Installation Guide

Eaton Fuller® Heavy-Duty Transmissions TRIG2400

June 2007

FR-11210B
FR-12210B
FR-13210B
FR-14210B
FR-15210B
FR-9210B
FRF-11210B
FRF-12210B
FRF-13210B
FRF-14210B
FRF-15210B
FRF-9210B
FRO-11210B
FRO-11210C
FRO-12210B
FRO-12210C
FRO-13210B
FRO-13210C
FRO-14210B
FRO-14210C
FRO-15210B
FRO-15210C
FRO-16210B
FRO-16210C
FRO-17210C
FRO-18210C
FROF-11210B
FROF-11210C
FROF-12210B
FROF-12210C
FROF-13210B
FROF-13210C
FROF-14210B
FROF-14210C
FROF-15210B
FROF-15210C
FROF-16210B
FROF-16210C

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Transmission Specifications

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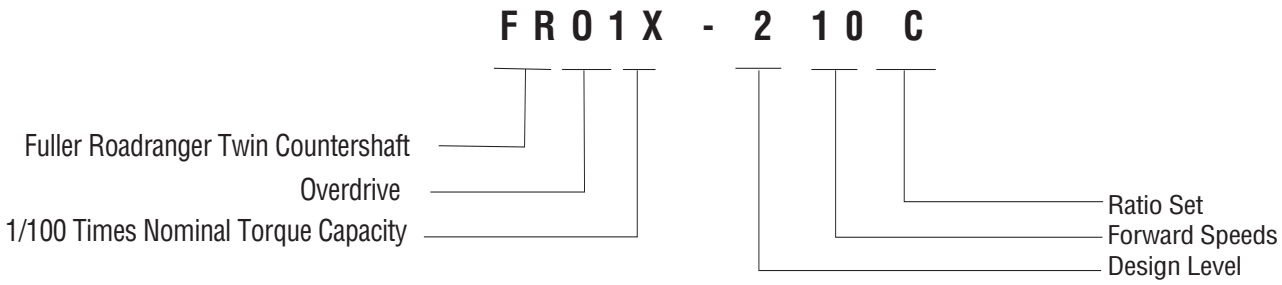
Transmission Specifications

Transmission Nomenclature

Model Designation Nomenclature

FR/FRO-1X210C



Ratios and Steps

Ten Speed Models

Gear Position	FR-1X210B		FRO-1X210B		FRO-1X210C		FRO-17210C &18210C	
	Ratio	Step In%	Ratio	Step In%	Ratio	Step In%	Ratio	Step In%
10	1.00		0.75		0.74		0.74	
9	1.34	34	1.00	34	1.00	35	1.00	35
8	1.81	35	1.36	35	1.38	38	1.38	38
7	2.45	35	1.83	35	1.90	38	1.90	38
6	3.32	35	2.48	35	2.59	37	2.64	39
5	4.46	35	3.34	35	3.62	40	3.62	37
4	5.97	34	4.46	34	4.90	35	4.90	35
3	8.09	35	6.05	35	6.75	38	6.75	38
2	10.95	35	8.19	35	9.29	38	9.29	38
1	14.80	35	11.06	35	12.69	37	12.94	39
HI Rev	3.63		2.72		2.81		2.81	
Lo Rev	16.21		12.12		13.75		13.75	
Overall Ratio	14.80		14.80		17.17		17.51	

Installation Length

	All Models & Series
From the Front Face of a Standard#1 Clutch Housing to the Front Face Of End Yoke in mm. [inch]	759.5 [29.9]

Transmission Dry Weight in kg [lbs.]

Series	900-1400		1500-1700	
Transmission Weight	268 [589]	268 [589]	272 [599]	272 [599]
SAE #1 Aluminum Clutch Housing Weight	10.4 [23]		10.4 [23]	
SAE #1 Cast Iron Clutch Housing Weight		34.5 [76]		34.5 [76]
Total Transmission Weight With Aluminum Clutch Housing	278 [612]		282 [622]	
Total Transmission Weight With Cast Iron Clutch Housing		302 [665]		306 [675]

Transmission Center of Gravity Location

with SAE No. 1 Aluminum Clutch Housing Less Shift Tower

Coordinates	Viewed From	Measured From	Direction	Values In mm [inch]
Longitudinal	Left Side	Front Face of Main Case	Rearward	251 [9.88]
Vertical	Left Side	Mainshafts Center Line	Upward	25.7 [1.01]
Lateral	Rear	Mainshafts Center Line	Left	0.0 [0.0]

Transmission Inertia (In Neutral)

Inertia in kg. m [ft.-lb. sec^2]	.13 [.093]

Oil Capacity and Fill

Nominal Oil Volume In liters [pints]		11.1 [23.5]
Oil Fill	OEM	To The Bottom Edge Of Filter Plug Hole

Transmission Specifications

Torque Capacity

Engineering Approval Required For Specific Application

FR-9210B			1288 N.m [950 Lb. ft.]
FR-11210B	FRO-11210B	FRO-11210C	1559 N.m [1150 Lb. ft.]
FR-12210B	FRO-12210B	FRO-12210C	1695 N.m [1250 Lb. ft.]
FR-13210B	FRO-13210B	FRO-13210C	1830 N.m [1350 Lb. ft.]
FR-14210B	FRO-14210B	FRO-14210C	1966 N.m [1450 Lb. ft.]
FR-15210B	FRO-15210B	FRO-15210C	2102 N.m [1550 Lb. ft.]
	FRO-16210B	FRO-16210C	2237 N.m [1650 Lb. ft.]
		FRO-17210C	2373 N.m [1750 Lb. ft.]
		FRO-18210C	2508 N.m [1850 Lb. ft.]

Transmission Dry Weight in kg (lbs) with Internal Cooler Option

Series	1800	
Transmission Weight	299 [660]	299 [660]
SAE #1 Aluminum Clutch Housing Weight	10.4 [23]	
SAE #1 Cast Iron Clutch Housing Weight		34.5 [76]
Total Transmission Weight with Aluminum Clutch Housing	310 [683]	
Total Transmission Weight with Cast Iron Clutch Housing		334 [736]

Transmission Center of Gravity Location with Internal Cooler Option

with SAE No. 1 Aluminum Clutch Housing Less Shift Tower

Coordinates	Viewed From	Measured From	Direction	Values In mm [inch]
Longitudinal	Left Side	Front Face of Main Case	Rearward	247.7 [9.75]
Vertical	Left Side	Mainshafts Center Line	Below	12.7 [0.50]
Lateral	Rear	Mainshafts Center Line	Left	1.5 [0.06]

Oil Capacity and Fill with Internal Cooler Option

Nominal Oil Volume in liters [pints]		15.1 [32]
Oil Fill	OEM	To the Bottom Edge of Filter Plug Hole

Lubrication Requirements

Proper lubrication procedures are the key to a good all around maintenance program.

Eaton Fuller Transmission are designed so that the internal parts operate in an oil circulating bath created by the motion of the gears and shafts.

Thus, all parts are amply lubricated if these procedures are closely followed:

1. Maintain oil level.
2. Inspect regularly.
3. Follow maintenance interval chart.
4. Use the correct grade and type of oil.
5. Buy from a reputable dealer.

Operating Temperatures

Transmissions must not be operated at temperatures above 250°F [120°C]. Operation at temperatures above 250°F [120°C] causes loaded gear tooth temperatures to exceed 350°F [177°C] which will ultimately destroy the heat treatment of the gears. If the elevated temperature is associated with an unusual operating condition that will recur, a cooler should be added, or the capacity of the existing cooling system increased.

The following conditions in any combination can cause operating temperatures over 250°F [121°C].

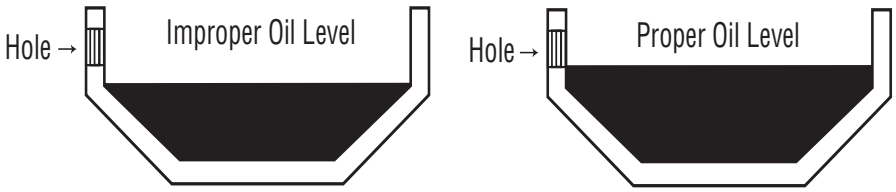
- Operating consistently at slower speeds
- High ambient temperatures
- Restricted air flow around transmission
- High horsepower
- Use of engine retarder

Transmission coolers must be used to reduce operating temperatures when the above conditions are encountered.

Note: For addition lubrication information, see TCMT-0021.

Proper Oil Level

Make sure oil is level with the filler opening. Because you can reach oil with your finger does not mean oil is at proper level. **(One inch of oil level is about one gallon of oil.)**



When adding oil, types and brands of oil should not be mixed because of possible incompatibility.

Transmission Operating Angles

If the transmission operating angle is more than 12 degrees, improper lubrication will occur. The operating angle is the transmission mounting angle in the chassis plus the percent of upgrade (expressed in degrees).

For operating angles over 12 degrees, the transmission must be equipped with an oil pump or cooler kit to insure proper lubrication.

Recommended Lubricant Types and Application*

See Form TCMT-0019, Eaton Fuller heavy duty and mid range transmissions "Lubrications Requirements".

WARNING: Do not use EP oils in the Transmissions!

Transmission Operating Limits

Contact Eaton Applications Engineering for the correct applications for approval.

Transmission Application Approval Request

Contact Eaton Applications Engineering for the correct application approval form.

