

## P545 Series Electronic Lube Oil Control

The P545 Series Electronic Lube Oil Control is designed for use on refrigeration compressors equipped with an oil pump that accepts a single-point differential pressure switch. The P400 switch continuously monitors net lube oil pressure and the P545 control locks out the compressor if lube oil pressure falls below the manufacturer's recommended net pressure for longer than the recommended lube oil time delay. Front-mount Light-Emitting Diodes (LEDs) indicate the status of the lubrication system, and a user-selectable, minimum-off time delay can be set to minimize compressor short cycling.

A Johnson Controls/PENN® R310AD Current Sensing Switch, sold separately, may be used to disable the P545 control lockout circuit during abnormal compressor shutdowns.



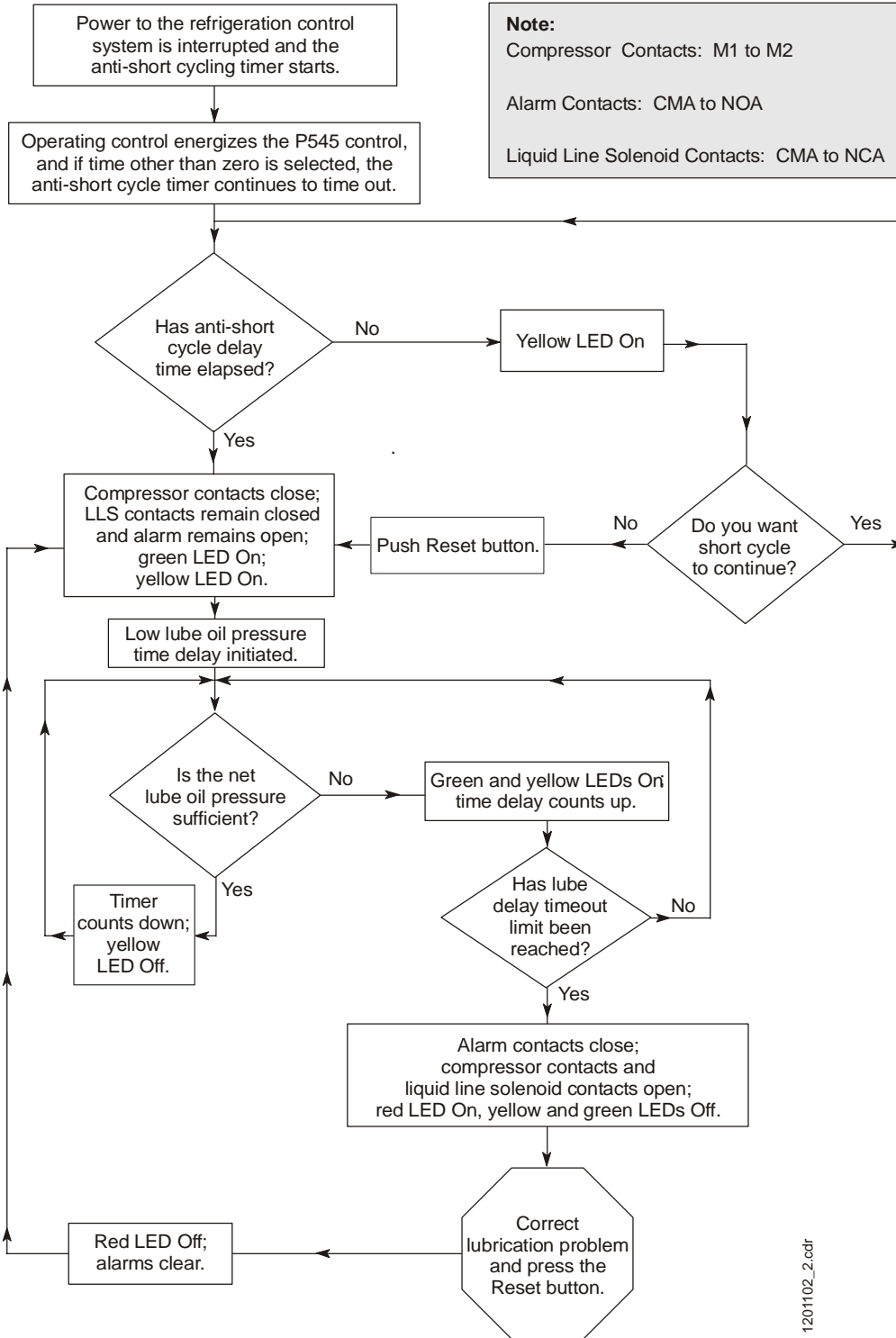
**Figure 1: P545 Electronic Lube Oil Control with P400 Single-Point Oil Pressure Differential Switch**

