) for the control to adjust to the initial position of that step.
Duration	It configures the duration time (up to 60s) of that step.

During the simulation of user-configured steps, the positioner will store the Setpoint and Position points of each step, for later plotting on the test graph, as exemplified in figure 3.29, which identifies the function of each parameter configured by the user for Step 1.

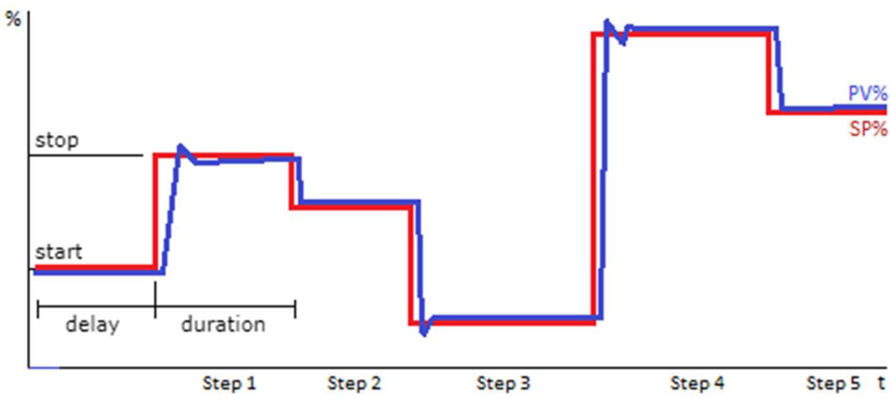


Figure 3.29 – Example of Step Response Test with five steps.

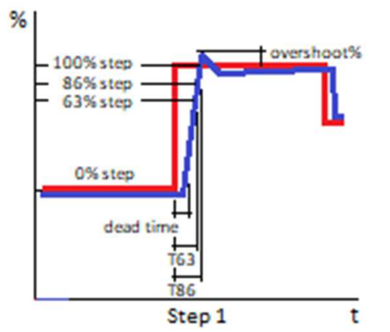


Figure 3.30 – Parameters of performance for step 1.

HINT

Note in figure 3.29 that only step 1 has the Delay parameter set above zero.
Setting this parameter to zero in the other steps causes the next step to be always started right after the previous step ends.

Furthermore, after the first step, the positioner will display the measured performance parameters, described below and indicated in figure 3.30.

Parameter	Description
Dead Time	Time (in seconds) for initial system movement after the start of the step.
T63 Time	Time (in seconds) for the system position to reach 63% of the step value.
T86 Time	Time (in seconds) for the system position to reach 86% of the step value.
Overshoot	Percentage of maximum overshoot measured after the step, in relation to the step value.

WARNING

*If the position does not reach at least the point of 86% of the step within the configured duration period (*Duration*), test will be aborted and status* Step Response Error *will be activated.*

Valve Open/Close Test (Valve Open/Close Test)

Test that verifies the time for the complete opening and closing of the system with maximum performance (maximum utilization of the applied pressure).

This test is performed automatically during the Automatic Position Calibration procedure, but can be performed individually by the user.

WARNING

*Performing this test will change the values of the open and close rate variables for Setpoint smoothing (*Rate Open/Close*) to the highest performing (fastest) possible values.*

Enable/Disable/Reset

The VVP10 Hart positioner offers the user the option to enable diagnostics individually, as well as restart them for new comparisons. The table below shows the functions available for each of the diagnoses.

Diagnosis	Enable	Reset
Reversal	YES	YES
Strokes	YES	YES
Mileage	YES	YES
Deviation	YES	YES
Histogram	YES	YES
Input Pressure	NO	YES
Temperature	NO	YES

WARNING

All diagnostics are DISABLED by default.

WARNING

The tests do not have the option for enabling or reseting, since they are executed manually by the user.

OTHER PREDICTIVE DIAGNOSTICS

Input Pressure

WARNING

This diagnostic will only be available for models that have pressure sensors installed. Check the Product Order Code for this feature (section 6.2).

Diagnostics for checking supply pressure limits. The user can configure the lower limit (*Pressure Lower Limit)* and upper limit (*Pressure Upper Limit)* for the positioner supply pressure, using the configured unit (*Pressure Unit* – psi or bar).

An alarm (*Pressure Out of Range*) will be activated, and a counter incremented when the supply pressure exceeds one of the configured limits. When the pressure measurement is between these limits the alarm will be automatically deactivated.

The user can configure the maximum value for the counter (*Pressure Counter Limit*), in order to generate an alarm (*Pressure Limit Alert*) when it is exceeded. This alarm is persistent, requiring the user to manually deactivate it, after verifying the cause of the pressure alert.

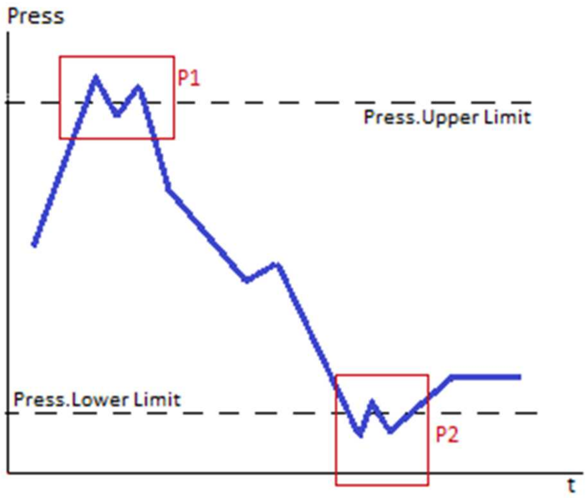


Figure 3.31 – Example of pressure alarms.

