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Installation Guide

Eaton Lightning Series Transmissions TRIG0580

October 2007

FRLO-14410C-T2
FRLO-15410C
FRLO-15410C-T2
FRLO-16410C
FRLO-16410C-T2
FRLOF-14410C
FRLOF-14410C-T2
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Table of Contents

Overview

This manual has been prepared for OEM engineering personnel. It contains technical details on the new Eaton Fuller Lightning “FRLO-1X410C-T2 series model transmission.

Information contained within this manual was accurate at the time of printing. However, you should contact your Eaton Fuller Engineering representative prior to start of engineering for a new application.

Transmission Features

- Ten forward and two reverse gear ratios
- Approximately 170 lbs. less weight than current product "Super 10"
- Approximately 4.5" (117mm) shorter overall length than current product "Super 10"
- All helical gearing for noise reduction
- Low inertia mainshaft with "Super 10" shift pattern for easy shifting
- Electronic Control Unit (ECU) manages range and splitter shifts for more precise shifts with reduced wear on shift parts
- ECU adjusts range and splitter shift performance to compensate for temperature extremes
- ECU continuously monitors transmission performance and if system malfunctions, activates warning light and stores diagnostic information
- Top-2 automated shifting between top two gears (9th and 10th) is optional
- Reduced shift lever travel - both fore/aft and side/side
- Transmission internal oil to water heat exchanger
- New main case design with reduction in gasket surfaces
- With the exception of the vehicle air inlet, transmission contains no external air lines or fittings
- Visual confirmation of proper oil level, without removal of the fill plug, using the oil level sight glass

Similarities to Current Eaton Fuller Transmissions

- Clutch housing, input shaft, and clutch brake interface meet SAE specification
- Uses same shift lever / remote control mechanisms. Mounting location in the same relative position

Significant Installation Differences from Current Eaton Fuller Transmissions

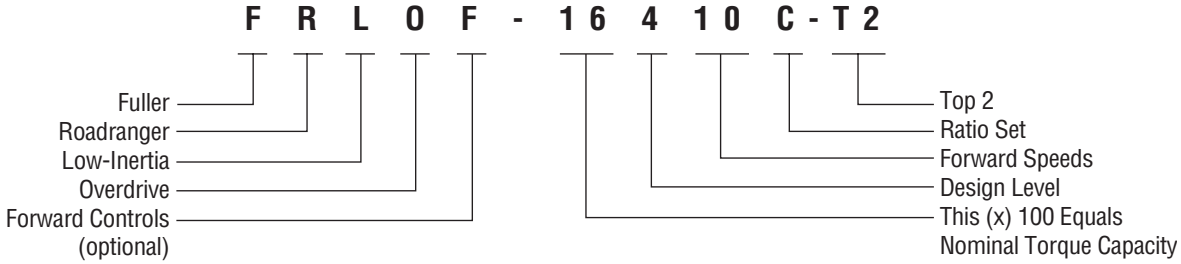
- New exterior dimensions and reduced weight
- Electric Shift Knob
- OEM designed electrical control harness including J1939
- Requires an electronic engine which is in compliance with SAE J-1939 and certified for the “4” series transmission
- Electronic Control Unit (ECU) control of range and split shifts
- One drop-in magnetic speed sensor dedicated for input into the transmission ECU
- Internal oil to water heat exchanger requiring connection to engine cooling system
- Vertical location of rear transmission rear support studs
- Two 6 bolt PTO openings vs. current product 8 bolt and 6 bolt PTO openings
- Two rear mounted countershaft driven PTO drives standard
- New main case design. No separate shift bar housing or auxiliary housing
- Transmission air inlet located on driver’s side of transmission versus passenger side
- Location of reverse and neutral switches. Also they are metric thread. The switches are the same as those used on the FR-series transmission
- RTV Sealant used on flange surfaces (Fasteners must not be removed)

Related Publications

Roadranger Warranty Guide	TCWY-0900
Roadranger Approved Lubricants	TCMT-0020
Roadranger Products Lubrication Manual	TCMT-0021
J1939 Engine Control Requirements Specification for Eaton Transmissions	Contact your Eaton Engineering Representative
In-cab Shift Pattern Instruction Label - Lightning Series	5586270
Driver Instructions - Lightning Series	TRDR-0580
Illustrated Parts Lists - Lightning Series	See Roadranger.com for Model Specific Parts Information
Installation Guide - Lightning Series	TRIG-0580
Service Manual - Lightning Series	TRSM-0580
Troubleshooting Guide - Lightning Series	TRTS-0580

Specifications

Model Nomenclature



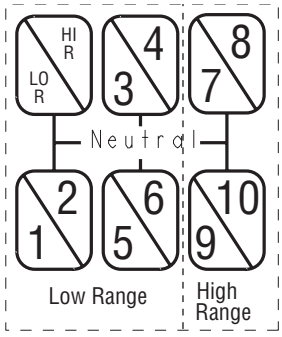
Gear Ratios and Steps

10 Forward and 2 Reverse Ratios

FRLO/F-xx410C-T2 Ratio FRLO/F-16410C-T2 Ratio		
Gear Position	Ratio	Step
10	.74 : 1	
9	1.00	36
8	1.39	39
7	1.88	36
6	2.64	40
5	3.57	36
4	4.95	39
3	6.72	36
2	9.33	39
1	12.66	36
Overall	17.15 : 1	
Reverse/Low	12.43	
Reverse/High	9.17	

Shift Pattern

The splitter button on shift knob selects one of two available ratios in each lever position except the lower right position. That position automatically will shift between the top two gear ratios.



The shift pattern instruction label for this Lightning series transmission is available as Eaton Fuller part number 5586257.

Weight

530 lbs. / 241 kg for transmission with SAE #1 aluminum clutch housing. Shifting controls, clutch release parts, output yoke or lubricant are not included.

Length

28.12” / 714 mm Dimension from face of clutch housing to front bottoming surface of companion flange or yoke.

Oil Capacity

27 pints

Transmission Center of Gravity Location

With SAE No. 1 aluminum clutch housing, less shifting controls and output yoke.

Coordinate	Viewed From	Measured From	Direction	Value - In (mm)
Longitudinal	Left side	Case/clutch housing interface	Rearward	9.37” (238)
Vertical	Left side	Mainshaft centerline	Upward	.32” (8.2)
Lateral	Rear	Mainshaft centerline	Left	.10” (2.5)

Inertia

(At Transmission input shaft, in Neutral) .0313 ft-lb-sec^2.

Warranty

Eaton component warranty coverage is listed in the Roadranger Warranty Guide TCWY-0900. This guide details complete component warranty coverage by specific vocation and their respective requirements.

To receive warranty coverage all terms and conditions in this manual must be adhered to.

Note: Any engine horsepower or torque re-rating beyond component ratings will immediately void the warranty.

Options

Standard Features

The following standard features are included on all Lightning series models:

- Eaton installed reverse switch (part number 4302748)
- Eaton installed neutral switch (part number 4302749)
- Eaton installed magnetic drain and magnetic fill plugs and sight glass
- Right and left countershaft extended splines for rear mounted PTO
- Right and left side openings for 6 bolt PTO
- Rear support studs (M16x1.5x34) & hex nuts (M16x1.5x 20) installed by Eaton
- 16 tooth magnetic speedometer rotor
- Oil breather
- Internal transmission cooler fitting (for applicable models) 7/8-14 UNF 2B with o-ring seat
- Clutch housing with both above and below pull type clutch provisions machined and bushings installed
- Output bearing cover with electronic speedometer provisions for two drop-in sensors (see section 5 on “Speedometer / Vehicle Speed Sensor” for additional detail)

Optional Features

The following options are available and must be specified when ordering a transmission.

Feature	Options
Clutch Housing	SAE #1 Aluminum
	SAE #1 Aluminum - Nodal engine mount
	SAE #1 Aluminum - Hydraulic release
Input Shaft	2” 10 spline
Front Bearing Cover	For pull type clutch
Output Yoke	Half round - 1710, 1760, 1810
	Full round - 1710, 1760, 1810
	SPL-170, SPL-250, RPL-20, RPL-25
Shift Controls	Low, Medium, High Tower
	LRC, SRC, CR
Shift Knob	With splitter control button only
Output Bearing Cover	Magnetic speedometer provisions for two drop-in sensors
	Magnetic speedometer provisions for two threaded sensors
Speedometer	Single output drop-in speed pickup
	Dual output drop-in magnetic speed pickup*
* Magnetic speed pickup for vehicle use may be supplied by vehicle manufacturer.	

Vehicle Interface - Mechanical

Dimensional Drawings

Computer Aided Design (CAD) drawings are available. Contact your Eaton Fuller Engineering Representative to discuss your specific needs and required format.

