ITVC Series

Intelligent Total Valve Controller

DVG AUTOMATION

GIVA GROUP

Gas Over Oil actuator with ITVC Line Break

Annex B:

- *Line Break*
- *Line Break-differential*

Document Number	Prepared	Approved	Date	Release
IOM-ITVC-LB	AA	GR	10/02/2016	04

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DVG *ITVC Series – "Intelligent Total Valve Controller"*
ANNEX B: Line Break and Line Break-differential

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1 Introduction

This document, **ITVC Annex B** contains the information to set and use the **Line Break function** of the **ITVC** **I**ntelligent **T**otal **v**alve **C**ontroller. It is supplied to the user together with the manual **IOM-ITVC-Basic** if the **ITVC** has the option "**Line Break function**".

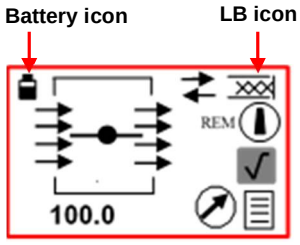
The "Annex B: Line Break function" should be considered an integral part of the document IOM-ITVC-Basic for actuator with Line Break function.
Refer to document "IOM-ITVC-Basic" for the complete Installation, Operation and Maintenance instructions of the ITVC
The "Annex B: Line Break function", together with the "IOM-ITVC-Basic" is an integral part of the apparatus and must be carefully read, understood and consulted before use and must be retained for future reference

WARNING!	
⚠	**Do not install, operate, or maintain an ITVC without first being fully trained and qualified in valve, actuator and accessory installation, operation and maintenance, and carefully reading and understanding the contents of this manual, including all safety cautions and warnings. For any questions regarding these instructions, contact the factory before proceeding.**

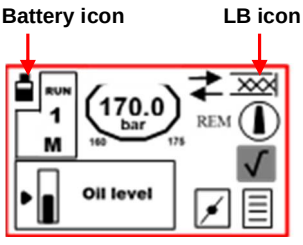
With reference to the manual **IOM-ITVC-Basic**, chapter ITVC HMI, paragraph **HOME** page, the Line Break function is available only if the ITVC display shows the **icon** or .
The icon signals that the Line Break function is available and working according to the settings, but the output to drive the actuator in safe position is **disabled**. No action is done by the ITVC to execute the **safe action**.
The icon signals that the execution of the safe action is **enabled.** If one of conditions described in the next paragraphs occurs, the ITVC will drive actuator and process valve in safe position.
The **Line Break** pages in the HMI menu allow setting the working parameters.

In general the ITVC with Line Break function is fitted with an optional backup battery pack of rechargeable lithium-ion batteries. The icon signals the charge level of the batteries. By the battery, the ITVC can work properly even if the main electrical power fails (see Battery option paragraph)

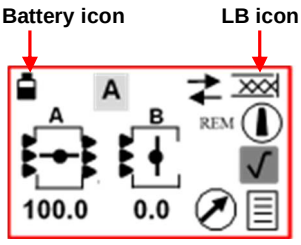
The below figures show the **HOME** page, **standard, HPU** and **HIPPS types** of the ITVC HMI. Refer to IOM-ITVC-Basic, ITVC HMI chapter, to view the HOME pages features. Refer to the above IOM to find the instructions relevant to **MENU chart** and **menu operations.**



HOME page standard type



HOME page HPU type



HOME page HIPPS type

The icon changes in if the Line Break function is enabled to carry out the safe action

The procedures described in this document use **HOME** page **standard type**.
The procedures to navigate in the menu are the same if the **HOME** page is **HPU** and **HIPPS type**. Only the **HOME** page changes.

Standard or extended endurance battery pack
(Rechargeable lithium-ion batteries)

ITVC equipped with battery pack

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2 Line Break protection system

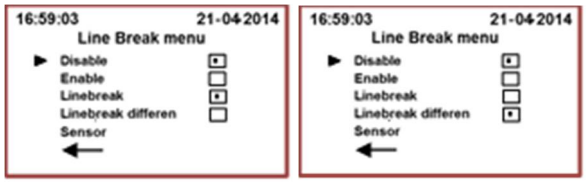
It is a system to be installed at a pipeline site to monitor the pipeline integrity and prevent dangerous conditions due to abnormal pressures or pressure changes. Basically it is made of pressure transmitters, actuator, process valve and ITVC logic solver. According to the system configuration the ITVC logic solver can be set to work as

- **Line Break**: If the ITVC detects an abnormal pressure drop rate or a dangerous pressure in the pipeline drives the actuator to **close** the process valve
  or alternatively
- **Line Break-differential**: If the ITVC detects a differential pressure outside the permissible limits, across the process valve, drives the valve in **safe position**. Three options are available: stayput, close, open

In this manual, **Line Break** function will be abbreviated by **LB**, and **Line Break-differential** by **LB-d**

The options in **Line Break menu** page of ITVC HMI allows:

- To set the **type** of Line Break function (**LB** or **LB-d**)
- To **Disable/Enable** the safe action execution (if the condition to do it occurs)
- To set the **sensor** architecture and working setpoints

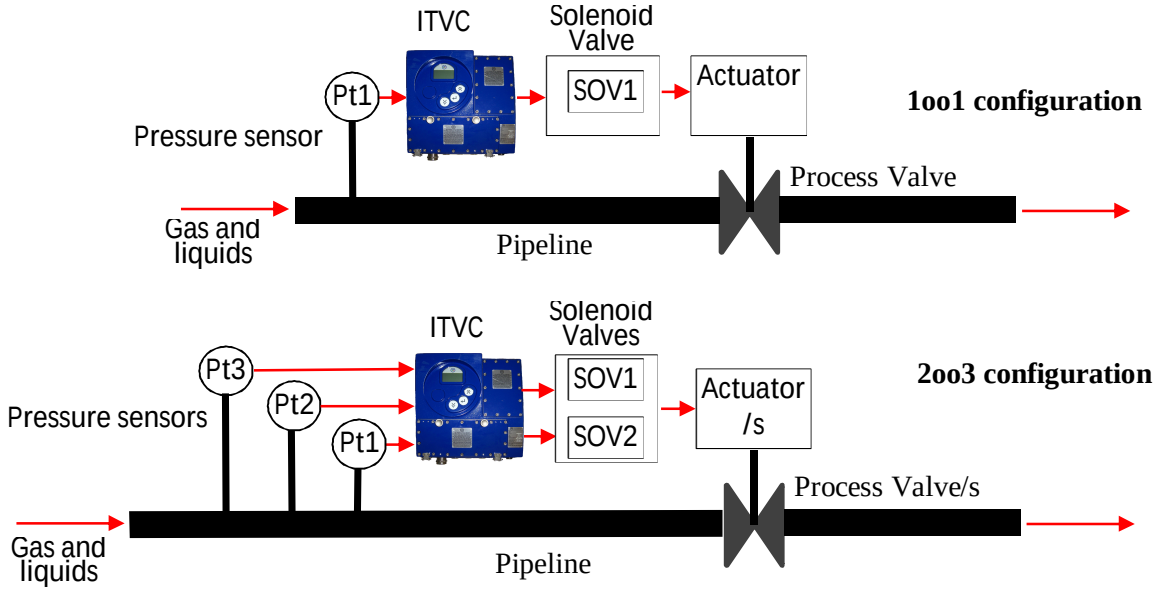


3 Line Break (LB)

This function protects the pipeline in three ways:

- Pressure drop rate higher than a configurable limit
- Pressure higher than a configurable limit
- Pressure less than a configurable limit

If the ITVC detects one of the above condition drives actuator and valve in **closure**.
Its features include logic solver function with redundancy of CPU's and voting mechanism, acquisition and record of pipeline pressure trends, local and remote control to open/close the process valve, suitability for gas and liquids applications.
It can be set to work in **1oo1**, **1oo2**, **1oo3** and **2oo3** configuration. The below figures show the 1oo1 and 2oo3 configurations



3.1 Operating mode

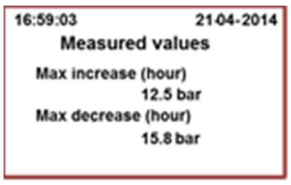
Three operating modes are available:

- **Acquisition :** the ITVC Line Break does not carry out any action to stroke the process valve, the **Valve Control** is off and forced to "**Disable**". The icon in the **HOME** page of display is ⋈. Acquisition of analogue pressure channels is continuously done and the values are visible as instantaneous measures and 24h graphs in the ITVC local display (see IOM-ITVC Basic, Visualization of pressures, Instantaneous measures and Historical data sub-menus paragraphs). The ITVC monitors two pressure data, "**Pressure increase / hour**" and "**Pressure decrease / hour**". If one the above measures exceeds the parameters "**Max pressure increase**" and "**Max pressure decrease**", the ITVC raises a **Warning**, the LED of the pushbutton ↵ lights-up, fuchsia colour, and the display shows the icon ⚠. After few minutes, and if the pressure remains stable, the warning is cleared but the type of warning with date and time is memorized in the ITVC permanent memory and is visible in the "**Line Break warning**" option of the **Measurement** menu. The measured "maximum increase and decrease / hour" are visible in the operating mode "**Monitor**". The action of parameters "Max pressure increase" and "Max pressure decrease" can be inhibited by the option "Available/Not available" in the setting operations. If the setting is "Not available", no warning is raised. **Open/Close, ESD actuator controls are available.**

- **Acquisition + Valve Control :** in this mode all features of **Acquisition** mode are actives, in addition, if the **Valve Control** is set "**Enable**" and if one of the "**Pressure events**" listed below occurs and persists for a configurable time (**Delay action**), the ITVC carries out the **Valve Control**, that is "to energize the SOV to stroke actuator and process valve in **close position**". An alarm is generated, the LED of the pushbutton ↵ lights-up, red colour, and the icon Ⓐ appears on the display. In the option "**Line Break events**" of the **Measurement** menu is available the event history with date, time and 24 hours graph.
  - **Pressure events:**
    - the pipeline pressure exceeds the configured maximum pressure (reaction time **400ms**)
    - the pipeline pressure is less than the configured minimum pressure (reaction time **400ms**)
    - the pipeline pressure drop / minute exceeds the configured pressure drop rate (reaction time **400ms**)

  If the "Pressure event" disappears in the "Delay action" time, no action is done.
  Once the Valve Control ends, **Open/Close actuator control are inhibited** (in the paragraph "Acquisition + Valve Control mode is described the procedure to restart the operation and clear the alarm).
  In general, the "**safe position**" is "**valve closed**", but it is configurable by the procedure described in the paragraph **ESD shutdown**, chapter "Setup, Administrator menu" of manual IOM-ITVC-Basic.