### Features and Benefits

<input type="checkbox"/> <b>Single-Pole Double-Throw (SPDT) Relay Contacts for Liquid Line Solenoid and Alarm Applications</b>	Allows liquid line solenoid to be closed if the P545 control shuts off the compressor due to low oil pressure (minimizes refrigerant migration); provides alarm indication, including circuits that use neon lights.
<input type="checkbox"/> <b>Relay Contact Output for Compressor</b>	Provides reliable, long-lasting operation
<input type="checkbox"/> <b>Built-in Test Circuit</b>	Verifies proper control operation quickly, without additional tools or equipment
<input type="checkbox"/> <b>Improved Noise Immunity</b>	Exceeds immunity requirements of UL 991 for transient overvoltage: IEC 61000-4-3 for radiated Radio Frequency (RF) and IEC 61000-4-6 for RF-induced conducted disturbances
<input type="checkbox"/> <b>Selection of Anti-short Cycle Time Delay</b>	Allows choice of anti-short cycle strategy for a wide range of equipment requirements; possible elimination of external short-cycle timer
<input type="checkbox"/> <b>User-Friendly Display Panel</b>	Displays the status of the compressor lubrication system continuously
<input type="checkbox"/> <b>Backwards Compatibility</b>	Allows easy replacement of existing electronic lube oil controls

# Operation

Figure 2 shows an operational flowchart for the P545 control.



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**Figure 2: P545 Control Flowchart**

**IMPORTANT:** The P545 control is intended to control equipment under normal operating conditions. Where failure or malfunction of the control could lead to an abnormal operating condition that could cause personal injury or damage to the equipment or other property, other devices (limit or safety controls) or systems (alarm or supervisory systems) intended to warn of or protect against failure or malfunction of the control must be incorporated into and maintained as part of the control system.

### Low Oil Pressure Timing Circuit Operation

All P545 control timing functions are designed to comply with compressor manufacturer requirements. Standard control models de-energize the compressor contactor if the low-pressure condition lasts longer than the factory-set time delay.

The oil pressure monitoring circuit on the P545 control compares the amount of time that the oil pressure is above opening point to the amount of time that the oil pressure is below opening point. If the oil pressure is above opening point more than it is below opening point, the control does not shut down the compressor.

If the oil pressure drops continuously below the opening point, the control times out in either 90 or 120 seconds, depending on the model. If the oil pressure is below opening point more than half of the time, the control times out but the timing is extended. This allows the control to protect the compressor when there are repeated low oil pressure signals interrupted by short periods of sufficient oil pressure.

### R310AD Current Sensing Switch for False Oil Failure Lockouts

False oil pressure failure lockouts can occur when the P545 control remains powered despite a loss of power to the compressor motor (for example, when an internal motor overload switch trips).

An R310AD switch disables the oil-failure delay timer when there is no power to the compressor, thus avoiding false lockouts.

Install the R310AD switch after the main contactor on one of the compressor power leads, and wire to terminals W1 and W2 on the P545 control. In addition, remove resistor R39 by cutting the leads to the circuit board. See Figure 13.

**IMPORTANT:** The R310AD switch does not work when the control's anti-short cycle delay timer is set at 0 seconds. You must set the timer to 35, 65, or 100 seconds. See *Anti-Short Cycle Delay* for further information.

### Anti-short Cycle Delay

Anti-short cycle delay establishes the minimum time that the controlled equipment is de-energized before restarting. After the P545 control has de-energized the equipment, the anti-short cycle delay is activated and the yellow LED lights. The equipment remains de-energized for the selected amount of delay time. The anti-short cycle delay on the P545 control may be set to 0, 35, 65, or 100 seconds.

### Backwards Compatibility

The P545 control and P400 switch offer backwards compatibility with previous offerings in the Johnson Controls/Penn product line and operate as shown in Table 1.

**Table 1: Control and Sensor/Switch Compatibility**

Test	P345 or P445 Control with P300 Sensor	P345 or P445 Control with P400 Switch	P545 Control and P300 Sensor	P545 Control and P400 Switch
<b>Wiring Harness<sup>1</sup></b>	WHA-P300-xxx Only	WHA-P300-xxx or WHA-P400-xxx	WHA-P300-xxx Only	WHA-P300-xxx or WHA-P400-xxx
<b>Test Switch</b>	6-8 Second Delay	Does not function <sup>2</sup>	Immediate	Immediate

1. WHA-P300-xxx is the 3-wire harness supplied with the P345 or P445 control and the P300 sensor. WHA-P400-xxx is the 2-wire harness supplied with the P545 control and the P400 switch.
2. When the P445 control is wired to a P400 switch, The **Test** button may operate when first powered up; however, after a couple minutes of operation, the **Test Switch** function no longer works. All other control functions operate normally.

