



# Operation Manual

PRODUCT NAME

Air Servo Cylinder  
For HART Communication

MODEL/ Series/ Product Number

IN-777-\*\*\*-F\*-H\*

**SMC Corporation**

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# Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard with the labels of "Caution," "Warning" or "Danger." They are all important notes for safety and must be followed in addition to International Standards (ISO/IEC)\*1), and other safety regulations.

\*1) ISO 4414: Pneumatic fluid power -- General rules relating to systems.

ISO 4413: Hydraulic fluid power -- General rules relating to systems.

IEC 60204-1: Safety of machinery -- Electrical equipment of machines .(Part 1: General requirements)

ISO 10218: Manipulating industrial robots -Safety.

etc.

	<b>Caution</b>	<b>Caution</b> indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
	<b>Warning</b>	<b>Warning</b> indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
	<b>Danger</b>	<b>Danger</b> indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

## Warning

### **1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.**

Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results.

The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product.

This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

### **2. Only personnel with appropriate training should operate machinery and equipment.**

The product specified here may become unsafe if handled incorrectly.

The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

### **3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.**

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.

2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.

3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

### **4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.**

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.

2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.

3. An application which could have negative effects on people, property, or animals requiring special safety analysis.

4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.



# Safety Instructions

## **Caution**

### **The product is provided for use in manufacturing industries.**

The product herein described is basically provided for peaceful use in manufacturing industries. If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.  
If anything is unclear, contact your nearest sales branch.

## **Limited warranty and Disclaimer/Compliance Requirements**

The product used is subject to the following “Limited warranty and Disclaimer” and “Compliance Requirements”.

Read and accept them before using the product.

### **Limited warranty and Disclaimer**

**1. The warranty period of the product is 1 year in service or 1.5 years after the product is delivered, whichever is first.\*2)**

**Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.**

**2. For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.**

**This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.**

**3. Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.**

**\*2) Vacuum pads are excluded from this 1 year warranty.**

**A vacuum pad is a consumable part, so it is warranted for a year after it is delivered.**

**Also, even within the warranty period, the wear of a product due to the use of the vacuum pad or failure due to the deterioration of rubber material are not covered by the limited warranty.**

### **Compliance Requirements**

**1. The use of SMC products with production equipment for the manufacture of weapons of mass destruction (WMD) or any other weapon is strictly prohibited.**

**2. The exports of SMC products or technology from one country to another are governed by the relevant security laws and regulation of the countries involved in the transaction. Prior to the shipment of a SMC product to another country, assure that all local rules governing that export are known and followed.**

## **Caution**

### **SMC products are not intended for use as instruments for legal metrology.**

Measurement instruments that SMC manufactures or sells have not been qualified by type approval tests relevant to the metrology (measurement) laws of each country.

Therefore, SMC products cannot be used for business or certification ordained by the metrology (measurement) laws of each country.

## 1. Introduction

This operation manual applies to the Air Servo Cylinder HART communication specifications (Product No.: IN-777-\*\*\*F\*\*-H\*).

IN-777 Air Servo Cylinder provides HART protocol communication as an option. Calibration, operation setting, and data confirmation become available by using 475 field communicator. Refer the manual of EMERSON for the operation.

This operation manual specifies HART communication functions only. Operation manual of "Air Servo Cylinder (No.K35-OMW0030)" shall be referred for basic operation of IN-777 Air Servo Cylinder.

## 2. Specifications

Other than HART communication, specifications are the same as basic type. Refer "4.Specification" of operation manual of "Air Servo Cylinder (No.K35-OMW0030)" for specifications.

