

What is a PLC?

PLC stands for **Programmable Logic Controller**.

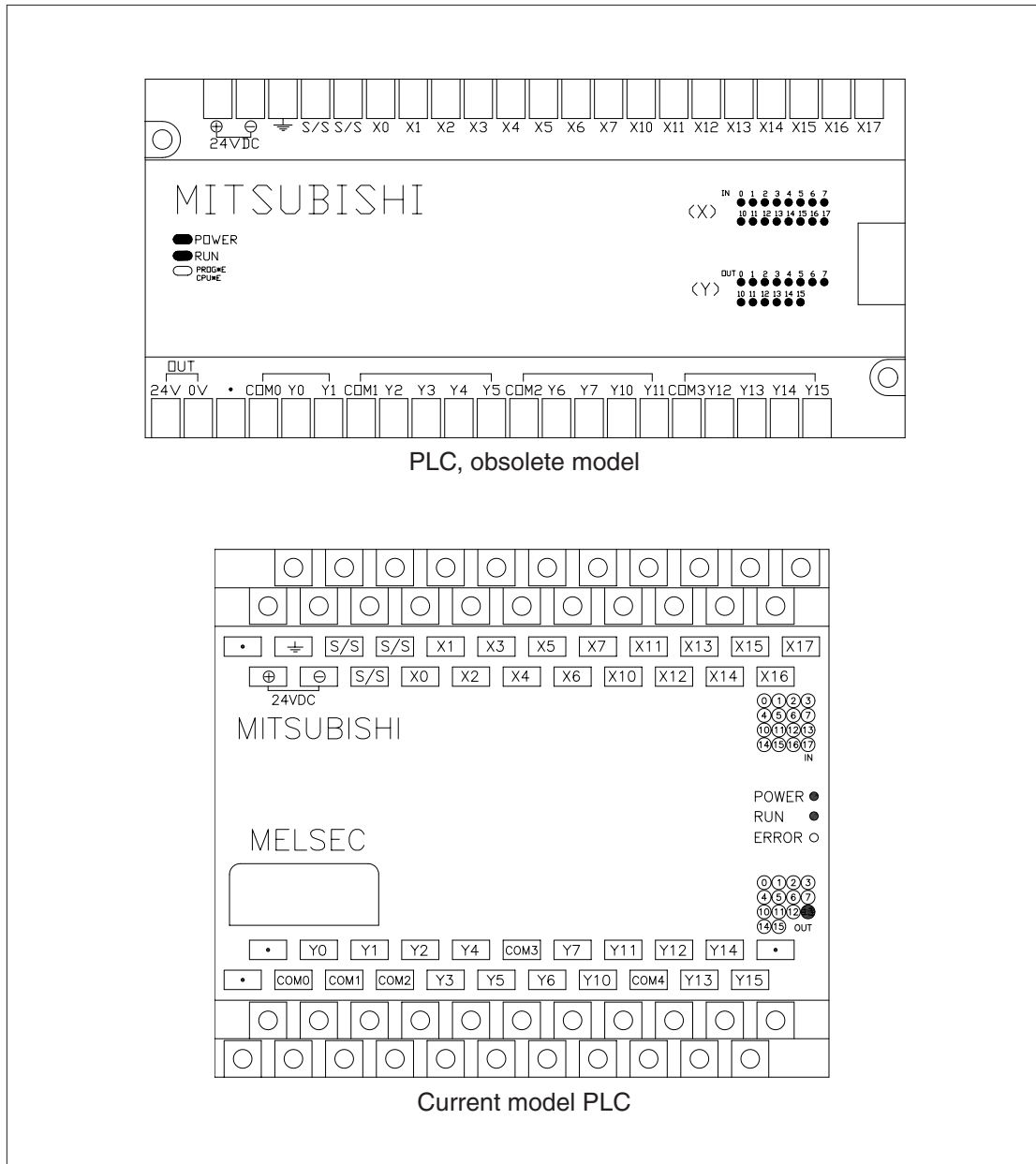


Figure 1 - PLC

A PLC is, by definition, a relay which is controlled by standard electrical inputs in combination with internal relay contacts to provide a variety of control parameters for an output. A PLC is a box with solid state relays.

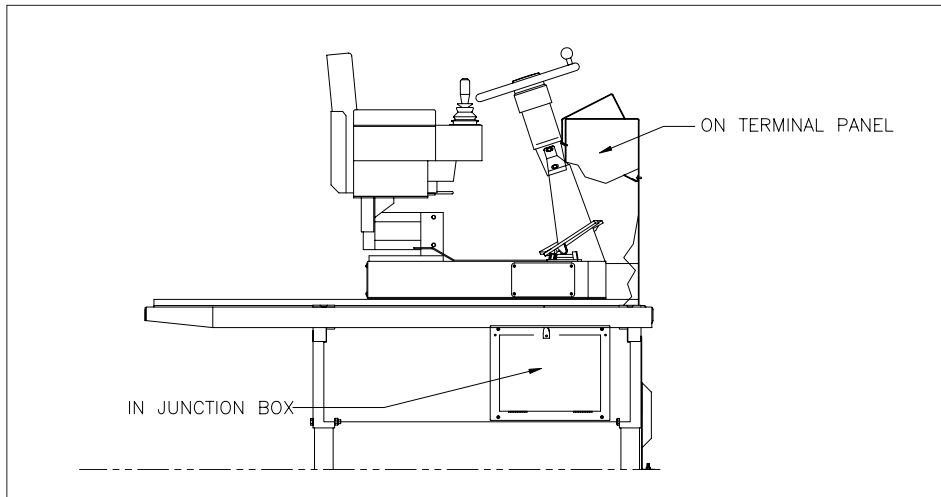


Figure 2 - Typical PLC location

Uses for the PLC

The PLC is used to control:

- Transmission shifting
- Control panel displays
- Options relay
- CAT engine torque limiting

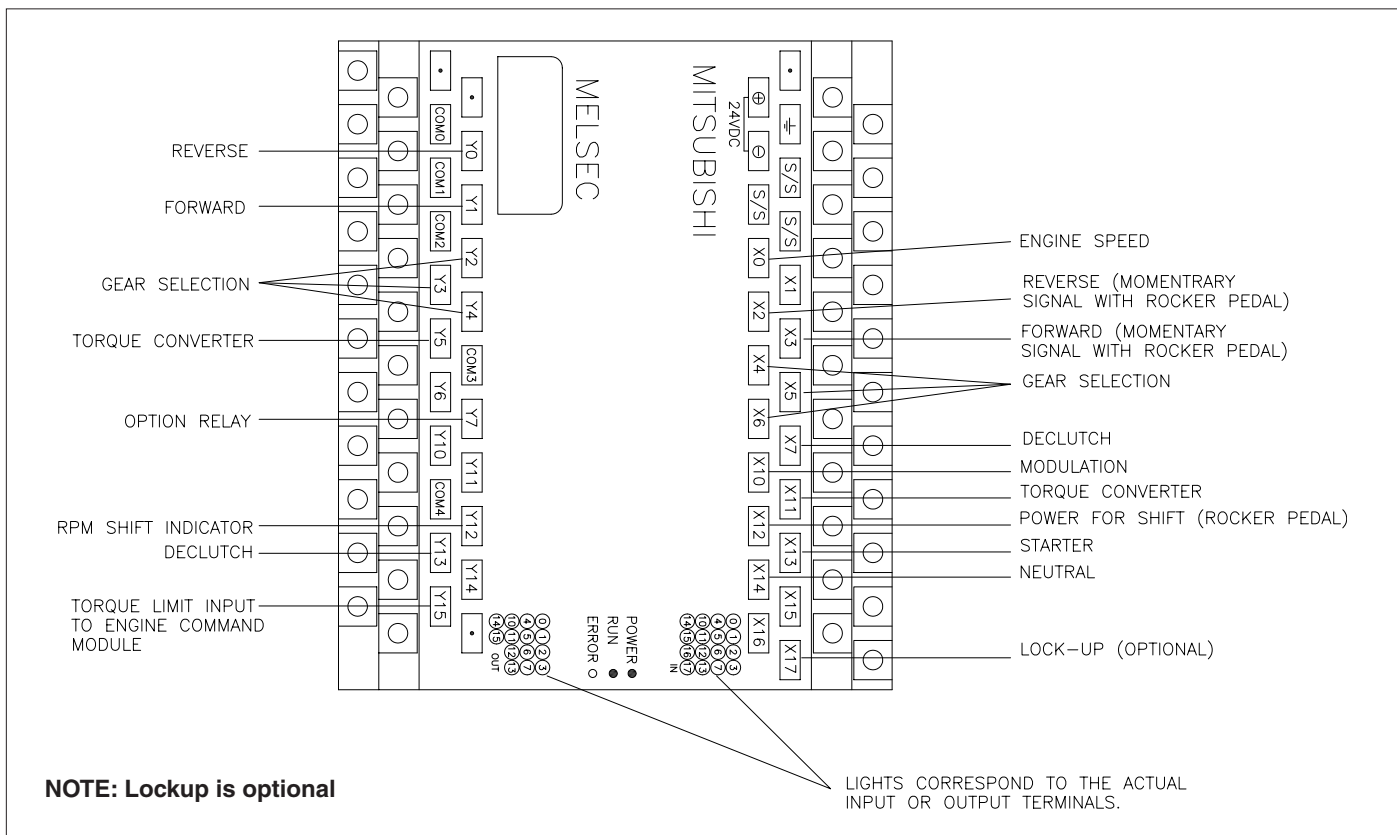


Figure 3 - Current PLC Model (without Optional Digital Display Monitor)