## Installation

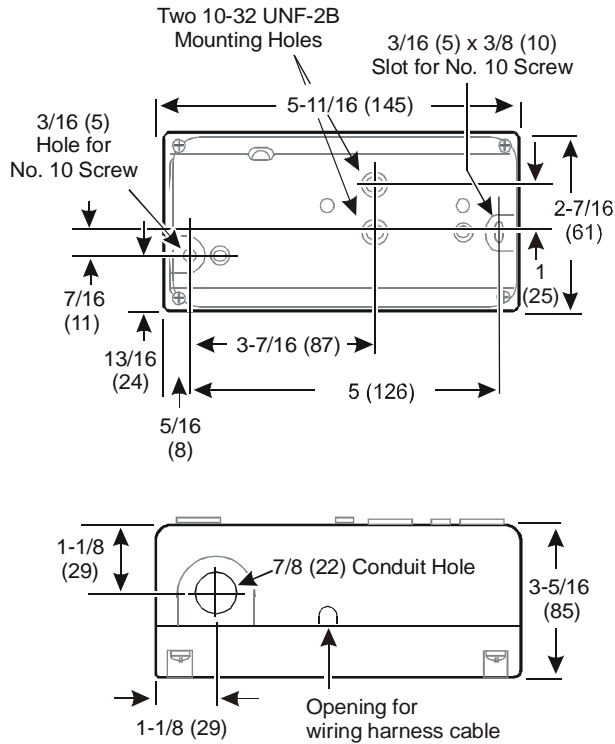


Figure 3: Control Dimensions, in. (mm)

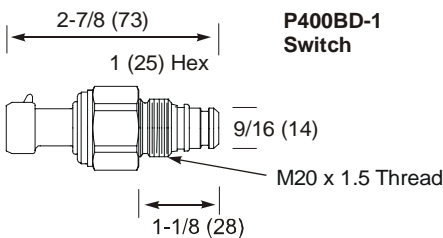
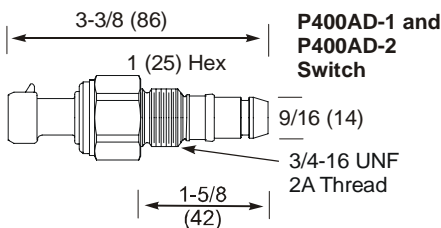
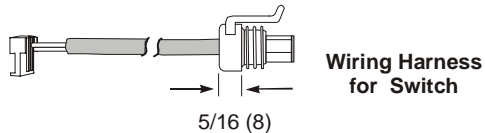


Figure 4: P400 Switch Dimensions, in. (mm)

## Mounting

### Mount the P545 Control

Use the mounting holes shown in Figure 5 for mounting the control on a flat vertical surface. Two No. 10 screws are provided for this purpose. Do not use longer screws, as damage to internal components may occur. Mount the control in an upright position, and avoid warping or bending the case.

Use the Universal Mount (Part No. 271-51) to mount the control to a vertical or horizontal surface. This requires two 10-32 UNF-2B screws (not included).

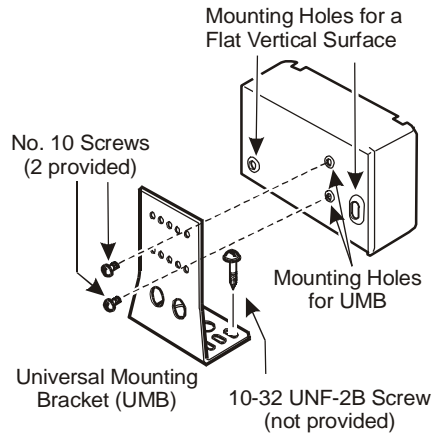


Figure 5: Mounting the P545 Control

### Mount the P400 Switch

If you modify an existing refrigeration compressor to accept the P400 switch, it may involve installing a sensor block (such as a Johnson Controls® CST29A-600C) or other part. For proper installation, follow all procedures recommended by the compressor manufacturer.

To mount the P400 switch:

1. Wet the switch nozzle and gasket with oil.
2. Fit the gasket over the nozzle as shown in Figure 6.
3. Install the switch in the lube oil port according to the compressor manufacturer's instructions.
4. Hand-tighten the switch until the surfaces of gasket and compressor housing meet.
5. Use a torque wrench to tighten the sensor until sealed (40 lb-ft recommended torque).

## Wiring

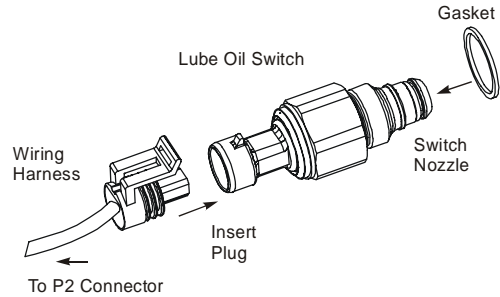
See Figure 7 through Figure 12 for typical wiring diagrams, or refer to the compressor manufacturer's specifications. Make all wiring connections using copper conductors only. Ensure all wiring conforms to the National Electrical Code and local regulations.



### **WARNING: Risk of Electric Shock.**

Disconnect 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.

