

System 350™ P352P Electronic Proportional Plus Integral Static Pressure Controls

The P352P is an electronic proportional only or proportional plus integral static pressure control with 0 to 10 VDC and 0 to 20 mA analog outputs. The P352P is also equipped with three user-selectable integration constants, as well as a wide adjustable throttling range. Two models cover the ranges of 0.5 to 5 in. W.C. and 0.025 to 0.25 in. W.C.

Like all System 350 products, the P352P is housed in a NEMA 1 high-impact thermoplastic enclosure. The modular design provides easy, snap-together connections for quick installation and future expandability.



Figure 1: P352P Electronic Proportional Plus Integral Pressure Control

Features and Benefits	
☐ Modular Design	Provides the flexibility to add a D352 Pressure Display Module and a Y350R Power Module
☐ Plug-in Connectors and 35 mm DIN Rail Mountability	Eliminates wiring between modules and reduces installation costs
☐ Two Models Cover a Wide Setpoint Range of 0.5 to 5 in. W.C. or 0.025 to 0.25 in. W.C.	Reduces inventory by encompassing pressure ranges required to support most static pressure control applications
☐ Minimum Output Adjustable from 0 to 60%	Tailors the output to the requirements of the controlled equipment
☐ Adjustable Throttling Range of 0.5 to 5 in. W.C. or 0.025 to 0.25 in. W.C.	Enables user to match the amount of control (maximum to minimum) required for a given application
☐ Field-selectable Reverse or Direct Acting Mode	Works in a variety of pressure applications
☐ Three User-selectable Integration Constants	Adjusts output to bring process to setpoint regardless of system load
☐ Interchangeable Pressure Transmitters	Increases versatility and serviceability

Application Overview

The P352P Pressure Controls can be used as stand alone devices or in conjunction with plug-in accessory modules to control variable speed drives, motor actuators, or other devices. The P352P Static Pressure Controls are not typically used with staging modules. Consult Johnson Controls Application Engineering for specific information if a question regarding a specific application arises. Typical applications include:

- duct static pressure control
- building pressurization

A typical System 350 static pressure control scheme includes the following:

- P352P Pressure Control
- Y350R Power Module (or 24 VAC transformer)
- D352CA Digital Pressure Display Module (in. W.C.)
- DPT-2640 Pressure Transmitter

Operation

IMPORTANT: Use this P352P Electronic Proportional Plus Integral Static Pressure Control only as an operating control. Where failure or malfunction of the [truncated name of device] could lead to personal injury or property damage to the controlled equipment or other property, additional precautions must be designed into the control system. Incorporate and maintain other devices, such as supervisory or alarm systems or safety or limit controls, intended to warn of or protect against failure or malfunction of the P352P Control.

IMPORTANT: Utiliser ce P352P Electronic Proportional Plus Integral Static Pressure Control uniquement en tant que dispositif de régulation. Lorsqu'une défaillance ou un dysfonctionnement du [nom abrégé de l'appareil] risque de provoquer des blessures ou d'endommager l'équipement contrôlé ou un autre équipement, la conception du système de contrôle doit intégrer des dispositifs de protection supplémentaires. Veiller dans ce cas à intégrer de façon permanente d'autres dispositifs, tels que des systèmes de supervision ou d'alarme, ou des dispositifs de sécurité ou de limitation, ayant une fonction d'avertissement ou de protection en cas de défaillance ou de dysfonctionnement du P352P Control.

The P352P operates on 24 VAC/VDC and provides two simultaneous analog outputs: 0 to 10 VDC and 0 to 20 mA. A ten segment front panel LED bar graph indicates percentage of output. Adjustable features include:

- setpoint
- minimum output
- throttling range (proportional band)
- integration constant

