Bendix® ET-S™ & ET-S2™ Suspended Electronic Treadle

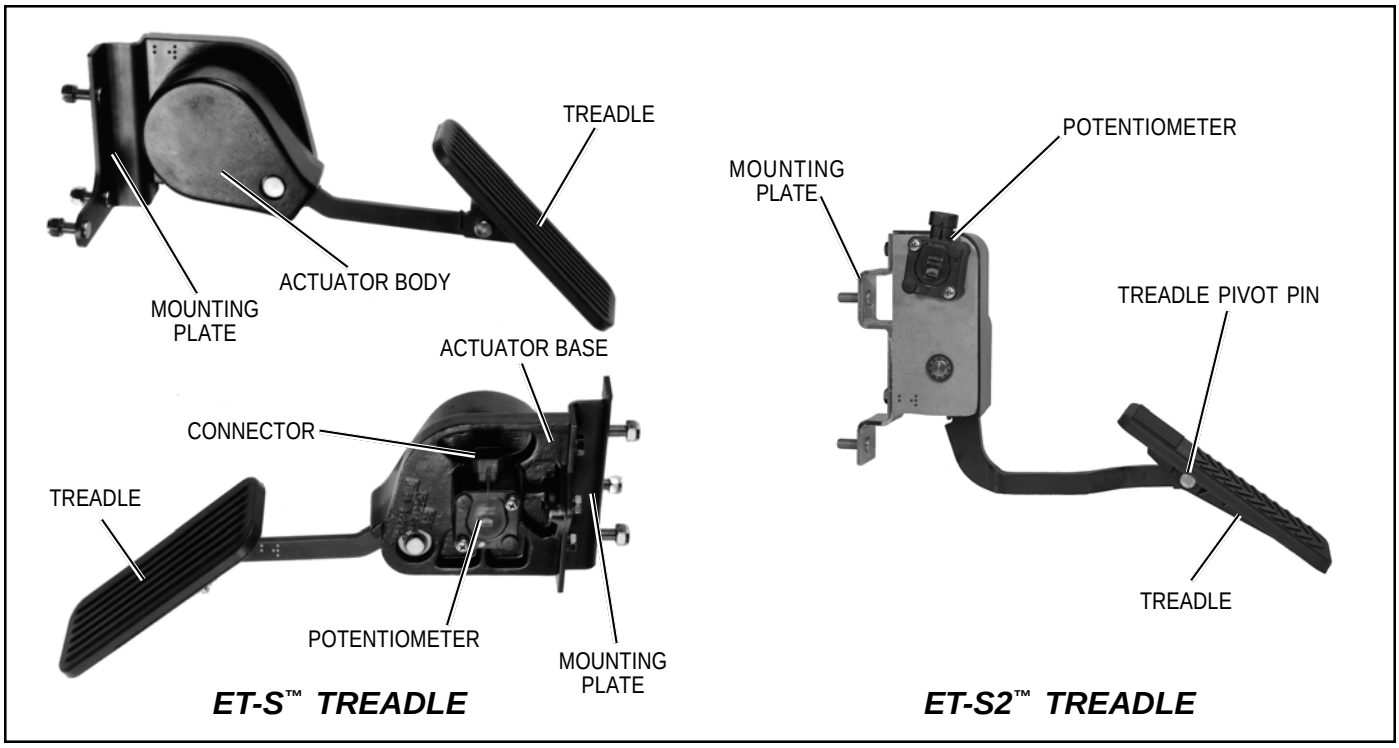

FIGURE 1 - ***ET-S™ AND ET-S2™ ELECTRONIC TREADLES***

DESCRIPTION

The ET-S™ and ET-S2™ treadles are engine compartment bulkhead mounted electronic treadles. On electronically controlled diesel engines, the electronic treadle fulfills the same function as a conventional mechanical throttle. However, rather than transmitting a mechanical force to the engine governor, the electronic treadle controls engine speed by supplying a variable electrical voltage to the engine's electronic controller.

The main components of the ET-S™ and ET-S2™ treadles are: a mounting plate, suspended treadle, potentiometer (variable resistor), actuator body and base. The selected potentiometer, chosen for a specific engine application, provides the electrical link to the engine control system.

