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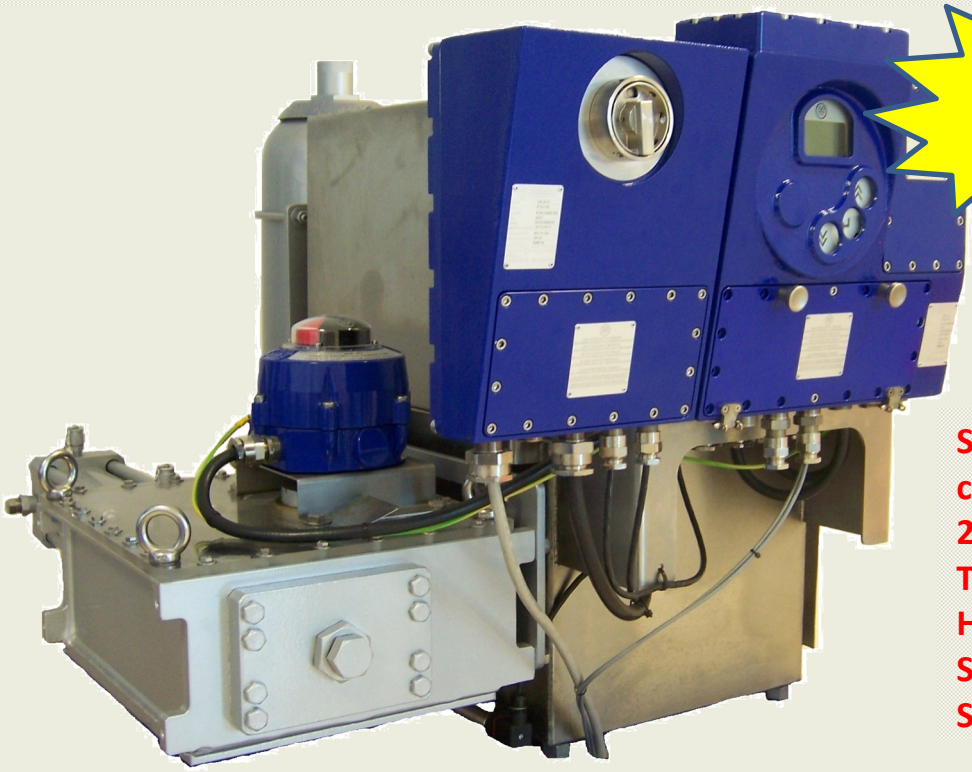
Electro-hydraulic actuator with self-contained HPU and ITVC electronic control



SIL 3

SIL certificate of conformity No: 28714183 rev.1
Type: B
HFT: 1
SC: 3
SIL: 3

Electro-Hydraulic actuator with self-contained HPU and ITVC electronic control.
Typical applications include safety related Emergency Shutdown function and Remotely Operated Valve control.
SIL 3 level of the safety functions, according to IEC61508, “Low Demand mode”.
Designed for use “in field”, in severe applications where operational failures can cause safety and environmental problems and production losses.
The complete electronic control consists in 2 main units, electrically and mechanically interconnected to work as one only single device:

- ITVC unit
- HPU control unit

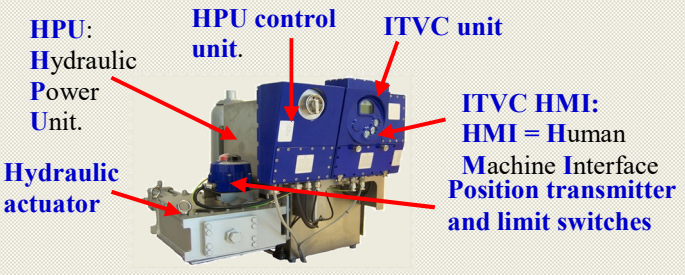
1 Product specifications

1.1 Electrical Power Supply

DC	24Vdc, +15%, -20%
AC 1-PH	230 Vac, 50Hz, +10%, -10%
AC 3-PH	230, 400, 440 Vac, 50Hz, +10%, -10%
12W	Max power absorbed from ITVC+HPU

Standard: one only electrical power to supply both **HPU control unit** and **ITVC unit**. On request, separated electrical power to supply the ITVC unit.
On request: backup battery pack (operating °C: -20 + 85°C):

Type	12 V Rechargeable Lithium-ion
Part Number	CBAEOZZ0001
Capacity	53 Ah



Example of hydraulic actuator with self-contained HPU and ITVC with HPU control units

Battery operation: in case of loss of main power supply, the ITVC takes the electrical power from battery and works regularly except motor control. Operation and recharge time depend on the number of transmitters and SOV's.