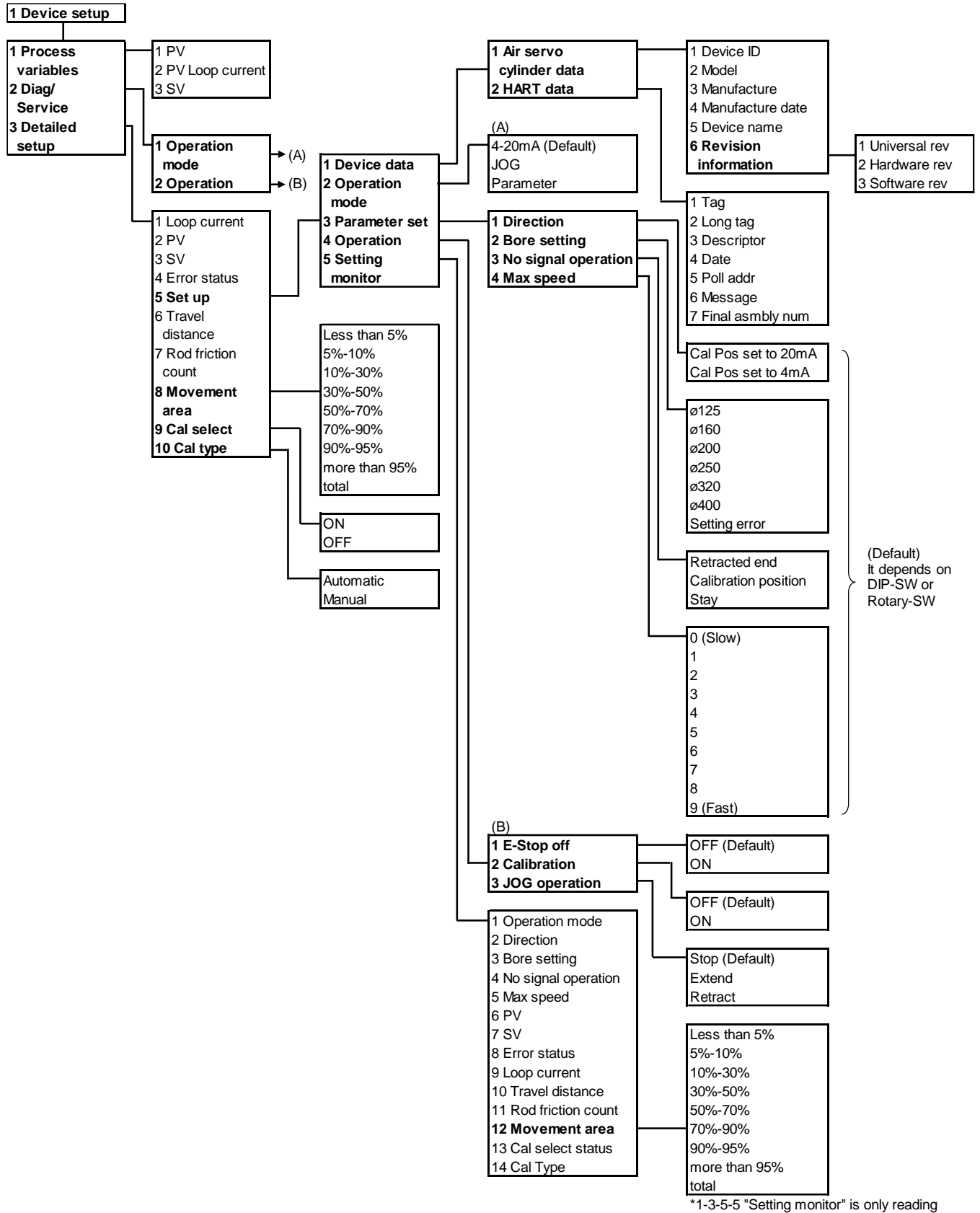
## 3. Function of HART Communication

Table 1 shows main functions of HART communication.