Engine Requirements

This transmission requires an electronically managed engine which is in compliance with SAE J-1939. The transmission ECU will communicate with the engine ECU over the J-1939 communication link. Contact your Eaton Fuller Engineering Representative for engines which are approved with the use of Lightning transmission. See Section 5: Vehicle Interface - Electrical, for wiring installation details.

Note: Any engine horsepower or torque re-rating beyond component ratings will immediately void the warranty.

Size	Material	Mounting Type	Clutch Release Type
SAE #1	Aluminum	Standard Engine Mount	Above and below centerline for pull type only, 222mm 8.75” release shaft external boss face*
SAE #1	Aluminum	Nodal Engine Mount, See Nodal Section*	Above and below centerline for pull type only, 210mm 8.25” release shaft external boss face*
SAE #1	Aluminum	Standard Engine Mount	Hydraulic Release
* Clutch release yoke pivot shafts			

Input Shaft

SAE 10 spline 2" (50.8mm) diameter. Pilot bearing diameter - 1.18" (30mm)

Master Clutch Requirements

Free-Travel Master Clutches

This transmission contains backlash or “free-travel” at the input shaft to main drive gear interface. This feature helps to prevent idle gear rattle. Because of this feature, the use of a master clutch containing free travel or pre-damped clutch discs is not recommended.

Soft Damped Clutch Discs

A soft rate damped clutch (7-spring, VCT, or Rockwell LTD) is required in all drivetrain systems using electronically controlled 10 liter engines and above. Eaton Fuller requires that transmission input torque spikes, due to drivetrain torsionals, must be less than 300 lbs. ft. above the nominal transmission input torque rating for engine speeds above 1000 rpm and vehicle road speeds above 20 mph.

Vehicle Air Supply Requirements

Inlet air pressure required	90-130 PSI (620-896 kPA)
Air Dryer	Required
Inlet Port Size	SAE 3/8" - 18 NPT

The inlet port is located on the transmission filter regulator assembly. This filter regulator is located on the left side of the transmission in the upper left rear quadrant. See transmission dimension drawings for location details.

The transmission filter regulator assembly regulates the vehicle supply air to 80 PSI (551 kPa).

No external air lines are present on this transmission. No external air lines are required for shift knob installation.

Vehicle Engine Exhaust Heat Source Clearance Envelope

The vehicle engine exhaust heat source can produce high temperatures that must be avoided by the transmission ECU. The exhaust piping, exhaust piping supports, or exhaust gas heat sources must not intrude within the transmission ECU heat source avoidance area. This heat source avoidance area is defined as a 88.9 mm [3.5inch] perimeter around the transmission ECU. The ambient temperature within this heat source avoidance area must be less than 250 F. See drawing 164-AD sheet 1 & 2 for the dimensional definition.

Shift Controls and Mounting Location

This transmission uses the same shift lever and remote slave control as current product Eaton Fuller transmission.

Three shift tower heights are available; Low, Medium, and High. Please note that the shift pattern of the Lightning transmission is tighter than many current models, which may allow the use of a lower tower. **Note: Because of the tighter shift pattern Eaton does not recommend the use of the high shift tower with Lightning.** Remote slave controls available from Eaton Fuller include; Low Remote Control (LRC), Single Rod Control (SRC), Cable Remote (CR). Contact your Eaton Fuller Engineering Representative for additional information or assistance in designing shift controls.

The mounting location is the same relative position as current Eaton Fuller transmissions. A standard shift opening and forward shift opening is available. The forward opening moves the low shift tower pivot ball 2.53" (64.4mm) forward from the standard opening location. See dimensional information for location details.

Note: See Section 5: Vehicle Interface - Electrical, for information on installation of shift knob.

Shift Lever Design

Travel Calculation

Recommended Shift Lever (Mechanical Advantage) Ratio is 5.5 - 6.5 : 1.

(Internal) Shift Lever Travel	Lightning	Lightning Super10	Lightning RT Models	Lightning FR Models
Rail Movement - Forward Gear Position	.43" (11mm)	88%	88%	100%
Rail Movement - Rearward Gear Position	.43" (11mm)	88%	88%	100%
Side Travel - Right (From center position)	.25" (6.4mm)	50%	50%	100%
Side Travel - Left (From center position)	.25” (6.4mm)	50%	50%	100%

Contact your Eaton Representative for applications with lever ratios outside of this range.

Shift Lever Jumpout Avoidance

Transmission shift lever jumpout can be an irritating problem for vehicle drivers. Careful truck design can minimize or eliminate this problem. Please refer to Remedies for Shift Lever Jumpout in the appendix of this document.

Transmission Oil Requirements

Use Eaton approved E-500 lubricants only. Gear oils formulated with EP additive packages must not be used with the Lightning transmission and will void the warranty. For additional information on lubricants reference Roadranger Products Lubrication Manual - TCMT-0021.

Type	Grade (SAE)	Ambient Temperature
Use Eaton Approved E-500 Lubricants only	50W	All

Oil lube tag 4304885 with the above oil use instruction is attached standard to the oil fill plug.

Transmission Oil Capacity

27 pints

Transmission Oil Level Sight Glass

The transmission is equipped standard with an oil level sight glass. The sight glass allows visual confirmation of correct oil fill in transmission. Proper oil fill is confirmed when the oil level is at the centerline of the sight glass. See dimensional drawings for location.

Transmission Cooling Requirement

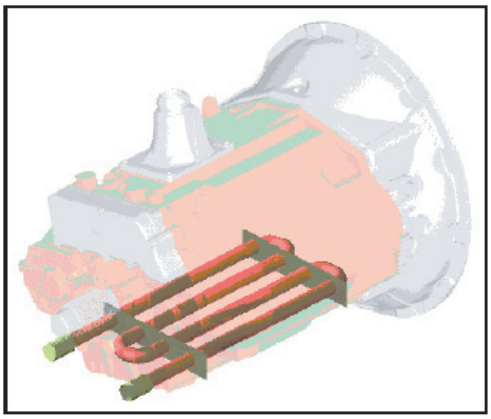
Transmission operating temperature requirements: - Transmissions must not be operated at temperatures above 250° F (120°C).

Internal Oil Cooler

This transmission will be equipped with an internal oil / water heat exchanger. Vehicle engine coolant is routed to the transmission where it circulates through a heat exchanging element in the bottom of the transmission case. Heat from the transmission oil is absorbed by the circulating engine coolant. The heat exchanger will also warm the transmission oil at low ambient temperatures. The heat exchanger inlet and outlet are located at the rear of the transmission.

In all cases, the coolant flow and coolant temperature must be sufficient to maintain transmission oil temperatures below 250°F (120°C) at worse case operating conditions.

It is recommended that the engine manufacturer is consulted in the application and connection of the transmission internal heat exchanger to the vehicle's engine.



The engine coolant circuit will require 400 ml of coolant to fill the heat exchanger. Additional coolant volume is in the lines between the engine and transmission.

A chart at the end of this section shows additional information of Eaton Transmission cooler applications.

WARNING: EP oils destroy heat exchangers. Do not use EP oils in transmissions.

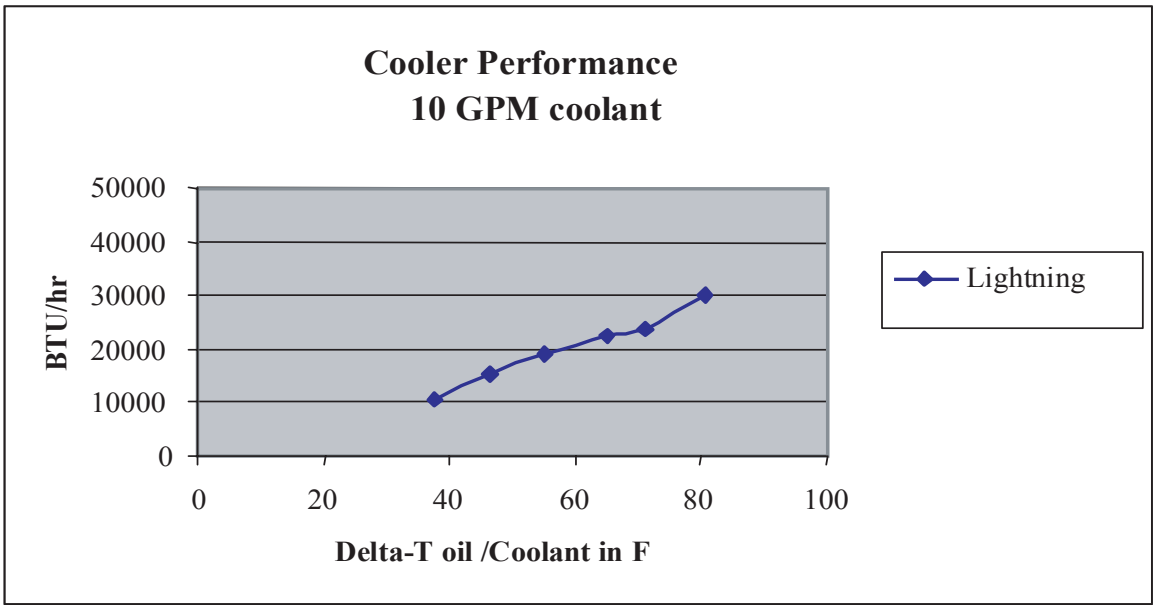
Note: The use of EP oils will void the transmission warranty