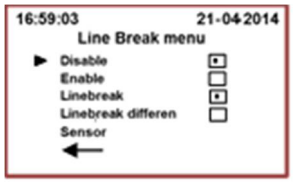
- **Monitor :** all acquisition features of "**Acquisition**" mode are available, **Valve Control** is off and forced to "**Disable**", check of "**Pressure increase / hour**" and "**Pressure decrease / hour**" is done as in **Acquisition** mode, but if the test fails, the ITVC does not raise any warning. The measured "maximum pressure increase / hour" and "maximum pressure decrease / hour" are visible in the local display of the HMI and can be cleared by the configuration options of the menu. The read values can be used to set the working parameters of Line Break function. The icon in the **HOME** page of display is ⋈. **Open/Close ESD actuator controls are available**.



3.2 Enable/Disable Valve Control

If the operating mode is "**Acquisition + Valve Control**", the option "**Enable**" = ON = "⊡ " in the **Line Break menu page**, enables the ITVC to perform the **Valve Control** (if a **Pressure event** occurs). The icon ⋈ in the **HOME** page of display changes in ⋈▶ .
On the contrary, the option "**Disable**" = ON = " ⊡ " inhibits the **Valve Control** even if a **pressure event** occurs . The icon in the **HOME** page of display changes from ⋈▶ to ⋈ .
In the operating modes "Acquisition" and "Monitor" the icon in the **HOME** page of display is ⋈ and the "**Enable**" option in the **LB page** is forced to OFF = ☐ .
The paragraph "**Enable/Disable VC"** shows the procedure to set the Enable/ Disable.

LB page
⊡ = ON
☐ = OFF



3.3 Working parameters

The paragraph **LB parameters** shows the procedure to set the working parameters of the Line Break function by the ITVC HMI.
The figure "**LB parameters**" shows the list of parameters to set.

LB parameters

Max pressure: the parameter sets the pipeline maximum working pressure.
If the measured pressure exceeds the "Max pressure" for the time "Delay action", a "**Pressure event"** occurs. If the operating mode is "Acquisition + Valve Control, "Enable" is " ⊡ =ON ", the ITVC Line Break energizes the SOV to close actuator and process valve.

Min pressure: the parameter sets the pipeline minimum working pressure.
If the measured pressure is less than "Min pressure" for the time "Delay action", a "**Pressure event"** occurs. If the operating mode is "Acquisition + Valve Control" and Enable" is " ⊡ =ON ", the ITVC Line Break energizes the SOV to close actuator and process valve.

Pressure drop in ACQVC mode: the parameter sets the allowable max pipeline **pressure drop /minute**. The action of the parameter can be inhibited by the option "Not Available/ Available" in the setting procedure.
If the setting is "available" and the measured pipeline pressure drop / minute exceeds the above parameter for the time "Delay action", a "**Pressure event**" occurs. If the operating mode is "Acquisition + Valve Control" and Enable" is " ⊡ =ON ", the ITVC Line Break energizes the SOV to close actuator and process valve. If the setting is "not available", the ITVC Line Break does not carry out any action in case of pipeline pressure drop.

Delay action: it is the time between the detection of the "**Pressure events**" described in the "Operating mode" paragraph and the start of the action to close the process valve. If the pressure event disappears during the time "Delay action", the ITVC Line Break does not carry out any action to move the process valve.

Operating mode: it allows setting the Line Break operating mode, as described in the previous paragraph "**Operating mode**". Three operating modes are available: Acquisition, Acquisition + Valve Control, Monitor

Maximum pressure increase: it sets the allowable maximum increase in pressure / hour. The parameter can be inhibited by the option "available/not available" in the setting procedure. If the measured "pressure increase / hour" exceeds the above parameter, the parameters is set "available", and the operating mode is "Acquisition" or "Acquisition + Valve Control", the ITVC Line Break raises a **Warning**, but the SOV is not energized and **no action is carried out to close** the process valve. In "Monitor" operating mode, no warning is generated and the measured maximum pressure increase can be viewed in the Monitor page of the menu.

Maximum pressure decrease: it sets the allowable maximum decrease in pressure / hour. The parameter can be inhibited by the option "available/not available" in the setting procedure. If the measured "pressure decrease / hour" exceeds the above parameter and the parameter is set "available", the ITVC Line Break raises a Warning, but the SOV is not energized and **no action is carried out to close** the process valve. In "Monitor" operating mode, no warning is generated and the measured maximum pressure decrease can be viewed in the Monitor page of the menu.

3.4 Acquisition + Valve Control operating mode

To start the LB operation
The Line Break carries out the **Valve Control** if the operating mode is "**Acquisition + Valve Control**" and only if "**Enable** is = ⊡ ". The paragraphs "Enable/Disable VC" shows the procedures to **Enable** the Valve Control. The icon in the **HOME** page of the display switches from ⋈ to ⋈▶ . The local and remote **Open/Close and ESD** commands are **available**. The ITVC Line Break continuously acquires and measures the pipeline pressure. If one of the "**Pressure events"** described in the previous paragraph "**Operating mode**" occurs and persists for the time "**Delay action**", the ITVC Line Break carries out the "**Valve Control"**, that means: to energize the SOV and stroke the actuator and the process valve in **closure** (safe position). After having closed the process valve the Valve Control switches in "**Disable**" and any **open/close command is inhibited**. The data of the "**pressure event**" (date, type of event, 24h pressure graph) are memorized in the ITVC permanent memory and can be viewed in the Measurement menu of the ITVC HMI. The icon in the **HOME** page of the display switches from ⋈▶ to ⋈ . ITVC signals Alarm and any **Open** and **Close** command is off.
If the **Pressure event** disappears within the time "**Delay action**", no action is done.

To restart LB operation after a Valve Control:

- restore the correct pressure in the pipeline
- set "Enable = ⊡ " in the Line Break parameters
- re-open the actuator by the local or remote open command

To re-open the valve without restoring the correct pressure in the pipeline:

- set Acquisition or Monitor control mode. The Alarm disappears, exit from MENU mode.
- move the valve by the local or remote open/close commands
- set the Acquisition + Valve Control mode
- when the pipeline pressure is correct, set the Line Break option "Enable = ⊡ "

To set in OFF the Valve Control function

- set Acquisition or Monitor operating mode. In the above modes the Valve Control is OFF, the option "Disable is = ⊡ " and "Enable is = □ " .

3.5 Remote signalling

In Acquisition + Valve Control mode and Enable = ⊡ , the **Monitor Relay** switches over when ITVC carries out the Valve Control.
The auxiliary output relays R1,…,R4 can be individually set to signal: Max pressure increase, Max pressure decrease, LB on=Enable, High LB pressure, Low LB pressure, Max pressure drop. The paragraphs "Output signalling relays" and "Output relays" in the IOM-ITVC-Basic give the procedure to set the above relays.

3.6 Local signalling

In "Acquisition" and "Monitor" operating modes, the **HOME** page of the display shows the icon .
In "Acquisition + Valve Control" mode and Disable = ⊡ , the **HOME** page of the display shows the icon .
In "Acquisition + Valve Control" mode and Enable = ⊡ , the **HOME** page of the display shows the icon . If Valve Control is performed, the ITVC signals Alarm by the red LED of the pushbutton ↵, and the display of the **HOME** page shows the icon A. The Alarm page shows the message

- **"High press limit** or **Low press limit** or **Press drop**", "**Linebreak action**", **Safety action LB**, and **Micro 2 alarm** (see the paragraph Visualization of Alarms and Warnings in the document IOM-ITVC-Basic).

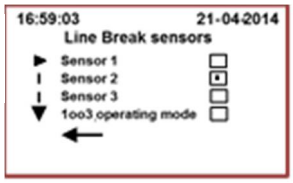
In "Acquisition" and in "Acquisition + Valve Control" modes, the conditions "Pressure increase and decrease / hour > Max pressure increase/decrease" are signalled by Warning. The LED of the ↵ pushbutton is on, fuchsia colour, and the display shows the icon ⚠. The Warning page of the display shows the message "Max pressure increase" or "Max pressure decrease". In Monitor operating mode the measured "Max pressure increase and decrease / hour" can be viewed. The clear option in the above page resets the displayed values.
The option "**Line Break Events**" in the **Measurement** menu shows the list of the "**Pressure events**" with date and time and the 24 hours graphs.
The option "**Line Break Warnings**" in the **Measurement** menu shows the list of the warnings with date and time. No graph is available.

3.7 Analogue inputs architecture

The option "**Sensor**" in the **Line Break menu page** allows setting the architecture of the analogue inputs connected to the pipeline pressure transmitters .
3 modes are available: **1oo1**, **1oo2**, **2oo3** and **1oo3**.
1oo1 mode: one only pressure transmitter, only Sensor 1 or 2 or 3 = ⊡ = ON, no voting mechanism, one only analogue input channel
1oo2 mode: two pressure transmitters, Sensor 1-2 or 1-3 or 2-3 = ⊡ = ON, voting mechanism, two analogue input channels
2oo3 mode: three pressure transmitters, Sensor 1-2-3 = ⊡ = ON, voting mechanism, three analogue input channels
1oo3 mode: three pressure transmitters, Sensor 1-2-3 = ⊡ = ON, voting mechanism, three analogue input channels, "1oo3 operating mode" = ⊡ = ON
The analogue input channels should be previously enabled/disabled by the Setup, Administrator, **Analog inputs** menu (see document IOM-ITVC-Basic).
The next paragraph "Diagnostics" describes the behaviour in case of failure.

LB page

LB sensor
⊡ = ON
□ = OFF



3.8 Output to drive the SOV

According to the user request, the ITVC can be configured to control one or two SOV's. ITVC functions include the test of electrical continuity and absence of short-circuit of coil of SOV's. It is described in the IOM-ITVC-Basic, paragraph "Test of coil of Solenoid Operated Valves" and in the procedures "Coil test" and "Test coil absorption", Setup chapter, Administrator menu. Any fault must be detected three consecutive times, before confirmation.

3.9 CPU redundancy

Line Break and emergency safety functions are managed by two independent CPU's working in parallel, in particular they manage input reading, logic processing and output enabling.

3.10 Diagnostics

3.10.1 CPU diagnostics

Diagnostics processed by each CPU includes: Diagnostics of comparison between the two CPUs, Software flow diagnostics, Watchdog, System clock monitor and Detection of a fault not imputable to an identified channel:

- Power supply diagnostics
- Temperature diagnostics
- Comparison diagnostics of redundant channels (1oo2 architecture)
- CPUs Comparison diagnostic

In case of the above mentioned instances, system switches to safe state.

