Fuller® Transmission

Troubleshooting Guide

TRTS4400
September 2009
FTS-XX108LL
FTS-XX112L

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Warnings & Cautions

⚠ WARNING

Follow the specified procedures in the indicated order to avoid personal injury.

Note: Additional relevant information not covered in the service procedure.

Before starting a vehicle:

- Ensure adequate fuel level.
- Sit in the driver's seat
- Place shift lever in neutral
- Set the parking brake

Before working on a vehicle or leaving the cab with engine running:

- Ensure ignition is off while hands are within the clutch housing area.
- Place shift lever in neutral
- Set the parking brake
- Block the wheels

When parking the vehicle or leaving the cab:

- Place shift lever in neutral
- Set the parking brake

⚠ CAUTION

Follow the specified procedures in the indicated order to avoid equipment malfunction or damage.

Do not release the parking brake or attempt to select a gear until the air pressure is at the correct level.

To avoid damage to the transmission during towing:

- Place shift lever in neutral
- Lift the drive wheels off of the ground or disconnect the driveline

Do not operate the vehicle if alternator lamp is lit or if gauges indicate low voltage.

Unplug the TCM before electrical welding service in any part of the vehicle.

All electrical connectors require maximum care when plugging or unplugging them from the TCM, harness, and components.

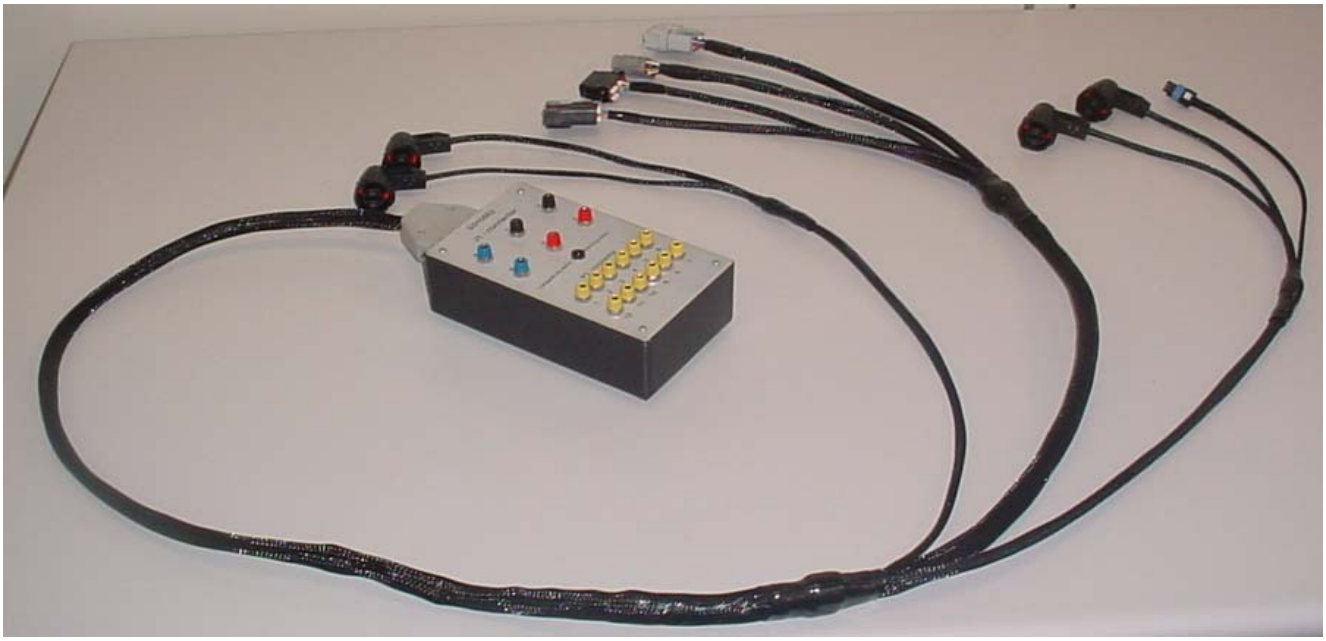
Suggested Tools

- Eaton Breakout Box Test Tool
  - Breakout Box - E015002
  - Harness - E015001
- Multimeter able to measure frequency (see appendix for specifications)
- Manometer (0 -10 bar)
- Service Publications
  - S-13 Transmission Service Manual, TRSM4400
  - S10 Transmission Service Manual, TRSM4300
  - Bypass System Troubleshooting Guide, TRTS4400
  - Driver Instructions for FTS/FTSO-XX1108LL, TRDR4300
  - Driver Instructions for FTS/FTSO-XX112L, TRDR4400

Note: For more information call Eaton Support 0800 17 05 51 (Valid only in Brazil)

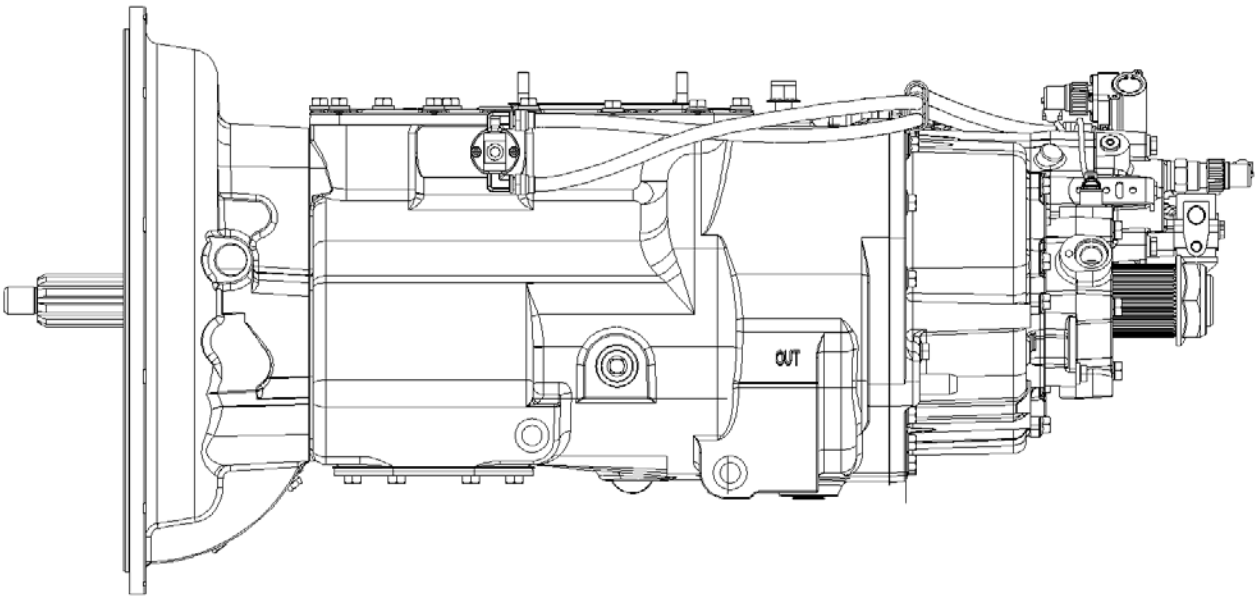
Electro Pneumatic Diagnose Tools

Breakout Box and Harness



Transmission Models Included

FTS-XX108LL



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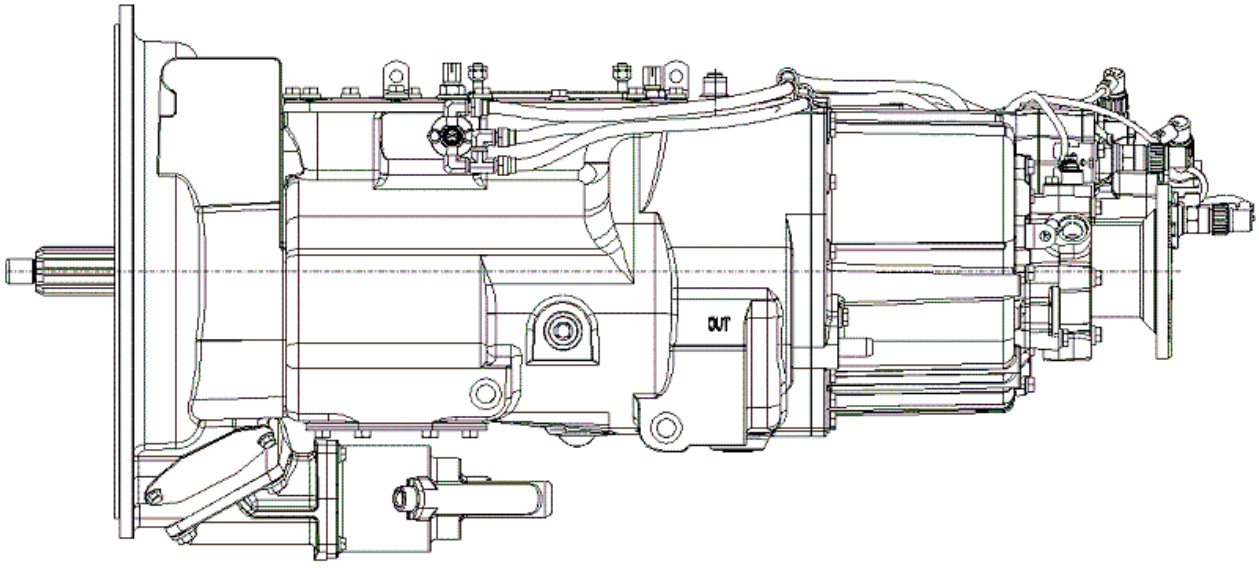


Symptom Based Isolation Procedure / Techniques

Fault Status Retrieval / Clearing

Fault Status Retrieval

- Retrieve Fault status by observing the transmission service lamp
  1. Place shift lever in neutral
  2. Set the parking brake
  3. Turn the ignition key on but do not start the engine. If the engine is already running, you can still retrieve fault status.
  4. To observe fault status locate the transmission service lamp on the vehicle dash area; if the service lamp is flashing consistently (more than 2 flashes) the transmission system has an active fault.

Note: The service lamp merely indicates that there is a fault in the transmission system by flashing consistently; diagnostic process will indicate which component/sub-system has failed.

Note: Under normal conditions at key on the service lamp will flash 2 times indicating that the transmission system is powered up and functioning properly.

Clearing Faults

- Any component or sub-system fault will clear itself when the transmission system powers up if a successful repair of the previous detected fault has been completed.

Symptom-Based Driving Procedure

If Driver Feedback is Available

1. Verify complaint with driver
2. Operate vehicle according to driver specified operation conditions
3. Reproduce symptom
4. Record symptom specifics such as speeds, conditions, and service lamp status
5. If service lamp is not flashing and a symptom is still present refer to specific model service manual for general troubleshooting symptoms and procedures
6. For additional assistance if symptom still present after all troubleshooting procedures have been attempted please contact Eaton Support at 0800 170551

If Driver Feedback is Not Available

1. Operate vehicle to normal operating temperatures
2. Operate vehicle in which several range shifts are attempted in each range selection
3. Reproduce symptom
4. Record symptom specifics such as speeds, conditions, and service lamp status
5. If service lamp is not flashing and a symptom is still present refer to specific model service manual for general troubleshooting symptoms and procedures
6. For additional assistance if symptom still present after all troubleshooting procedures have been attempted please contact Eaton Support at 0800 170551

Sympton Overview

High-Speed Downshift Protection

The Orion control module is equipped with advanced diagnostic features to evaluate the integrity of the system and provide operator feedback of a system fault. In addition, if the fault shall result in a condition that shall compromise the reliability of the transmission or result in a safety risk, the system logic will compensate and default to a safe mode. The diagnostic capability of the control module includes identification of the following component failures. The service light used for identification of a component failure is on for 2 seconds upon vehicle start up to allow for identification of a service light burn-out. The service light will flash for 1 second on and 1 second off for the following failures:

- Speed Sensor Failure
- Range Valve Failure
- Deep Range Valve Failure
- Range Switch Failure
- Deep Range Switch Failure
- Pneumatic Failure (a pneumatic failure resulting in the engagement of the 4th and not-allowed deep range state will result in a high range default and fault identification
- Ignition Failure (the control module will not shut off if the ignition fails while the vehicle is moving).
- Battery Failure (the control module is capable of operating on the ignition power if the battery shall fail while the vehicle is moving).