- reverse or direct acting mode of operation

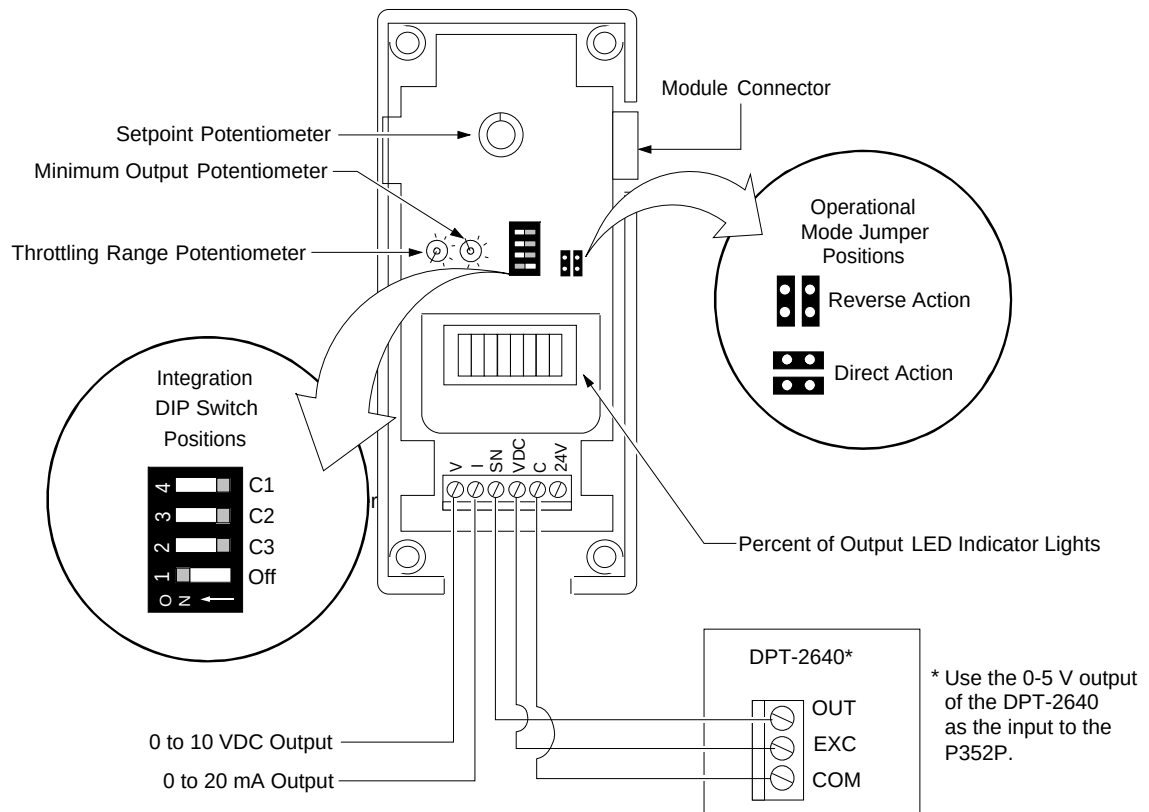


Figure 2: Interior View Showing P352P Features

Minimum Output Adjustment

This adjustment is used to set the minimum voltage or milliamper (mA) output that the P352P will provide. It can be set from 0 to 60% (up to 6 VDC or up to 12 mA).

Example: A controlled device that responds to a 4 to 20 mA output would require that the minimum output be adjusted to 20% or 4 mA (see Figure 3).

The “MIN OUTPUT” adjustment is located on the lower circuit board to the right of the throttling range potentiometer. One bar will light on the bar graph LED (front of control) for each 10% increase in range.

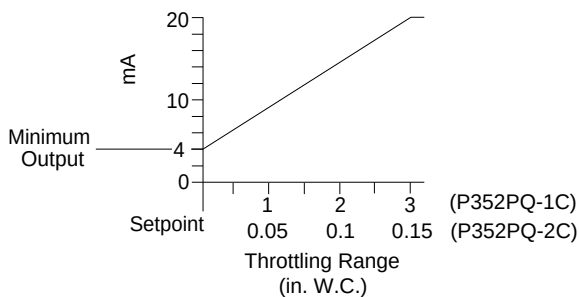


Figure 3: Minimum Output Set to 20% (4 mA) and Throttling Range Set to 3 in. W.C. (P352PQ-1C) or 0.15 in. W.C. (P352PQ-2C)

Throttling Range (Proportional Band)

The throttling range can be adjusted from 0.5 to 5 in. W.C. (P352PQ-1C) or 0.025 to 0.25 in. W.C. (P352PQ-2C) (see Figure 3). Adjustment is made using the potentiometer marked “THROT RANGE” located on the lower printed circuit board to the left of the “MIN OUTPUT” potentiometer.