3.10.2 Analogue inputs diagnostics

The range-ability of the analogue input circuits is from 3 to 21 mA.
CPU's 1 and 2 perform the following diagnostics:

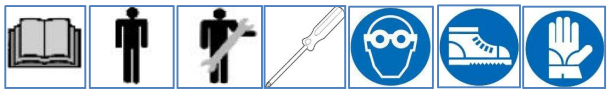
- **Under-range** and **Over-range**
  - ➢ Both CPU's assumes that if signal is <3mA or >21mA the transmitter or the acquisition stage is damaged

  Action performed:
  - **1oo1** architecture:
    - **Valve Control** (SOV energization and closure of actuator)
    - Local alarm and display of type of fault
    - Switch-over of Monitor relay
  - **1oo2** architecture:
    - Local "MRT timer" alarm and display of type of fault
    - Switch-over of Monitor relay
    - Exclusion of damaged channel
    - Operation in **1oo1** architecture for a maximum time equal to MRT. Correct system must be restored (repair or replace the device) or **Valve Control** will be carried out at the end of MRT time. The menu option **MRT,** in the **Measurement** menu, displays the remaining time before than MRT time ends
      - **Valve Control** will be carried out if the surviving analogue channel fails in the MRT time
  - **1oo3** architecture:
    - Local "MRT timer" alarm and display of type of fault
    - Switch-over of Monitor relay
    - Exclusion of damaged channel
    - Operation in **1oo2** architecture for a maximum time equal to MRT. Correct system must be restored (repair or replace the device) or **Valve Control** will be carried out at the end of MRT time. The menu option **MRT,** in the **Measurement** menu, displays the remaining time before than MRT time ends
      - In the MRT time, operation in **1oo1** architecture if a further analogue channel fails (due to over-under range) and **Valve Control** if also the surviving analogue channel fails
      - In the MRT time, **Valve Control** if comparison between the two channels fails
  - **2oo3** architecture:
    - Local alarm and display of type of fault
    - Switch-over of Monitor relay
    - Exclusion of damaged channel
    - Operation in **1oo2** architecture for a maximum time equal to MRT. Correct system must be restored (repair or replace the device) or **Valve Control** will be carried out at the end of MRT time. The menu option **MRT,** in the **Measurement** menu, displays the remaining time before than MRT time ends
      - In the MRT time, **Valve Control** will be carried out if the remaining analogue channels fail (due to over/under range or out of comparison)

- **Continuous comparison** and **voting** for **1oo2, 1oo3** and **2oo3** architectures
  After A/D conversion, if a single signal deviation is more than 5% compared to the reading of each remaining signal, both CPU's assume that:
  - Analog inputs in **1oo2** architecture: one of two signals is not reliable, but it is not possible to identify which one
  - Analog inputs in **2oo3** architecture: channel with the signal out of deviation range is considered damaged

  Action performed:
  - **1oo2** architecture:
    - **Valve Control** (SOV energization and closure of actuator)
    - Local alarm and display of type of fault
    - Switch-over of Monitor relay
  - **1003** architecture:
    - Local "MRT timer" alarm and display of type of fault
    - Switch-over of Monitor relay
    - Exclusion of damaged channel
    - Operation in **1oo2** architecture for a maximum time equal to MRT. Correct system must be restored (repair or replace the device) or **Valve Control** will be carried out at the end of MRT time. The menu option **MRT,** in the **Measurement** menu, displays the remaining time before than MRT time ends
      - in the MRT time, **Valve Control** will be carried out if the analogue channels comparison fails or in case of under/over range in one channel
  - **2oo3** architecture:
    - Local alarm and display of type of fault
    - Switch-over of Monitor relay
    - Exclusion of damaged channel
    - Operation in **1oo2** architecture for a maximum time equal to MRT. Correct system must be restored (repair or replace the device) or **Valve Control** will be carried out at the end of MRT time. The menu option **MRT,** in the **Measurement** menu, displays the remaining time before than MRT time ends
      - In the MRT time, **Valve Control** will be carried out if the remaining analogue channels fail (due to over/under range or out of comparison)
- Restart operations:
  - check/repair transmitter, restore pressure
  - clear MRT alarms in the **Measurement** menu, **MRT** sub-menu
  - clear Alarms and Warnings
  - restore Line Break operation and open the actuator if **Valve Control** was done
- Any fault must be detected three consecutive times, before confirmation.
- If one sensor fails the **ITVC signals alarm**, but if the LB is set "Disable" the **open/close and ESD** commands are **available**

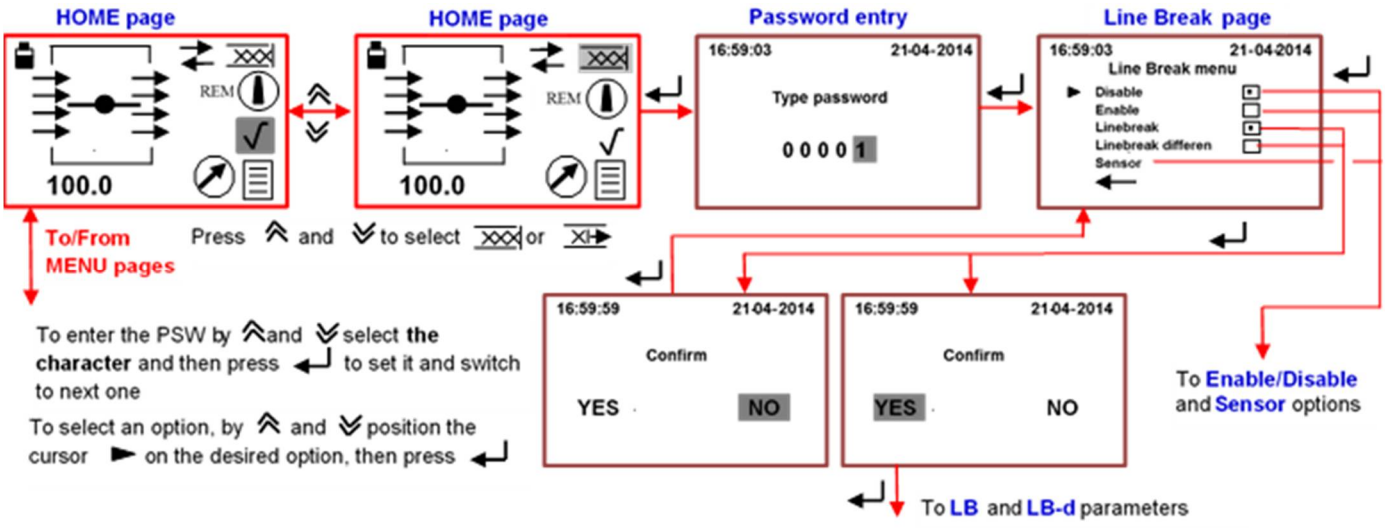
3.11 LB menu in the ITVC HMI



The procedures to view the instantaneous values of the pressure transmitters, the historical data and the alarms are described in the paragraphs "**Visualization of pressures**", "**Instantaneous measures sub-menu**", "**Historical data sub-menu**" and "**Visualization of Alarms and Warnings**" of the document "**IOM-ITVC-Basic**". Refer to **ITVC HMI** chapter of the above IOM to find the instructions relevant to **HOME** page, **navigation** in the **MENU** and **MENU chart**.

Here below are described only the procedures to set the **LB** parameters, to enable/disable the Valve Control, to set the operating mode and sensor architecture. Access to **LB** menu is allowed only by password "**ADMINISTRATOR**".

To enter in the **LB** menu, by ⩓ and ⩔ position the cursor on the icon ⌧ or ⌧→ and then press ↵ . Enter the password **Administrator** ("default 00001"). The ITVC display shows the Line Break menu page.



To switch back from **Line Break page** to **HOME page** press ⩓⩔ simultaneously or by ⩓ and ⩔ position the cursor ► on ← and press ↵

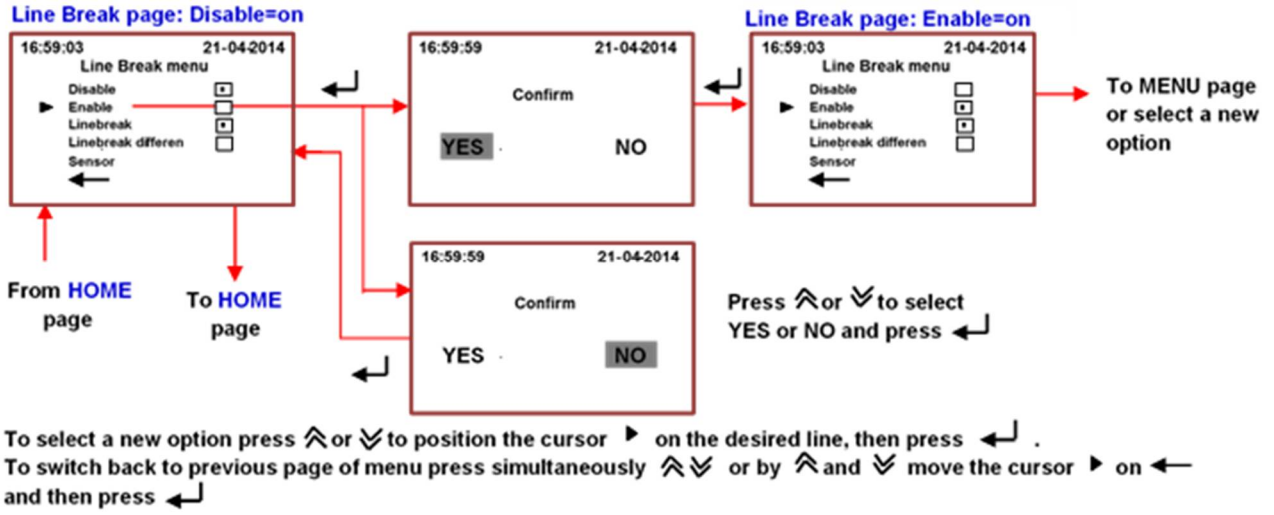
The above figure refers to the "**Standard type**" of **HOME** page (see IOM-ITVC-BASIC, paragraph HOME page). The procedure to navigate in the LB menu is the same in case of **HOME** pages "**HPU type**" and "**HIPPS type**".