NOTE

Depending on the pressure working range, the user can configure the counter limit to zero, in order to be warned persistently if the pressure goes beyond the limits at some point.

In the graph of Figure 3.31, the *Pressure Out of Range* alarm will be activated, and the counter will be incremented in the P1 and P2 regions, considering the values of the limits in the black horizontal lines (disregarding oscillations in the 5 psi range). The alarm will be off at all other points on the graph between the configured limits.

The diagnostics also provides the user with the maximum and minimum input pressure values recorded during positioner operation since the last reset. On restarting, counter, maximum/minimum registers and alarms are reset.

The default values for the Pressure parameters are *Pressure Lower Limit = 0 psi, Pressure Upper Limit = 100 psi* and *Pressure Counter Limit = 0* (see note).

Temperature (Temperature)

Diagnostics for checking temperature limits. The user can configure the lower limit (*Temperature Lower Limit*) and upper limit (*Temperature Upper Limit*) for the temperature measured by the positioner, using the configured unit (*Temperature Unit* – °C or °F).

An alarm (*Temperature Out of Range*) will be activated, and a counter incremented when the temperature exceeds one of the configured limits. When the temperature measurement is between these limits the alarm will be automatically deactivated.

The user can configure the maximum value for the counter (*Temperature Counter Limit*), in order to generate an alarm (*Temperature Limit Alert*) when it is exceeded. This alarm is persistent, requiring the user to manually deactivate it, after verifying the cause of the temperature alert.

NOTE

Depending on the working temperature range, the user can set the counter limit to zero, in order to be persistently alerted if the temperature exceeds the limits at any time.

In the graph of figure 3.32, the *Temperature Out of Range* alarm will be activated, and the counter will be incremented in the T1 and T2 regions, considering the values of the limits in the black horizontal lines (disregarding oscillations in the 1°C range). The alarm will be deactivated at all other points on the graph between the configured limits.

The diagnostics also provides the user with the maximum and minimum temperature values recorded during the positioner operation, since the last reset. On restarting, counter, maximum/minimum registers and alarms are reset.

The default values for the Temperature parameters are *Temperature Lower Limit = -40°C, Temperature Upper Limit = 85°C* and *Temperature Counter Limit = 0* (see note).

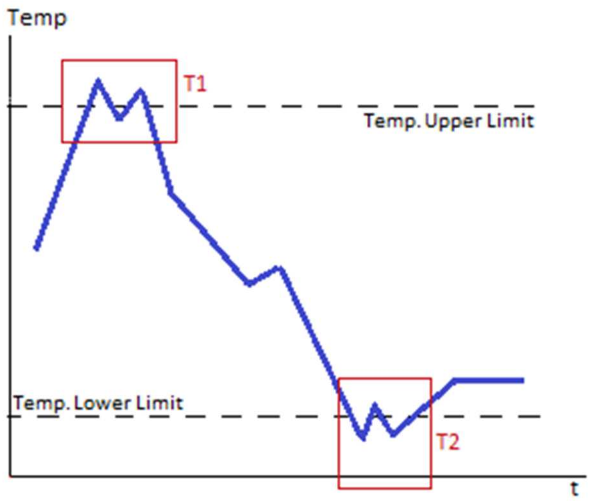


Figure 3.32 – Example of temperature alarms.

Digital I/O

WARNING
This diagnostic will only be available for the discrete and complete models of positioner. Check the Product Order Code for this feature (section 6.2).

The VVP10 HART has an auxiliary function for monitoring discrete input signals (superior and inferior), such as valve end switches, for example. With the digital input function enabled in the *Dig Input Mode* parameter, the *Dig Input Low* and *Dig Input High* alarms will be activated when the terminal inputs *DI1* and *DI2* are activated, respectively.

The discrete output function also has two channels (*DO1* and *DO2*), enabled in the *Dig Output Mode* parameter. The action of the outputs can be configured to follow the digital inputs (*DI1* and *DI2*), follow the Control Deviation alert *(DO1)* or to monitor the position limits configured in *Dig Out Low Limit* and *Dig Out High Limit*, for outputs *DO1* and *DO2*, respectively. This action is configured by the *Dig Out Action* parameter.

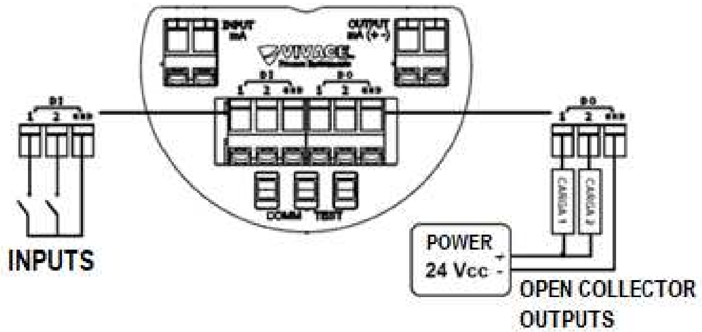


Figure 3.33 – Connections for digital inputs and outputs.

