

EX200-HART

Compact Electronic Actuator
Positioner – for use in EX2010A
System

Features

- Simple two-step calibration
- 4-20mA current command signals and current or potentiometer feedback signal.
- Actual position 4-20mA calibrated output with HART communications
- MANUAL mode
- Stepping mode with adjustable ON and OFF times
- Selectable solenoid drive sense for failsafe operation
- Selectable default operation on command signal/feedback signal break
- ESD solenoid output - 24Vdc open drain
- Fault output - 24Vdc open drain
- Hydraulic pump drive controlled by demand or external pressure sensors
- External fault contact monitoring
- Selectable interlock between ESD and fault outputs
- Low power - normal operation less than 1.5W
- Direct mounting with Compact Ex d Enclosure System EX2010A

The EX200 can be used in any positioning system relying on the on-off control of the position driver including electro-hydraulic actuators and reversing ac motors (with the addition of suitable relays or contactors). The EX200 can accept positional feedback from a three-wire potentiometer or a position transducer with a current output. The EX200 is mounted to a special chassis plate and fitted within an Ex d enclosure - EX2010 A. All field and customer wiring is taken through a close-coupled Ex e enclosure. All signals and power supplies are referenced to power supply zero ensuring safe connection to centralised digital control systems (DCS).

The EX200-HART has a HART communications modem on the actual position output, compatible with Version 6. This gives access to the Primary Variable (actual position), the Secondary Variable (desired position) and a number of private commands to assist in the configuration of the positioner.

Operation

The instrument compares two analogue signals, one representing the desired position (command signal) and the other representing the actual position (feedback signal) of the actuator.

A difference between these two signals will cause one of the EX200 outputs to operate, driving the actuator to the desired position.

A positional Dead-zone may be adjusted to overcome “hunting” problems associated with mechanical overrun of the actuator. The speed of transit of the actuator can be reduced by selecting the stepping mode that provides independently adjustable on and off times for the open and close solenoid operation.

Physical

The EX200 is mounted on a chassis plate and housed within an Ex d enclosure. The circuit boards are coated with a resist layer that protects the track from moderate condensation and mould growth problems. Connections within the EX d are by factory assembled 0.1” connectors and must not be disturbed or re-wired. Initial configuration adjustments are via internal jumper links, usually set to customer requirements on order.

Wiring

A typical wiring diagram is shown on Page 7. Wiring to the Ex e enclosure should be completed by suitably trained personnel taking into account the following notes:

- To ensure RFI compliance the analogue signals should be routed in copper braided screened cables with a fill factor density of at least 0.7.
- The screens should be terminated to the metal of the actuator housing, ideally at a suitable metal cable gland.
- Signal cables should be routed separately from power and switching conductors.

Positioner set-up

The solenoid, ESD and fault output sense are set up by internal jumper links. Signal break default modes and local HART enable/disable are set by two “power up” sequences. Check the accompanying Certificate of Calibration/Conformity for the factory setting of the jumper links. If a change in the solenoid and other output links is required, then the top cover of the instrument has to be removed to access the links:

- 1) If the instrument is difficult to access, make a note of the wiring, disconnect and remove the EX200 from its enclosure.
- 2) Work in a clean, dry area and use electrostatic discharge protection equipment - a wrist strap and a grounded work mat to make the changes.
- 3) Unscrew the two M2.5x6 screws from the top of the instrument.
- 4) Check with drawing 1460-016 for position of jumper links on the base printed circuit board and make the necessary changes. Note that ONLY one selection, + or -, MUST be made for each of the output blocks - LINC LDEC LESD LFLT even if the fault or ESD outputs are not used. Link A is selected as required. Unused links should be put on the in-board pin of the block.
- 5) Double check and record the selection then reverse the above procedure to reassemble the EX200.

Setting solenoid operating sense

If the actuator has a spring assisted return to a default position it may be necessary to change the sense of the output solenoid such that at the desired balance point one of the solenoids is energised thus holding the actuator position against the spring. Follow the procedure described in **Positioner set-up** above and select between LDEC +/- and LINC +/- links for the required solenoid sense.