Integration Constant

Proportional controls cannot hold a process at the exact setpoint. A proportional offset is always present and is due to the fact that the control output reaches 0% at setpoint. Any load on the system will cause the point of control to be offset from the setpoint. The greater the load on the system, the further the control point will be offset from the setpoint (this is commonly referred to as “proportional offset”).

Some proportional only controls are designed with their setpoint located midway through the proportional band to help compensate for this offset, but a fixed 50% controlled device action at setpoint does not necessarily match the system load. Depending on the load, the control point can still be held some distance from setpoint. This results in a plus/minus error from the setpoint rather than a single-ended error.

The P352P has an integration feature, which measures the control point’s distance from setpoint and automatically adjusts the amount of control output. Over a period of time, the P352P’s output is brought into balance with the system load at setpoint (see Figure 4). The rate of correction automatically increases as the process deviates further from setpoint.

On traditional proportional plus integral controls, the amount of correction is sometimes in danger of becoming too large. When the output of the actuated device (valve or damper) is fully open or closed and the setpoint still cannot be reached, the integration error continues to grow. The result is called “integral windup.” The P352P avoids “integral windup” with a patented circuit that puts a dynamic ceiling on the integrator. This resets the integration error when the sensor goes just above the setpoint plus the throttling range (in DA [Direct Action] mode) or just below the setpoint minus the throttling range (in RA [Reverse Action] mode). This will allow the process to recover from an out-of-range condition without a long period of overshoot.

The P352P has three field-selectable integration constants as well as an off position. The DIP switch block that selects the integration constant is located on the lower circuit board next to the RA/DA mode jumper blocks (see Figure 2). The field-selectable integration constants include:

- **OFF (Switch 1 to On position, all others Off)** provides proportional only operation.

Note: In open-loop (without feedback) applications, select “OFF” proportional only operation.

- **C3 (Switch 2 to On position, all others Off)** is the slowest integration constant (equal to 9 min.) and is suitable for most proportional plus integral applications. It is recommended that C3 be the initial setting.

- **C2 (Switch 3 to On position, all others Off)** selects a five minute integration constant. If the rate of system recovery to setpoint is sluggish with the control set to C3 and it is determined that the system has enough capacity to drive the process to setpoint at a faster rate, the C2 setting may be used.
- **C1 (Switch 4 to On position, all others Off)** is the fastest integration constant (equal to 2.5 min.). C1 should be used only in instances where the rate of change at the transmitter is extremely rapid and system capacity can compensate for that rapid change.