Prevent Deep / High Selection

The transmission utilizes two range pistons, each with a for/aft position to achieve three range positions. The mechanical design of the actuation and engagement system results in a total of four potential configurations. The fourth position that is not utilized results in an auxiliary ratio of deep range. However, while the transmission power flow achieves the deep ratio, the load and differential speed imparted on the mechanical elements can result in damage to the transmission. To prevent transmission damage and operator confusion, the system is designed to prevent this configuration. This is prevented by a mechanical interlock in the master control valve that prevents selection of this configuration. However, analysis has indicated that there are electrical and pneumatic failure modes that can result in this configuration. The control module is equipped with logic to recognize this and automatically shift the transmission to high range.

Bypass System

If the transmission has a electronic component failure it will go into down shift protection mode. When in down shift protection, the transmission will engage high range at the first opportunity and will keep it in high range until the source of the failure is gone. The by-pass mode was created to allow the vehicle to be driven only in low range if high range is not suitable for conditions. This will allow the vehicle to be driven to a place where the repair can be done. To turn on the by-pass system the driver must stop the vehicle, use the parking brake and turn on the by-pass OEM control (inside the vehicle cabin).

Vehicle Electrical Pretest

Step A

- Key Off
- Remove chassis interface connector (J1) from transmission control module and use a Volt Ohm-Meter to measure resistance between Battery (-) Negative pins 7 and 8 and Negative Battery Post.
  - If battery (-) negative pin 7 and 8 reading is between 0 and 1 ohms, continue to Step B.
  - If the reading is outside of range, repair ground supply according to OEM guidelines. Repeat Step A to verify ground supply.

Step B

- Key On
- From the (J1) connector use a Volt Ohm-Meter to measure voltage between Vehicle Ignition pin 6 and Battery (-) Negative pins 7 and 8.
  - If voltage is between 11 and 13 volts on a 12-volt system, or 22 to 26 on a 24-volt system, continue to Step C.
  - If voltage is outside of range, repair Vehicle Ignition voltage supply according to OEM guidelines. Repeat Step B to verify Ignition voltage supply.

Step C

- Key On
- From the (J1) connector use a Volt Ohm-Meter to measure voltage battery between Battery Positive pin 5 and Battery (-) Negative pins 7 and 8.
  - If voltage is between 11 and 13 volts on a 12-volt system, or 22 and 26 volts on a 24-volt system, test complete.
  - If voltage is outside of range, repair Battery Positive voltage supply according to OEM guidelines. Repeat Step C to verify Battery Positive voltage.

Pneumatic Pretest

Step A

- Ignition Off
- Using a 4-bar minimum pressure gauge, check chassis air pressure going into air / filter regulator.
  - If reading is 8-9 bar, continue to Step B.
  - If the reading is outside of range, repair air pressure according to OEM guidelines. Repeat Step A.

Step B

- Using a 4-bar minimum pressure gauge, check pressure on transmission output side of air / filter regulator.
  - If reading is 7.34 - 7.93 bar continue to symptom based diagnostic isolation procedures section.
  - If reading is outside of range, replace air filter regulator and repeat Step B to verify air pressure reading.

Symptom Based Diagnostic Tests

Precautions

Common Installation Issues

- Master Control Valve lines not attached correctly from the filter regulator to the deep range and range valves.
- Control module software is incorrect. Make sure the control module software has been correctly programmed for the model, speed sensor rotor (8-16 tooth), and vehicle electrical system (12 or 24 VDC).
- Vehicle electrical power supply is not connected properly.

⚠ CAUTION

Other components/causes associated with a range system failure but not covered in the troubleshooting procedures.

Range Cylinder

- Debris or contamination in the cylinder
- Range cover (air leak)

Internal components linked with range shift issues - auxiliary section of Service Manual

First Step

Procedure 1 (Checking the Condition of the System)

1. Overall system review, checking for loose or damaged wires or connectors.
2. Turn off the vehicle and keep the key in the 'OFF' position.
3. Check if the bypass OEM control is turned off, inside the vehicle. Location of OEM bypass control will vary. Please contact OEM for location.
4. Unplug the negative plug from battery.
5. Unplug all connectors from TCM and transmission.
6. Clean all components and harness connections and terminals with contact cleaner.
7. It is recommended to apply Nyogel 760 on female terminal. Be sure that the product be applied inside the terminal and the excess removed.
8. Connect all connectors.
9. Reconnect the battery.
10. Check if the light is blinking; if yes proceed to test procedures.

Note: Nyogel is an electricity conductor gel, must be applied with care to not cause short circuit between the terminals.

System Not Able to Default to Low Range with Flashing Service Lamp

(Bypass System Not Functioning)

Step A

- Perform Electrical Pretest.

Step B

- Perform Pneumatic Pretest.

Step C

- Bypass System Check
  1. After removing the airline, actuate the OEM supplied control that allows the driver to switch default from high to low range and check for airflow.
     - If air is present, proceed to the Range Solenoid Valve Test in the "Component Test Procedures" Section.
     - If no air is present, contact the OEM for troubleshooting procedures.

Note: For the FTS-XX112L model transmissions, the bypass valves are hooked together in series from the OEM control.

Service Lamp Does Not Turn on During Power Up

Procedure 1

1. Follow Procedure 2 below to connect the breakout box and the harness;
2. Unplug a connector from any valve, if both the vehicle service lamp and the breakout box lamp start to blink it is operating properly, plug the valve connector back.
3. If only the breakout box blinks, check the vehicle service lamp and its connection/harness
4. If only the vehicle service lamp blinks check the breakout box and the harness.
5. If none of the lamps blinks replace the TCM.

Procedure 2

1. Unplug the negative plug from battery.
2. Turn off the vehicle keep the key on position 'OFF.'
3. Unplug the connector P1 and J1 from TCM.
4. Plug P1 and J1 on P1B and J1B.
5. Plug P1A and J1A on ECU.
6. Plug the connector DB62 at the breakout box.
7. Reconnect the battery.
8. Put the vehicle key at the "On" position, but don't start the engine.
9. Follow Procedure 1 Steps 2-5.

FTS-XX108LL Symptom Diagnostic Table

Before start:

1. Check if the By-pass is off.
2. Check if the air supply is dry and clean.
3. Check if there is air leakage on pneumatic system, like lose nipples, damaged hoses, etc.
4. Check if the vehicle has 8.0 bar or more.
5. Set the key at the on position, don't start the engine.

⚠ IMPORTANT

All range shifts happen during the neutral position, so perform all tests with the lever in Neutral position.

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Low range doesn't work	**Pilot air line**	• Remove the air line P at range valve • Select low range at the knob	There is air supply	None
			There isn't air supply	• Check if there is air leakage through P air line • Check if the knob is supplying air to air line P. If not, replace the knob.
		• Remove the air line P at range valve • Select high range at the knob	There is air supply	None
			There isn't air supply	• Check if P has been replaced by SP • Check if the knob is supplying air in high range. If yes, replace the knob.

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Low range doesn't work	**Master control valve (knob)**	Remove the air line H/L at master control valve	There is air supply	None
			There isn't air supply	• Check if the air supply is correctly assembled • Check if H/L from filter regulator is connected in H/L in master control valve • Check the hoses
		• Remove the air line P at master control valve • Select low range at master control valve	There is air supply	None
			There isn't air supply	• Check if the air supply is correctly assembled • Check the hoses, if they are ok and there is no air flow replace the master control valve

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Deep range doesn't work	**Pilot air line**	• Remove the air line SP at range valve • Select deep range at the knob	There is air supply	None
			There isn't air supply	• Check if there is air leakage through SP air line • Check if the knob is supplying air to air line SP. If not, replace the knob.
		• Remove the air line SP at range valve • Turn off the deep range	There is air supply	None
			There isn't air supply	• Check if SP has been replaced by P • Check if the knob is supplying air in deep range. If yes, replace the knob.

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Deep range doesn't work	**Master control valve (knob)**	Remove the air line S at master control valve	There is air supply	None
			There isn't air supply	• Check if the air supply is correctly assembled • Check if S from filter regulator is connected in S in master control valve • Check the hoses
		• Remove the air line SP at master control valve • Select low-low at master control valve	There is air supply	None
			There isn't air supply	• Check if the air supply is correctly assembled • Check the hoses, if they are ok and there is no air flow replace the master control valve

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Shifting low range / low-low is slow or doesn't work	**Air filter / regulator**	• Assemble the manometer in the output at the air filter • Measure the output pressure	< 7,3 bar (7,56 bar is the work pressure)	• Assemble the manometer at the air filter input air. • Measure the input pressure. • If it is the same value check the vehicle air supply • If the value is higher than the on the output replace the air filter / regulator.
			= 7,56 bar (work pressure)	• Check the exhaust valve (next item)

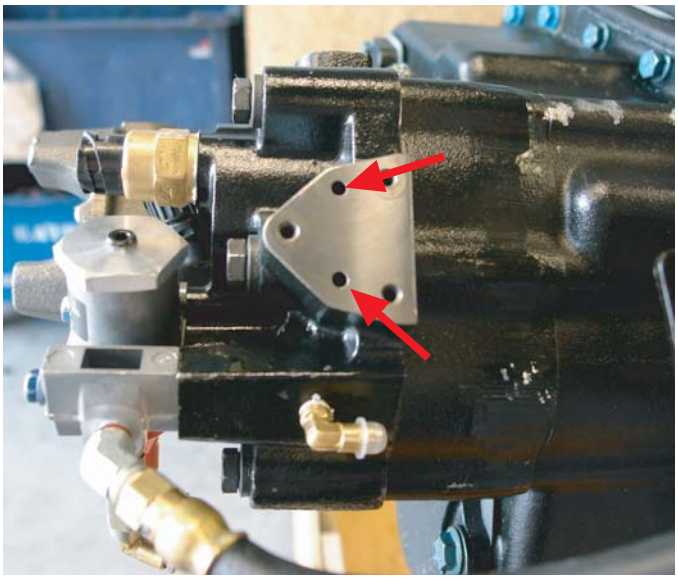
SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Shifting low range / low-low is slow or doesn't work	**Exhaust valve**	• Assemble the manometer in the output at the exhaust valve. • Measure the output pressure.	• On neutral minimum of 7,5 bar • In any shift position 0 bar	• If it correct the exhaust valve is OK • Check range valve (next item).
				• If it is not correct. • Disassemble the exhaust valve and check if the spring is in the correct position, according to the picture (end of this section). • If not, correct the spring. • If the assembly is correct and the measures are out of specification, replace the exhaust valve.
	Range valve	• If everything is OK during air filter and exhaust valve tests. • Disassemble the range valve and inject air at 8 bar in the low / high hole (see picture in the end of this section).	If low and high range work correctly.	Replace the range valve
			If low and high range doesn't work correctly.	Check the transmission (next item)
	Insert valve (Emboloplunger)	Remove the air supply SP - low-low (see picture in the end of this section) and select low-low at the knob (be sure to fasten the hose to avoid accidents)	There is air supply	None. Go to next step.
			There isn't air supply	Check if the air supply is correctly assembled or if there is leakage at the hoses.
		Connect the air supply SP	Correct low-low shift	None
		Remover the filter regulator and inject 8 bar in the low-low holes (see picture in the end of this section	Incorrect low-low shift	Remove the insert valve and check if there is water or other contamination, clean the parts and replace the insert valve
	Transmission	Disassemble and check general condition of the following components: cylinders, pistons, o'rings and gaskets.	Humidity, rust, wearing, contamination or damaged o'rings.	Replace damaged components.

Obs1: Under pressures lower than de 6.0 bar the system doesn't work. Low performance between 6.0 e 7.0 bar. Higher than de 7.0 bar normal.