The **Line Break menu** has the following options: Enable, Disable, Linebreak, Linebreak differen and Sensor. In the next paragraphs is the description of each option relevant to **LB**. The chapter 4 describes the **LB-d**

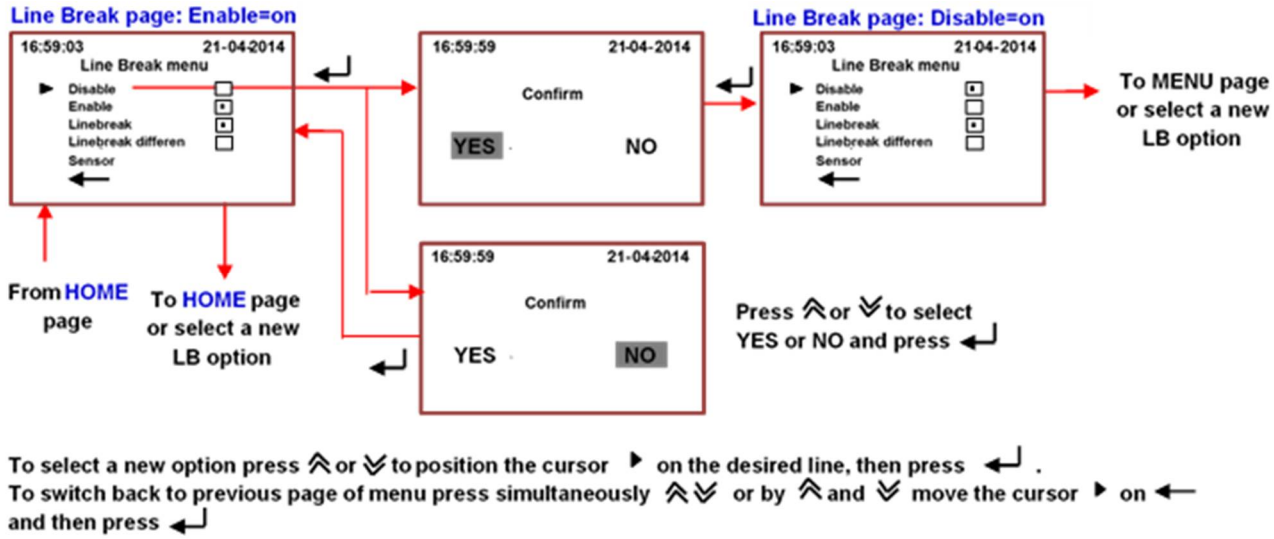
3.11.1 Enable / Disable Valve Control

- **Enable**: if a "**Pressure event**" occurs and lasts for the time "Delay action", the ITVC energizes the SOV to move the actuator in safe position (closure). The "Enable" option is available only if the parameter "**Operating mode**" is "**Acquisition + Valve Control**". The icon of the **HOME** page is .
- **Disable**: even if a "**Pressure event**" occurs and lasts for the time "Delay action", the ITVC does not move the valve. The icon of the **HOME** page is .
- **ON** = ⊡ , **OFF** = □ .

Enable Valve Control procedure:

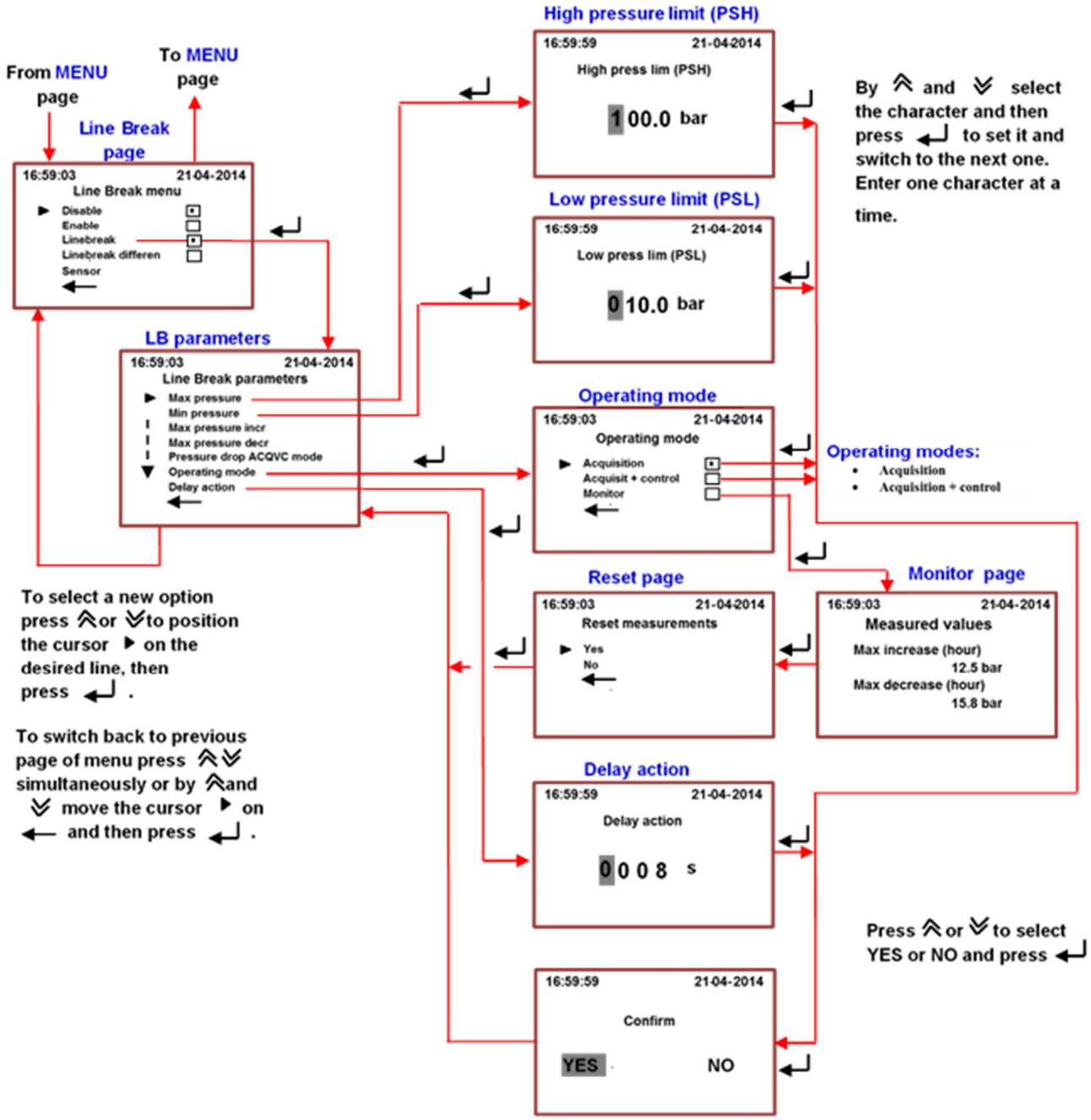


Disable Valve Control procedure:

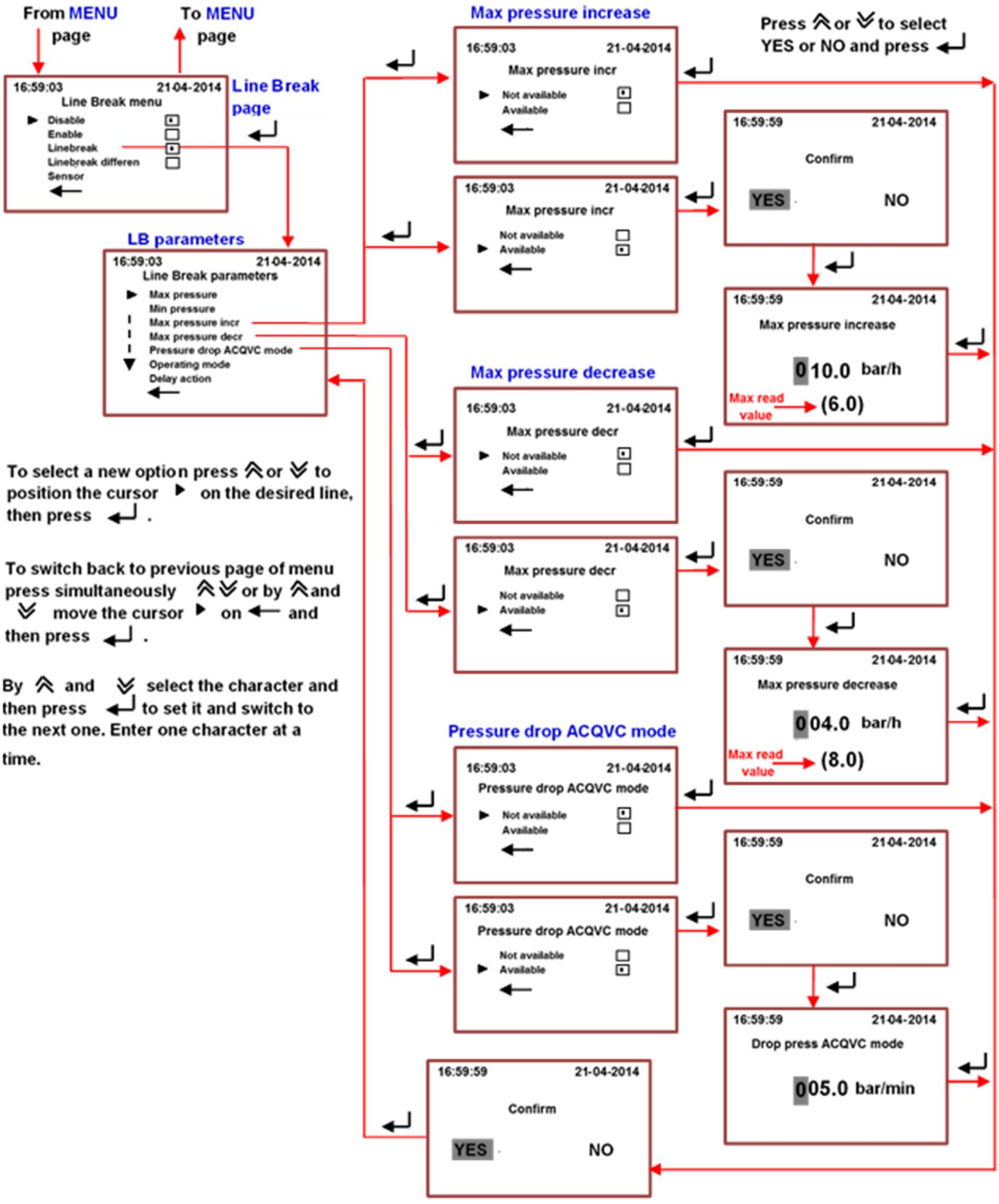


3.11.2 LB parameters

The below figures shows the procedure to set the values of the LB Parameters "**Max pressure, Min pressure, Operating mode, Delay action, Max pressure diff.**", described in the previous paragraph **"Line Break working parameters"**.
In the operating mode "**MONITOR**", the option **YES**, in the **Reset page,** clears the **measured** Max increase / hour and Max decrease / hour in the "**Monitor page**" of display

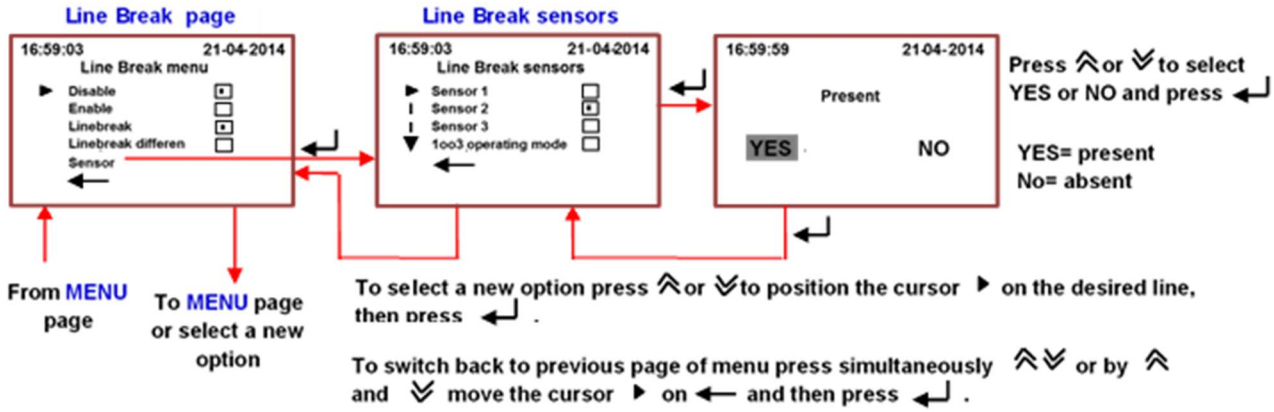


The below figures show the procedure to set values of the LB Parameters "**Max pressure increase**, **Max pressure decrease** and **Pressure drop ACQVC (ACQ**uisition **+ V**alve **C**ontrol)**"**, described in the previous paragraph **"Line Break working parameters"**.