Setting the emergency fail solenoid and fault output sense

These two outputs can respond to failures in the control signals to the system and an external fault input. The EX200 normally sets these two outputs as energised when healthy but the sense of the outputs can be reversed by following the procedure described in **Positioner set-up** above and selecting between LESD +/- and LFLT +/- links for the required outputs.

Setting the command signal break default operation

The positioner can be configured to move to a default position or freeze at the current position in the event of the command or feedback signal faults. These faults are characterised as:

- a) the command falling below 1mA - command signal break
- b) the potentiometer wiper showing less than 0.25V - potentiometer maximum or wiper break
- c) the potentiometer wiper showing more than 4.7V - potentiometer minimum break.

A one-off operation of the positioner will store the choice in non-volatile EEPROM memory.

1. Hold in the MANUAL pushbutton and apply power to the positioner.
2. The MANUAL LED will light continuously and the DECREASE / INCREASE LED will show the current, balanced, state of the actuator.
3. Pressing the manual DECREASE and INCREASE pushbuttons will cause the appropriate DECREASE and INCREASE LEDs to “toggle” on and off.
4. Select a pattern of LEDs to show the desired fail state. This will depend on the link-configured solenoid sense:
For double-acting systems,
No LEDs = Freeze on fail, DEC LED ON = Drive close on fail, INC LED ON = Drive open on fail
For spring to close systems (DEC solenoid energised at balance)
DEC LED ON = Freeze on fail, No LEDs = Drive close on fail, INC & DEC LED ON = Drive open on fail
For spring to open systems (INC solenoid energised at balance)
INC LED ON = Freeze on fail, INC & DEC LED ON = Drive close on fail, No LEDs = Drive open on fail
5. When satisfied press the MANUAL pushbutton again.
6. Remove power from the positioner.

Setting the HART private command enable and remote slow/fast operation

The positioner can be configured to enable/disable reception of a private command used to remotely set the pulsing mode timers and the dead zone. The procedure also allows local resetting of the HART command allowing local adjustment of stepping times and selection of continuous or stepping operation should HART communications fail.

1. Hold in the CALIBRATE pushbutton and apply power to the positioner
2. Release the CALIBRATE pushbutton
3. The CALIBRATE LED will light continuously
4. Pressing the manual INCREASE pushbutton will cause the INCREASE LED to “toggle” on and off
5. Select the INCREASE LED *ON* to enable the remote setting via HART
6. Select the INCREASE LED *OFF* to enable local adjustment of stepping times via front panel adjustments
7. Pressing the manual DECREASE pushbutton will cause the DECREASE LED to “toggle” on and off
8. Select the DECREASE LED *ON* to enable the remote selection of continuous or stepping via HART
9. Select the DECREASE LED *OFF* to enable local selection of continuous or stepping mode via DIL switch
10. Any combination of these selections is permitted
11. When satisfied press and release the CALIBRATE pushbutton again
12. Remove power from the positioner.

Note that this setting can be cancelled via HART Private Command 129 (81h).

Setting the self-contained pump control options

The EX200 has an output to control a hydraulic pump supplying power to the actuator. The pump can be configured to operate on demand, when a change in the control signal requires the actuator to move, or under the control of low and high-pressure switches in the hydraulic circuit. Follow the procedure described in **Positioner set-up** above and select from link block LKA as follows:

A	Function
Out	Pump output operates on demand with a 5 second run-on after demand ceases
In	Pump output operates when hydraulic pressure falls below the Low Level switch setting and switches off when the pressure exceeds the High Pressure switch setting.

Setting the stepping option timers

Note that HART remote flag has to be disabled by the power-up routine described above before these local settings can be executed. The stepping mode operation is set on the front panel DIL switches but the initial setting should be done prior to first use. If stepping operation is required, the ON and OFF timers for the open and close solenoids have to be set. This operation is best performed when the actuator hydraulics are isolated but the settings can be trimmed during normal operation of the system.