Table 1

Description	Details
1. Checking and changing of the equipment information	Checking and changing of the Air Servo Cylinder information
2. Checking and changing of the HART communication setting	
3. Setting and checking of the parameter	Setting of the operation mode
	Setting of the operating direction
	Setting of the valve position when 0mA is input (Fully closed / fully opened / current position retained)
	Setting of the cylinder bore size
	Setting of the maximum cylinder speed
4. Calibration	Setting of the set point (Position where dart valve closed)
5. Setting and checking of the operation mode	Command of the Emergency stop (E-stop) and stop-release
	Switching to 4-20mA mode, JOG mode, or Parameter mode
6. JOG operation	Start / stop command to the JOG operation
7. Checking of the operating conditions	Current position of the cylinder
	Target position of the cylinder
	Error and alarm status
	Travel distance
	Rod friction count
	Movement area

# 4. Menu Tree



## 5. Parameter Comparison

In HART communication parameter setting items, there are items which function is the same as button operation of the main unit, but different description. Table 2 shows the comparison of expression of Operation manual "Air Servo Cylinder (No.K35-OMW0030)" and the expression of 475 field communicator. Refer "4. Menu Tree".

Table 2

Operation manual (No.K35-OMW0030)	475 Field Communicator		Menu tree No.
	Expression	setting	
Target position	PV	—	1-3-2
Feedback position	SV	—	1-3-3
Error status	Error status	—	1-3-4
Operation mode	Operation mode	4-20mA	1-3-5-2
		JOG	
		Parameter	
Piston rod movement direction	Direction	Cal Pos set to 20mA	1-3-5-3-1
		Cal Pos set to 4mA	
Bore size	Bore setting	ø125 ø160 ø200 ø250 ø320 ø400 Setting error (Read only)	1-3-5-3-2
No signal operation	No signal operation	Retracted end Calibration position Stay	1-3-5-3-3
Maximum piston rod speed	Max speed	0 (Slow) 1 2 3 4 5 6 7 8 9 (Fast)	1-3-5-3-4
Emergency stop	E-Stop off	OFF	1-3-5-4-1
		ON	
Calibration	Calibration	OFF	1-3-5-4-2
		ON	
JOG operation	JOG operation	Stop	1-3-5-4-3
		Extend	
		Retract	

## 6. Confirmation and Change of Device Information

### 1. Checking and changing of the equipment information

Items	Explanation	
Device ID	You can check the ID information of the Air Servo Cylinder board.	
Model	You can check the product classification of the Air Servo Cylinder.	
Manufacture	You can check the manufacturer's ID.	
Manufacture date	You can check the date of manufacture of the Air Servo Cylinder board.	
Device name	You can check the device name. It displays "SMC AIR SERVO CYLINDER"	
Revision information	Universal rev	Revision of the HART protocol is displayed.
	Hardware rev	Revision of the Air Servo Cylinder board is displayed.
	Software rev	Revision of the Air Servo Cylinder board software is displayed.

### 2. Checking and changing of the HART communication setting

Items	Explanation
Tag	You can check and change the tag assigned to the Air Servo Cylinder. Number of characters that can be entered: 8 characters.
Long tag	You can check and change the long tag assigned to the Air Servo Cylinder. Number of characters that can be entered: 32 characters.
Descriptor	Optional information can be entered at user's site. Number of characters that can be entered: 16 characters.
Date	Date can be entered at user's site.
Poll addr	This is the address of the Air Servo Cylinder. Set the address at "0" when using the Air Servo Cylinder with one to one communication, and set it at "0 to 63" when using multiple equipment routed together in one loop such as split range type or multi drop type.
Message	Optional message can be entered at user's site. Number of characters that can be entered: 32 characters.
Final asmbly num	You can check and change the specified management numbers such as date of final setting of the Air Servo Cylinder.



### 3. Setting and checking of the parameter

Items	Explanation
Operation mode (1) 4-20mA (2) JOG (3) Parameter	You can switch the mode to 4-20mA, JOG, or Parameter. You can check the current setting mode.
Direction	You can set the operating direction. The setting is available only in Parameter mode. You can check the current setting mode. (You can set the cylinder operating direction [Retracted / Set point] at 4mA input.)
No signal operation	You can set the forced operating direction of the Air Servo Cylinder with no 4-20mA input. You can check the current direction. Three modes (Retracted end / Calibration position / Stay) are available. The setting is available only in Parameter mode.
Bore setting	You can set the bore size of the Air Servo Cylinder. You can check the current size. The setting is available only in Parameter mode.
Maximum speed	You can set the maximum Air Servo Cylinder speed at 4-20mA operation mode. You can check the current speed. The setting is available only in Parameter mode.