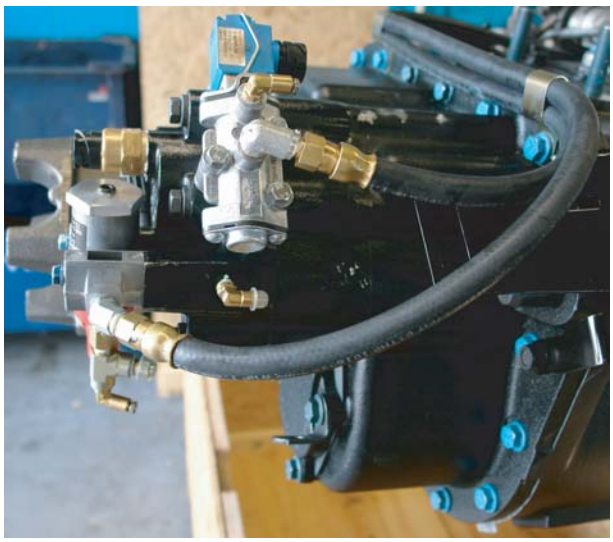
Obs2: If any solid contamination is found replace the air filter / regulator.

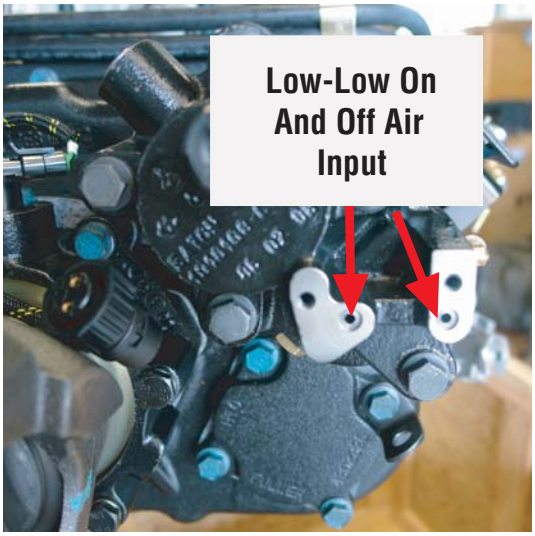
Obs3: Pictures of Exhaust Valve assembly

Correct Pin and Spring Assembling at Exhaust Valve

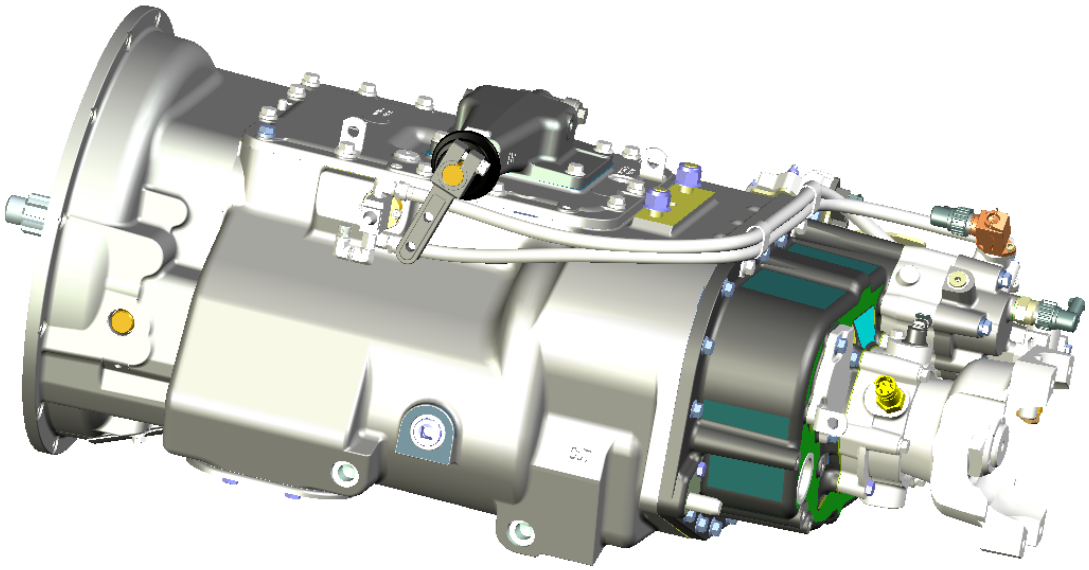


Low and High Range Air Input





Low-Low On and Off Air Input



Low and High Range and Low-Low Air Input

FTS-XX112L Symptom Diagnostic Table

Before start:

- Check if the By-pass is off (optional, depending on the OEM).
- Check if the air supply is dry and clean.
- Check if there is air leakage on pneumatic system, like lose nipples, damaged hoses, etc.
- Check if the vehicle has 8.0 bar or more.
- Set the key at the on position, don't start the engine.

⚠ IMPORTANT

All range shifts happen during the neutral position, so perform all tests with the lever in Neutral position.

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Low range doesn't work	**Pilot air line**	• Remove the air line P at range valve • Select low range at the knob	There is air supply	None
			There isn't air supply	• Check if there is air leakage through P air line • Check if the knob is supplying air to air line P. If not, replace the knob.
		• Remove the air line P at range valve • Select high range at the knob	There is air supply	None
			There isn't air supply	• Check if P has been replaced by SP • Check if the knob is supplying air in high range. If yes, replace the knob.

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Low range doesn't work	**Master control valve (knob)**	Remove the air supply H/L in master control valve	There is air supply	None
			There isn't air supply	• Check if the air supply is correctly assembled • Check if H/L from filter regulator is connected in H/L in master control valve • Check the hoses
		• Remove the air supply P at the master control valve • Select low range	There is air supply	None
			There isn't air supply	• Check if the air supply is correctly assembled • Check the hoses, if they are ok and there is no air flow replace the master control valve

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Deep range doesn't work	**Pilot air line**	• Remove the air line SP at range valve • Select deep range at the knob	There is air supply	None
			There isn't air supply	• Check if there is air leakage through SP air line • Check if the knob is supplying air to air line SP. If not, replace the knob.
		• Remove the air line SP at range valve • Turn off the deep range	There is air supply	None
			There isn't air supply	• Check if SP has been replaced by P • Check if the knob is supplying air in deep range. If yes, replace the knob.

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Deep range doesn't work	**Master control valve (knob)**	Remove the air supply S in master control valve	There is air supply	None
			There isn't air supply	• Check if the air supply is correctly assembled • Check if S from filter regulator is connected in S in master control valve • Check the hoses
		• Remove the air supply SP at the master control valve • Select deep range	There is air supply	None
			There isn't air supply	• Check if the air supply is correctly assembled • Check the hoses, if they are ok and there is no air flow replace the master control valve

SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Shifting low range / deep range is slow or doesn't work	**Air filter / regulator**	• Assemble the manometer in the output at the air filter • Measure the output pressure	< 7,3 bar (7,56 bar is the work pressure)	• Assemble the manometer at the air filter input air. • Measure the input pressure. • If it is the same value check the vehicle air supply • If the value is higher than on the output replace the air filter / regulator.
			= 7,56 bar (work pressure)	• Check the exhaust valve (next item)

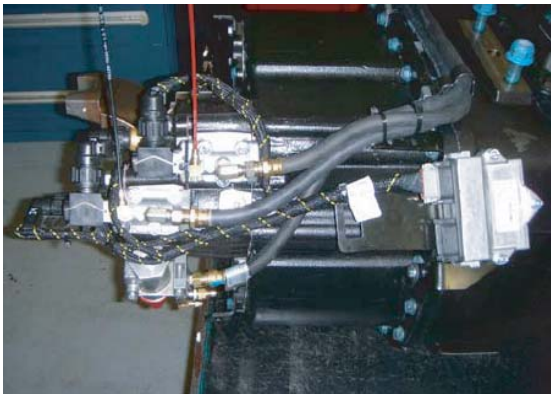
SYMPTOM	COMPONENT	PROCEDURE	OUTPUT	ACTION
Shifting low range / deep range is slow or doesn't work	**Exhaust valve**	• Assemble the manometer in the output at the exhaust valve. • Measure the output pressure.	• On neutral minimum of 7,5 bar • In any shift position 0 bar	• If it correct the exhaust valve is OK • Check range valve (next item).
				• If it is not correct. disassemble the exhaust valve and check if the spring is in the correct position, according to the picture (end of this section). • If not, correct the spring. • If the assembly is correct and the measures are out of specification, replace the exhaust valve.
	Deep and Range valve	• If everything is OK during air filter and exhaust valve tests. • Disassemble the valve and inject air at 8 bar in the low / high hole (see picture in the end of this section).	If low and high range work correctly.	Replace the range valve
			If low and high range doesn't work correctly.	Check the transmission (next item)
	Transmission	Disassemble and check general condition of the following components: cylinders, pistons, o'rings and gaskets.	Humidity, rust, wearing, contamination or damaged o'rings.	Replace damaged components.

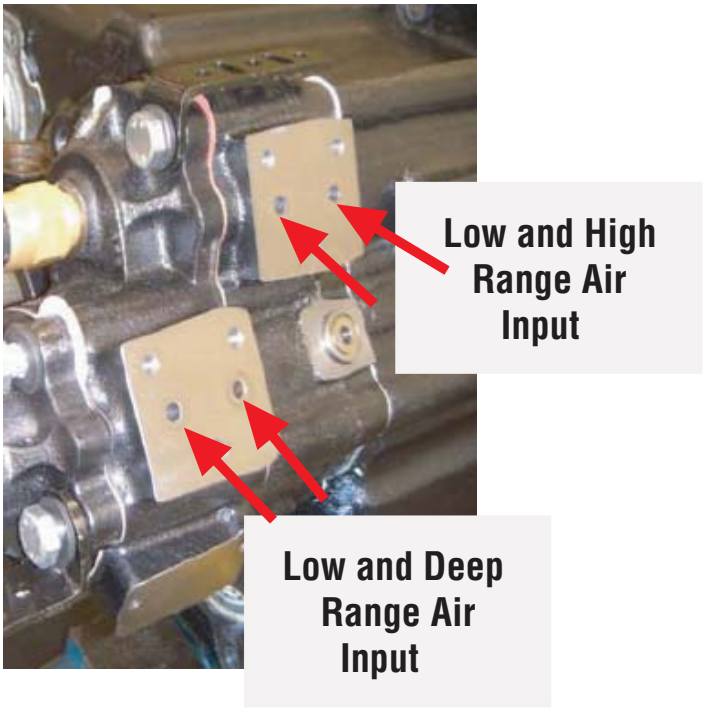
Obs1: Under pressures lower than de 6.0 bar the system doesn't work. Low performance between 6.0 e 7.0 bar. Higher than de 7.0 bar normal.

Obs2: If in any check solid contamination found replace the air filter / regulator.

Obs3: Pictures of Exhaust Valve assembly

Correct Pin and Spring Assembling at Exhaust Valve





Component Based Diagnostic Procedures

First Step

Procedure 1 - Checking the Condition of the System

1. Overall system review, checking for loose or damaged wires or connectors.
2. Turn off the vehicle and keep the key in the 'OFF' position.
3. Check if the bypass OEM control is turned off, inside the vehicle. Location of OEM bypass control will vary. Please contact OEM for location.
4. Unplug the negative plug from battery.
5. Unplug all connectors form TCM and transmission.
6. Clean all components and harness connections and terminals with contact cleaner.
7. It is recommended to apply Nyogel 760 on female terminal. Be sure that the product be applied inside the terminal and the excess removed.
8. Connect all connectors.
9. Reconnect the battery.
10. Check if the light is blinking; if yes proceed to procedure 2 below.

Note: Nyogel is an electricity conductor gel, must be applied with care to not cause short circuit between the terminals.

Procedure 2

1. Unplug the negative cable from battery.
2. Turn off the vehicle and keep the key in the 'OFF' position.
3. Unplug the connector P1 and J1 from TCM.
4. Plug P1 and J1 on P1B and J1B.
5. Plug P1A and J1A on TCM.
6. Plug the connector DB62 at the break out box.
7. Reconnect the battery.
8. Put the vehicle key at the "On" position, but don't start the engine.

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COMPONENT	PROCEDURE	OUTPUT	ACTION
ECU	• Follow Procedure 02 • Select Neutral and start the engine. • Measure between the terminals C - D and E - F with a multimeter on Vdc position and the + side on terminals D e F.	23 a 26 Vdc	If the output is out of the specification, check the TCM fuses, cable continuity and ground, battery voltage, generator voltage.
	After all next checks (until the end of this table).	Panel light is still blinking.	Replace the TCM

COMPONENT	PROCEDURE	OUTPUT	ACTION
Range Valve	• Follow Procedure 02 • Measure between the terminals 5 - 8 with a multimeter on Vdc position and the + side on terminals 8.	11 a 14 Vdc	• Replace the J5 by the J8 from the harness and measure again. • If the same output than before replace the range valve. • If the output between 22 and 26 V, replace the transmission harness.
		0 Vdc	• Replace the J5 by the J8 from the harness and measure again. • If the same output than before replace the range valve. • If the output between 22 and 26 V, replace the transmission harness.

