

Fuller Advantage™ Manual Transmission TRIG0970 EN-US

April 2014



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Introduction and General Information

Warnings and Cautions

This symbol is used throughout this manual to call attention to procedures where carelessness or failure to follow specific instructions may result in personal injury and/or component damage.

Departure from the instructions, choice of tools, materials and recommended parts mentioned in this publication may jeopardize the personal safety of the service technician or vehicle operator.



Warning: Failure to follow indicated procedures creates a high risk of personal injury to the servicing technician.

Caution: Failure to follow indicated procedures may cause component damage or malfunction.

Important: Highly recommended procedures for proper service of this unit.

Note: Additional service information not covered in the service procedures.

Tip: Helpful removal and installation procedures to aid in the service of this unit.

Important Notice

Any reference to brand name in this publication is made as an example of the types of tools and materials recommended for use and should not be considered an endorsement. Equivalents may be used.

The description and specifications contained in this service publication are current at the time of printing.

Eaton Corporation reserves the right to discontinue or modify its models and/or procedures and to change specifications at any time without notice.

About This Manual

This Eaton® publication is intended to be a reference guide for the installation of manual shift Fuller® Advantage transmissions. General vehicle and transmission information is provided to cover the wide range of applications. This information benefits the OEM installer by providing the correct installation procedures to ensure the utmost in satisfactory operation and long service life. For additional transmission information, see the Suggested Tools section in this manual. For specific engine information contact the engine OEM.

Failure to adhere to Eaton Installation Requirements may affect transmission performance and/or warranty coverage.

Transmissions installed at OEM facilities shall meet and be approved by Eaton Application Engineering. Contact Eaton Application Engineering or your OEM Application Engineering department for the proper Application form.

OEM Design Responsibility

OEM facilities shall submit a design package to Eaton Corporation OEM Engineering Support Group for approval prior to any OEM build. A design package consists of the following information.

Transmission air supply: Source of air supply and routing and clipping of air supply line.

Transmission cooling system: Cooler type and capacity, cooler hose(s) routing and clipping.

Individual harness drawings: Construction detail of individual wiring harnesses including harness routing location and clipping points.

Wiring schematic: High-level schematic of how this transmission interfaces with the vehicle.

Application Approval

Fuller Advantage model transmission systems installed at OEM facilities must meet the requirements as defined in TRAG2600. If your application does not meet these requirements you must submit an approval to Eaton Application Engineering as defined in TRAG2600.

- **Driveline Torque Requirements** - Driveline angular acceleration and driveline torque shall not exceed requirements stated in Eaton Application Guideline specification TRAG2600.
- **Applications and PTO Applications**- refer to Application Guidelines Manual TRAG2600 and TRIG2600 for PTO application guidelines.

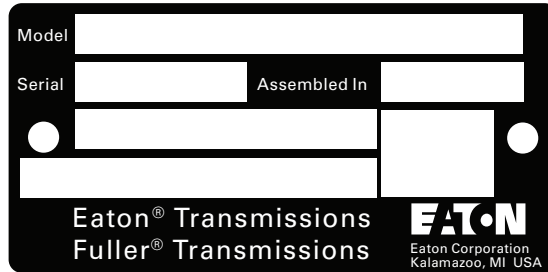
Every effort has been made to ensure the accuracy of the information contained in this manual. However, Eaton Corporation makes no warranty, either expressed or implied, based on the information provided. With each new application, engine manufacturers should be contacted to make sure desired engines are compatible with these systems.

Transmission Identification Tag

All Fuller Advantage transmissions are supplied with component identification tags. All tags are located on the bottom of the transmission.

Care should be taken not to damage the identification tag during the installation process.

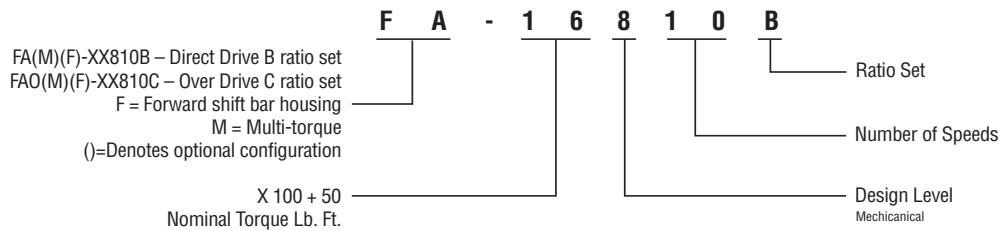
Do not remove the identification tag.



Product Identification

Nomenclature

Fuller® Advantage Transmissions



Product Familiarization

Similarities and Differences Compared to Current Manual Products

Note: In all cases where differences have been identified, see the respective installation requirements for details.

Similarities with Fuller[®] RT/FR/FRO Manual Transmission Products

- Identical PTO locations and PTO fit up requirements
- Identical shift tower options
- Compatible with existing Fuller RT clutch housings with pressure lube system
- Compatible with the existing SRC and LRC shift devices
- Shift lever travel is the same as current RT products
- Site glass same as RT
- Pump port is same location as RT

Differences and Features with Fuller[®] RT/FR/FRO Manual Transmission Products

- Oil sump protrusion on the bottom of the transmission main case
- Aluminum shift bar housing
- Aluminum range and bearing covers
- O-ring seal for shift tower to shift bar housing interface
- Cooler is not required on some applications. See TRAG2600 for details
- Shift lever travel is greater than FR/FRO series
- Fuller Advantage has imperial fasteners vs. FR with metric
- Through-shaft PTO is only available in the lower left location
- Temperature sensor is in the right rear
- Aluminum back box cover

Suggested Tools/Publications

O.E. Tool & Equipment Group/Kent-Moore SPX Corporation: 800-520-2584

Part No.	Description
5505027	Volt/Ohm Meter (Standard commercially available VOM)

Eaton Service Parts: 800-826-HELP (4357)

Part No.	Description
T-100483	Clutch Alignment Tool, 10T, 2"

Deutsch: 95765-2250

Part No.	Description
DTT-16-02	Hand Crimping Tool - Stamped Pins
DTT-16-00/01	Hand Crimping Tool - Solid Pins

Service Publications

TRSM0970	Service Manual for External components
TRTS0970	Troubleshooting Guide
TRDR0970	Drivers Instructions

Vendor List

DEUTSCH

(Connectors)

Industrial Products Division
37140 Industrial Ave.
Hemet, CA 92545

Phone: 909-765-2250
Fax: 909-765-2255

www.deutschipd.com
www.laddinc.com (Ladd Industries)

PACKARD Electric

(Connectors)

Pioneer-Standard Electronics, Inc.
Packard Branch
5440 Naiman Parkway
Solon, OH 44139

Phone: 800-PARKARD (722-5273)
Fax: 219-378-6650

www.delphiconnect.com

RAYCHEM

(Wire)