1. Set DIPswitch 3 to ON. This selects timer setting mode. Manual mode is selected automatically.
2. Set DIPswitch 1 to ON. *Do not select DIPswitches 1 and 2 ON together.* The DECREASE LED will flash and the decrease solenoid will operate. Adjust CAL1 potentiometer to vary the ON time and CAL2 potentiometer to vary the off time. Time the on/off transition over a few cycles to obtain the required result.
3. Press the CALIBRATE button to store the decrease step timer values.
4. Set DIPswitch 1 to OFF.
5. Set DIPswitch 2 to ON. *Do not select DIPswitches 1 and 2 ON together.* The INCREASE LED will flash and the increase solenoid will operate. Adjust CAL1 potentiometer to vary the ON time and CAL2 potentiometer to vary the off time. Time the on/off transition over a few cycles to obtain the required result.
6. Press the CALIBRATE button to store the increase step timer values.
7. Set DIPswitch 1 to OFF.
8. Set DIPswitch 3 to OFF.
9. The stepping option can be selected by setting DIL switch 4 ON.
10. The above sequence, or part of it, can be selected at any time during normal operation but the actuator will move during the adjustment so hydraulic isolation is advised.

These settings can be overwritten via Private Command 129 (81h).

First time operation

WARNING !!

The actuator and associated mechanical equipment connected to it could possibly move in an unpredictable manner during initial calibration. Ensure that all personnel take appropriate precautions.

1. Ensure that any end of travel limit switches and mechanical stops are correctly adjusted before operation.
2. Apply power and provide the 4-20mA command signal. Press the Auto/Manual Switch. Check that the Auto/Manual LED is lit.
3. Operate the Open and Close buttons and confirm that the actuator moves as required.
4. The system must be calibrated before automatic mode is selected.

Calibration

Calibration can only be carried out local to the EX200 unit so it is essential to have purged the area in order to access the EX200 and provide local command signal injection. An alternative is to use the remote DCS to inject and read the actual position signal and transfer the information by handheld radio. If this approach is used ensure that the radio is operated 2m or more from the EX200 and associated wiring.

A command signal is required, normally in the range 4-20mA (Terms 20+ and 21-) and a DVM with a 0-200mA range to read the retransmitted position signal (Terms 13+ and 14-).

1. Press the CALIBRATE button, and hold until the CALIBRATE LED goes out. When the button is released, the CALIBRATE LED will flash briefly once per second.
2. The positioner has been switched automatically into Manual, non-stepping mode so use the INCREASE / DECREASE buttons to set the actuator to the required position for the minimum, 4mA command signal. This position can be either fully open or fully close, or indeed anywhere in the mechanical range of the actuator.
3. Set the command signal to 4mA.
4. Adjust the CAL1 potentiometer to give the required output for the chosen position. Note that this not need be 4mA to match the command signal, but can be any value in the range 0.5mA to 22mA.
5. Press and hold the CALIBRATE button until the CALIBRATE LED goes out. Release the button and the CALIBRATE LED will flash twice briefly every second.
6. Use the INCREASE and DECREASE buttons to set the actuator to the required position for the maximum, 20mA command signal. As before, this can be any position within the mechanical range of the actuator.
7. Set the command signal to 20mA.

8. Adjust the CAL1 potentiometer to give the required output for the chosen position. Note that this not need be 20mA to match the command signal, but can be any value in the range 0.5mA to 22mA.
9. Press and hold the CALIBRATE button until the CALIBRATE LED goes out. Release the button to complete the calibration sequence.

General operation

When calibration has been completed the EX200 reverts to automatic mode and to stepping operation if DIL switch 4 is set ON (remote setting disabled). The actuator should now follow the command signal input and move to the desired position. If there is any instability in positioning, particularly if the hydraulic flow rate is high, then the DEADZONE potentiometer can be set progressively clockwise, half a turn at a time, until stable positioning following a step change can be achieved, but, again, only if remote setting is disabled.

Normal operation - fault detection

If the command signal or the feedback signal goes towards zero (less than 0.5V at the terminals, across any shunt fitted) then the selected fail mode will operate. The actuator will freeze position, drive down or drive up and the control to the ESD solenoid will be removed. The system will recover to normal operation when the signals are re-instated. If the external fault contact is broken, then the fault output will change, as will the emergency solenoid if the appropriate bit is set, via HART in Command 129 (81h), otherwise the fault input operates only the fault output. The fault condition is reset as soon as the external fault contact is restored. If the unit is in "stepping mode" (DIL switch 4 = ON) then failure mode drive can be either in the selected stepping mode or, if DIL switch 1 is ON, then the unit will fast-fail to its default position. If remote changes are enabled then all the above option can be changed via HART in Command 129 (81h).