Air Specifications

Master Valve: Same As Current Product

Thread Size	1/2"-13 UNC
Jam Nut Across Flats Dimension MM. [inch]	19.05 [0.75]

Vehicle Air Supply Requirement

Air Pressure, kPA [PSI] *	620-896 [90-130]
Air Type	Clean and Dry
Air Supply Port (IN)	SAE 3/8"-18 NPTF Pipe Thread
Air Supply Port Location (IN)	Refer to Appendix "Shift Bar Housing"
Pilot (P)	SAE 1-16"-27 NPTF Pipe Thread
Pilot Port Location (P)	Refer to Appendix "Shift Bar Housing"

Air Control Module Port Identification

Port	Description	Size
P	Range Pilot	1/16"-27 PTF
S	Source Air 517-586 kPA [75-85 PSI]	1/16"-27 PTF
H	High Range Air Cylinder Pressure	1/16"-27 PTF
L	Low Range Air Cylinder Pressure	1/16"-27 PTF
IN	Air Supply Port	3/8"- 18 PTF
F	Filtered Unregulated Air	1/16"-27 PTF

* Transmission must have an uninterrupted air supply to assure proper performance for all operating conditions. A 3/8" O.D. supply air line size or larger is recommended.

Note: Air additives such as alcohol or deicer should not be permitted to enter the air supply. Additives could cause damage to air system components which could lead to degraded transmission performance.

Interface Features

Air Fittings

(per D.O.T./FMVSS 106)

Type	Straight Push-In
Material	Brass
Threads	1/16" - 27 PTF-1 Short
Hex Head Size mm [inch]	9.65 [0.38]
Thread Sealant	Yes

Air Lines

(per D.O.T./FMVSS 106)

Size, mm [inch]	4.0 [5/32]
Material	Nylon
Colors	Black (P Port)
	Red (S Port)

Available Options

Models		FR-XX210B	FRO-1X210B		FRO-1X210C		
Options	Series	900-1400	1100-1400	1500-1600	1100-1400	1500-1700	1800
Integral Oil Pump		Option	Option	Std.	Option	Std.	Option
Thru-Shaft PTO		Option	Option	Option	Option	Option	Option
Neutral Switch Provision		Std.	Std.	Std.	Std.	Std.	Std.
Neutral Switch		Option	Option	Option	Option	Option	Option
Reverse Switch Provision		Std.	Std.	Std.	Std.	Std.	Std.
Reverse Switch		Option	Option	Option	Option	Option	Option
FR Shift Bar Housing		Std.	N/A	N/A	N/A	N/A	N/A
FRO Shift Bar Housing (+)		N/A	Std.	Std.	Std.	Std.	Std.
FR Forward Shift Bar Housing		Option	N/A	N/A	N/A	N/A	N/A
FRO Forward Shift Bar Housing (+)		N/A	Option	Option	Option	Option	Option
(+) with an "X" mechanism to maintain standard progressive "H" shift pattern.							
Internal Cooler		Option	Option	Option	Option	Option	Option

Driver Controlled Main Differential Lock Applications or Controlled Traction Differentials

The following lists the recommended practice for single and tandem drive axles with driver controlled main differential lock applications or controlled traction differentials (CTD).

1. Connections are permitted for signal purposes only. No connections are allowed that will use air to power any device.
2. Signal purposes are defined as devices that do not consume any significant volume of air, more than 32.77 cc.568 MPa (2.0 cubic inches @ 85 PSIG) of air to fill and actuate these devices including connecting plumbing paraphernalia.
3. Maximum connecting line size is 5/32 inch O.D (.096 inch I.D.), such as our DOT air tubing used for connecting the Roadranger Shift Knob to the transmission.

Note: The 5/32 inch DOT tubing has an internal volume of .0869 cubic inch per foot of length which equates to 11.5 feet of length per cubic inch of volume.

A potential source for a relay valve for use with the traction control is:

Humphrey Products
P.O. Box 2008
Kalamazoo, MI 49003
Phone 269-381-5500 (Fax 269-381-4113)

Humphrey Products offers a 1/4" orifice 3-way normally open pilot valve (part number 250A-3-11-21A-VAI (-20 versus -21A if a base is not needed)) which should be ordered with a Viton elastomer seal. This valve has a volume capacity on the pilot side of less that 0.5 cubic inches.

Supply air to the inlet of the normally open pilot valve should be from the same vehicle air source as used by the transmission. The outlet of the valve should be plumbed to the air supply for the traction control system. Use a 5/32 O.D. DOT tubing air line from the transmission air module high range cylinder port labeled "H" (air module top right-hand side near the air supply port) to the valve pilot port. Therefore, air will be permitted to flow only when either high range or synchro-saver modes are not in effect.

Warning: Equivalent 6 & 7 product models are plumbed such that a normally closed valve is used and pilot air is supplied from the low range port "L" on the slave valve. Therefore, do not use the same model valve as used by the 6 & 7 series product and do not use the pilot signal from the " L" port on the FR Series air module. This change is due to the use of a synchronizer protection device. Anytime the transmission is in gear, either high or low range there will be pressure in the "L" port on the FR Series air module.

Shifters

Shift Tower Options**

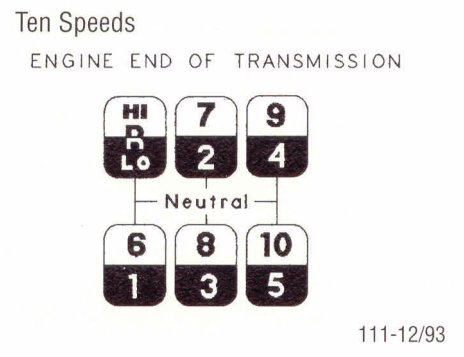
Tower Locations*	Standard		Forward
Tower Type**	Low	Mid	High
Fore/Aft Locations From Front of Clutch Housing [in]	17.07***		14.54***

*See Appendix
** Same as current towers, except metric mounting screws.
*** Same as 6 and 7 series products.

Shift Pattern

All models will have standard progressive "H" shift pattern.

Ten Speeds



Shift Controls

Note: For Shift Controls, 5.5 - 6.5:1 Mechanical Advantage is Recommended.

Remote Controls*	SRC	LRC	RLC
Designation	Single Rod Control	Low Remote Control	Remote Lever Control
Shift Lever***	Same as 6 & 7 series products **		
Lever Isolator	Same as 6 & 7 series products		

* Same as current controls, except metric mounting screws.

** Shift knob threads are 1/2-13 inch.

***Use the appropriate ratios (Appendix: Shift Levers) for computing the in-cab shift knob envelope of various tower and shift lever combinations.

Switches*

Reverse***	Location in Shift Bar Housing	In left rear quadrant **
	Supply Voltage	12 and 24 volts
	Type	Normally open (closed and reverse)
	Connector type	Packard weather-pack (connector p/n 120157952 with 12124582 (M) terminal and 12010293 cable seal (or equivalent)
	Threads	M14X2.00
	Wrench Size	22 mm
Neutral ***	Location in Shift Bar Housing	At the rear on center**
	Supply Voltage	12 and 24 volts
	Type	Normally Closed (closed in neutral)
	Connector type	Packard weather-pack (connector p/n 12015378 with 12124582 (M) terminal and 12010293 cable seal (or equivalent)
	Threads	M16x1.50
	Wrench Size	22 mm

* Provisions are standard, switches are optional.
** See Appendix.
*** For actuation characteristics see the switch drawings on pages 11 & 12.

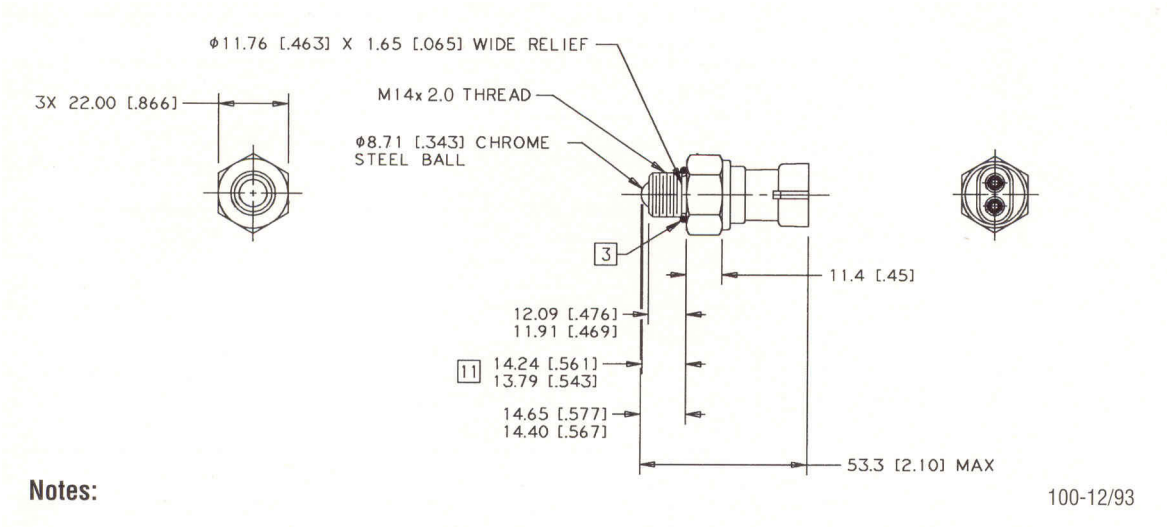
WARNING: This switch should not be the sole source means of detecting neutral.

Electronic Speed Sensor - Push In

Eaton Part Number	A-6724	A-6736
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	12040750	12040756
*Packard Cable Seal	12040751	12040757
**Packard Socket Number (Quantity)	12124075 (2)	12124075 (4)
*Used To Make Packard Assembly **Need both Packard Assembly andPackard Sockets for proper wiring harness interface.		