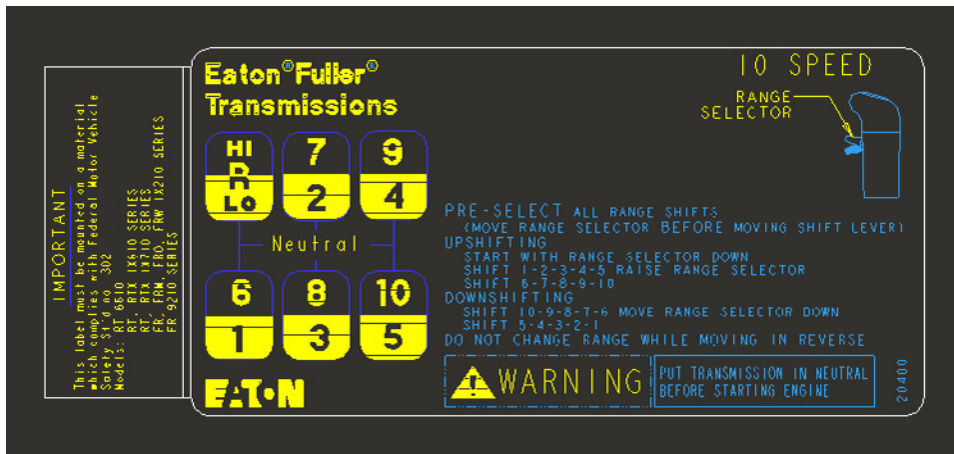
Electronics OEM Components Division
300 Construction Drive
Menlo Park, CA 94025-1164

Phone: 800-260-9909
Fax: United States: 800-260-9999
Fax: Worldwide: 650-365579
www.raychem.com

Vehicle Space Claim

Shift Label Requirements

1. The shift label should be located in the cab so that it is visible in the driver seat.
2. Shift labels are available for multiple shift devices in French, Spanish, and English.
3. The OEM must match the label with the installed shift device.



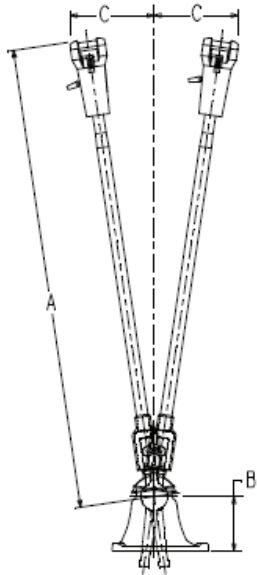
Shift Levers

Recommended Tower Types Based on Overall Height ('A' & 'B') and Recommend Lever Ratios (5.5–6.5)	
Tower Type	Overall Height Range (inches)
Low	30–35
Medium	36–42
High	43–50

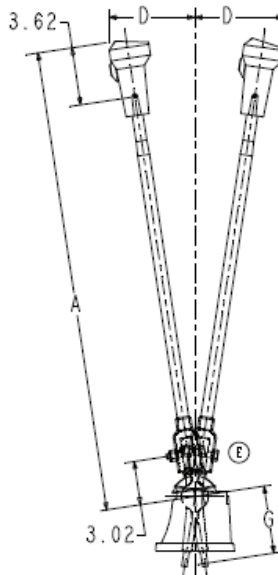
Low Tower Reduces High Tower Shift Force by 35% when 'A' = 30"						
Tower Type	Travel C (inches)	Travel D (inches)	Travel E (inches)	Travel F (inches)	B	G
Low	$0.104 \times A + 1.25 + (A \times 0.02)$	$0.106 \times A + 1.50 + (A \times 0.02)$	$0.286 \times A + 1.25 + (A \times 0.02)$	$0.086 \times A + 1.25 + (A \times 0.02)$	3.75	4.71
Medium	$0.086 \times A + 1.25 + (A \times 0.02)$	$0.088 \times A + 1.50 + (A \times 0.02)$	$0.235 \times A + 1.25 + (A \times 0.02)$	$0.070 \times A + 1.25 + (A \times 0.02)$	4.75	5.71
High	$0.073 \times A + 1.25 + (A \times 0.02)$	$0.075 \times A + 1.50 + (A \times 0.02)$	$0.200 \times A + 1.25 + (A \times 0.02)$	$0.060 \times A + 1.25 + (A \times 0.02)$	5.75	6.71

Vehicle Space Claim

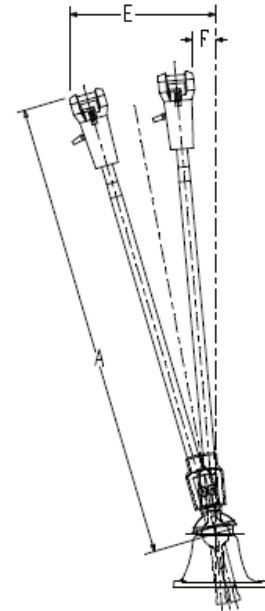
FOREWARD AND AFTER LEVER MOTION
STANDARD CONTROL ONLY