### 4. Calibration

Item	Explanation
Calibration	You can set the set point (e.g. Position where dart valve closed). It is necessary to set the operation mode (page 5) to JOG mode. Set the current cylinder position when signal is input at 4mA or 20mA (It depends on the direction setting).

### 5. Setting and checking of the operation mode

Items	Explanation
E-stop	You can perform and release the Emergency stop of the Air Servo Cylinder. You can check the current setting mode.
Operation mode (1) 4-20mA (2) JOG (3) Parameter	You can switch the mode to 4-20mA, JOG, or Parameter. You can check the current setting mode.

6. JOG operation command


Item	Explanation
JOG operation	You can start / stop the JOG operation. It is necessary to set the mode (page 5) to JOG mode. The operating speed is 50 mm/s constantly.

7. Checking of the operating conditions

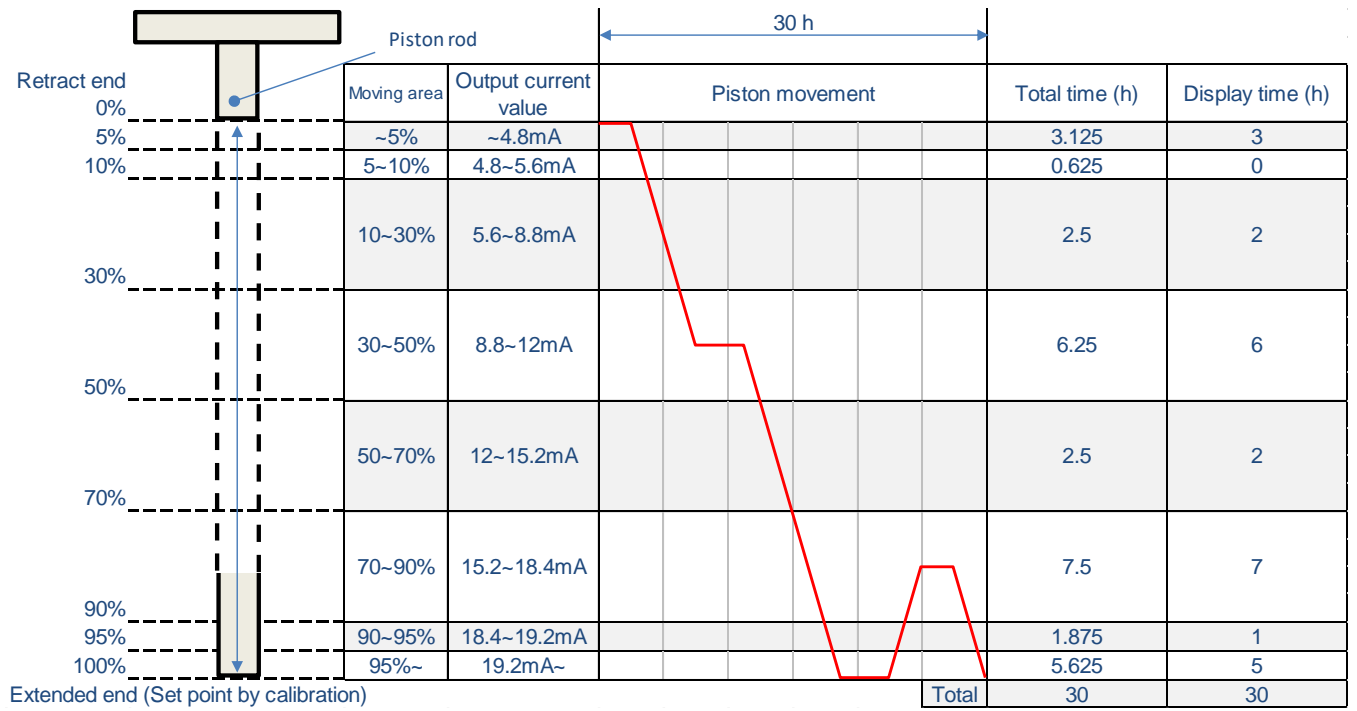
Items	Explanation
Loop current	You can check the current value input to the air servo cylinder. The current value corresponds to the target position.
PV	You can check the target position value in "%" which is currently recognized by the Air Servo Cylinder.
SV (Cylinder position)	You can check the current cylinder position value in "%".
Error status (Error and alarm status)	You can check the current error and alarm status.
Travel distance	You can check the travel distance value in "m" of Air Servo Cylinder.
Rod friction count	You can check the rod friction count of Air Servo Cylinder.*1
Movement area	You can check the number of hours in a certain position of Air Servo Cylinder.*2
Cal select status	Status can be selected: Calibration method selection status / normal operation status.
Cal type	Calibration type can be selected: Automatic / Manual.

