

P445 Series Electronic Lube Oil Control

The P445 Series Electronic Lube Oil Control is designed for use on refrigeration compressors equipped with an oil pump that accepts a single-point differential pressure transducer. The P445 control senses net lube oil pressure and 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 LEDs (Light-Emitting Diodes) 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 Relay, sold separately, may be used to disable the P445 control lockout circuit during abnormal compressor shutdowns.



Figure 1: P445 Electronic Lube Oil Control

Features and Benefits

<input type="checkbox"/> SPDT (Single-Pole Double-Throw) Relay Contacts for Liquid Line Solenoid and Alarm Applications	Allows liquid line solenoid to be closed if the P445 control shuts off the compressor due to low oil pressure. Provides alarm indication, including circuits that use neon lights.
<input type="checkbox"/> Relay Contact Output for Compressor	Provides reliable, long-lasting operation
<input type="checkbox"/> Built-in Test Circuit	Verifies proper control operation quickly, without additional tools or equipment
<input type="checkbox"/> Improved Noise Immunity	Exceeds immunity requirements of UL 991 for transient overvoltage: IEC 61000-4-3 for radiated RF and IEC 61000-4-6 for RF-induced conducted disturbances
<input type="checkbox"/> Selection of Anti-short Cycle Time Delay	Allows choice of anti-short cycle strategy for a wide range of equipment requirements; possible elimination of external short cycle timer
<input type="checkbox"/> User-friendly Display Panel	Continuously displays status of the compressor lubrication system
<input type="checkbox"/> Standardized Mounting, Outer Case Size, and Wiring	Easily replaces many existing electromechanical and electronic lube oil controls

Operation

The P445 control operates as follows:

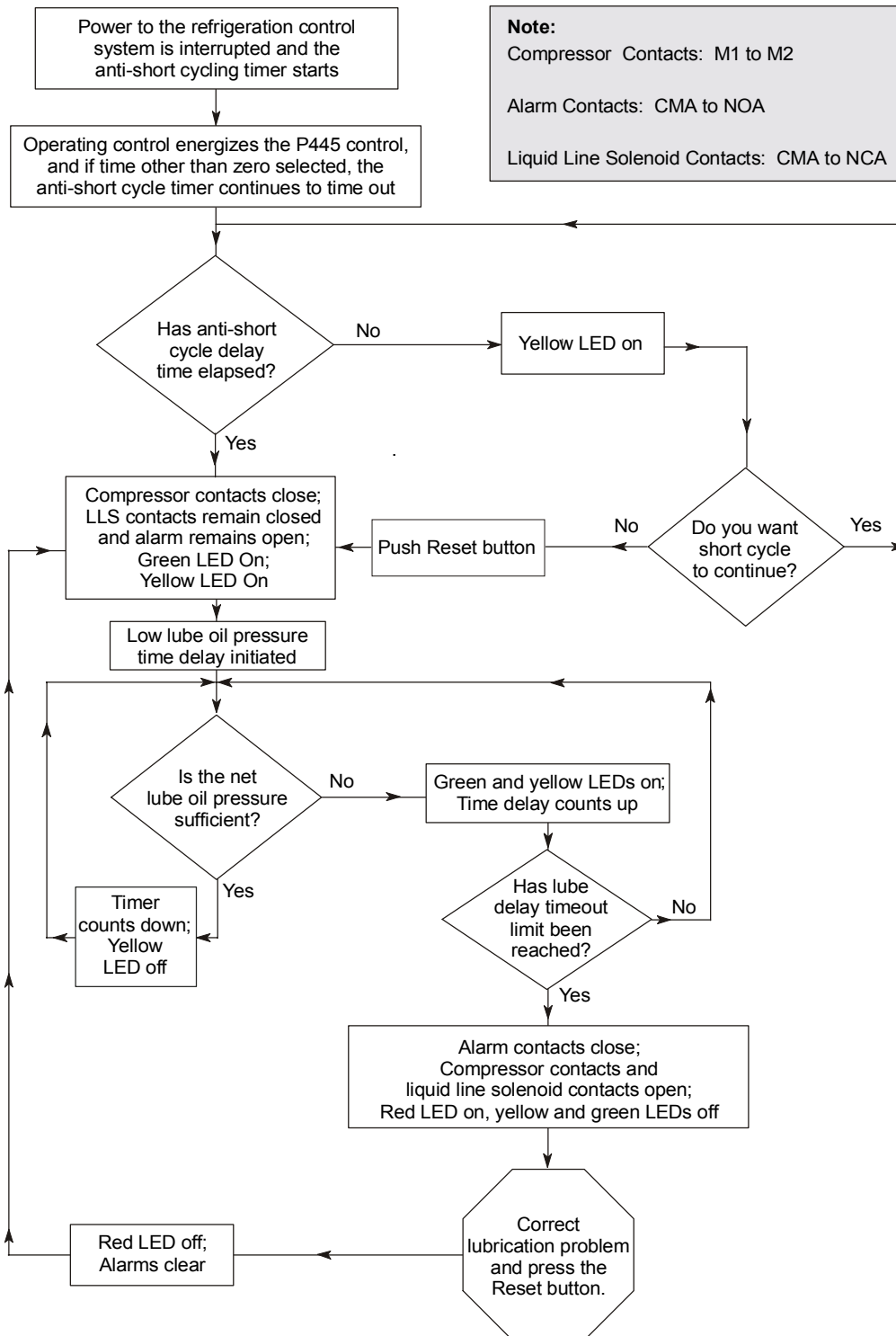


Figure 2: P445 Control Flowchart

Low Oil Pressure Timing Circuit Operation

All P445 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 P445 control compares the amount of time that the oil pressure is above setpoint to the amount of time that the oil pressure is below setpoint. If the oil pressure is above setpoint more than it is below setpoint, the control will not shut down the compressor.

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

Special quantity orders are available with timing that resets every time the oil pressure rises above the setpoint. Call Johnson Controls/PENN Application Engineering at (414) 274-5535 for further information.

Dimensions

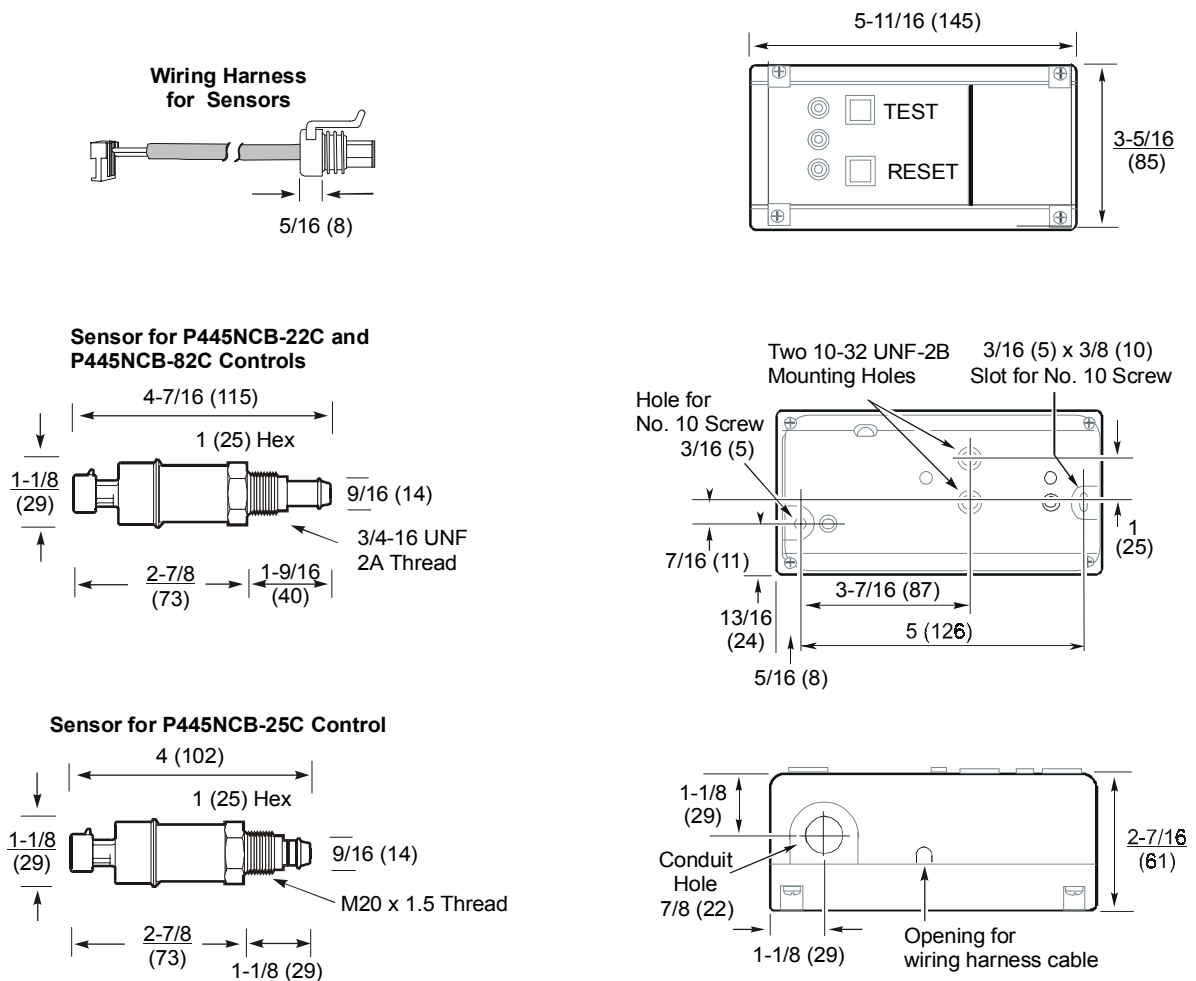


Figure 3: Sensor and Control Dimensions, in. (mm)

Installation

IMPORTANT: The P445 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.

Mounting the P445 Control

For mounting to a flat vertical surface, use the mounting holes shown in Figure 4. 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.

A Universal Mount (Part No. 271-51) is available for mounting to a vertical or horizontal surface. This requires two 10-32 UNF-2B screws (not included).

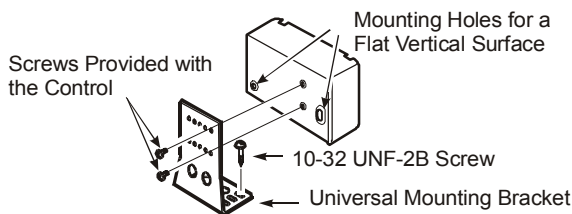


Figure 4: Mounting the P445 Control

Installing the Sensor

Note: Modifying an existing refrigeration compressor to accept the single point sensor 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.

1. Wipe and dry all affected surfaces before mounting the sensor.
2. Fit the fiber washer over the sensor nozzle as shown in Figure 5.
3. Install the sensor in the lube oil sensor port according to the compressor manufacturer's instructions.

4. Handtighten until surfaces of fiber washer and compressor housing meet.
5. Tighten until sealed. Do not apply more than 25 lb-ft of torque to the fiber washer. Torque over 25 lb-ft may cause seal failure.

Refer to Figure 5 and the following procedure to connect the sensor to the control:

1. Insert the plug into the sensor connector until it snaps and locks in place.
2. Connect the wiring harness to the P445 control at P2. See Figure 6 for the location and orientation of the sensor connection.

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

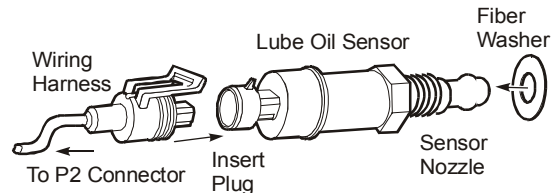


Figure 5: Connecting the Wiring Harness to the Sensor

R310AD Relay for False Oil Failure Lockouts

False oil pressure failure lockouts can occur when the P445 control remains powered despite a loss of power to the compressor motor (for example, when an internal motor overload switch trips).

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

Install the R310AD relay after the main contactor on one of the compressor power leads, and wire to terminals W1 and W2 on the P445 control. In addition, remove resistor R39 by cutting the leads to the circuit board. See Figure 6.

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

Anti-Short Cycle Delay

Anti-short cycle delay establishes the minimum time that the controlled equipment is de-energized before restarting again. After the P445 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 P445 control may be set to 0, 35, 65, or 100 seconds.

Setting the Anti-Short Cycle Timer

The anti-short cycle delay timer is set to 100 seconds at the factory. For a different delay, move the jumper at P1 to the desired position. (See Figure 6, Inset B.)

Note: If the jumper is removed, the P445 will operate at the default delay of 100 seconds.

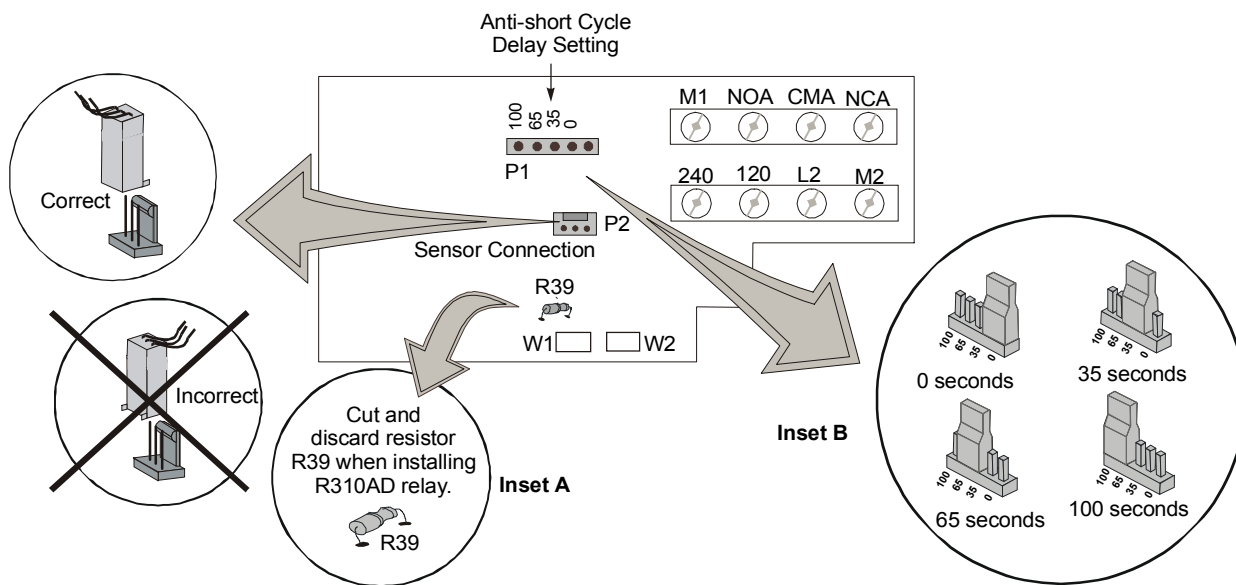


Figure 6: Terminal Designations and Jumper Positions for Anti-Short Cycle Delay

Wiring

See Figures 7 through 12 for typical wiring diagrams, or refer to compressor manufacturer's specifications.

- Make all wiring connections using copper conductors only.
- All wiring must be installed to conform to the National Electric Code and local regulations.

WARNING: Risk of Electrical Shock.
Disconnect all power before making electrical connections to avoid possible electrical shock or equipment damage.

Internal Wiring Diagram

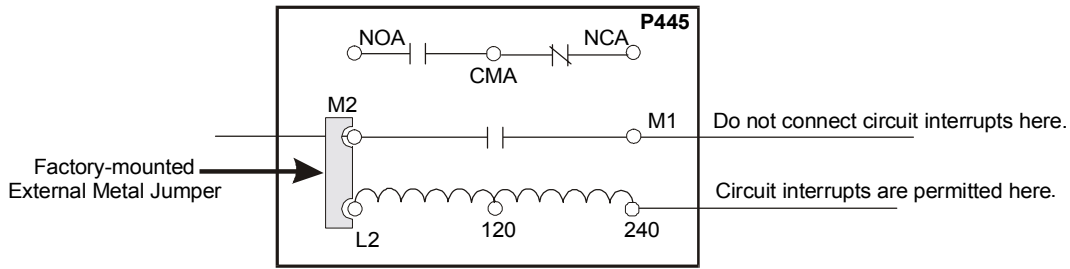


Figure 7: Internal Wiring Diagram for the P445 Control

Ladder Diagrams for the P445 Control

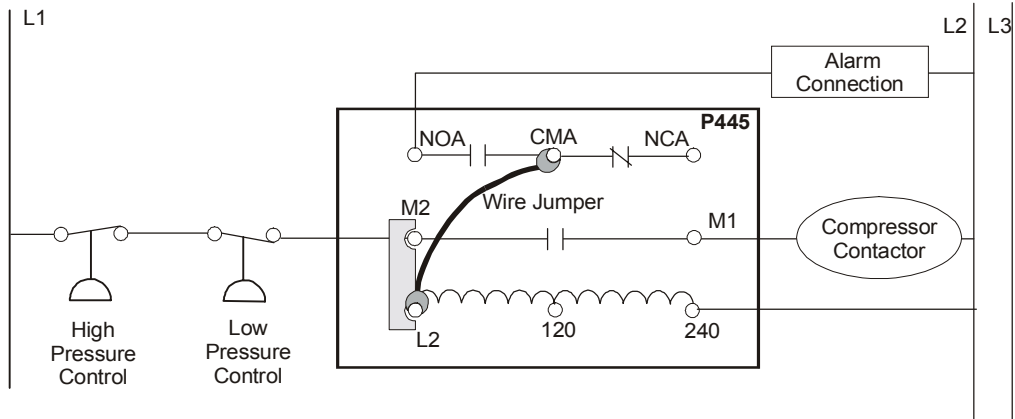


Figure 8: Typical P445 Application with Alarm Circuit Powered by Line Voltage

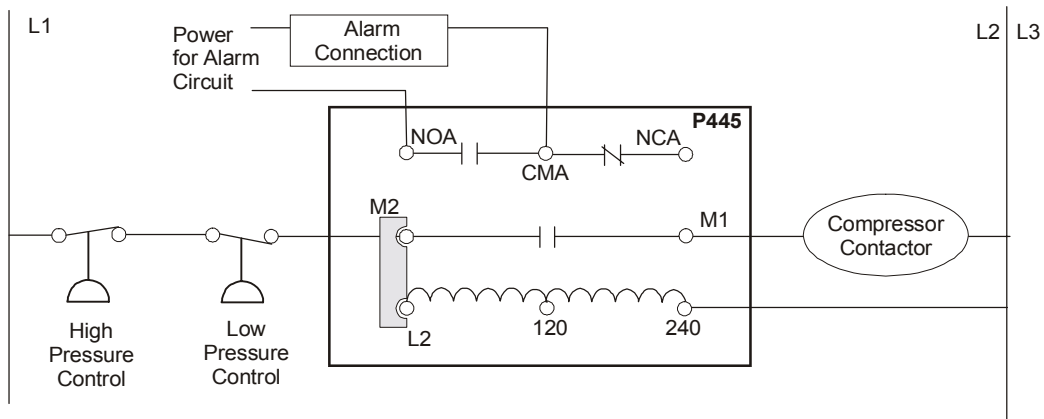


Figure 9: Typical P445 Wiring with Alarm Circuit Powered by a Separate Voltage

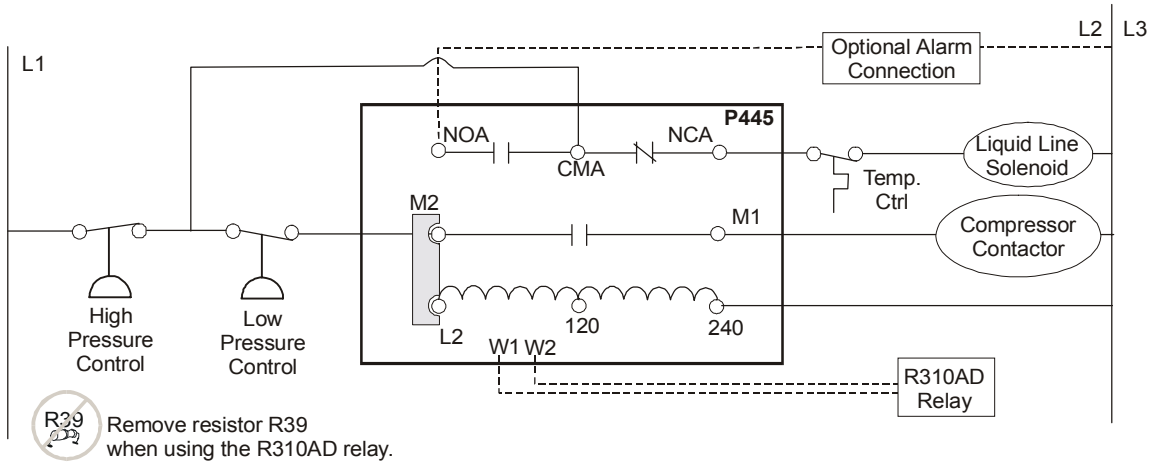


Figure 10: Typical P445 Application with Liquid Line Solenoid Valve

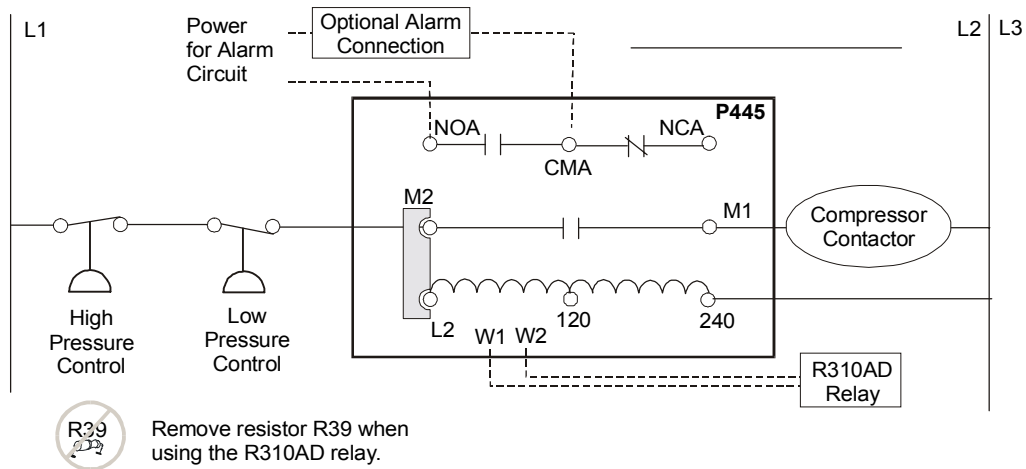


Figure 11: Typical P445 Application with Control in Front of Compressor Contactor

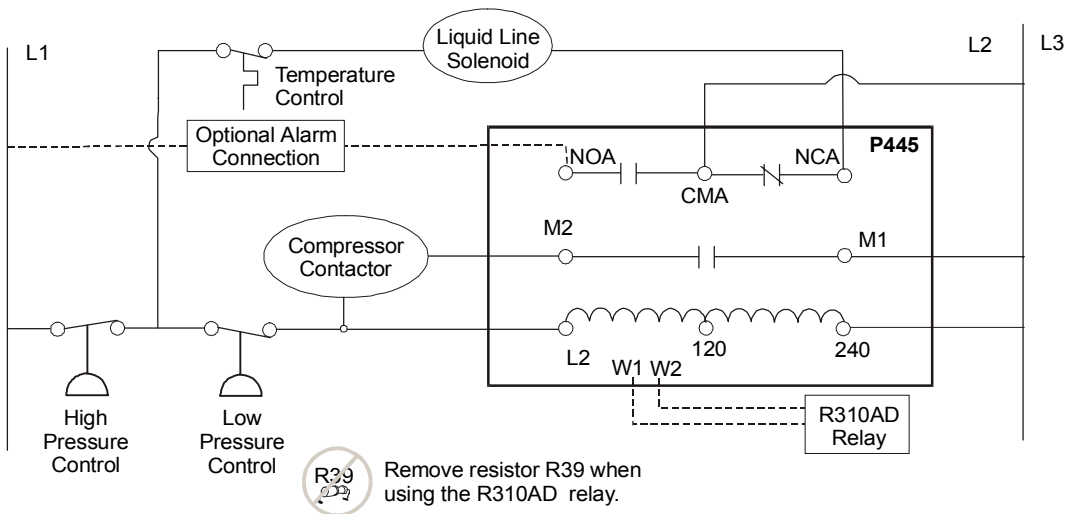


Figure 12: Typical P445 Application with Control After Compressor Contactor

Checkout Procedure

Operating Status


Front panel LEDs display the operating status of the system. 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 fixed setpoint of the P445 sensor.
- **Green (RUN) and Yellow (TIMING) LEDs:** The compressor contactor is energized, but the lube oil pressure is below the setpoint. 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 will remain de-energized until the anti-short cycle delay is complete, and then restart automatically.
- **Red (LOCKOUT) LED:** The P445 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 P445 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 Electrical Shock.
Disconnect power supply before making electrical connections to avoid possible electrical shock or equipment damage.

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

Note: On systems using the R310AD current sensing relay, remove relay connections to control terminals W1 and W2, and connect a jumper between those two terminals. (See Figure 6.)

3. Re-energize the supply voltage to the P445 control. Verify that all operating and limit controls are closed.

4. The compressor contactor circuit energizes and both the yellow and green LEDs illuminate 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.
5. After the factory-set low pressure time delay, the control de-energizes (locks out) the contactor. The red LED illuminates 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.
6. Press RESET. The red LED turns off and the green and yellow LEDs turn on. The contactor is now energized.

Note: **The P445 control cannot be reset without power.** The control will remain in a lockout condition (compressor contactor de-energized) until the Reset button is pressed, even if power is removed from the control.

7. De-energize the supply voltage. Reconnect the compressor leads to the contactor, or reset the disconnect. If an R310AD relay is used, remove resistor R39 and connect the relay leads to terminals W1 and W2 on the control. See Figure 6.
8. 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 will start and both the green and yellow LEDs will light. The yellow LED will turn off when the pressure level reaches the setpoint, usually *within seconds of starting the compressor*.

Operational Control Test

Use this test to verify the P445 control is operating correctly. This test simulates a low oil pressure condition and initiates an abbreviated (8-second) timing cycle followed by a 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.
2. The yellow LED (low pressure warning stage) will light for approximately 8 seconds before the red LED illuminates and the control de-energizes (locks out) the compressor contactor. The control alarm circuit (NOA contact) will be energized.
3. Wait 100 seconds and press the Reset button to energize the contactor and restart the motor.

Troubleshooting

Refer to Table 1 to troubleshoot the P445 control.

Table 1: Troubleshooting P445 Control Problems

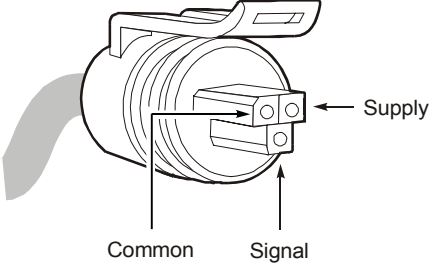
LED Status	Troubleshooting Procedure
<p>Red LED On</p> 	<ol style="list-style-type: none"> 1. Connect pressure gauges at the oil pump discharge and at the crankcase. 2. Press RESET on the control. <ol style="list-style-type: none"> a. If the green and yellow LEDs light but the compressor remains off, inspect the wiring and check for an overheated motor. <ol style="list-style-type: none"> 1. If compressor motor is overheated, determine the cause and correct. (An R310AD relay may be installed along with the control to provide a controlled shutdown caused by thermal overload.) b. If the P445 control does not energize the compressor contactor, the pressure sensor or sensor cable may be bad. <ol style="list-style-type: none"> 1. Disconnect the wiring harness from the sensor, and press RESET. If the system restarts correctly, replace the sensor. 2. If the system does not restart with the wiring harness disconnected, unplug the harness from the control, and press RESET. If the system restarts correctly, replace the wiring harness. c. If both the green and yellow LEDs turn on for the duration of the time delay and the system shuts down, observe the crankcase and oil pump pressure gauges. <ol style="list-style-type: none"> 1. If the system does not reach sufficient oil pressure by the end of the time delay, check the compressor and system for problems. 2. If the system does reach sufficient pressure, disconnect the wiring harness at the sensor. Connect a DC voltmeter to the supply and common terminals of the wiring harness, and press RESET. The voltmeter should read between 4.75 and 5.35 VDC. 3. If the voltage is below 4.75 VDC, test the wiring harness for continuity. If faulty, replace the harness and repeat this step. 4. If the wiring harness is OK and the voltage is higher than 5.35 VDC or lower than 4.75 VDC, replace the P445 control. 5. If the control and the wiring harness are OK, remove the voltmeter and use a single piece of 22 gauge wire as a jumper between the common and signal terminals of the wiring harness. Press RESET. If the green LED lights and the yellow LED goes off, replace the sensor. Otherwise, replace the control.
<p>No LEDs Are Lit</p>	<p>Check power source.</p>
<p>Dim, Flickering Yellow LED</p>	<ol style="list-style-type: none"> 1. Check power source. 2. Confirm that the compressor is operating at sufficient pressure, and without excessive pressure fluctuations. 3. If the oil pressure is sufficient and the yellow LED still flickers, replace the sensor.
<p>Control Does Not Lockout The Compressor When Lube Oil Pressure Is Low</p>	<ol style="list-style-type: none"> 1. Verify that the sensor is installed properly and that the wiring harness is connected securely to the circuit board. 2. Follow the procedure described in Step C for troubleshooting the control and sensor.

Table 2: Troubleshooting R310AD Relay Problems

Problem	Possible Solution
<p>Control does not respond to R310AD relay. (Control locks out the compressor after compressor shutdown. Red LED is lit.)</p>	<p>Make sure that the anti-short cycle delay is not set at 0 seconds.</p>
<p>Control does not respond to R310AD relay. (Indicated by the green LED turning on for approximately four seconds, followed by the yellow LED turning on for the duration of the selected anti-short cycle time delay. This process repeats indefinitely.)</p>	<ol style="list-style-type: none"> 1. Check that resistor R39 has been cut and discarded. 2. Check the R310AD relay; replace if necessary.
<p>Contactors energizes for three or four seconds. It remains off during the anti-short cycle time delay, and then repeats (compressor is unable to start during the 3 to 4 second period).</p>	<p>Most likely caused by insufficient current to the R310AD relay.</p> <ol style="list-style-type: none"> 1. Check compressor for internal overloads. 2. Check the compressor wiring. 3. Check compressor's contactor. 4. Check compressor for general failure.

Repairs and Replacement

Field repairs or calibration must not be made. Sensors, sensor cables, and replacement controls are available

as separate items through local Johnson Controls wholesalers and the original equipment manufacturer.

Ordering Information

Table 3: Ordering Information

Product Code Number	Description
P445NCB-22C	Electronic Lube Oil Control, 120 Second Lube Oil Delay Fixed Setpoint Pressure: 9 psi (62 kPa), 3-1/3 ft (1 m) Cable Includes Sensor with American Threads (Copeland)
P445NCB-25C	Electronic Lube Oil Control, 90 Second Lube Oil Delay Fixed Setpoint Pressure: 10 psi (69 kPa), 3-1/3 ft (1 m) Cable Includes Sensor with Metric Threads (Tecumseh/Bitzer)
P445NCB-82C	Electronic Lube Oil Control, 120 Second Lube Oil Delay Fixed Setpoint Pressure: 6.5 psi (44.8 kPa), 3-1/3 ft (1 m) Cable Includes Sensor with American Threads (Carlyle)
P300AD-1C	Replacement Sensor for P445NCB-82: 6.5 psi (44.8 kPa); Carlyle Includes WHA-P300-100C Wiring Harness
P300AD-2C	Replacement Sensor for P445NCB-22: 9.0 psi (62 kPa); Copeland Includes WHA-P300-100C Wiring Harness
P300BD-1C	Replacement Sensor for P445NCB-25: 10.0 psi (69 kPa); Tecumseh/Bitzer Includes WHA-P300-100C Wiring Harness
KITP445-82C	CST29A-600C Sensor Block for Carlyle Compressor Series O6CC, O6D, and O6E; includes Allen-head Bolts P445NCB-82 Electronic Lube Oil Control, 120 Second Lube Oil Delay, Fixed Setpoint Pressure: 6.5 psi (44.8 kPa), 3-1/3 ft (1 m) Cable, Includes Sensor with American Threads (Carlyle) Note: Contact Carlyle Compressor Co. at (800) 462-2759 to order Sensor Block Gasket O6DA505632
WHA-P300-100C WHA-P300-430C	Wiring Harness; Lengths: 3-1/3 ft (1 m) 14 ft (4.3 m)
R310AD-1C	Low-voltage Current Sensing Relay
271-51	Universal Mounting Bracket

Specifications

Product	P445NCB Electronic Lube Oil Control; manual reset with alarm and liquid line solenoid outputs
Power Requirements	120 or 240 VAC, 50/60 Hz +10%, -15%; power consumption: 3 VA
Fixed Setpoint Pressure	P445NCB-82: 6.5 psi (44.8 kPa) P445NCB-22: 9 psi (62 kPa) P445NCB-25: 10 psi (69 kPa)
Lube Oil Time Delay (Factory Settings)	P445NCB-25: 90 ±12 seconds P445NCB-22, P445NCB-82: 120 ±15 seconds
Anti-short Cycle Timer	Four selectable positions: 0, 35, 65, and 100 seconds (nominal times)
Type of Refrigerant	Non-corrosive refrigerants only
Electrical Connections	Control: Screw type terminals on a barrier terminal strip Sensor: Snap-connect at sensor end, 3-pin plug at control end
Maximum Electrical Rating	Isolated relay output to compressor contactor (M-1 and M-2) Pilot duty 375 VA at 120 VAC, 750 VA at 240 VAC
Alarm Circuit (Relay)	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
Backplate Material Case and Cover Material	0.062 in. (1.6 mm) cold rolled steel High impact thermoplastic
Ambient Operating Conditions	-40 to 131°F (-40 to 55°C)
Ambient Storage Conditions	-40 to 185°F (-40 to 85°C)
Dimensions (L x W x D)	Control: 5-11/16 x 3-5/16 x 2-7/16 in. (145 x 85 x 61 mm) Sensors: 4-7/16 x 1-1/8 in. (115 x 29 mm) and 4 x 1-1/8 in. (102 x 29 mm)
Approximate Shipping Weight	1.70 lb (0.515 kg)
Accessories	See Table 3: Ordering Information
Sensor Overpressure	No reverse pressure allowed 100 psi (690 kPa) maximum differential (high to low) pressure; 225 psig (1551 kPa) maximum system pressure (high, low, or both with differential <100 psi)
Sensor Torque	25 lb-ft maximum
Agency Listings	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 Johnson Controls/PENN Application Engineering at (414) 274-5535. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.



Controls Group
507 E. Michigan Street
P.O. Box 423
Milwaukee, WI 53201

Printed in U.S.A.
www.johnsoncontrols.com