SIDE SELECT LEVER MOTION
STANDARD AND FORWARD CONTROL

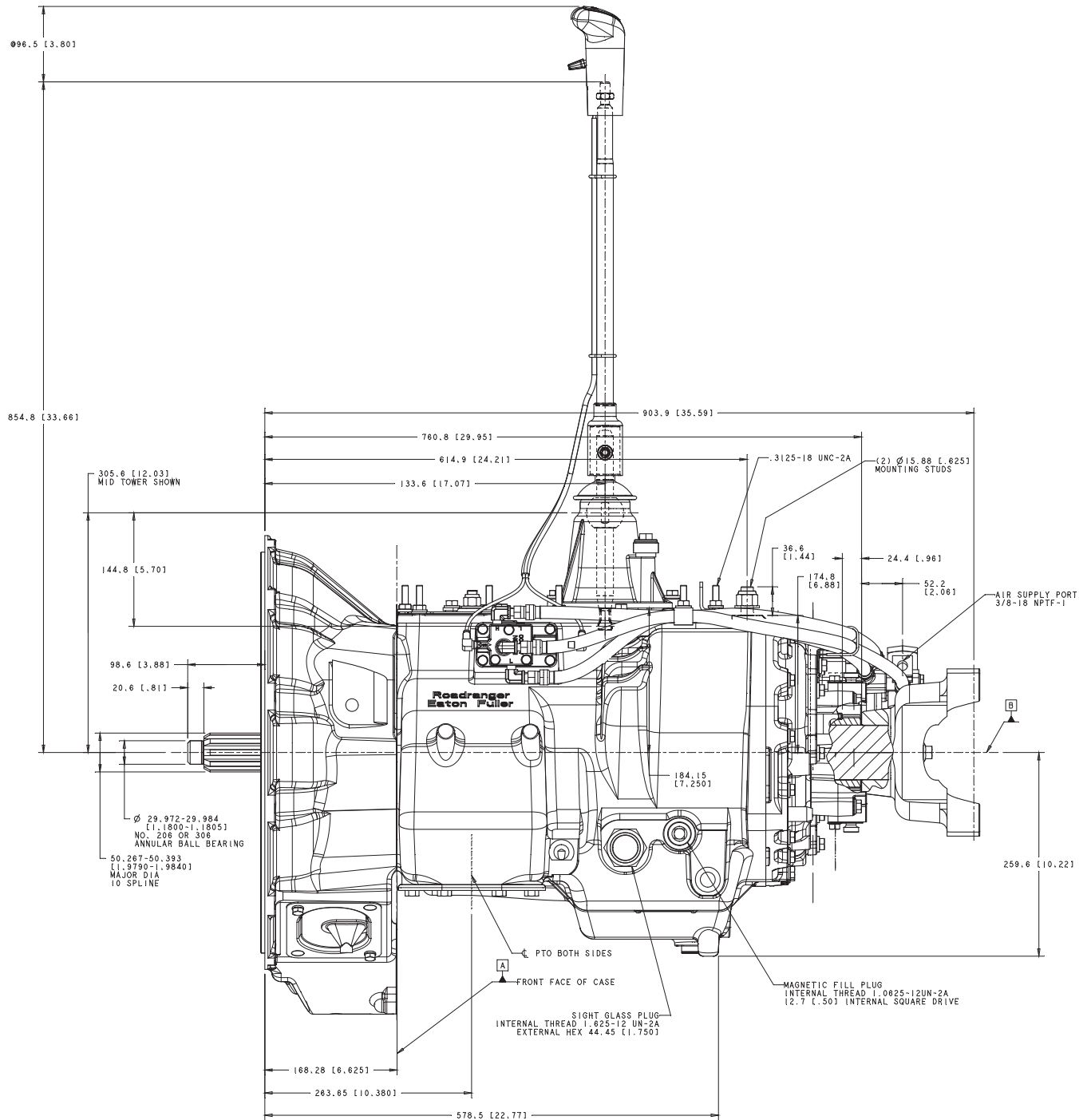


FOREWARD AND AFTER LEVER MOTION
FORWARD CONTROL ONLY

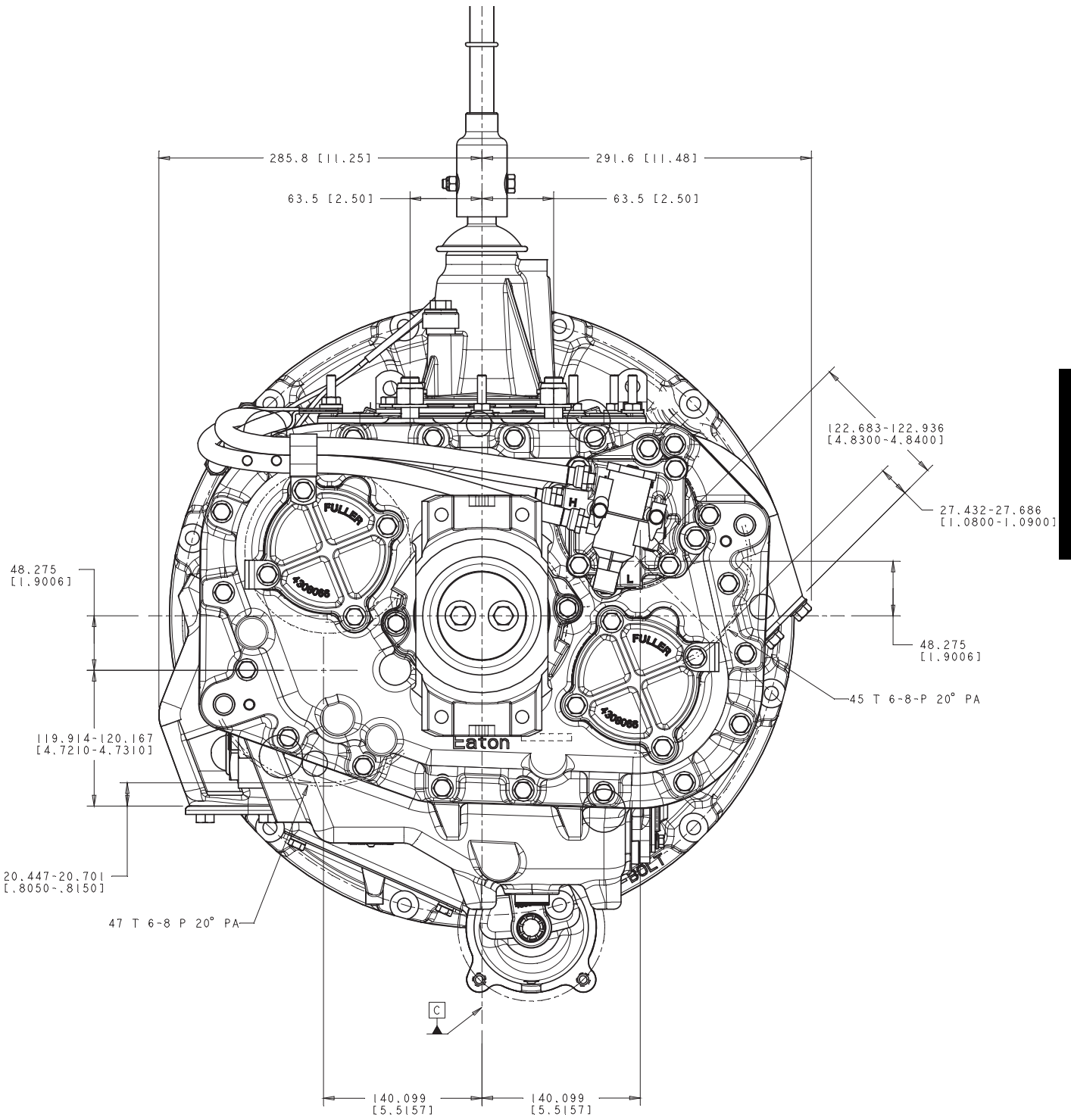


Fuller Advantage 10-Speed

Note: For transmission weights, see Specifications Guide.



Vehicle Space Claim



Vehicle Space
Claim

Clutch Interface

Pilot Bearing Specifications

The OEM is responsible for the design and selection of pilot bearings to mate with our product. Eaton recommends high quality pilot bearings procured from Original Equipment Manufacturers. Significant decrease in life may occur with the use of generic brand pilot bearings. Eaton recommends using pilot bearings, in conformance with SAE J1731 Pilot Bearings for Truck and Bus Applications, with viton seals and synthetic grease compatible with operating temperature range of -40° F to 300° F. Bearing internal clearance should be a C3 or greater.

The following pilot bearings are currently the minimum Eaton Clutch Division recommends. The operating temperature that the pilot bearing sees has increased in the last several years. This creates operating conditions that are no longer acceptable to the standard pilot bearings and grease. In addition, the life of the clutch has increased. The use of high temperature grease and Viton seals are now mandatory to ensure adequate bearing life. Pilot bearing failure usually results in a warranty claim for drag or clutch noise. This results in a claim against Eaton Clutch.

Below is a list of the recommended Pilot Bearings. All of these bearings have Viton seals and a high temperature grease in addition to a C3 fit. It is acceptable to use synthetic high temperature grease and a C5 fit if desired. If the supplier specific bearing is no longer available, contact the supplier for an equivalent alternative bearing.