COMPONENT	PROCEDURE	OUTPUT	ACTION
Transmission Speed Sensor	• Follow Procedure 02 • Put the ignition key at the "off" position. • Measure between the terminals 1 - 12 with a multimeter on Ohm position	600 a 800 Ohms @ 20ºC	• If the output is out of specification replace J2 the J2 from the harness. • If same output replace the transmission speed sensor. • If the output is OK, replace the transmission harness.
	• Follow Procedure 02 • Disassemble the propeller shaft from the transmission. • Engage the 4th gear a keep the engine on 1250 rpm. • Increase the engine rotation to 2000 rpm. • Measure between the terminals 1 - 12 with the multimeter on Hz position in both rpm's	• Engine at 1250 rpm - Output: 540 a 580 Hz • Engine at 2000 rpm - Output: 850 a 950 Hz	• If the output is out of specification replace J2 the J2 from the harness. • If same output replace the transmission speed sensor. • If the output is OK, replace the transmission harness

COMPONENT	PROCEDURE	OUTPUT	ACTION
Range Switch	• Follow Procedure 02 • Engage high range. • Measure between the terminals 2 - 11 with the multimeter on Vac position	3,0 a 4,5 Vac	• If the output is out of specification replace J3 the J3 from the harness. • If same output replace the range switch. • If the output is OK, replace the transmission harness.
	• Follow Procedure 02 • Engage low range. • Measure between the terminals 2 - 11 with the multimeter on Vac position	0 a 0,010 Vac	• If the output is out of specification replace J3 the J3 from the harness. • If same output replace the range switch. • If the output is OK, replace the transmission harness.

Obs: 1

- **Unplug the TCM before electrical welding service in any part of the vehicle.**
- The connectors P1, J1, P1A, J1A, P1B e J1B require maximum care when plugging or unplugging them from TCM and harness.
- The range and deep valves bobbin have a resistance between 213 and 235 Ohms @ 20ºC
- The breakout box warning lamp has the same behavior of the cabin warning lamp (it lights for 2 seconds when the key is "on" position and flash when the transmission is in downshift protection).

FTS-XX112L

COMPONENT	PROCEDURE	OUTPUT	ACTION
ECU	• Follow Procedure 02 • Select Neutral and start the engine. • Measure between the terminals C - D and E - F with a multimeter on Vdc position and the + side on terminals D e F.	23 a 26 Vdc	If the output is out of the specification, check the TCM fuses, cable continuity and ground, battery voltage, generator voltage.
	After all next checks (until the end of this table).	Panel light is still blinking.	Replace the TCM

COMPONENT	PROCEDURE	OUTPUT	ACTION
Range Valve	• Follow Procedure 02 • Measure between the terminals 5 - 8 with a multimeter on Vdc position and the + side on terminals 8.	11 a 14 Vdc	• Replace the J5 by the J8 from the harness and measure again. • If the same output than before replace the range valve. • If the output between 22 and 26 V, replace the transmission harness.
		0 Vdc	• Replace the J5 by the J8 from the harness and measure again. • If the same output than before replace the range valve. • If the output between 22 and 26 V, replace the transmission harness.

COMPONENT	PROCEDURE	OUTPUT	ACTION
Deep Range Valve	• Follow Procedure 02 • Measure between the terminals 6 - 7 with a multimeter on Vdc position and the + side on terminals 7.	11 a 14 Vdc	• Replace the J6 by the J6 from the harness and measure again. • If the same output than before replace the deep range valve. • If the output between 22 and 26 V, replace the transmission harness.
		0 Vdc	• Replace the J6 by the J6 from the harness and measure again. • If the same output than before replace the deep range valve. • If the output between 22 and 26 V, replace the transmission harness.

COMPONENT	PROCEDURE	OUTPUT	ACTION
Transmission Speed Sensor	• Follow Procedure 02 • Put the ignition key at the "off" position. • Measure between the terminals 1 - 12 with a multimeter on Ohm position	600 a 800 Ohms @ 20ºC	• If the output is out of specification replace J2 the J2 from the harness. • If same output replace the transmission speed sensor. • If the output is OK, replace the transmission harness.
	• Follow Procedure 02 • Disassemble the propeller shaft from the transmission. • Engage the 4th gear a keep the engine on 1250 rpm. • Increase the engine rotation to 2000 rpm. • Measure between the terminals 1 - 12 with the multimeter on Hz position in both rpm's	• Engine at 1250 rpm - Output: 540 a 580 Hz • Engine at 2000 rpm - Output: 850 a 950 Hz	• If the output is out of specification replace J2 the J2 from the harness. • If same output replace the transmission speed sensor. • If the output is OK, replace the transmission harness

COMPONENT	PROCEDURE	OUTPUT	ACTION
Range Switch	• Follow Procedure 02 • Engage high range. • Measure between the terminals 2 - 11 with the multimeter on Vac position	3,0 a 4,5 Vac	• If the output is out of specification replace J3 the J3 from the harness. • If same output replace the range switch. • If the output is OK, replace the transmission harness.
	• Follow Procedure 02 • Engage low range. • Measure between the terminals 2 - 11 with the multimeter on Vac position	0 a 0,010 Vac	• If the output is out of specification replace J3 the J3 from the harness. • If same output replace the range switch. • If the output is OK, replace the transmission harness.

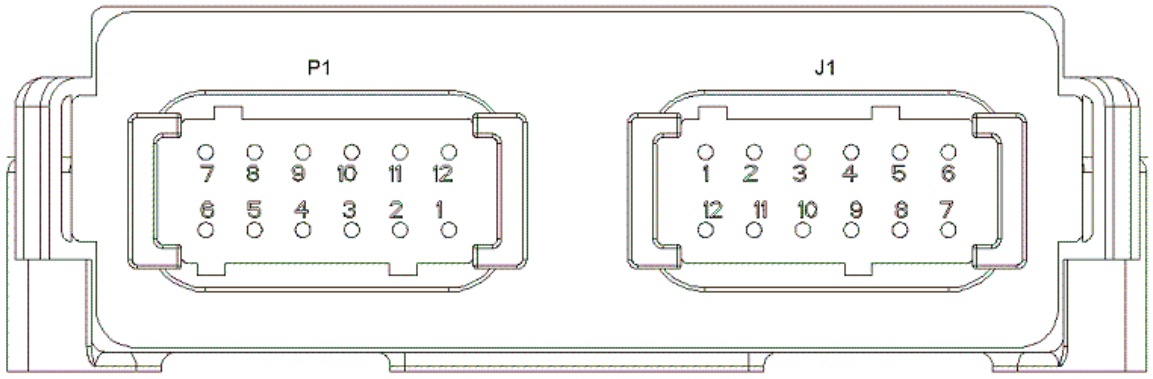
COMPONENT	PROCEDURE	OUTPUT	ACTION
Deep Switch	• Follow Procedure 02 • Engage low range. • Measure between the terminals 3 - 10 with the multimeter on Vac position	3,0 a 4,5 Vac	• If the output is out of specification replace J4 the J7 from the harness. • If same output replace the deep switch. • If the output is OK, replace the transmission harness.
	• Follow Procedure 02 • Engage low range. • Measure between the terminals 3 - 10 with the multimeter on Vac position	0 a 0,010 Vac	• If the output is out of specification replace J4 the J7 from the harness. • If same output replace the range switch. • If the output is OK, replace the transmission harness.

Obs: 1

- **Unplug the TCM before electrical welding service in any part of the vehicle.**
- The connectors P1, J1, P1A, J1A, P1B e J1B require maximum care when plugging or unplugging them from TCM and harness.
- The range and deep valves bobbin have a resistance between 213 and 235 Ohms @ 20ºC
- The breakout box warning lamp has the same behavior of the cabin warning lamp (it lights for 2 seconds when the key is "on" position and flash when the transmission is in downshift protection).

Appendix

Connector Pin Descriptions



Note: Connector diagram applies for both models.

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FROM CONNECTOR	PIN	TO CONNECTOR	PIN	WIRE GAUGE	WIRE TYPE	LABEL
P1	1	J2	B	16	GXL	OUTPUT SPEED LOW
P1	12	J2	A	16	GXL	OUTPUT SPEED HIGH
P1	2	J3	2	16	GXL	RANGE SWITCH NEG
P1	11	J3	1	16	GXL	RANGE SWITCH POS
P1	5	J4	2	16	GXL	RANGE NEG
P1	8	J4	1	16	GXL	RANGE POS