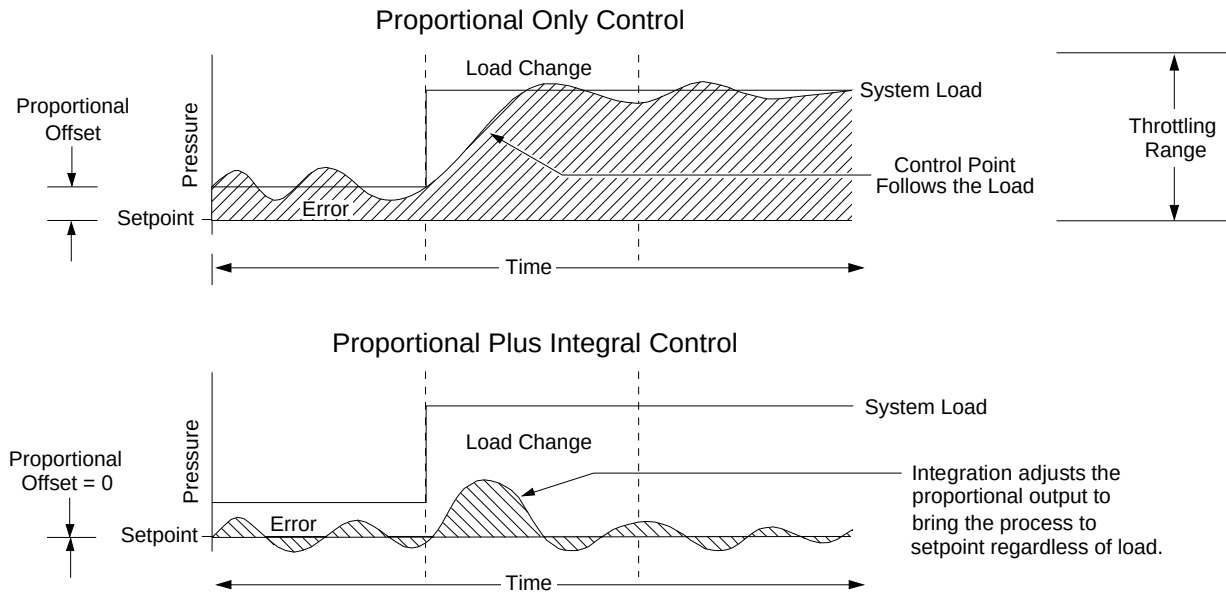


Figure 4: Operation of Proportional Only vs. Proportional Plus Integral Control

Mode of Operation (Direct or Reverse)

The RA/DA mode is selected by the jumper blocks located on the lower circuit board just to the right of the integration constant DIP switch block. Position the jumper blocks vertically for reverse action and horizontally for direct action.

With the jumper blocks in the RA position, the analog output increases as the pressure drops (see Figure 5).

With the jumper blocks in the DA position, the proportional output will increase as the pressure rises.

As shipped from the factory, the RA/DA jumper blocks are installed in the reverse acting mode.

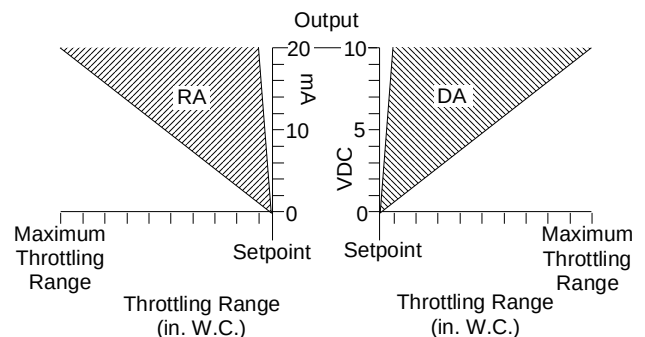


Figure 5: Direct or Reverse Acting Proportional Bands Shown in "Proportional Only" Mode (Shaded Area Shows Throttling Range Possibilities from Minimum to Maximum)