The user can also configure the verification time to generate the output alarm, through the *Dig Out Alert Time* parameter. Thus, when the event of generation of any of the outputs occurs, a time counter will be triggered so that the outputs are only generated after the time configured by the user. In addition to activating the *Dig Output Low* and *Dig Output High* alarms, the *DO1* and *DO2* terminals will output the signals corresponding to the outputs (high or low).

Figure 3.33 shows the connection terminals for the VVP10 HART digital input and output channels.

3.10. FDT/DTM CONFIGURATION

FDT/DTM-based tool (Ex. PACTware®, FieldCare®) can be used for device information, configuration, monitoring, calibration and diagnosis with HART® technology. Vivace offers the DTM files for all of its devices (HART® and Profibus PA).

PACTware® is property of *PACTware Consortium* and can be found on http://www.vega.com/en/home_br/Downloads.

The following figures exemplify DTM configuration screens for VVP10 HART using Vivace's VCI10-UH interface and PACTware®. Note that the directory with the menus available for the DTM (*OnLine Parameterize*) follows the configuration tree format shown in item 3.6 (figure 3.7).

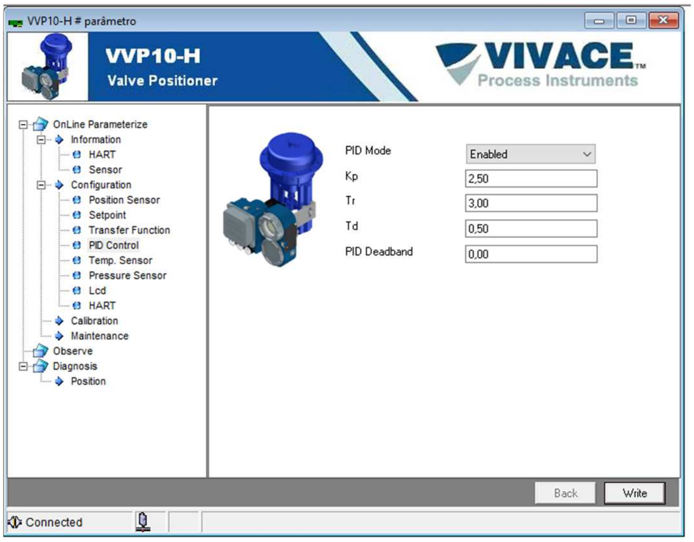


Figure 3.34 – "PID Control" configuration screen.

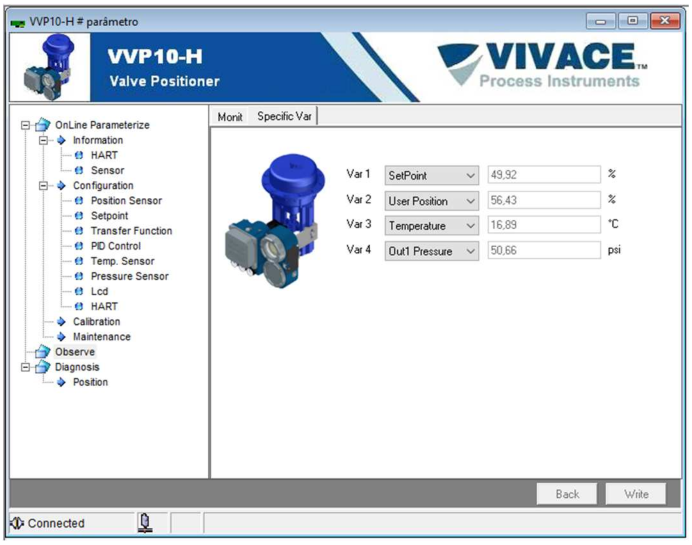


Figure 3.35 – "Observe" monitoring screen.

NOTE
For complete details of each of the functions provided by the positioner via DTM, see section 3.6 – Programming Tree with HART Configurator.

4 MAINTENANCE

VVP10 HART Valve Positioner, like all Vivace products, is rigorously evaluated and inspected before being shipped to the customer. However, in case of a malfunction, diagnosis can be made to verify that the problem is located in the sensor installation, in the configuration of the equipment or if it is a problem of the positioner.

4.1. ASSEMBLY AND DISASSEMBLY PROCEDURES

WARNING
Before disassembling the equipment, make sure it is switched off! *Maintenance of electronic boards should not be performed under penalty of loss of equipment warranty.*

Following are the steps for disassembling the positioner for maintenance and repair of parts. Values in parentheses indicate the part identified in the exploded view (Figure 4.1). To assemble the positioner, simply follow the reverse sequence of the disassembly steps

Access to Terminal Block

1 Remove the blind cover (20) to access the positioner terminal block;
2 Take care of the cover locking screw. By turning it clockwise, the cover is released for opening, while in the opposite direction it is locked;
3 Remove the power supply and current return from the positioner, removing all the wiring by the electrical connection.