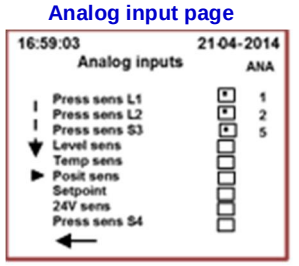


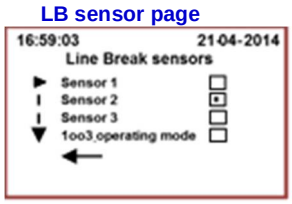
3.11.3 LB Sensor option

The procedure described below allows setting the analogue input architecture.
Sensor 1: it corresponds to "L1 Pressure sensor" in the Measurement and Setup menu
Sensor 2: it corresponds to "L2 Pressure sensor" in the Measurement and Setup menu
Sensor 3: it corresponds to "S3 Pressure sensor" in the Measurement and Setup menu
The character " ⊡ " indicates presence of transmitter, the character " □ " indicates absence.
To avoid alarms, it is important that the configuration of the **LB sensor** page in the Line Break menu is according to the setting of the **Analog inputs** page in the **Administrator**, **Setup** menu. If a sensor is "not available" (□) in the **Analog input** page it must be set "absent" (□) also in the **LB sensor** page. Vice-versa, if a sensor is set "available" (⊡) in the **Analog inputs** page in the **Administrator**, **Setup** menu, it should be set "present" in the **LB sensor** page and Line Break function works according to description in the paragraph "Analogue input architecture". It is mandatory that the above settings is according to the pressure transmitters really connected to the analogue input channels of the ITVC.
The "1oo3 operating mode" sets the analogue input channels architecture to work in **1oo3** mode, see "Diagnostics" paragraph.

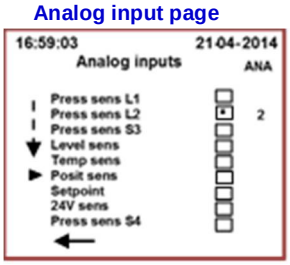


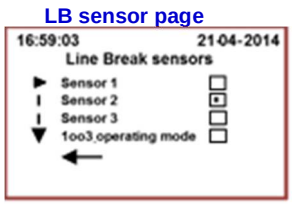
Note: A sensor set "available" in the **Analog inputs** page in the **Administrator**, **Setup** menu, and "absent" in the **LB sensor** page, is not used by the Line Break function, but if it fails, it generates an Alarm (even if not used). The figure below shows an example of setting in case of **1oo1** analogue input architecture.





This settings is not correct. The working pressure transmitter is Sensor 2, connected to analogue channel 2, Press sens L2 in the Analogue input page of Administrator, Setup menu. Even if not used by the Line Break function, the pressure sensors connected to analogue channels 1 and 5, Press sens L1 and Press sens S3 generates alarms in case of failures (or if they are not connected to ITVC), since they are set as "available". They must be configured "not available"

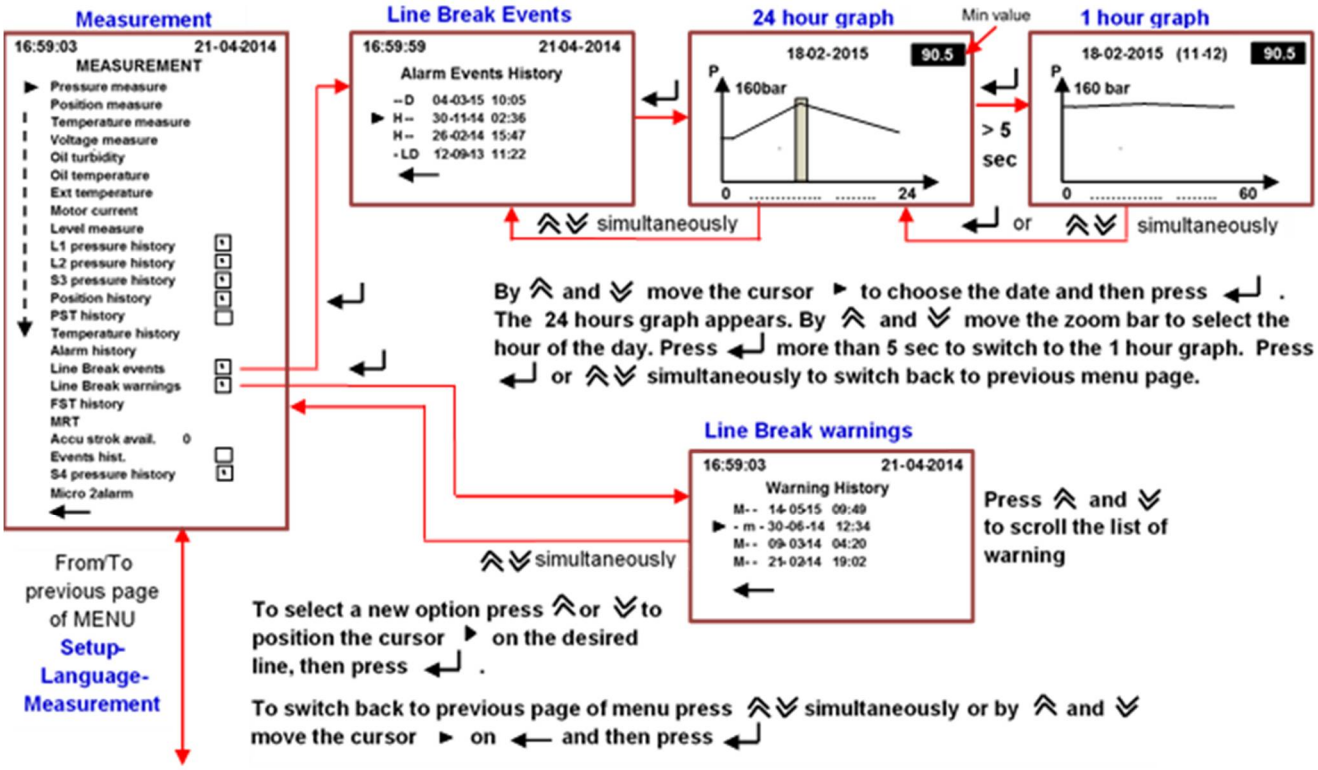




Correct settings. The working pressure transmitter is Sensor 2, connected to analogue channel 2, Press sens L2 in the Analogue input page of Administrator, Setup menu. Press sens L1 and S3 are "not available".

3.11.4 LB options in the MEASUREMENT menu of ITVC HMI

The below procedure allows viewing the "**Pressure events**" history and graphs and the Line Break warning list and date. In the Line Break Events page, **D** stays for Pressure Drop rate, **H** stays for High pressure, **L** stays for Low pressure In the Line Break warnings page the character "**M**" stays for "Max pressure increase" and "**m**" stays for "Max pressure decrease". The procedure to move in the **Measurement** menu are described in the manual IOM-ITVC-Basic.



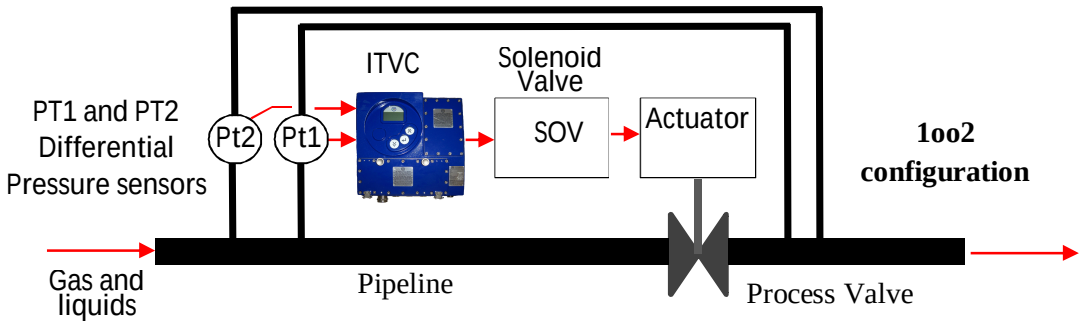
In the manual IOM-ITVC-Basic, Measurement menu, Historical data sub-menu are described the procedures to view the instantaneous pressure measures and the L1, L2, S3, S4 pressure history and graph. History and graph are available only if they are marked with the symbol "⊡".