OPERATION

The electronic treadles provide smooth, graduated throttle control through the function of its potentiometer (variable resistor). The drive shaft of the cam follower assembly transfers any movement of the treadle to the potentiometer.

	DETROIT DIESEL	CATERPILLAR	CUMMINS
CLOSED THROTTLE IDLE (OPEN)	7 - 18%	10 - 20%	5 - 17%
OPEN THROTTLE (FULL)	74 - 90%	75 - 90%	70 - 81%

FIGURE 2 - ***OUTPUT VOLTAGE, AS A PERCENTAGE OF SUPPLY VOLTAGE***

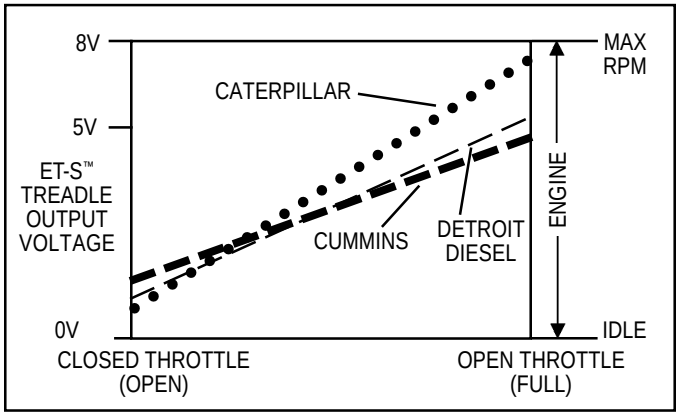

FIGURE 3 - ***OUTPUT VOLTAGE***

As the potentiometer rotates, its resistance changes. This way, the potentiometer can react to the driver's request for engine power through the ET-S™ or ET-S2™ treadle by changing resistance. The resulting change of voltage is sensed by the electronic engine controller.

The electronic treadle receives its supply voltage from the engine control unit. If the driver does not request engine power, the treadle is in the idle position. This condition is also referred to as "Closed Throttle." In this state, the potentiometer returns the minimum percentage of supply voltage to the engine control unit (see Figure 2).

As the driver depresses the treadle, the electronic treadle output voltage increases (see Figure 3). The potentiometer allows an increased amount of its supply voltage to return to the engine control unit, which in turn increases the engine's speed.

In the full, or "Open Throttle" position, the driver has depressed the treadle to its furthest possible point. This is the state of least potentiometer resistance. The electronic treadle returns the maximum percentage of supply voltage to the engine control unit (see Figure 2).

PREVENTIVE MAINTENANCE

Important: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

Because no two vehicles operate under identical conditions, maintenance intervals will vary. Experience is a valuable guide in determining the best maintenance interval for a vehicle.

GENERAL

Important: Visually check for physical damage to the electronic treadle such as broken or missing parts. Actuate the pedal five times from stop to stop, noting any binding or soft pedal response.

Important Note: DO NOT DISASSEMBLE THE ACTUATOR BODY. Replace the ET-S™ or ET-S2™ treadle if there is any binding, soft pedal actuation or if the nylon washers or retaining rings indicated in Figure 4 are cracked or have signs of deterioration.

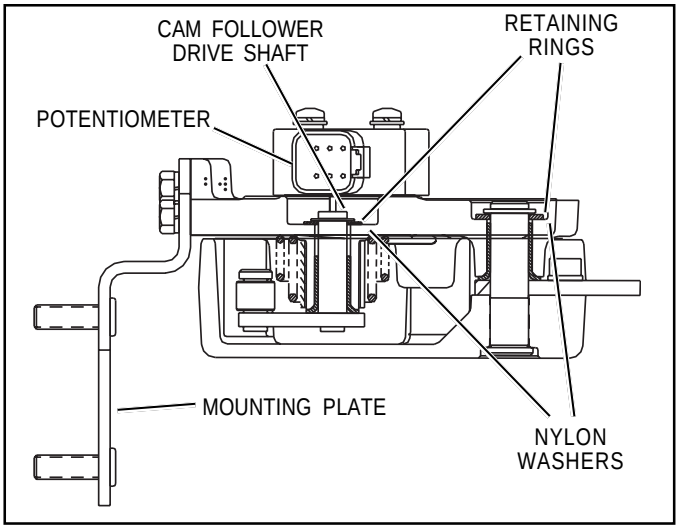

FIGURE 4 - ***TOP SECTIONAL VIEW***

Perform the inspections presented at the prescribed interval. If the electronic treadle fails to function as described, it should be repaired or replaced with a new or genuine Bendix remanufactured unit, available at any authorized parts outlet.

