

WESTLOCK

CONTROLS

Product Overview

ICoT Intelligent SmartCal positioners provide continuous valve position control in proportional response to an external control signal (setpoint) to the ICoT. Non-contact position feedback, negligible bleed manifold design, advanced auto-calibration and PID autotuning capabilities puts the ICoT in the forefront of positioner technology.

5200 – Engineered resin enclosure, 3-button on-board keypad for calibration

5300 – Engineered resin enclosure, communication via HART® protocol and calibration with 3-button keypad or HART® communicator

5400 – Engineered resin enclosure with 3-button keypad and FOUNDATION Fieldbus™ network capability

Agency Approvals: Non-incendive*

5200 and 5300 Series Class I, Division 2, Groups A, B, C & D; Class II & III, Division 2, Groups F & G/ T4 Ta=85 deg. C, Type 4 Enclosure

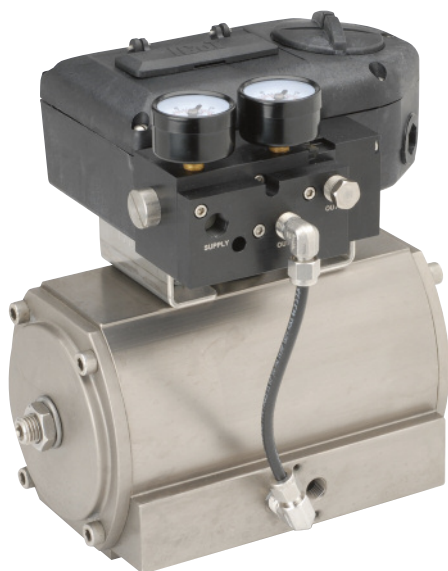
5400 Series Class I, II & III, Division 2, Groups A, B, C, D, E, F & G/ T4 Ta= 80 Deg C, Type 4, 4X Enclosure

* Consult your sales representative for Canadian Approvals.

Intrinsically Safe*

5200 and 5300 Series Class I, II & III, Division 1, Groups A, B, C, D, E, F & G/ T4 Ta=85 Deg C, Type 4 Enclosure (NEMA 4) (with approved IS Barrier)

5400 Series Class I, II & III, Division 1, Groups A, B, C, D, E, F & G/ T4 Ta=80 Deg C, Type 4, 4X Enclosure (Entity and Fisco) (with approved IS Barrier)



Westlock™ ICoT 5000 Series Positioners

5200, 5300 and 5400 (FOUNDATION Fieldbus™), Non-incendive or Intrinsically Safe

Remote Mount Capability

Since valve position feedback to the ICoT positioner is accomplished by non-contacting means, the ICoT has the unique ability to be mounted remotely (up to a distance of 150 feet) from the device it is controlling. In the event the control valve is located in either a high vibration or extremely corrosive environment, the non-contact position feedback feature allows for isolated placement of the positioner.

Linear Control

The ICoT proximity positioner represents a significant departure from previous attempts to reliably measure valve stem position. A static slide-by actuation assembly, attached to the valve stem, is the only “moving part” of the positioner. Position sensing is performed totally by non-contacting means. Output updating takes place twenty times per second. A microprocessor implements any alteration required to provide the equivalent of equal percentage, quick opening, or linear valve characteristics.