OEM Guidelines for the Lightning internal coolers:

- Provide 10 GPM coolant @1500 RPM
- Maximum coolant "In-Cooler" temperature not to exceed 200° F

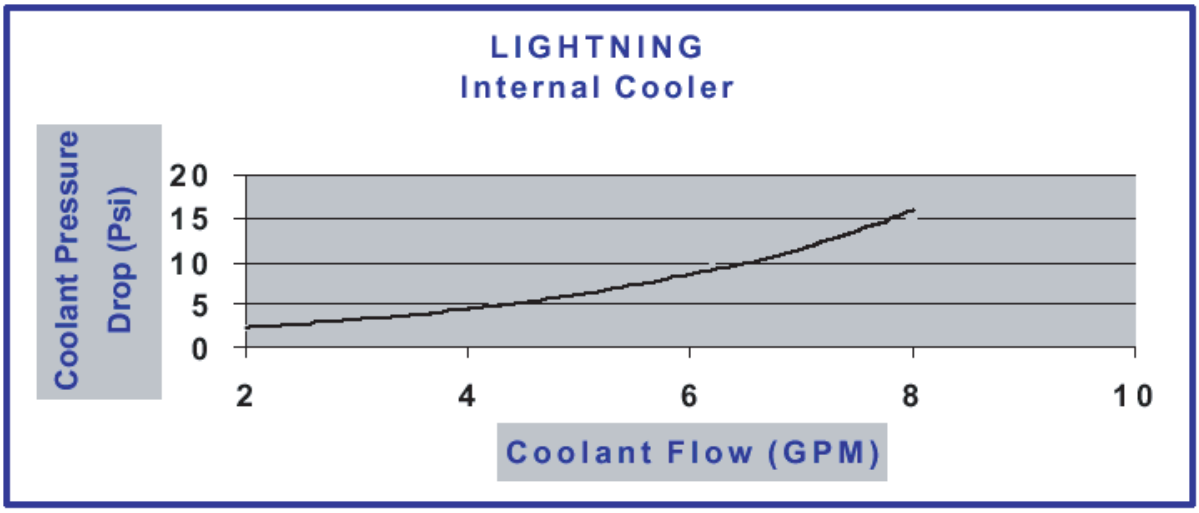
Internal Transmission Cooler Heat Transfer Capability

The following chart shows the Lightning Internal Cooler heat transfer performance over a range of temperature differential conditions with an engine coolant consisting of a 50/50 mix of ethylene glycol and water. The engine coolant thermostat setting was 180°F with 10 gallon per minute coolant flow.



Internal Transmission Cooler Coolant Flow Characteristics

The chart below describes the engine coolant flow characteristic for the Lightning Internal transmission Cooler. The pressure requirements to provide the associated coolant flow can be derived from the characteristic curve.



Internal Transmission Cooler Fittings

Location: Cooler ports are located at the rear of the transmission. See dimension drawings for location details.

Fitting size and type: 7/8-14 UNF-2B female (with o-ring seat)

Fastener Information

REMOVAL OF ANY TRANSMISSION CAPSCREWS TO INSTALL BRACKETS OR WIRE HARNESSES IS NOT ALLOWED AND WILL VOID THE WARRANTY FOR OIL LEAKS. This transmission uses anaerobic gasket sealant. Removal and reinstallation of the clutch housing and any cover capscrews can result in future oil leakage and would void warranty for oil leaks.

Eight M8 stud end special screws (with hex nuts provided) are utilized at the rear countershaft bearing covers and PTO covers at selective locations for use by the vehicle manufacturer in attaching miscellaneous harnesses, hoses etc. (2 studs at 2:00 & 4:00 position and 2 at 8:00 & 10:00 position respectively at the RH & LH rear bearing covers; 2 studs at the centerline positions of each of the 6 bolt PTO LH & RH covers). The special screws clamping the covers to the transmission case must not be loosened when attaching or removing the provided M8 hex nuts. The recommended torque range for the M8 hex nuts is 27-31 N.m (20-23 Lb.Ft).

Four M10x1.5 tapped holes are also provided on the top of the transmission case for exclusive use by the OEM for wiring and hose harness attachment. The fasteners must not exceed thread engagement more than 16.00 mm (.63”)]maximum. The recommended fastener torque range is 54- 61 N.m (40-45Lb.Ft). See dimension drawings for location detail. In addition, lifting eyelets on the top and rear of the transmission can also be used for harness attachment.

All capscrews and stud fasteners are metric thread size. Pipe plugs, oil fill plug, and oil drain plug are SAE standard.

Lifting Eyelets

Cast protrusions with machined holes are incorporated into the transmission case. Two eyelets are present on the top of the transmission. Two eyelets are present on the rear of the transmission. Eyelet hole diameter is currently 17.8 mm (.70").

Rear Transmission Support

Two M16 mounting studs are provided at the rear of the transmission. These top positioned studs allow attachment of a rear transmission support bracket.

The centerline of these mounting studs is located 614.8 mm (24.20”) back from mounting surface at front of clutch housing. This is the same dimension as the current Eaton Fuller transmission.

The spacing of the mounting studs is also the same. However, the height of the mounting stud pad is now higher at 206.5mm (8.13”) from the transmission centerline versus a 174.8mm (6.88”) dimension for the current product.

The standard Eaton 5577504 stud fastening length (34mm stud length – 20mm nut) = 14 mm. Thread size: nut attachment end - M16x1.5. Attachment nut: final assembly recommended torque specification = 230 – 257 N.m [170 – 190 lbs. ft.]. On centerline with spacing of 127 mm (5.00”).

WARNING: To avoid damage to the transmission - for installations not utilizing the standard Eaton installed stud above, any alternate transmission housing rear support threaded fastener must meet the following minimum criteria.

Fastener thread must be compatible with the transmission tapped hole specification of M16x2.0 – 4H.

Transmission housing end of fastener: the length of fastener full threads must be less than 18mm [.71 “].

Transmission housing end of fastener: the fastener full thread is to transition to the shank diameter and must provide a limitation to the installed depth of the fastener into the transmission housing tapped hole. Limitation on the installed depth of the fastener into the transmission tapped hole must be less than 21 mm [.83 “].

Speedometer/Vehicle Speed Sensor

See“Vehicle Interface - Electrical” on page 14, for installation information.

Output Spline

Type	Involute
Outside Diameter	69.9 mm (2.75”)
Number of teeth	54
Diametrical pitch	20-40
Pressure angle in degrees	37.5

Output Yoke

The transmission can be ordered with the output yoke installed by Eaton Corporation, or the yoke can be obtained separated by the OEM and installed by the OEM.

The same output yokes used on Eaton Fuller “2” FR Series and “9” RT Series are used on the Lightning Series.

Note: The rear seal surface is not on the output yoke.

The following output yoke options are available.

Series	Configuration	Yoke Front Face to Cross Center Dimension	Eaton Fuller Part Number
1710	Half Round	143 mm (5.63”)	5505543
1710	Full Round	143 mm (5.63”)	5505544
1760	Half Round	143 mm (5.63”)	5505545
1760	Full Round	143 mm (5.63”)	5505546
1810	Half Round	143 mm (5.63”)	5505547
1810	Full Round	143 mm (5.63”)	5505548
RPL25	Half Round	159 mm (6.26”)	5505553
SPL170	Half Round	142 mm (5.60”)	5505571
SPL250	Half Round	145 mm (5.71”)	5505572
92N	Half Round	143 mm (5.63”)	5505578

PTO Interface

6 Bolt Side Openings

Two 6-bolt PTO openings are provided, one on each side of the transmission. See dimensional drawings for location details.

The 6 bolt PTO is driven off a countershaft gear, turning at 63% of engine speed. The side mount PTO must utilize dowel pins to insure proper helical gear alignment with the transmission.

Drive Gear: 51 Teeth, 8.38 Diametric Pitch, 17.5º Pressure Angle, 33.1º Right Hand Helix Angle

Rear Countershaft Mounted

Two rear countershaft mounted PTO locations are provided, one on each side of the transmission. See dimensional drawings for location details.