Inputs and Outputs

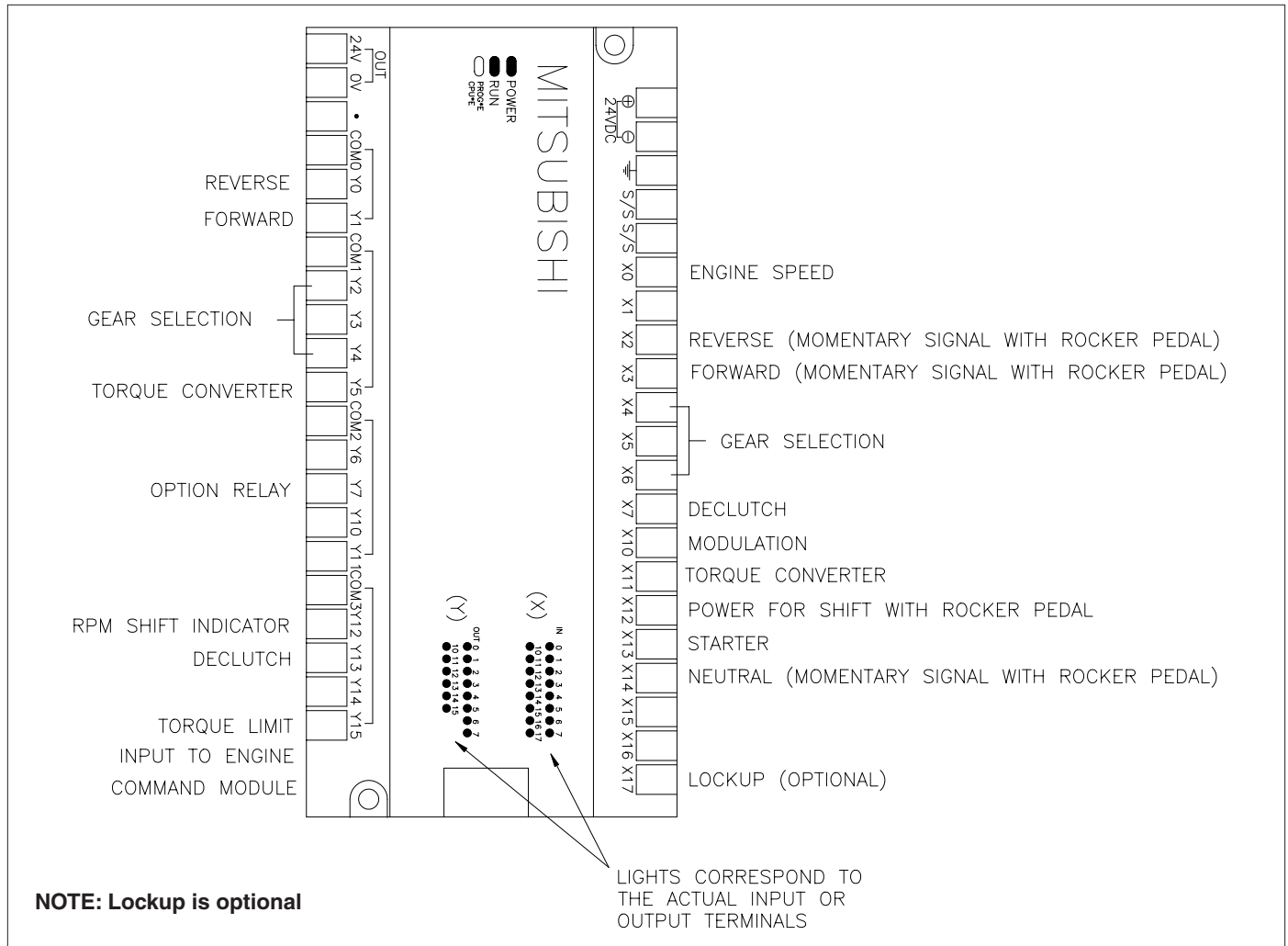


Figure 4 - PLC, Obsolete

Inputs (indicated by an X) are similar in function to a coil on a relay.

Outputs (indicated by a Y) are the controlled circuits or relay contacts.

The outputs connect to a given Y terminal and its corresponding COM terminal. COM terminals can either be (+) or (-).

For old-style (obsolete) PLC models:

<u>OUTPUTS</u>	<u>COM TERMINALS</u>
Y0, Y1	COM0 (+)
Y2, Y3, Y4, Y5.....	COM1(+)
Y6, Y7, Y10, Y11	COM2(+)
Y12, Y13, Y14, Y15.....	COM3 (-)

For current PLC models:

<u>OUTPUTS</u>	<u>COM TERMINALS</u>
Y0	COM0 (+)
Y1	COM1 (+)
Y2, Y3, Y4, Y5.....	COM2 (+)
Y6, Y7, Y10, Y11.....	COM3 (+)
Y12, Y13, Y14, Y15.....	COM4 (-)

This controller uses the following +24V inputs (X):

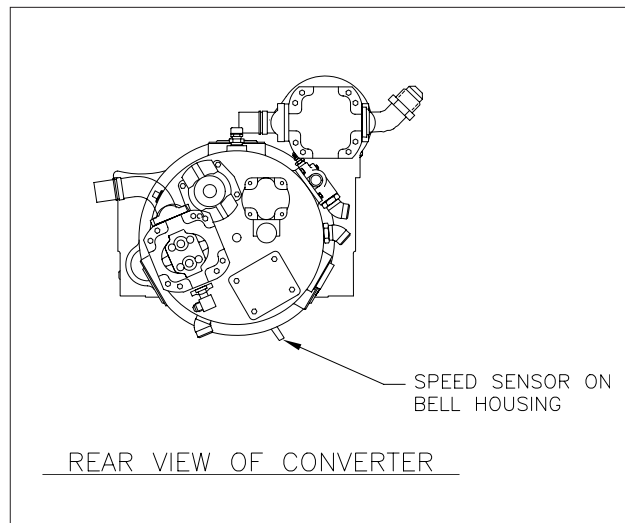


Figure 5 - Speed Sensor Location

- A speed sensor in the bell housing. This provides a pulse to determine engine speed.
NOTE: Machines with the Cummins QSX Engine receive the engine speed signal from the engine's electronic control module (ECM).
- A pressure switch on the left brake pedal, for the declutch.

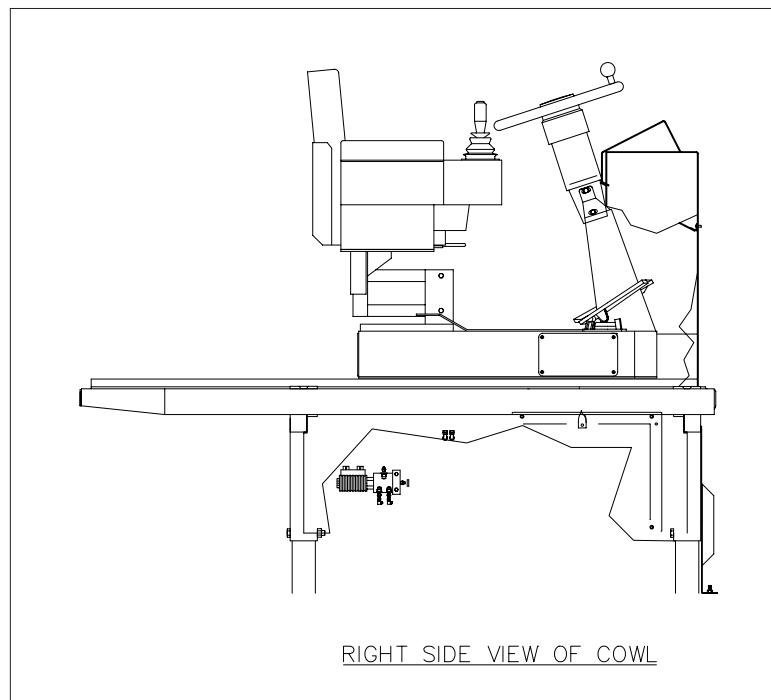


Figure 6 - Pressure Switch Location

- The shift selector, Forward/Reverse, 1st, 2nd, 3rd. Fourth gear is designated by either forward or reverse inputs only.
- The key switch. Signal from the starter circuit to reset the transmission to neutral.

The following outputs (Y) are controlled by the PLC:

- The transmission manifold solenoids for Forward, Reverse, 1st, 2nd, 3rd gear.
- The option relay solenoid.
- The torque limit on the CAT 3406E engine control module.
- The torque converter.