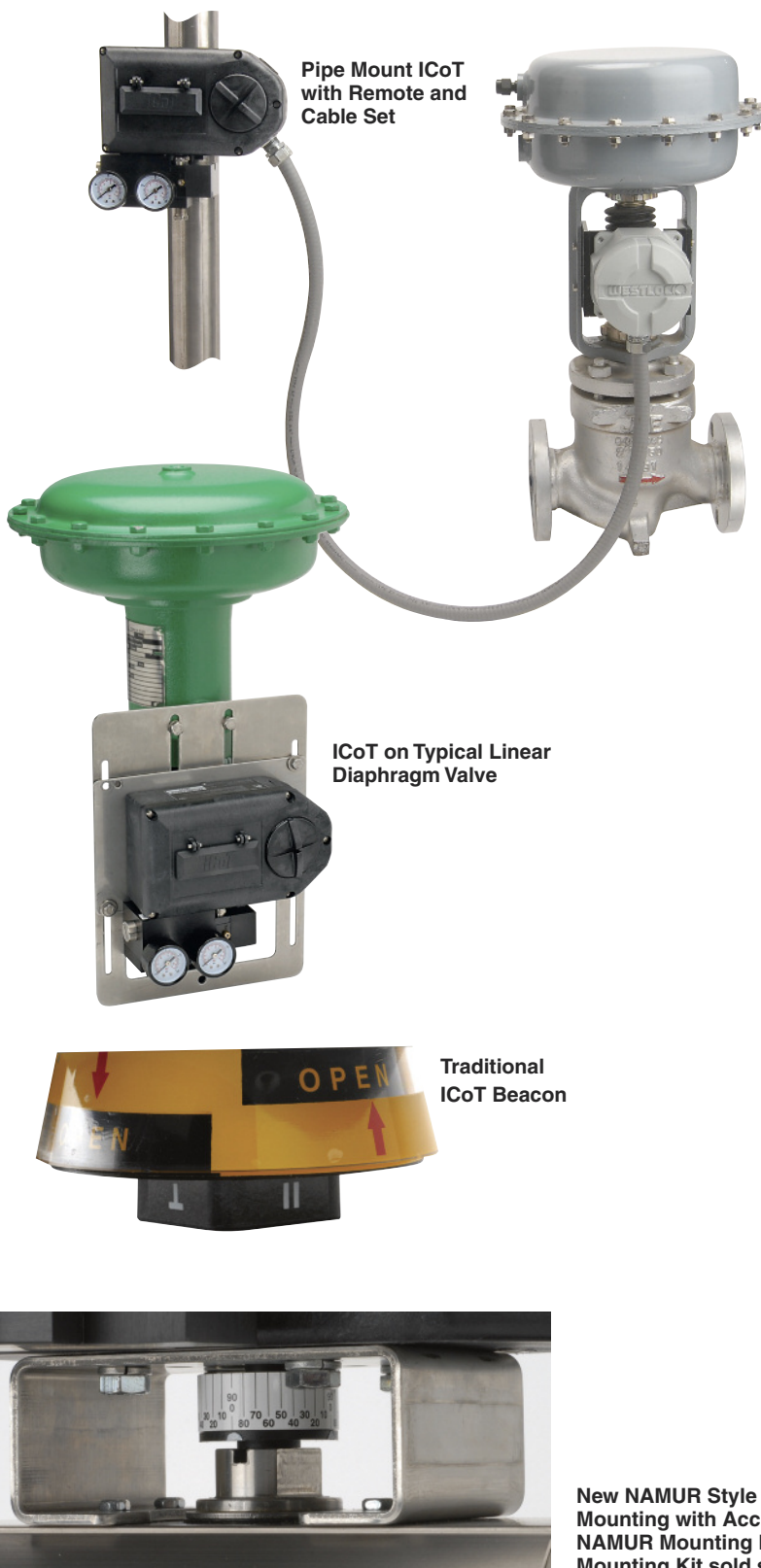
Output of the processor is the “setpoint” input for the servo amplifier circuitry, while the position sensor provides feedback. The position sensor output signal is also fed to the analog-to-digital converter permitting a wide range of diagnostic information to be generated.

Rotary Control

Since the valve position sensing is performed totally by proximity means, hysteresis within the positioner is non-existent. This feature allows for extremely accurate tracking of the control signal to within $1/10$ of 1 mA. A non-contact position sensor, employing Hall Effect magnetic principles for position feedback, is embedded within the ICoT housing. An external magnetic module, attached to the output shaft of the actuator and housed in the beacon assembly, rotates about the Hall Effect sensor. An analog-to-digital converter interfaces between the positioner sensor and a microprocessor while also transmitting the incoming position command (instrument signal) to the microprocessor. Servo circuitry is then utilized for implementation of position control.

Non-Contact Position Feedback

Unlike conventional positioners, the ICoT feeds back accurate valve position without the need for linkages, levers, and rotary or linear seals. Position sensing is performed totally by non-contacting means, permitting use of advanced control strategies where knowledge of valve position is used in predictive and other algorithms.



Pipe Mount ICoT with Remote and Cable Set

ICoT on Typical Linear Diaphragm Valve

Traditional ICoT Beacon

New NAMUR Style Beacon and Mounting with AccuTrak NAMUR Mounting Kit (NAMUR Mounting Kit sold separately)

Negligible Bleed

Designed to consume the least possible amount of control air at steady state, the ICoT 5000 Series Positioners can greatly reduce the air consumption of your process and reduce the demand on instrument air compressors. To increase reliability, the ICoT employs a patented lapped spool and floating sleeve design. This balanced construction relies on an air bearing which eliminates any metal-to-metal contact and results in a mean time between failures (MTBF) of 1,666,666.7 hours or 333.3 years.

Integrated Position Transmitter (5200 and 5300 Series)

The ICoT is available with an integrated 4-20 mA position feedback transmitter. This cost effective feature helps eliminate the requirement for the purchase of externally mounted devices when knowledge of valve position is required at a remote location. As opposed to conventional devices, position sensing is performed by non-contacting means, based upon characterization of flux strength as a function of axial position.