Vendor	Seal Type	Bearing Series 6205	Bearing Series 6306	Bearing Series 6006
NTN	Viton	6205 LLUA1/C3	6306 LLUA1/C3	6006 LLUA1 C3/LX16
KOYO	Viton	6205 2RKF-S2/C3	6306 2RKF-S2/C3	-
NSK	Viton	6205 DDU7/C4 ENS	6306 DDU7/C4 ENS	6006 DDWA18A C4/ENSS
SKF	Viton	6205 2RS2/C3	6306 2RS2/C3	-
FED-MOG	Viton	6205 VV/C3	6306 VV/C3	-
PEER	Viton	6205-2VRLD-C3	6306-2VRLD-C3	6006-2VRLD-C3

Grease Hose

Optional grease hose for release bearing sold separate.

Transmission Interface

Clutch Housings

Size	SAE #1				
Mount	Standard	Standard	Nodal, Symmetrical	Nodal, Symmetrical	Standard
Material	Cast Iron	Aluminum	Cast Iron	Aluminum	Aluminum
Length mm [inch]	168.3 [6.625]				
Release Option*	1, 2, 3	1, 2	1, 3, 4	1, 3	5
Clutch Housing to Flywheel Housing Mounting Hole Diameter	12.319 +/- 0.101 [0.485 +/- 0.004]				
Weight in kg [lbs]	See Specifications Guide.				

*Release options:

1. Above centerline, pull
2. Above centerline, pull and below centerline, push
3. Below centerline, pull
4. Above and below centerline, pull
5. Hydraulic release

Transmission Interface

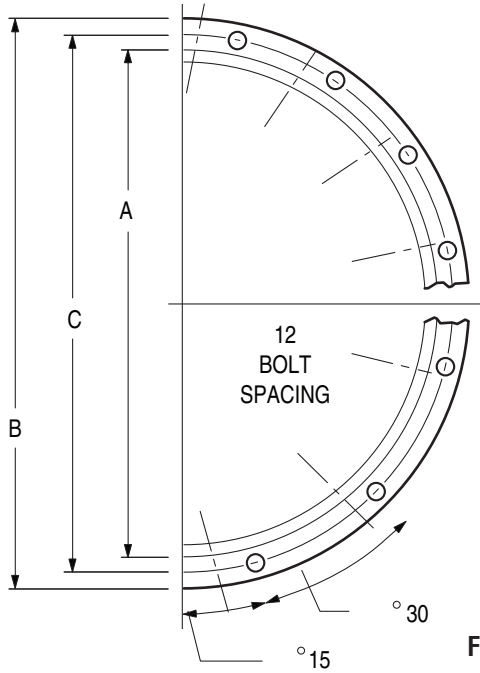


Fig. 1

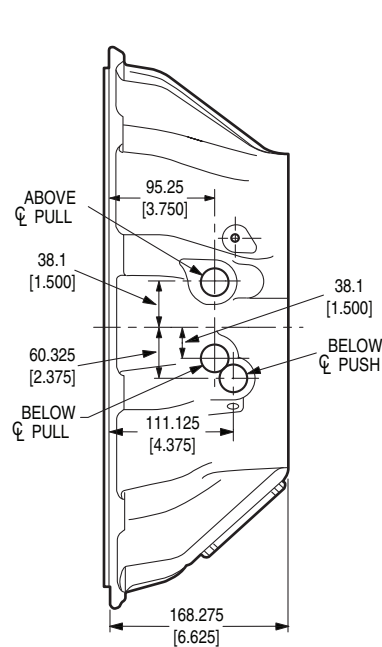
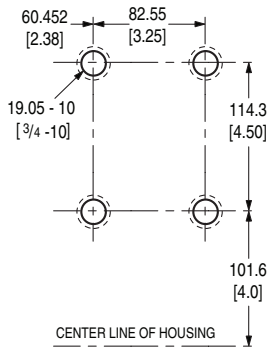
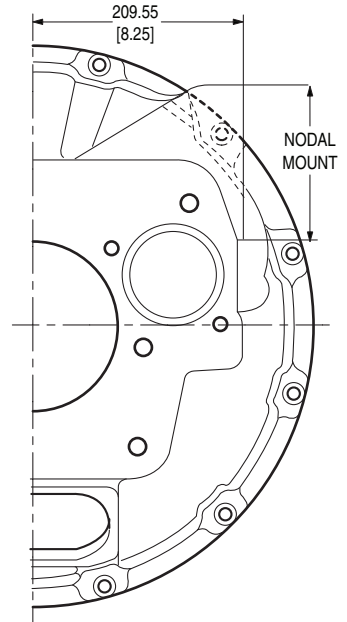
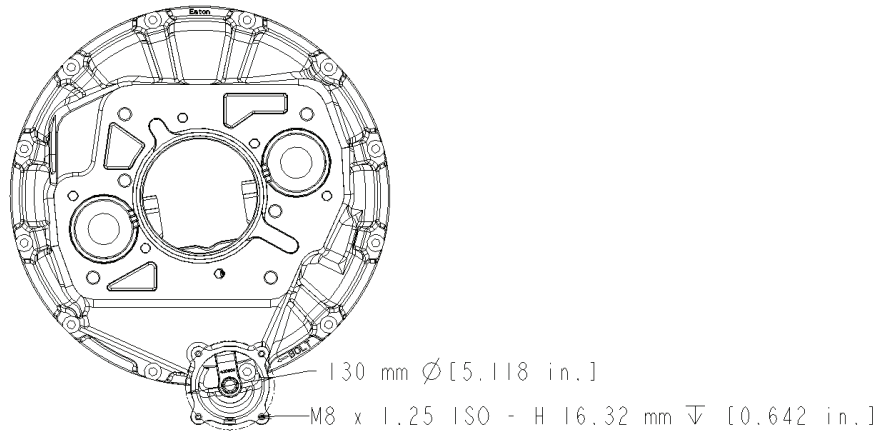