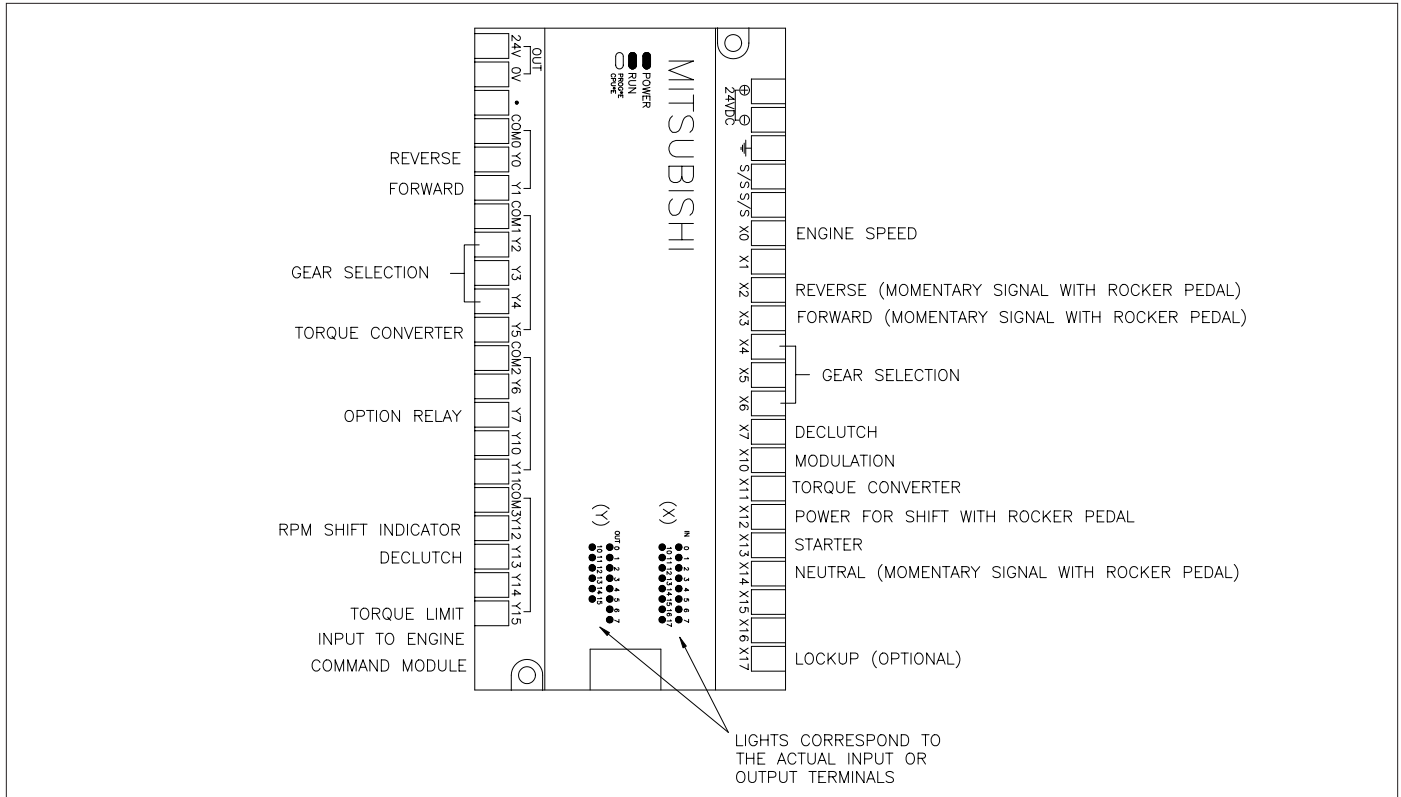


Figure 7 - Inputs & Outputs (Obsolete PLC model)

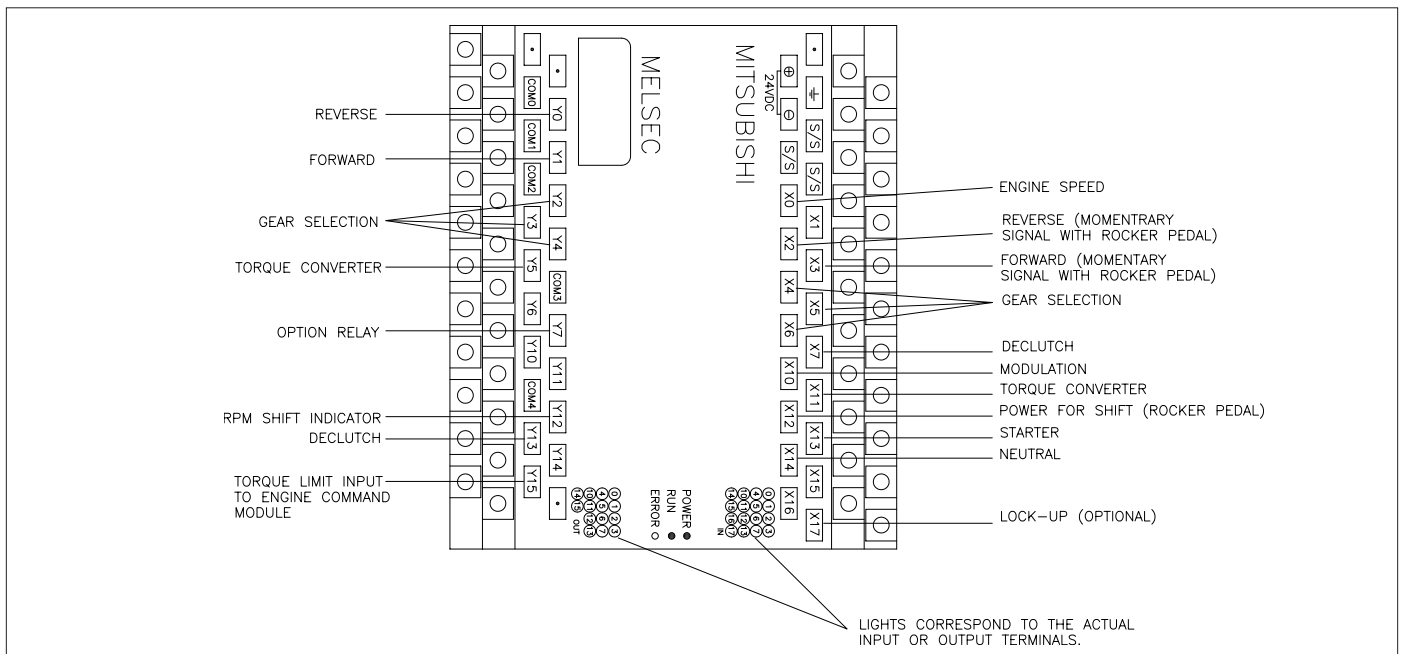


Figure 8 - Inputs & Outputs (Current PLC model without Optional Digital Display Monitor)

The Internal Logic Used to Control Inputs

- Shifting direction and resetting the declutch is only allowed when the engine speed is between 480 and 900 rpm.
- The option relay (Y7) is activated when the engine speed is **greater** than 480 rpm. This relay powers the Air Dryer, Strobe Lights, Defroster Fan, and the Air Conditioner.
- Torque Limit (Y15) is turned on if the engine speed is **greater** than 1900 rpm and you are **not** using the hoist or tilt function. A pressure switch is located on the pressure side of the hoist/tilt control valve. Unless this switch is activated the available engine torque is kept at its lower preset value. When engine speed is between low idle and 1900 rpm, Y15 is off and the engine is at its highest torque setting.