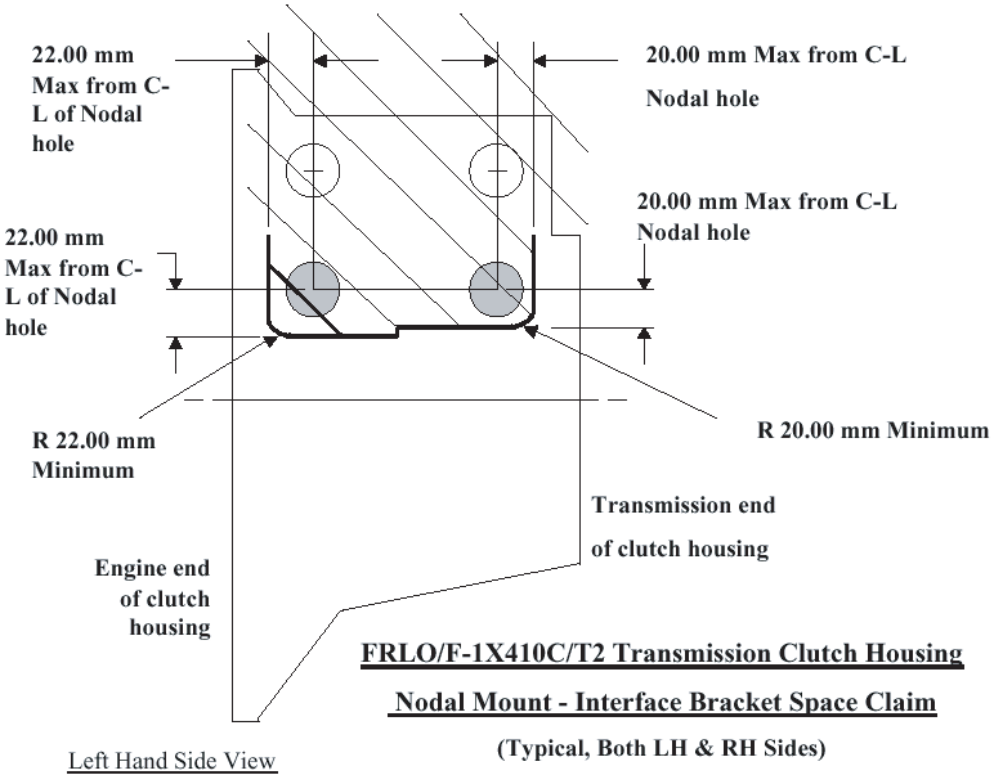
The rear countershaft mounted PTO is driven off a splined extension of the front countershaft. The drive speed is turning at 63% of engine speed.

Drive spline: 31 Teeth, 24 Diametric Pitch, 25º Pressure Angle

Note: Reference Eaton Service Manual (TRSM-0580) for PTO installation and sealant requirements.

Clutch Housing Nodal Mount Interface

The SAE symmetrical nodal mount interface is provided. The nodal mount interface bracket space claim is defined in the following dimensional drawing.



FRLO/F-1X410C/T2 Transmission Clutch Housing

Nodal Mount - Interface Bracket Space Claim

(Typical, Both LH & RH Sides)

Vehicle Interface - Electrical

Vehicle Electrical Requirements

The OEM is responsible for designing and providing a wiring harness and connector for the vehicle to transmission electrical interface. The OEM is also responsible for providing the J-1939 and J-1587 data link to the transmission.

Contact your Eaton Fuller Engineering representative early in the harness design for assistance. This OEM wiring harness design (and the interface with the vehicle and transmission) must be reviewed with Eaton Transmission Engineering prior to production.

Top-2 Operation

Lightning transmissions can be specified with the optional Top2 (T2) feature. T2 is an automated shifting function between the top two transmission gear ratios (9th & 10th gears). The Lightning T2 operation is controlled by the transmission Electronic Control Unit (ECU) compared to other Eaton Super10 Top-2 models which relied on the engine Electronic Control Module (ECM) for T2 control.

Engine Requirements

This transmission requires an electronically managed engine which is in compliance with SAE J- 1939. The transmission ECU will communicate with the engine ECU over the J-1939 communication link. Contact your Eaton Fuller Engineering representative for compatible engines that have been certified for the “4” series transmission.

Note: Any engine horsepower or torque re-rating beyond component ratings will immediately void the warranty.

Engine VEP Settings

The engine VEP settings for Lightning are different compared to Super 10 Top-2. To avoid Engine faults and possible performance issues, the following engine settings are required for Lightning:

TOP 2 - Disabled or Off

Transmission Solenoid(s) - Disabled or Off

J-1939 - Enable

Detroit Diesel Optimized Idle System

This system requires the addition of a low output / low gain vehicle output speed sensor (VSS) hardwired to the engine ECM. In addition to the dedicated VSS the engine configuration setting for 'Transmission_ID' must be set to: Transmission ID #0 - Manual This setting allows the engine to recognize the dedicated hardwired VSS for output speed and maintains required J1939 communication between the transmission and engine.

Contact Detroit Diesel for additional information

Road Speed Governor Configuration

Engine Road Speed Governor configuration must be configured so that the governed speed settings do not interfere or inhibit the transmission from reaching the automatic Top-2 (9-10) shift point.

Minimum Cruise Control Speed Settings

Engine Minimum Cruise Speed Settings may effect the cruise control 'Resume' function if the minimum speed is set above the engine speed RPM that results at the completion of the automatic Top-2 (9-10) upshift. If this occurs the minimum cruise speed setting must be lowered.

Wiring Harness Design Notes

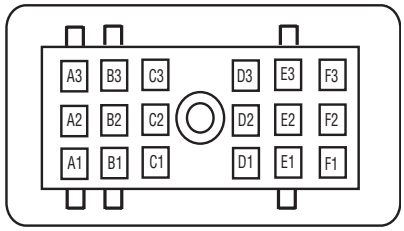
All wires to be 16 Gage GXL per SAE J-1128

All wires to be identified.

Transmission Electronic Control Unit (ECU) Connection

ECU Connector (Contained on ECU) 18 pin sealed connector: Cinch P/N 58101-18-011 (Packard P/N 12040923 is equivalent).

ECU Mating Connector (shown) (Supplied by OEM) Use Packard sealed connector P/N 12040921 with P/N 12103881 terminal or equivalent to connect the vehicle harness to the ECU.



The following circuits are required for connection to the transmission ECU.

Circuit	Pin Location	Description	Notes
VBATT	A1	Battery Positive Voltage 12 volt	10 Amp auto reset circuit breaker required. No relay permitted
VIGN	B1	Switch Battery Positive Voltage -Switched Ignition - 12 volt	10 Amp auto reset circuit breaker required. No relay permitted
GND1	A3	Battery Negative	Connection required at or near vehicle ground point
GND2	B3	Battery Negative	
J-1939+	C1	Engine Communication - J1939 High	Configured per J-1939 physical layer specification
J-1939-	C2	Engine Communication - J1939 Low	
CAN_Shield (J-1939)	C3	Engine Communication - J1939 Shield	
J-1587+	A2	Serial Communication - Diagnostics J-1587 High	
J-1587-	B2	Serial Communication - Diagnostics J-1587- Low	
SPD1+	D1	Transmission Output Speed	
SPD1-	D2	Transmission Output Speed	
Knob_Gnd	F3	Shift Knob Ground	
Srv_ Light	D3	Power to Knob mounted service light	
Splitter_SW	E3	Voltage Signal to Splitter Switch	
Cruise /Retarder	E1, E2, F1, F2	Reserved for engine cruise / engine retarder	Contact your Eaton Fuller Engineering representative for availability.

Shift Knob

This transmission uses an electric shift knob. Unlike previous Eaton Fuller shift knobs, which switched a pneumatic signal, this knob uses an electrical signal to indicate a driver intended splitter shift.

The shift knob also includes a small transmission service lamp to alert the driver to vehicle interface malfunctions and transmission malfunctions.

Standard Shift Knob - Includes control button for transmission splitter shift

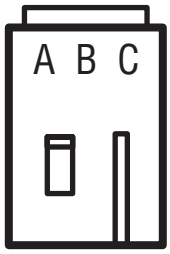
Shift Knob Connection

Packard™ 3 pin connectors are used for connection at the shift knob. A second connector at the base of the shift tower can be added by the OEM customer to facilitate shift lever installation and removal. However, this second connection could reduce harness reliability and is not recommended. This second connector must be fully sealed from external contaminants. Contact your Eaton Representative for second connector detail if this option is used.

Standard Shift Knob Connections

The standard shift knob is equipped with the following Packard™ series 150 3-way connector (female body type).

Provided by Eaton as part of the knob



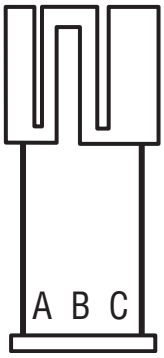
Packard 12047781 Body (female)

Packard 12047783 Secondary/Lock

Packard 12064971 Terminal Socket (22 gage)

The OEM wiring harness must use the following Packard™ series 150 3-way connector (male body type).