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

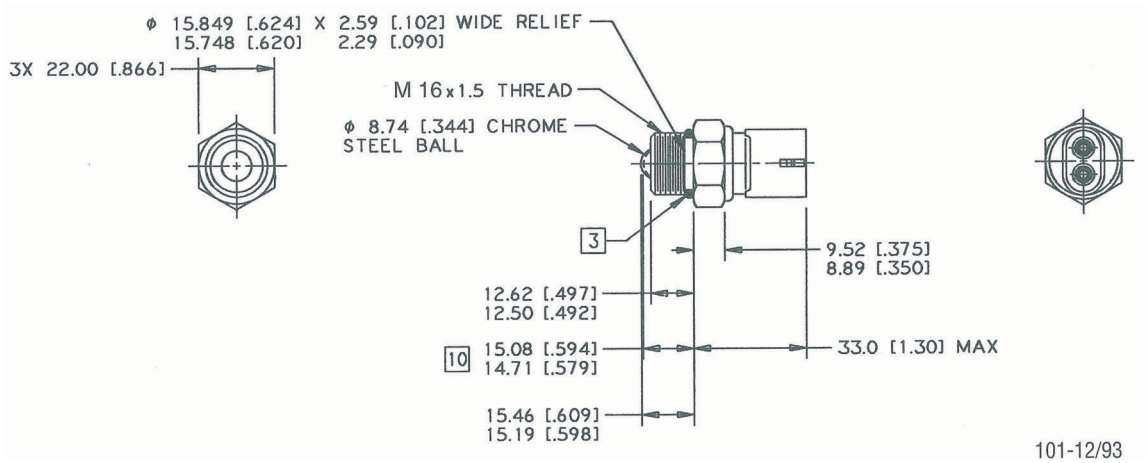
Reverse Switch



Notes:

1. Switch to be received with O-ring, Eaton No. 5568504.
2. Switch mates with Packard Electric weather pack connector number 12015792 with a 12124582(M) terminal and 12010293 cable seal or equivalent.
3. Switch makes contact within this range.

Neutral Switch



Notes:

1. Switch to be received with O-ring, Eaton NO. 5568510.
2. Switch mates with Packard Electric weather pack connector number 12015378 with a 12124582(M) terminal and 12010293 cable seal or equivalent.
3. Switch breaks contact within this range and remains open to flush.

Power Take Off Openings

Type	Description	Data
Six Bolt (Standard)	Mounting surface's angle with horizontal in degrees *:	57 (rotated at 12 deg. C.W. from current products)
	Center line's horizontal distance in mm [inch]*:	10.43 [264.9]
	Mounting bolt thread	Metric, M10x1.50
Eight Bolt Standard	Mounting surfaces angle with horizontal in degrees*:	0 (same as current products)
	Center lines horizontal distance in mm [inch] *:	10.43 [264.9]
	Mounting bolt threads	Metric M12x1.50
Thru Shafts (Optional)	Locations	Upper right and lover left quadrants
	Mounting bolt threads	Metric, M10x1.50
	Bolt pattern *	Chelsea 541 thru-shaft

*See Appendix: Transmission Dimensions - End and Side Views.

PTO Drive Gear Information

	Eight Bolt	Six Bolt
Number of Teeth	47	45
Diametral Pitch	6	6
Pressure Angle (degrees)	20	20
Outside Diameter, mm [in]	205.5/205.2 [8.090/8.080]	196.68/196.66 [7.750/7.740]
Root Diameter, mm [inch]	188.47 [7.420] min.	180.00 [7.087] min.
Ball Diameter, mm [inch]	7.409 [.2917]	7.409 [.2917]
Measurement over balls, mm [inch]	209.27/209.06 [8.239/8.231]	200.81/200.61 [7.906/7.898]
Mounting depth*, mm [inch]	27.68/27.44 [1.090/1.080]	20.80/20.45 [.815/.805]
Gear face location from center line of opening, mm [inch]	12.7 [.500] (ahead)	
Input speed for PTO, as percentage of engine speed	65 87 84	(FR-9210B/1X210B) (FRO-1X210B) (FRO-1X210C)

*3/4-16 Threaded Sensor Rear Bearing Cover Available Upon Request.

Speedometer Drive

Electronic (Standard)	Rotor	Number of teeth	16 teeth
	Sensor	Clock positions	10 & 12 or 4 & 6 o'clock
		Type	Variable reluctance push-in*
		Connector supplier	Packard - metri-pack 150
		Output voltage/air gap	.5 Vp-p (min) .01" to .09"
		Sensor inductance	1 to 5 henries
Mechanical (Option)	Driver	Number of teeth	6 **
	Driven Gear	Number of teeth	12 **
		SAE type	A (.405" O.D.210" I.D./.068" slot)
		Clock positions	6 & 12 o'clock 4 & 10 o'clock on mechanical

*3/4-16 Threaded Sensor Rear Bearing Cover Available Upon Request.
** Others are available on OEM request.

Interface Features

Output Shaft Spline

Type	Involute
Outside diameter in inch [mm]	2.75 [69.85]
Number of teeth	54
Diametral pitch	20-40
Pressure angle in degrees	37.5

Output Shaft Yokes (No Seal Interface)

Part Number	Series	Type	Housing to Front Face of End Yoke (mm)	(inches)	Nominal Yoke Face to Center (mm)	(inches)	Housing to Cross Center (mm)	(inches)
5505543	1710	Half Round	760.2	29.93	143.0	5.63	903.2	35.56
5505544	1710	Full Round	760.2	29.93	143.0	5.63	903.2	35.56
5505545	1760	Half Round	760.2	29.93	143.0	5.63	903.2	35.56
5505546	1760	Full Round	760.2	29.93	143.0	5.63	903.2	35.56
5505547	1810	Half Round	760.2	29.93	143.0	5.63	903.2	35.56
5505548	1810	Full Round	760.2	29.93	143.0	5.63	903.2	35.56
5505553	RPL25	Half Round	760.2	29.93	159.0	6.26	919.2	36.19
5505571	SPL170	Half Round	760.2	29.93	142.0	5.60	902.4	35.53
5505572	SPL250	Half Round	760.2	29.93	145.0	5.71	905.2	35.64
5505578	92N	Half Round	760.2	29.93	143.0	5.63	903.2	35.56

Integral Oil Pump, Cooler - Option

Type	Gerotor
Output in GPM	4.2 @ 2100 input shaft RPM
Min. relief pressure, PSI [kPA]	60 [417]

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

Installation Effects of Internal Cooler

The cooler is located in the transmission bottom with two 1/2-14 NPFT-1 thread (3/16 UNF-2B straight threads optional) with o-ring ports opening downward. Inlet and outlet ports are interchangeable since there are no one-way valves internal to the cooler. Threaded elbows or straight fittings of your choice fitted with appropriate lengths of coolant line connect to the currently available ports on the engine complete the coolant circuit. Add miscellaneous line supports where appropriate to complete.

The temperature sensor port has been relocated to the cooler cover, directly rearward of the inlet and outlet ports. The new cooler occupies the space claim of the previous sensor port; however, the new location is very close to the previous location making OEM wiring harness changes unlikely. Verification of harness fit-up is still advised. Also, the size of the port has not changed.

The geometry of the transmission bottom surface (where the cooler and cooler cover is located) should be reviewed for any possible interference in the truck chassis, and with OEM assembly plant fixtures used for trimming transmissions prior to truck installation.

Internal Cooler Option

Specifications	
Cooler type	Submerged tube and fin
Typical cooling capacity	12,000 BTU
Minimum coolant flow rate	4 GPM
Minimum coolant temperature	200° F
Minimum engine RPM (for above specifications)	1200 Typical
Coolant ports on transmission cover	3/4-16 UNF-2B straight thread with o-ring (2 ports) or 1/2-14 NPFT-1
Coolant lines to cooler	*OEM specified (similar to in-cab heaters)
Related Specifications	
Transmission lube fill and drain plugs	1 1/16-12 UN-2A with O-ring
-Magnetic fill and drain plugs	Optional
Temperature sensor port	1/2-14 NPTF
Serviceablity	External access via removal of cover**

*Coolant lines and connections to cooler are the responsibility of the OEM and should be consistent with their standards for cooling lines. Reference SAE J720

**Removal also facilitates in vehicle gear inspection of transmission

Note: For additional assembly drawings for the internal cooler option, see the drawing at the end of this document.

CAUTION: The internal oil cooler option requires more oil to level fill than the standard offering. Operation of the transmission at the incorrect oil level could damage the transmission and void the warranty.