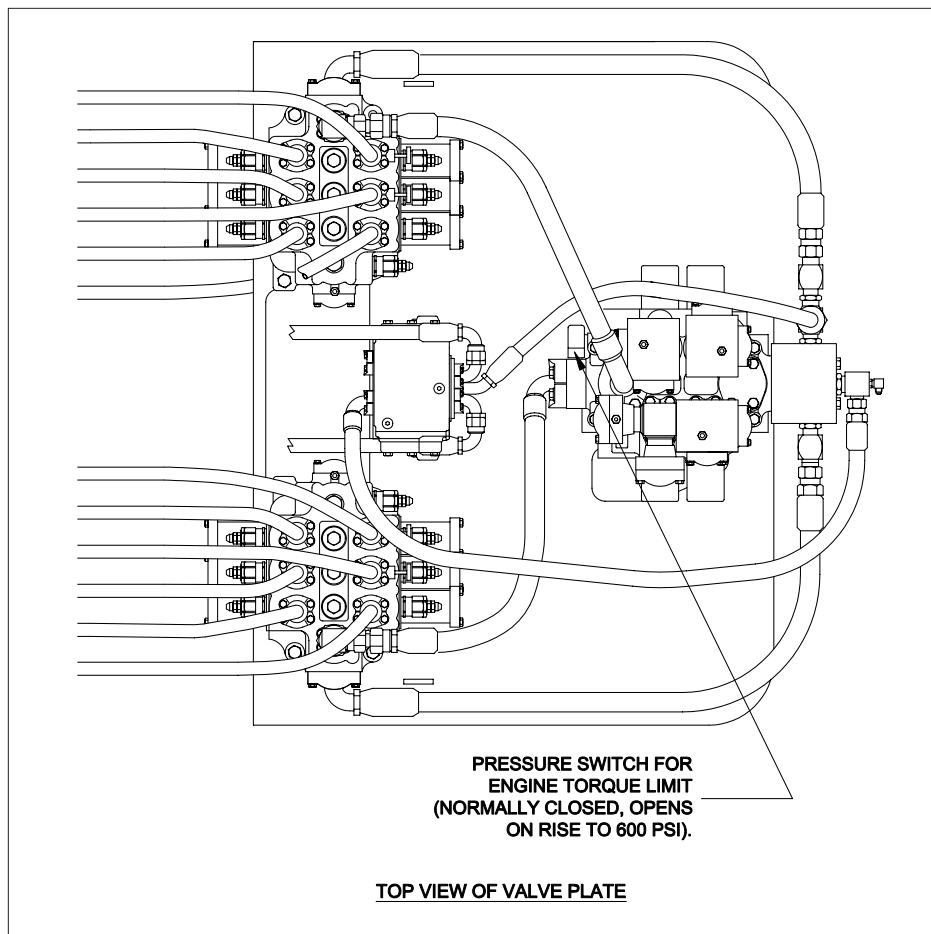


Figure 9 - Pressure Switch Location

Troubleshooting Outputs

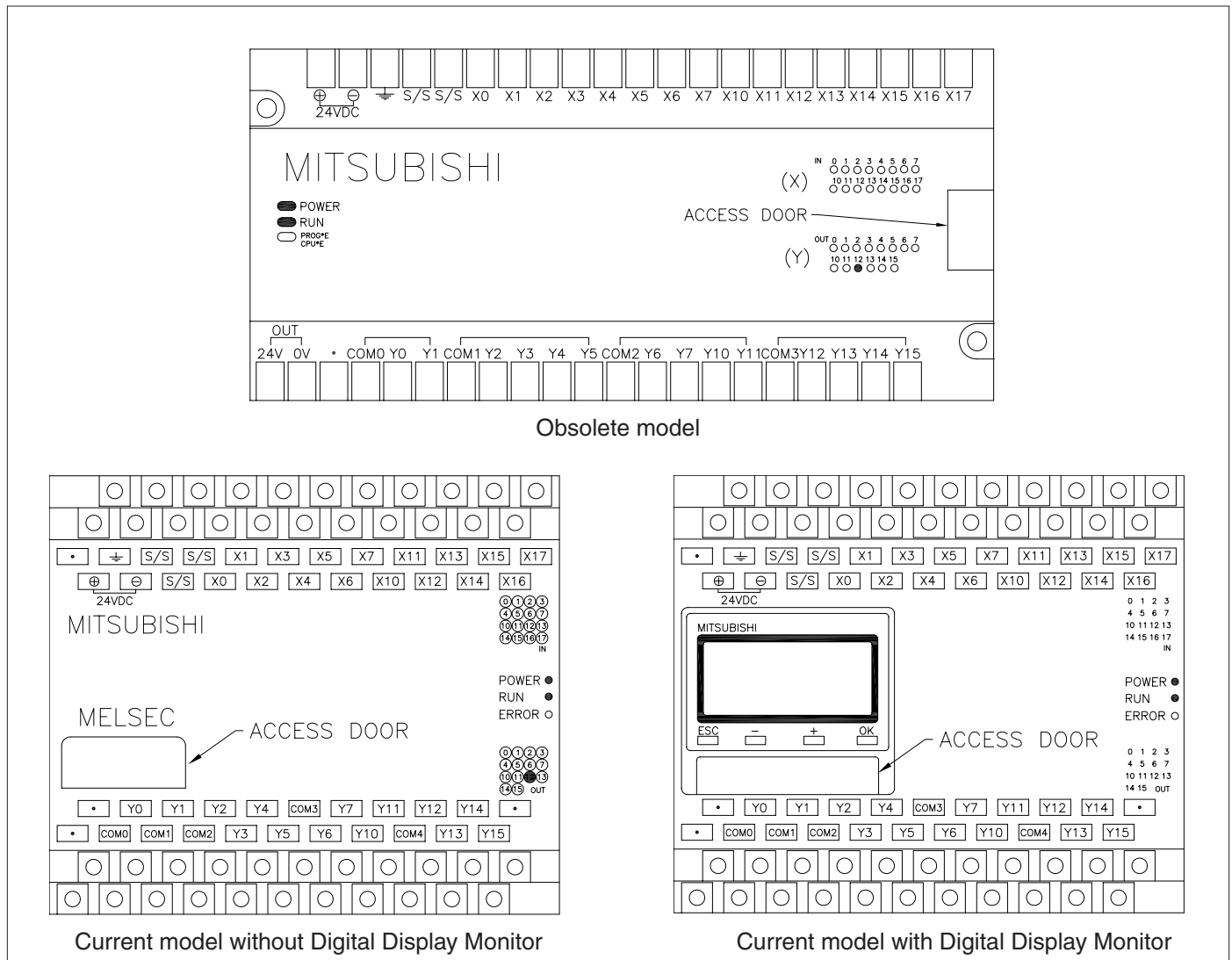


Figure 10 - Troubleshooting Outputs

⇒ Whenever the ignition switch is in the on position, both the Power and the Run indicator lights should be on. Y12 is on only when the engine speed is between 480 and 900 rpm (refer to Figure 10). This will provide a check of the speed sensor operation. The speed sensor is critical to declutch and shifting operations.

NOTE: For machines using the rocker pedal controls, X12 will always be on whenever the power is on.

- At any engine speed between 480 and 900 rpm the Y12 light on the PLC should be on.
- If this light comes on or is intermittent at high engine speeds, check the wiring to the switch assembly. Verify that the speed sensor is adjusted properly (refer to page 8 for procedure), or replace the speed sensor if necessary. For the location of the speed sensor, refer to Figure 5.

NOTE: All PLC models have an RUN/STOP switch located under the access door. When the PLC is being programmed, the switch should be in the STOP position. For the PLC to function correctly, it should be in the RUN position and remain there.

Speed Sensor

NOTE: Not applicable for machines with Cummins QSX engines.

To ensure a strong signal it is critical for both the speed sensor/flywheel tooth gap to be correctly set, and the keyway/index mark must be oriented perpendicular to the plane of flywheel rotation.

The engine flywheel tooth gap/proximity switch gap can be between 0.055 in. and 0.150 in. We recommend a gap of 0.110 ± 0.014 in. See Figure 11. Each complete revolution of the proximity switch will change the gap by 0.055 in. (1 turn = 0.055 in.).

The slight keyway located at the knurled end of the sensor functions as an index mark. The keyway/index mark must be oriented perpendicular to the direction of flywheel rotation. See Figure 12.

Easy installation procedure:

1. Ensure that the top of a flywheel tooth is in line with the center of the proximity switch hole.
2. Gently screw in the proximity switch until it touches the top of a tooth on the flywheel.
3. Back out the proximity switch 1 full turn $\pm 1/4$ turn.
4. Turn the proximity switch keyway/index mark to the nearest side perpendicular to the direction of flywheel rotation. This will result in a flywheel tooth/switch gap of 0.110 ± 0.014 in. -
5. Secure in position using the proximity switch's jam nuts. To avoid damaging the switch do not over tighten. Torque to 50 lbs. ft. ± 10 lbs. ft.). **Make sure the index mark remains perpendicular to flywheel rotation.**



CAUTION

CAUTION: DO NOT ALLOW SENSOR FACE TO CONTACT OTHER MAGNETS, AS THIS WILL CHANGE THE SENSOR'S CALIBRATION.

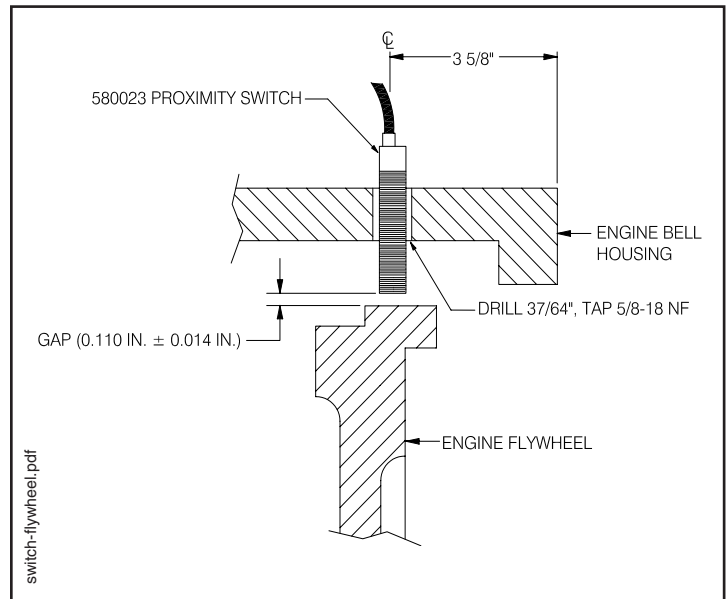


Figure 11 - Flywheel Tooth/Switch Gap

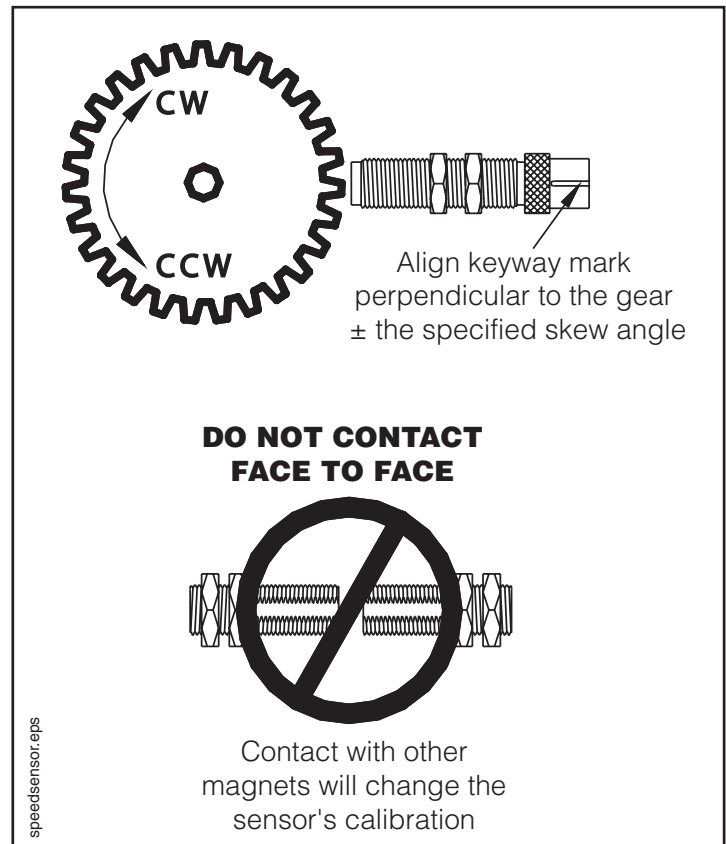
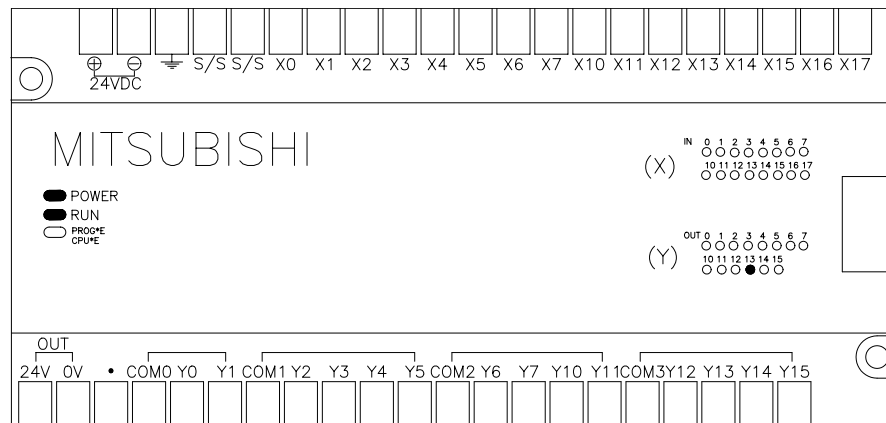
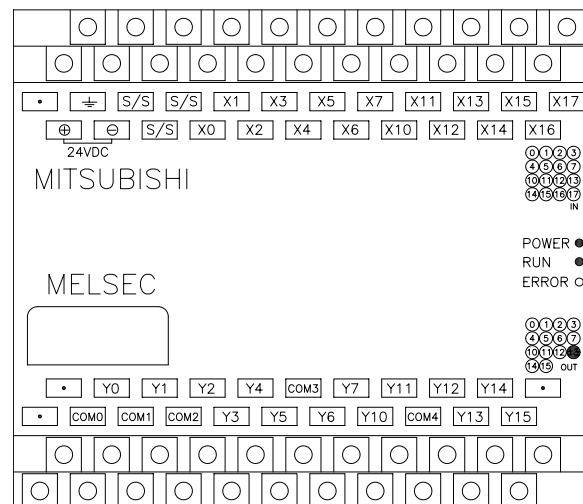


Figure 12 - Keyway/Index Mark Orientation



Obsolete model



Current model (without Optional Digital Display Monitor)

Figure 13 - Troubleshooting Outputs

⇒ Y13 is on when declutched (refer to figure 13). This light will remain on after declutching at high rpm until the engine speed is lowered to between 480 and 900 rpm and resets. When Y13 is on, Y0 and Y1 will be off regardless of inputs X2 and X3.