Provided by the OEM as part of the harness



Packard 12047782 Body (male)

Packard 12047784 Secondary Lock

Packard 12047581 Terminal Pin (18 gage)

Packard 12059894 Terminal Pin (22 gage)

OEM Vehicle Harness Pin Outs

Knob Packard Connector Pin	Circuit	Trans ECU Connector Pin
A	Srv_ Light	D3
B	Knob_Gnd	F3
C	Splitter_SW	E3

Shift Knob Lever Harness – Strain Relief

The harness portion containing the Splitter Switch, Ground, and Service Light wiring that is channeled along the shift lever, must be strain relieved to the lever in at least one location between the exit of harness from the base of the shift lever (typically at the floor board boot) and the bottom of the shift knob skirt. The harness strain relief must limit the loading to less than 3 lbs. ft. at the connection at the shift knob.

Reverse Switch

The 4302748 reverse switch will be installed by Eaton. The reverse switch is a normally open ball type switch. When the transmission is shifted to reverse, the ball is depressed and the switch closes.

Location Left side, top of transmission. See dimensional drawings for location details.

Thread Size M14 - 2.0

Mating Connector Packard P/N 12015792

Neutral Switch

The 4302749 neutral switch will be installed by Eaton. The neutral switch is a normally closed a ball type switch. When the transmission is shifted into any gear, the ball is depressed and the switch opens.

Location Left, rear, top of transmission. See dimensional drawings for location details.

Thread Size M16 - 1.5

Mating Connector Packard P/N 12015378

WARNING: This switch should not be the sole source means of detecting neutral.

Speedometer / Vehicle Speed Sensor

The speedometer / vehicle speed sensor for the Lightning transmission has significant differences from other Eaton transmissions. The transmission ECU requires a dedicated electronic drop-in speed sensor that will be installed by Eaton and will be connected to the OEM electrical harness. Additional detail is listed below on the speedometer rotor, bearing cover, and drop-in speed sensors. Contact your Eaton representative with any additional questions.

Speedometer Rotor

The Lightning transmission is supplied with a 16-tooth rotor for magnetic speed pick-up. A mechanical speedometer drive is not available on this transmission model.

Output Bearing Cover Speed Sensor Provisions

The standard output bearing cover supplied with the transmission has two drop-in speed sensor provisions. The standard cover allows provisions for two drop-in sensors available to the vehicle manufacturer at the 4:00 & 8:00 positions. The installed drop-in A-7365 sensor dedicated to the transmission ECU is installed at the 10:00 c position. The option is available for Eaton to install the single, or dual, output sensor(s) in either of the two available drop-in positions (4:00 & 8:00).

The optional output bearing cover has two threaded speed sensor provisions. The optional cover allows provisions for two threaded sensors available for the vehicle manufacturer at the 4:00 & 8:00 positions. The installed drop-in A-7365 sensor dedicated to the transmission ECU is installed at the 10:00 c position. Eaton will not install the threaded speed sensor type. See dimensional information for location details.

Detroit Diesel Optimized Idle System

When this system is activated an additional low output / low gain thread-in or drop-in output speed sensor may be needed in addition to the dedicated drop-in speed sensor supplied by Eaton. Contact Detroit Diesel for additional information.

"Drop-in" Speed Sensor

Drop-in speed sensors are available from Eaton. These are a non-adjustable magnetic style. Two types are available, single output or dual output.

Speed Sensor Specifications:

Output voltage .5V peak to peak

Sensor resistance 2K - 5K ohms

Sensor Inductance 1 to 5 Henries

Connector Packard Metri-Pack 150

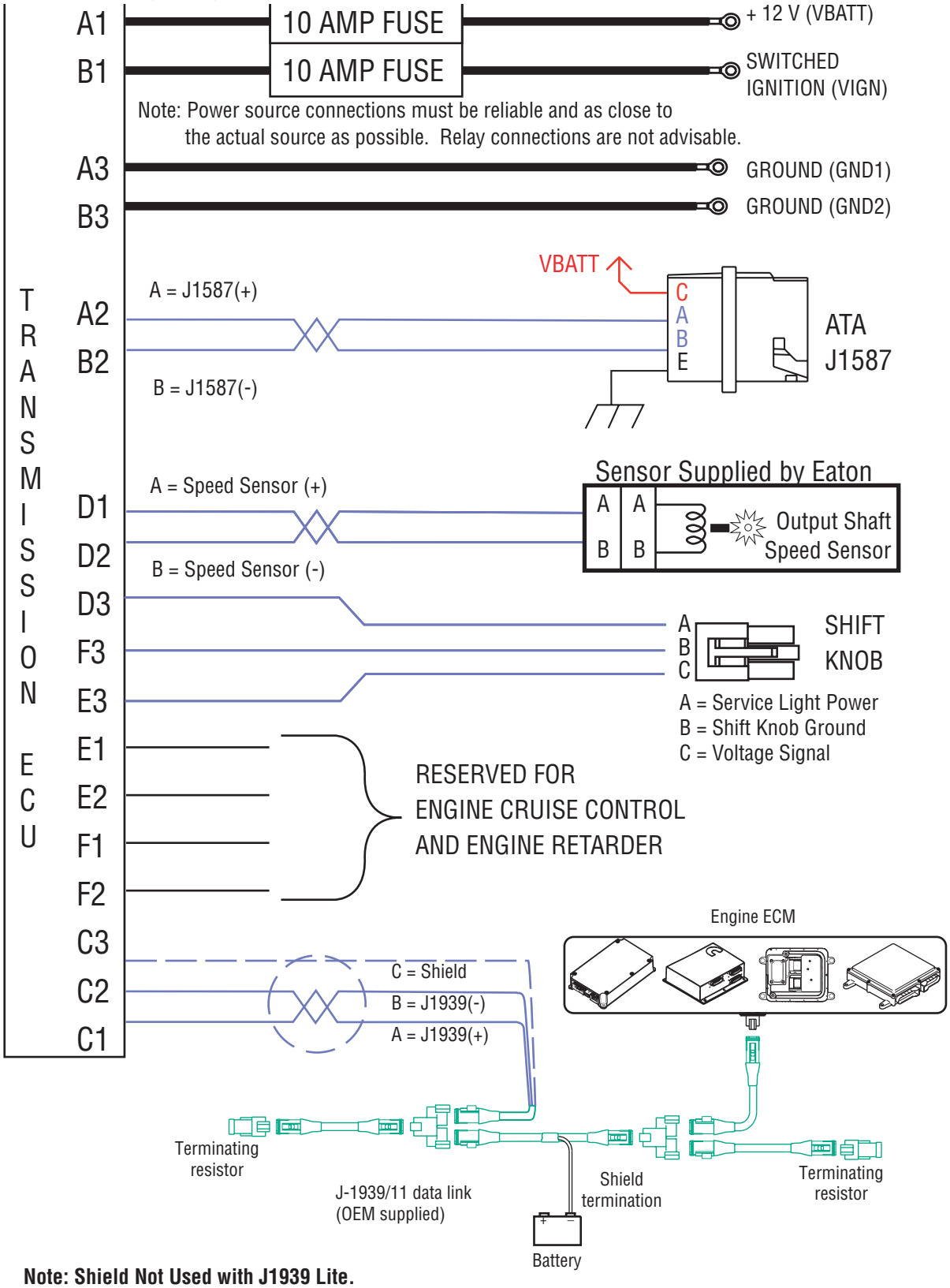
Single Output Sensor (Two Terminal) Eaton Fuller P/N A-7365

Mating Connector Parts	Eaton Fuller P/N	Packard P/N
Connector Body	5506567	12162192
Connector Seal	5507525	12040750
Cable Seal	5507526	12040751
Assembly		12162193
Socket	5507046	12124075

Dual Output Sensor (Four Terminal) Eaton Fuller P/N A-7366

Mating Connector Parts	Eaton Fuller P/N	Packard P/N
Connector Body	5506607	12162187
Connector Seal	5507534	12040756
Cable Seal	5507535	12040757
Assembly		12162188
Socket	5507046	12124075

Vehicle Wiring Diagram



Note: Shield Not Used with J1939 Lite.

Transmission Application Approval

Transmission Application Approval Form

The intended use of all transmission installations must be approved by Eaton Fuller engineering. Complete Form FUL-170 and submitted to: Email: TransApplications@Eaton.com, Fax: 269-342-3574. All notes and limitations on Form FUL-169L apply.

Wiring harness design and construction must also be approved by Eaton Fuller engineering. Contact your Eaton Fuller Engineering representative for details.

Driveline Torsional Vibration

Transmission input torque spikes due to drive train resonance, must be less than 300 lbs. ft. above the nominal transmission input torque rating for engine speeds above 1000 rpm and vehicle road speeds above 20 mph. This requirement may demand careful attention to driveline operating in addition to the required "soft damped clutch".