Refer to data sheet "DS-ITVC-LB-PST-xx-hpu" to see the additional characteristics of Line Break and Partial Stroking Test functions. The present data sheet reports only the features of the ITVC with HPU control module.

1.2 I/O's of Electronics

		Analogue inputs	Digital inputs	Output relays	Analogue outputs	Coil drivers	Contactor drivers	BUS control
HPU control unit	Terminal block (to user and HPU)	3	4	2		5	2 **(a)**	**Standard:** 2 x RS485 Modbus RTU **On request:** HART
ITVC unit	Terminal block (to user)	1	8	5	2			
	Terminal block (to actuator)	4	4	3		8		

(a) In case of 24 Vdc and 2 pumps, the contactor of second pump should be placed in an additional enclosure
(b) I/O's characteristics described in paragraphs 3, 4, 5

1.3 Actuator performance data

Operating pressure		Max 350 barg (5076 psi)
Operating temperature	Standard Low	From -20 °C to + 85 °C From -60 °C to + 85 °C
Travel time		Min 1 sec
Torque range (Quarter turn)	Single acting spring return Double acting	Up to 800 000 Nm Up to 800 000 Nm
Thrust range (Linear)	Single acting spring return Double acting	Up to 1 500 000 N (Cylinder) and 300 000 N (Spring) Up to 1 500 000 N

2 HPU control features

2.1 Electrical protection

Main power switch	To switch on/off the electrical power of the actuator
Voltage sensor	To measure the voltage supply. The value can be viewed by the HMI of the ITVC. If the voltage is out of the configured limits an alarm is generated and the pump motors are blocked
Phase loss sensor	Only 3 PH version. In case of phase loss an alarm is generated and the pump motors are blocked
Current sensors	To measure the absorbed current. The value can be viewed by the HMI of the ITVC. If the current is out of the configured limits an alarm is generated and the pumps are blocked
Current unbalance	This control is available only if the main power supply is **3-PH**. If the difference between the current of phases is greater than a configurable value an alarm is generated and pump are blocked

2.2 Hydraulic Pumps and Electrical Motors

1 Pump	1 electrical motors	1 motor contactor inside the **HPU control** unit
2 Pumps	2 electrical motors	2 motor contactors inside the **HPU control** unit, only if AC 1PH or 3PH

In case of 2 pumps and DC power supply, the second contactor will be placed in an additional enclosure.

2.3 Pump control

By oil pressure measurement	Oil pressure is measured by a 4-20 mA analogue pressure transmitter. Oil pressure is visible in the HOME page of the ITVC HMI. **Pump exchange** (in case of 2 pumps): • Cyclic: one pump at a time works. Pump exchange after a configurable time • Master-Slave: one pump at a time works. If the master pump is in alarm, the second pump (slave) starts.	**1 or 2 pumps**
By accumulator volume loss (-5% and -10%)	Oil accumulator (piston type) is fitted with switches to detect "end travel, volume loss -5% and volume loss -10%" (this system is according to **SHELL** specification DEM 1) • **Pump selection:** the first pump to start can be selected by the ITVC HMI.	**Only 2 pumps**

2.4 Oil level measurement

Analogue input	HPU equipped with a 4-20 mA oil level transmitter. Level is visible in the HOME page of the ITVC HMI	Alarm and block of pumps if the oil level is lower than the configured value
Digital input	HPU equipped with a level switch to detect the minimum level in the oil reservoir	Alarm and block of pump if the sensor detects low oil level in the reservoir

Estimation of residual stroke by accumulator: if oil level measurement is **analogue** and pump control is **by pressure measurement**, an algorithm calculates the number of residual strokes with the remaining pressurized oil in the accumulator. The estimated value is visible by the menu options of ITVC HMI.