Access to Display

1 Remove the display cover (15) to access the display (17) and main board (18) of the positioner;
2 Take care of the cover locking screw. By turning it clockwise, the cover is released for opening, while in the opposite direction it is locked;
3 Unscrew the two screws on the display and the main board. Disconnect the signal connection cable and the power cable from the main board.

Access to Filter and Silencer Elements

1 Remove the manifold (12) through the four allen screws. At the rear of the manifold are the three filter elements (10). Periodic exchanges are recommended, depending on the quality of the compressed air used;
2 Take care of the existence of 5 o-rings at the rear of the manifold, during removal;

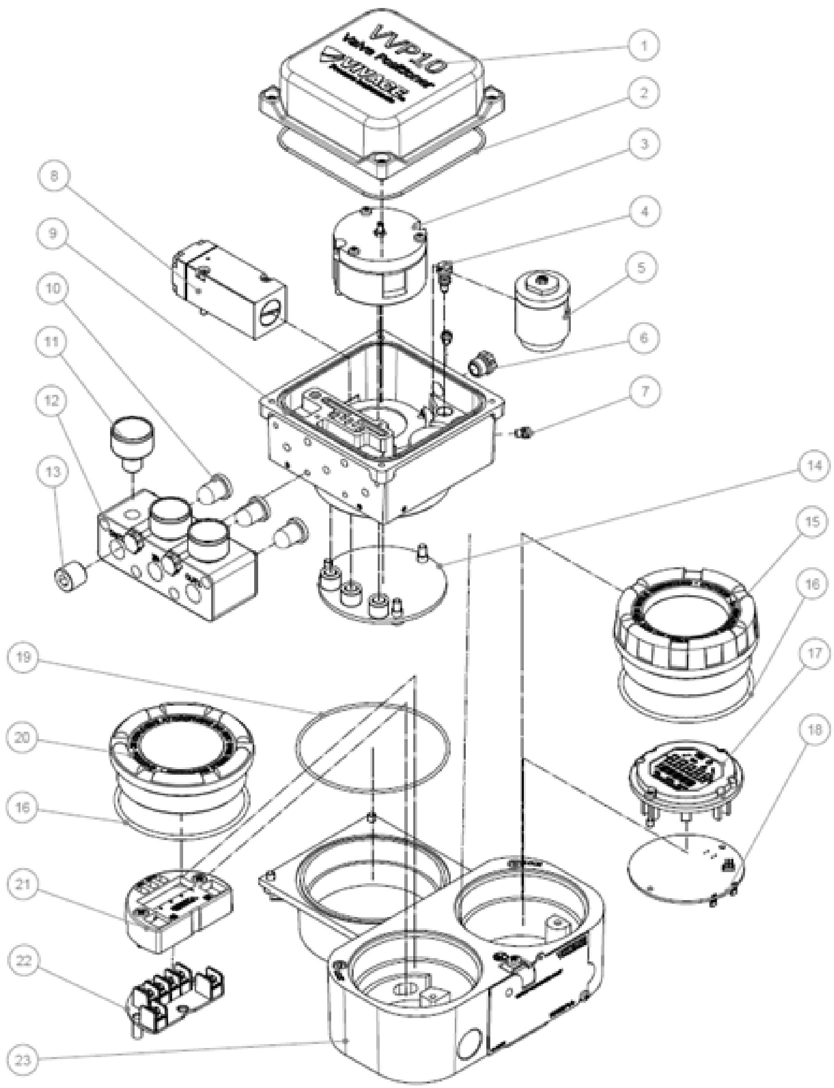


Figure 4.1 – VVP10 HART exploded view.

3 In the manifold there are two exhaust vents (6) containing the mufflers, which are also recommended for periodic switching. There is also a third vent vent, located on the opposing face of the air casing, to provide exhaust of the I/P assembly.

Access to Pneumatic Compartment

1 Remove the top cover (1) through the four cross-head screws;
2 Remove the spool valve assembly (8) through the two allen screws, ensuring that there is an o-ring and gasket between this assembly and the pneumatic housing (9);
3 Remove the internal pressure regulator assembly (5) by simply unscrewing the complete assembly by the lateral "flats". Take care not to unscrew by the "flat" of the regulator cover, since there will be access to the regulator housings;
4 Also note the existence of two o-rings on the lower face of the regulator;
5 Remove the restriction screw (4) by unscrewing it and then pulling it with a pair of pliers. This restriction has a small diameter hole and is recommended to be cleaned periodically;
6 Remove the I/P - magnetic coil assembly (3) through the two larger allen screws. Do not remove by the three smaller screws, because, this way, there will be access to the reed and internal of the coil assembly;
7 If you need to calibrate the coil assembly and the regulator assembly, you can remove the calibration plugs (7) and attach an appropriate device that can be supplied by Vivace to monitor the pressures. Refer to the specific positioner maintenance manual on the Vivace website if you need to perform this procedure.

Access to Electronic Compartment

1 Remove the electronic housing (23) from the pneumatic housing (9) through the four allen screws. There is a cylindrical joint between the casings with little diametral clearance, due to the tolerances required by the certification standards in explosive atmospheres;
2 Remove the signal connection cable (from the display compartment), the Hall sensor power cable and the position return cable (from the terminal compartment) from the analog plate (14);
3 Remove the analog board (14) from the pneumatic housing through the three cross-slot screws;
4 Check for the existence of three insulating rings under the analog plate, in versions with pressure sensors. Each has two o-rings to seal the pressures around the sensors on the analog board.