For additional help with Driveline Vibration, see RRMT-0001 and RRMT-0002 on www.Roadranger.com.

Transmission Application Approval Forms

FUL-170

Eaton® Fuller®

Application Approval Form FUL-170 – Rev. 01/04

Transmissions

Approval I.D. No.: _____ **Dealer Information**

Chassis #(s): _____ Dealership Name: _____

No. of Vehicles: _____ Dealer Address: _____

Projected Build Date: _____

OEM / Plant Location: _____ / _____ Contact: _____

Customer/Fleet: _____ Telephone: _____ FAX: _____

APPROVAL REQUEST FOR: Transmission Model _____ Oil Cooler: ☐ YES ☐ NO

ENGINE INFORMATION:

Make: _____ Model: _____ Displacement: _____ Liters

Rated Horsepower _____ at _____ RPM Peak Torque _____ Lbs-ft at _____ RPM

Governed Speed: _____ RPM Top Speed Limit Setting _____ MPH Cruise Speed _____ MPH

DRIVELINE INFORMATION:

Rear Axle	Make:		Model:		Ratios:	/	
Drive Tires	Make:		Model:		Size:	or Revs/Mile	
Retarder	Make:		Model:		Type:	HP	
Clutch	Make:		Model:				
Trans Case /Aux. Trans	Make:		Model:		Ratios:	/	

CHASSIS INFORMATION

Model: _____ Drive Configuration (6x4, 4x2) _____ Vehicle Voltage (12 or 24v) 12 V

Max Weight on Drive Wheels _____ Lbs Max GVW _____ Lbs Max GCW _____ Lbs

VOCATIONAL AND BODY SPECIFIC INFORMATION:

Vocation (Line Haul, Dump, Refuse, Mixer, etc) _____

Body Type _____ Trailer Type _____ # Trailers _____

Area of Operation: Country(s) _____ State / Province/Region _____

Road Usage: Highway _____ % Secondary/City _____ % Off-Highway _____ % Off-Road _____ %

Maximum Grade on Which Vehicle will be Required to Operate _____ %

TRANSMISSION FEATURE / OPTION REQUIREMENTS: (CHECK BOX OF APPROPRIATE CONFIGURATION)

PTO Usage: None ☐ 6 Bolt Engine ☐ Split-Shaft ☐ Countershaft: 6 Bolt ☐ 8 Bolt ☐ Aux ☐

PTO Model: _____ PTO Driven Equipment: _____

PERSON SUBMITTING REQUEST _____ **PHONE:** _____ **FAX:** _____

FIRM NAME & ADDRESS:

THIS APPLICATION IS:
ADDITIONAL NOTES / REQUIREMENTS:
SIGNED: **APPLICATION ENGINEER:** **DATE:**

1. This Application Approval Form (FUL-170) is intended for use as an approval for warranty ONLY. An approval indicates that the given configuration meets the minimum requirements of the specified product; it does not indicate approval to ship the product.
2. All Eaton warranty guidelines apply for coverage and specific labor repair times. Reference Eaton publications TCWY-0600 and TCWY-0900.
3. Refer to form FUL-169 ( ) for Blanket Application Requirements.

Eaton Corporation – TOA
P.O. Box 4013
Kalamazoo, MI 49003
Phone: (269) 342-3000
Fax: (269) 342-3574
TransApplications@Eaton.com

FUL-169

Eaton® Fuller®
Transmissions

Form FUL-169L

APPROVED ON-HIGHWAY* APPLICATIONS FOR EATON LIGHTNING TRANSMISSIONS

Written Approval Required For All Applications Not Meeting the Requirements of This Form - Use Form FUL-170 (Request for Application Approval).

General requirements that must be met by ALL applications (Blanket or Submitted):

- All requirements for the base product as stated on Form FUL-169 must be met.
  Products included in this approval are:

FRLO-14410C, FRLO-14410C- T2
FRLO-15410C, FRLO-15410C- T2
FRLO-16410C, FRLO-16410C- T2

For Engines certified by Eaton for use with Lightning transmissions, see form FUL-200T (Top 2 and Lightning Engine Compatibility matrix).
Transmissions are in compliance with SAE J1939 requirements, the OEM is responsible to ensure Compatibility with other J1939 devices.
Vehicle air system must include an air dryer.
Eaton approved synthetic lubricant required - per form TCMT-0021.
Vehicle must have 12-volt electrical system.
SAE J1922 ATC (Automatic Traction Control) is not compatible with Lightning.
CAT Brakesavers are not allowed for use with Lightning.
Vehicles must have a minimum of .3% gradeability at cruise speed and 1% gradeability at peak torque. Calculations are to be made at maximum rated conditions
Vehicles are to be used in USA, Canada and Mexico only. International / export sales will not be approved at this time.

Requirements that must be met for blanket approval – ***Applications not meeting these guidelines must be submitted to Eaton for approval.***

All applications above 80,000lb GCW need to be submitted for individual approval. (See note #1)
All applications for non-typical highway (i.e. dump, refuse, and other “vocational” applications) need to be submitted for individual application approval.

Note #1: This requirement is largely due to the uncertainty in the industry regarding cooling system performance (both temperature and flow), particularly with ‘02 emission engines. As the industry gains experience with the cooling system requirements for these new engines, the GCW limits will be reviewed.

*On-Highway is defined as limited access and general highways. Grades less than 8%, well maintained, concrete or asphalt surface, no more than 10% off-highway operation. Maintained gravel, crushed rock, hard packed dirt or similar road surfaces are acceptable when grades are less than 3%.

12/02

Line Inspection

This line inspection section was developed as an installation tool for line personnel to help ensure the correct operation of the Lightning transmission as it is installed in each vehicle. This general guide is a starting point that can be integrated into existing line assembly procedures.

Pre-Start Checks

These items should be conducted prior to the initial engine start-up.

1. Turn the key switch and visually observe the shift knob. Does the service light turn on? If yes, there is ignition power to the transmission. Perform the test with the splitter button in high and low split.
2. Visually verify that the transmission ignition power supply is protected by an automatic resetting 15 amp/12 VDC fuse or circuit breaker.
3. Visually verify that the battery power is protected by an automatic resetting 15 amp/12 VDC fuse or circuit breaker.
4. Verify the transmission has been filled with the correct amount and type of lubricant before starting the engine. The Lightning slight plug can be utilized to determine the correct amount. Use only Eaton Roadranger CD-50 or Eaton approved E-500 lubricant.
5. Verify the engine VEP settings are set properly. The engine controller should be set with
    a. 5.1. Top2 – Disabled or off
    b. 5.2. Transmission Solenoids – Disabled or off
    c. 5.3. J-1939 - Enabled

Dyno/Road Test

1. Verify correct clutch adjustments and correct pedal free travel per clutch manufacturer's specifications.
2. Verify through normal operations that the temperature gauge (if installed) is functional.
3. Note that the AutoRange feature will not trigger the range air shift if the vehicle is not moving (this is different than the AutoRange function on the Super-10 transmission).
4. Verify through normal operations that the engine brake functions correctly per the manufacturer's specifications.
5. Verify, during operation on the dyno or road test, proper operation of the splitter button, AutoRange shift, and the Top-2 function.
6. Visually check for lubricant and engine coolant drips or residue on the transmission and related cooler lines.
7. Make sure that the correct transmission dash label is present and that the driver's instruction booklet is included with the other vehicle information.
8. Verify that the transmission diagnostic port (SAE J-1587) is accessible, either mounted on the dash left side or just under the dash left side.
9. Verify that the label to alert the customer of the type and brand of lubricant used on the transmission is attached to the transmission or included with the other vehicle information.
10. Clear historical fault codes by using the ignition key switch. To do this, place the shift lever in Neutral and set the parking brakes. Begin with the key in the ON position. Turn the key off and back on six times within five seconds (OFF/ON/ OFF/ON/ OFF/ON/ OFF/ON/ OFF/ON/ OFF/ON).

Appendix

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 forces 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.

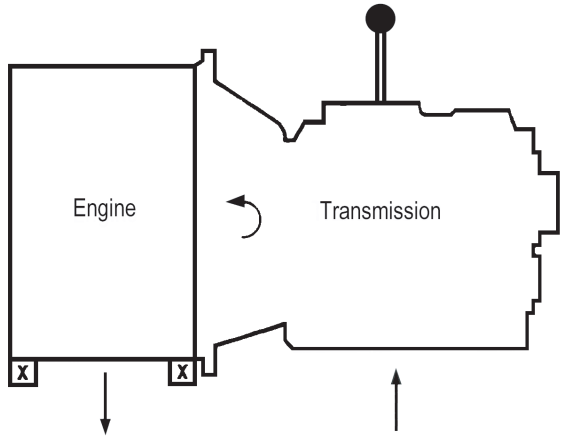
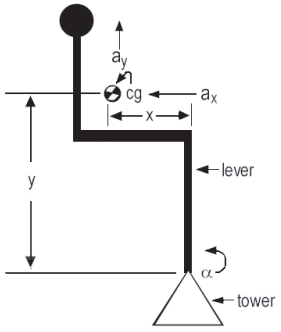


Figure 1



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

T_j = Jumpount torque
M = Mass of lever
I = Moment of intertia 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

Figure 2

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 drivetrain has very low torque, such as vehicle coast conditions, since friction from torque in the drivetrain locks the engaged sliding clutch to the gear and greatly overcomes any jumpout forces imposed.