4 Line Break differential (LB-d)

The ITVC monitors the pressure across the process valve and carries out the safe action if the differential pressure is outside the limit. The following **LB-d** options can be set:

- **Safe action**:
  - stayput, open, close
- **Condition to start**:
  - differential pressure higher than a configurable limit
  - differential pressure less than a configurable limit
- **Differential pressure limit**:
  - configurable pressure value to compare with the read pressure and decide if the safe action should start
- **Enable/Disable**:
  - by this parameter the LB-d safe action is enabled/disabled

Only **1oo2** configuration of analogue inputs is available. The reaction time is 200ms



4.1 Operating mode

If the setting is "**Enable**" the icon of the **HOME** page is : the local and remote open/close and ESD commands are available. If the configured "**condition to start**" is **true**, the ITVC drives actuator and valve to the **safe position** (stay in position or open or close). The icon of the **HOME** page becomes and LB-d switches to "**Disable**" status. The ITVC signals alarm by the icon A and by the LED of the pushbutton that lights-up red colour. The Monitor relay switches over. The **alarm visualization** page of the ITVC HMI shows: "**Linebreak action**", "**Press out of limit**", "**Micro 2 alarm**" and "**Safety action**". The alarm is recorded also in the "**Alarm history**" register (Measurement menu). The local and remote **open/close** commands to move actuator and valve **are inhibited**, but the **ESD command** is still available since it has the **highest priority**.
Even if the "condition to start" becomes false the LB-d remains in "Disable" status, the ITVC maintains the alarms and the open/close commands are off.
In case of ESD command sent after the "condition to start" occurs, the ITVC drives actuator and valve to the safe position set in the ESD parameters (**ESD safety position**). When the ESD command disappears, since the LB-d status is "Disable", the actuator remains in the last position.
Vice-versa if the ESD command was sent before the "condition to start" occurs, the LB-d remains in "Enable" status. Due to ESD command, actuator and valve move to the ESD safety position, but if the ESD command is removed and the "condition to start" is true, actuator and valve perform the LB-d safe action
To **restore LB-d operation** it is necessary

- to check that the differential pressure is in the acceptable limit
- to set the parameter "Enable" = ON in the ITVC HMI.

The alarm is cleared and the local and remote open/close commands are available.

If the setting is "**Disable**" the icon of the **HOME** page is . The ITVC works according to IOM-ITVC-basic. The differential pressure is continuously measured and visible by the ITVC HMI, but the safe action is inhibited e no alarm is generated even if the "condition to start" is true.

4.2 CPU redundancy

Line Break-differential is safety function managed by two independent CPU's working in parallel, in particular they manage input reading, logic processing and output enabling.

4.3 Output to drive the SOV

ITVC functions include the test of electrical continuity and absence of short-circuit of coil of SOV. It is described in the IOM-ITVC-Basic, paragraph "Test of coil of Solenoid Operated Valves" and in the procedures "Coil test" and "Test coil absorption", Setup chapter, Administrator menu. Any fault must be detected three consecutive times, before confirmation.

4.4 Diagnostic

Analogue input diagnostic
The range-ability of the analogue input circuits is from 3 to 21 mA.
CPU's 1 and 2 perform the following diagnostics:

- **Under-range** and **Over-range**
  - Both CPU's assumes that if signal is <3mA or >21mA the transmitter or the acquisition stage is damaged

  Action performed:
  - Local "MRT timer" alarm and display of type of fault
  - Switch-over of Monitor relay
  - Exclusion of damaged channel
  - Operation in **1oo1** architecture for a maximum time equal to MRT. Correct system must be restored (repair or replace the device) or the configured **LB-d safe action** will be carried out at the end of MRT time. The menu option **MRT,** in the **Measurement** menu, displays the remaining time before than MRT time ends
    - **LB-d safe action** will be carried out if the surviving analogue channel fails in the MRT time

- **Continuous comparison** and **voting**
  After A/D conversion, if a single signal deviation is more than 5% compared to the reading of each remaining signal, both CPU's assume that:
  - One of two signals is not reliable, but it is not possible to identify which one

  Action performed:
  - **LB-d safe action**
  - Local alarm and display of type of fault
  - Switch-over of Monitor relay

CPU's diagnostic
Diagnostics processed by each CPU includes: Diagnostics of comparison between the two CPUs, Software flow diagnostics, Watchdog, System clock monitor and Detection of a fault not imputable to an identified channel:

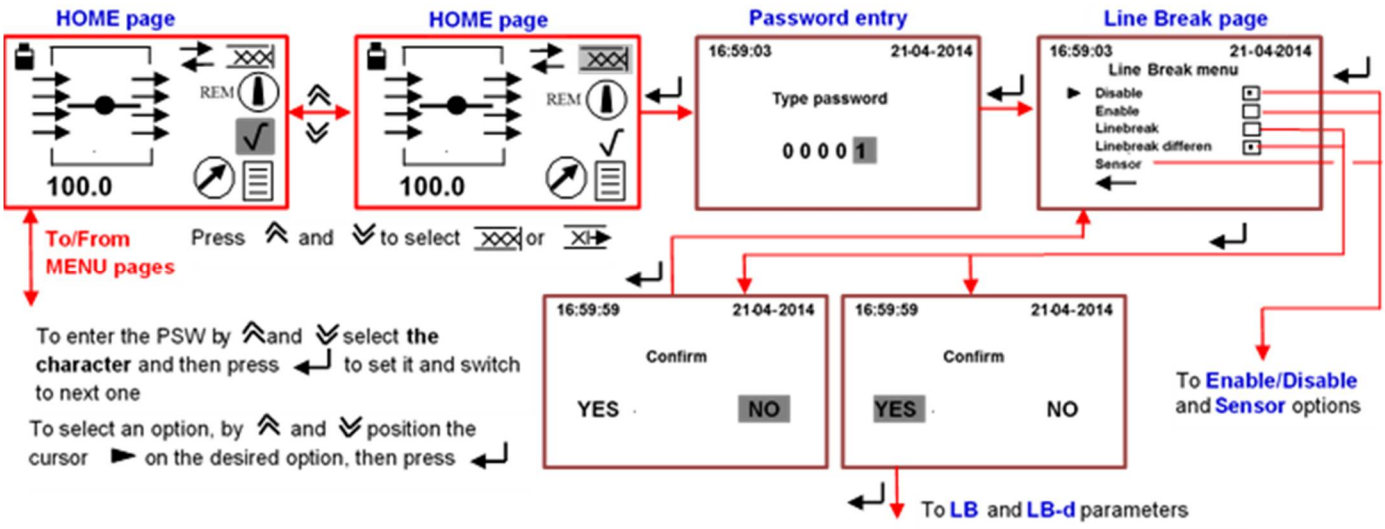
- Power supply diagnostics
- Temperature diagnostics
- Comparison diagnostics of redundant channels (1oo2 architecture)
- CPUs Comparison diagnostic

In case of the above mentioned instances, system switches to safe state.

4.5 LB-d menu in the ITVC HMI

The procedures to view the instantaneous values of the pressure transmitters, the historical data and the alarms are described in the paragraphs "**Visualization of pressures**", "**Instantaneous measures sub-menu**", "**Historical data sub-menu**" and "**Visualization of Alarms and Warnings**" of the document "**IOM-ITVC-Basic**". Refer to **ITVC HMI** chapter of the above IOM to find the instructions relevant to **HOME** page, **navigation** in the **MENU** and **MENU chart**.
Here below are described only the procedures to set the **LB-d** parameters, to enable/disable the **safe action**, to set the working parameters and sensor architecture. Access to **LB-d** menu is done only by password "**ADMINISTRATOR**".

To enter in the **LB-d** menu, by ⩓ and ⩔ position the cursor on the icon ⊠ or ⊡ and then press ↵. Enter the password **Administrator** ("default 00001"). The ITVC display shows the Line Break menu page.



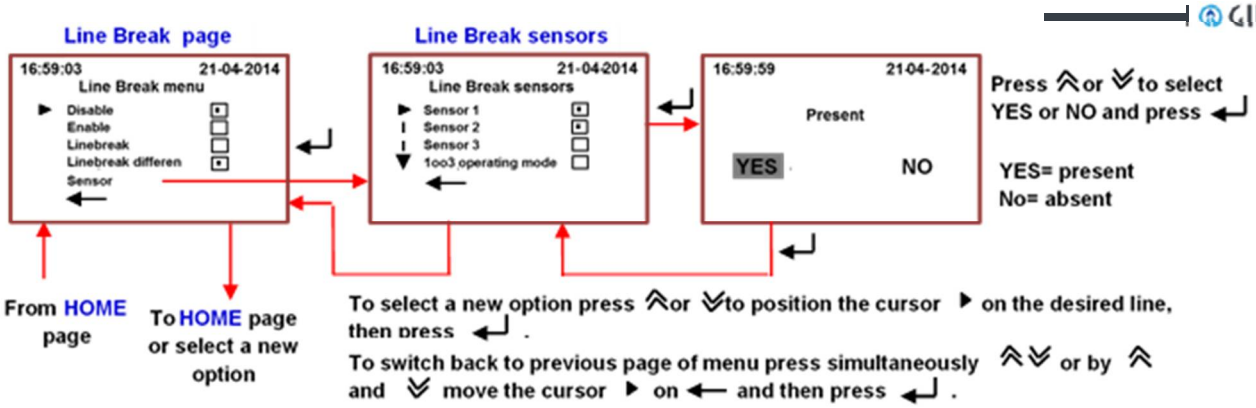
To switch back from **Line Break page** to **HOME page** press ⩓⩔ simultaneously or by ⩓ and ⩔ position the cursor ► on ← and press ↵

The above figure refers to the "**Standard type**" of **HOME** page (see IOM-ITVC-BASIC, paragraph HOME page). The procedure to navigate in the LB menu is the same in case of **HOME** pages "**HPU type**" and "**HIPPS type**".

The **LB menu** has the following options: Enable, Disable, Linebreak, Linebreak differen and Sensor. In the next paragraphs is the description of each option relevant to **LB-d**. The chapter 3 describes the **LB**

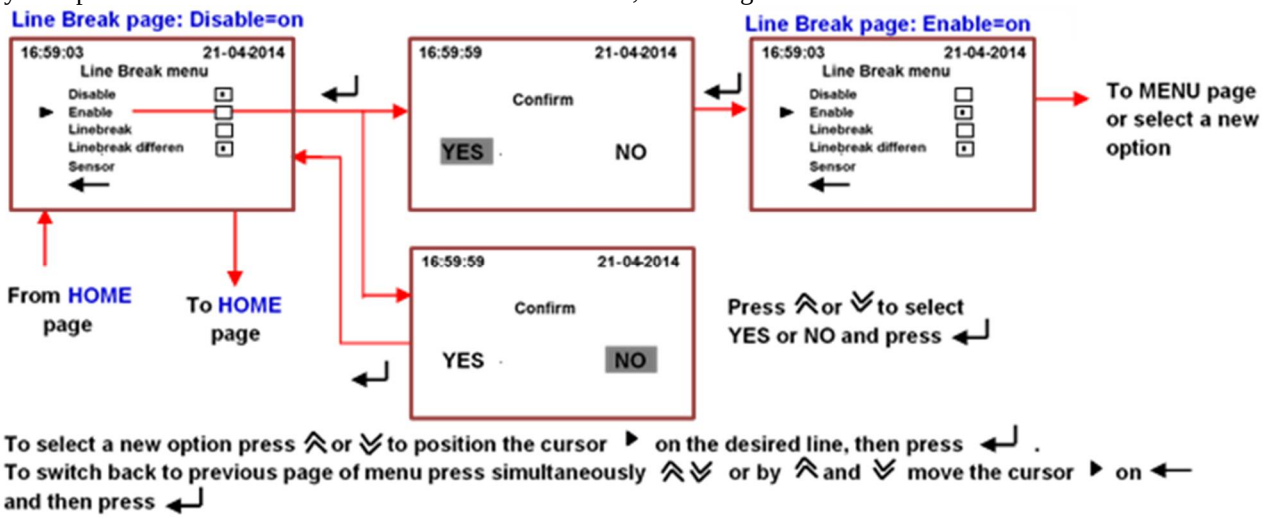
4.6 LB-d Sensor option

The 4-20 mA differential pressure transmitters should be connected to Sensor 1 and Sensor 2 (⊡) . The same configuration should be present in the Analog input page of the Administrator menu (Press sens L1 and Press sens L2). The below figure shows the Line Break sensor page. The options "Sensor 3" and "1oo3 operating mode" are not available.
By the Measurement menu, instantaneous measures and 24-hour records of the read pressures can be visualized. See IOM-ITVC-basic and IOM-ITVC-LB par. 4.3