Figure 4.2 shows optional remote sensor components.

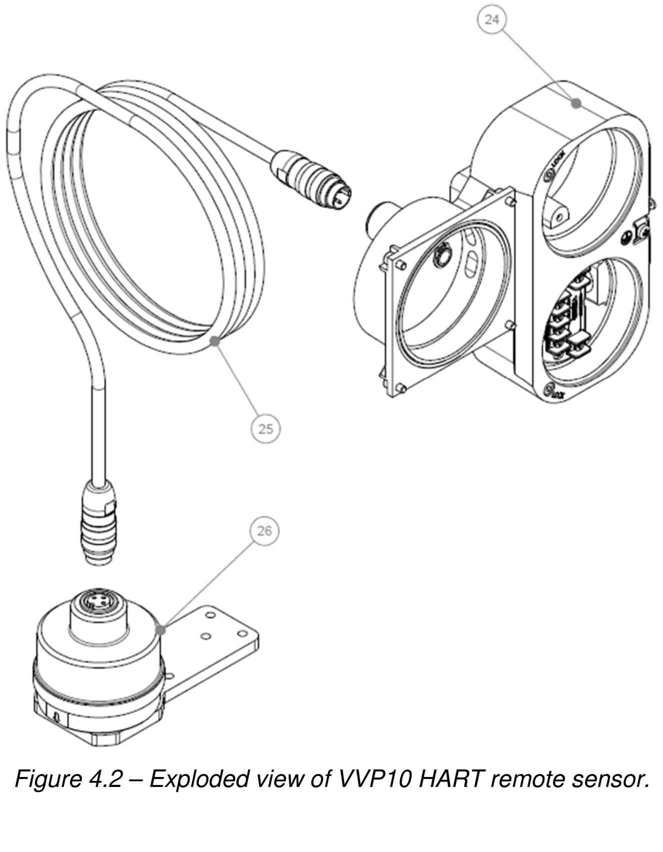


Figure 4.2 – Exploded view of VVP10 HART remote sensor.

4.2. SPARE PARTS

All the spare parts available for VVP10 HART can be bought directly from *Vivace Process Instruments.* Those parts are listed on table 4.1.

VVP10 HART – SPARE PARTS LIST					
DESCRIPTION	**REF FIG. 4.1**	**CODE**	**DESCRIPTION**	**REF FIG. 4.1**	**CODE**
REMOTE SENSOR EXTENSION	26	2-10042	I/O ANALOG BOARD (includes screws)	14	2-10053
LIGHT MODEL COIL EXTENSION CABLE	-	2-10106	COMPLETE ANALOG BOARD (includes screws, o-rings, insulator rings)	14	2-10054
REMOTE SENSOR 5 METER CABLE	25	2-10039	HOUSING PLUG	13	1-10015
REMOTE SENSOR 10 METER CABLE	25	2-10040	MANIFOLD SET (includes o-rings, screws, filter elements and manometers)	12	2-10069
REMOTE SENSOR 20 METER CABLE	25	2-10041	MANOMETER	11	1-10016
ELECTRONIC HOUSING – REMOTE SENSOR	24	2-10034	FILTER ELEMENT	10	1-10018
ELECTRONIC HOUSING – STANDARD SENSOR	23	2-10035	PNEUMATIC HOUSING (for no pressure sensor model)	9	2-10072
I/O TERMINAL BLOCK BOARD	22	2-10045	PNEUMATIC HOUSING (for pressure sensor model)	9	2-10073
STANDARD TERMINAL BLOCK BOARD	22	2-10046	REEL VALVE SET (includes screws, o-ring and sealing joint)	8	2-10074
I/O TERMINAL BLOCK COVER (includes screws)	21	2-10065	PLUG FOR CALIBRATION SOCKET (includes o-ring)	7	2-10068
STANDARD TERMINAL BLOCK COVER (includes screws)	21	2-10066	VENT SET (includes silencer)	6	2-10067
LIGHT MODEL TERMINAL BLOCK (includes screws)	21	2-10107	INTERNAL REGULATOR SET (includes o-rings)	5	2-10070
BLIND COVER (includes o-ring)	20	2-10003	RESTRICTION (includes o-rings)	4	2-10071
ELECTRONIC HOUSING O-RING	19	1-10017	COIL SET - I/P (includes o-rings and screws)	3	2-10075
LIGHT MODEL MAIN BOARD (includes coil extension cable)	18	2-10108	SUPERIOR COVER O-RING	2	1-10019
STANDARD MAIN BOARD	18	2-10047	SUPERIOR COVER (includes screws)	1	2-10076
PRESSURE SENSOR MAIN BOARD	18	2-10048	MAGNETIC TOOL	-	3-10001
I/O MAIN BOARD	18	2-10049	ROTATIVE MAGNET	-	2-10022
COMPLETE MAIN BOARD	18	2-10050	LINEAR 40 MAGNET	-	2-10023
DISPLAY (includes screws)	17	2-10006	LINEAR 70 MAGNET	-	2-10024
COVER O-RING	16	1-10001	LINEAR 100 MAGNET	-	2-10025
DISPLAY COVER (includes o-ring)	15	2-10002	LINEAR 150 MAGNET	-	2-10104
STANDARD ANALOG BOARD (includes screws)	14	2-10051	UNIVERSAL ROTATIVE BRACKET	-	2-10077
PRESSURE SENSOR ANALOG BOARD (includes screws, o-rings, insulator rings)	14	2-10052	UNIVERSAL LINEAR BRACKET	-	2-10078

Table 4.1 –VVP10 HART spare parts.