2.5 Oil temperature measurement

Analogue input	Oil temperature is measured by a 4-20 mA temperature transmitter. Oil temperature is visible by the ITVC HMI	**High temperature:** Alarm and block of pumps if the temperature is higher than the configured value. **Low temperature:** Only alarm and optional heater control
Digital input	HPU is fitted with a thermostat to detect the maximum oil temperature	Alarm and block of pump if the sensor detects high oil temperature

2.6 Oil cleanness measurement

Analogue input	Oil cleanness is measured by a 4-20 mA transmitter and is visible by the ITVC HMI	Alarm and block of pumps if the oil turbidity is higher than the configured value.

2.7 Additional digital sensors

Door switch	To signal the opening of the door of the HPU enclosure. It generates a Warning
Handpump selector	If the handpump selector is in MANUAL the electrical pumps are blocked
Pneumatic micro switch	Special application (only on request)
PST mechanical	Special application (only on request)
Piston posit SW low-low	Option only in case of pump control by volume loss. It generates alarm and pump block

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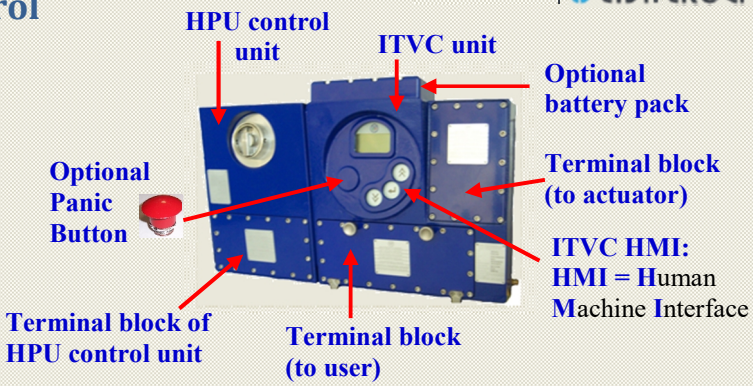
3 I/O's available to Remote Control

3.1 Terminal block of HPU control unit

Output relays	2 relays: single side stable, voltage free SPDT contact, from 24 Vdc-ac to 230Vac / 5A. Condition to switch configurable by ITVC HMI. **Options available:**	
	Motor 1 running Motor 2 running	Motor 1&2 running Heater on/off.



3.2 ITVC Terminal block (to user)

Digital inputs (see Table 2)	• 4 digital inputs, optocoupled, 1 common, from 22Vdc-ac to 130Vdc-ac, max 5 mA each input. o Open and Close remote commands from control room, reaction time **300 ms** o IN3, IN4 remote commands, configurable by means of the ITVC HMI, see Table 2 • 2 independent ESD1 and ESD2 input channels: optocoupled, from 22Vdc-ac to 130Vdc-ac, max 5 mA each input, reaction time **600 ms.** Configuration by means of the ITVC HMI, see IOM ITVC-Basic • 2 digital inputs, optocoupled, 1 common, from 22Vdc-ac to 130Vdc-ac, max 5 mA each input. o IN1 and IN2, remote commands, reaction time **300 ms.** Configuration by ITVC HMI, see Table 2
Output relays (see Table 1)	• Monitor Relay: single side stable, voltage free SPDT contact, from 24 Vdc-ac to 230Vac / 5A. It collects the status of Alarm and MRT alarm • 4 relay: latching, voltage free SPST contact, from 24 Vdc-ac to 230Vac / 5A. Condition to switch and contact action (make and break) configurable by ITVC HMI, see table 1
Analogue input	• 4-20 mA optocoupled insulating amplifier. To be used as Position Demand input in the modulating actuators
Analogue outputs (Table 3)	• 2 independent channels, 4-20 mA optocoupled insulating amplifiers, active and passive loop, max load 750 ohm, 24Vdc. Output retransmission is available only if an analogue input is set as input to read the relevant transmitter. Output signal configuration by means of ITVC HMI, see table 3.
Service voltages	• Vr: 24 Vdc / 100 mA • Vr1: 24 Vdc / 100 mA
BUS control	• STD: 2 independent, redundant, optocoupled RS 485 Modbus RTU lines, max 90 devices each line. • On request HART. 24VDC/4-20mA position feedback output + Hart over the same signal, vers. 7.5, EDD.