Troubleshooting guide

1. Check for the power to the PLC. The **POWER** indicator light on the cover of the PLC should be on. The PLC is powered by the accessory relay and protected by a 3 amp circuit breaker on the input (X) side and a 15 amp circuit breaker on the output side (Y). See Figure 14.
2. Next, make sure that the 24V output terminals, (COM0, COM1 and COM2 on machines using the old PLC model, and COM0, COM1, COM2 and COM3 on machines using the current PLC model) all have 24 volts. The COM terminals provide power to the output relays.
3. On old PLC models, make sure that COM3 is connected to ground (-). On current PLC models, COM4 should be connected to ground.

In order for the PLC to control the various outputs, all inputs must be correct. To troubleshoot the transmission problems, verify the inputs from the Shifter and the outputs to the Transmission control module. See Figures 7 and 8 for inputs and outputs on PLC models.

When experiencing a problem with the PLC, a simple check to determine if the PLC is operating correctly is to install a jumper wire. On the obsolete models, jump from COM2 to X10. On current models, jump from COM3 to X10.

NOTE: Remove the jumper wire after the test.

If the PLC operates correctly with the jumper, the problem is not with the PLC but indicates a problem with receiving the correct signal from the proximity switch.

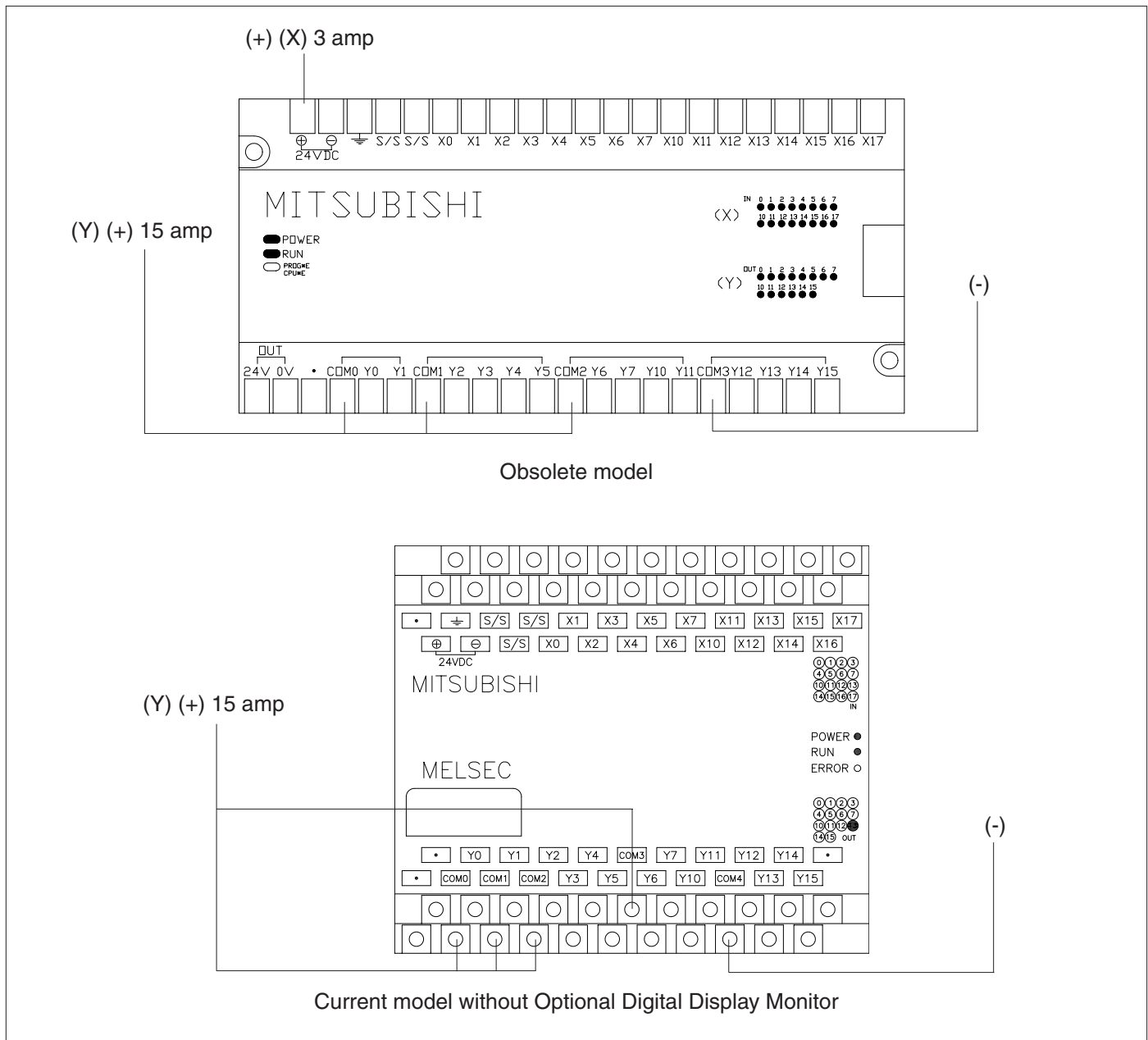


Figure 14 - Troubleshooting Outputs

For machines using Clark Transmission Shifter Controls:

	Inputs (Shifter)	Outputs (Trans. Module)
4th Gear Forward	X3	Y1
3rd Gear Forward	X3, X6	Y1, Y4
2nd Gear Forward	X3, X6, X5	Y1, Y4, Y3
1st Gear Forward	X3, X6, X5, X4	Y1, Y4, Y3, Y2
Neutral		
1st Gear Reverse	X2, X6, X5, X4	Y0, Y4, Y3, Y2
2nd Gear Reverse	X2, X6, X5	Y0, Y4, Y3
3rd Gear Reverse	X2, X6	Y0, Y4
4th Gear Reverse	X2	Y0

For machines using Rocker Pedal Controls:

	Inputs (Shifter)	Outputs (Trans. Module)
4th Gear Forward	X3 (momentary)	Y1
3rd Gear Forward	X3 (momentary), X6	Y1, Y4
2nd Gear Forward	X3 (momentary), X5	Y1, Y4, Y3
1st Gear Forward	X3 (momentary), X4	Y1, Y4, Y3, Y2
Neutral	X14 (momentary)	
1st Gear Reverse	X2 (momentary), X4	Y0, Y4, Y3, Y2
2nd Gear Reverse	X2 (momentary), X5	Y0, Y4, Y3
3rd Gear Reverse	X2 (momentary), X6	Y0, Y4
4th Gear Reverse	X2 (momentary)	Y0

NOTES:

1. When Declutch Indicator is on, Y0 and Y1 will remain off regardless of inputs X2 and X3.
2. Y13 will stay on after X7 is turned off until engine rpm is between 480 and 900.

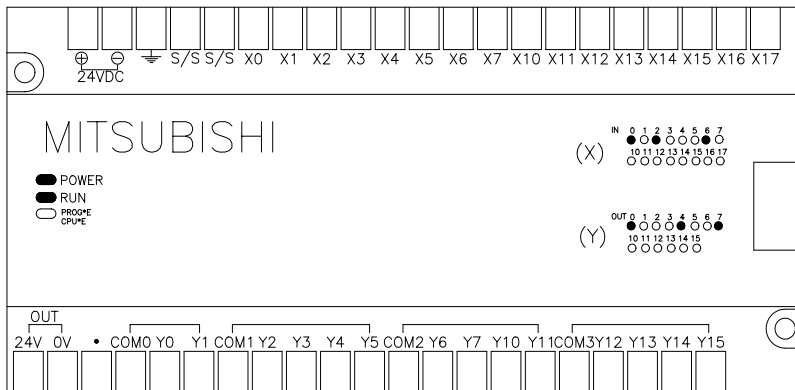
Clark Transmission Shifter Controls Troubleshooting Guide

Scenario:

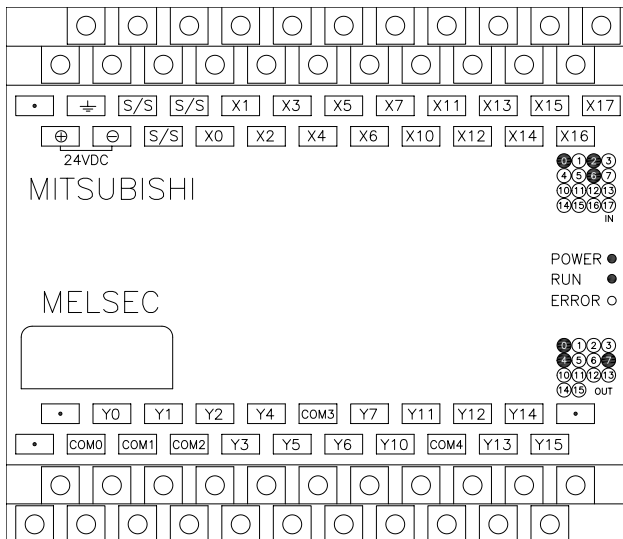
Engine speed=1100
 Speed Selection=3rd
 Range Selection=Reverse