Dimensions

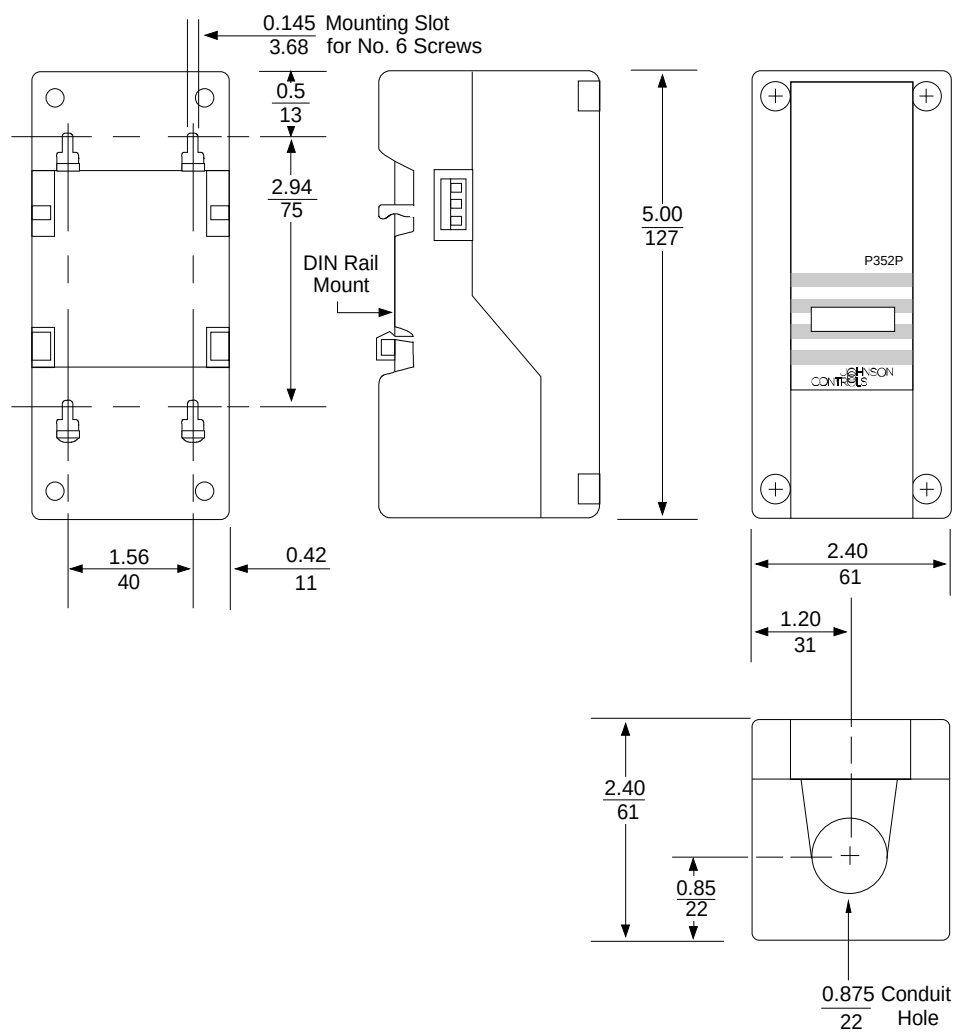


Figure 6: P352P Dimensions, in./mm

Installation and Wiring

The P352P is housed in a compact NEMA 1 plastic enclosure designed for standard 35 mm DIN rail mounting. The P352P is not position sensitive but should be mounted for convenient wiring and adjustment. Four key-slot mounting holes on the back of the control case are provided should surface mounting be required.

Note: When mounting the P352P (or any System 350 Module) to rigid conduit, attach the hub to the conduit before securing the hub to the control enclosure.



WARNING: Risk of Electric Shock.

Disconnect the power supply before making electrical connections. Contact with components carrying hazardous voltage can cause electric shock and may result in severe personal injury or death.

AVERTISSEMENT: Risque de décharge électrique.

Débrancher l'alimentation avant de réaliser tout branchement électrique. Tout contact avec des composants porteurs de tensions dangereuses risque d'entraîner une décharge électrique et de provoquer des blessures graves, voire mortelles.

- All wiring must be installed to conform to the National Electrical Code and local regulations. For maximum electrical rating of control, see label inside the control cover. Use copper conductors only.
- The P352P can output a variable signal from 0 to 10 VDC or 0 to 20 mA. (Both outputs can be used simultaneously.) Connections are made to the terminal block located in the wiring compartment at the bottom of the case.
- Connection can be made to both the voltage and milliampere outputs, allowing the P352P to drive two outputs simultaneously (off the same RA or DA ramp). This feature can be used to

drive different types of motor actuators or variable speed drives.

Table 1: Terminal Designations

Terminal Designation	Terminal Description
V	0 to 10 VDC output
I	0 to 20 mA output
SN	0-5 VDC input from the pressure transmitter (in. W.C.)
VDC	14 VDC power supply for the pressure transmitter
C	Power supply common for the pressure transmitter
24V	24 volts AC or DC

Transmitter Connection

The P352P pressure control is used with a DPT-2640 Differential Pressure Transmitter, which is powered by the 14 VDC power supply of the P352P. The transmitter is connected to the P352P at the 6-conductor terminal block located at the bottom of the lower circuit board.

Shielded cable is not generally required for transmitter wiring on runs of less than 50 feet. When using shielded cable, isolate and tape the shield at the transmitter. Connect the shield to the "C" terminal on the P352P.