Table 1

Output relay options:			
Name	**Description**	**Name**	**Description**
No set	No condition to trip	PST failed	PST failed
Max pressure increase	Max pressure increase in Line Break operation	Low HPU pres	Low pressure of HPU
Max pressure drop	Max pressure drop in Line Break operation	High HPU pres	High pressure of HPU
Warning	Warning. See warning table	High HPU volt	Failure voltage of HPU
LB on	Line Break operation active.	PSLL	Pressure Switch Low-Low
High LB pres	High pressure in Line Break operation	PSHH	Pressure Switch High-High
Low LB pres	Low pressure in Line Break operation	Pump fault	Pump failure
No voltage	Voltage failure	Magnet HPU	Magnetothermal switch of HPU
Pos no reach	Position not reached	Unity door	Switch of device door
Low bat	Low battery	Magneto mot 1	Magnetothermal switch of motor 1
Phase unbalance	Current absorbed from phases not balanced	Magneto mot 2	Magnetothermal switch of motor 2
Selec REM	Local selector in REMOTE	Oil level	Oil level alarm
Selec LOC	Local selector in LOCAL	Temperature	Temperature alarm
Selec OFF	Local selector in OFF	Pneum micro	Pneumatic micro-switch
LS op	Electrical Switch in opening	Micro PST mech	Mechanical PST micro-switch
LS cl	Electrical Switch in closing	Selec LOC/MAN	Local selector LOCAL/AUTOMATIC of HPU
LS PST	Limit switch PST	Pressure switch	Pressure switch (repetition of digital input)
Max pres decr	Max pressure decrease	Performing PST	PST in execution

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Table 2

Digital input options
• Interlock open • Interlock close • PST command • Remote STOP • LB action inhibit • Pressure switch • Aut-man

Table 3

Analogue output options	
• Pressure L1 retransmission • Pressure L2 retransmission • Pressure S3 retransmission • Oil level retransmission • ITVC temperature retransmission • Valve position retransmission • Position demand retransmission • Pressure S4 retransmission	4-20 mA Retransmission is available only if actuator or HPU is equipped with the relevant transmitter and an analogue input is set to read the signal (see Table 4)

4 A/D Inputs available for sensors of actuator and HPU

HPU control unit

It has:
- 3 analogue
- 4 digital

input channels, available for sensors from HPU. They are configurable by the ITVC HMI and the **tables 4** and **5** show the digital and analogue HPU sensor options. The I/O's are available on the terminal block of HPU control unit

Table 4

Analogue inputs	Transmitter options
Max 3 4-20 mA transmitters	Oil pressure Oil level Oil cleanness Oil temperature

Table 5

Digital inputs	Sensor options
Max 4 ON-OFF sensors	Oil piston end travel switch Oil volume loss -5% switch Oil volume loss -10% switch Oil piston posit switch low-low Oil level switch Oil temperature switch Door switch Handpump selector Pneumatic switch PST mechanical switch

ITVC unit

It has:
- 4 analogue
- 4 digital

input channels, available for sensors from actuator. They are configurable by the ITVC HMI and the **tables 6** and **7** show the digital and analogue actuator sensor options. The I/O's are available on the ITVC terminal block (to actuator)

Table 6

Analogue inputs	Transmitter options
Max 4 4-20 mA transmitters	Line pressure L1 Line pressure L2 Line pressure S3 Oil level ITVC temperature Valve position Position Demand Cylinder pressure S4 24V sens

Table 7

Digital inputs	Sensor options
Max 4 ON-OFF sensors	Open Limit switch Close Limit switch PST travel switch Oil level switch S3 min pressure switch S3 max pressure switch Fault inverter switch HPU magnetothermal switch Contactor 1 failure switch Contactor 2 failure switch PSLL switch PSHH switch Mechanical PST switch

5 Digital outputs to control actuator and HPU

ITVC unit	8 coil drivers		24Vdc, fuse protection, to drive coils of SOV's. Test to check the coil integrity. The outputs are configurable by ITVC HMI. The settings include type of function (SOV to open, SOV to close, for ESD, for PST, etc.), and mode (de-energize / energize to operate)
	3 relays		Available for special applications
	Service voltage		24V/1.5A to supply the SOV coils
HPU control unit	5 coil drivers		24Vdc, fuse protection, to drive coils of SOV's, test to check coil integrity
	2 drivers for contactors		24Vdc, fuse protection, to drive the contactors of pump motors.
		2 contactors	On board of HPU control unit if main voltage is 3 PH or 1 PH AC
		1 contactor	If main voltage is DC: one contactor is on board of HPU control unit, the contactor to drive the second motor is in separated enclosure