Declutch Pedal Released
 Not Declutched

Scenario:



Obsolete model



Current model

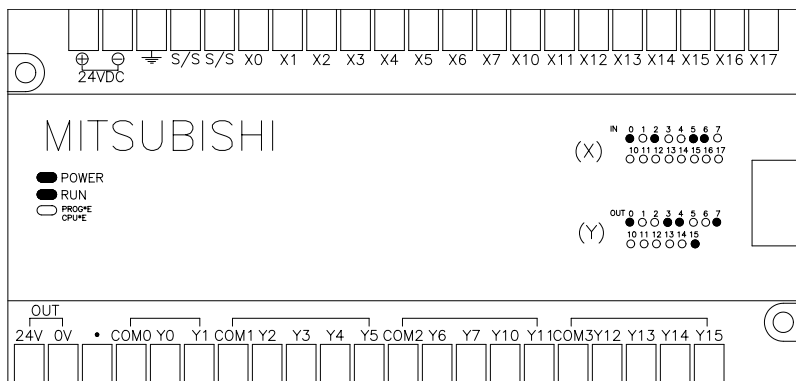
- RPM greater than 480: Y7 is on
- RPM greater than 900: Y12 is off
- 3rd Gear: X6 & Y4 are on
- Reverse Range: X2 & Y0 are on
- Power to PLC: X0, Power and Run Lights are on.
- RPM greater than 480: Y7 is on

Engine Speed=2000
 Speed Selection=2nd
 Range Selection=Reverse

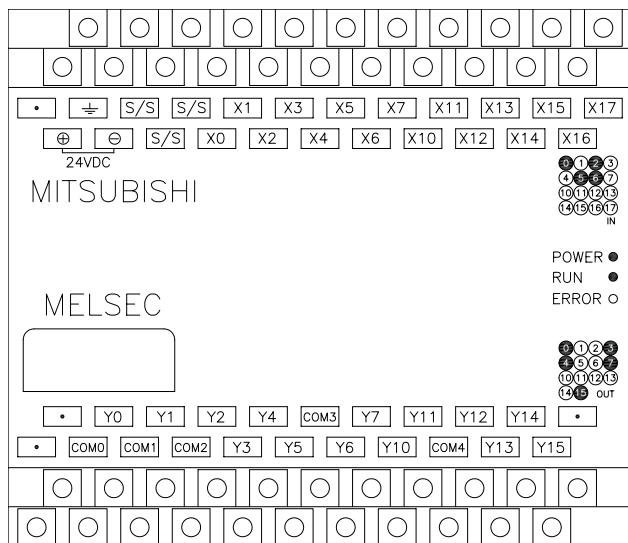
Declutch Pedal Released
 Not Declutched

Scenario:

- RPM greater than 900 so Y12 is off
- Reverse Range: X2 & Y0 are on
- 2nd Gear: X5, X6, Y3 & Y4 are on
- RPM is greater than 1900 with less than 600 psi on Hoist/Tilt Hydraulic Circuit so Y15 is on
- Power to PLC so X0, Power & Run lights are on



Obsolete model



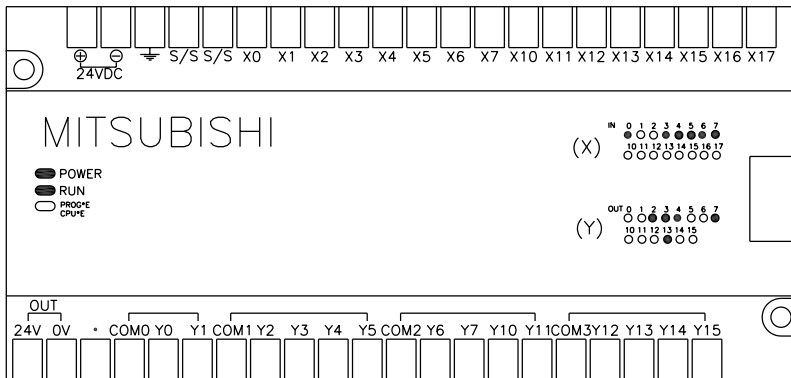
Current model

Engine Speed=1800
 Depressed
 Speed Selection=1st
 Range Selection=Forward

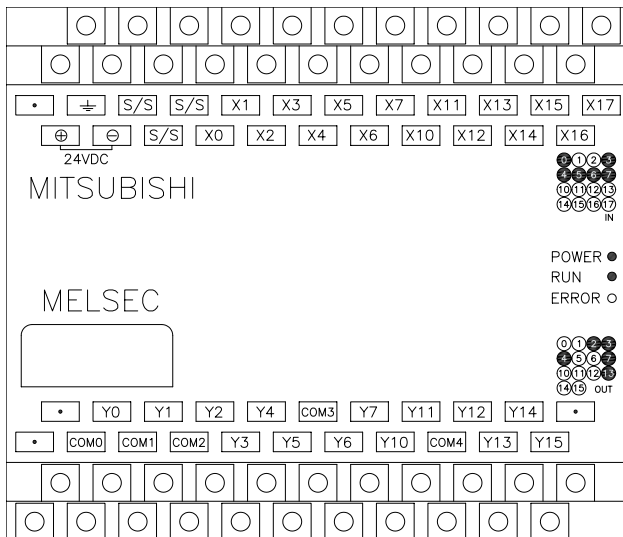
Declutch Pedal
 Declutched

Scenario:

- RPM is greater than 480: Y7 is on
- RPM is greater than 900: Y12 is off
- 1st Gear: X4, X5, X6, Y2, Y3, Y4
- Forward range: X3 is on
- Declutched & declutch pedal is depressed: X7 & Y13 are on
- Power to PLC: X0, Power & Run lights are on



Obsolete model



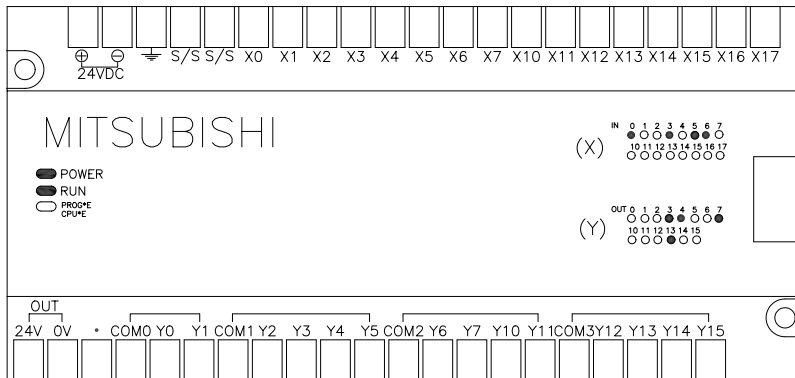
Current model

Engine Speed=1500
 Speed Selection=2nd
 Range Selection=Forward

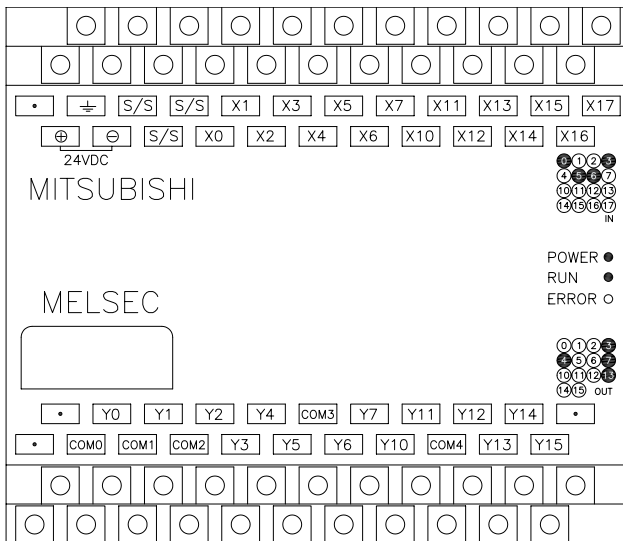
Declutch Pedal Released
 Declutched

Scenario:

- RPM greater than 480 so Y7 is on
- RPM greater than 900 so Y12 is off
- 2nd Gear: X5, X6, Y3 & Y4 are on
- Forward Gear: X3 is on
- Declutched: Y13 is on
- Declutch pedal released: X7 is off
- Power to PLC: X0, Power & Run lights are on