Intelligent Calibration, Local Keypad (5300 Series)

ICoT intelligent positioners are equipped with a HART® interface or a 3-button “membrane keypad” for performing on-site electronic calibration. The AutoCal feature allows for simple zero and span adjustments as well as PID and transducer calibration.

HART® Protocol (5300 Series)

The ICoT positioner responds to HART® commands for ease of calibration and provides intelligence for the control valve through a microprocessor based diagnostic system utilizing the HART® protocol. Accurate measurement of valve stem position, input signal, and actuator pressure offer operating personnel a real-time perspective on the state of control at the valve.

FOUNDATION Fieldbus™ (5400 Series)

FOUNDATION Fieldbus™ communications protocol is an industry proven international standard (IEC 61158) designed for use in the process industry. Features include multi-drop capabilities (as many as 32 devices per segment), extended trunk length, single loop integrity, “control in the field,” power and communications on a shielded twisted pair network, and compatibility with intrinsically safe networks. A key feature of the FF protocol is the ability to select where control of the process is situated – in the host, in the field, or in various combinations of both locations.

On-Board Sensors/Error Detection

The ICoT positioner has the capability to constantly monitor its own operation. If an error or failure condition occurs, it will be displayed on the local LCD, or, if the positioner is supplied with a HART® interface, the error codes will be displayed on a hand-held terminal or PC maintenance station. The following codes are provided:

Err3 = Low input pressure or clogged filter
Err6 = Calibration error

% PS 50.0	SP 50.0
12.0 mA	ERR3

The alarm conditions and additional diagnostic capabilities are provided through a number of sensor elements in the transducer which are capable of indicating problematic operation. A pressure switch detects low air pressure entering the positioner. In conjunction with a supply pressure switch, a determination can be made that either a restricted filter is responsible for low air pressure entering the positioner or a bonafide low supply pressure conditions exists. A 0-100% position feedback transmitter is available integrated within the electronics of the ICoT positioner.

Local LCD Display

The local LCD display provides an abundance of on-site diagnostic information. While the valve is being controlled by the positioner, and the error signal is NOT zero, the displayed information will alternate between setpoint and position as percentage. Each value is displayed for a period of two seconds. Once the setpoint and valve position agree to within less than ± 0.5%, the display will only show position.

The range of values displayed are from 0.0% (fully closed) to 100% (fully open). Displayed resolution is in 0.1% increments, however, internal calculations are maintained at higher precision.

% PS 50.0	SP 50.0
12.0 mA	ACAL

AutoCal

The ICoT is equipped with a 3-button keypad interface and a 4-digit, 0.5" tall LCD that allows for automated calibration of the positioner.

System calibration is performed easily. During the calibration process, the microprocessor measures position sensor voltage along with input setpoint current and establishes the amount of control signal required to move the valve to its end limits.

An on-board microprocessor uses the calibration data to provide accurate operation over the full span of valve travel during normal operation. The actual valve position measured and the amount of control signal applied at any time is a result of microprocessor interpolation. The interpolation method is operator selectable and can be Linear, Quick Opening, or Equal Percentage.

Split range and reverse acting operation are easily configured.

Autotuning

The setting of the proportional, integral, and derivative functions ("PID"), also referred to as "tuning" can become quite complex and tedious. By utilizing the microcontroller within the ICoT, Westlock™ has designed an algorithm which automatically tunes all three parameters. This procedure is referred to as "autotuning".

Upon receiving a request for autotune, the positioner enters into a digital mode and overrides any setpoint command. It initiates the routine by setting "P", "I", and "D" at their lowest values. It will then begin to increase the "P" value until it reaches "Ultimate P". At this instance the CPU records "Ultimate P" and the coinciding period of oscillation. With the recorded data in memory, the CPU then performs a modified Ziegler-Nichols analysis and correspondingly assigns correct values to the "P", "I", and "D" functions.

PID Control

A positioner is a servo system that continuously controls the position (output) of a valve in accordance with an external control signal referred to as setpoint. In a proportional type system, the setpoint is constantly being subtracted from the output (position). This signal, resulting from the

constant subtraction, is termed as error ($\text{setpoint} - \text{output} = \text{error}$) which multiplied by a constant is used to modify the final output. The magnitude of this product is termed proportional gain or "P" ($\text{error} \times \text{constant} = P$).

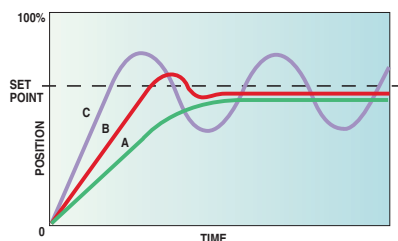
It would seem that the greater one makes "P" the less the error would appear in the final output. Unfortunately, in practice, this does not hold true.