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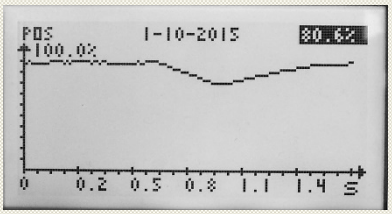
6 Actuator control

Type of actuator	Electro-hydraulic, single acting spring return or double acting, on-off or modulating service, with or without self-contained HPU
Position sensor	
Analogue	Position is measured by a 4-20 mA position transmitter. End of travel acquisition by the ITVC HMI configuration procedure
Digital	Position Limit Switches to indicate the end of travels. Manual setting of limit switches and acquisition of end of travel by the ITVC HMI procedures
Actuator control mode	
Local	The local pushbuttons of the ITVC HMI work as open, close, stop actuator commands. Push to run and latched control mode configurable by ITV HMI
Remote	The actuator is remotely controlled by the signals received from control room in the digital and analogue inputs. Push to run and latched mode configurable by ITV HMI
OFF	No electric command to move the actuator is available
Redundant ESD, Emergency Shut-Down: 2 independent ESD1 and ESD2 channels, diagnostic on each channel, 1oo2 or 2oo2 operation, ETT (Energize to trip) and DETT (De-energize to trip) options, momentary and latched with manual reset modes.	
Interlock: Interlock function to remotely inhibit open or close. Configuration by ITVC HMI	
Actuator safety position: Open, Close, Stayput positions, configurable by ITVC HMI	

7 ITVC features

- Control and drive of actuator and HPU
- Failsafe function
- Redundant RS 485 Modbus RTU communication line (On request HART)
- Optional **Line Break** and **PST** functions (see data sheet DS-ITVC-LB-PST-xx-hpu)
- Bluetooth wireless communication
- Sensor of Temperature of Electronics
- Alarm, Warning, Event loggers and graphs
- Real time clock and battery
- **Human Machine Interface** (**HMI**) with graphic LCD display and non-intrusive, touch-sensitive, pushbuttons. Multi-language menu, **icon** based. **User friendly** navigation in the menu and access to it by password, to protect against unauthorized change. Local configuration by HMI of both ITVC and HPU control unit



Example of Position vs. time graph (PST function)

- **SIL 3 features:** the specific ITVC SIF functions "**ESD Emergency shutdown**, **Line Break, HIPPS** and **Panic Button"** comply with **IEC61508,** application **"Low Demand mode".** The certificate is available on request. If used as SIL 3 logic solver, the ITVC works with 2 CPU's running in parallel and different architectures 2oo3, 1oo2, 1oo1 of inputs and outputs, according to the project requirements.
- **Separated mounting option:** to mount the ITVC and HPU Control units separately from actuator. The maximum length of cable between ITVC and actuator is **50m**.
- **Optional battery:** rechargeable lithium-ion battery pack, to keep the ITVC working in monitoring mode in case of loss of main power supply, only for -20°÷+85°C version
- **Optional Panic Button:** local pushbutton to drive the actuator in safe position. Reaction time **600 ms**
- **Operating temperature:** see limits reported in "Classification and Certification of ITVC and HPU control units"

7.1 Configuration features

In general the setting of I/O's is done in the DVG Automation factory. It depends on the type of actuator, SOV's and HPU and on the remote control mode required by the user. On field site, the user should only set the actuator travel limits and if necessary modify few parameters to optimize the system performance.

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7.2 Diagnostic features

Powerful diagnostic program to monitor hardware and software execution.
The safe action execution depends on the seriousness of malfunction. 3 levels of malfunctions are available:

- **Alarm:** Action depends on the malfunction (only signalling, block of actuator, safe action)
- **MRT alarm:** The safe action starts only when the MRT (Maximum Time to Repair) expires.
- **Warning:** the ITVC does not perform any action