5 CERTIFICATION

The VVP10 is designed to meet national and international intrinsic safety standards and explosion proof, and has Inmetro certificate, whose identification plates are displayed below.

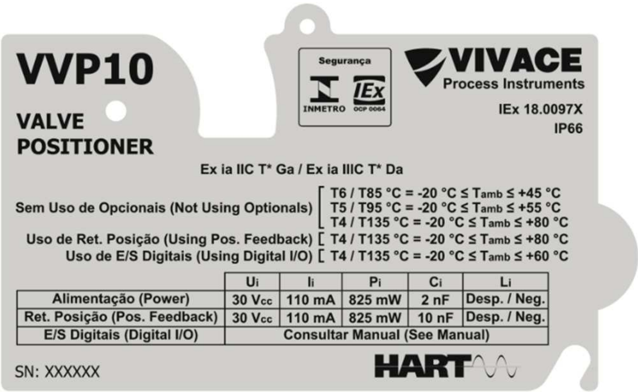


Figure 5.1 – Ex ia plate for VVP10 HART.

Figure 5.2 – Ex d plate for VVP10 HART.

PARAMETERS FOR INTRINSICALLY SAFE MODEL

Power imput terminals:

U_i = 30 V; I_i = 110 mA; P_i = 825 mW; C_i = 2 nF; L_i = negligible

Position return terminals:

U_i = 30 V; I_i = 110 mA; P_i = 825 mW; C_i = 10 nF; L_i = negligible

Digital input and output terminals:

OUT: U_i = 24 V; I_i = 110 mA; P_i = 660 mW; C_i = 12.2 nF; L_i = negligible

IN: U_o = 6.5 V; I_o = 6.5 mA; P_o = 10.5 mW; C_o = 24 nF; L_o = 800 mH

CLASS OF TEMPERATURE

Without optionals

Environment Temperature Range		
-20 °C to +45 °C	-20 °C to +55 °C	-20 °C to +80 °C
T6 / T85 °C	T5 / T95 °C	T4 / T135 °C

When using terminals for Position Return

Environment Temperature Range
-20 °C to +80 °C
T4 / T135 °C

When using terminals for Digital Input and Output

Environment Temperature Range
-20 °C to +60 °C
T4 / T135 °C

6 TECHNICAL CHARACTERISTICS

6.1. IDENTIFICATION

VVP10 HART has an identification plate affixed to the top of the housing, specifying the model and serial number, as shown in figure 6.1.

**For plate models with specific certification, see section 5.*

Figure 6.1 – Identification plate of VVP10 HART.

6.2. ORDERING CODE

VVP10 ***Valve Positioner***

Communication Protocol	H	HART
	P	PROFIBUS
Model	L	LIGHT
	S	STANDARD
	P	PRESSURE SENSOR
	D	DISCRETE I/O
	C	COMPLETE
Sensor Type	0	STANDARD
	1	REMOTE 05 METERS
	2	REMOTE 10 METERS
	3	REMOTE 20 METERS
	4	REMOTE 05 METERS WITH POTENTIOM. RULER
	5	REMOTE 10 METERS WITH POTENTIOM. RULER
	6	REMOTE 20 METERS WITH POTENTIOM. RULER
Magnet for Actuator Course	0	ROTATIVE (30 TO 120 DEGREES)
	1	LINEAR (COURSE < 30 mm)
	2	LINEAR (30 mm < COURSE < 70 mm)
	3	LINEAR (70 mm < COURSE < 100 mm)
	4	LINEAR (100 mm < COURSE < 150 mm)
	A	NO MAGNET
Manometers	0	NO MANOMETERS
	1	WITH MANOMETERS
Certification Type	0	NO CERTIFICATION
	1	INTRINSICALLY SAFE
	2	EXPLOSION PROOF
Certification Body	0	NO CERTIFICATION
	1	INMETRO
Housing Material	A	ALUMINUM
	I	INOX
Electrical Connection	1	1/2 - 14 NPT
Painting	0	NO PAINTING
	1	BLUE - RAL 5005
	2	BLUE - PETROBRÁS
Mounting Bracket	0	NO BRACKET
	1	UNIVERSAL LINEAR BRACKET
	2	UNIVERSAL ROTATIVE BRACKET

Ordering Code Example:

VVP10	- H	S	0	A	1	0	0	A	1	1	0

6.3. TECHNICAL SPECIFICATION

The following table shows the technical specifications for VVP10 HART.