The maximum recommended length of 14 to 22 AWG shielded transmitter cable is 1,000 feet (305 meters).

Table 2: Transmitter Connections

Terminal Designations	
P352P	DPT-2460-3 DPT-2640-7
SN	OUT
VDC	EXC
C	COM

Add-on Modules

The D352 Digital Pressure Display Module and Y350R Power Module are designed to connect together and plug into the P352P, via a connector on its right side. The preferred order of the modules is (from left to right) control module, power module, and display module.

D352 Pressure Display Module

The D352 receives its power, pressure, and setpoint information from the P352P. A three-digit Liquid Crystal Display (LCD) gives continuous read-out of the sensed pressure. Pushing the "PRESS FOR SETPOINT" button will cause the setpoint of the adjoining P352P to be displayed.

Y350R Power Module

The Y350R provides a convenient method of powering System 350 Modules from a 120 or 240 VAC power source. The Y350R supplies 24 VDC unfiltered to the modules.

Adjustments

P352P

1. Remove P352P cover by loosening the four captive cover screws.
2. Set the RA/DA jumper blocks to the desired mode of operation. Position the jumper blocks vertically for RA (Reverse Acting) or horizontally for DA (Direct Acting) (see Figure 2).
3. Adjust the throttling range potentiometer to desired setting. Clockwise rotation increases the throttling range.

If the P352P is to be used in proportional plus integral mode, the initial throttling range adjustment should not be set below 3 in. W.C. for the P352PQ-1C and 0.15 in. W.C. for the P352PQ-2C. A narrow proportional band used in conjunction with the integration may result in unstable control.

4. If minimum output is required, set the minimum output potentiometer to the desired position. Output can be read with a voltmeter or can be adjusted using the ten segment, front panel LED.

Note: Before setting the minimum output potentiometer, be sure the control is not generating an analog output signal.

For each 10% increase in range, one bar will light on the front panel LED. In a milliampere application, each bar equals 2 mA. In a voltage application, each bar equals 1 volt. (See Figure 3 for an example.)

Example: To set the P352P for a minimum output of 4 mA, turn the minimum output potentiometer clockwise until the second LED segment lights. Slowly back off the potentiometer counter-clockwise until the second segment just goes out.

5. Make sure the system is stable before selecting integration. Refer to *Checkout Procedure*.
6. Adjust the control to the desired setpoint and replace cover.

Note: The P352PQ-1C setpoint at mid scale is factory calibrated to a tolerance of ± 0.05 in. W.C. (The P352PQ-2C has a midscale calibration tolerance of ± 0.0025 in. W.C.)

The setpoint tolerance at the extreme ends of the setpoint scale can be ± 0.15 in. W.C. for the P352PQ-1C model (± 0.0075 in. W.C. for the P352PQ-2C).

The D352 Display Module is unaffected by this tolerance shift. Use the D352 to achieve the most accurate setpoint selection.

Checkout Procedure

1. Before applying power, make sure installation and wiring connections are according to job specifications.
2. After necessary adjustments and electrical connections have been made, put the system in operation and observe at least three complete operating cycles to determine that the system is stable.
3. If integration is required, select the C1, C2, or C3 integration constant. C3 is the recommended initial setting. (Refer to the *Integration Constant* section.)
4. Put the system back into operation. Observe system operation and make additional adjustments to obtain stable control (if necessary).
 - If the DVM voltage is between 13.9 and 14.1 VDC, proceed to Step 2.
 - If the DVM voltage is above 14.1 VDC, replace the P352P.

IMPORTANT: Removing the sensor will either turn the blower off or on, depending on mode selected on the P352P.

- d. Check the voltage again.
 - If the DVM voltage rises to a value between 13.9 and 14.1 VDC, then replace the transmitter.
 - If the DVM voltage is still below 13.9 VDC, then replace the P352P.