HART Command Summary

The HART signal can be superimposed on either the retransmitted position or command analog loops. This selection is normally done in our factory according to order details. Please check documentation to find out which loop is used.

Universal Commands

The EX200-HART supports Universal Commands Rev 7 (as of August 2007). Consult Hart Communication Foundation document HCF_SPEC-127 Universal Command Specification. Of the 22 commands, Commands 4,5 and 10 are NOT supported.

Common Practice Commands

The EX200-HART supports Common Practice Commands Rev 8 (as of September 2006). Consult Hart Communication Foundation document HCF_SPEC-151 Common Practice Command Specification. Commands 34, 35, 49, 59, 122, 123 are supported.

Private Commands

The EX200-HART has 2 Private Commands, a read and write pair dealing with parameters within the positioners. The body of the message is 11 bytes:

Command 128 (80h) - Device Specific Command, Read positioner parameters

Received Data:
None

Response Data:
[0-1] INC off time H/L
[2-3] Dec off time H/L
[4-5] INC on time H/L
[6-7] DEC on time H/L
[8-9] Dead zone H/L
[10] Remote enable byte

Command 129 (81h) - Device Specific Command, Write positioner parameters

Received Data:
[0-1] INC off time H/L
[2-3] Dec off time H/L
[4-5] INC on time H/L

- [6-7] DEC on time H/L
- [8-9] Dead zone H/L
- [10] Remote enable byte

Response Data:

- [0-1] INC off time H/L
- [2-3] Dec off time H/L
- [4-5] INC on time H/L
- [6-7] DEC on time H/L
- [8-9] Dead zone H/L
- [10] Remote enable byte

Bytes 0 - 7 Stepping timers

The stepping (or slow operation) timers described above can be set remotely, if enabled. Each timer is set in 10mS increments; 1 second would be set as **00h 64h**.

Bytes 8 - 9 Positioning dead zone

The positioner dead zone can be set remotely, if enabled. Each bit is approximately 0.1% of range, depending on the mechanical versus electrical range of the feedback device: a +/- 0.5% dead zone would be set at **00h 05h**.

Byte 10 positioner “soft switch”

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Function	Command by HART	ESD and Fault O/P	HART override	HART override	HART override	Solenoid speed	HART remote enable	Not assigned
1	Enabled	Separated	Drive Up	Drive Down	Freeze	Step mode	Enabled	
0	Disabled	Linked	Command Signal	Command Signal	Command Signal	Continuous drive	Disabled	

Bit 0: Not assigned, future use.

Bit 1: Set – enables ALL parameter setting via Command 129 (81h) and disables EX200-HART front panel adjustments of stepping timers and dead zone.

Clear – enables EX200-HART front panel adjustments of stepping timers and dead zone and rejects any other parameter data in Byte 10 (factory default)

Bit 2: Set – forces stepping mode, if Bit 1 is set.

Clear – allows selection of stepping mode via DIL switch position 4 (factory default)

Bit 3: Set – stops the actuator and ignores changes in command signal, if Bit 1 is set.

Clear – positions to command signal (factory default)

Bit 4: Set – Drives actuator down, if Bit 1 is set

Clear – positions to command signal (factory default)

Bit 5: Set – Drives actuator up, if Bit 1 is set

Clear – positions to command signal (factory default)

(Note – only one of bits of 3,4 and 5 to be set)

Bit 6: Set – Separates fault output (triggered from contact break at terminals 15,19) from the ESD output, triggered by a command or feedback signal break.

Clear – fault input or signal break triggers both fault output and ESD output (factory default)

Bit 7: Set – When bit 2 is set, enables remote command signal via Command 130. Disables analog command input.

Clear – Disables remote command signal, Command 130.

Command 130 (82h) - Device Specific Command, Write command signal as 0 – 100.0% IEEE 754 floating point

Received Data:

[0-3] Command signal (SV) as IEEE 754 floating point

Response Data:

[0-3] Command signal (SV) as IEEE 754 floating point

Self contained operation

If self-contained operation is required then a pump starter circuit should be connected to the pump output at terminals 9 and 10. In the case of a dc pump this will be a suitably rated relay and in the case of an ac pump a rated ac contactor. In both cases, the control coils should have a parallel diode to protect the EX200 from switching transients and the pump circuit should have fuse or contact breaker protection. If operation on demand has been selected then the pump will operate for five seconds after the positioner has reached balance. This delay allows for the gradual recharge of any accumulators in the hydraulic circuit.