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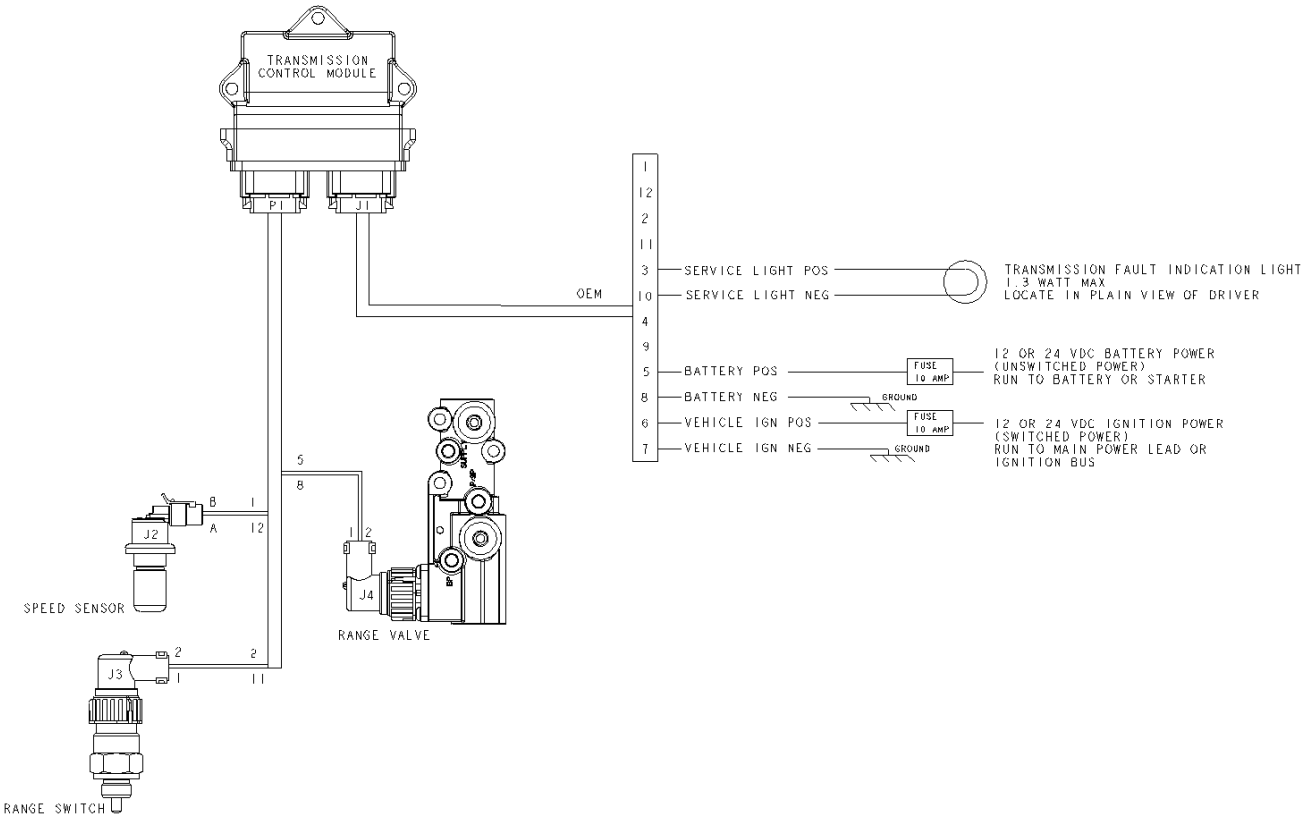
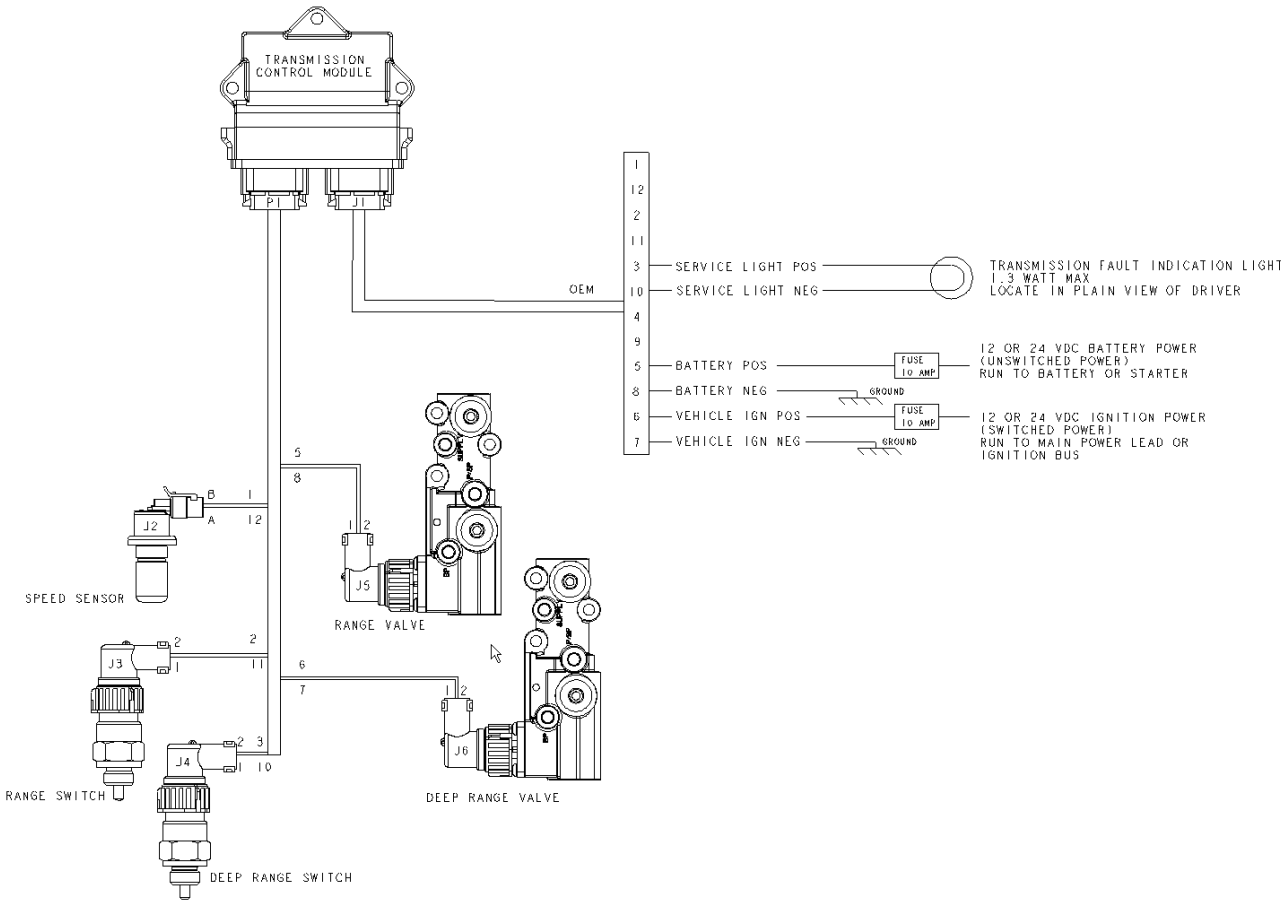
FROM CONNECTOR	PIN	TO CONNECTOR	PIN	WIRE GAUGE	WIRE TYPE	LABEL
P1	1	J2	B	16	GXL	OUTPUT SPEED LOW
P1	12	J2	A	16	GXL	OUTPUT SPEED HIGH
P1	2	J3	2	16	GXL	RANGE SWITCH NEG
P1	11	J3	1	16	GXL	RANGE SWITCH POS
P1	3	J4	2	16	GXL	DEEP SWITCH NEG
P1	10	J4	1	16	GXL	DEEP SWITCH POS
P1	5	J5	2	16	GXL	RANGE NEG
P1	8	J5	1	16	GXL	RANGE POS
P1	6	J6	2	16	GXL	DEEP RANGE NEG
P1	7	J6	1	16	GXL	DEEP RANGE POS