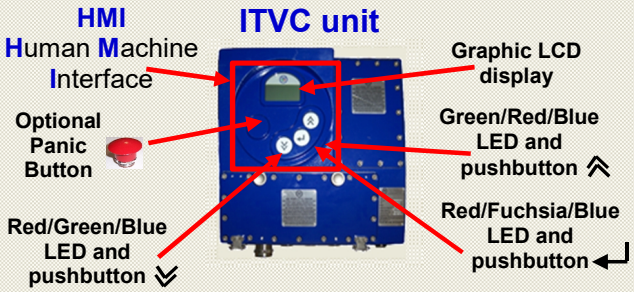
Detailed visualization of Alarms, MRT alarms and Warning by the local display. Remote signalling by Monitor relay and additional output relay (see table 1). **Alarm history** logger to record the Alarms, MRT alarms and dates

See IOM-ITVC Basic and Annex A,…,D to see details about the detected malfunctions and relative actions

7.3 ITVC HMI

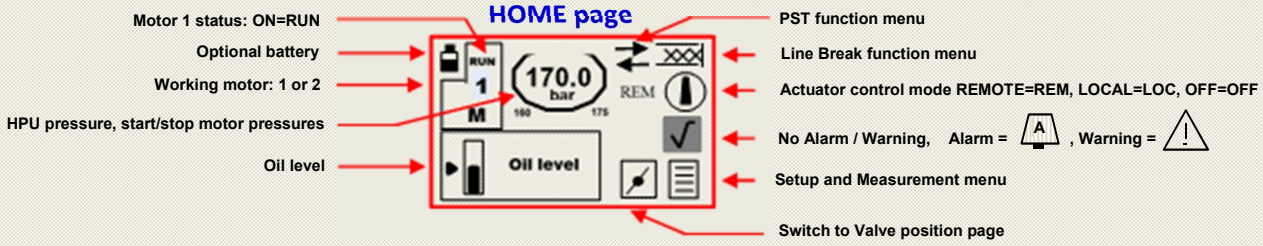
Main functions:
To set the **actuator control mode** in LOCAL, OFF, REMOTE and to drive it **in opening and closing.**
To navigate in the **MENU** to

- view and modify the working parameters
- view the values of the variables managed by the ITVC
- view loggers and graphs Alarms, curves, etc.)



LED's signalling: 3 Green /Red/Fuchsia/blue LED of pushbuttons to indicate the status of opening, closing, open closed, intermediate position, Alarm, MRT alarm, Warning

The figure below shows an example of **HOME** page of the ITVC HMI



8 Classification and Certification of ITVC and HPU control units

ATEX certificate: EUM1 12 ATEX 0789 X

ITVC version without accessories:	II 2GD Ex db IIB+H2 T5 Ex tb IIIC T88°C	$-60°C \le T_{amb} \le +85°C$
ITVC version with pressure transmitter:	II 2GD Ex db IIB+H2 T5 Ex tb IIIC T95°C	$-20°C \le T_{amb} \le +85°C$
	II 2GD Ex db IIB+H2 T5 Ex tb IIIC T95°C	$-45°C \le T_{amb} \le +85°C$
ITVC version with battery box:	II 2GD Ex db IIB+H2 T5 Ex tb IIIC T88°C	$-20°C \le T_{amb} \le +85°C$
ITVC version with battery box and pressure transmitter:	II 2GD Ex db IIB+H2 T5 Ex tb IIIC T95°C	$-20°C \le T_{amb} \le +85°C$

IECEx certificate: IECEx EUT 14.0008 X
IP 68: according to EN 60529 SIL: certificate 28714183 rev.1 Type:B HFT:1 Sc:3 SIL:3
TR CU – Certificate No. RU C-IT.ГБ08.B.01875
Resistance to Vibration – Certificate No. 223221TRFENV – IEC 60068-2-6
Seismic test – Certificate No. 223221TRFENV – IEC 60068-2-27
In case of ITVC version with HPU Control module, the gas group IIB+H2 changes in IIB
ATEX and IECEx certificates of HPU control module:
1. ATEX certificate : EUT 14 ATEX 1272 X IECEx certificate: IECEx EUT 14.0006 X
Optional Pressure transmitter series ATRD certificates:
1. ATEX: EPT 18 ATEX 3039 U IECEx certificate: IECEx EUT 180030 U

Refer to IOM-ITVC-Basic and Annex A, B, C, D to see detailed instructions relevant to operation by ITVC HMI, troubleshooting, Alarm / MRT alarm / Warning tables, configuration options, etc.
Refer to diagrams supplied with the actuator to see the electrical and hydraulic connections.
Refer to data sheets of actuator to see classification and certification of actuator, SOV's, components, etc.

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