Graph #1 displays the response of a positioner to a sudden change of setpoint for different values of "P". Setting a small value to "P" results in a final output which differs from the desired output by a large error (curve A). Setting a large value to "P" results in an uncontrollable continuous oscillation of output termed "Ultimate P" (curve C). By interpolating different values of "P", a value may be obtained which produces a medium error having a stable response (curve B). However, the result of a proportional only type system still results in a relatively large error and slow speed of response.

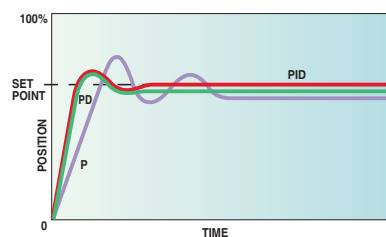
The ICoT smart positioner greatly enhances the performance of the proportional only type system. A derivative ("D") is added to the servo of the ICoT. "D" is the derivative of the output with respect to time or the speed at which the valve position moves multiplied by a constant ($\text{speed} \times \text{constant} = \text{"D"}$). The positioner is now converted into a "PD" servo type system. The addition of "D" into the system increases speed of response while decreasing overshoot. It also allows for "P" to increase above the ultimate proportional value, thereby reducing the final error (see graph #2).

In order to decrease the error even further, a third function, "I", is added to the "PD" servo. The integrator ("I") slowly decreases the error when the position reaches stability. This addition of the "I" function converts the ICoT into a "PID" servo type system.

Graph #1



Graph #2



ICoT 5000 Series Features and Benefits

5200, 5300 and 5400 Features and Benefits

- 3-button interface and LCD for easy calibration and information display.
- Split range and reverse acting operation are easily configured (5200 and 5300 Series).
- Single design for both spring return and double acting actuators.
- Utilizes non-contact means of measuring valve position (Hall Effect sensor). This eliminates the need for drive arms and linkages and increases the overall resolution, accuracy, and reliability.
- Advanced Auto-calibration feature, taking care of positioner gain settings, zero and span adjustments, and internal adjustments.
- Digital speed controls allow valve speed to be adjusted using microprocessors control.
- Available with optional dry contact limit switches.
- Available with optional 4-20 mA position feedback transmitter (5200 and 5300 Series).
- High Flow spool valve option for larger actuator/valves. Eliminates the need for volume boosters in some applications.
- Large and highly visible position indicator for rotary applications.
- Single design for both rotary and linear valves, reducing inventory requirements.
- Easily accommodates large stroke valves, such as knife gates, without the use of drive arms.
- Communication and diagnostics available through the use of HART® digital Protocol (5300 Series).
- Fully compatible with AMS™ software (5300 Series).
- FOUNDATION Fieldbus™ includes analog input, analog output and PID block (5400 Series).

Additional Features and Benefits: ICoT 5300 Intelligent Positioner with HART® Capability



Maintenance Improvements via HART® Diagnostics

A pressure transducer compares actuator output pressure to the incoming transducer signal for diagnostic purposes. These two parameters are graphically displayed via the HART® interface and provide valuable data. For example, the relationship between actuator pressure and valve travel allows for stem friction, spring rate, and benchset parameters to be calculated. Excessive stem friction may imply the presence of packing or guide bushing problems. Additionally, detection of a non-operational spool valve within the ICoT positioner is also made possible by the pressure sensor whose output is utilized for comparison with the servo output command to the transducer.

The principle advantage of online diagnostics is the ability to detect deviations from established patterns of behavior as they occur under actual operating conditions.

Control valves are the most maintenance intensive components commonly used in instrumentation and control systems. By inclusion of internal parameter sensing within the valve positioner, forewarning of the need for maintenance is made available with a comfortable degree of lead time.

The ICoT positioner's diagnostic compatibility is based upon observations of the following operating parameters:

- Valve position vs. input signal.
- Actuator pressure vs. valve position.
- Airset filter outlet pressure.
- Confirmation of principal operating pressures within positioner.
- Pressure generation within packing gland area.

ICoT 5000 Series Features and Benefits

Intelligent Control

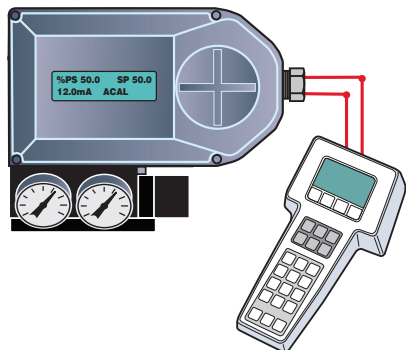
ICoT, with HART® protocol, opens up an endless array of new possibilities for improving efficiency and preventive maintenance procedures in all areas pertaining to control valve usage.