Fig. 2



#1 Housing Only Fig. 3



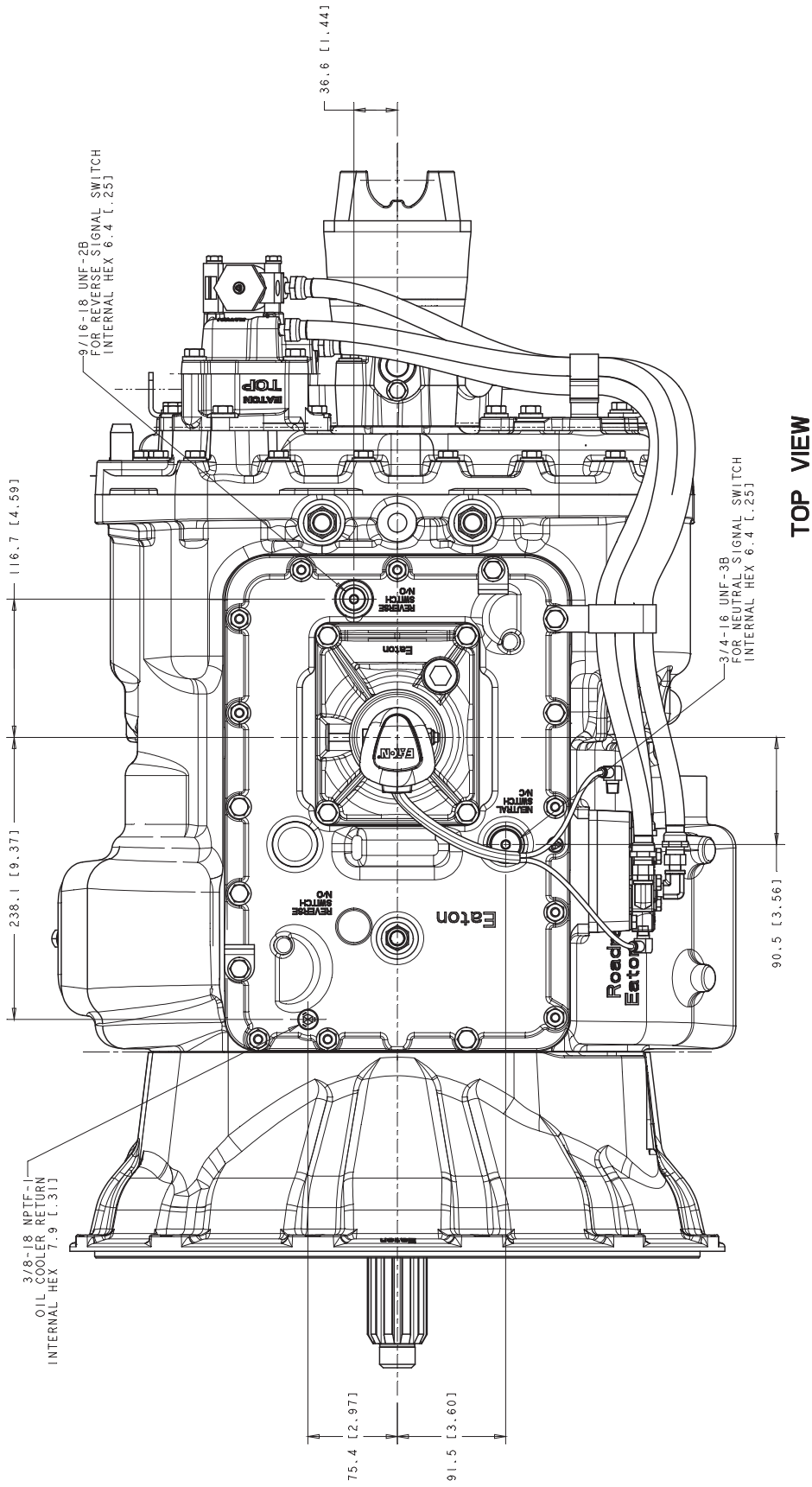
Nodal Mount - Denotes side mounting pads used for support of transmission and engine. See Fig. 2
 Symmetrical - Denotes symmetrical bolt mounting pattern of nodal mount. See Fig. 3

SAE Size No.	A Pilot Diameter	B Outside Diameter	C Bolt Circle	Qty	Capscrew Size
1*	511.175 [20-1/8]	552.45 [21-3/4]	530.225 [20-7/8]	12	11.1125 [7/16]

*SAE #1 denotes clutch housing size. See Fig. 1

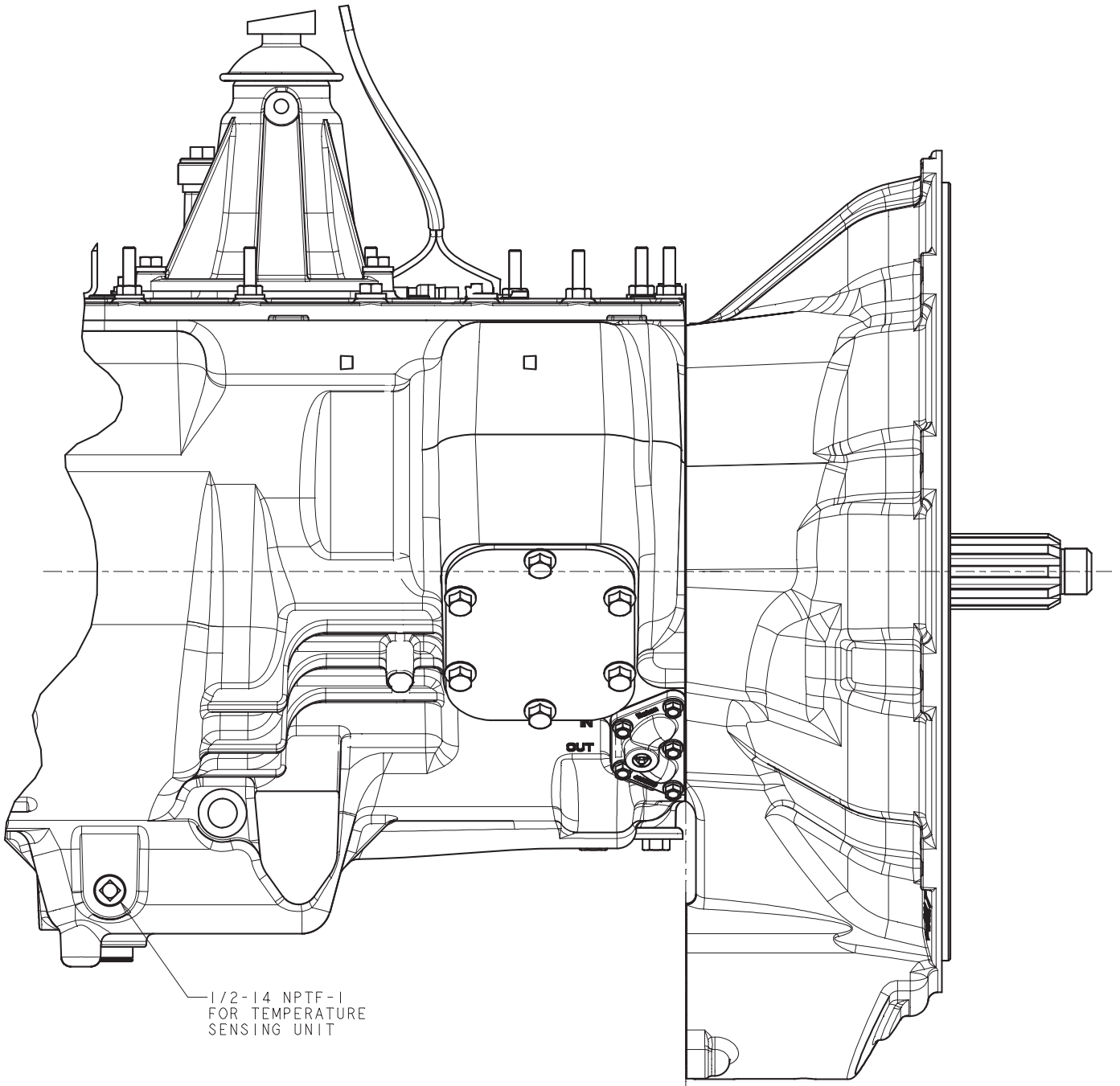
Transmission Interface

Top View



TOP VIEW

Side View



Handling

Handle the transmission carefully to avoid damage to the transmission components and surrounding vehicle components.