Every 3 months, or 25,000 miles, or 900 operating hours:

1. Remove any accumulated contaminants and visually inspect the exterior of the electronic treadle assembly for physical damage or excessive corrosion.
2. Inspect electrical connections and cable assembly for signs of corrosion, wear, or physical damage. Replace as necessary.
3. Inspect treadle spring, sleeve bearing, nylon washer, rubber treadle cover (ET-S™ treadle only) and retaining ring for cracks or deterioration. Replace as necessary.

ET-S™ & ET-S2™ TREADLE REMOVAL

1. Park the vehicle on a level surface and block the wheels.
2. Drain the air pressure from all vehicle reservoirs.
3. Disconnect the cable assembly of the potentiometer. Lift the lock tab and pull the connectors until they disengage.
4. Remove the electronic treadle from the vehicle, set aside the mounting hardware for reassembly.

DISASSEMBLY

Please note that the internal mechanism of the ET-S™ and ET-S2™ treadle are not field-serviceable and therefore individual parts or parts kits are not available for these components. Disassembly may lead to malfunction of the ET-S™ or ET-S2™ treadle.

The following instructions cover the maintenance and replacement of the potentiometer and treadle (with its bearing, spring etc.) only. The instructions provided with those items should be followed in lieu of the steps presented here. There are no other field-serviceable parts.