Troubleshooting

If the control system does not function properly, verify that the proper mode is selected on each module (e.g., RA/DA) and then use the following procedures to determine the cause of the problem:

1. Check for the proper voltage source applied to the P352P Control.

- a. Connect a Digital Voltmeter (DVM) between the "24 V" (+) and "C" (-) terminals located on the P352P's terminal block (Figure 2).
 - If an external transformer is used, select AC volts on the DVM and verify that the voltage is between 20 and 30 VAC.
 - If a Y350R Power Module is used, select DC volts on the DVM and verify that the voltage is between 16 and 38 VDC.
 - If an external DC power supply is used, select DC volts on the DVM and verify that the voltage is between 22 and 29 VDC.
- b. If the DVM reading is within the indicated voltage range, select DC volts on the DVM (DVM must be accurate to +/- 0.1 VDC) Connect the (+) lead to the "VDC" terminal and the (-) lead to the "C" terminal.

2. Check the P352P for proper operation.

Note: Step 1 must be performed first.

- a. Select the RA mode.
- b. Adjust the setpoint until it equals the throttling range.

Note: The right-most LED in the bar graph should be on.
- c. Adjust the setpoint to minimum (turn completely counter-clockwise).

Note: The illuminated LED should move from right to left, two or more positions.
- d. Select DA mode.

Note: All LEDs should be off and the VDC output should be 0.1 VDC.

- e. Adjust the minimum output from 0 to 60% by turning the potentiometer completely clockwise.

Note: As the potentiometer is adjusted in the clockwise direction, the P352P's "V" output voltage should go from 0 to 6 VDC and the "I" output current should go from 0 to 12 mA. The LEDs should turn on, one at a time, from left to right (until LED 6 is on).

If the LEDs do not come on or the "V" or "I" outputs do not change as described above, replace the P352P.

3. Check pressure transmitter for proper output voltage.

- a. Re-adjust the P352P back to the desired control settings (see the *Adjustments* section); then reconnect the pressure transmitter and energize the blower.
- b. Connect the DC voltmeter (+) lead to the P352P "SN" terminal and the (-) lead to the "C" terminal; then, using Figure 7, convert the voltage to pressure (P_T).

Note: A transmitter output of 0 to 5 VDC should correspond to a pressure of 0 to 0.5 in. W.C. for the DPT-2640-3 or to a pressure of 0 to 10 in. W.C. for the DPT-2640-7 (see Figure 7).

- If the voltage conversion to pressure (P_T) deviates substantially from the actual, replace the transmitter.
- If the voltage conversion to pressure at the transmitter (P_T) is close to the actual pressure, then:

- If the proportional plus integration control is selected, wait for the system to stabilize, then verify that the transmitter pressure (P_T) is very close to the selected setpoint pressure.
- If the proportional only control is selected, make sure the transmitter pressure is above the setpoint (for DA mode) or below the setpoint (for RA mode).

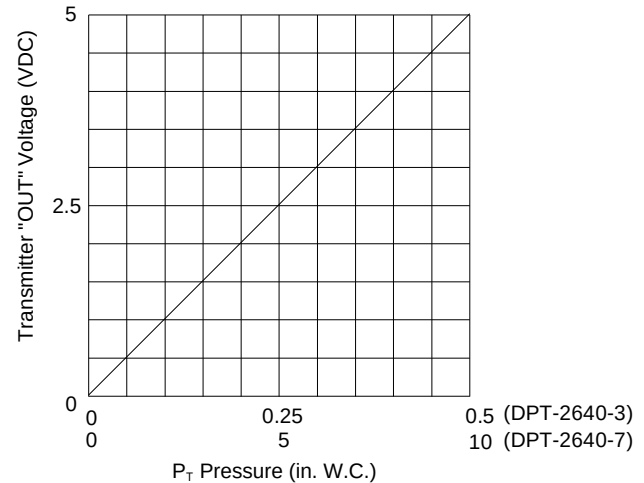


Figure 7: Transmitter Voltage vs. Pressure

4. Check the D352 Display Module.

If there is no D352 in the system, skip this step.

Note: Steps 1 through 3 must be performed first.

- a. Check pressure at the transmitter. The display should read the same pressure.
- b. If the D352 does **not** read the correct transmitter pressure (P_T), replace the D352.
- c. Press the setpoint button on the display module to read the selected setpoint.
- d. If the D352 displays a reading other than the expected setpoint value, check the setpoint potentiometer setting and correct if necessary. If the display continues to read an incorrect or out-of-range (>0.520 in. W.C. for the P352PQ-2C) value, replace the D352.