- Use a hoist or transmission jack that permits precise control of the transmission movement during installation.

Transmission Preparations

Note: Eaton has provided several double-ended studs that can be used for attaching vehicle components to. Sensor and lifting eye fasteners are not to be used for securing additional OEM brackets under any circumstances. This includes cap screws used to fasten the shift bar housing, rear housing, bearing covers, and PTO covers. The Fuller Advantage utilizes a different sealing method than previous models of Fuller transmissions. Therefore, it is imperative that bolts are not removed from the shift bar housing and rear plate of the transmission.

Note: No mechanical speedometer.

Reverse and Neutral Switches

Supply Voltage	12V System (9V–16V)
	24V System (16V–32V)
Switching Currents	10 amps for 12V circuit
	3 amps for 24V Circuit
Sensor Loads	< 1 amp for 12V or 24V
Switch State	Normally Closed

Switch Options

Reverse and neutral switch openings are standard on all heavy duty Fuller transmissions. The transmission will be shipped with plugs in these openings, unless switches are ordered by the OEM and pre-installed by Eaton.

Reverse Switches

Thread	0.5625-18 UNF-2B
Wrench Size	7/8
Part Number	4304808
Mating Connector Information	Weather Pack PN
Connector Assembly Part Number	12015378
Terminal (Qty. of 2 required)	12124582
Cable Seal (Qty. of 2 required)	12010293
Part Number	22940
Connector Type	Screw
Screw Terminal Details	2 x 8-32 x 0.25 in. with #8 internal lock washer

Neutral Switches

Thread	0.750-16 UNF-2A
Wrench Size	7/8
Part Number	4304809
Connector Type	Weather Pack
Mating Connector Information	Weather Pack Part Number
Connector Assembly Part Number	12015378
Terminal (Qty. of 2 required)	12124582
Cable Seal (Qty. of 2 required)	12010293
Part Number	22941
Connector Type	Screw
Screw Terminal Details	2 x 8-32 x 0.25 in. with #8 internal lock washer

End Yoke Retaining Design

All Fuller Advantage model transmissions have a two bolt retainer plate design that retains the end yoke. The Fuller Advantage transmission will be shipped with the end yoke installed. In the event that a yoke needs to be re-installed, special care should be exercised to snug each bolt to 35 ft-lbs prior to attaining full torque of 84–92 ft-lbs. For reference, these bolts are M12 x 1.25 x 60 mm Grade 10.9 per DIN 6921.

Output Speed Sensor - Push In

Eaton Part Number	4307349	4307353	
Output Type	Single	Dual	
Packard Connector Information to Mate to Eaton Sensor			
Packard Assembly Number**	12162193	12162188	
Packard Connector Body*	12162192	12162187	
Packard Connector Seal*	12040751	12040757	
Packard Cable Seal*	12040751	12040757	
Packard Socket Number (Quantity)**	12124075 (4)	12124075 (2)	
Connector Pinouts:	Pin "A"	Positive Terminal	Positive Terminal Coil 1
	Pin "B"	Negative Terminal	Negative Terminal Coil 1
	Pin "C"	N/A	Positive Terminal Coil 2
	Pin "D"	N/A	Negative Terminal Coil 2
*Used To Make Packard Assembly			
**Need both Packard Assembly and Packard Sockets for proper wiring harness interface.			


Note: Need both Packard Assembly and Packard Sockets for proper wiring harness interface.


Rotor	Number of teeth	16 teeth
Sensor	Clock positions	10 and 12 o'clock or 4 and 6 o'clock
	Type	Variable reluctance push-in
	Connector supplier	Packard metri-pack 150
	Output voltage/air gap	0.3 Vp-p (min) 0.01" to 0.09"
	Sensor inductance	0.6–3.7 henries with an input signal of 1kHz @ 1 Vpk-pk

Mounting Transmission to Engine

Use the two transmission lifting eyes provided. The lifting eye position shall not be changed on the transmission.

- Use a two point lift chain or transmission jack with a minimum capacity of 1500 lbs.
- Inspect the engine to transmission mating surfaces for damage or debris prior to installation. Make sure the engine flywheel housing face, transmission clutch housing face, input shaft, etc. are free of paint, debris, rust, and any type of damage before installation.
- Input Shaft To Clutch Alignment - Engaging the transmission into gear will allow for the rotation of the input shaft by rotating the output shaft/yoke.
- Adjust the lift chain or transmission jack to obtain the same relative angle as the engine. The face of the engine flywheel housing and the face of the transmission clutch housing shall be parallel during installation. Rotate the output shaft/yoke while sliding the input shaft into the clutch to line up the splines. If the transmission is properly aligned and the clutch splines are properly aligned, very little force is required to slide the input shaft through the clutch and into the pilot bearing.
- If interference is encountered, move the transmission away from the engine to investigate the cause. The use of excessive force to overcome misalignment may cause damage to the transmission input shaft and the clutch.
- Once the transmission is seated against the engine flywheel housing, align the clutch housing bolt holes with the engine flywheel housing bolt holes and install all capscrews and tighten finger tight.

 **Important:** The clutch housing shall be flush against the engine flywheel housing before tightening any capscrews. Do not use the capscrews to seat housing.

 **Important:** Do not tighten any mounting capscrews until all capscrews have been installed and finger tightened. Do not remove the transmission support chain or jack until all mounting bolts have been tightened.

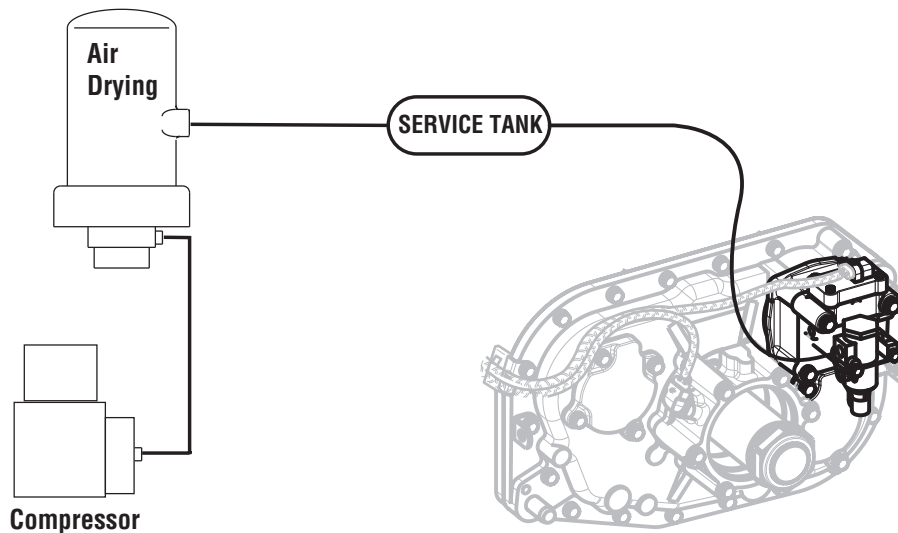
 **Important:** Never use the clutch release arm to pull the transmission into the engine flywheel housing. This will cause clutch over-adjustment.