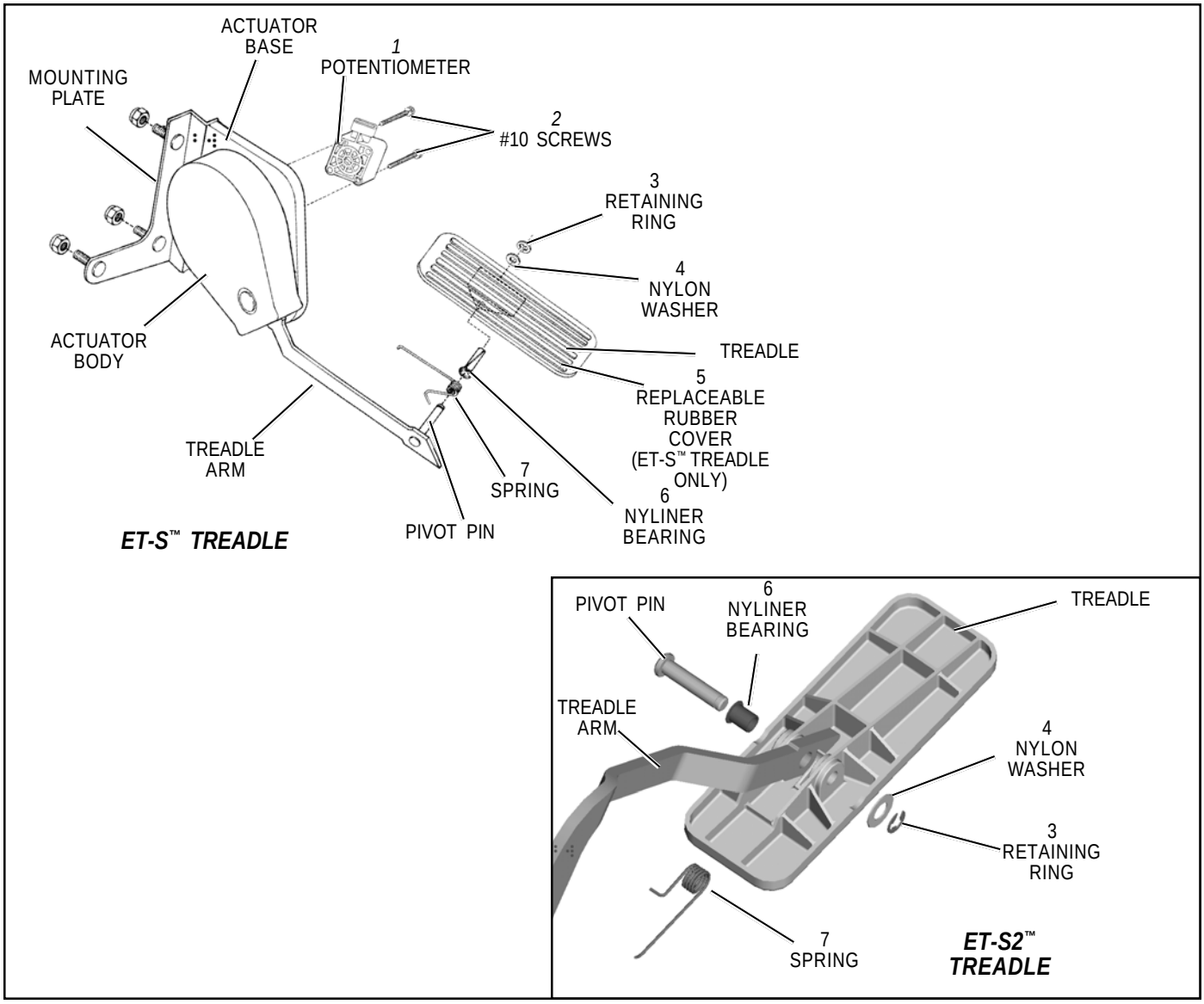

FIGURE 5 - ***ET-S™ AND ET-S2™ TREADLE EXPLODED LINE DRAWING***

All other repairs require replacement of the ET-S™ or ET-S2™ treadle.

Refer to Figure 5 throughout the procedures.

Treadle Removal:

ET-S™ Treadle

Position the treadle on its side with the potentiometer facing up. Remove the small retaining ring (3) and small nylon washer (4) that hold the treadle on to the treadle arm and set aside for the assembly process. After the washer is removed, pull the treadle off, carefully releasing the pressure from the treadle spring (7). Set the spring (7), nyliner bearing (6) and the treadle aside for the reassembly process. Inspect rubber treadle cover - replace if necessary.

ET-S2™ Treadle

Position the treadle assembly on its side with the potentiometer facing down. Remove the small retaining ring (3) and the nylon washer (4) from the treadle pivot pin.

Remove the pivot pin from the treadle assembly. Gently release the tension on the treadle spring (7) while removing the treadle from the treadle arm. Remove the nyliner bearing (6) from the treadle arm.

Potentiometer Removal:

Secure the mounting plate. **Important**: Do not clamp the assembly by the treadle actuator body or base since overclamping may cause the casting to be distorted.

Remove the two screws (2) that secure the potentiometer (1) to the actuator base. The potentiometer (1) can then be lifted away from the drive shaft.

CLEANING AND INSPECTION

1. Use suitable solvent to clean all metal parts (note that mineral spirits may damage the paint finish).
2. Inspect the treadle and mounting plate for severe corrosion, pitting, or cracks. Replace as necessary. Superficial corrosion and/or pitting is acceptable.

3. Inspect the cable assembly for loose or frayed wires, physical damage, or any contaminants on the connectors. Replace as necessary.

ASSEMBLY

1. Securely clamp the treadle mounting plate.
2. (a) ***For Detroit Diesel Potentiometers***: Align the drive slot, and engage the potentiometer the drive tang at the end of the drive shaft (see Figure 4). Rotate the potentiometer clockwise until the first set of mounting holes align. Secure using two screws: torque to 25 (±5) in. lbs.

   (b) ***For Caterpillar Position Sensor***: Aligning the drive slot, the position sensor engages the drive tang at the end of the drive shaft (see Figure 4). Rotate the position sensor clockwise until the first set of mounting holes align. Secure using two screws : torque to 20 (±2) in. lbs.