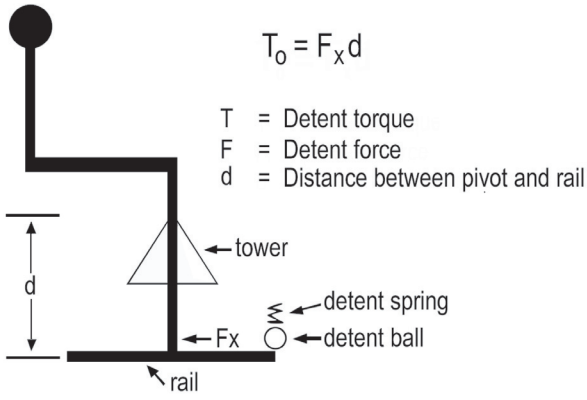
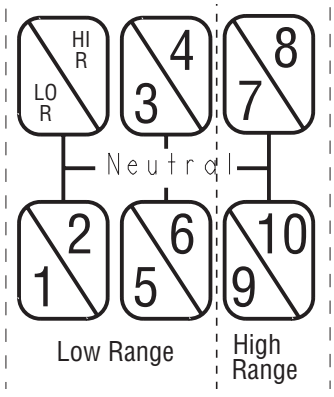


Figure 3

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 matches 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:

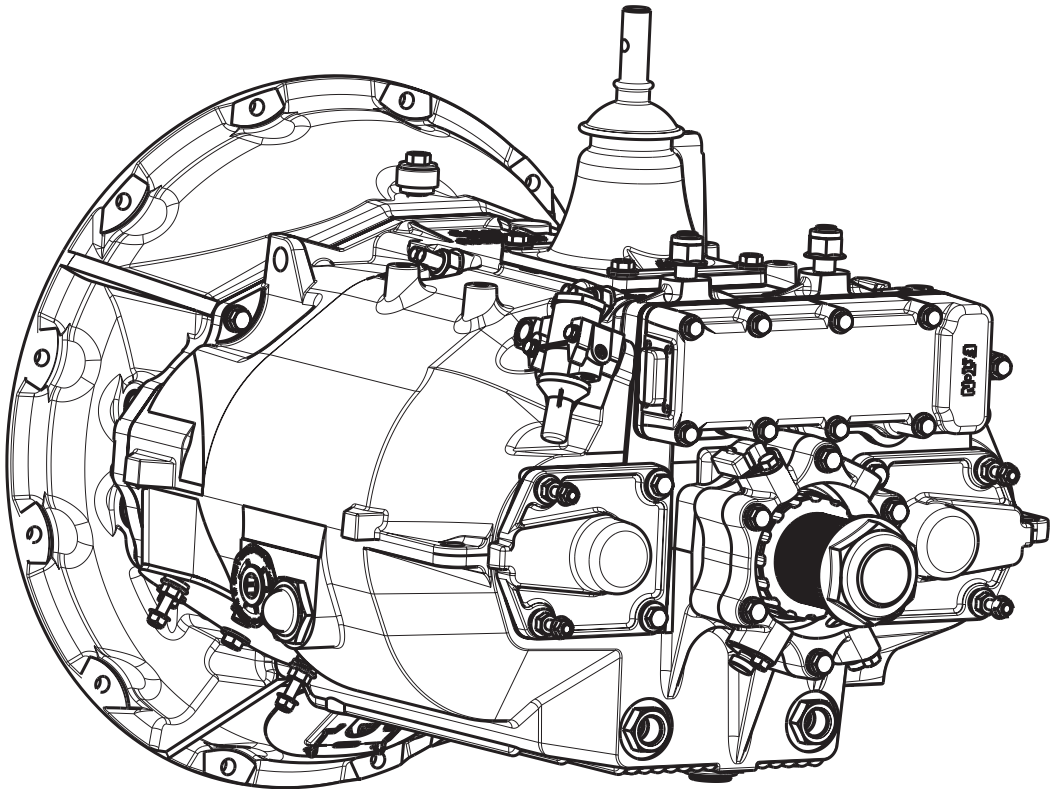
1. Design shift lever offsets forward of the shift lever pivot point. As Figure 2 shows, when the lever center of gravity is forward of the shift tower, the inertial torque due to the vertical acceleration from road-induced vibration will counteract the dominating rotational acceleration, resulting in 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 mode 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, RT, FR, FRO Transmission Models - 5.5/1 to 6.5/1.