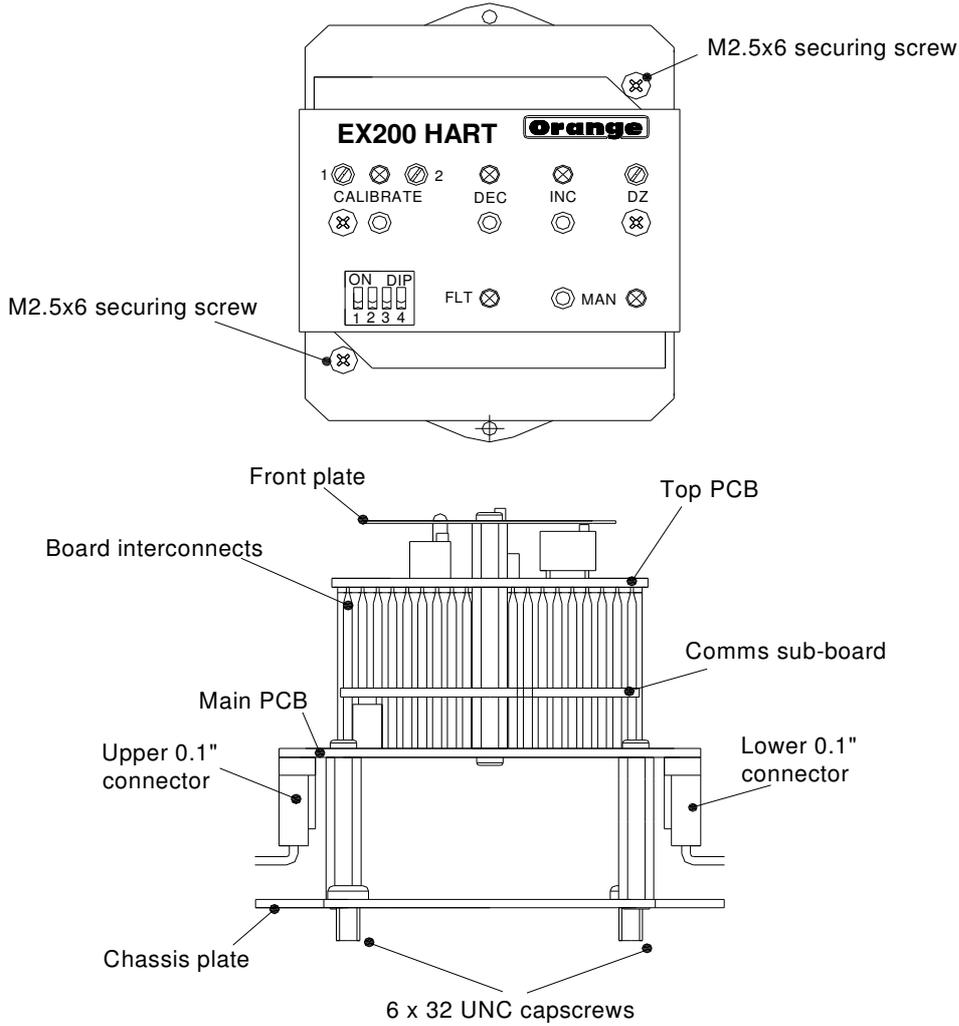
All calibration parameters are stored within the processor EEPROM and are restored each time the controller is powered up. The controller will respond to current command and feedback signal conditions within 100mS of power being applied to the system.

Maintenance

The outside of the enclosure can be cleaned using a damp cloth. Do not use solvents. Do not open the enclosure whilst a hazard is present.

No internal parts are user serviceable and component level repairs should not be attempted. If a fault occurs then please return the unit to the Manufacturers describing the nature and circumstances of the problem.