% PS 50.0	SP 50.0
12.0 mA	ACAL

Intelligent Calibration HART® Protocol

The ICoT 5300 provides intelligence for the control valve through a microprocessor-based system utilizing the HART® protocol. Accurate measurement of valve stem position, input signal, and actuator pressure can be recorded during normal operation, thereby providing information for control valve signature generation.

A standard hand-held terminal (the HART® Communicator) may be utilized for field operations in conjunction with a remote PC for maintenance information and documentation.

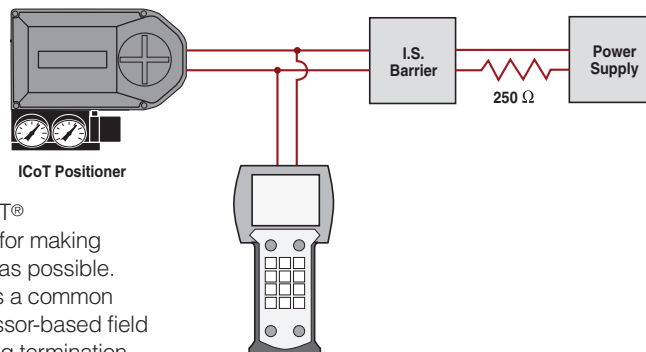


Online Diagnostics via HART® Link

- “Stick-slip” detection.
- Excessive static position error.
- Low air supply pressure.
- Clogged air supply filter.
- Restricted transducer nozzle.
- Transducer diaphragm air leak.
- Non-functioning spool valve.
- Calibration error.

HART® Hand-Held Terminal

A single 4-20 mA ICoT positioner with up to two master devices may be connected to each HART® loop. The primary master is generally a management system or a PC while the secondary unit can be a hand-held terminal or laptop computer.



A standard hand-held HART® Communicator is available for making field operations as uniform as possible. The Model 375 functions as a common tool for HART® microprocessor-based field instruments. From any wiring termination point in the loop, the battery-powered Model 375 can perform diagnostic, configuration, and interrogation functions. Additionally, while the 375 is offline, configuration data can be stored for later downloading to one or more positioners. Simultaneous communication capabilities allow the hand-held terminal to receive data from and send data to the positioner without disrupting the positioner's signal from the control room.

Communication

Model communicates with ICoT Smart Positioners via HART® protocol. Communication is accomplished by superimposing a high frequency signal on top of the 4-20 mA output signal. This allows simultaneous communication and output without compromising loop integrity.



Additional Features and Benefits: ICoT 5400 FOUNDATION Fieldbus™ Enabled Intelligent Positioner



Intelligent Calibration FOUNDATION Fieldbus™ Protocol

The ICoT 5400 provides intelligence for the control valve through a microprocessor-based system utilizing the FOUNDATION Fieldbus™ protocol.

ICoT 5000 Series Features and Benefits

Accurate measurement of valve stem position, input signal, actuator pressure, cycle time and cycle count data can be recorded during normal operation, thereby providing information for control valve signature generation.

The positioner has a local LCD display which indicates valve position, setpoint in percentage open, calibration status, alarms status and whether the ICoT is in local or fieldbus control. The ICoT has the capability to self monitor operation. If a failure condition occurs, an error message is displayed on the local LCD display and communicated to the Host system via fieldbus.

Intelligent Control

The FF ICoT provides accurate measurements of valve stem position, input signal, actuator pressure and travel time. With the internal trending capability of the ICoT information for control valve signature generation is developed for use in predictive maintenance.

FOUNDATION Fieldbus™

FOUNDATION Fieldbus™ (FF) communications protocol is an industry proven international standard (IEC 61158) designed for use in the process industry. Features include multi-drop capabilities (as many as 32 devices per segment), extended trunk length, single loop integrity, "control in the field," power and communications on a shielded twisted pair network, and compatibility with intrinsically safe networks. A key feature of the FOUNDATION Fieldbus™ protocol is the ability to select where control of the process is situated – in the host, in the field, or in various combinations of both locations.

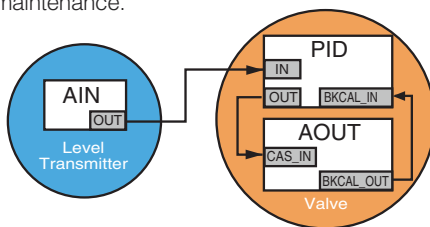
FOUNDATION Fieldbus™

Conformance Documentation

The Westlock™ 5400 IS FF ICoT is a FOUNDATION Fieldbus™ registered device having successfully completed the required conformance tests to ITK revision 5.0.