\*1 Rod friction count indicates the number of times an abnormal stop of the piston rod occurred such as stick-slip.

\*2 Movement area indicates the duration for the operating piston to remain in a specified range. The range covers from the retracted end (0%) to the calibration set point (100%). The range is divided into 8 sections. The duration for which the piston remains (during both operating and stopping) in the specified area is recorded for 1 hour by the controller.

 <b>Caution</b>
<b>If the power supply voltage is disconnected before 1 hour has passed, the accumulated time (less than one hour) will be reset. For example, when the power supply voltage is stopped for 1 hour and 45 minutes, the accumulated time will be 1 hour. When the power supply voltage is turned on again, the accumulation starts from 1 hour. When calibration is performed again, the recorded data is reset.</b>

(Recording example)



## 7. HART Communication

### Caution

1. Refer 475 field communicator manual from EMERSON for 475 field communication usage.
2. Unless input current 4 to 20mADC is supplied to IN-777 Air Servo Cylinder, HART communication is not available.

#### ■ IN-777 Air Servo Cylinder

This manual describes the version below. Communication may not be available if version is not the same.

HART Universal command revision: 7

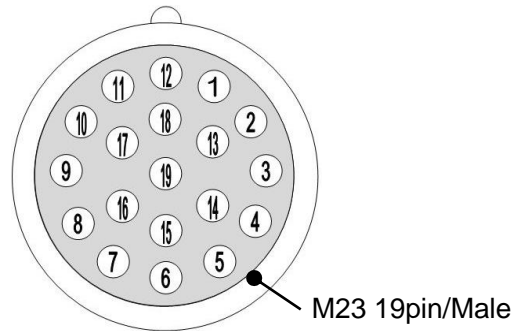
#### ■ 475 Field Communicator

If operate IN-777 Air Servo Cylinder with 475 field communicator, perform "Check for Updates" in "475 Easy Upgrade Programming Utility" to register IN-777 Air Servo Cylinder data to 475. (Refer 475 field communicator manual from EMERSON for details). When IN-777 Air Servo Cylinder is not registered yet, contact SMC. Update 475 field communicator firmware and module upon necessity.

## 8. Electrical wiring

Perform wiring according to the connector pin numbers and the wiring diagram.