EX200 dimensions and front panel



Note – elevation is rotated by 90°

Physical Description

Size with chassis plate – 60mm wide, 73mm high, 80mm deep

Weight with chassis plate – 0.25kg

Specification**COMMAND SIGNAL INPUT**

4-20mA nominal 240R input impedance

ANALOGUE POSITION OUTPUT SIGNAL

0.5-22mA can be calibrated anywhere in this range, normally 4-20mA into 400R maximum sourcing or sinking, selected on order from factory.

FEEDBACK SIGNAL INPUT

Potentiometer 3-wire, any value greater than 200R

4-20mA nominal 240R input impedance

SWITCHED OUTPUTS x 5

Maximum 3A for each output (max controller volt drop at 3A = 0.27V)

INSTRUMENT SUPPLY (excluding solenoids)

24V dc nominal (15-36V absolute maximum range) - 1.3W excluding solenoids

55mA maximum current drawn in normal use

USER ADJUSTMENTS**DEC** Button to close actuator in Manual**INC** Button to open actuator in Manual**MAN** Button to toggle auto/manual mode**CAL** Button to select Calibrate mode and store calibration data*Timer setting*

DIP Switch 1 - Set stepping timers – DECREASE ON and OFF

DIP Switch 2 - Set stepping timers – INCREASE ON and OFF

DIP Switch 3 - No function

DIP Switch 4 - No function

Normal operation

DIP Switch 1 - Select continuous operation on fault if in stepping mode

DIP Switch 4 - No function

DIP Switch 4 - Select stepping mode timers

DIP Switch 4 - Select stepping mode

DZ Potentiometer to set positioning dead zone - clockwise to increase**CAL1** Calibration adjustment and ON time for stepping mode**CAL2** Adjustment for OFF time for stepping mode**INTERNAL LINKS**Output sense - one position + or - *must* be selected for each output, even if the output is unused

LINC + and - Increase solenoid sense links (Factory setting +)

LDEC + and - Decrease solenoid sense links (Factory setting +)

LESD + and - Emergency solenoid sense links (Factory setting +)

LFLT + and - Fault output sense links (Factory setting +)

Other function links

LKA Hydraulic pump control mode select (Factory setting - out)

ENVIRONMENT

Operating temperature -40°C to +85°C

Storage temperature -40°C to +115°C

PERFORMANCE - the following applies to the EX200 only, characteristics of the feedback element and actuator system response will have additional effects.

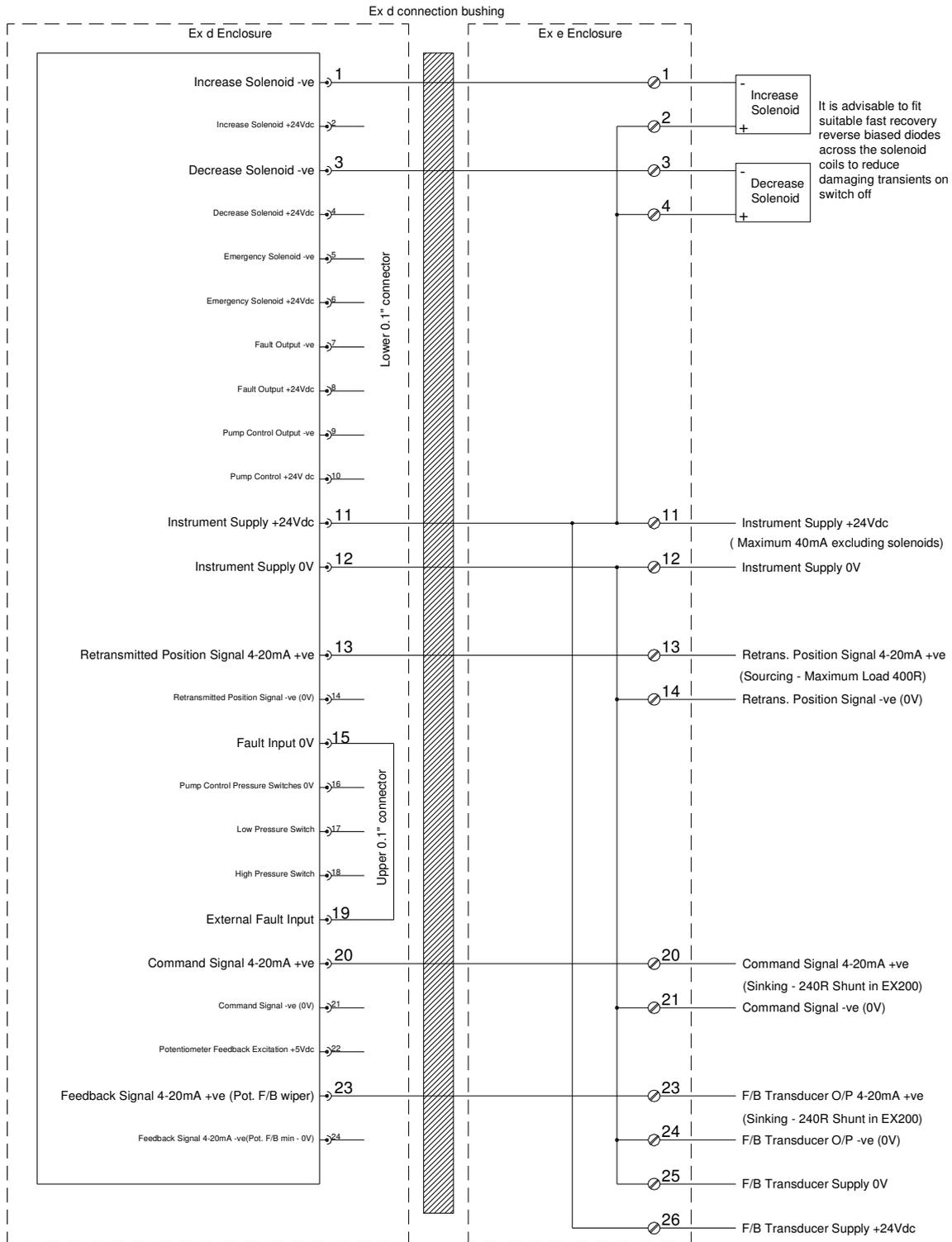
Conversion 10 bit max normal conversion range (4-20mA) = 1 in 800.