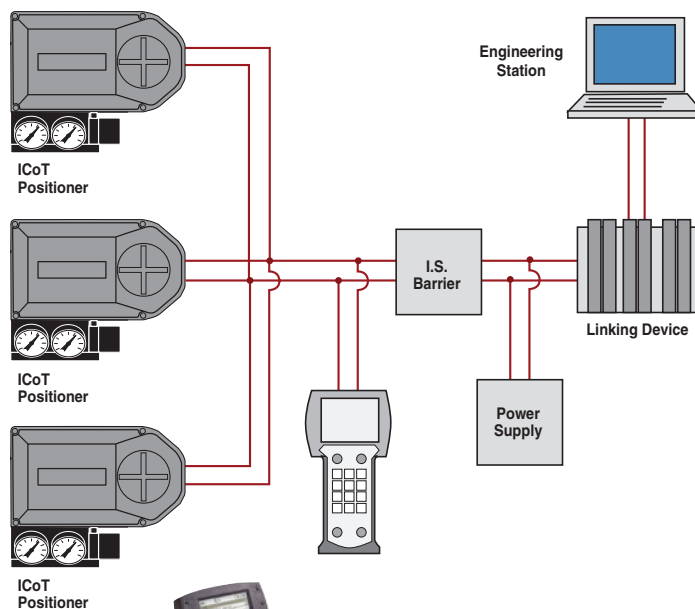
FF ICoT DD and CFF Availability

The CFF and DD are downloadable from the Foundation's website at www.fieldbus.org or also available on CD, please contact your local sales representative for more information.



FOUNDATION Fieldbus™ Conformance Documentation

Manufacturer	Westlock Controls
Model	ICoT Valve Controller 5400-IS
Category	Final Control Element
Type	IS Pneumatic Positioner
Tested Function Blocks	1xAI(s), 1xAO(s), 1xPID(s)
Other Blocks	1xTBA(c), 1xTBH(c)
H1 Profile Class	31PS
H1 Device Class	Basic
Test Camp. Number	45100
MANUFAC_ID	0x574343
DEV_TYPE	0x1100
DEV_REV	0x02
ITK Version	5.0



Handheld Programmers

The Rosemount Model 375 communicates with the FF ICoT Smart Positioners via the FF protocol.

ICoT 5000 Series Features and Benefits



Online Diagnostics

- “Stick-slip” detection.
- Excessive static position error.
- Low air supply pressure.
- Clogged air supply filter.
- Restricted transducer nozzle.
- Transducer diaphragm air leak.
- Non-functioning spool valve.
- Calibration error.

Diagnostic and Configuration Software

The ICoT possesses the capability to predict rather than react to valve maintenance needs. With the ICoT positioner, operating personnel gain a real-time perspective on the state of control at the valve, including a view of operating integrity and emerging alert conditions. Timely information about each control valves condition is quickly made available to the plant’s production and maintenance engineers.

The principle advantage of online diagnostics is the ability to detect deviations from established patterns of behavior as they occur under actual operating conditions.

SP-50%	PV-49.9%
F-CTRL	ERROR 6D

Control valves are the most maintenance intensive components commonly used in instrumentation and control systems. By inclusion of internal parameter sensing within the valve positioner, forewarning of the need for maintenance is made available with a comfortable degree of lead time

The ICoT positioner’s diagnostic compatibility is based upon observations of the following operating parameters:

- Valve position vs. input signal.
- Actuator pressure vs. valve position.
- Airset filter outlet pressure.
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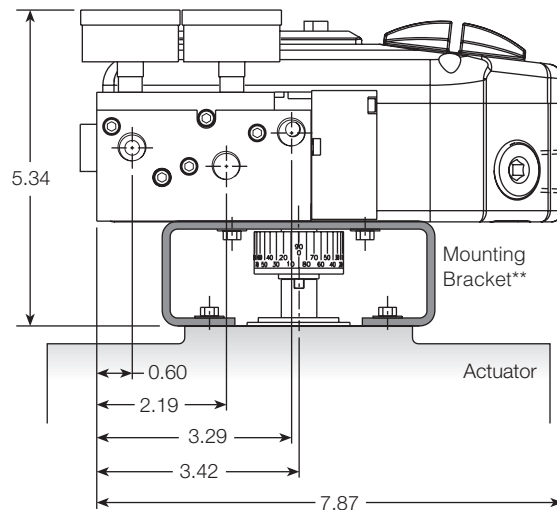
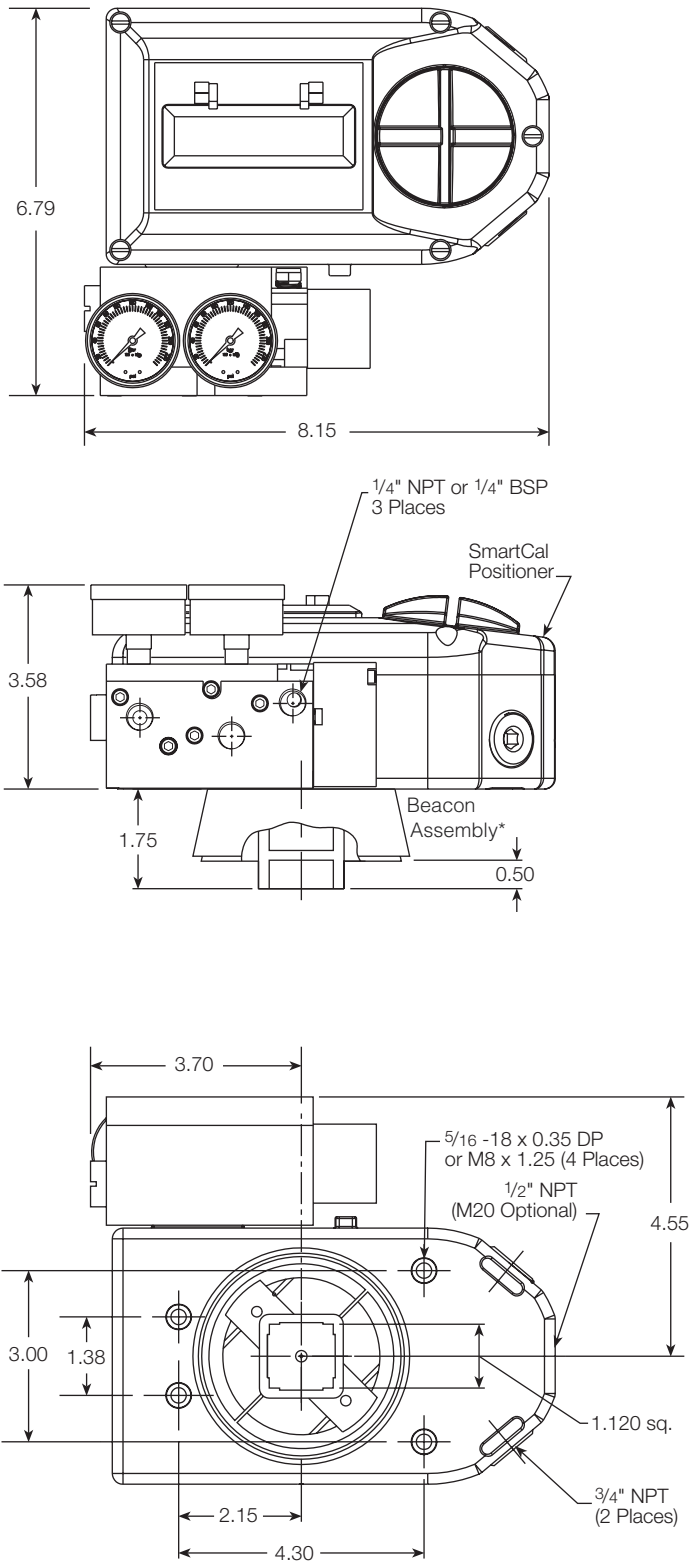
Technical Specifications