### 1. Connector pin numbers (Male side)

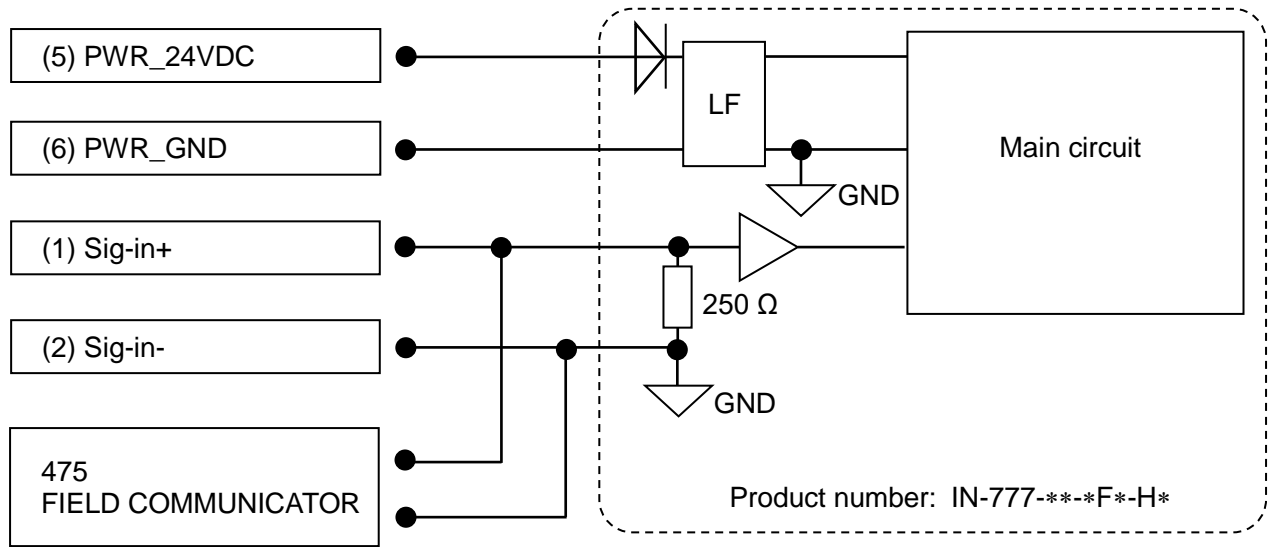


Pin No.	Signal name	Input/output status	Description
1	Sig-in+	Input	4-20mA analog input signal (+) with HART
2	Sig-in-	Input	4-20mA analog input signal (-) with HART
3	JOG+(*1)	Input	JOG operation signal (Move to the extended end direction)
4	JOG-(*1)	Input	JOG operation signal (Move to the retracted end direction)
5	PWR_24VDC		+24 VDC Power supply
6	PWR_GND		Power supply GND
7	Pos-out+	Output	4-20 mA analog output signal (+)
8	Pos-out-	Output	4-20 mA analog output signal (-)
9	CTR	Output	Controller normal signal
10	CYL	Output	Positioning sensor error signal
11	VAL	Output	Valve error signal
12	GND_I/O	—	Input/output signal GND
13	CAL(*1)	Input	Calibration signal
14	E-STOP	Input	Emergency stop signal (Negative edge triggered *2)
15	-	-	-
16	RF	Output	Piston rod friction error signal
17	PWR	Output	Power supply error signal
18	-	-	-
19	-	-	-

\*1 JOG+, JOG- and CAL are valid when the Operation mode (Menu Tree No.1-3-5-2) is in 4-20mA mode.

\*2 Emergency stop is performed when signal is OFF.

2. Wiring diagram (Number in brackets indicates the pin numbers)



## 9. HART Communication Method

### **Caution**

Confirm followings before starting HART communication.

1. Air Servo Cylinder IN-777 is supplied with 24V as input voltage.
2. Air Servo Cylinder IN-777 is supplied with 4 to 20mA as input current.
3. 475 field communicator wiring is arranged.
4. Refer 475 field communicator manual from EMERSON for 475 field communication usage.

Procedure to start HART communication

Wire 475 field communicator to input current to IN-777 Air Servo Cylinder, and turn on the power supply of 475 field communicator. After starting 475 field communicator's OS, synchronization with the Air Servo Cylinder automatically starts.

## 10. Setting

This model performs setting of normal/reversed switching of the piston rod travel direction during the target position operation; cylinder bore size, piston rod operating direction at no signal operation and piston rod speed during the target position operation by Air Servo Cylinder switch and HART communication. The setting by each method is explained below.

### 1. Setting by Air Servo Cylinder switch

Refer "6. Setting" of operation manual of "Air Servo Cylinder (No.K35-OMW0030)".