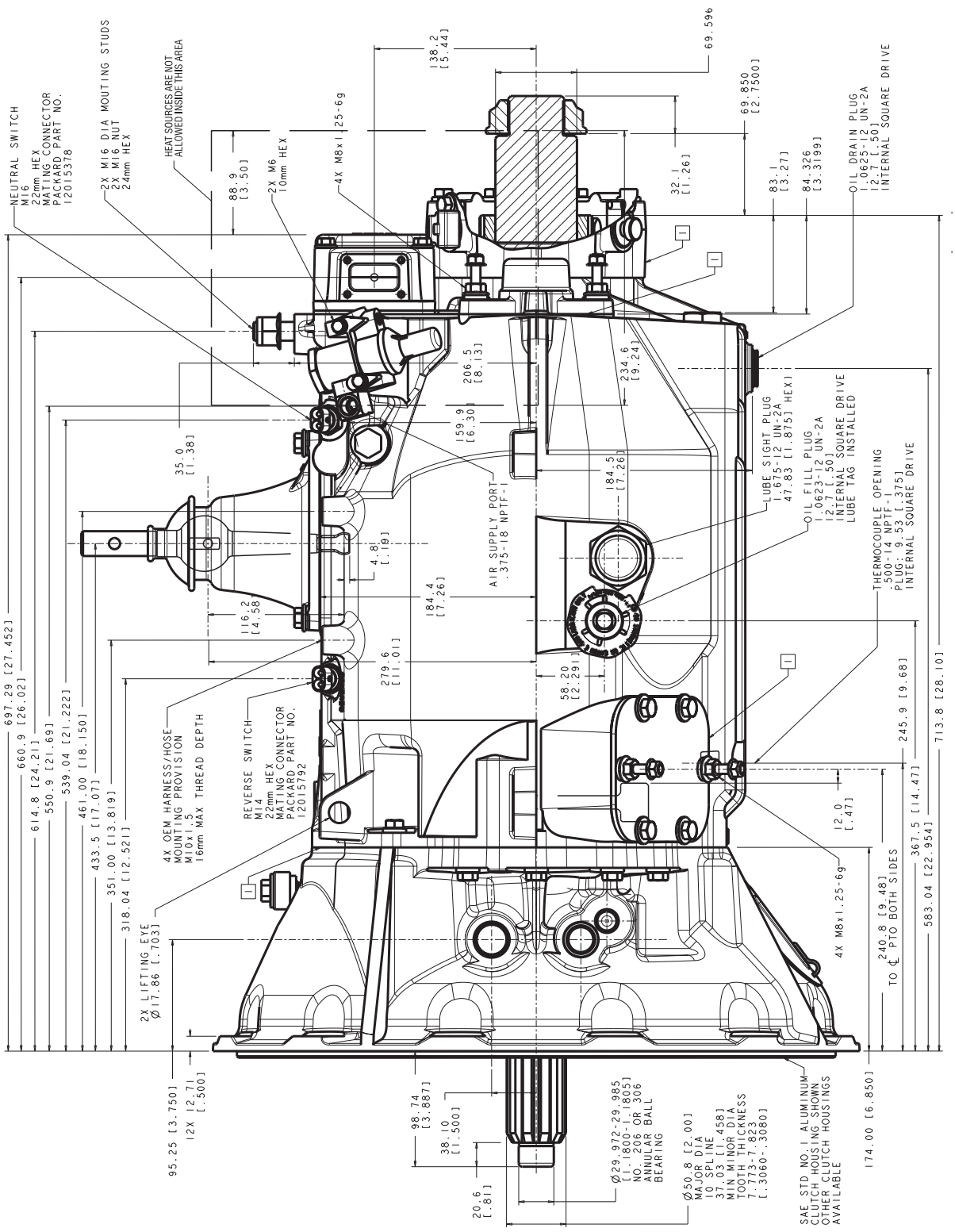


Ratios

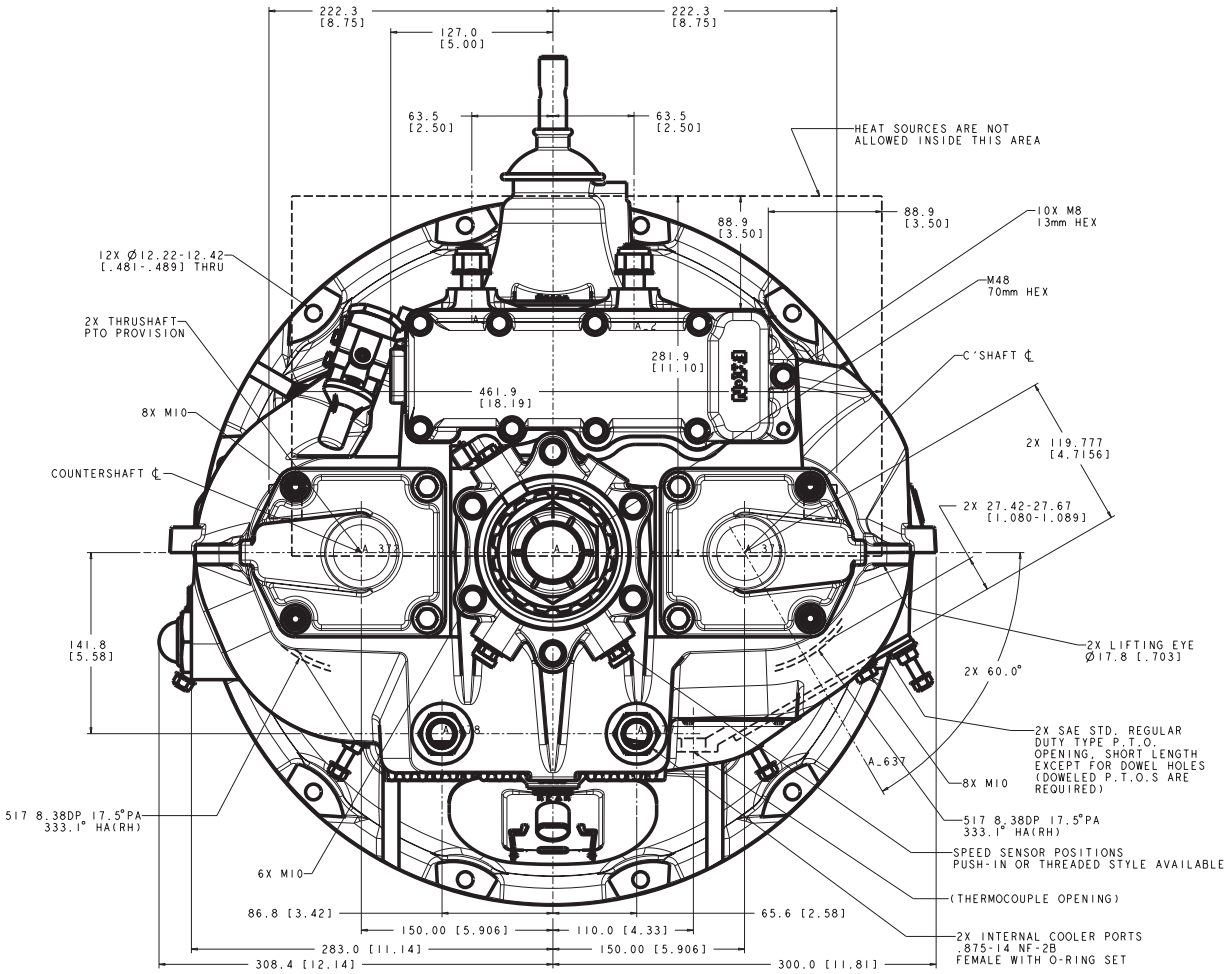
Speed	Ratio	% Step
10th	0.74	
9th	1.00	36
8th	1.39	41
7th	1.88	36
6th	2.64	40
5th	3.57	39
4th	4.95	36
3rd	6.72	36
2nd	9.33	39
1st	12.66	36
Hi Rev	9.17	
Lo Rev	12.43	
Overall Ratio	17.15 to 1	



Side View


NEUTRAL SWITCH
M16
22mm HEX
MATING CONNECTOR
PACKARD PART NO.
12015378
2X M16 DIA MOUTING STUDS
2X M16 NUT
24mm HEX
HEAT SOURCES ARE NOT
ALLOWED INSIDE THIS AREA
88.9
[3.50]
2X M6
10mm HEX
4X M8x1.25-6g
138.2
[5.44]
69.596
69.850
[2.7500]
32.1
[1.26]
83.1
[3.27]
84.326
[3.3199]
OIL DRAIN PLUG
1.0625-12
[27.00-2A]
INTERNAL SQUARE DRIVE
206.5
[8.13]
234.6
[9.24]
159.9
[6.30]
35.0
[1.38]
LUBE SIGHT PLUG
1.675-12 UN-2A
47.83 [1.875] HEX)
OIL FILL PLUG
1.0623-12.7
[27.00-2A]
INTERNAL SQUARE DRIVE
LUBE TAG INSTALLED
184.5
[7.26]
AIR SUPPLY PORT
.375-18 NPTF-1
4.8
[.19]
184.4
[7.26]
116.2
[4.58]
279.6
[11.01]
58.20
[2.291]
THERMOCOUPLE OPENING
.500-14 NPTF-1
PLUG: 9.53 [.375]
INTERNAL SQUARE DRIVE
697.29 [27.452]
660.9 [24.21]
614.8 [24.21]
550.9 [21.69]
539.04 [21.222]
461.00 [18.150]
433.5 [17.07]
351.00 [13.819]
318.04 [12.521]
4X OEM HARNESS/HOSE
MOUNTING PROVISION
M10x1.5
16mm MAX THREAD DEPTH
REVERSE SWITCH
M14
22mm HEX
MATING CONNECTOR
PACKARD PART NO.
12015792
245.9 [9.68]
713.8 [28.10]
12.0
[.47]
367.5 [14.47]
583.04 [22.954]
4X M8x1.25-6g
240.8 [9.48]
TO ℄ PTO BOTH SIDES
2X LIFTING EYE
Ø17.86 [.703]
95.25 [3.750]
12X 12.71
[.500]
98.74
[3.887]
38.10
[1.500]
20.6
[.81]
Ø29.972-29.985
[1.1800-1.1805]
NO. 206 OR 306
ANNULAR BALL
BEARING
Ø50.8 [2.00]
MAJOR DIA
10 SPLINE
37.03 [1.458]
MINIMUM DIA
TOOTH THICKNESS
7.773-7.823
[.3060-.3080]
174.00 [6.850]
SAE STD NO.1 ALUMINUM
CLUTCH HOUSING SHOWN
OTHER CLUTCH HOUSINGS
AVAILABLE

Rear View


222.3 [8.75]
127.0 [5.00]
222.3 [8.75]
63.5 [2.50]
63.5 [2.50]
HEAT SOURCES ARE NOT ALLOWED INSIDE THIS AREA
88.9 [3.50]
88.9 [3.50]
10X M8 13mm HEX
12X Ø12.22-12.42 [.481-.489] THRU
M48 70mm HEX
2X THRUSHAFT PTO PROVISION
281.9 [11.10]
C'SHAFT ℄
461.9 [18.19]
8X M10
2X 119.777 [4.7156]
COUNTERSHAFT ℄
2X 27.42-27.67 [1.080-1.089]
141.8 [5.58]
2X LIFTING EYE Ø17.8 [.703]
2X 60.0°
2X SAE STD. REGULAR DUTY TYPE P.T.O. OPENING, SHORT LENGTH EXCEPT FOR DOWEL HOLES (DOWELED P.T.O.S ARE REQUIRED)
8X M10
517 8.38DP 17.5°PA 333.1° HA(RH)
517 8.38DP 17.5°PA 333.1° HA(RH)
SPEED SENSOR POSITIONS PUSH-IN OR THREADED STYLE AVAILABLE
6X M10
(THERMOCOUPLE OPENING)
86.8 [3.42]
65.6 [2.58]
150.00 [5.906]
110.0 [4.33]
2X INTERNAL COOLER PORTS .875-14 NF-2B FEMALE WITH O-RING SET
283.0 [11.14]
150.00 [5.906]
308.4 [12.14]
300.0 [11.81]

Note: Features and specifications listed in this document are subject to change without notice and represent the maximum capabilities of the software and products with all options installed. Although every attempt has been made to ensure the accuracy of information contained within, Eaton makes no representation about the completeness, correctness or accuracy and assumes no responsibility for any errors or omissions. Features and functionality may vary depending on selected options.

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