Interface Features

Clutch Housings

Size	SAE #1			
Mount	Standard	Standard	Nodal, Symmetrical	Nodal, Symmetrical
Material	Cast Iron	Aluminum	Cast Iron	Aluminum
Length mm [inch]	168.3 [6.625]	168.3 [6.625]	168.3 [6.625]	168.3 [6.625]
Pedal Shaft Configuration *	1, 2, and 3*	1, 2, and 3*	4 and 5*	1 and 4*
Clutch Housing to Flywheel Housing Mounting Screws	M10X1.5 or 7/16"-14UNC	M10X1.5 or 7/16"-14UNC	M10X1.5 or 7/16"-14UNC	M10X1.5 or 7/16"-14UNC
Weight in kg [lbs]	34.5 [76]	10.4 [23]	41.7 [92]	13.6 [30]

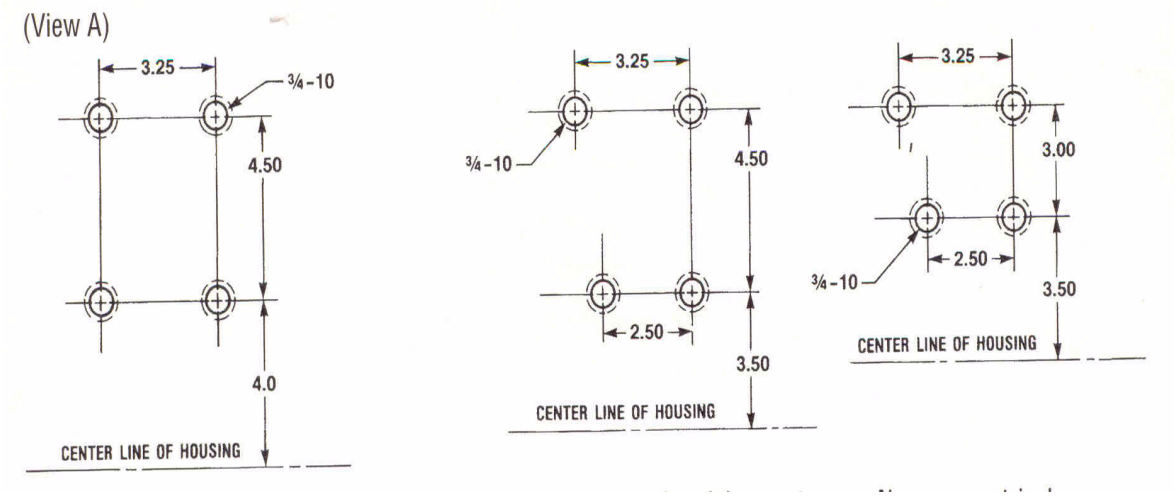
Additional Clutch Housings

Size	SAE #2		
Mount	Standard	Standard	Nodal, Non-Symmetrical
Material	Cast Iron	Aluminum	Cast Iron
Length mm [inch]	168.3 [6.625]	168.3 [6.625]	168.3 [6.625]
Pedal Shaft Configuration *	1, 2, and 3 *	1, 2, and 3 *	1 and 4 *
Clutch Housing to Flywheel Housing Mounting Screws	M10X1.5 or 3/8"-16UNC	M10X1.5 or 3/8"-16UNC	M10X1.5 or 3/8"-16UNC
Weight in kg [lbs]	30.8 [68]	9.5 [21]	39.9 [88]

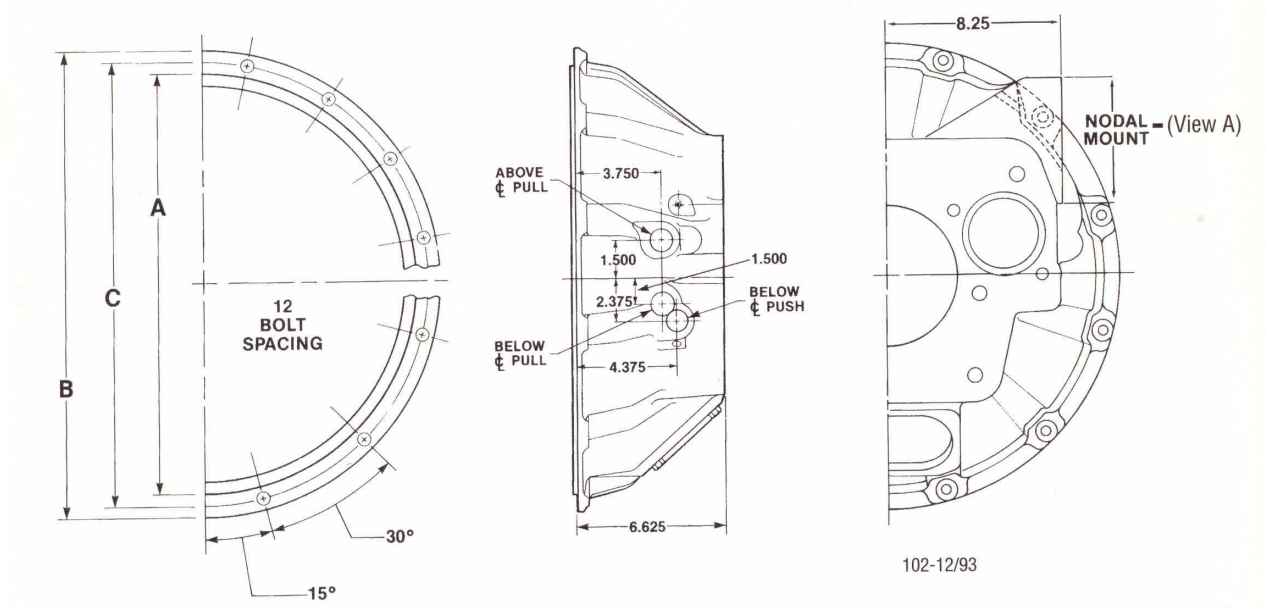
*

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

Clutch Housing Terms - Heavy Duty



Symmetrical - Denotes symmetrical bolt mounting pattern of nodal mount.
Non symmetrical - Denotes non symmetrical bolt mounting pattern of nodal mount.
Nodal Mount - Denotes mounting pads used for support of transmission and engine.



SAE #1 & SAE #2 denotes clutch housing size				
SAE Size Number	A Pilot Diameter	B Outside Diameter	C Bolt Circle	Capscrew Quantity
1	20-1/8	21-3/4	20-7/8	12
2	17-5/8	19-1/4	18-3/8	12

Input Shaft

External Splines

Standard Splines* - All Models Except FR-9210		FR-9210B
Type	Square	Square
Nominal Diameter in mm [inch]:	50.8 [2]	43.9 [1.75]
Number of Teeth	10	10
Pilot Bearing Nominal Journal Diameter, mm [inch]	30 [1.18]	30 [1.18]

*Contact Eaton for additional options.

Upper Mounting Studs (For Transmission Rear Support)

Thread size, out of transmission	Metric, M16X1.50
Thread size, into transmission	Metric, M16X2.00
Studs spacing, mm [inch]	127 [5.00]
Horizontal distance from the case's front face, mm [inch] *	446.3 [17.57]
Lateral distance from the mainshaft's centerline, mm [inch] *	63.5 [2.50]
Vertical distance of mounting surface from mainshaft's centerline, mm [inch] *	209.8 [8.26]

* See Appendix "Transmission Dimensions - End View"

CAUTION: Studs or bolts must not have more than 18 mm of thread engagement into transmission or damage to transmission may result.

Transmission Rear Support Requirements

In general, a rear support for any on-highway application is not required.

It is the responsibility of the vehicle OEM to determine if the entire engine/transmission mounting system requires a rear support to keep the maximum bending moment at the engine rear mounting face within the allowable limits (ref. SAE SP-479).

Typical reasons to use a rear mount are:

- Excessive bending moment at rear of engine due to weight and center of gravity location of transmission.
- Reduces the potential of shift lever jumpout associated with soft engine mounting systems.
- Severe off-highway applications.

Threaded Fasteners

Straight Threads	Metric
Pipe plug and air fitting threads	American standard pipe

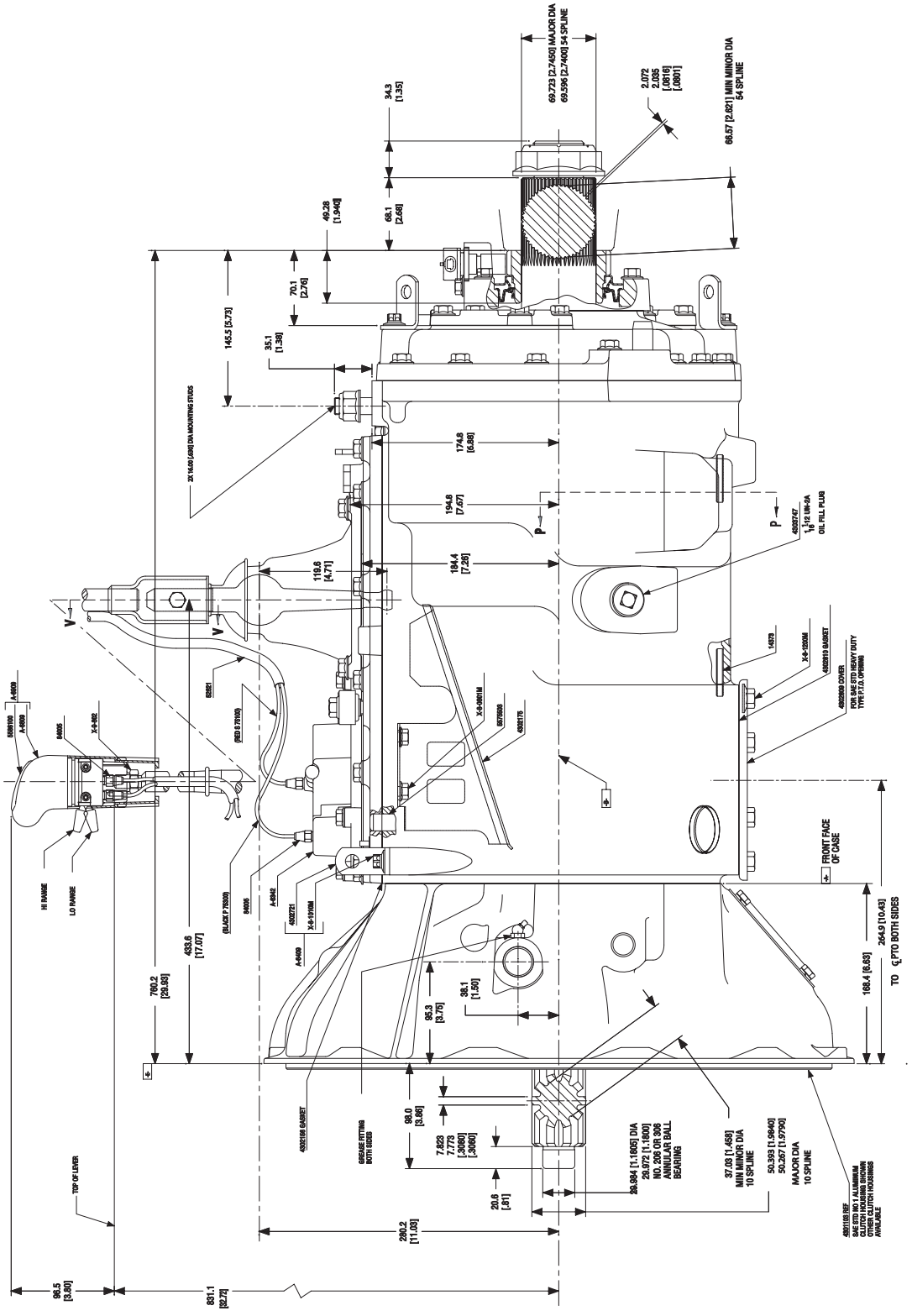
Threaded Fasteners Tightening Torque Specifications