Wiring Diagrams for All Models

FTS-XX108LL

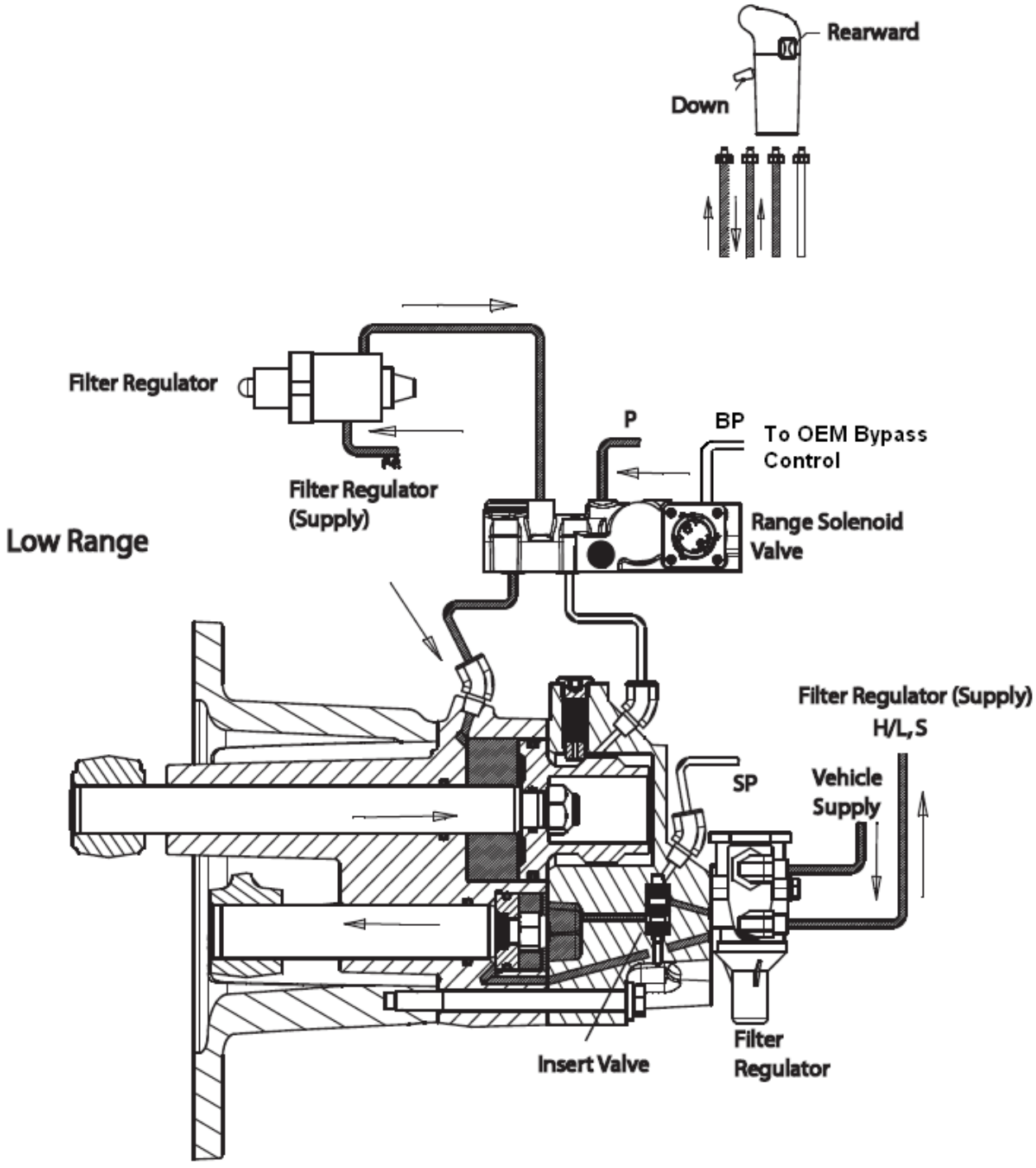


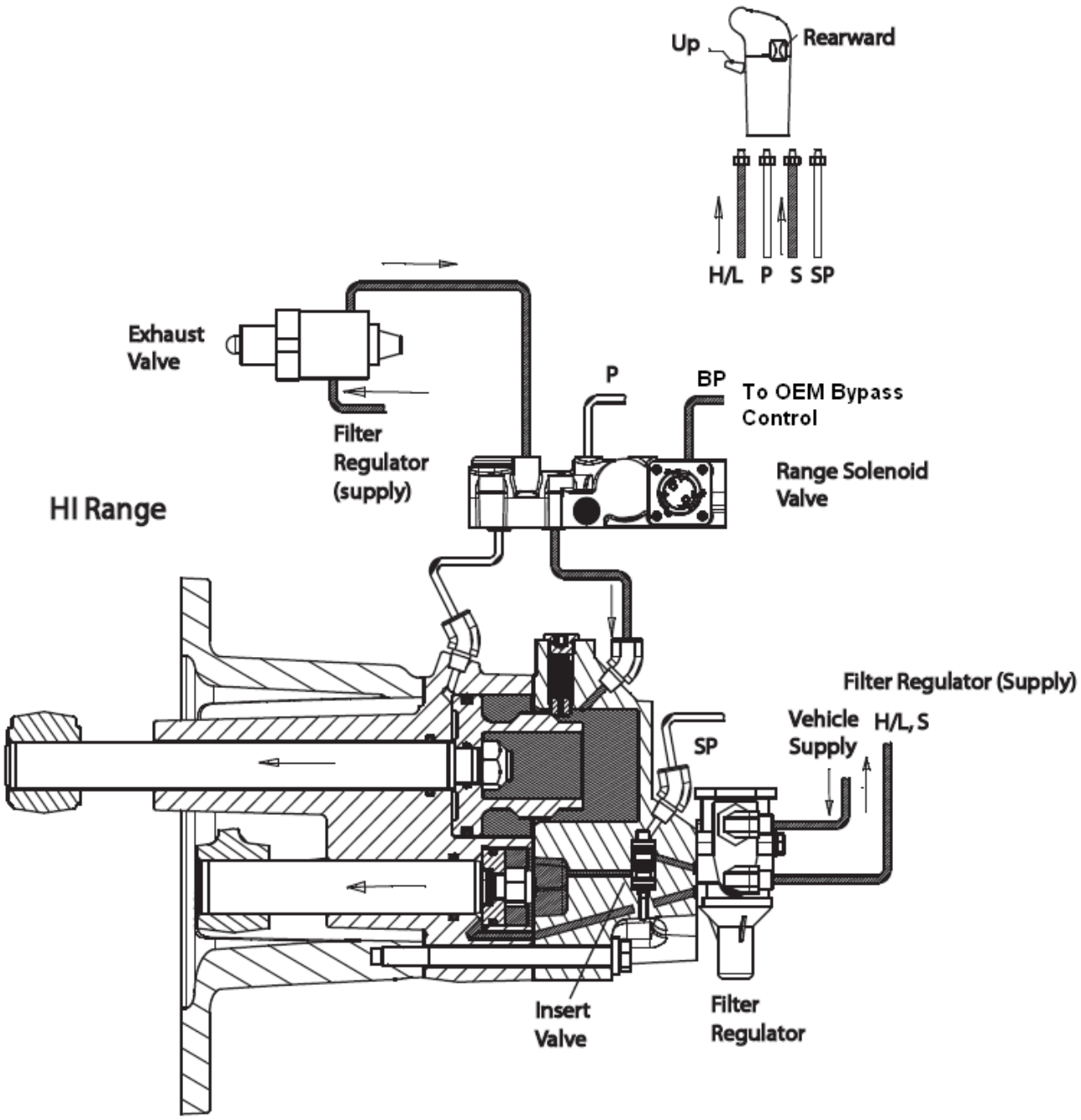
FTS-XX112L

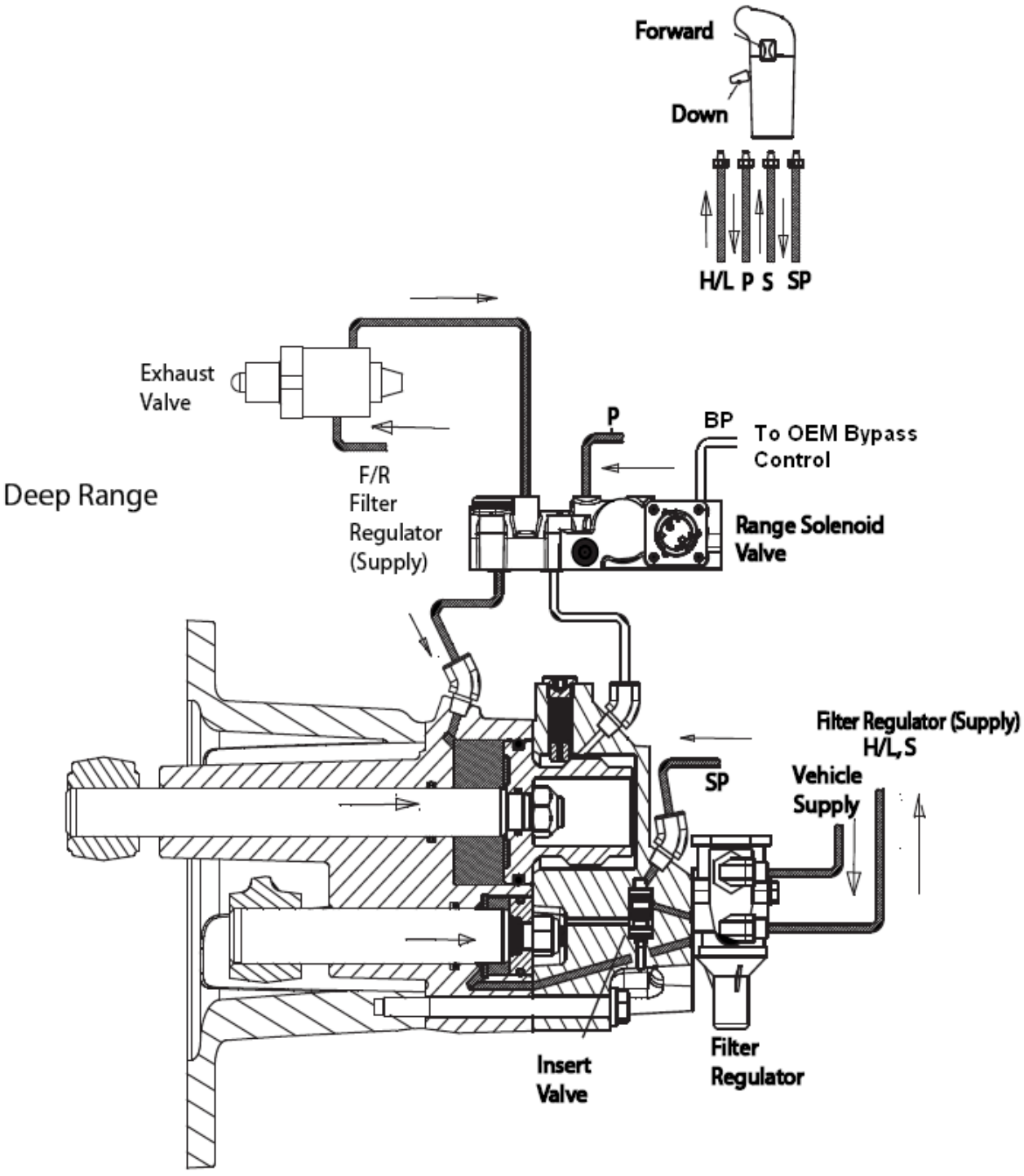

TRANSMISSION CONTROL MODULE
P1
J1
OEM
SERVICE LIGHT POS
SERVICE LIGHT NEG
TRANSMISSION FAULT INDICATION LIGHT
1.3 WATT MAX
LOCATE IN PLAIN VIEW OF DRIVER
BATTERY POS
BATTERY NEG
VEHICLE IGN POS
VEHICLE IGN NEG
FUSE 10 AMP
GROUND
12 OR 24 VDC BATTERY POWER
(UNSWITCHED POWER)
RUN TO BATTERY OR STARTER
12 OR 24 VDC IGNITION POWER
(SWITCHED POWER)
RUN TO MAIN POWER LEAD OR
IGNITION BUS
J2
SPEED SENSOR
J5
RANGE VALVE
J3
RANGE SWITCH
J4
DEEP RANGE SWITCH
J6
DEEP RANGE VALVE

Air System Overview

FTS-XX108LL




Up
Rearward
H/L P S SP
Exhaust Valve
Filter Regulator (supply)
P
BP
To OEM Bypass Control
Range Solenoid Valve
HI Range
Filter Regulator (Supply)
Vehicle Supply
H/L, S
SP
Insert Valve
Filter Regulator


Forward
Down
H/L P S SP
Exhaust Valve
F/R Filter Regulator (Supply)
P
BP
To OEM Bypass Control
Range Solenoid Valve
Deep Range
Filter Regulator (Supply) H/L, S
SP
Vehicle Supply
Insert Valve
Filter Regulator

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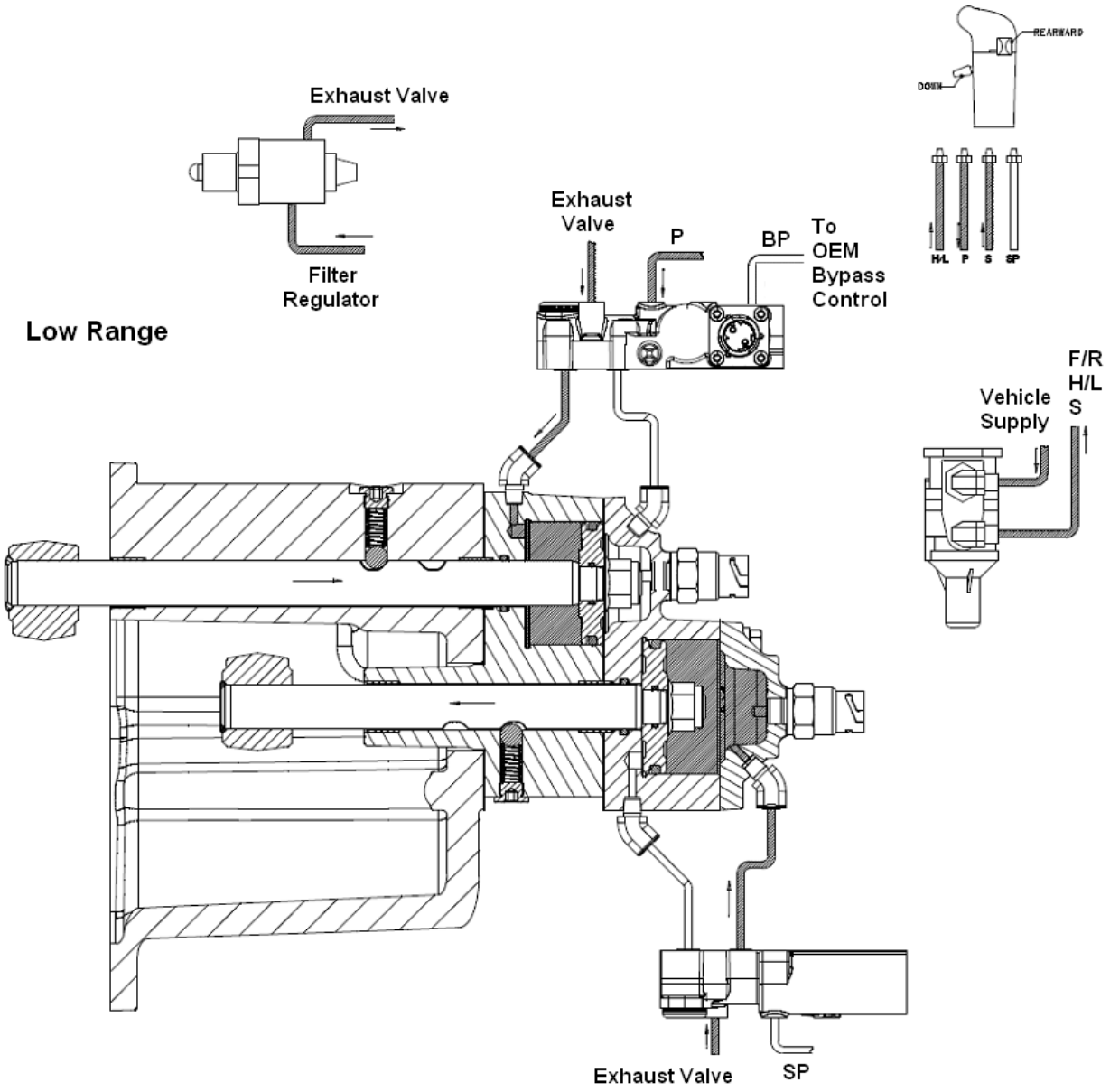
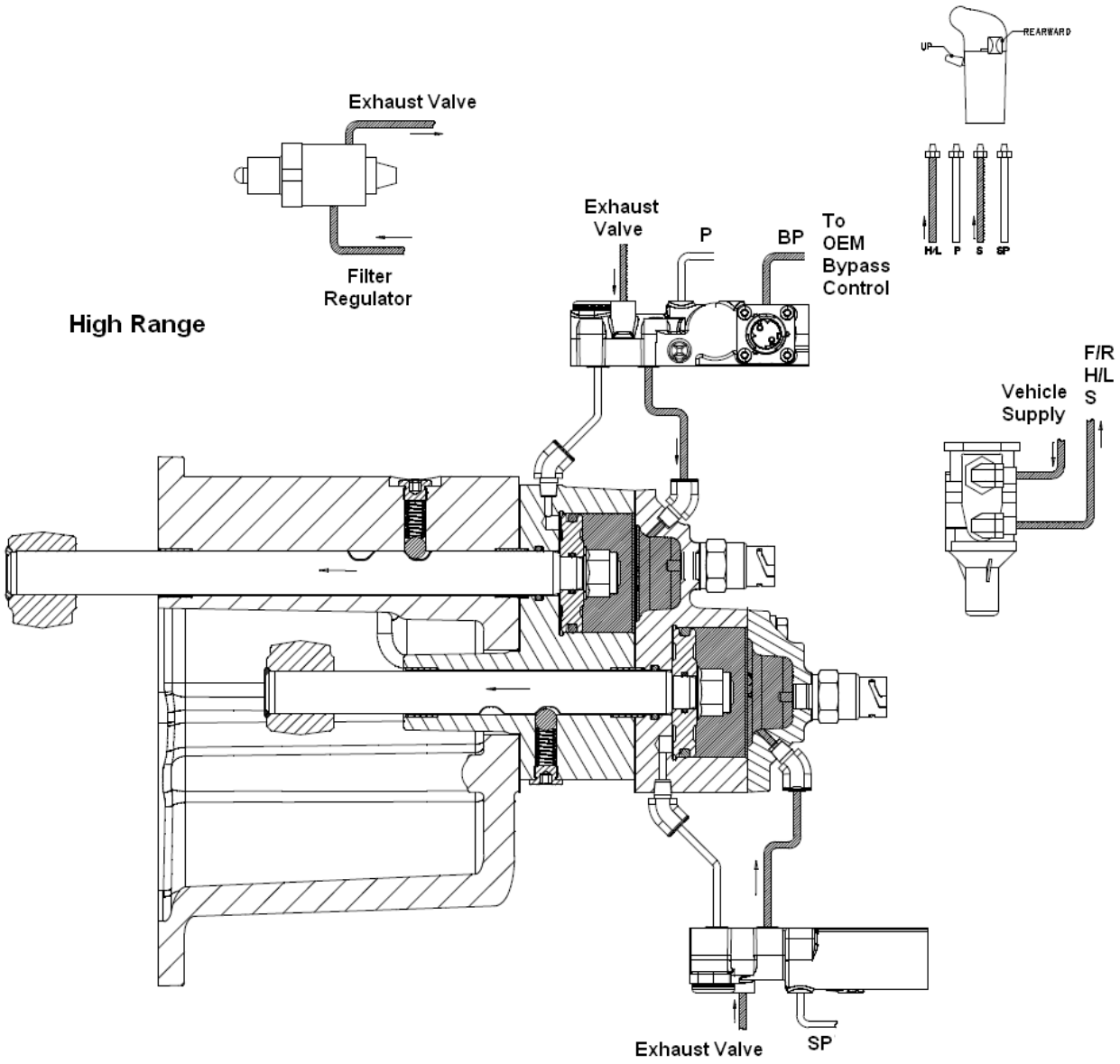
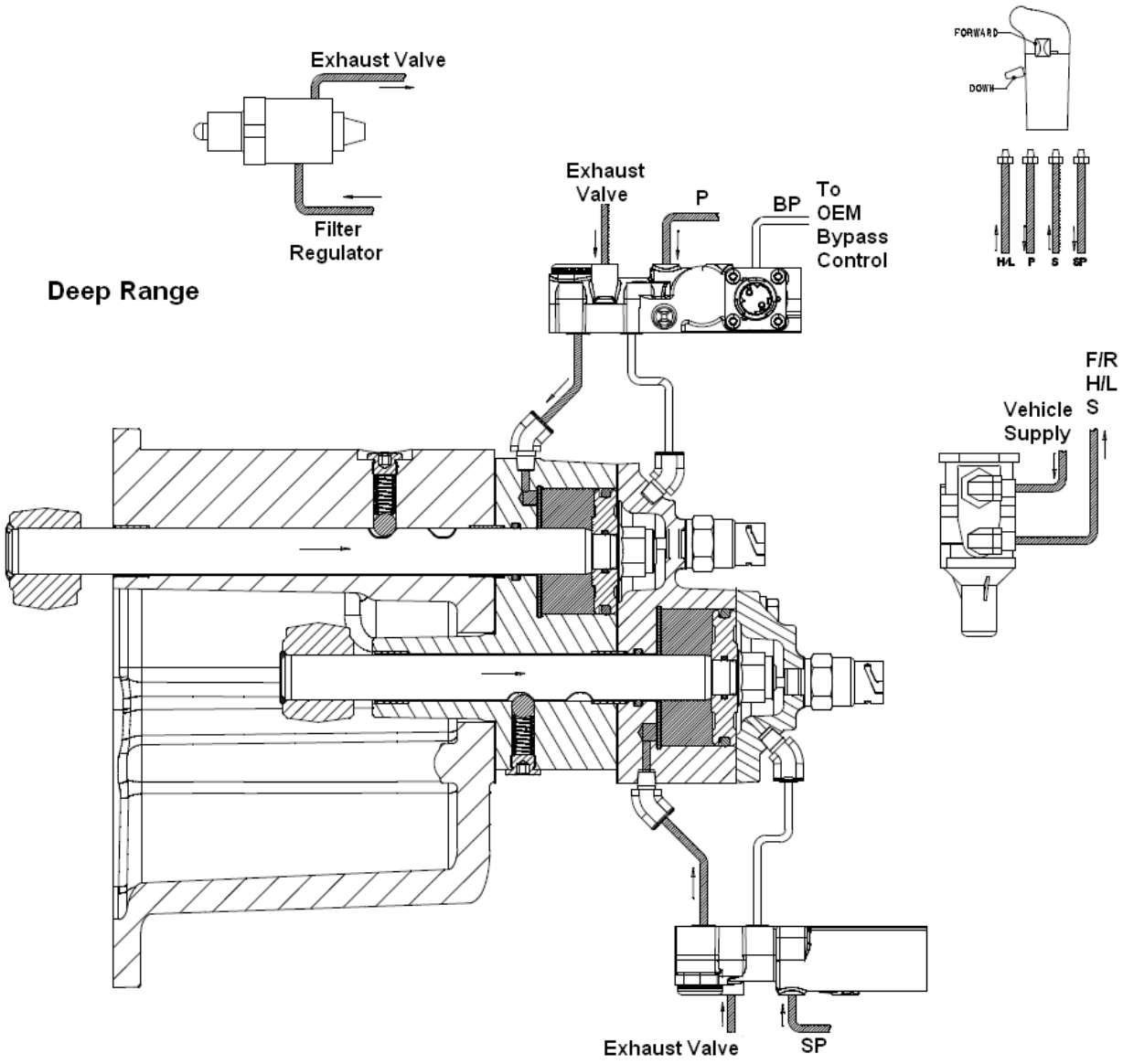
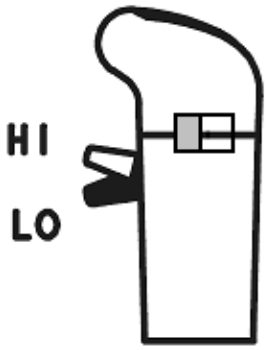