Obsolete model



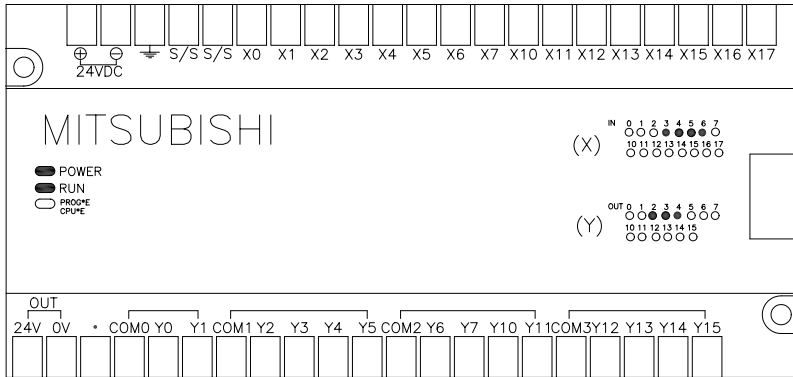
Current model

Engine Speed=0
 Speed Selection=1st
 Range Selection=Forward

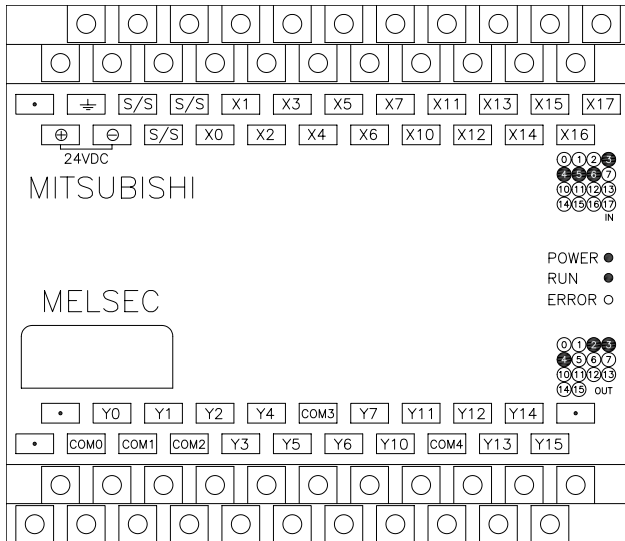
Declutch Pedal Released
 Not Declutched

Scenario:

- RPM below 480: Y7 & Y12 are off
- 1st Gear: X4, X5, X6, Y2, Y3 & Y4 are on
- Forward range: X3 is on
- There is power to the PLC: Power & Run lights are on



Obsolete model

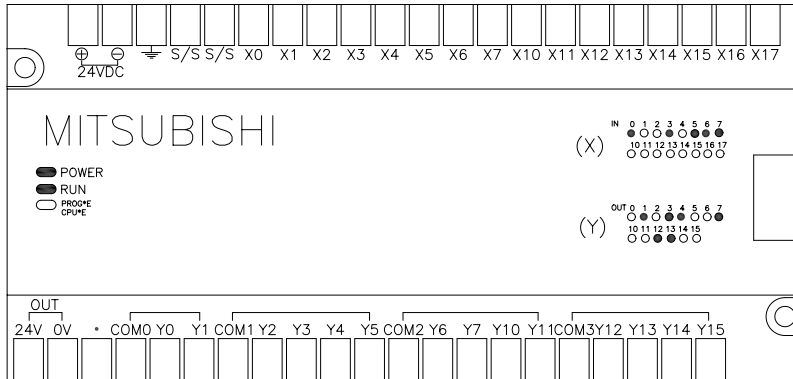


Current model

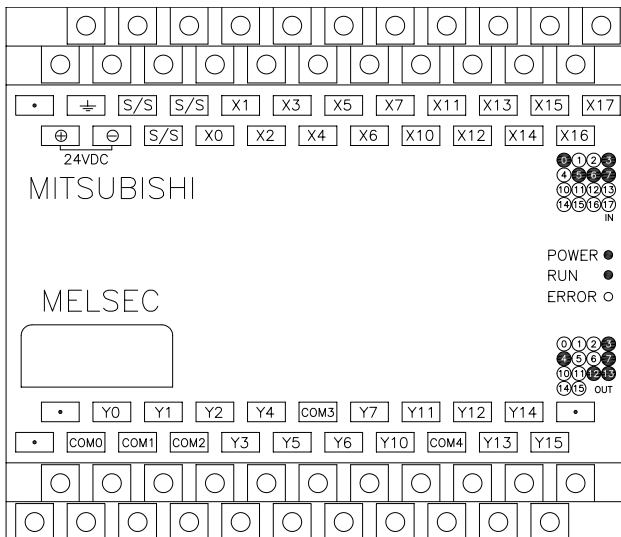
Engine Speed=750
 Speed Selection=2nd
 Range Selection=Forward

Declutch Pedal Released
 Declutched above 900 RPM

- RPM is above 480: Y7 is on
- RPM is between 480 & 900: Y12 is on
- 2nd Gear: X5, X6, Y3 & Y4 are on
- Forward Range: X3 is on
- Declutched: X7 & Y13 are on
- There is power to the PLC: X0, Power & Run lights are on



Obsolete model



Current model

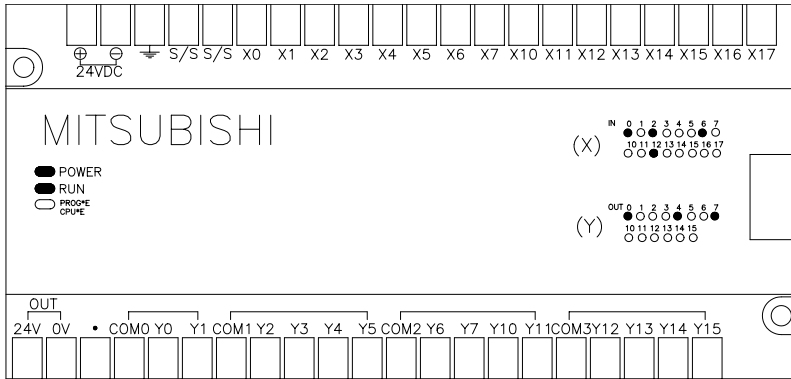
Rocker Pedal Controls Troubleshooting Guide

Scenario:

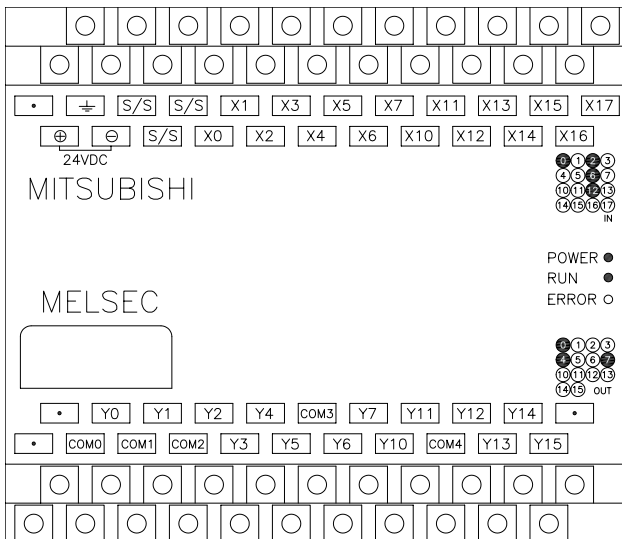
Engine speed=1100
 Speed Selection=3rd
 Range Selection=Reverse

Not Declutched

- RPM greater than 480: Y7 is on
- RPM greater than 900: Y12 is off
- 3rd Gear: X6 & Y4 are on
- Reverse Range: X2 is on momentarily & Y0 is on
- Power to PLC: X0, X12, Power and Run Lights are on.



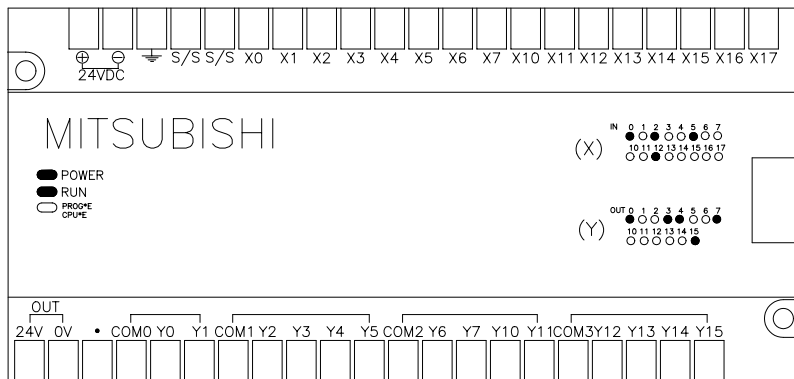
Obsolete model



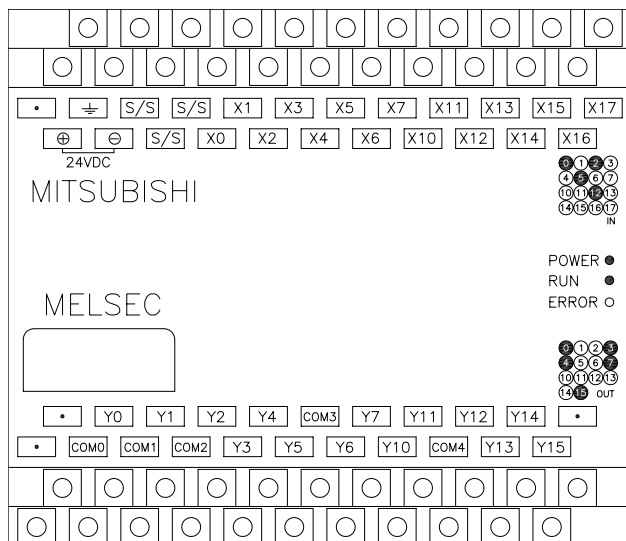
Current model

Scenario:

Engine Speed=2000 Not Declutched
 Speed Selection=2nd
 Range Selection=Reverse



Obsolete model



Current model

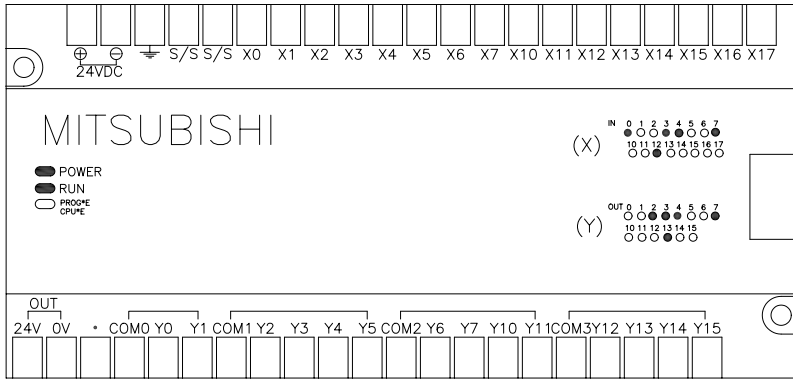
- RPM greater than 480: Y7 is on
- RPM greater than 900 so Y12 is off
- Reverse Range: X2 is on momentarily & Y0 is on
- 2nd Gear: X5, Y3 & Y4 are on
- RPM is greater than 1900 with less than 600 psi on Hoist/Tilt Hydraulic Circuit so Y15 is on
- Power to PLC so X0, X12, Power & Run lights are on