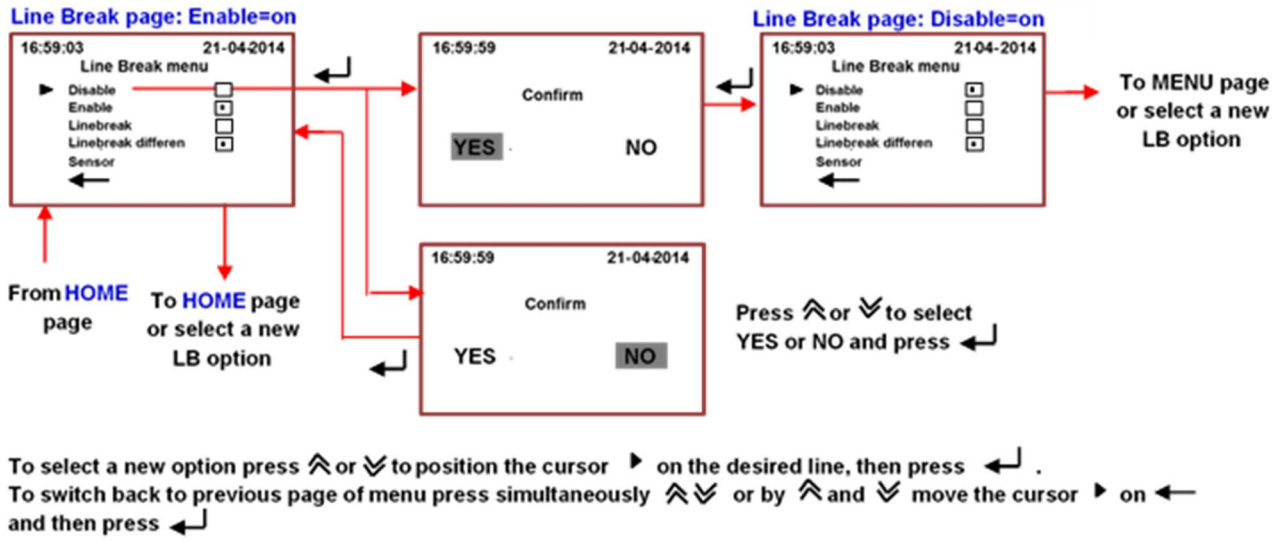


4.7 LB-d Enable / Disable

By the option "**Enable**" and if the "condition to start" is true, the configured safe action is carried out



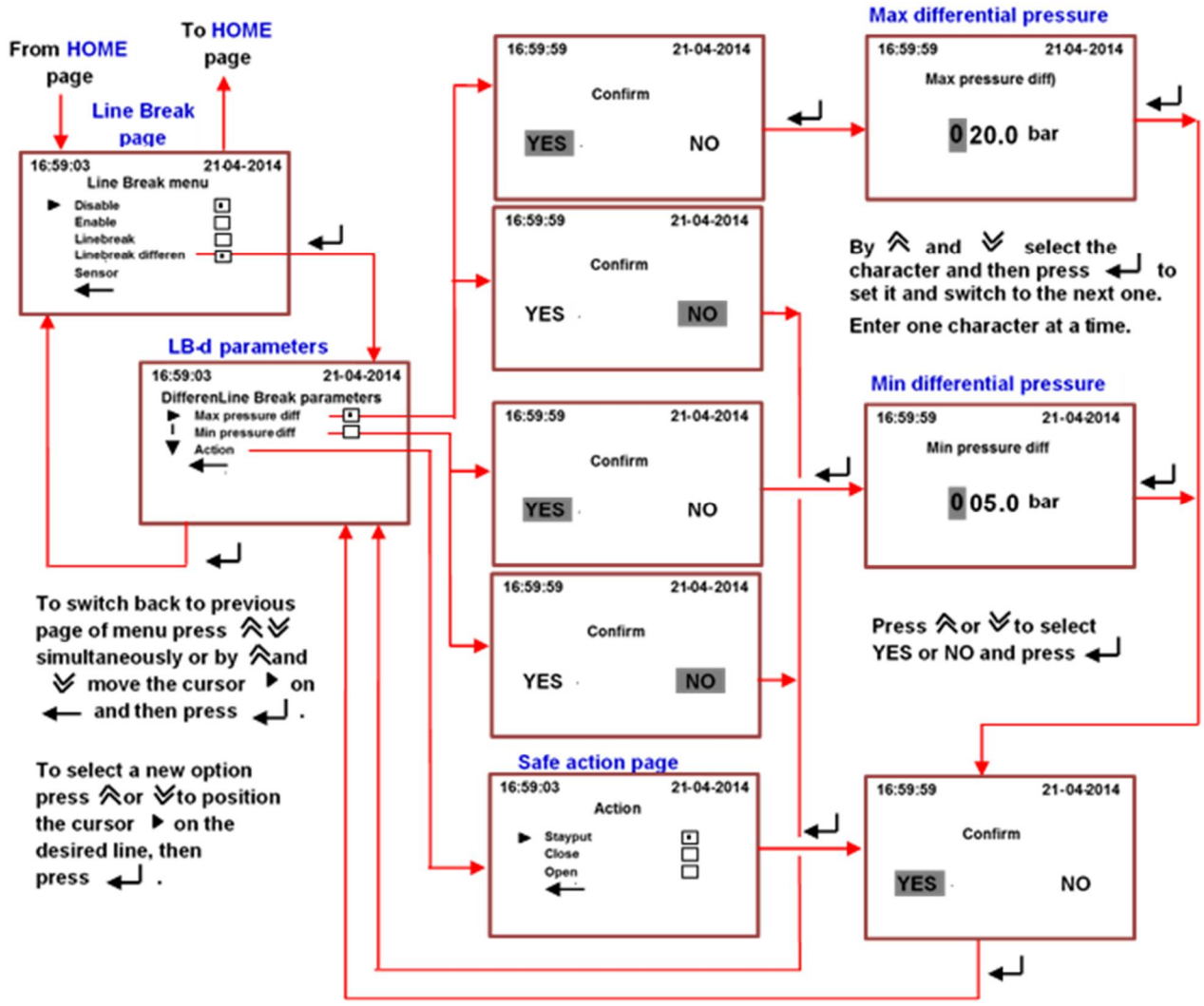
By the option "**Disable**" the configured safe action is inhibited



4.8 LB-d parameters

By this option the following parameters can be set:

- **Condition to start**: type of test to decide if the safe action should start. Two options are available: The “read differential pressure is higher than a configured limit” or “the read differential pressure is less than a configured limit”. One only test at a time can be set
- **Max differential pressure**: limit of pressure if the “condition to start” is “differential pressure is higher than a configured limit”
- **Min differential pressure**: limit of pressure if the “condition to start” is “differential pressure is less than a configured limit”
- **Safe action**: action to perform if the configured test is true. Three options are available, stayput, open, close. One option at a time can be set.



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5 Battery option

If required, ITVC can be equipped (only -20°÷+85°C ITVC version) with a rechargeable lithium-ion battery, which in case of power supply failure, keeps the ITVC functioning even if the main electrical power fails. Battery option is available for all types of ITVC controller but in general is requested in the versions with Line Break.

PLEASE NOTE THAT IN CASE OF "ENERGIZE-TO-TRIP" ESD ACTION, BATTERY IS MANDATORY

MINIMUM BATTERY OPERATING TIME IN MONITORING MODE

(ITVC disconnected from power supply; No. 3 sensors + No. 1 position sensors connected)

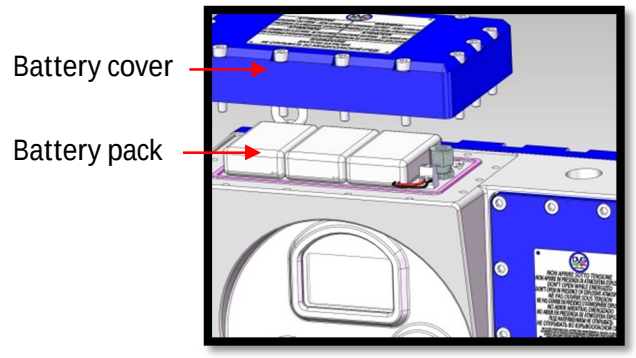
STANDARD BATTERY: 12 hours (battery capacity 53Wh) - **DVG P/N: CBAEOZZ0001**

EXTENDED BATTERY: 36 hours (battery capacity 160Wh) - **DVG P/N: CBAEOZZ0002**

In case of power supply failure, battery recharge cycle will start automatically when power supply is restored. The recharge time is max 9 hours (standard pack) and 27 hours (extended pack), charge current 500mA.

- The battery is located on top of the ITVC, in the battery compartment.
- Electrical connection between battery and the ITVC module is according to ATEX.
- The ITVC is shipped with the battery **connected** and **disabled**. After installation and start-up of ITVC, **enable the battery** from the **ADMINISTRATOR menu.**

REPLACE BATTERY IN A SAFE AREA AND USING ONLY DVG ORIGINAL PARTS.



WARNING!	
	Use only genuine DVG AUTOMATION parts. *Use of components not manufactured by DVG AUTOMATION will void your warranty, might adversely affect the performance of the instrument, and could cause personal injury and property damage.*

Local signalling: If the battery is enabled the **HOME** page of the ITVC HMI shows the icon . The icon shows also the charge level of battery. If the battery is **discharged** or **unconnected** the ITVC raises an **alarm** and the icon is . The LED of pushbutton lights-up, red colour, the Open and Close actuator commands are available and work. The alarm should be reset by the procedure described in the paragraph "Visualization of alarms and warning" of the IOM-ITVC-Basic.