REARWARD
DOWN
H/L
P
S
SP
Exhaust Valve
Filter
Regulator
Exhaust
Valve
P
BP
To
OEM
Bypass
Control
Low Range
F/R
H/L
S
Vehicle
Supply
Exhaust Valve
SP


Exhaust Valve
Filter
Regulator
High Range
Exhaust
Valve
P
BP
To
OEM
Bypass
Control
UP
REARWARD
H/L
P
S
SP
F/R
H/L
S
Vehicle
Supply
Exhaust Valve
SP


Exhaust Valve
Filter
Regulator
Deep Range
Exhaust
Valve
P
BP
To
OEM
Bypass
Control
FORWARD
DOWN
H/L
P
S
SP
F/R
H/L
S
Vehicle
Supply
Exhaust Valve
SP

Master Control Valve Configurations

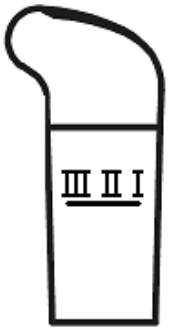
Eaton Roadranger Valve with Range Selection and Blue Reduction Button



- Reduction button rearward = Deep reduction
- Reduction button forward = Low reduction

Air Hose Hook-Ups

- S port = constant air supply
- HL port = constant air supply
- P port = range valve
- SP port = deep range



3-Position Control Valve

- Position 1 = Deep reduction
- Position 2 = High range
- Position 3 = Low range

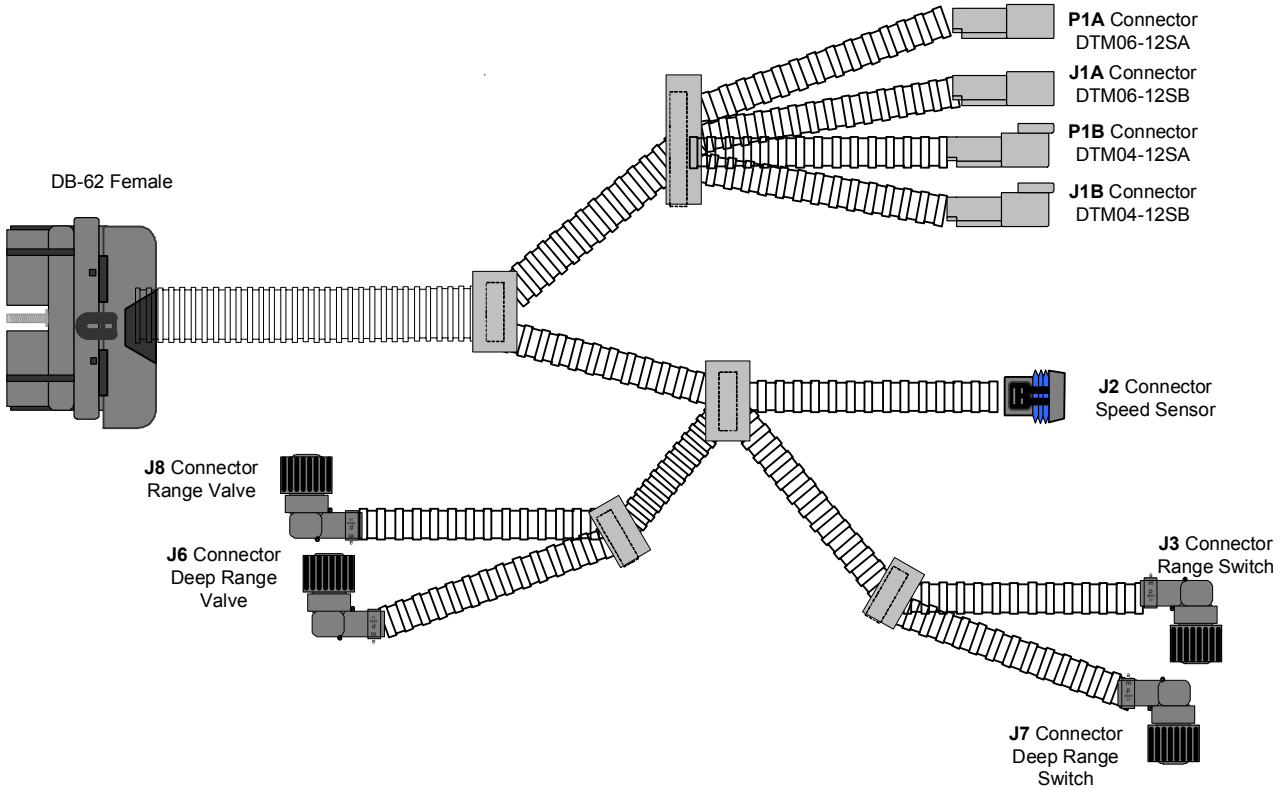
Air Hose Hook-Ups

- 1 = Supply line
- 3 = Exhaust line
- 21 = Deep pilot
- 22 = Range pilot
- 23 = Plug

Eaton Test Tool (Breakout Box)

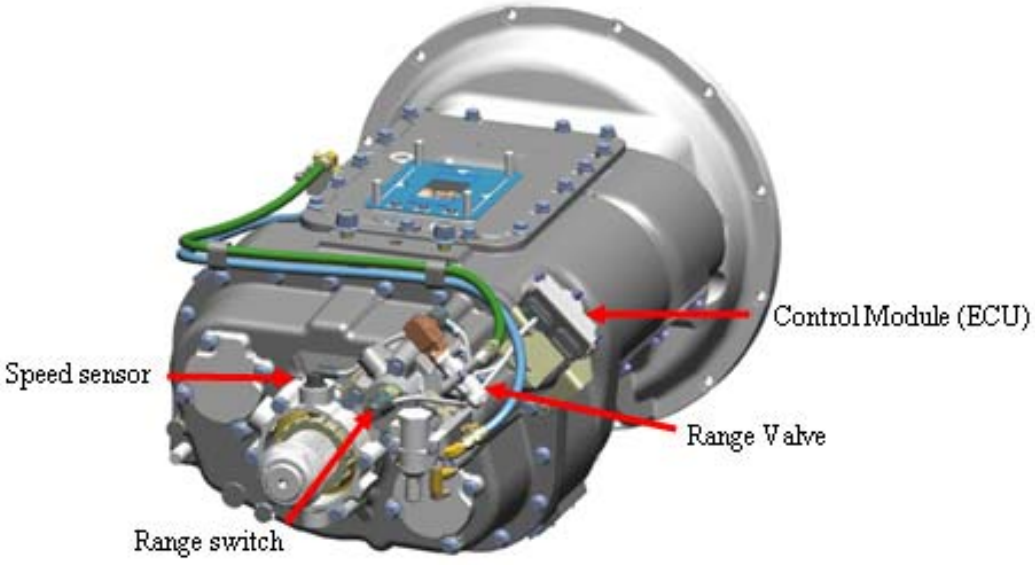
The breakout box warning lamp has the same behavior as the cabin warning lamp (it lights for 2 second when the key is in the "on" position and flashes when the transmission is in downshift protection mode).