### 2. Setting by HART communication

Direction (Menu Tree No.1-3-5-3-1), Bore setting (Menu Tree No. 1-3-5-3-2), No signal operation (Menu Tree No.1-3-5-3-3) and Max speed (Menu Tree No.1-3-5-3-4) are available by setting the Operation mode (Menu Tree No.1-3-5-2) to Parameter mode. When the body power supply is turned OFF and power is applied again, the switch setting of the Air Servo Cylinder body is enabled.

#### 2-1. Direction (Menu Tree No.1-3-5-3-1)

Setting	Relationship between the analogue input signal and the piston rod movement direction
Cal Pos set to 20mA	
Cal Pos set to 4mA	

#### 2-2. Bore setting

With Bore setting (Menu Tree No.1-3-5-3-2), the bore size of the Air Servo Cylinder used can be set. The available bore sizes are  $\varnothing 125$ ,  $\varnothing 160$ ,  $\varnothing 200$ ,  $\varnothing 250$ ,  $\varnothing 320$  and  $\varnothing 400$ .

#### 2-3. No signal operation

With No signal operation (Menu Tree No.1-3-5-3-3), the piston rod operation can be set when the input signal of 3.5mA or less is input. The available operation is Retracted end. Calibration position and Stay.

#### 2-4. Max speed

With Max speed (Menu Tree No.1-3-5-3-4), the maximum operating speed of the piston rod can be set. The relation between the set value and speed is shown in the table below.

setting No.									
0	1	2	3	4	5	6	7	8	9
Slower	→→(Speeds up gradually.)→→								Faster

### **! Caution**

When setting the cylinder bore size, set the cylinder bore size of the body (IN-777) used. When different bore size is set, vibration may occur or piston rod positioning may fail.



## 11. Operation Mode and Functions

This model can set the JOG operation, Calibration and Emergency stop by Air Servo Cylinder signal input and HART communication. The operation with each method is explained below.

### 1. JOG operation, Calibration and Emergency stop operation by Air Servo Cylinder input signal

When JOG operation and Calibration are performed by Air Servo Cylinder input signal, set the operation mode (Menu Tree No.1-3-5-2) to 4-20mA. Emergency stop is valid for all the setting of Operation mode (Menu Tree No.1-3-5-2).

Refer to 7-1. JOG Operation, 7-2 Calibration and 7-5 Emergency Stop of the operation manual (K35-OMW0030) for the signal input method of each operation.

### 2. Operation by HART communication

#### 2-1 JOG operation

Set the Operation mode (Menu Tree No.1-3-5-2) to JOG.

Each operation is performed by setting JOG operation (Menu Tree No.1-3-5-4-3) to Stop, Extend and Retract. The default setting is Stop.

If JOG operation is set to Extend or Retract when Operation mode is set to JOG, perform Stop once and then perform Extend and/or Retract.

#### 2-2 Calibration

The piston rod movement range (set point) can be set when using the Target position operation (refer to 7-3). By performing the Calibration, the relationship between the piston rod position (from the retracted end to the set point) and the current value (4-20 mA) input to Sig-in+ and Sig-in- can be set. Once the Calibration is performed, the set point is stored in the product and will be recorded even when the power supply is OFF.

There are two types of Calibration mode; Automatic and Manual.

The set point is not set when the product is shipped from the factory.

For how to change the calibration mode (Automatic mode or Manual mode), refer to the 7-2-1.

Change the mode Operation manual (K35-OMW0030).

#### 2-2-1 Auto calibration

Set the Operation mode (Menu Tree No.1-3-5-2) to JOG.

Auto calibration is performed by turning ON the Calibration (Menu Tree No.1-3-5-4-2). The position at which the piston rod must stop for 1 second, due to an external stopper or cylinder extended end, is set as a set point. The default Calibration setting is OFF.

#### 2-2-2 Manual calibration

Set the Operation mode (Menu Tree No.1-3-5-2) to JOG.

Perform JOG operation (Menu Tree No.1-3-5-4-3) by turning ON Extend or Retract to move the piston rod to the required stop position by turning ON Stop (example: position where an external stopper is located). When the calibration is ON, the position where the piston rod stops is set as a set point. The default Calibration setting is OFF.