Using Rear Supports

The OEM is responsible for determining if rear supports are needed. The OEM is responsible for nodal mount and rear mount design. Refer to OEM for rear or nodal mount fastener torque specifications.

Air Supply and Air Drying Requirements

- It is required to use a high quality commercially available air dryer in the air supply line before the transmission.
- Minimum air requirement for the transmission is 90 PSI [6.21 bar].
- A minimum of 1/4" I.D. [0.635 cm] diameter air supply line is required.
- The transmission air supply is required to be routed from the air tank, which supplies air to either the front or rear vehicle service brakes, with a gauge indicator in the cab.
- Transmission airlines should not be routed or attached at the bottom air tank fittings to avoid any chances of introducing moisture into the airline.
- Care should be used when routing the air supply to avoid kinks and close contact to heat sources.
- The transmission air supply shall be connected to the air filter/regulator mounted on the range cylinder cover.
- Air additives such as alcohol devices should not be permitted to enter the transmission air supply. Additives could cause damage to air system components, which could lead to degraded transmission performance.
- Transmission must have an uninterrupted air supply.



**Do not tie wrap air line
to wire harness on transmission**

Lubrication Requirements and Specifications

Fuller Advantage Transmission Gear Box Lubrication Requirements

Eaton requires the use of a transmission lubricant that meets PS-164 rev 7 specification.

A list of approved lubricants and suppliers can be found in the Approved Lubricant Supplier Manual, TCMT0020.

Not using the required lubricant will result in degraded performance and shortened life of the product. Refer to the Lubrication Manual, TCMT0021, for the latest information regarding lubrication requirements.

Note: Eaton recommends the use of Eaton Roadranger Lubricants. Roadranger SAE 50 Synthetic Lubricant and Eaton PS-164 rev 7 are the only approved synthetic lubricants.

Note: Failure to adhere to Eaton installation requirements may affect the transmission performance and / or warranty coverage.

Required Lubricant
Transmission Gear Box - Eaton Roadranger SAE 50 Synthetic Lubricant or PS164 Rev 7 approved lubricant.

Warnings and Cautions

- Before working on a vehicle, place transmission in neutral, set brakes, and block wheels.
- Do not introduce additives and / or friction modifiers. Additives of any kind added later to the oil can result in unpredictable consequences. No liability of any kind will be accepted by Eaton for any damage resulting from the use of such additives.
- Do not mix lubricants of different grades.
- Use clean containers when transferring lubricant from the bulk storage to the transmission. Containers used for anti-freeze or water should be cleaned prior to use.
- Do not re-use lubricant.
- Failure to use the required lubricant will affect the transmission performance and the warranty coverage.
- SAE 15W-40 viscosity grades are not allowed in Eaton transmissions.

Operating Temperatures and Cooling Requirements

The Fuller Advantage transmission is designed to operate without a cooler for some applications. For cooler-less operation requirements refer to TRAG2600.

Transmission Oil Level

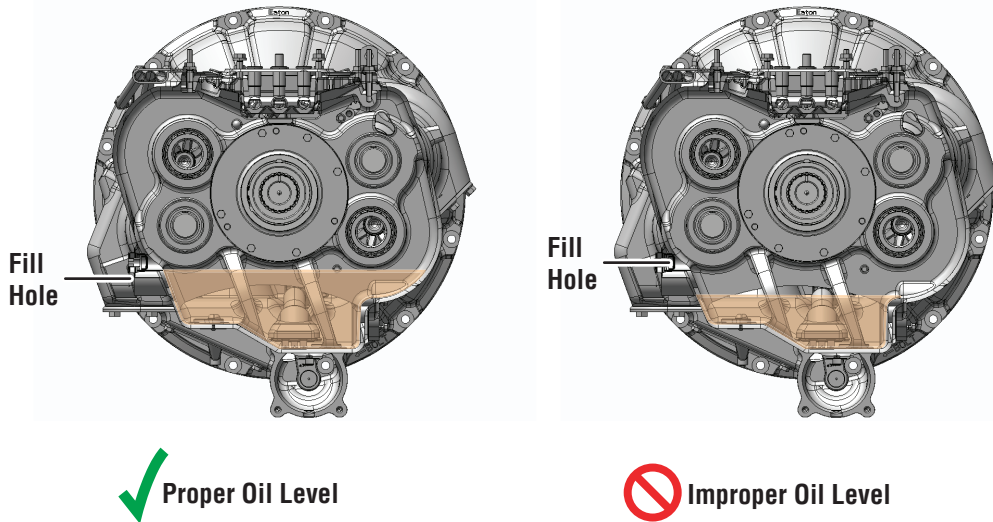
Note: Before checking oil level, engine must be idling in neutral for at least two minutes and lubricant temperature must be between 60° F and 120° F (15.5° C and 48.8° C.) This will ensure that all oil coolers are filled.

Transmission Capacity (Approximate)	
Fuller Advantage 10-Speed	16 pints

1. Place vehicle on level ground.
2. Turn engine off.
3. Remove fill hole plug.
4. Lubricant must be level with the bottom of the fill hole (+/- 3 mm).
5. Reinstall the fill hole plug and torque to recommended torque value.
6. Clean off any oil residue.

Make sure that the transmission lubricant is level with the bottom of the fill opening (+/- 3 mm).

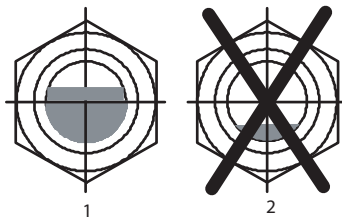
Note: Being able to reach the lubricant with your finger does not indicate that the lubricant is at the proper level.



The transmission is equipped standard with an oil level sight glass. When the transmission oil level is at or above 3/4 of the sight glass then it is at or above the minimum oil fill level.

To check the oil level with the sight glass:

- Vehicle engine shall be stopped and parked on level ground.
- Wipe dirt from the oil level sight glass.
- When the transmission oil level is at or above 3/4 of the sight glass then it is at or above the minimum oil fill level.



Torque Specifications

Description	Torque Value lbs. ft. [N•m]	Thread Size	Additional Comments
Transmission-to-Engine Capscrews	Refer to OEM for Specification		
Clutch-to-Flywheel Capscrews	See Clutch Installation Guide		
1 Reverse Switch	20–25 lb-ft [27–34 Nm]	0.5625-18	
1 Neutral Switch/Cap	20–25 lb-ft [27–34 Nm]	0.75-16	
2 Air Filter Regulator Capscrews	8–12 lb-ft [10.8–16.02 Nm]	0.25-20	Apply Loctite 242 to threads.
1 Lubricant Fill Plug	60–75 lb-ft [47–61 Nm]	1.25-NPT	
Lifting Bracket Capscrews	30–35 lb-ft [448 Nm]	0.375-16	Apply Loctite 242 to threads.
Transmission Nodal Mount Capscrews	Refer to OEM for Specification		Apply Loctite 242 to threads.
Transmission Rear Mount Nuts/Capscrews	Refer to OEM for Specification	0.625-11	
2 Bolt Output Yoke	84–92 lb-ft [113–124 Nm]	M12x60	Torque both bolts to 35 lb-ft prior to obtaining full torque.
Shift Lever Mounting Screws	30–40 lb-ft (454 Nm)	0.375-16	N/A
6 Bolt PTO Cover	35–45 lb-ft (48–61 Nm)		
8 Bolt PTO Cover	50–65 lb-ft (68–88 Nm)		
Clutch Housing Hand Hole Capscrew	12–16 lb-ft (16–22 Nm)		
Integral Hydraulic Clutch Housing Release Fork Pivot Shaft Screw	106–114 lb-ft (144–154 Nm)		
Oil Cooler Return Port	15–20 lb-ft (20–27 Nm)	3/8-18 NPTF-1	

Design Remedies for Shift Lever Jumpout

Annoying shift lever jumpout may occur on every truck if road conditions are severe enough, but this possibility can be minimized if some basic design guidelines are followed.