Fastener's Description	Socket or Driver Size	Where Used	Recommended Torque N·m [LB. ft.]
Capscrew, M8-1.25 x 30	13 mm	Air system module	27 - 31 [20 - 23]
Capscrew, M10-1.5 x 20	15 mm	Cover - six bolt PTO	
Capscrew, M10-1.5x 25	15 mm	Cover - countershaft bearing, rear	
Capscrew, M10-1.5 x 30	15 mm	Cover - bearing, front	
		Cover, internal cooler	
Capscrew, M10-1.5 x 35	15 mm	Housing - shift bar	54 - 61 [40 - 45]
		Tower - shift	
		Housing - remote control	
		Plate - rear	
Capscrew, M10 - 1.5 X 45	15 mm	Cover, bearing, rear (at dowel pin boss)	
Capscrew, M10 - 1.5 X 50	15 mm	Cover bearing, mainshaft rear	
Capscrew, M12- 1.75 x 20	16 mm	Cover - eight bolt PTO	77 - 88 [57 - 65]
Capscrew, M12- 1.75 X 35	16 mm	Housing - clutch	97 - 108 [72 - 80]
Capscrew, M12 - 1.75 X 85	16 mm	Housing - clutch	
Switch - reverse, M14-2.0	22 mm	Housing - shift bar	20 - 27 [15 - 20]
Plug - reverse switch, M14-2.0	22 mm	Housing - shift bar	20 - 27 [15 - 20]
Switch - neutral, M16-1.5	22 mm	Housing - shift bar	20 - 27 [15 - 20]
Plug neutral switch, M16-1.5	22 mm	Housing - shift bar	20 - 27 [15 - 20]
Nut, M16 x 1.5	24 mm	Studs - clutch housing	244 - 240 [180 - 200]
Nut, M48 x 2	70 mm	Shaft - output	610 - 675 [450 - 500]
Nut, M16	24 mm	Stud- mounting, upper support	230 - 260 [170 - 190]
Capscrew, 5/16" - 18 UNC, 2A	1/2 in	Cover - hand hold, clutch housing	27 - 34 [20 - 25]
Plug, 3/8"-PTF	5/16" Hex driver	Port - cooler return line	46 - 53 [34 - 39]
Plug, 1/2" - 14 NPTF	3/8" square driver	Port - output internal pump	51 - 62 [38 - 46]
Plug, 3/4" pipe	1/2" square driver	drain - oil	61 - 74 [45 - 55]
Plug, 1 1/16"-12	1/2" square driver	Fill & drain oil *	47 - 68 [35 - 50]

*Internal cooler option only.

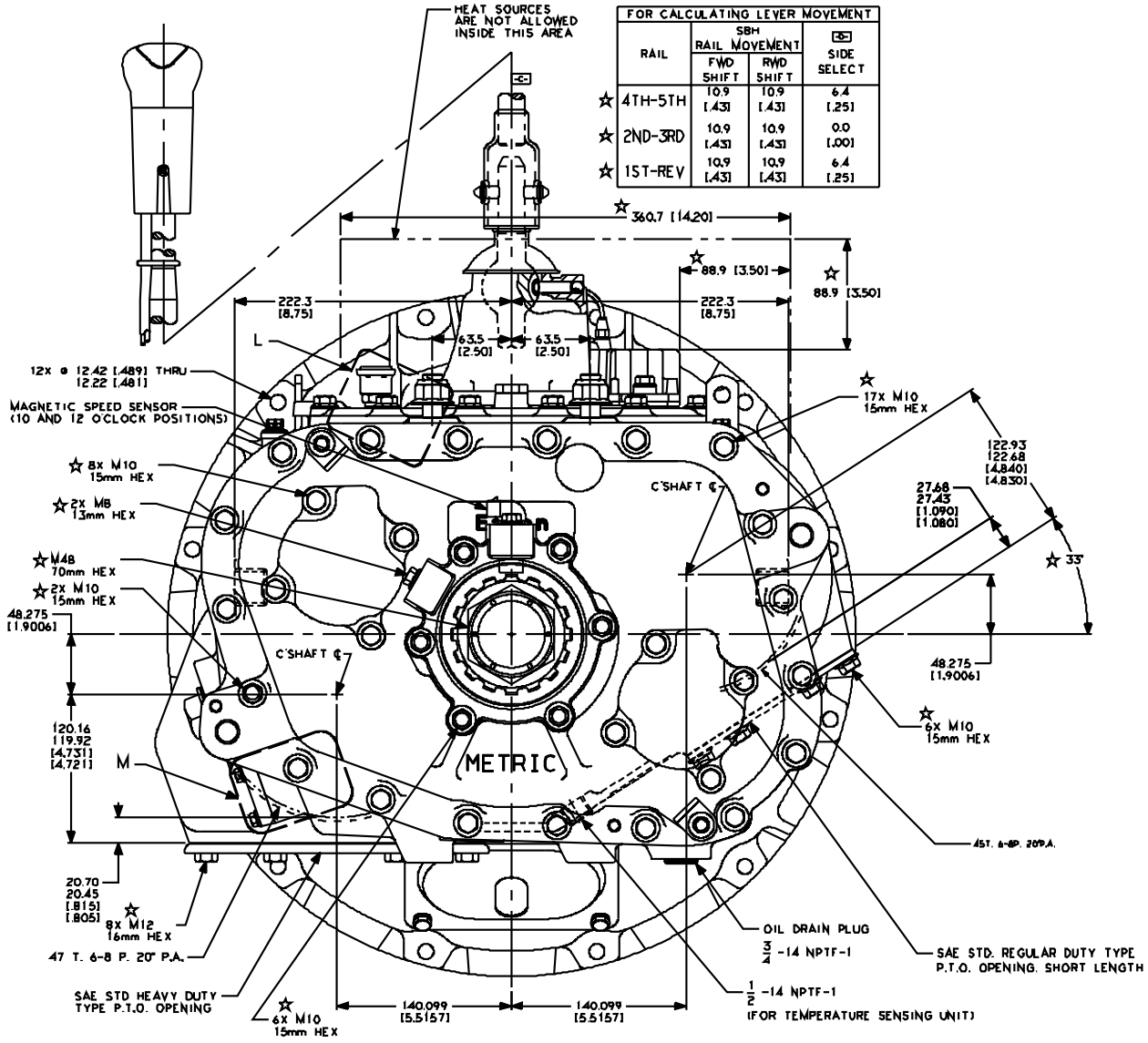
Transmission Dimensions - Side View*

*Features different from 6 & 7 series product.



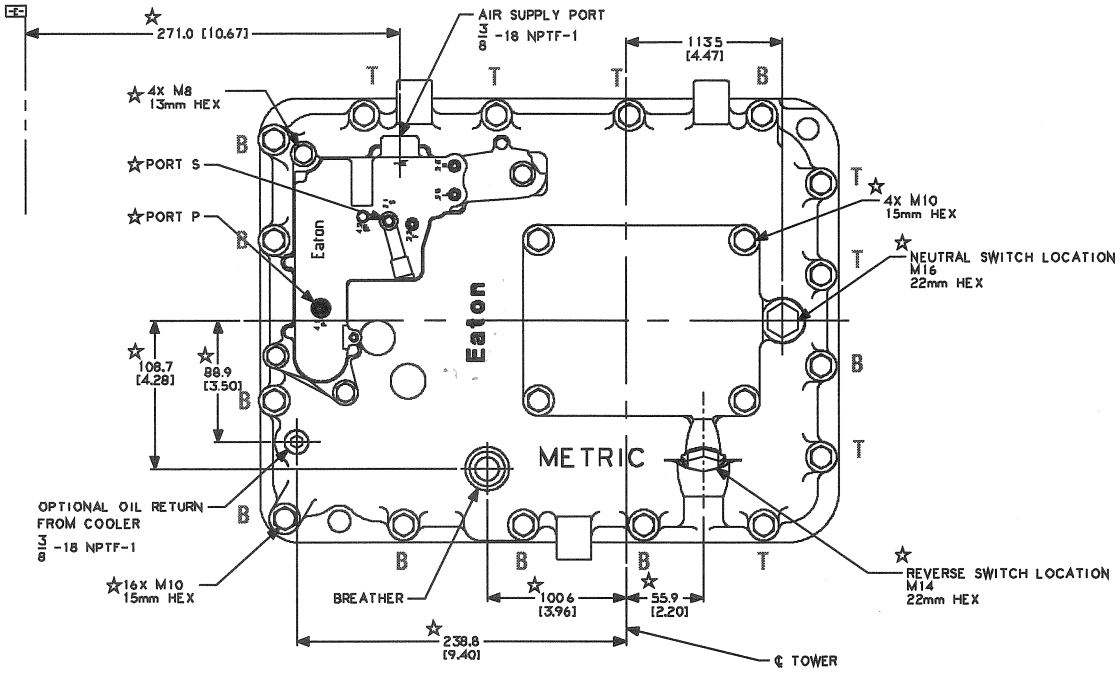
Transmission Dimeensions - End View

*Features different from 6 & 7 series product.