\*If Calibration is ON after setting the Operation mode to JOG, turn OFF the Calibration once and turn it ON again.

#### 2-3 Emergency stop

Emergency stop is performed by turning OFF the E-Stop off (Menu Tree No.1-3-5-4-1). Emergency stop is valid for all the setting of Operation mode (Menu Tree No.1-3-5-2). The default setting is OFF.

## 12. 4-20 mA mode

When the operation (Target position operation) where the cylinder is operation by input current (4-20mA) is performed, set the Operation mode (Menu Tree No.1-3-5-2) to 4-20mA. Refer to 7-3. Target Position Operation for the signal input method.

## 13. No signal operation

When an analog input signal of 3.5 mA or less is input, the piston rod operates according to the No signal operation setting set beforehand (Refer to 10.Setting "1. Setting by Air Servo Cylinder switch" or "2-3. No signal operation").

## 14. Error status

Error status (Menu Tree No.1-3-4) and the descriptions are shown below.

Error code	Error name	Possible causes	Countermeasures
0	No error		
1	Power supply error (Outside of 24 V $\pm$ 10%)	The power supply voltage between the power supply terminal PWR_24V and PWR_GND is outside of 24 VDC $\pm$ 10%.	Use a power supply voltage of 24 VDC $\pm$ 10%.
2	Power supply error (Below 17 V)	The power supply voltage between the power supply terminal PWR_24V and PWR_GND is below 17 V.	Use a power supply voltage of 24 VDC $\pm$ 10%.
3	Incorrect cylinder bore size setting	All DIP switches No. 2, 3 and 4 are ON or OFF, which is an incorrect setting.	Change the setting of the DIP switch correctly. (Refer to operation manual K35-OMW0030).
4	Over current to the positioning sensor	Over current flowed to the positioning sensor.	Refer to *1.
5	Incorrect positioning sensor signal	Non-conformance occurred in the connection of the positioning sensor and controller or on the positioning sensor signal.	
6	Incorrect positioning sensor connection	Non-conformance occurred in the connection of the positioning sensor and controller.	Remove the controller to confirm that the connector of the sensor harness which connects the controller board and the positioning sensor is mounted correctly.
7	Over current to the emergency stop valve	Over current flowed to the emergency stop pilot valve (E-STOP valve).	Replace the emergency stop pilot valve. (Refer to *1.)
8	Over current to the servo valve	Over current flowed to the servo valve.	Replace the servo valve. (Refer to *1.)
9	Incorrect servo valve connection	Non-conformance occurred in the connection of the servo valve and controller.	Remove the controller to confirm that the connector of the valve harness which connects the controller board and the valve unit is mounted correctly.
A	Piston rod friction	Malfunction occurred in the piston rod.	Check the condition of the rod, and remove unbalanced load and/or foreign matter as necessary.
B	Controller error	Non-conformance occurred in the controller.	Refer to *1.

\*1 Contact your SMC sales representative.

## 15. Trouble shooting

If any irregular operation is found during the usage of this Air Servo Cylinder, perform countermeasures in the below table of troubleshooting. For troubles due to cause other than HART communication, refer "9. Trouble Shooting" of operation manual of "Air Servo Cylinder (No.K35-OMW0030)".

Content	Possible cause	Countermeasure	Page to refer
Communication not available	475 communicator is not connected	Connect input current line with 475 field communicator	13
	Air servo cylinder's polling address is set other than "0"	Change the setting of 475 field communicator	8
	Input current is not stabilized	Ground the air servo cylinder	-
	Upper status controller does not match	Change upper status controller	-
	Input current is not applied	Apply correct input current(4 to 20 mADC)	13
	Other cause	Contact SMC	-
Setting change not available	Operation is in 4-20mA mode or JOG mode	Change operation mode to parameter mode	15
	Other cause	Contact SMC	-

Revision history

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NOTE: Specifications are subject to change without prior notice and any obligation on the part of the manufacturer.  
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