Performance	Linearity: < ±0.1% Full Scale (using user table) Resolution: < 0.1% Full Scale Repetibility:< 0.1% Full Scale Hysteresis: < 0.1% Full Scale
Air Supply Effect	Negligible
Position Sensor	Sensor without contact, Hall effect, Local or Remote
Power Supply for Device	4-20 mA, no polarity ; Input impedance 500 Ω / 20 mA.
Power Supply for Position Feedback	12-45 Vdc (open collector), Isolation 1500 Vdc (Feedback 4-20 mA @12 bits, 4 uA resolution, 0.1% accuracy)
Communication Protocol / Configuration	HART 7 Remote configuration using EDDL or FDT/DTM tools. Local configuration using magnetic tool.
Classified Area Certification	Intrinsically Safe and Explosion Proof (INMETRO)
Air Supply Pressure / Output Pressure Range	1.4 – 9.65 bar (20 -140 psi). Oil, dust and water free, according to ANSI/ISA S7.0.01-1996 standard. / 0 to 100% of Air Supply Input
Air Consumption	40 psi (2.8 bar): 6 l/min (0.21 cfm) 80 psi (5.5 bar): 9,5 l/min (0.34 cfm)
Flow Capacity	116 psi (8 bar): 283 l/min (10 cfm);
Setpoint Characterization	Linear, Equal Percentage, Quick Open and User Table (up to 16 points)
Environment Temperature Limits	Ambient: -40 to 85 °C (-40 to 185 °F) Storage: -40 to 90 °C (-40 to 194 °F) LCD: -10 to 80 °C (14 to 176 °F) operation. -40 to 85 °C (-40 to 185 °F) no damage. Remote Sensor Operation: -40 to 105 °C (-40 to 221 °F)
Humidity Limits	0 to 100% RH (Not-Condensable Relative Humidity)
Vibration Effects	± 0.3%/g of span during the following conditions: 5-15 Hz for 4 mm constant movement. 15-150 Hz for 2g. 150-2000 Hz para 1g. Follows IEC60770-1.
Electromagnetic Interference Effects	According to IEC 61326:2002
LCD Display	5-digit, rotative, multi-function and bargraph
Stroke Movement	Linear: 3 to 150 mm Rotative: 30 to 120°
Action Type	Direct and Reverse, Single and Double, Air to Open or Air to Close
Self-Calibrations and Advanced Diagnostics	Position Self-Calibration and PID Self-Tuning FST (Valve Signature), PST and Step Response Diagnostics
Mounting	Using universal brackets for linear and rotative actuators/valves
Pressure Sensors - Optional	For input, output 1 and output 2 pressure measurement.
Discrete Inputs (Stroke-Limits) - Optional	2 isolated dry contact inputs
Discrete Outputs (Safety Valves/Solenoid) - Optional	2 open-collector outputs, max. 400 mA, 24 Vdc
Electrical Connection	1/2 - 14 NPT
Pneumatic Connection	Input and Outputs: 1/4 -18 NPT. Pressure Gauges: 1/8 - 27 NPT
Housing Material	Aluminum / Plastic (only pneumatic block lid)
Approximated Weight	3 kg (without mounting bracket)
Pressure Gauges - Optional	Input and output pressures monitoring. 0-160psi scale. ABS housing, polycarbonate display, brass connection.
Protection Degree	IP66

Table 6.1 – Technical specification for VVP10 HART.

7 WARRANTY

7.1. GENERAL CONDITIONS

Vivace ensures its equipment from any defect on manufacturing or component quality. Problems caused by misuse, improper installation or exposure to extreme conditions are not covered by this warranty.

The user can repair some equipment by replacing spare parts, but it is strongly recommended to forward it to *Vivace* for diagnosis and maintenance in cases of doubt or impossibility of correction by the user.

For details about the product warranty, see the general term warranty on Vivace website: www.vivaceinstruments.com.br.

7.2. WARRANTY PERIOD

Vivace ensures the ideal operating conditions of their equipment by a period of two years, with full customer support regarding to installation, operation and maintenance for the best use of the equipment.

It is important to note that even after warranty period expires, Vivace assistance team is ready to assist customer with the best support service, offering the best solutions for the installed system.

APPENDIX I – INFORMATION FOR CLASSIFIED AREAS

WARNING

The appropriate safety procedures for the installation and operation of electrical installations must be followed in accordance with the regulations of each country in question, as well as the decrees and directives on hazardous areas, such as intrinsic safety, explosion proof, increased safety, among others.

In Brazil, this product must be installed in compliance with the electrical installations standard for explosive atmospheres (ABNT NBR IEC 60079-14).

The installation, inspection, maintenance, repair, overhaul and recovery activities of the equipment are the responsibility of the users and must be carried out in accordance with the requirements of current technical standards and the recommendations of Vivace Process Instruments. If the area is classified, use a certified plug. Conduit threads must be sealed according to the sealing method required by the hazardous area.

The product mentioned in this manual, when purchased with a certificate for classified or hazardous areas, loses its certification when its parts are exchanged or exchanged without undergoing functional tests and approval by Vivace Process Instruments or authorized technical assistance, which are the legal entities competent to certify that the equipment, as a whole, complies with applicable standards and directives. The same happens when converting equipment from one communication protocol to another (for example, from HART/4-20mA to Profibus-PA, or vice versa, as the Vivace product line offers this possibility). In this case, it will be necessary to send the equipment to Vivace or its authorized service.

The certificates are different, according to the application and security required, and it is the user's responsibility to use them correctly.