Scenario:

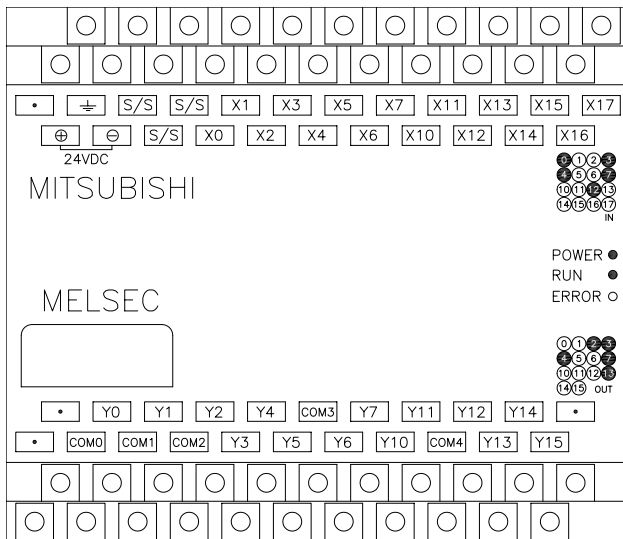
Engine Speed=1800
 Speed Selection=1st
 Range Selection=Forward

Declutch Pedal Depressed
 Declutched

- RPM is greater than 480: Y7 is on
- RPM is greater than 900: Y12 is off
- 1st Gear: X4, Y2, Y3, Y4
- Forward range: X3 is on momentarily
- Declutched & declutch pedal is depressed: X7 & Y13 are on
- Power to PLC: X0, X12, Power & Run lights are on



Obsolete model



Current model

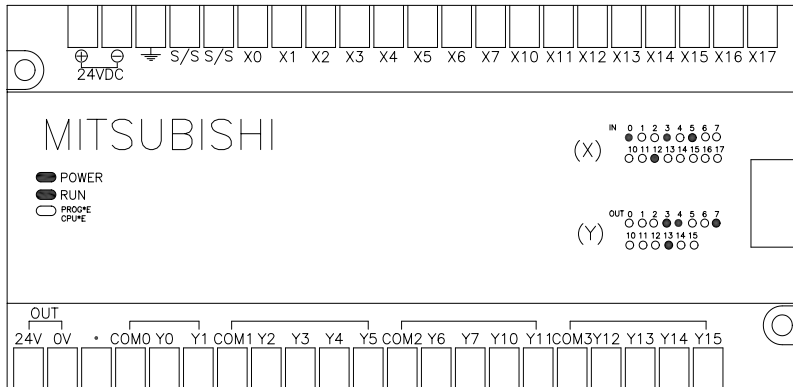
Scenario:

Engine Speed=1500
 Speed Selection=2nd
 Range Selection=Forward

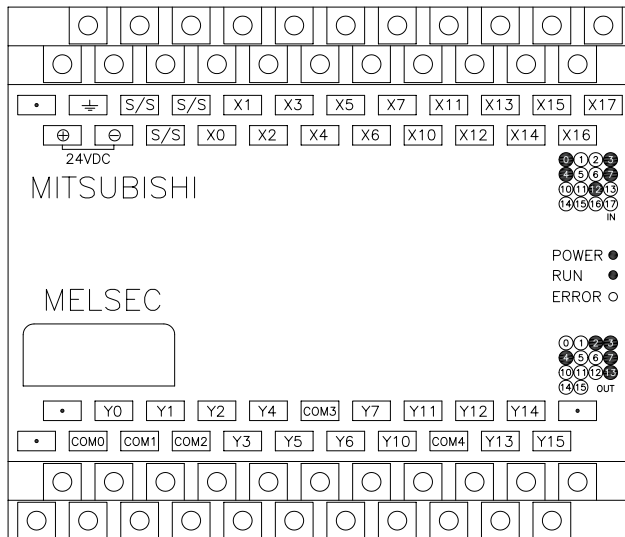
Dec clutch Pedal Released
 Dec clutch above 900 RPM

Scenario:

- RPM greater than 480 so Y7 is on
- RPM greater than 900 so Y12 is off
- 2nd Gear: X5, Y3 & Y4 are on
- Forward Gear: X3 is on momentarily
- Dec clutch: Y13 is on
- Dec clutch pedal released: X7 is off
- Power to PLC: X0, X12, Power & Run lights are on



Obsolete model

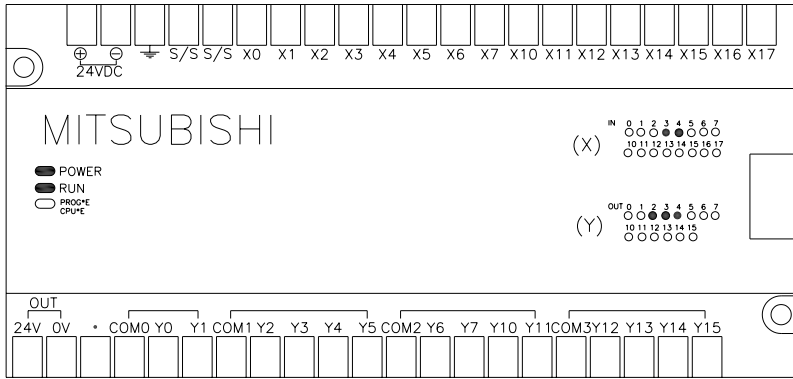


Current model

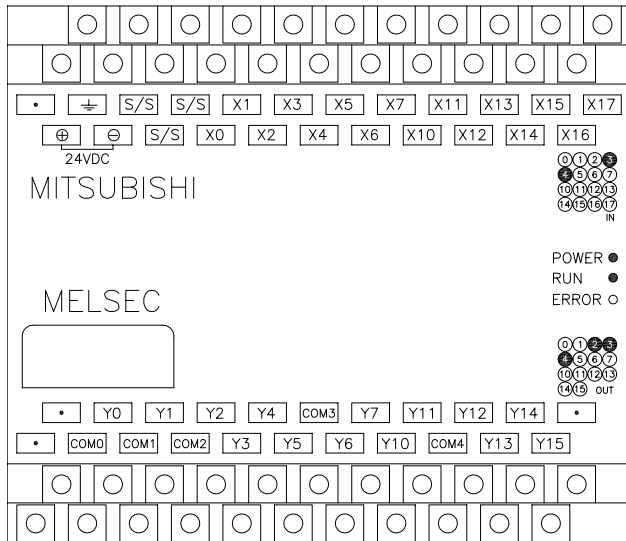
Engine Speed=0
 Speed Selection=1st
 Range Selection=Forward

Declutch Pedal Released
 Not Declutched

- RPM below 480: Y7 & Y12 are off
- 1st Gear: X4, Y2, Y3 & Y4 are on
- Forward range: X3 is on momentarily
- There is power to the PLC: Power & Run lights are on



Obsolete model



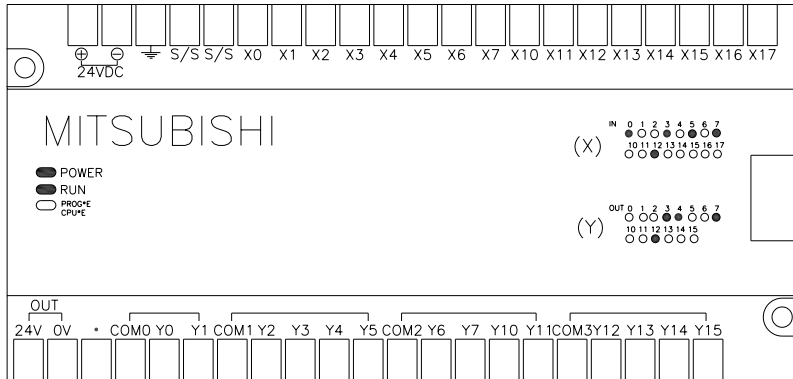
Current model

Scenario:

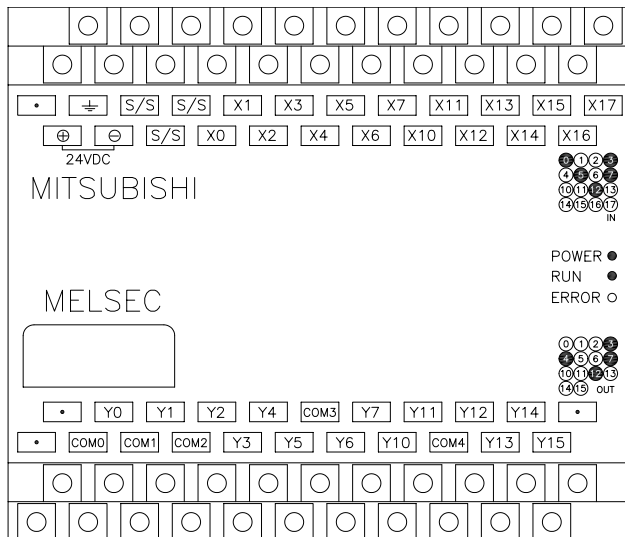
Engine Speed=750
 Speed Selection=2nd
 Range Selection=Forward

Declutch Pedal Depressed
 Declutched

- RPM is above 480: Y7 is on
- RPM is between 480 & 900: Y12 is on
- 2nd Gear: X5, Y3 & Y4 are on
- Forward Range: X3 is on momentarily
- Declutched and RPM is 480–900: Y1 is off until brake pedal is released
- There is power to the PLC: X0, X12, Power & Run lights are on



Obsolete model



Current model