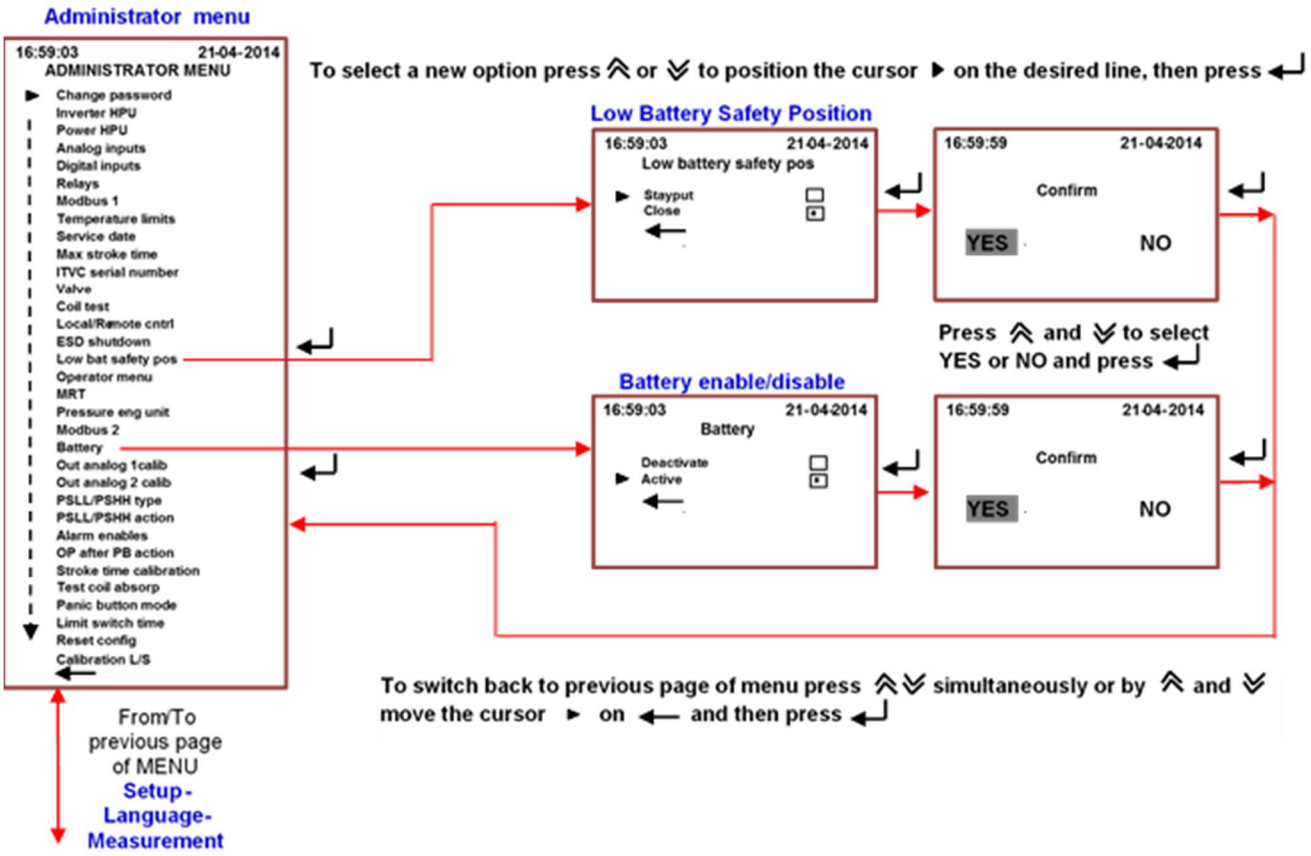
Remote signalling: in case of battery alarm the **Monitor relay** switches-over. The auxiliary output relays R1,…,R4 can be individually set to signal "**Low battery**". The paragraphs "Output signalling relays" and "Output relays" in the IOM-ITVC-Basic give the procedure to set the above relays.

Configuration options: in the SETUP, ADMINISTRATOR menu are available two configuration options

- Battery: the option "Deactivate" disables the battery, the option "Active" enables the battery
- Low bat safety pos: it sets the action in case of battery alarm, stayput or close.

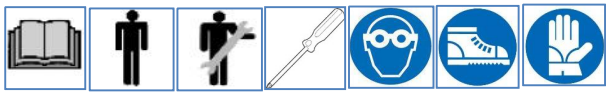
5.1 Setting options in the ADMINISTRATOR menu

The figure below shows the procedure to enable/disable the battery and to set the action in case of battery alarm



See the manual **IOM-ITVC-Basic**, chapter SETUP, ADMINISTRATOR to find more instruction relevant to navigation and setting of parameters

6 Troubleshooting



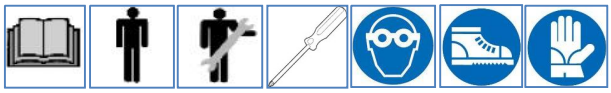
In addition to the alarms listed in the paragraph TROUBLESHOOTING of manual **IOM-ITVC-Basic**, the tables below show the **Alarms** and **MRT Alarms** and the **Warnings** generated by the Line Break function and diagnostics of pressure analogue inputs. They include also the alarms in case of **ITVC with battery pack**. The alarm of diagnostics of CPU's and output SOV's are in the paragraph TROUBLESHOOTING of manual **IOM-ITVC-Basic.**
ITVC signals the presence of an Alarm remotely by the **Monitor relay** and locally by the icon A in the **HOME** page. The LED of pushbutton ↵ lights-up red colour. In case of warning the display shows the icon ⚠ and the LED of pushbutton ↵ lights-up, fuchsia colour.
Use the procedure described in the paragraph "**Visualization of Alarms and Warnings**" of document "**IOM-ITVC-Basic**" to view the current alarms and warnings.
In case of **MRT Alarm**, in the list of current alarms there is the alarm "**MRT timer**". By the procedure "**Instantaneous measures sub-menu**" in the **Measurement** menu of "**IOM-ITVC-Basic**", the type of alarm and the remaining MRT time can be viewed. By the above procedure the MRT alarm can be cleared, but it will be effective only if the malfunction is solved.
The tables below show the potential causes of the alarms and the action to do to solve the problem.

Device	Alarm displayed	Potential cause	Action
LB and LB-d	LINE BREAK ACTION	Line Break action in progress	Solve emergency and restore ITVC
	SENS OUT OF COMP (1oo2)	Sensor comparison failed	Check sensors. If necessary replace
LB	SENS **n** OUT COMP (2oo3) (**n= 1÷3**)	Sensor **n** comparison failed	Check sensor n. If necessary replace
	PRESS DROP	Pipeline pressure drop rate exceeds the limit	Solve emergency and restore ITVC
	LOW PRES LIMIT PSL	Pipeline pressure lower than limit	Solve emergency and restore ITVC
	HIGH PRES LIMIT PSH	Pipeline pressure exceeds the limit	Solve emergency and restore ITVC
LB-d	PRESS OUT OF LIMITS	Differential pressure out of setpoint	Solve emergency and restore ITVC
	DISCREPANCY ALARM	Difference > 2 bar in the two measures of the differential pressure	Check sensors and restore ITVC
Battery	LOW BATTERY	Low battery voltage	Check power supply. Restore power supply and after 2 hours check again alarm. If necessary, replace battery
	NO BATTERY	Low battery voltage or battery disconnected	Check if battery is activated in Administrator menu. Check power supply. Restore power supply and after 2 hours check again alarm. If necessary, check battery connections and/or replace battery

Device	MRTAlarm displayed	Potential cause	Action
LB and LB-d	SENS **n** OUT OF RANGE (n=1-3)	Sensor **n** out of range	Check sensor n. If necessary replace
	SENS **n** OUT OF COMP (n=1-3)	Sensor **n** out of comparison and voting process	Check sensor n. If necessary replace

Device	Warning displayed	Potential cause	Action
LB	MAX PRESSURE INCREASE	Max pressure increase / hour exceeded	Solve emergency and restore ITVC
	MAX PRESSURE DECREASE	Max pressure decrease / hour exceeded	Solve emergency and restore ITVC

7 Start-up



The following checks should be added to the procedures described in the chapter START-UP of the document **IOM-ITVC-Basic** LB start-up

7.1 LB start-up

- the digital inputs and outputs should be according to the wiring diagram
- the reading of the pressure transmitter should be correct and according to working pressure of the pipeline. If the configuration is 1oo2,1oo3 or 2oo3 check that the deviation is less than 5%. View the values by the procedure described in the paragraph “Visualization of pressures” in the manual IOM-ITVC-Basic.
- check that no Alarm, MRT alarm or Warning is present (Led of pushbutton ↵ should be off).
- check the settings of Line Break parameters. In particular check that the parameters “Maximum and Minimum pressure” are according to the operating pressures of the pipeline
- Check that parameter “Max pressure drop ACQVC” is set “available” and the value is correct
- open the actuator, and set “Enable” if the operating mode is “Acquisition + Valve Control”.
- Check that icon in the HOME page of ITVC display is .
- If the ITVC is fitted with battery pack see the procedure in the paragraph “Battery option” to enable it.

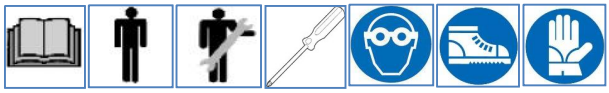
If the pressure drop rate in the pipeline is unknown, it is suggested to proceed as follows:

- set the parameter “Max pressure drop ACQVC” as “not available”
- set the parameters “Max pressure increase” and “Max pressure decrease” as available and enter a small value, to generate warning as described in the previous paragraphs.
- Keep the system in operation for a significant time and then check the LB warning in the “Measurement” menu. View the “Max pressure increase and decrease in the “**Monitor**” page of the Line Break parameters (Operating mode).
- Clear the Warnings. Set the “Max pressure increase” and “Max pressure decrease” as not available” or enter a value higher than the reading in the “Monitor” page. Clear the reading in the “Monitor” page.
- Set the “Max pressure drop ACQVC” as “available and enter the value measured by the above procedure.

7.2 LB-d start-up

- The digital inputs and outputs should be according to the wiring diagram
- The reading of the pressure transmitter should be correct and according to working pressure of the pipeline. Deviation should be less than 5%. View the values by the procedure described in the paragraph “Visualization of pressures” in the manual IOM-ITVC-Basic.
- Check that no Alarm, MRT alarm or Warning is present (Led of pushbutton ↵ should be off).
- Check the settings of LB-d parameters. Set the parameter “Enable”
- Check that icon in the HOME page of ITVC display is .
- If the ITVC is fitted with battery pack see the procedure in the paragraph “Battery option” to enable it

8 Installation and Maintenance



Refer to document **IOM-ITVC-Basic**. No additional instruction are requested for Line Break function.
If ITVC is fitted with battery pack, see paragraph “Battery option” in this manual

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