Always follow the instructions provided in this Manual. Vivace is not responsible for any loss and/or damage resulting from the improper use of its equipment. It is the user's responsibility to know the applicable regulations and safe practices in their country.

Explosions can result in death or serious injury, as well as financial loss. Installation of this equipment in explosive atmospheres must comply with national regulations and type of protection. Before installing, check and make sure that the certificate parameters are in accordance with the classification of the area in which it will be installed.

Maintenance and Repair of Certified Equipments

WARNING

Modification of equipment or replacement of parts supplied by any supplier not authorized by Vivace Process Instruments is prohibited and will invalidate the certification.

Identification Plate with Certification

The equipment is marked with options for protection types. Only use it according to the area classification. If an equipment has been previously installed and/or used in an explosion-proof area, do not use it in an intrinsically safe area, as the certification criteria are different, which may put the area at risk..

WARNING

When the equipment is used as explosion proof "Ex d" or for enclosure protection "Ex t", it cannot be used as intrinsically safe "Ex ia".

Intrinsically Safe/Not-Lightable Applications

In explosive atmospheres with intrinsic or non -light safety requirements, always note the circuit input parameters and applicable installation procedures.

The certified equipment must be connected to an adequate intrinsic security barrier. Check the intrinsically safe parameters involving the barrier, as well as the equipment, cables and connections. Grounding the associated instruments bus should be isolated from carcass panels and supports. The use of armored cable is optional and, when used, the non-grounded end of the cable should be isolated. The capacitance and inductance of the more CI and LI cable should be smaller than co and the associated equipment.

WARNING

It is recommended to NOT remove covers when powered.

Explosion Proof/Flame Proof Applications

Use only certified explosion-proof/flameproof connectors, adapters and cable glands. The electrical connection inputs must be connected using conduits with sealing or closed units, with a cable gland or certified metal plug, at least with IP66.

WARNING
Do NOT remove covers when powered!

Housing

The lid should be tight with at least 8 turns of complete thread to prevent moisture penetration or corrosive gases until it touches the enclosure.

1/3 back (120º) should be squeezed to ensure total sealing. Lock the covers using the locking screw.

Attention

The certificate number is finalized by the letter "X" to indicate that:
- during the installation of the equipment is the responsibility of the user, use appropriate cable and cable press. For an ambient temperature greater than or equal to 60°C, the heating resistance of the cables used should be at least 20 K above room temperature.
- models with enclosure made of aluminum alloy, can only be installed in "Zone 0", if during installation the risk of impact or friction occurs between the enclosure and iron/steel parts.
- equipments with Ex d approved for Gb category, cannot have the pressure sensor installed in industrial processes classified as "Zone 0".
- the activities of installation, inspection, maintenance, repair, review and recovery of equipment are the responsibility of users and must be performed according to the requirements of the current technical standards and the recommendations of Vivace Process Instruments.
- IP enrollment applications, must require appropriate waterproof seals (non -harmless silicone seal is recommended) in all NPT threads.

Applicable Standards (Brazil)

ABNT NBR IEC 60079-0:2013
Atmosferas explosivas - Parte 0: Equipamentos – Requisitos gerais
ABNT NBR IEC 60079-1:2016
Atmosferas explosivas - Parte 1: Proteção de equipamento por invólucro à prova de explosão "d"
ABNT NBR IEC 60079-7:2008
Atmosferas explosivas - Parte 7: Proteção de equipamentos por segurança aumentada "e"
ABNT NBR IEC 60079-11:2013
Atmosferas explosivas - Parte 11: Proteção de equipamento por segurança intrínseca "i"
ABNT NBR IEC 60079-18:2016
Atmosferas explosivas - Parte 18: Construção, ensaios e marcação do tipo de proteção para equipamentos elétricos encapsulados - "m"
ABNT NBR IEC 60079-26:2016
Equipamentos elétricos para atmosferas explosivas - Parte 26: Equipamentos com nível de proteção de equipamento (EPL) Ga
ABNT NBR IEC 60079-31:2014
Atmosferas explosivas - Parte 31: Proteção de equipamentos contra ignição de poeira por invólucros "t"
ABNT NBR IEC 60529:2017
Graus de proteção para invólucros de equipamentos elétricos (Código IP).

APPENDIX II – TECHNICAL ANALYSIS REQUEST

FSAT

Technical Analysis Request Form

Company:	**Unit/Department:**	**Shipping Invoice nº:**
Standard Warranty: ( )Yes ( )No	**Extended Warranty: ( )Yes ( )No**	**Buying Invoice nº:**

COMMERCIAL CONTACT	
Complete Name:	**Position:**
Phone and Extension:	**Fax:**
e-mail:	

TECHNICAL CONTACT	
Complete Name:	**Position:**
Phone and Extension:	**Fax:**
e-mail:	

EQUIPMENT DATA	
Model:	**Serial Num.:**

PROCESS INFORMATION			
Environment Temperature (ºC)		**Work Temperature (ºC)**	
Min:	**Max:**	**Min:**	**Max:**
Operation Time:		**Fail Date:**	

FAIL DESCRIPTION: Here user should describe in detail the observed behaviour of product, frequency of fail occurence and repeatability. Also, should inform operational system version and a quick description of control system architecture where the equipment was installed.

ADDITIONAL OBSERVATION: