TRANE® AIR CONDITIONING

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LITERATURE FILE NO.

HCOM-SB-20A

GENERAL SERVICE BULLETIN

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SUBJECT: OPERATION AND TROUBLESHOOTING, ROBERTSHAW MP13, MP23 AND MC20 SOLID STATE MOTOR PROTECTORS

INTRODUCTION:

The purpose of this service bulletin is to discuss the operation of and outline troubleshooting procedures for the solid state Robertshaw motor protector relays used in Trane equipment.

DISCUSSION:

Identification

Three Robertshaw motor protector relays are used on Trane equipment. These are the Robertshaw MP13 (Trane Part No. RLY-545), the MP23 (Trane Part No. 545), the old style MC20 (Trane Part No. 589) and the new style MC20 (Trane Part No. CNT-710). Refer to Figures 1, 2 and 3.

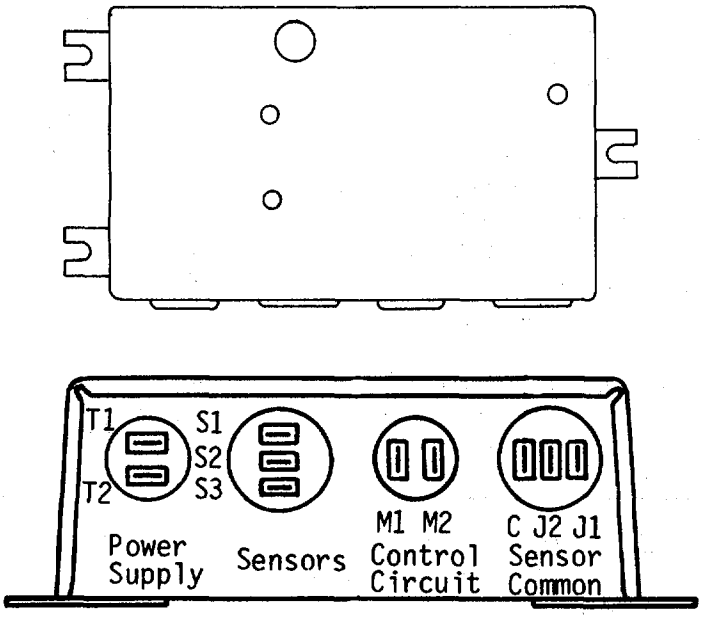


FIGURE 1 - MP13

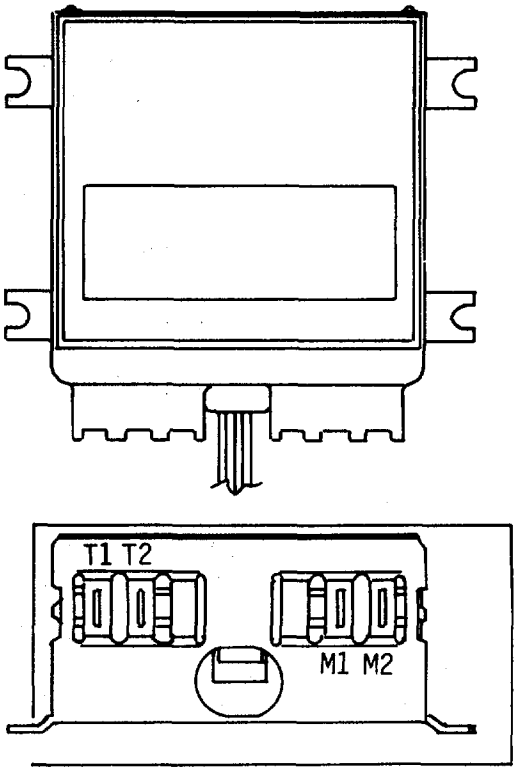


FIGURE 2 - MP23

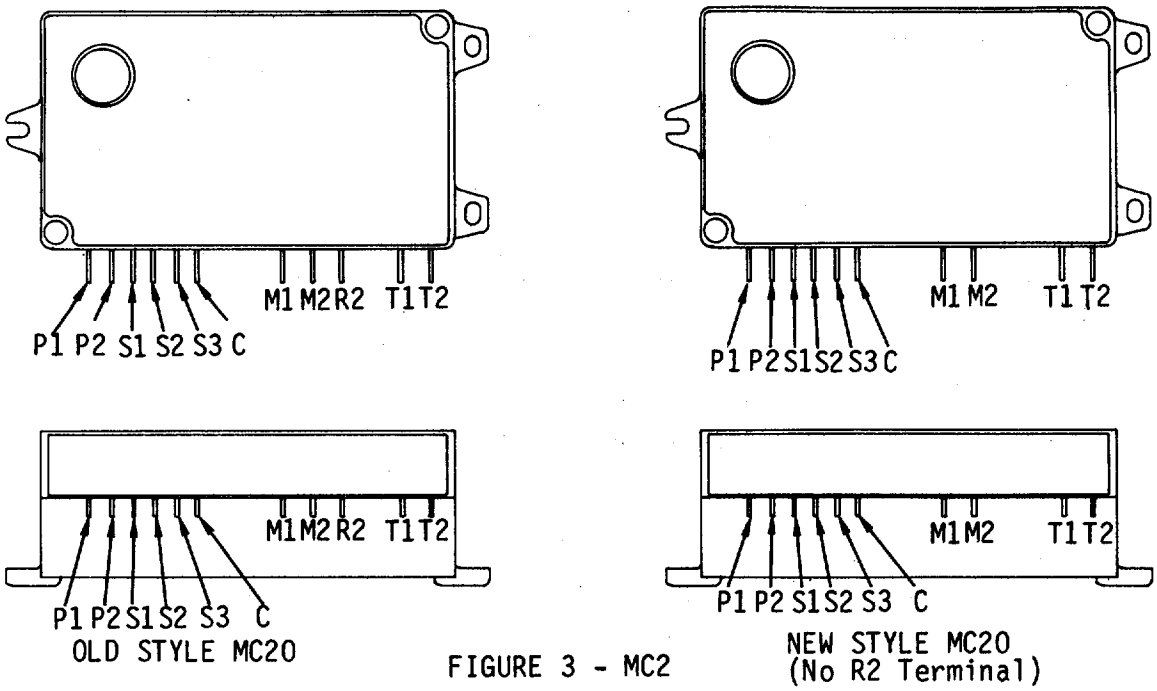


FIGURE 3 - MC2

The operation of the three Robertshaw motor protector relays are similar with the main difference being that the MC-20 incorporates an oil pressure sensing function.

The proper wiring connections and basic operation of each control is discussed below:

MP-13

1. The two terminals marked "Power Supply" (T1 and T2) are connected to L1 and L2 of the control voltage respectively.
2. The control circuit is connected to the two terminals marked "control circuit" (M1 and M2). When the motor temperature is below 200 F, the M1 and M2 contacts in the module are closed and the pilot circuit is energized. NOTE: At motor temperatures below 200 F, resistance of all motor temperature sensors will be below 100 ohms. If the motor temperature rises beyond safe limits, the resistance of the motor sensors increases, causing the control circuit (M1, M2) to open. This control circuit will remain open until the motor cools to 170 F (95 ohms sensor resistance).
3. The "sensor leads", S1, S2, S3 and "sensor common" C are connected to the sensor and common terminals located on the compressor terminal board.

MP-23

The MP-23 is very similar in operation to the MP-13. The T1 and T2 terminals are connected to L1 and L2 respectively of the control voltage. The control circuit is connected to the M1, M2 terminals. The sensor leads are orange. The common lead is black. When the motor temperature is below 200 F, contacts M1 and M2 are closed. If the motor attains a temperature of 200 F contacts M1 and M2 will open, and will not reclose until the motor cools to 170 F.

MC-20

1. Terminals T1 and T2 on the module are connected to L1 and L2 respectively of the control voltage.
2. P1 and P2 are the differential pressure switch (DPS) connections. The DPS is located on the junction box of the Model "M" and "R" compressors. The function of the DPS is to sense the net oil pressure of the compressor. The DPS contacts open below 15 psig net oil pressure. The oil failure function of the control operates as follows:

   a. When the compressor is started, a timing circuit within the motor protector module is energized. This timing circuit (approximately 90 seconds) when uninterrupted, opens the contacts of M1-M2 at timing out. If oil pressure in properly established and maintained during this timing period, the P1-P2 circuit disables the timer and prevents the M1-M2 contacts from opening. If the proper oil pressure is not established by the end of the timing period, M1-M2 contacts open, stopping the compressor. The motor protection circuit must be manually reset to continue compressor operation.

   b. Terminal R2 is tied to a sensing circuit which insures the MC-20 trips the manual reset circuit on an oil pressure failure.
3. a. The motor temperature sensing circuit (S1,S2,S3 and C) contacts open if the temperature at any compressor motor winding sensor exceeds 200F (100 ohms).

   b. M1-M2 contacts reset automatically when the temperature at all motor winding sensors falls below 170F (95 ohms).
4. The operation of the new style MC-20 motor protector is identical to the old. However, the new style MC-20 does not have an R2 terminal. The timing circuit on the new unit is internal and is activated by current flow through M1-M2.

TROUBLESHOOTING

If an operating compressor has tripped out on motor protection, give it a minimum of one hour cooling period to allow the M1-M2 contacts to close. If the contacts remain open after this time, perform a resistance check on the motor sensors.

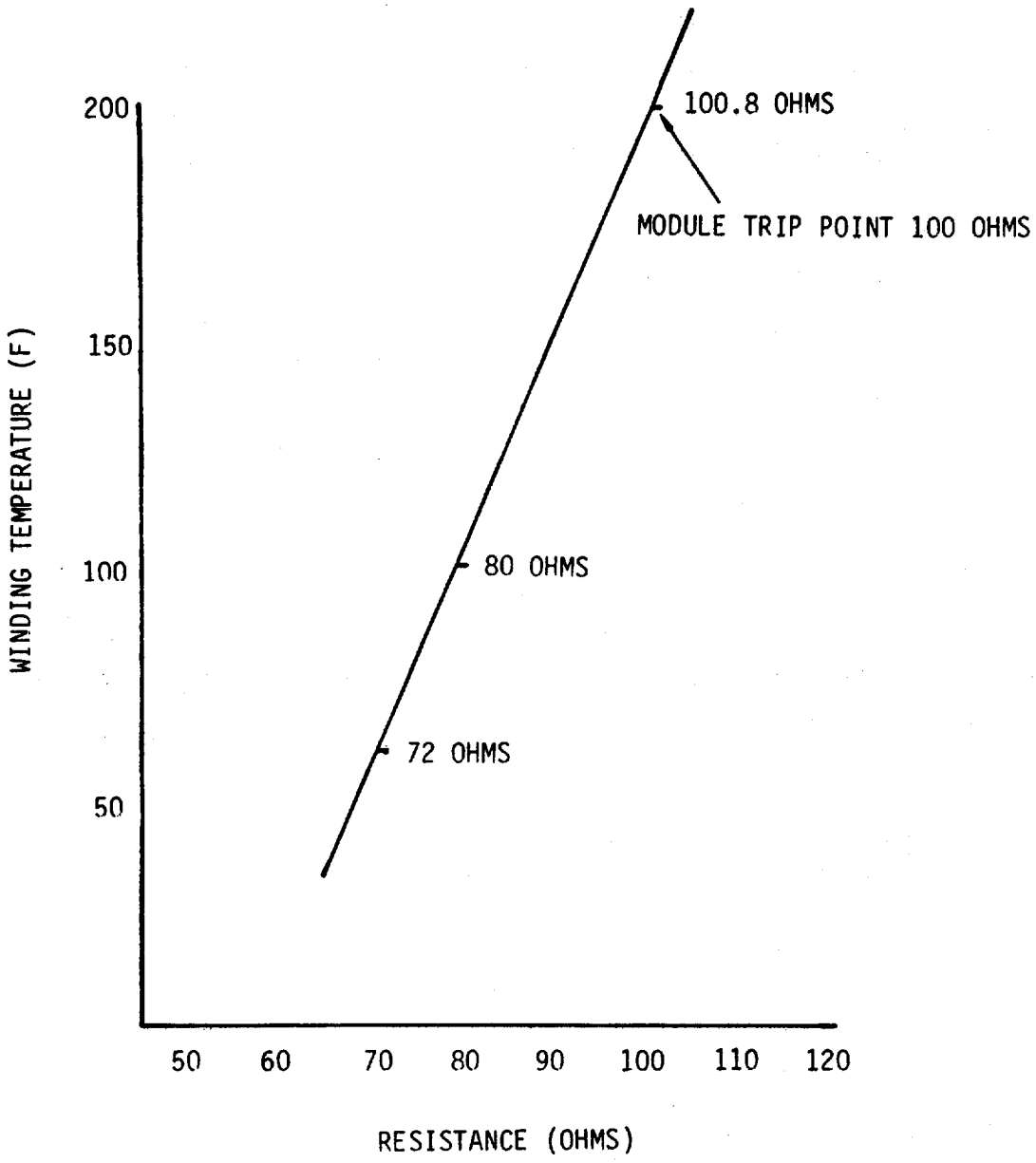
MOTOR SENSOR RESISTANCE CHECK

1. Disconnect the sensor leads and the common lead at the motor protector terminals.
2. Use an ohmmeter (three volt maximum) to measure the resistance between each sensor lead and the common lead. Resistance should fall in the 75-90 ohm range as indicated by Curve 1.

   CAUTION: Measure resistance with an ohmmeter only. Current in excess of three volts can damage the motor sensors.

Resistance readings must fall within the indicated range. Proper operation of the entire control system depends on the presence of a continuous circuit through all three sensors. A resistance reading approaching zero ohms indicates a short in the circuit while an infinity reading indicates an open connection. If the ohmmeter indicates that one of the sensors is open, the

sensor can be bypassed by using the "Motor Sensor Bypass" procedure that follows. This will allow the motor to operate with the protection of two of the original three sensors. If the resistance of more than one of the sensors does not fall in the required range, the motor should be replaced or the control circuit modified to allow the motor to run without protection.



CURVE 1 - Sensor Resistance Versus Compressor Motor Winding Temperature

BYPASSING OPEN MOTOR SENSORS

If only one of the motor sensors has been damaged (open circuit), the protector module will prevent further compressor operation even though the motor itself may remain in good condition. Once the open sensor is located by taking resistance readings, it can be bridged out of the control circuit with a resistor. This will allow the motor to run with two winding protection instead of three. Two sensor operation does not provide as high a degree of protection as three, but does allow continued compressor operation with a satisfactory level of motor protection.

Open Motor Sensor Bypass Procedure

This procedure applies to all three motor protection modules (MP-13, MP-23 and MC-20). This is a temporary field fix that provides for continued system operation until proper repairs can be made.

1. Take resistance readings to locate the open sensor.
2. Install the resistor specified in Figure 4 between the common terminal (C) and the terminal of the openb sensor (S1,S2 or S3). Installation of the resistor will indicate the presence of an acceptable amount of resistance in the damaged sensor circuit and allow continued compressor operation.

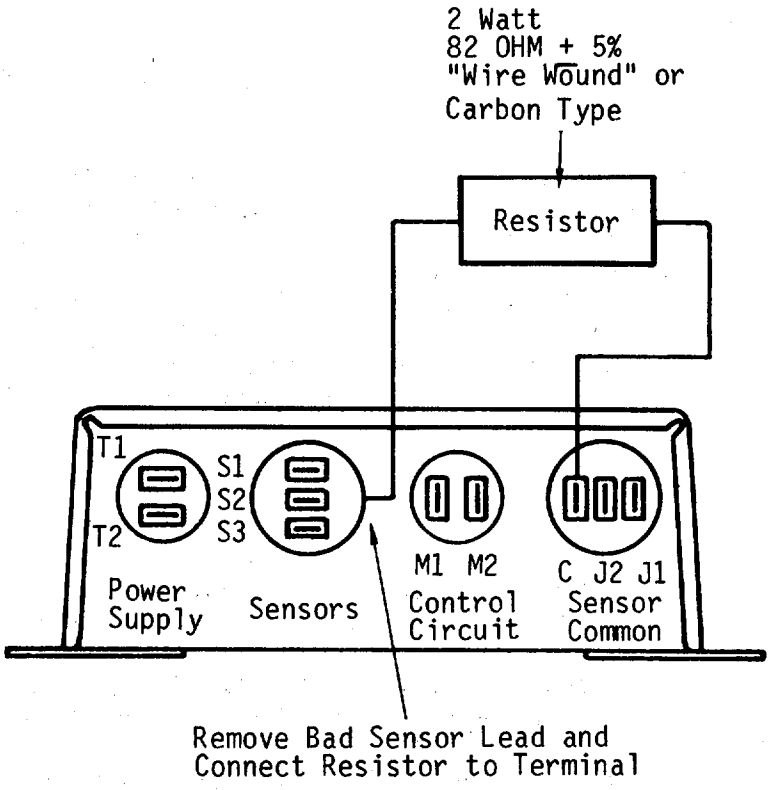


FIGURE 4 - Resistor Installed to Bypass Open Motor Sensor

TESTING THE MOTOR PROTECTOR MODULE

After checking the sensor resistance (if required), install a jumper across the M1-M2 terminals to bypass the motor protector control circuit. If the compressor runs with the jumper installed and stops when it is removed, test the protector module for proper operation.

The proper testing procedure for an MP-13, MP-23 or MC-20 motor protector module requires the use of a test board (Figure 5). The parts required to build the test board are listed below.

NUMBER REQUIRED	PART REQUIRED
3	82 OHM, 1/2 WATT WIRE WOUND OR CARBON RESISTOR (± 10% GRADE)
3	0-25 OHM, VARIABLE RESISTOR
1	120 VAC PILOT RELAY OR SMALL CONTACTOR
1	6 CONNECTION TERMINAL STRIP AND MISCELLANEOUS WIRE AND CONNECTIONS

TEST BOARD CALIBRATION

Use this procedure to carefully calibrate the test board before using it to test the motor protector module.

1. Use a high quality ohmmeter (digital preferred) to adjust the total resistance of each of the three series resistor circuits (82 ohms + 0-25 ohms) to 100 ohms. When each circuit indicates 100 ohms, mark the position of each of the variable resistor shafts.
2. Turn the variable resistors to reduce the total resistance reading of each of the three series resistor circuits (82 ohms + 0-25 ohms) to 93 ohms. Again, mark the position of the variable resistor shafts.
3. Calibration is complete. Total resistance for each circuit should now read 93 ohms.

MODULE TESTING PROCEDURE

Once the test board is calibrated, testing can proceed.

1. Connect the leads of the test board to the motor protector module as shown in Figure 5.
2. Install a jumper between terminals P1-P2 of the MC-20 protector module (Figure 5). There are no P1-P2 terminals on the MP-13 or on the MP-23 modules.
3. When testing an older version of the MC-20 which has an R2 terminal, no connections to the R2 terminal are necessary.
4. If the module being tested is the MC-20, depress and hold the reset button in for a minimum of five seconds to reset the control circuit. The MP-13 and the MP-23 do not have a reset button.
5. Energize the test board by connecting it to a 120 VAC power source. The relay of the test board should pull in and remain energized.

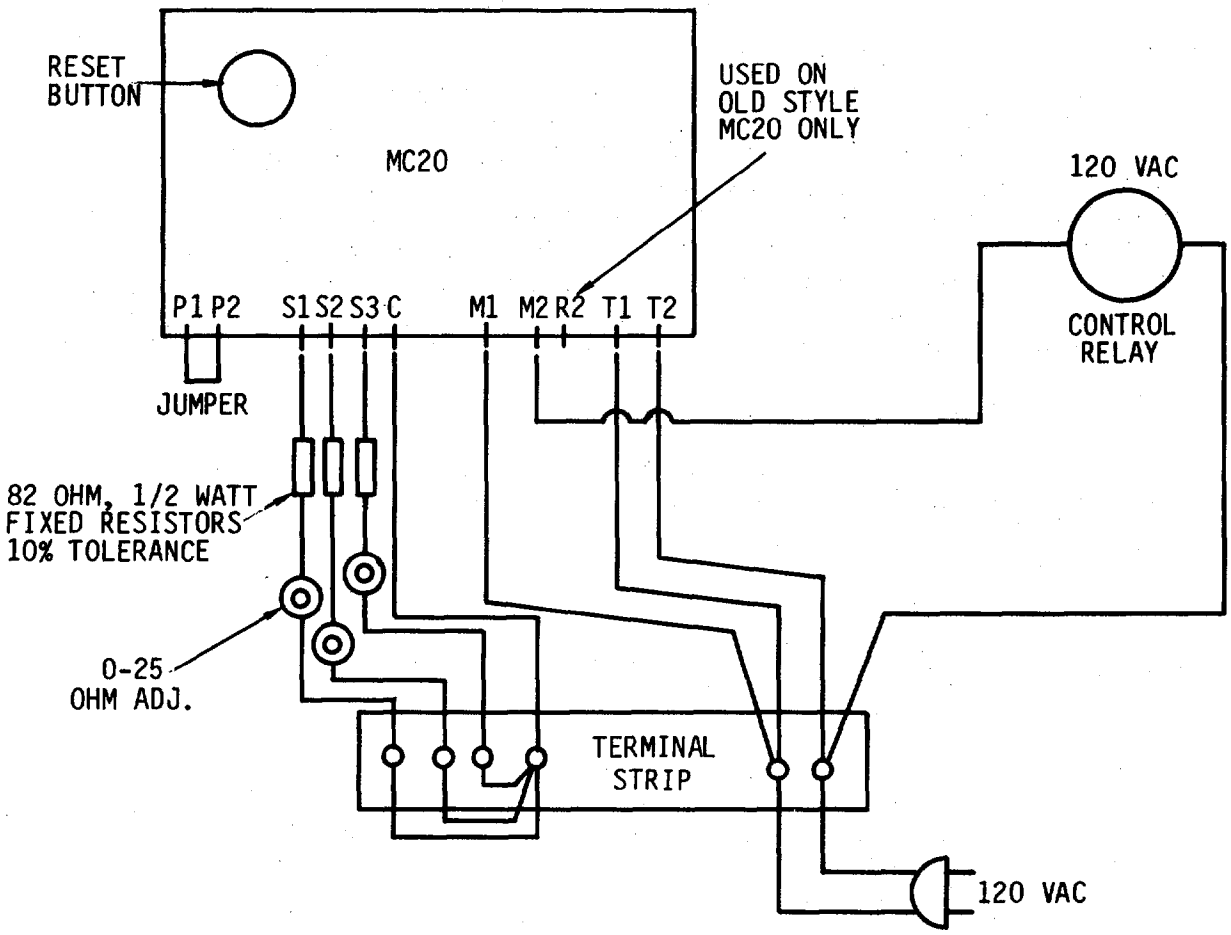


FIGURE 5 - Schematic Showing Test Board Connected to an MC-20 Motor Protector

Sensor Input Check

1. If the control relay remains properly energized, increase the resistance of one of the variable resistors from the 93 ohm position to the 100 ohm position that was marked on the test board during the calibration procedure. The M1-M2 contacts of the protector module should open and deenergize the control relay. Return the variable resistor to the 93 ohm position. The M1-M2 contacts of the protector should close and reenergize the control relay. Repeat the procedure for the two remaining variable resistors. If the unit performs as described, the motor sensor inputs are performing properly. If the trip point (M1-M2 open) for any of the three sensor inputs is above 105 ohms, the module should be replaced.

Oil Failure Circuit Check

Once the sensor inputs are checked for proper operation, check the oil failure circuit on the MC-20 protector module.

1. Start the test with the test board energized (control relay energized) and all three variable resistors at minimum position.
2. Remove the jumper from the P1-P2 terminals and begin timing. After 90 seconds, M1-M2 contacts should open, deenergizing the control relay.
3. When M1-M2 open and the control relay deenergizes, press and hold the reset button for a minimum of five seconds. After five seconds, release the button. The M1-M2 contacts should close and pull in the control relay. Any protector module that will not trip or reset on this simulated oil failure should be replaced.

FIELD TESTING THE MP-13 AND MP-23

Use this procedure to field test the MP-13 and MP-23 motor protector module when no test board is available. Refer to Figure 6.

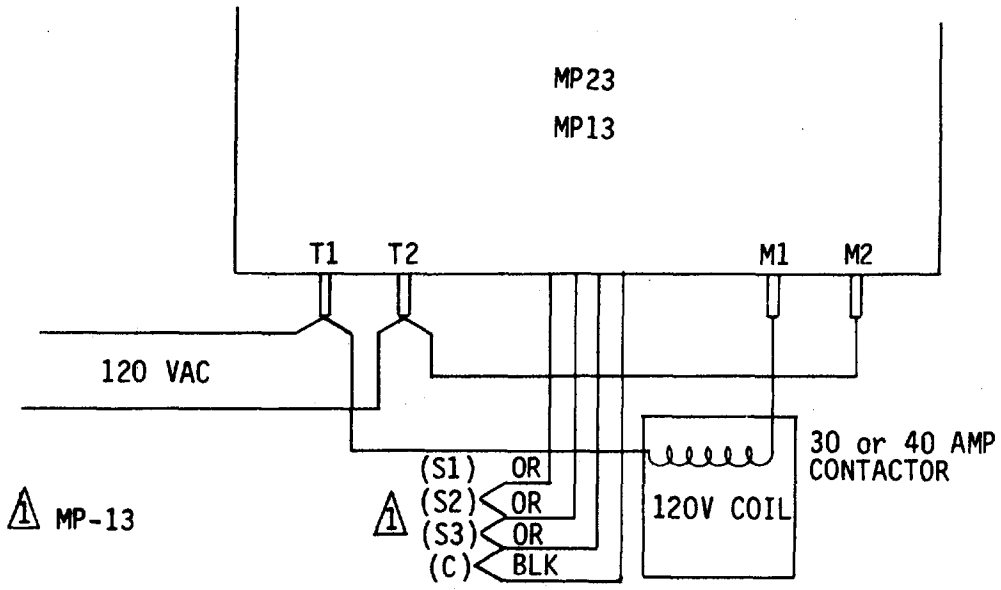


FIGURE 6 - Field Testing the MP-13 and the MP-23 Motor Protector

1. If testing the MP-13, connect the three orange (OR) sensor leads and the black (BLK) common lead together. If testing the MP-23, install a jumper across all sensor terminals (S1,S2,S3) and the common (C) terminal.
2. Connect a 120 VAC contactor coil between terminals T1 and M1 of the module.
3. Connect M2 to T2.
4. Apply 120 volt power to terminals T1 and T2. The contactor will energize.
5. Remove one of the sensor leads (S1,S2,S3 or OR) from the connected bundle. The 120 VAC contactor should deenergize.
6. Repeat this for each of the three sensor leads in the bundle. If the contactor deenergizes each time, the module is operating satisfactorily.

Investigation of nuisance lockouts with the MP-23 protector module has found that the MP-23 is sensitive to external electromechanical interference. Noise interference (voltage spikes) can be generated by the energizig and deenergizing of electromechanical devices such as liquid line solenoid valves, compressor unloader valves, antirecycle timers, etc.

If an MP-23 is causing nuisance lockouts, replace it with a new style MC-20 motor protector (no R2 terminal), a fuse assembly and a time delay relay. Refer to Service Bulletin HCOM-SB-25 for details concerning the new style MC-20 motor protector.

The new style MC-20 has an internal oil pressure timing circuit. If the MC-20 is used to replace the MP-23, install a jumper across terminals P1-P2 on the MC-20. Testing of the MC-20 shows it to be impervious to the types of electromechanical interference that can cause nuisance lockouts with the MP-23. The MC-20 has built-in noise suppression filtering to prevent inadvertent opening of the M1-M2 contacts.

FIELD TESTING THE MC-20

Use this procedure to field test the MC-20 motor protector module if no test board is available. Refer to Figure 7.

1. Install a jumper from the sensor terminals (S1,S2,S3) to the common (C) terminal.
2. Connect a 120 VAC contactor coil between terminals T1 and M1.
3. Connect M2 to T2.
4. Apply 120 VAC power to terminals T1 and T2 and begin timing. With the module connected as described, the P1-P2 contacts are open, simulating oil pressure failure. The contactor should deenergize at a point between 60 and 90 seconds from timing start.
5. When the contactor deenergizes, press and hold the reset button for five seconds to reset the protector circuit.

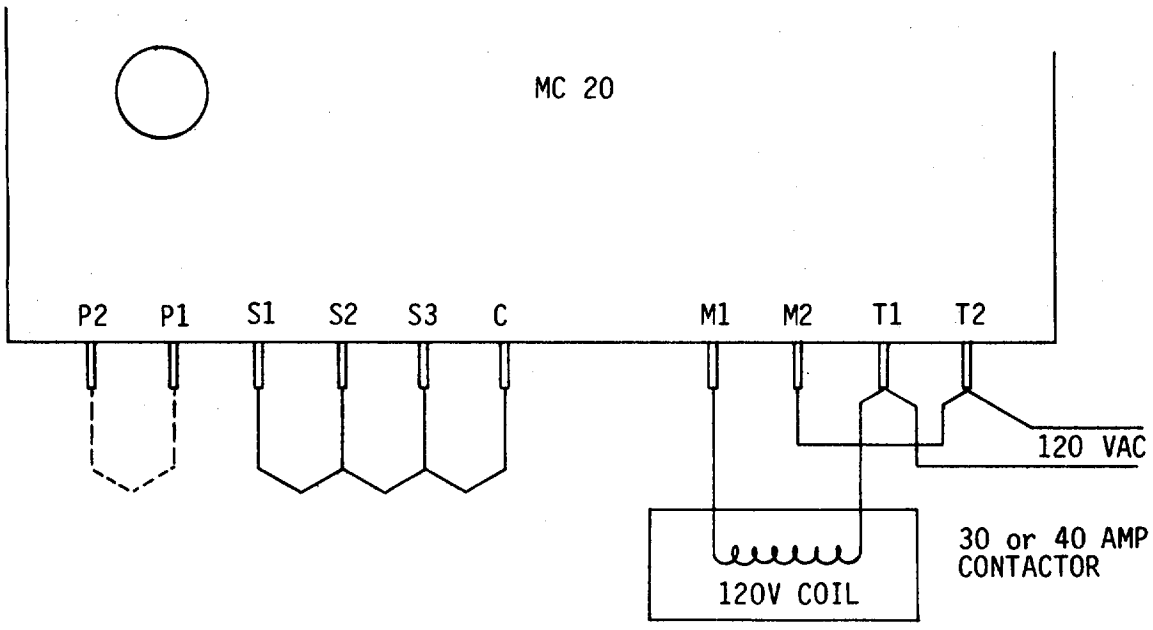


FIGURE 7 - Field Testing the MC-20 Motor Protector

6. Install a jumper across terminals P1-P2 and begin timing to 120 seconds. The contactor should remain energized.
7. Disconnect the jumper to one of the sensor (S1,S2,S3) terminals. The contactor should deenergize. Reconnect the jumper. Repeat for each of the other two sensor terminals. If the contactor deenergizes each time a sensor is disconnected, the module is operating satisfactorily.

Differential Pressure Switch Check

Once proper operation of the MC-20 is confirmed, use this procedure to check the operation of the differential pressure switch (DS) located on the compressor.

1. Relieve all pressure from the compressor.
2. Disconnect the two flare fittings that connect the DPS to the compressor.
3. Apply 20 psig pressure on the DPS through the fitting disconnected from the compressor oil pump connection.
   NOTE: A small amount of leakage through the switch is normal.
4. Connect an ohmmeter to the DPS terminals.
5. Slowly reduce the pressure on the switch to 10 + 2 psig. If the ohmmeter indicates opening of the DPS contacts, the DPS is operating satisfactorily.

NEW PRODUCTION

All new reciprocating products with Robertshaw motor protection devices are equipped with the new style MC-20 (no R2 terminal) protector module.