Technical Description of Jumpout

Shift lever jumpout is a force caused by the inertial effects of excessive road-induced vibration in the drivetrain. This road-induced shock causes the engine/transmission to pitch on its mounts as shown in Figure 1. This pitching occurs at the natural frequency of the engine/transmission/mount system, usually between 7 and 10 Hz. This pitching induces high vertical, fore/aft, and rotational accelerations on the transmission, and in particular, the shift lever. The shift lever then develops an inertial torque about its pivot, as determined by the sum of the inertial torques, as shown in Figure 2. **Note that a rearward lever offset adds to the jumpout torque, whereas a forward offset reduces the total jumpout torque.**

Figure 1

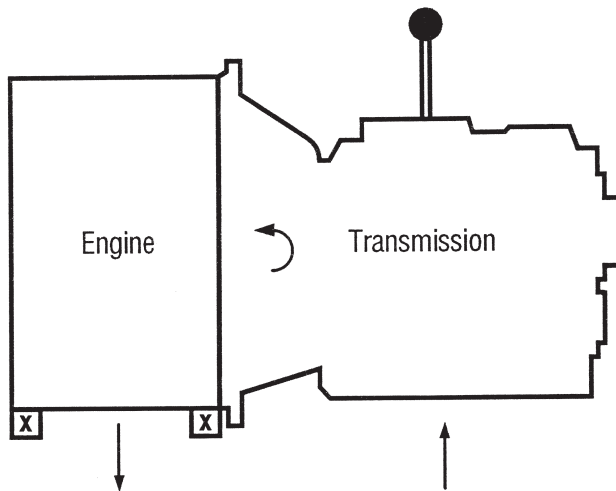
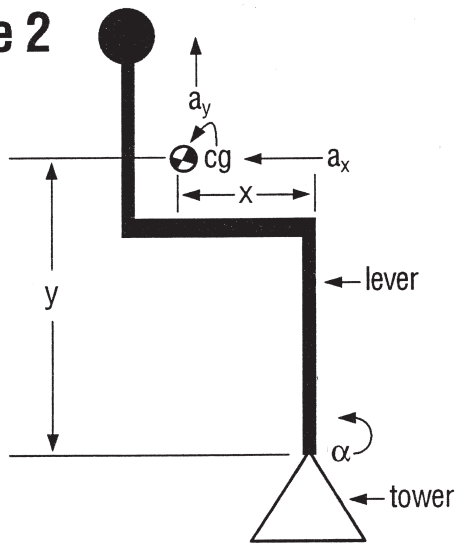


Figure 2

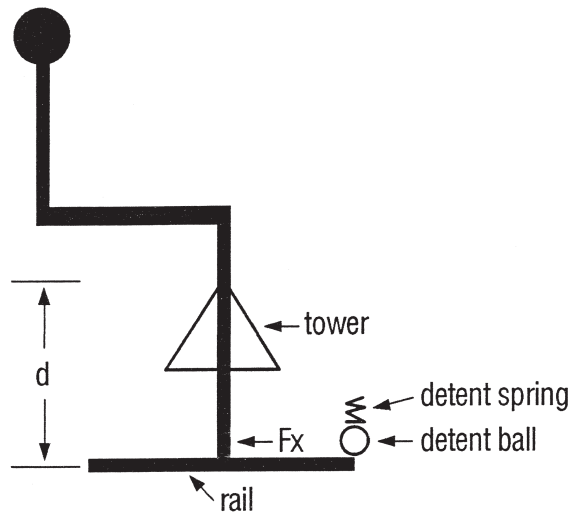


$$T_j = a_x My - a_y Mx + I\alpha$$

- T_j = Jumpout torque
- M = Mass of lever
- I = Moment of inertia of lever
- a_x = Fore/aft acceleration
- a_y = Vertical acceleration
- α = Angular acceleration of lever
- x = Distance between cg of lever and pivot
- y = Vertical distance between cg of lever and pivot
- cg = Center of gravity

This jumpout torque is resisted by the rail detent force times its moment arm determined by the distance between the pivot and the rail (Figure 3). When the jumpout torque overcomes the detent torque, jumpout occurs. This always occurs when the drive-train has very low torque, such as vehicle coast conditions, since friction from torque in the drive train locks the engaged sliding clutch to the gear and greatly overcomes any jumpout forces imposed.

Figure 3



$$T_o = F_x d$$

T_o = Detent torque

F_x = Detent force

d = Distance between pivot and rail

Since the lever itself is a dynamic system, it has its own natural frequency. Unfortunately, this also occurs between 7 and 10 Hz. This frequency is determined by lever height, lever offset, tower height, and isolator stiffness. If the natural frequency of the engine/transmission match that of the lever, propensity for jump out is greater because the engine amplified inertial forces are amplified further by the lever resonance.

Steps to Prevent Shift Lever Jumpout in Truck Design

1. Design shift lever offsets forward of the shift lever pivot point. As Figure 2 shows, when the lever center of gravity is forward of the shift tower, the inertial torque due to the vertical acceleration from road-induced vibration will counteract the dominating rotational acceleration, resulting in a much lower total jumpout torque about the pivot point. Design the shift lever location slightly behind the driver to capitalize on this beneficial effect.
2. Design the engine/transmission pitch mode frequency away from the shift lever natural frequency. We recommend that the engine/transmission pitch node be designed to 10 Hz. We think this is a good trade off between noise/vibration/harshness considerations and excessive engine motion. If a low shift tower is specified with an isolator, the lever system natural frequency will occur at 8 Hz or below. This is far enough away from the engine/transmission pitch mode frequency to eliminate any coincident amplification.
3. Provide friction damping in the rear transmission support. Double leaf springs at the transmission rear support can provide interleaf friction that will effectively damp the engine/transmission pitch mode motion, thereby reducing jumpout torques.

Note: Shift lever mechanical advantage guidelines are as follows: FS Transmission Models - 8.5/1 to 10.0/1, T, FA, RT, FR, FRO Transmission Models - 5.5/1 to 6.5/1.

Change Control Log

Last Revised Date	Description of Clarifications and Updates
April 9, 2014	Added Oil Cooler Return Port Torque Specifications
May 14, 2013	Removed Low Oil Switch info throughout

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