Note: If the control and add-on modules all appear to be operating properly, but the field device still does not turn on and off as expected, check the wiring from the P352P to the field device.

Repairs and Replacement

Do not make field repairs or perform calibration.
The DPT-2640 Differential Pressure Transmitter and replacement controls are available through local Johnson Controls representatives.

Table 3: Ordering Information

Item	Product Code Number	Description
P352P Proportional Plus Integral Pressure Control	P352PQ-1C P352PQ-2C	Setpoint Range: 0.5 to 5 in. W.C.; Throttling Range: 0.5 to 5 in. W.C. Setpoint Range: 0.025 to 0.25 in. W.C.; Throttling Range: 0.025 to 0.25 in. W.C.
Display Module	D352CA-1C D352CA-2C	Digital Pressure Display Module: 0 to 9.99 in. W.C. Digital Pressure Display Module: 0 to 0.999 in. W.C.
Power Module	Y350R-1C	120/240 VAC, 50/60 Hz input
Pressure Transmitter	DPT-2640-7 DPT-2640-3	0 to 10 in. W.C. (use with P352PQ-1C) 0 to 0.5 in. W.C. (use with P352PQ-2C)
Conduit Adapter	ADP11A-600R	1/2 in. Snap-fit EMT Conduit Adapter (box of 10)
DIN Rail Section	BKT287-1R BKT287-2R	35 x 7.5 mm, 0.305 m (12 in.) long 35 x 7.5 mm, 0.914 m (36 in.) long
DIN Rail End Clamps	PLT344-1R	Consists of Two End Clamps
Cable for Remote Mounting of D352 Display Module	WHA29A-600R WHA29A-603R WHA29A-604R	3 ft (0.9 m) 25 ft (7.6 m) 50 ft (15.2 m)

Notes

Specifications

Product	P352P Electronic Proportional Plus Integral Static Pressure Controls
Sensor Input Range	P352PQ-1C: 0 to 10 in. W.C. corresponding to 0 to 5 VDC P352PQ-2C: 0 to 0.5 in. W.C. corresponding to 0 to 5 VDC
Setpoint and Throttling Range	P352PQ-1C: 0.5 to 5 in. W.C. P352PQ-2C: 0.025 to 0.25 in. W.C.
Supply Voltage*	AC Supply: 20-30 VAC Class 2, 50/60 Hz, 5 VA max. Y350R Power Module: See <i>Add-on Modules</i> below. DC Supply: 22 to 29 VDC at 50 mA max.
Analog Output	0 to 10 VDC (550 ohm Load Minimum) and 0 to 20 mA (600 ohm Load Maximum) Both outputs are designed to withstand short circuits to COM and 24 VAC.
Minimum Output	Adjustable from 0 to 60% of Full Output
Output Indication	A ten segment LED bar graph indicates percentage of output.
Control Action	Direct or reverse action is jumper selectable.
Power Requirement	3.2 VA
Integration Constant	Three Selectable Rates C1, C2, C3 and an OFF Position
Ambient Temperature	Operating: -30 to 150°F (-34 to 66°C) Shipping: -40 to 185°F (-40 to 85°C)
Ambient Humidity (all modules)	0 to 95% RH Non-condensing; Maximum Dew Point: 85°F (29°C)
Transmitters	P352PQ-1C uses a DPT-2640-7; 0 to 5 VDC, 0 to 10 in. W.C. range. P352PQ-2C uses a DPT-2640-3; 0 to 5 VDC, 0 to 0.5 in. W.C. range.
Material	Case, Cover: NEMA 1 High-impact Thermoplastic
Agency Listings	UL Guide No. XAPX and cUL Guide No. XAPX7, File E27734

*Only one input voltage source may be used.

Add-on Modules:

Y350R	Input Voltage: 120/240 VAC, 50/60 Hz
D352	Display Range: See Table 3.

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult Johnson Controls/PENN Application Engineering at 1-414-524-5535. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

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