Electrical	5200/5300	5400
Input signal	4-20 mA DC	Two wire FOUNDATION Fieldbus™, Polarity insensitive
Minimum voltage	12.3 Volts DC	9 - 35 VDC
Maximum voltage	30.0 Volts DC	N/A
Impedence	615 Ohms at 20 mA	N/A
Reverse polarity protection	Yes	N/A
Pneumatic	5200/5300/5400	
Supply pressure*	15 to 45 psi (low pressure option) 40 to 120 psi (high pressure option) * As required by actuator for proper control	
Output flow rate	8.0 scfm @ 25 psi 16.2 scfm @ 90 psi	
Air consumption	0.03 scfm @ 20 psi (low) 0.08 scfm @ 90 psi (high)	
Technical	5200/5300/5400	
Linearity	± 0.5% Rotary ± 1.0% Linear (for travel under 1.25")	
Valve travel	Rotary: Minimum 45°, Maximum 95° Linear: Minimum 0.25", Maximum 48"	
Hysteresis	0.2% of span	
Repeatability	0.2% of span	
Environmental	5200/5300/5400	
Operating temperature	-40°F to +185°F [-40°C to +85°C]	
Thermal coefficient	2% / 100°C	
Mechanical	5200/5300/5400	
Connections	Pneumatic: 1/4" NPT (F) (3/8" NPT (F) for High Flow version) Electrical: 1/2" NPT (F) (M20 optional)	
Materials of construction	Enclosure: Nylon, glass filled Cover gasket: Silicone Pneumatic manifold: Aluminum anodized Die cast zinc Stainless steel Pneumatic seals: BUNA-N	
Weight	7.2 pounds	
Electrical Classification	5200/5300/5400	
	<ul style="list-style-type: none"> • Non-Incendive as <ul style="list-style-type: none"> – 5200 and 5300: Class I, Division 2, Groups A, B, C & D; Class II & III, Division 2, Groups F & G/ T4 Ta=85 deg. C, Type 4 Enclosure – 5400: Class I, II & III, Division 2, Groups A, B, C, D, E, F & G/ T4 Ta= 80 Deg C, Type 4, 4X Enclosure • Intrinsically Safe as <ul style="list-style-type: none"> – 5200 and 5300: Class I, II & III, Division 1, Groups A, B, C, D, E, F & G/ T4 Ta=85 Deg C, Type 4 Enclosure (with approved IS Barrier) – 5400: Class I, II & III, Division 1, Groups A, B, C, D, E, F & G/ T4 Ta=80 Deg C, Type 4, 4X Enclosure (Entity and Fisco) (with approved IS Barrier) <p>Consult your sales representative for Canadian Approvals.</p>	
Optional Features	5200/5300/5400	
Airset	Filter regulator combo with 5 micron filter element	
Limit switches	Two SPST hermetically sealed switches (rated for 2 amp at 24 VDC)	
	5200/5300	
Feedback transmitter	4-20 mA output (loop powered)	

Westlock™ ICoT 5000 Series Positioners

5200, 5300 and 5400 (FOUNDATION Fieldbus™), Non-incendive or Intrinsically Safe

Dimensions



* Beacon Assembly - not applicable for linear models.

** Mounting Bracket - must be ordered separately.

Ordering Guide

Base Model

- 52 Intelligent positioner
- 53 Intelligent positioner with HART® Capability
- 54 FOUNDATION Fieldbus™ positioner (standard with IS)

Actuator Type

- 1 Linear*
- 3 Rotary

Mounting Style

- 0 Direct Mount (ICoT mounted on actuator)
- 5 Remote Mount (ICoT mounted remote from actuator)
- 7 NAMUR Mount (order with stainless NAMUR mounting kit separately)
- 8 ModMount (for Keystone MRP and 79U actuators only; supplied with mounting kit)

Hazardous Rating

- NI Non-incendive
- IS Intrinsically Safe (standard for base Model 54)

Housing Material

- E Engineered Resin

Supply Pressure

- H High Pressure (40 - 120 psi)
- L Low Pressure (15 - 45 psi)
- V High Flow (40 - 120 psi for larger actuators)

Calibration/Communication

- K Via 3-Button on-board keypad (Series 52 only)
- B 3-Button on-board keypad and Hart Protocol (Series 53 only)
- F 3-Button on-board keypad and Fieldbus Protocol (Series 54 only)

Conduit Entry

- A One 1/2" NPT (F)
- B One M20 (F)

Limit Switch Options

- 0 None
- 2 Two SPST hermetically sealed switches** (not available with Mounting Style 7)

Position Transmitter Output

- A None
- B 4-20 mA Transmitter (not applicable on base Model 54)

Pneumatic Connections

- N 1/4" NPT (3/8" NPT with High Flow Option)
- B 1/4" BSP (3/8" BSP with High Flow Option)
- F 1/4" NPT with Filter-regulator Assembly (3/8" NPT with High Flow Option)

53 3 5 IS E H B A 2 B N = Model Number **5335ISEHBA2BN**

* Linear valve stroke and fail position must be specified at time of quotation.
 ** Not available with "Linear" Actuator Type or "Remote Mounting Style."

Westlock™ ICoT 5000 Series Positioners

5200, 5300 and 5400 (FOUNDATION Fieldbus™), Non-incendive or Intrinsically Safe

USA/Canada: Saddle Brook, NJ
Ph: 201-794-7650
Dedicated Order Fax: 201-794-4790
General Fax: 201-794-0913
www.westlockcontrols.com

Europe/Asia: Kent, England
Ph: + 44 189 251 6277
Fax: + 44 189 251 6279
www.westlockuk.com

South America: Barueri, Sao Paulo
Ph: + 55 11 2588 1400
Fax: + 55 11 2588 1410
www.westlock.com.br

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