**Note:** The control does not function properly if the wiring harness is connected improperly at the circuit board.



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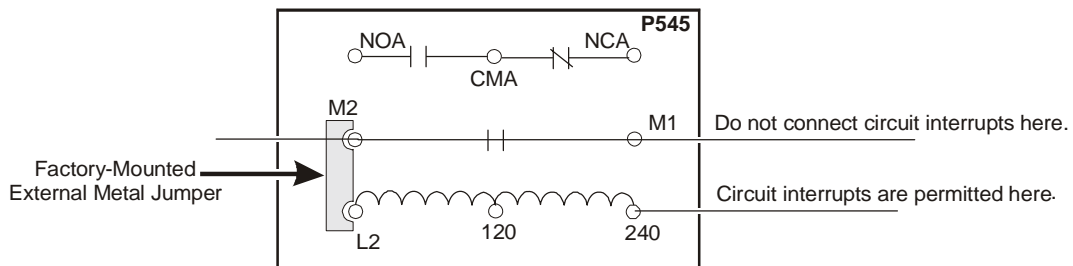
**Figure 6: Connecting the Wiring Harness to the P400 Switch**

## Wire the P400 Switch

Use this procedure to connect the P400 switch to the control:

1. Insert the plug into the connector until it snaps and locks in place. See Figure 6.
2. Connect the wiring harness to the P545 control at P2. See Figure 13 for the location and orientation of the differential oil pressure switch connection.

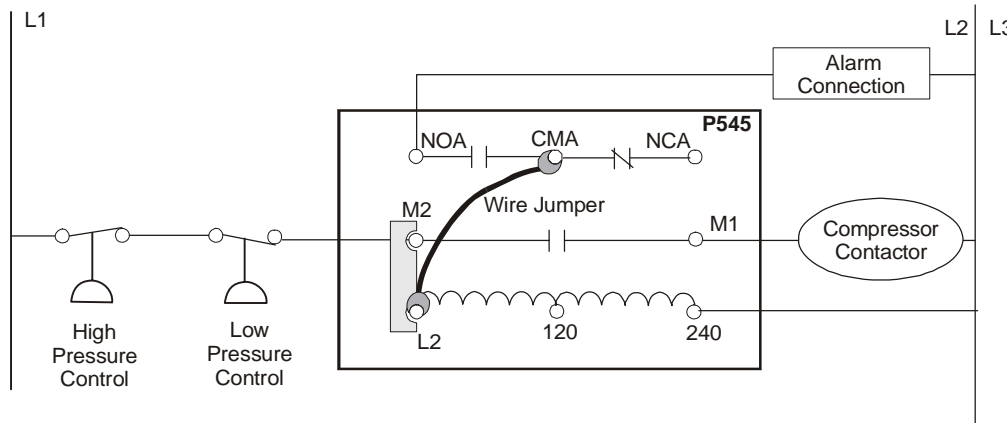
## Internal Wiring Diagram



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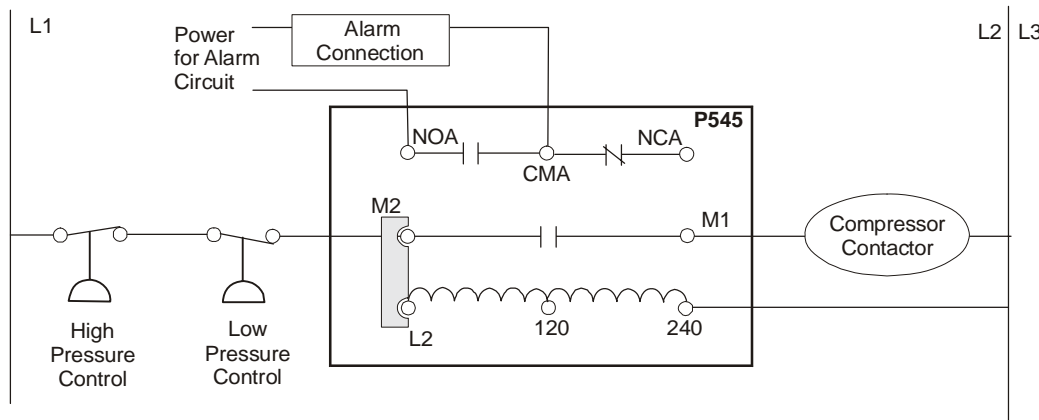
**Figure 7: Internal Wiring Diagram for the P545 Control**

## Ladder Diagrams for the P545 Control



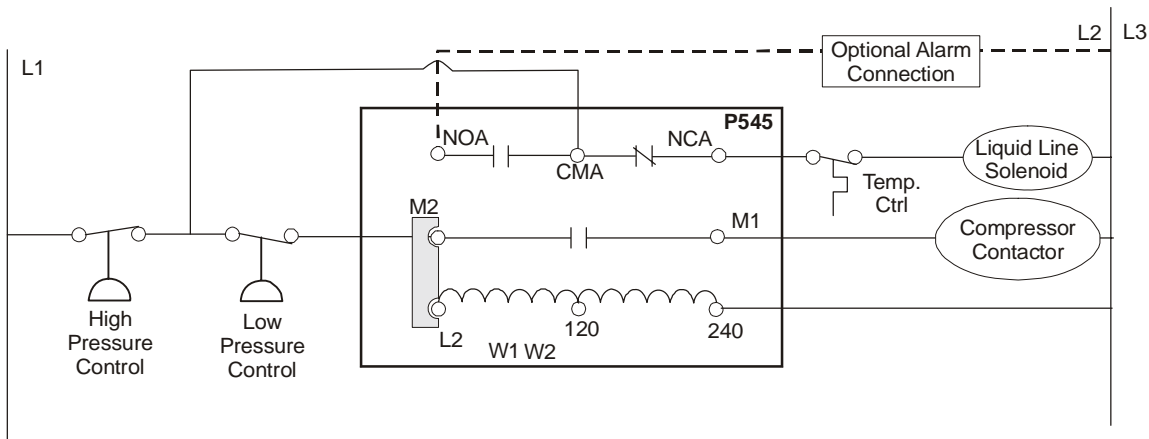
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**Figure 8: Typical P545 Control Application with Alarm Circuit Powered by Line Voltage**



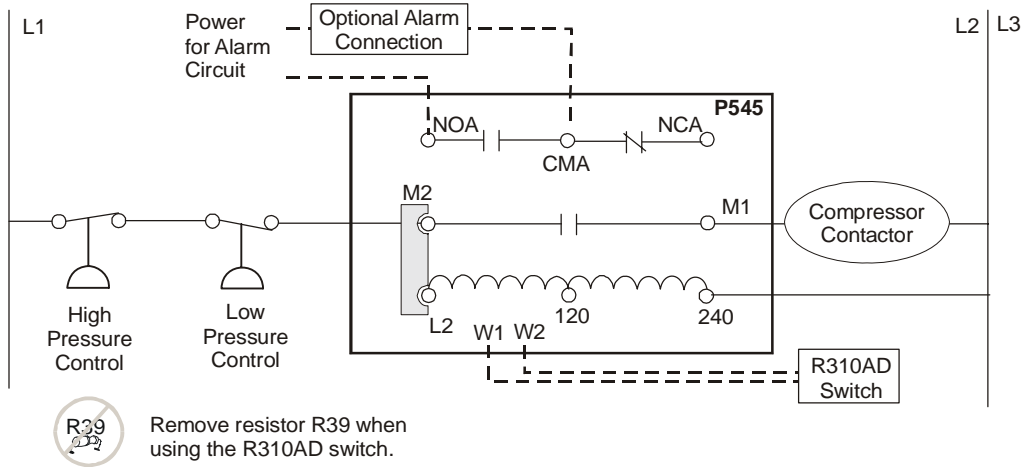
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**Figure 9: Typical P545 Control Wiring with Alarm Circuit Powered by a Separate Voltage**



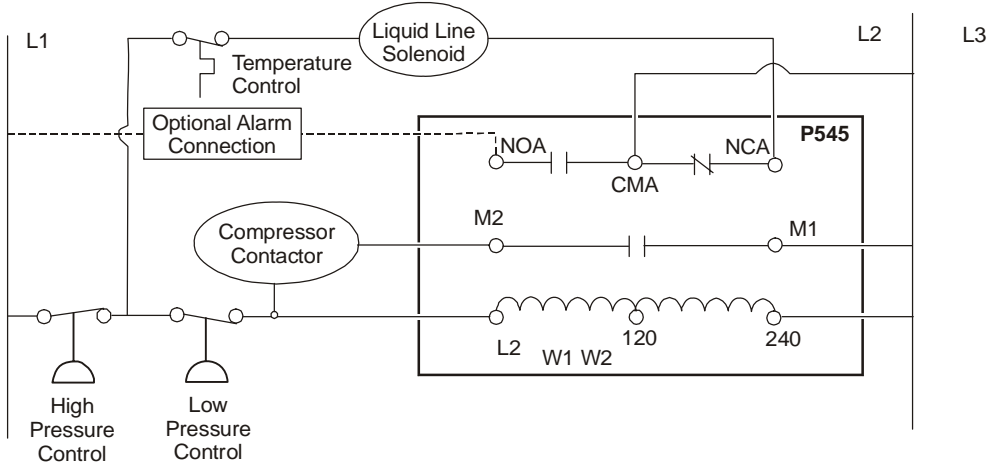
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**Figure 10: Typical P545 Control Application with Liquid Line Solenoid Valve**



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**Figure 11: Typical P545 Control Application with an R310AD-1 Current Sensing Switch**



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**Figure 12: Typical P545 Control Application with Control After Compressor Contactor**

## Setup and Adjustments

The anti-short cycle delay timer is factory-set to 100 seconds. For a different delay, move the jumper at P1 to the desired position. (See Figure 13, Inset B.)

**Note:** If the jumper is removed, the P545 control operates at the default delay of 100 seconds.

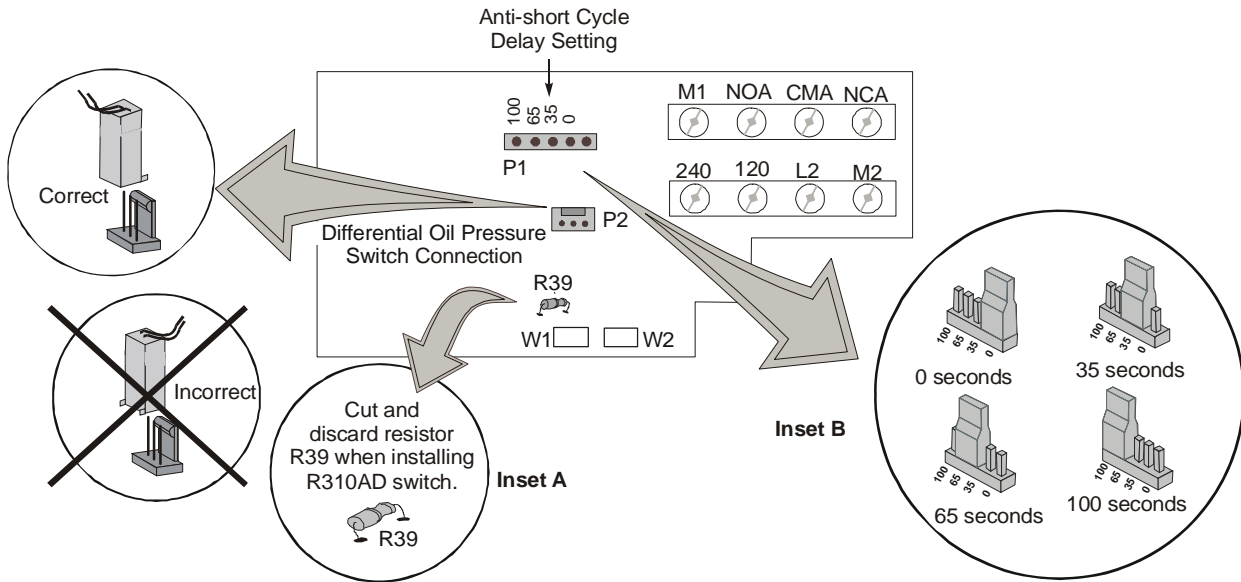


Figure 13: Terminal Designations and Jumper Positions for Anti-short Cycle Delay

### Operating Status

Front panel LEDs display the operating status of the system and assist in troubleshooting (see Table 2). Status conditions are as follows:

- **Green (RUN) LED only:** The compressor contactor is energized, and the system's net oil pressure is at or above the opening point of the P400 switch.
- **Green (RUN) and Yellow (TIMING) LEDs:** The compressor contactor is energized, but the lube oil pressure is below the opening point. Timing circuit is active.
- **Yellow (TIMING) LED only:** Power to the control has been interrupted and restored before the anti-short cycle delay has elapsed. The compressor contactor remains de-energized until the anti-short cycle delay is complete, and then restarts automatically.
- **Red (LOCKOUT) LED:** The P545 control has de-energized the compressor contactor (lockout condition), because it detected a lubrication problem at the compressor.

### Electrical Checkout Procedure

Use the following procedure to test the P545 control during initial installation and maintenance:

1. De-energize the supply voltage to the control and the compressor circuit. Make certain that any disconnect switches or circuit breakers feeding the circuit are open.



#### **WARNING: Risk of Electric Shock.**

Disconnect 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.

2. Disconnect the contactor from the compressor motor, or disconnect power to the compressor.

**Note:** On systems using the R310AD switch, remove relay connections to control terminals W1 and W2, and connect a jumper between those two terminals. (See Figure 13.)

3. Re-energize the supply voltage to the P545 control. Verify that all operating and limit controls are closed.



**Note:** The compressor contactor circuit energizes and both the yellow and green LEDs light up after the short-cycle delay has expired. The green LED indicates that the compressor contactor is energized. The yellow LED indicates that net oil pressure is low and that the timing circuit is activated.

When the low pressure time delay elapses, the control de-energizes (locks out) the contactor. The red LED lights up and the yellow and green LEDs turn off. The control's alarm contacts (Terminals CMA to NOA) close and the liquid line solenoid contacts (Terminals CMA to NCA) open.

4. Press RESET. The red LED turns off and the green and yellow LEDs turn on. The contactor is now energized.
5. De-energize the supply voltage. Reconnect the compressor leads to the contactor, or reset the disconnect. If an R310AD switch is used, reconnect the compressor leads to the contactor. See Figure 13.

6. Re-energize the supply voltage. If operating and limit controls are closed and power has been removed for longer than the anti-short cycle delay, the compressor starts and both the green and yellow LEDs light up. The yellow LED turns off when the lube oil pressure level reaches the opening point, usually within seconds of starting the compressor.

**Operational Control Test**

Use this test to verify the P545 control is operating correctly. This test simulates a low oil pressure condition and initiates an immediate lockout of the compressor.

1. With power to the control, adequate oil pressure available, and contactor energized (only the green LED is on), press and hold down the Test button.

**Note:** The red LED lights up and the control de-energizes (locks out) the compressor contactor. The control alarm circuit (NOA contact – see Figure 7) is energized.

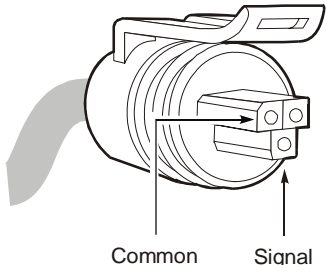
2. Wait 100 seconds and press the Reset button to energize the contactor and restart the motor.

**Note:** The P545 control cannot be reset without power. The control remains in a lockout condition (compressor contactor de-energized) until the Reset button is pressed, even if power is removed from the control.

**Troubleshooting**

See Table 2 to troubleshoot the P545 control.

**Table 2: Troubleshooting P545 Control Problems**

LED Status	Troubleshooting Procedure
No LEDs are lit.	Check the power source.
<p>Red LED is On.</p>  <p>Common      Signal</p> <p><b>WHA-P400-xxx Wiring Harness Plug</b></p> <p style="font-size: small;">12011012_plug.cdr</p>	<p>Use these steps to resolve the problem:</p> <ol style="list-style-type: none"> <li>1. Connect pressure gauges at the oil pump discharge and at the crankcase.</li> <li>2. Press RESET on the control.               <ol style="list-style-type: none"> <li>a. <b>If the green and yellow LEDs light but the compressor remains off</b>, inspect the wiring and check for an overheated motor. If the compressor motor is overheated, determine the cause and correct the problem. (An R310AD current sensing switch may be installed along with the control to provide a controlled shutdown caused by thermal overload.)</li> <li>b. <b>If both the green and yellow LEDs turn on for the duration of the time delay and the system shuts down</b>, observe the crankcase and oil pump pressure gauges.                   <ul style="list-style-type: none"> <li>- If the system does not reach sufficient oil pressure by the end of the time delay, check the compressor and system for problems.</li> <li>- If the system does reach sufficient pressure:                       <ol style="list-style-type: none"> <li>1. Disconnect the wiring harness at the P400 switch.</li> <li>2. Use a single piece of 22-gauge wire as a jumper between the common and signal terminals of the wiring harness.</li> <li>3. Press RESET.</li> <li>4. If the green LED lights and the yellow LED turns off, replace the P400 switch. Otherwise, replace the P545 control.</li> </ol> </li> </ul> </li> </ol> </li> </ol>

LED Status (Cont.)	Troubleshooting Procedure
<b>Yellow LED is dim and flickering.</b>	Use these steps to resolve the problem: <ol style="list-style-type: none"> <li>1. Check the power source.</li> <li>2. Confirm that the compressor is operating at sufficient pressure and without excessive pressure fluctuations.</li> <li>3. Check the wiring harness for loose connections.</li> <li>4. If the oil pressure is sufficient, the cable connections are good, and the yellow LED still flickers, replace the P400 switch.</li> </ol>
<b>Control does not lock out the compressor when lube oil pressure is low.</b>	Use these steps to resolve the problem: <ol style="list-style-type: none"> <li>1. Press the test button.               <ol style="list-style-type: none"> <li>a. If the P545 control does not lock out in 8 seconds or less, replace the control.</li> <li>b. If the P545 control locks out properly, go to Step 2.</li> </ol> </li> <li>2. Disconnect the wiring harness from the P545 control. Press the Reset button.</li> <li>3. If the compressor starts and runs through the time delay (yellow and green LEDs lit) and then locks out, check the wiring harness for shorted condition. If the wiring harness tests okay, replace the P400 switch.</li> </ol>
<b>Control does not respond to R310AD switch. (Control locks out the compressor after compressor shutdown. Red LED is lit.)</b>	Make sure that the anti-short cycle delay is <b>not</b> set at 0 seconds.
<b>Control does not respond to R310AD switch. (Indicated by the green LED turning on for approximately 4 seconds, followed by the yellow LED turning on for the duration of the selected anti-short cycle time delay. This process repeats indefinitely.)</b>	Use these steps to resolve the problem: <ol style="list-style-type: none"> <li>1. Check that resistor R39 has been cut and discarded.</li> <li>2. Check the R310AD switch; replace if necessary.</li> </ol>
<b>Contactors energizes for 3 or 4 seconds. It remains off for the duration of the anti-short cycle time delay, and then repeats (compressor is unable to start during the 3 to 4 second period).</b>	Insufficient current to the R310AD switch is the most likely cause of this condition. Use these steps to resolve the problem: <ol style="list-style-type: none"> <li>1. Check compressor for internal overloads.</li> <li>2. Check the compressor wiring.</li> <li>3. Check compressor's contactor.</li> <li>4. Check compressor for general failure.</li> </ol>

## Ordering Information

Use the following tables to order the P545 control, the P400 switch, or accessories.

**Table 3: P545 Electronic Lube Oil Control Ordering Information**

Product Code Number	Lube Oil Delay (Seconds)	P400 Switch	Wiring Harness	Fits Compressors Manufactured by
P545NCB-22C*	120	P400AD-2	WHA-P400-100	Copeland®
P545NCB-25C*	90	P400BD-1	WHA-P400-125	Bitzer
P545NCB-82C*	120	P400AD-1	WHA-P400-100	Carlyle

\* Switch and wiring harness included

**Table 4: P400 Single-Point Differential Oil Pressure Switch Ordering Information**

Product Code Number	Open Point (Differential Pressure)	Close Point (Differential above Open Point)	Threads	Wiring Harness
P400AD-1C*	7 ± 1.0 psid	Less than or equal to 2.0 psid	3/4-16 UNF	WHA-P400-100
P400AD-2C*	12.75 ± 0.75 psid	Less than or equal to 1.5 psid		
P400BD-1C*	10 ± 1.5 psid	Less than or equal to 3.0 psid	M20 x 1.5	WHA-P400-125

\* Wiring harness included

**Table 5: Wiring Harnesses and Other Accessories Ordering Information**

Product Code Number	Description
KITP545-82C	<b>CST29A-600C Sensor Block</b> (for Carlyle Compressor Series O6CC, O6D, and O6E); includes Allen-head bolts*. <b>P545NCB-82 Electronic Lube Oil Control</b> ; includes P400AD-1C switch and WHA-P400-100C wire harness
WHA-P400-100C	3 1/3 ft (1 m) length wiring harness
WHA-P400-125C	4 ft (1 1/4 m) length wiring harness
WHA-P400-250C	8 ft (2 1/2 m) length wiring harness
WHA-P400-430C	14 ft (4 1/3 m) length wiring harness
R310AD-1C	Low-Voltage Current Sensing Switch
271-51	Universal Mounting Bracket

\* Contact Carlyle Compressor Co. at (800) 462-2759 to order Sensor Block Gasket 06DA680063.

## Repair and Replacement

Do not attempt field repairs or calibration. Switches, alternate length wiring harnesses, and replacement controls are available as separate items through local Johnson Controls wholesalers and the original equipment manufacturer.

## Technical Specifications

<b>Product</b>	P545NCB Electronic Lube Oil Control; manual reset with alarm and liquid line solenoid outputs	
<b>Power Requirements</b>	120 or 240 VAC, 50/60 Hz +10%, -15%; power consumption: 3 VA	
<b>Open Point (Differential Pressure)</b>	P545NCB-22/P400AD-2:	12.75 ± 0.75 psid (87.9 ± 5.17 kPa)
	P545NCB-25/P400BD-1:	10 ± 1.5 psid (68.9 ± 10.3 kPa)
	P545NCB-82 P400AD-1:	7 ± 1.0 psid (48.2 ± 6.9 kPa)
<b>Lube Oil Time Delay (Factory Settings)</b>	P545NCB-22:	120 ± 15 seconds
	P545NCB-25:	90 ± 12 seconds
	P545NCB-82:	120 ± 15 seconds
<b>Anti-short Cycle Timer</b>	Four selectable positions: 0, 35, 65, and 100 seconds (nominal times)	
<b>Type of Refrigerant</b>	Non-corrosive refrigerants only	
<b>Electrical Connections</b>	Control: Screw type terminals on a barrier terminal strip Sensor: Snap-connect at sensor end, 3-pin plug at control end	
<b>Maximum Electrical Rating</b>	Isolated relay output to compressor contactor (M-1 and M-2) Pilot duty 375 VA at 120 VAC, 750 VA at 240 VAC	
<b>Alarm Circuit (Relay)</b>	NOA contact:	Pilot duty 125 VA at 120/240 VAC; 60 W tungsten at 120/240 VAC
	NCA contact:	Pilot duty 125 VA at 120 VAC, 250 VA at 240 VAC
<b>Backplate Material</b>	Cold rolled steel	
<b>Case and Cover Material</b>	High impact thermoplastic	
<b>Ambient Operating Conditions</b>	-40 to 131°F (-40 to 55°C)	
<b>Ambient Storage Conditions</b>	-40 to 185°F (-40 to 85°C)	
<b>Approximate Shipping Weight</b>	1.80 lb (0.82 kg)	
<b>Agency Listings</b>	UL Listed, File SA516, CCN SDFY UL Listed for Canada, File SA516, CCN SDFY7	

*The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult the local Johnson Controls office or Johnson Controls/PENN Application Engineering at (414) 524-5535 or 1-800-275-5676 (1-800-ASK-JNSN). Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.*



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