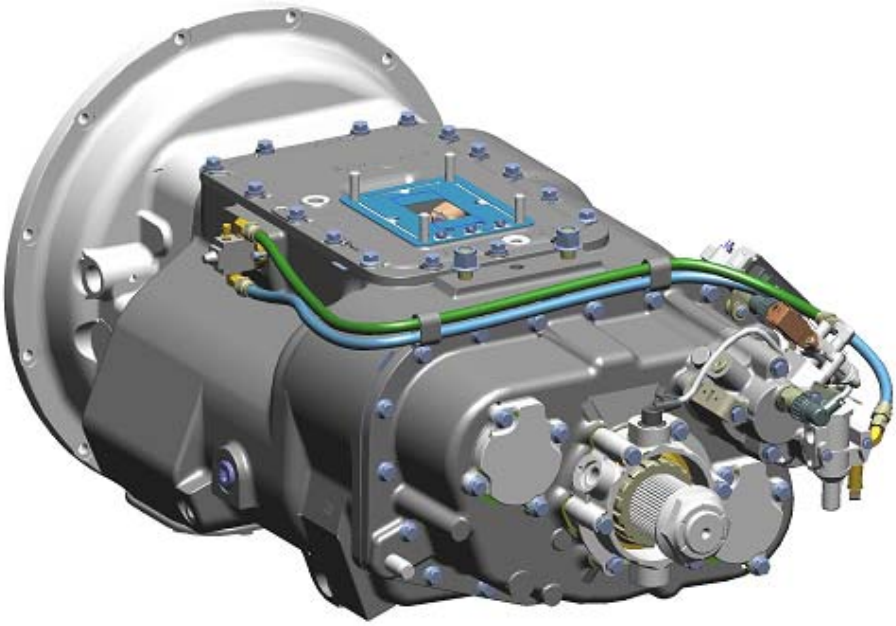
Electrical Harness Diagram



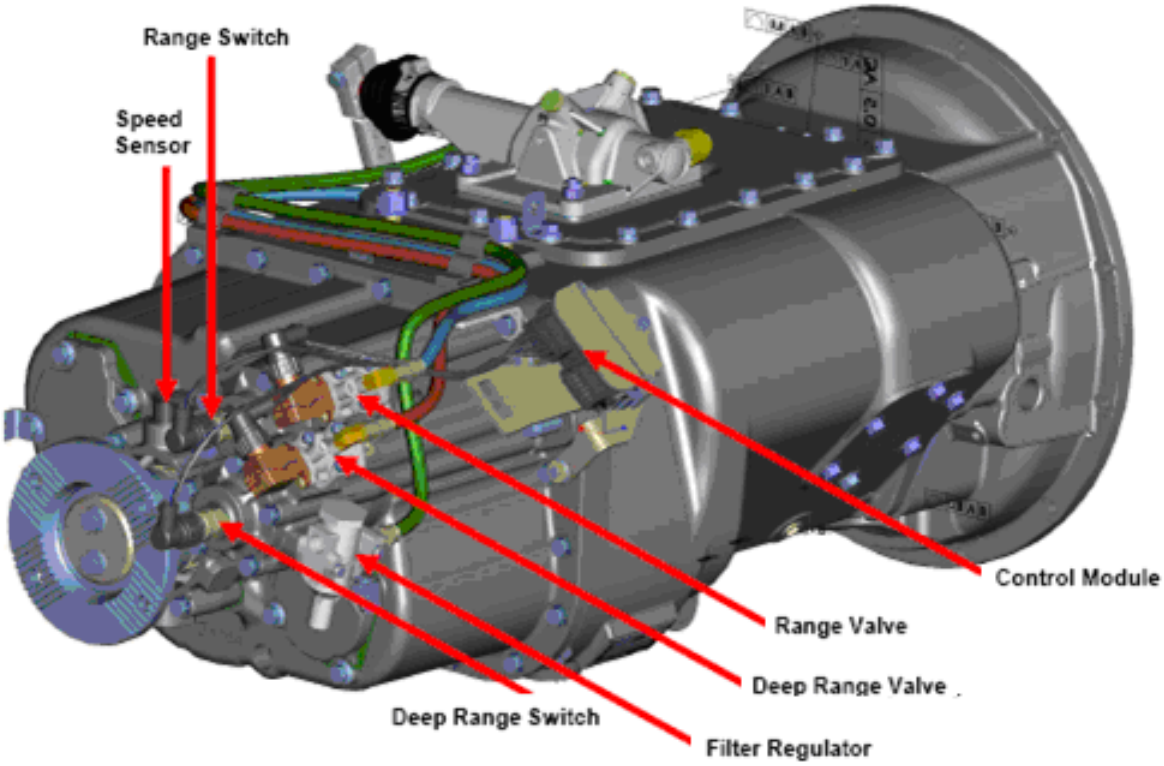
Component Locations

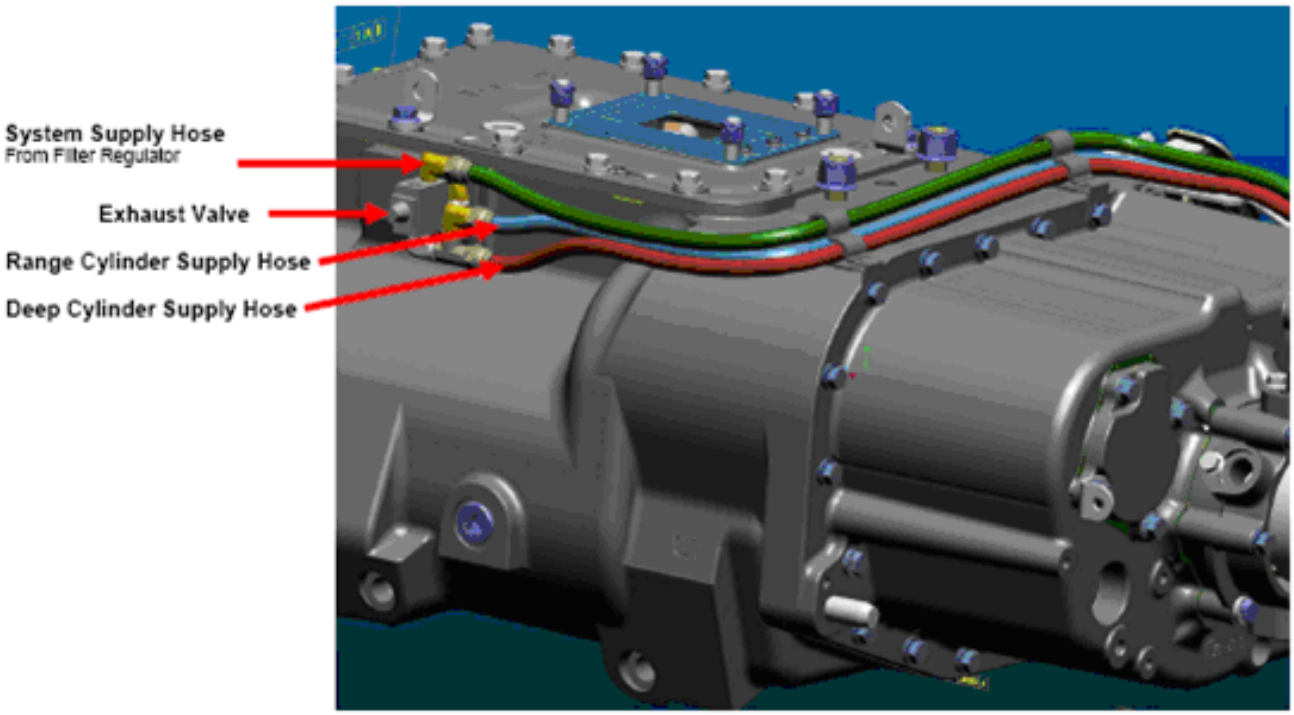
FTS-XX108LL





FTS-XX112L


Range Switch
Speed Sensor
Control Module
Range Valve
Deep Range Valve
Deep Range Switch
Filter Regulator


System Supply Hose
From Filter Regulator
Exhaust Valve
Range Cylinder Supply Hose
Deep Cylinder Supply Hose

ESPECIFICAÇÕES DO MULTÍMETRO

Características Técnicas

- Display: 3 3/4 Dígitos, 4000 Contagens com Barra Gráfica
- Taxa de Amostragem: Aprox. 3 vezes/segundo
- Indicação de Bateria Fraca.
- Indicação de Polaridade: Automática, negativo (-) indicado
- Indicação de Sobrefaixa: OL é mostrado
- Seleção de Faixa: Manual ou Automática
- Data Hold
- Ambiente de Operação: 0ºC a 40ºC (32ºF a 104ºF),RH<80%
- Ambiente de Armazenamento: -20ºC a 60ºC (-4ºF a 140ºF), RH<80%
- Altitude de Operação: 2000m
- Altitude de Armazenamento: 10000m
- Coeficiente de Temperatura: 0.1 x (precisão especificada) / 1°C <18ºC ou > 28ºC
- Alimentação: Pilhas ou Bateria 9V
- Segurança/ Conformidade: IEC1010 CAT II 1000V de Sobretensão e Dupla Isolação

Tensão DC

- Faixas: 400mV, 4V, 40V, 400V, 1000 V
- Precisão: 400mV ± (1,5%+6D); 4V ~ 400V ± (0,5%+6D); 1000V ± (1,0%+4D)
- Resolução: 0.1mV, 1mV, 10mV, 100mV, 1V
- Impedância de Entrada: >10MOaHMS na faixa de 400mV; 40MOaHMS nas outras faixas
- Proteção de Sobrecarga: 1000V DC / 750V AC RMS

Corrente DC

- Faixas: 400µA, 4000µA, 40mA, 400mA, 20A
- Precisão: 400µA ~ 400mA ± (1,0%+5D); 20A ± (1,2% + 10D)
- Resolução: 0.1µA, 1µA, 10µA, 100µA, 10mA
- Queda de Tensão: Máximo 1.2V na entrada mA; Máximo 100mV na entrada A
- Corrente Máxima: 20A
- Proteção de Sobrecarga: Fusível de Ação Rápida

Tensão AC

- Faixas: 400mV,4V, 40V, 400V, 750V
- Precisão: 400mV ± (1,5% +6D); 4V ~ 400V ± (0,8%+6D); 750V ± (1,0%+6D)
- Resolução: 0,1mV, 1mV, 10mV, 100mV, 1V
- Impedância de Entrada: >10M OHMS na faixa de 400mV; 40M OHMS nas outras faixas
- Resposta em Frequência: 40Hz a 100Hz para a faixa de 750V; 40Hz a 400Hz para outras faixas

- A tensão AC é mostrada como o valor eficaz para uma onda senoidal (RMS)
- Proteção de Sobrecarga: 1000V DC / 750V AC RMS

Corrente AC

- Faixas: 400µA, 4000µA, 40mA, 400mA, 20A
- Precisão: 400µA ~ 400mA ± (1,5%+5D); 20A ± (2,0%+15D)
- Resolução: 0.1µA, 1µA, 10µA, 100µA, 10mA
- Queda de Tensão: Máximo 1,2V na entrada mA; Máximo 100mV na entrada A
- Corrente Máxima: 20A
- Resposta em Frequência: 40Hz a 100Hz na faixa de 20A; 40Hz a 400Hz nas outras faixas
- A corrente AC é mostrada como o valor eficaz para onda senoidal (RMS)
- Proteção de Sobrecarga: Fusível de ação rápida

Resistência

- Faixas: 400 OHMS, 4k OHMS, 40k OHMS, 400k OHMS, 4M OHMS, 40M OHMS
- Precisão: 400 OHMS ± (0,8%+5D); 4k OHMS ~ 4M OHMS ± (0,8%+4D); 40M OHMS ± (1,2%+5D)
- Resolução: 0.1 OHMS, 1 OHMS, 10 OHMS, 100 OHMS, 1k OHMS, 10k OHMS
- Tensão de Circuito Aberto: Aprox. 400mV
- Proteção de Sobrecarga: 250V DC / Pico AC

Freqüência / Duty Cycle (Somente Autorange)

- Faixas: 100 Hz, 1kHz, 10kHz, 100kHz, 1MHz, 10MHz,30MHz
- Precisão: ± (0,5%+4D) para todas as faixas
- Resolução: 0.01Hz, 0.1Hz, 1Hz, 10Hz, 100Hz, 1kHz, 10kHz
- Sensibilidade de Entrada: 1V RMS
- Proteção de Sobrecarga: 250V DC / Pico AC

Continuidade

- Faixa: Continuidade
- Limiar: (30± 20) OaHMS
- Tensão de Circuito Aberto: Aprox. 0,5V
- Proteção de Sobrecarga: 250V DC / Pico AC

Acessórios

- Manual de Instruções
- Pontas de Prova (Preta e Vermelha)