Shift Bar Housing - Standard Control

*Features different from 6 & 7 series product.



STANDARD CONTROL
(FR & FRO)

B - Blind Hole
T - Through Hole

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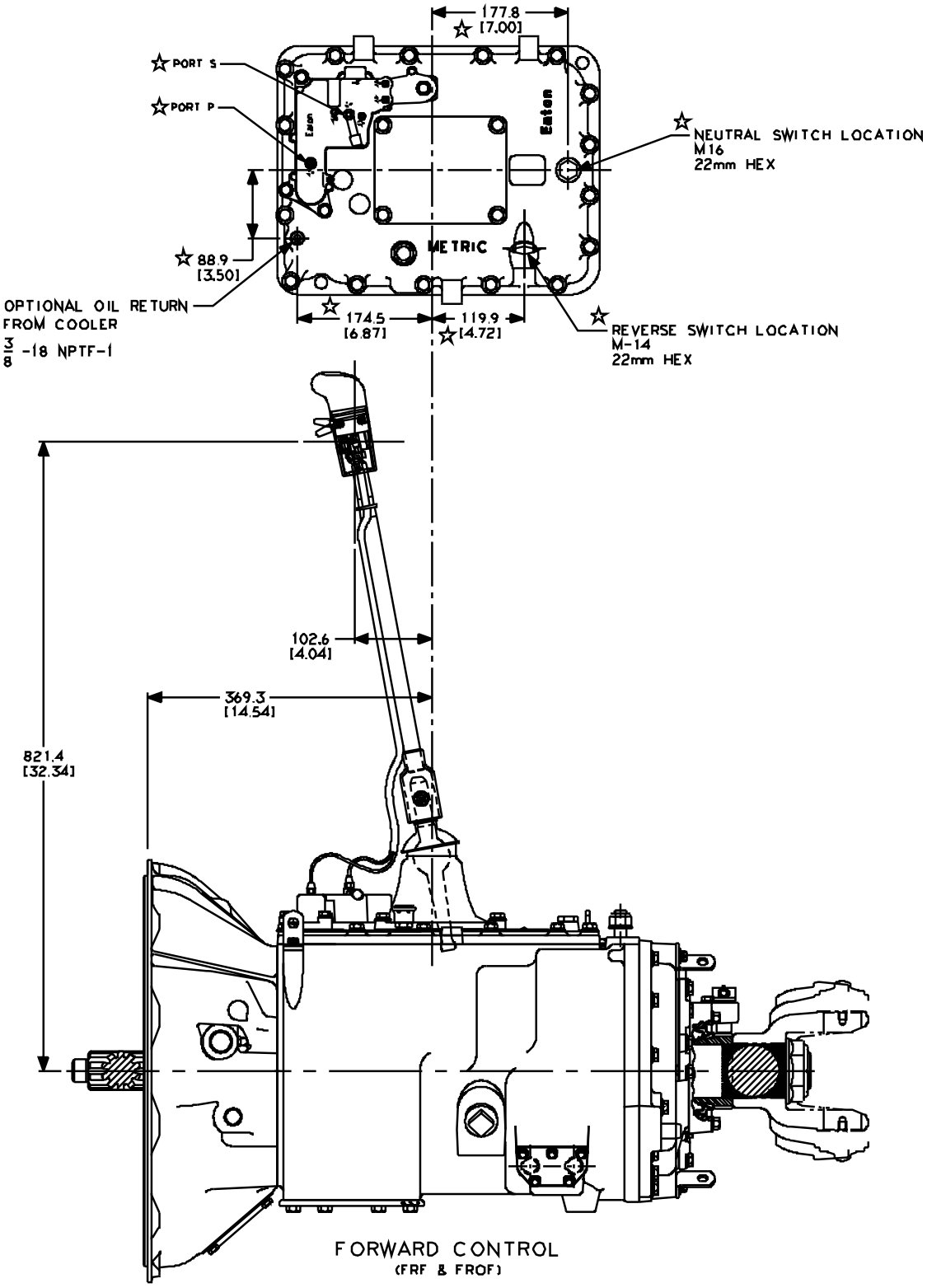
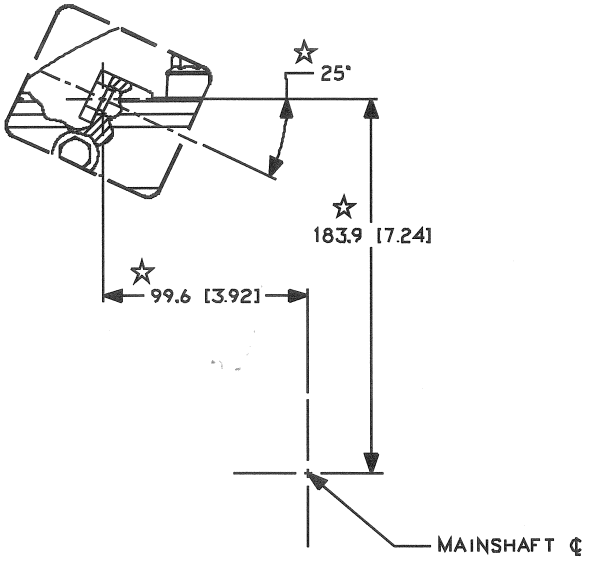
Shift Bar Housing - Forward Control

*Features different from 6 & 7 series product.



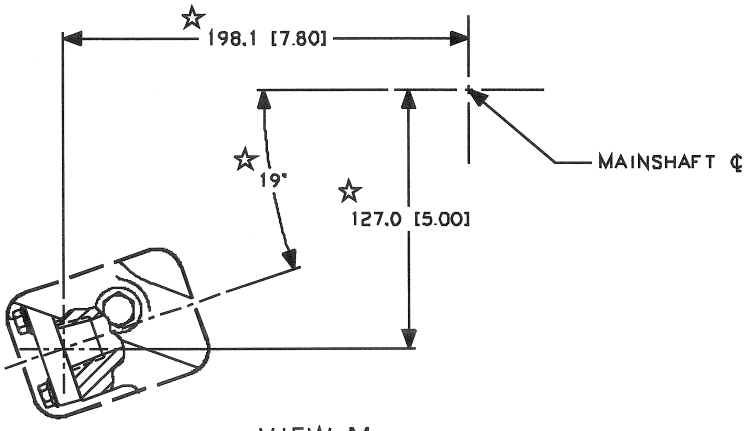
Reverse Switch

* Features different from 6 & 7 series product. Refer to Transmission Dimension - End View for location.



VIEW **L**

Oil Cooler Ports



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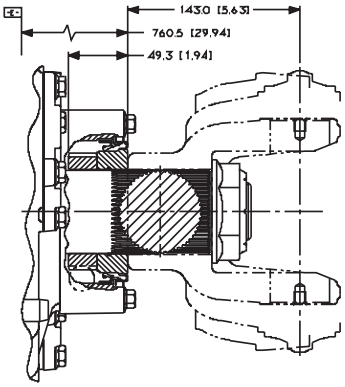
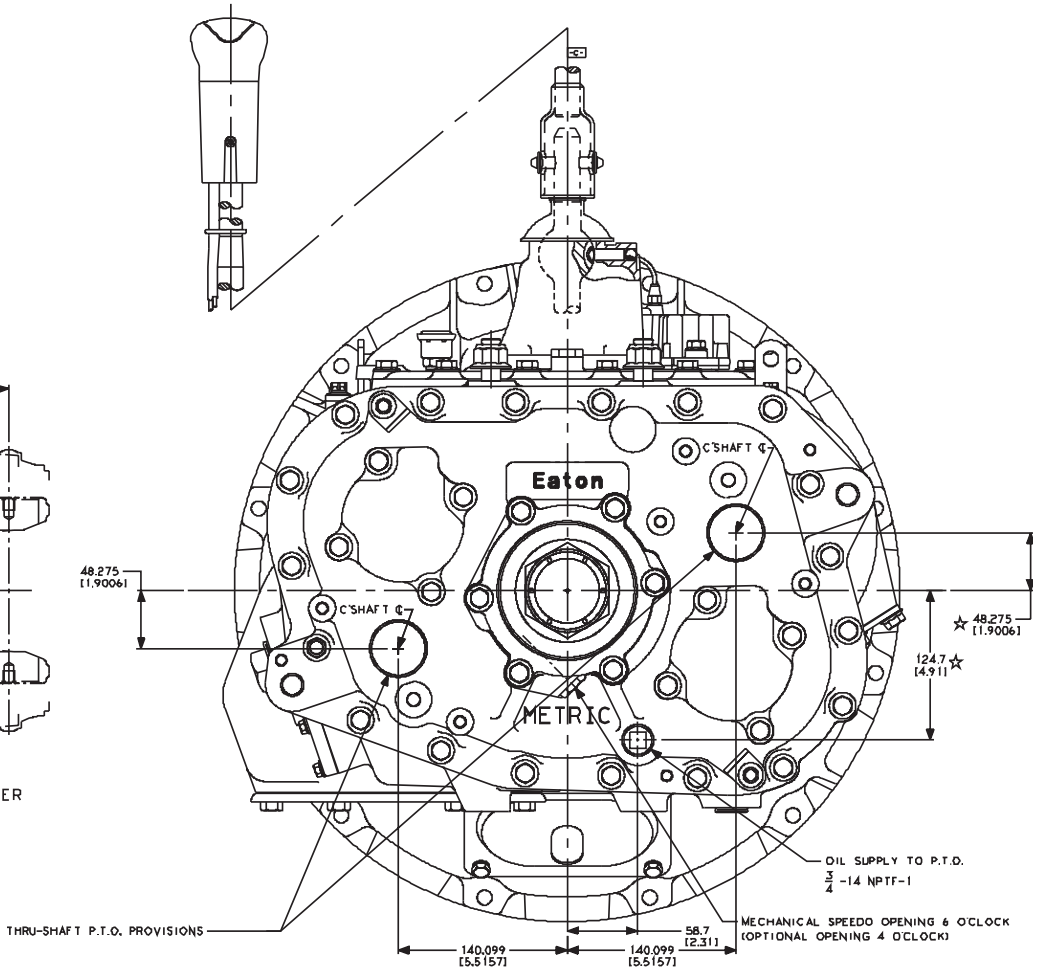
Optional Equipment Location*

*Features different from 6 & 7 series products.



MECHANICAL SPEEDOMETER



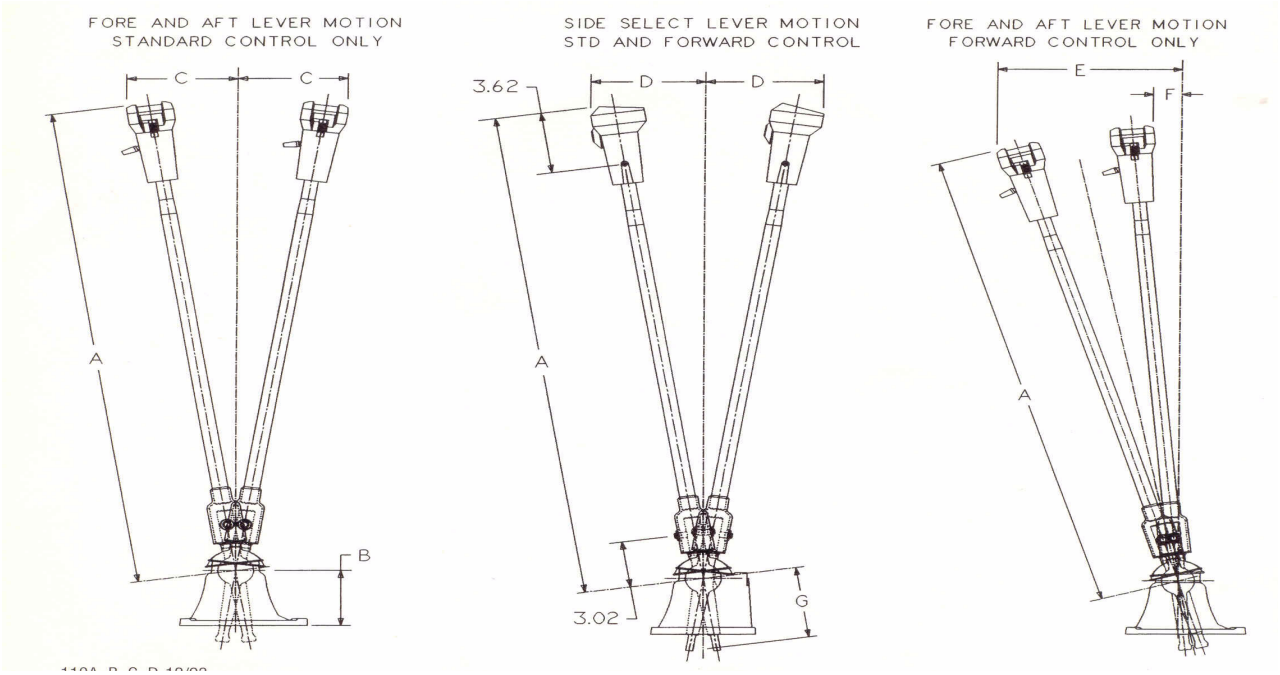
OPTIONAL THRU SHAFT P.T.O.'S
AND MECHANICAL SPEEDOMETER

Shift Levers

Recommended Tower Types Based on Overall Height ('A' & 'B') and Recommend Lever Ratios (5.5 to 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"				
Application	(Inch)	Low	Med	High
FRO/FRO xx2xx Family	Travel C**	.093 x A + 1.25 + (A x .02)	.077 x A + 1.25 + (A x .02)	.066 x A + 1.25 + (A x .02)
	Travel D**	.053 x A + 1.50 + (A x .02)	.044 x A + 1.50 + (A x .02)	.037 x A + 1.50 + (A x .02)
	Travel E**	.273 x A + 1.25 + (A x .02)	.226 x A + 1.25 + (A x .02)	.193 x A + 1.25 + (A x .02)
	Travel F**	.090 x A - 1.25 - (A x .02)	.074 x A - 1.25 - (A x .02)	.063 x A - 1.25 - (A x .02)
	B	3.75	4.75	5.75
	G	4.71	5.71	6.71

RECOMMENDED LEVER RATIO IS 5.5 - 6.5:1
LEVER RATIO = A / G
**FOR SOLID LEVER SUBTRACT.02 X "A" FOR SOLID LEVER TRAVEL



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 if Figure 2. **Note that a rearward lever offset adds to the jumpout torque, whereas a forward offset reduces the total jumpout torque.**

Figure 1

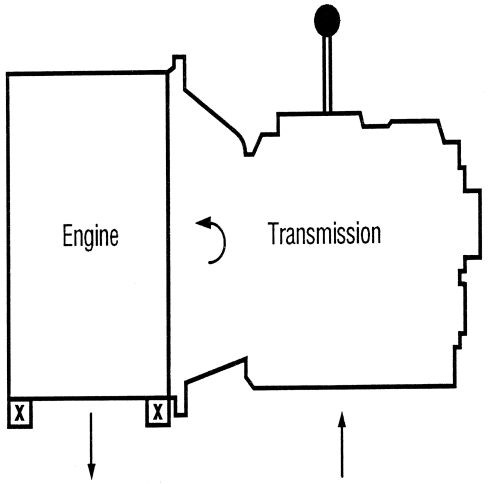
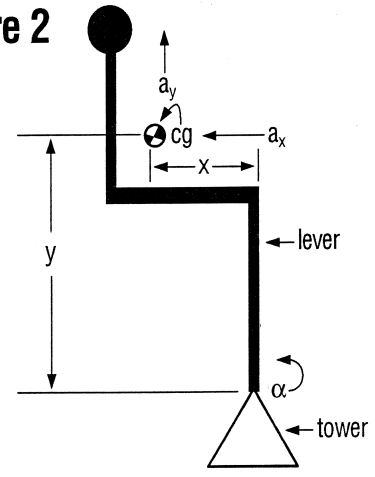


Figure 2

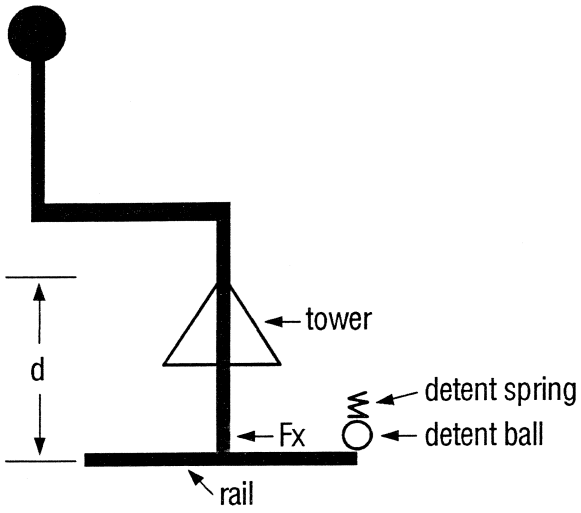


$$T_j = a_x My - a_y Mx + I\alpha$$

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 drivetrain 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

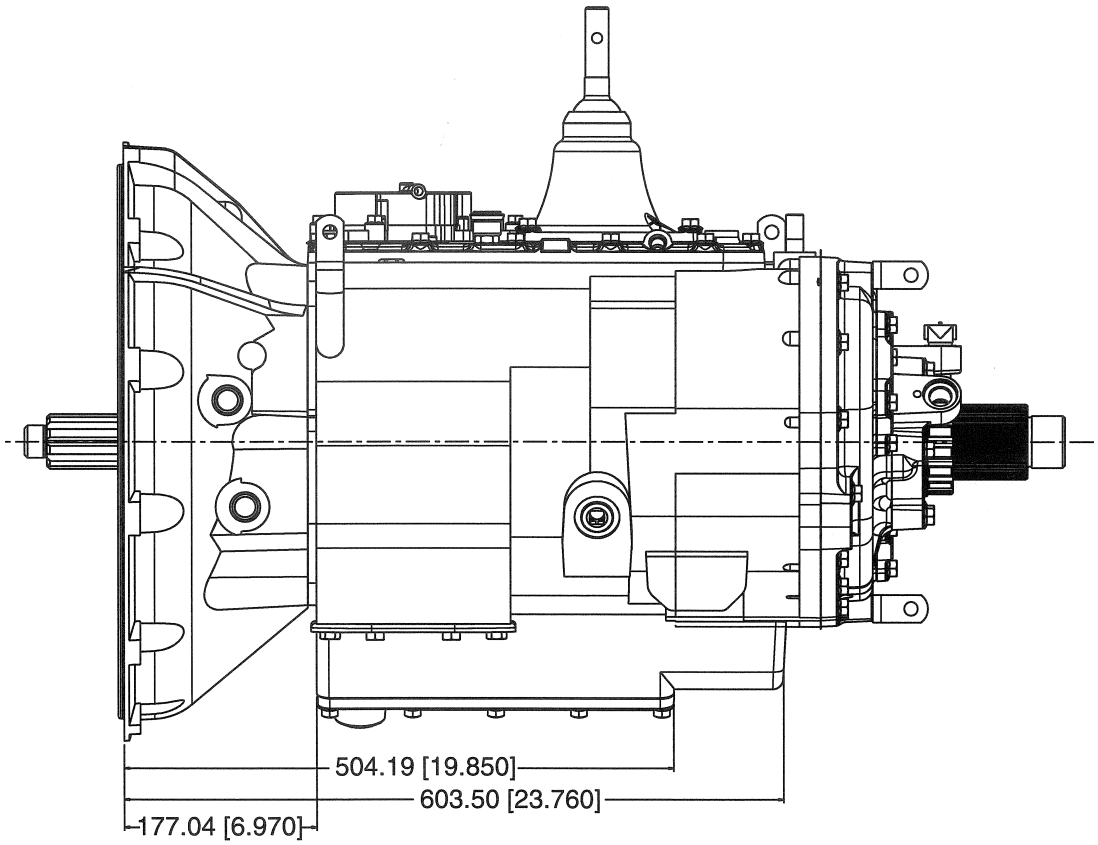
Since the lever itself is a dynamic system, it has its own natural frequency. Unfortunately, this also occurs between 7 and 10 Hz. This frequency is determined by lever height, lever offset, tower height, and isolator stiffness. If the natural frequency of the engine/transmission match that of the lever, 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, RT, FR, FRO Transmission Models - 5.5/1 to 6.5/1.

Optional Internal Cooler - Side View



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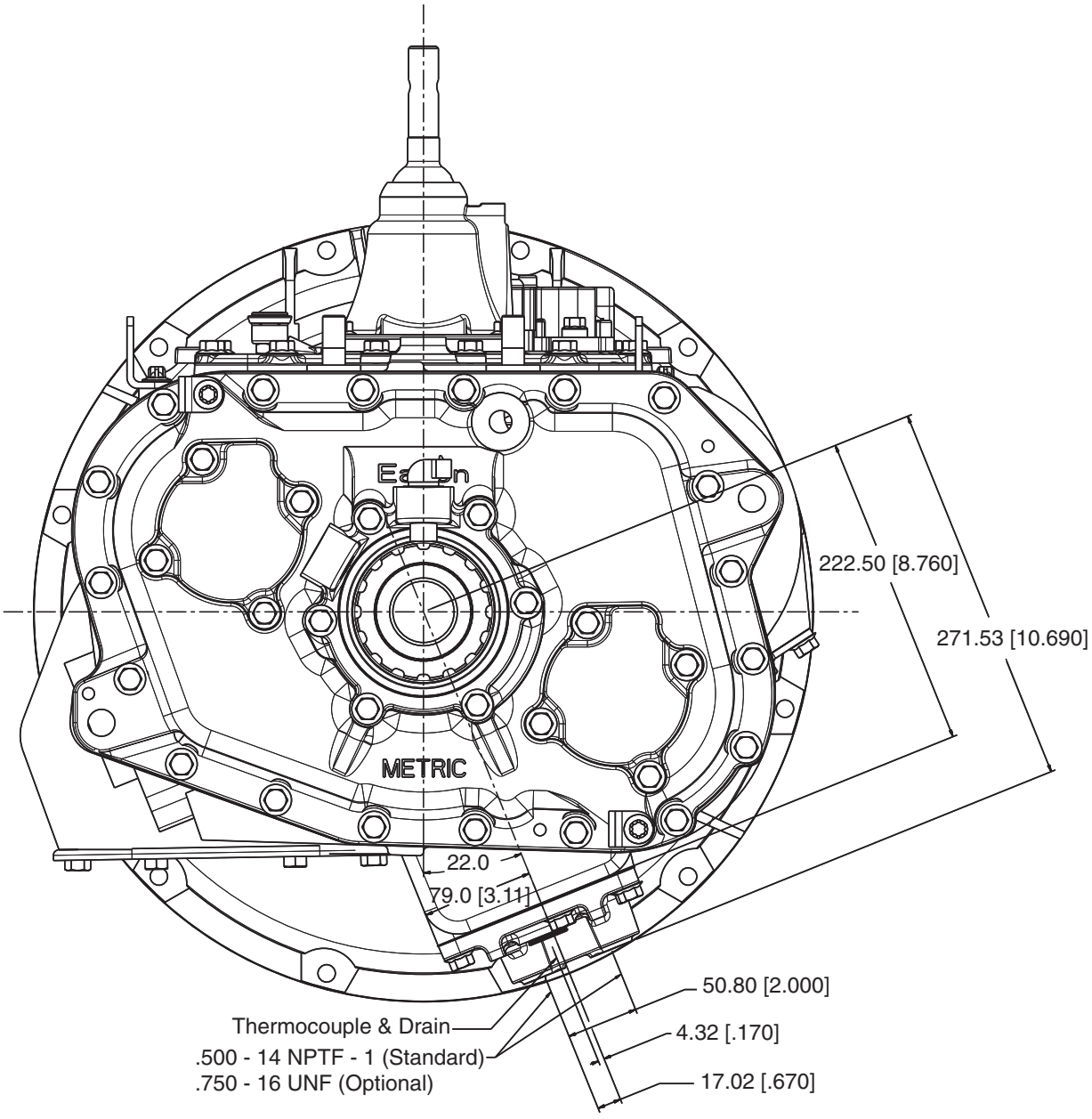
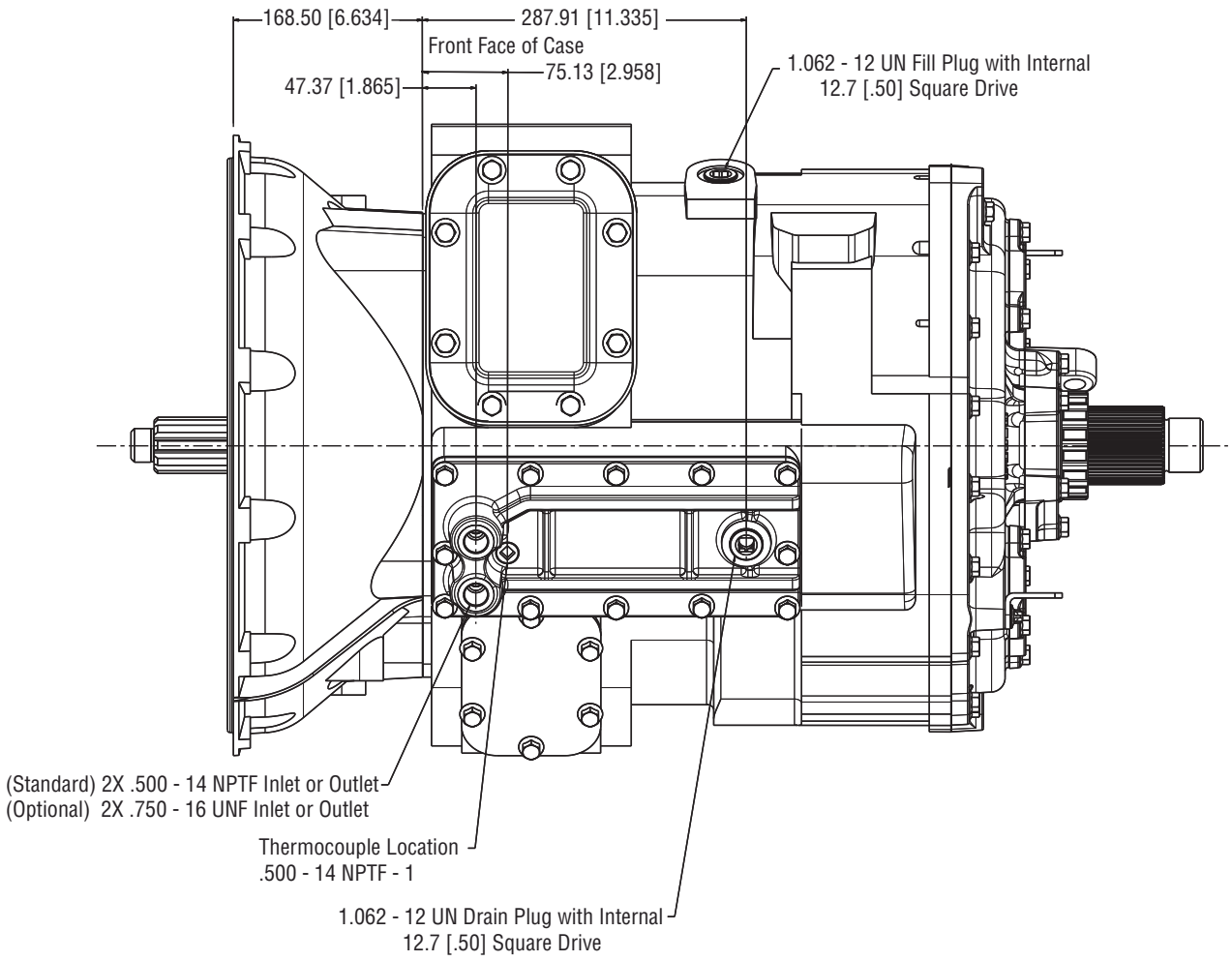
Optional Internal Cooler - End View



Optional Internal Cooler - Bottom View



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