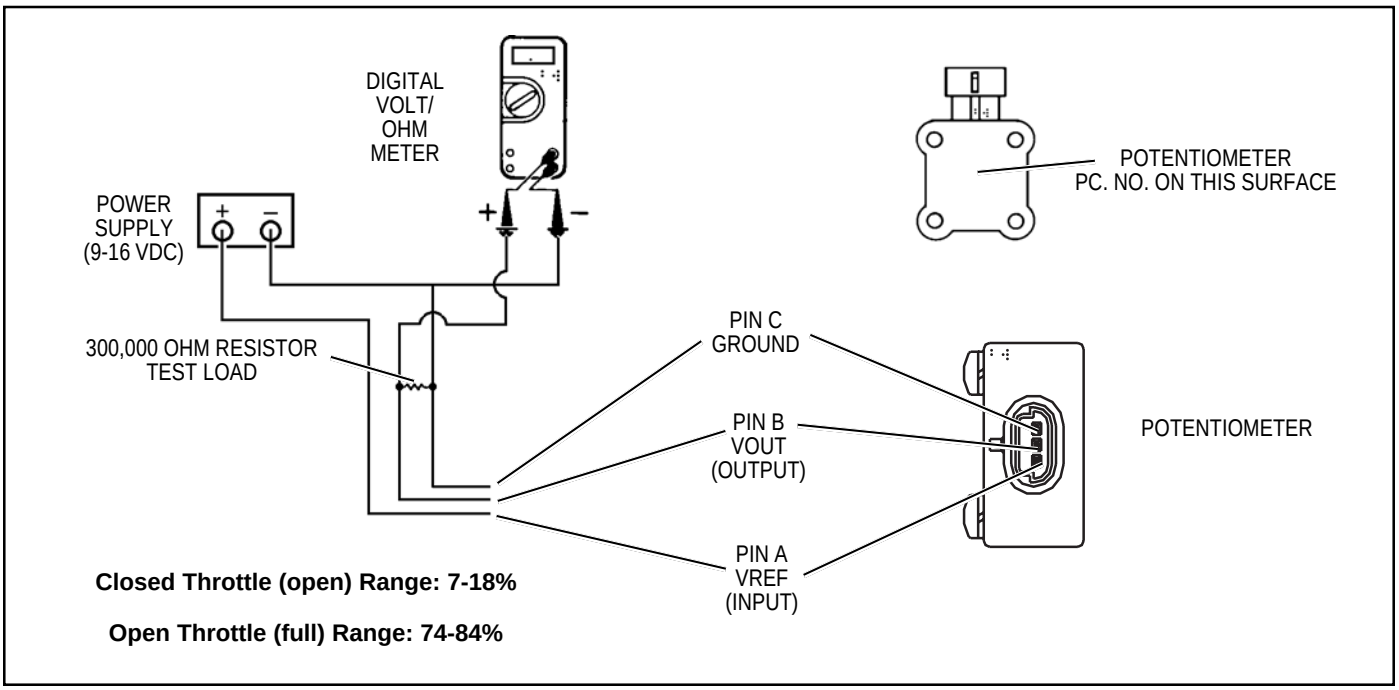

FIGURE 6 - ***ELECTRICAL TEST SCHEMATIC FOR THE DETROIT DIESEL CONNECTOR***

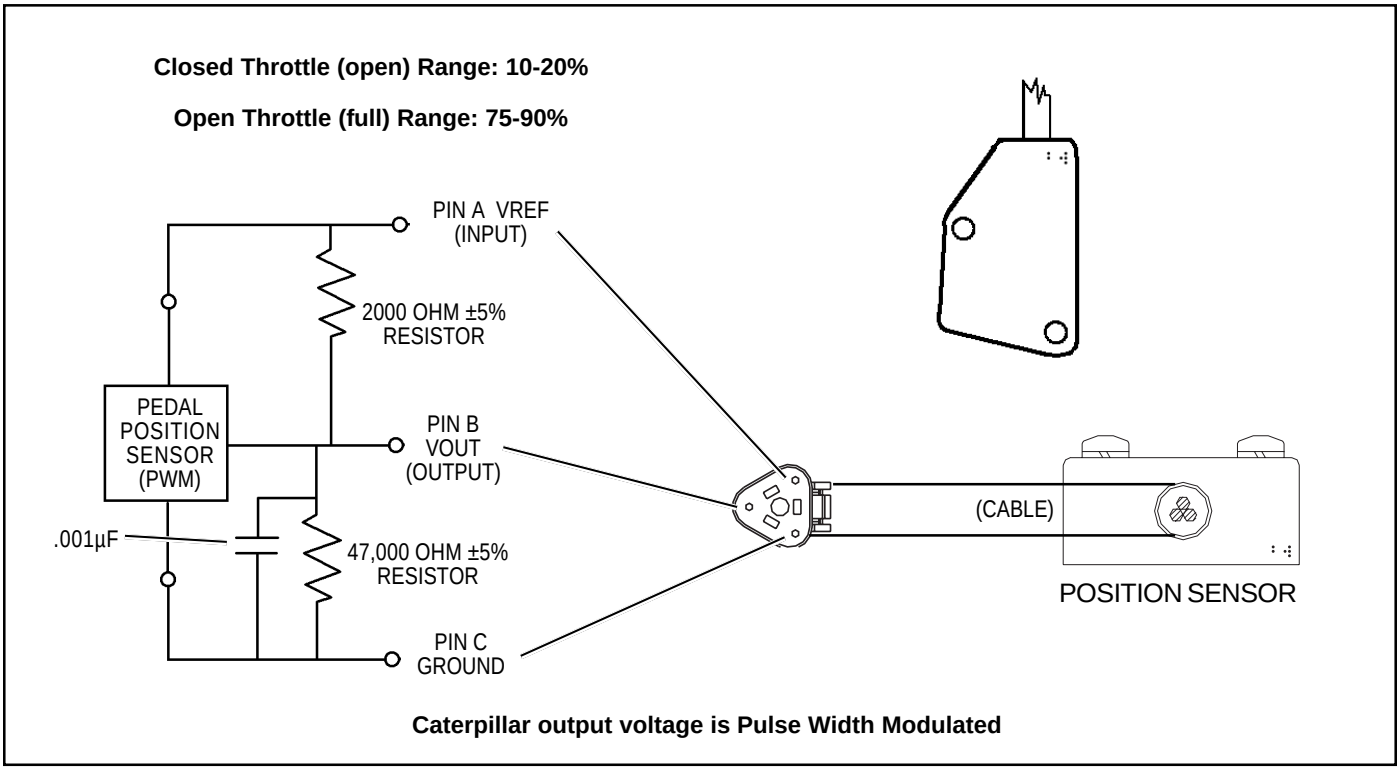

FIGURE 7 - ***ELECTRICAL TEST SCHEMATIC FOR THE CATERPILLAR CONNECTOR***

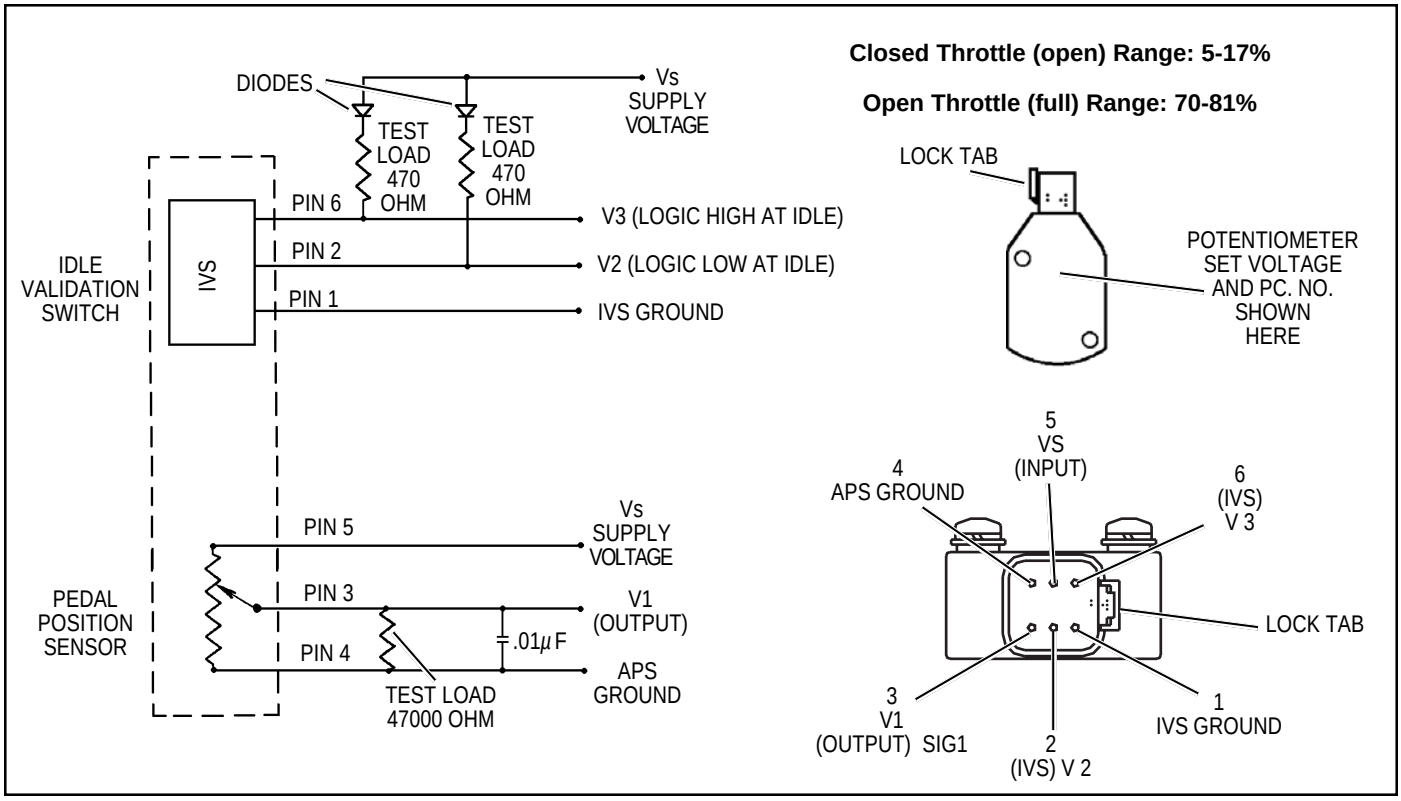

FIGURE 8 - ***ELECTRICAL TEST SCHEMATIC FOR THE CUMMINS CONNECTOR***

(c) ***For Cummins Potentiometers***:

Test 1: Where the set resistance and voltage is shown on a label. The Cummins potentiometer on the ET-S™ and ET-S2™ treadle has an integral idle validation switch. It also has a set resistance value marked on the cover, which needs to be used to properly install the potentiometer. The drive slot in the potentiometer should engage with the drive tang at the end of the drive shaft. Next rotate the potentiometer until the hole in the metal sleeve matches the mounting holes on the actuator base. Loosely screw the potentiometer in place but do not tighten. Connect an ohmmeter to pins 3 (APS output) and 4 (APS ground) as shown in Figure 8. Now the installer should read the set resistance value marked on the label. Rotate the potentiometer until the ohmmeter reads the same resistance as shown on the label within ±10 Ohms. Next, while holding the potentiometer at the set resistance screw and lock the potentiometer in place (torque to 25 inch pounds ±5). The sleeves lock into the body of the potentiometer for easy removal and reassembly.