O/P switch res. +/-1 bit theoretically, modified to up to +/-5% of span by dead band .

Accuracy (Theo.) 0.125% span based on conversion resolution of 1 in 800.

Accuracy (actual) 0.5% span based on 25% turn down of feedback range.

HART Revision 7 + 16 bit Manufacturers and Device ID



Typical system wiring diagram for a safe area installation

EX200 Terminal Descriptions

Connections are made via two 12 way 0.1" free sockets. The lower connector is numbered 1-12 from the left and the upper connector is numbered 13-24, again from the left. All 0V points are common to supply 0V.

Lower Conn.	Description	Voltage	Comment
1	Increase Solenoid –ve output	max +36V	Set to 0V to energise solenoid
2	Increase Solenoid +ve output	max +36V	Always at supply potential
3	Decrease Solenoid –ve output	max +36V	Set to 0V to energise solenoid
4	Decrease Solenoid +ve output	max +36V	Always at supply potential
5	Emergency solenoid -ve output	max +36V	Set to 0V to energise solenoid
6	Emergency solenoid +ve output	max +36V	Always at supply potential
7	Fault output -ve output	max +36V	Set to 0V to energise output
8	Fault output +ve output	max +36V	Always at supply potential
9	Pump output -ve output	max +36V	Set to 0V to energise output
10	Pump output +ve output	max +36V	Always at supply potential
11	Instrument Supply +ve	+15 to+36V	
12	Instrument Supply 0V	0V	
Upper Conn.			
13	Actual position signal +ve	+12V	Scaled to actuator movement
14	Actual position signal -ve	0V	set in range 0.5 - 22mA
15	Instrument ground for switched I/Ps	0V	
16	Instrument ground for switched I/Ps	0V	
17	Low pressure switched input	+5V	switch current <0.5mA
18	High pressure switched input	+5V	switch current <0.5mA
19	External fault switched input	+5V	switch current <0.5mA
		connect 15 and 19 if external fault is not used	
20	Command signal +ve (4-20mA)	<+5V	240R shunt
21	Command signal -ve (4-20mA)	0V	
22	Feedback potentiometer maximum	+5V	Potentiometer >200R
23	F/B potentiometer wiper / 4-20mA +ve	<+5V	Current signal optional 240R shunt
24	F/B potentiometer minimum / 4-20mA -ve	0V	