Test 2: Where the potentiometer has no label, but has engraved set voltage shown. The Cummins potentiometer on the electronic treadle has an integral idle validation switch. It also has a set voltage value marked on the cover, which needs to be used to properly install the potentiometer. The drive slot in the potentiometer should engage with the drive tang at the end of the drive shaft. Next rotate the potentiometer until the hole in the metal sleeve matches the mounting holes on the actuator base. Loosely screw the potentiometer in place but do not tighten. Construct the test circuit following the circuit diagram shown in Figure 8. To make the test circuit connect the test load resistor (47,000 Ohms) and a capacitor (.01 MicroFarads) across pins 3 and 4 of the potentiometer. Then connect a voltmeter to the lead ends of the test circuit. Next connect a 5 volt power supply to the potentiometer at pin 4 (APS ground) and pin 5 (supply voltage). Caution: Sensor may be damaged if supply exceeds 5 volts. Now the installer should read the set voltage value marked on the potentiometer. Rotate the potentiometer until the voltmeter reads the same voltage as shown on the potentiometer within ±.02 volts. Next screw and lock the potentiometer in place (torque to 25 inch pounds ±5). The sleeves lock into the body of the potentiometer for easy removal and reassembly.

Test 3: Perform the following Operational Test before installing the electronic treadle:

OPERATIONAL TEST

[Note for Cummins potentiometers only: The optimum output & switch points should be achieved when the idle voltage equals the set voltage or set resistance written on the potentiometer. Use the test circuit shown in Figure 8.**]**

a. Check that the electronic treadle mounting plate is securely attached to a smooth, flat surface in such a way that does not twist the unit.

b. Connect the potentiometer or position sensor to the volt meter and power supply as shown in Figures 6, 7 or 8, depending on the model. **Note**: The power supply needs to be 5 VDC. Do not exceed this voltage.

c. Verify that the closed throttle (idle) output voltage, as a percentage of supply voltage, is within the limits listed in Figure 2. For example, with a supply voltage of 5 volts, for the Caterpillar potentiometer in its closed throttle position, read between 0.5 to 1.0 volts (10%-20% of supplied voltage).

d. Depress the treadle to its full throttle position. The output voltage, as a percentage of supply voltage, should be within the limits listed in Figure 2. For example, with a supply voltage of 5 volts, for the Caterpillar position sensor in its open throttle position, read between 3.75 to 4.5 volts (75-90% of supplied voltage).

e. Make five full applications and record idle position voltage each time. Verify that idle position voltages recorded do not vary by more than .4% (For example, for a 5 volt supply, if there is any variation, the difference between the high and low readings should not exceed .02 volts).

If the electronic treadle fails to function within its specified ranges, it should be repaired or replaced with a new or genuine Bendix remanufactured unit, available at any authorized parts outlet.

Treadle Installation:

ET-S™ Treadle

1. Replace the rubber treadle cover if needed.
2. Place the spring (7) on the treadle pivot pin.
3. Install the nyliner bearing (6) into the treadle. **Note:** the nyliner bearing collar is placed on the treadle arm side. Holding the spring in position, the treadle is then installed. The nylon washer (4) and retaining ring (3) secure the treadle into position.
4. Make sure the ET-S™ treadle has a smooth, even treadle movement.
5. Install the ET-S™ treadle on the vehicle (see *ET-S™ & ET-S2™ Treadle Installation*).

ET-S2™ Treadle

1. Position the treadle assembly on its side with the potentiometer facing up.
2. Insert the nyliner bearing (6) into the treadle arm with the collar up (toward potentiometer side). The nyliner bearing (6) will protrude through the treadle arm providing a guide for the treadle spring (7).
3. Place the treadle spring (7) on the protruding portion of the nyliner bearing with the tangs of the treadle spring (7) pointing toward the ET-S2™ treadle body. The short tang should rest on the top side of the treadle arm. Align the treadle arm and treadle spring with the recess in the underside of the treadle.
4. Insert the pivot pin from the potentiometer side of the ET-S2™ treadle assembly through the treadle, treadle arm, nyliner bearing (6) and spring (7). Secure with the nylon washer (4) and retaining ring (3).
5. Make sure the ET-S2™ treadle has smooth, even treadle movement.
6. Install the ET-S2™ treadle on the vehicle (see *ET-S™ & ET-S2™ Treadle Installation*).

ET-S™ & ET-S2™ TREADLE INSTALLATION

1. Using the mounting hardware set aside, install the assembled electronic treadle on the vehicle. Torque to between 85 and 110 lb. in.
2. Reconnect the cable connector by plugging it into the potentiometer's integral connector and pushing until the lock tab snaps into place.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**

8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**