MERITOR
RUN WITH THE BULL

TECHNICAL BULLETIN TP-12126

DRIVELINE APPLICATION GUIDE

Revised 08-22

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Notes

Purpose of These Guidelines

The guidelines contained in this document describe the correct method required to size Meritor drivelines operated in the United States and Canada. These guidelines are not intended to be used for any other purposes or in any other territories.

For any questions concerning guidelines contained in this document, such as interpretation and calculations; or for loadings or configurations outside the parameters of these guidelines, please contact Meritor's OnTrac™ Customer Service Center at 866-668-7221 or visit our website: www.meritor.com/warranty.

Changes to Guidelines

These guidelines are subject to change at any time, without prior notice, at the discretion of Meritor. To ensure you have the most current guidelines, please contact Meritor's OnTrac™ Customer Service Center at 866-668-7221 or visit the Literature on Demand section of meritor.com to access publication TP-12126, Driveline Application Guidelines.

Warranty

Meritor drivelines that are included in the guideline and operated within the vocational limitations provided in this document are covered by Meritor's warranty. For complete details and specific coverage, refer to publication SP-95155, Commercial Vehicle Systems Warranty. To access this publication, visit the Literature on Demand section of meritor.com.

Contact Meritor for questions concerning warranty coverage and application approvals for Meritor drivelines operated outside of the parameters provided in these guidelines. Operating variances in torque, horsepower, speed, environment, angles and the number of stops and starts have been shown to have a notable influence on the service life of a driveline.

Comparing Meritor's RPL Series Permalube™ and Xtended Lube MXL™ Series Drivelines

Meritor offers two types of drivelines: the RPL Series Permalube™ and the Xtended Lube MXL™ Series.

- RPL Series Permalube™ drivelines maintain lubrication for the life of the driveline.
- Xtended Lube MXL™ Series drivelines are greaseable and require lubrication at specific intervals. Refer to Maintenance Manual 1, Preventive Maintenance and Lubrication, for complete information, or visit the Literature on Demand section of meritor.com to access this publication.

Notes

1. For review and approval of brakes, axles, Meritor products, suspensions, Telma® retarders, trailer axles, transfer cases, wheel ends and other components, contact Meritor's OnTrac™ Customer Service Center at 866-668-7221.
2. Where a chassis is being sold as an incomplete vehicle, it is the responsibility of the OEM and/or the dealer to accurately convey all approved driveline selection information to the body builder. Also, it is the responsibility of the final vehicle builder to ensure the assigned tagged values for gross axle weight rating (GAWR) and gross vehicle weight (GVW), and gross combination weight (GCW) do not exceed those limits approved by Meritor. This includes auxiliary axles and Federal Motor Vehicle Safety Standards (FMVSS) brake standards.
3. Meritor's warranty obligation does not cover overload, misuse or abuse by the operator, and applications not approved by Meritor, including but not limited to unapproved vocation usages, unapproved drivetrain configuration, unapproved load distribution changes, and unapproved testing of any kind. Refer to publication SP-95155, Commercial Vehicle Warranty, for complete information on Meritor's warranty coverage.
4. Any use of Meritor driveline components in vehicles equipped with an automatic transmission retarder must be submitted to Meritor for approval.

1 Notes

5. Any use of Meritor driveline components in vehicles equipped with hybrid propulsion systems must be submitted to Meritor for approval.
6. For calculated application values outside the standard and approved limits specified in these guidelines, contact your Meritor DriveForce™ representative or Meritor's OnTrac™ Customer Service Center at 866-668-7221. The correct selection of a driveline product depends on correctly identifying the vocation.
7. For Linehaul vocations, the Linehaul sizing charts must be used. The Non-Linehaul sizing charts are not appropriate for the selection of driveline sizes in the Linehaul vocation.
8. For Non-Linehaul vocations, the Non-Linehaul sizing charts must be used.
9. The approval limits in this application guideline apply to driveline systems that follow Meritor's recommendations. For maintenance and service information, please refer to Maintenance Manual MM-96147, Drivelines and Maintenance Manual 1, Preventive Maintenance and Lubrication. Visit Literature on Demand at meritor.com to access these publications.
10. When calculation methods lead to values exceeding the acceptable limits set by this guideline, Meritor advises submitting an application request or contacting Meritor's OnTrac™ Customer Service Center at 866-OnTrac1 (668-7221) for driveline application approval.
11. The swing diameter values in Table B shows the diameter measured across the outer most corners of the universal yoke. The swing diameter, together with the tube size aide in determining the necessary clearance for the rotating driveline.
12. These guidelines supersede previous versions.

Requirements

The correct selection and sizing of drivelines is dependent on how the vehicle will be used in service as well as the vehicle characteristics.

1. Maximum driveline torque

The use of lower numerical axle ratios increases the possibility of torque spikes in the drivetrain exceeding the maximum rated torque values for the driveline. Driveline maximum-rated torque limits stated in Table B, Driveline Properties, cannot be exceeded in either steady-state or transient conditions.

2. Torsional and inertial accelerations

Recommended limits for torsional and inertial accelerations resulting from non-constant velocity motion of universal joints operating at angle are as follows:

Table A: Maximum Acceleration Values

Application	Torsional Acceleration (rad/sec^2)	Inertial Acceleration (rad/sec^2)
Medium Truck and On-Highway Linehaul	300	800
Vocational and Off-Highway	500	1000

These values represent levels where some driveline vibrations have been shown to become noticeable to some of the vehicle occupants. The degree of vibration will vary based on vehicle configuration and joint angles. Inertial acceleration is proportional to joint angle. Torsional acceleration is proportional to the angle difference between the joints.

3. Automated manual transmissions

All applications that include an automated manual transmissions with an engine torque rating of 1,000 lb-ft or greater must specify only the following main drivelines:

Meritor RPL35, RPL35SD, RPL25, RPL25SD or 18MXL Full Round or Easy Service™ Drivelines

4. Angles

The maximum allowable joint angle is 6 degrees. With two jointed drivelines, the difference in angles between both joints must not exceed 1.5 degrees. Minor adjustments of the vehicle ride height can severely alter the U-joint operating angles and result in reduced U-joint life or reduced performance.

5. Multiple Reduction Axle

Where a chassis is equipped with a two-speed, double reduction or planetary wheel-end axle, use the greatest numerical value obtained as a result of the multiplied axle ratio for driveline size calculations.

3 Driveline Sizing Process

Driveline Sizing Process

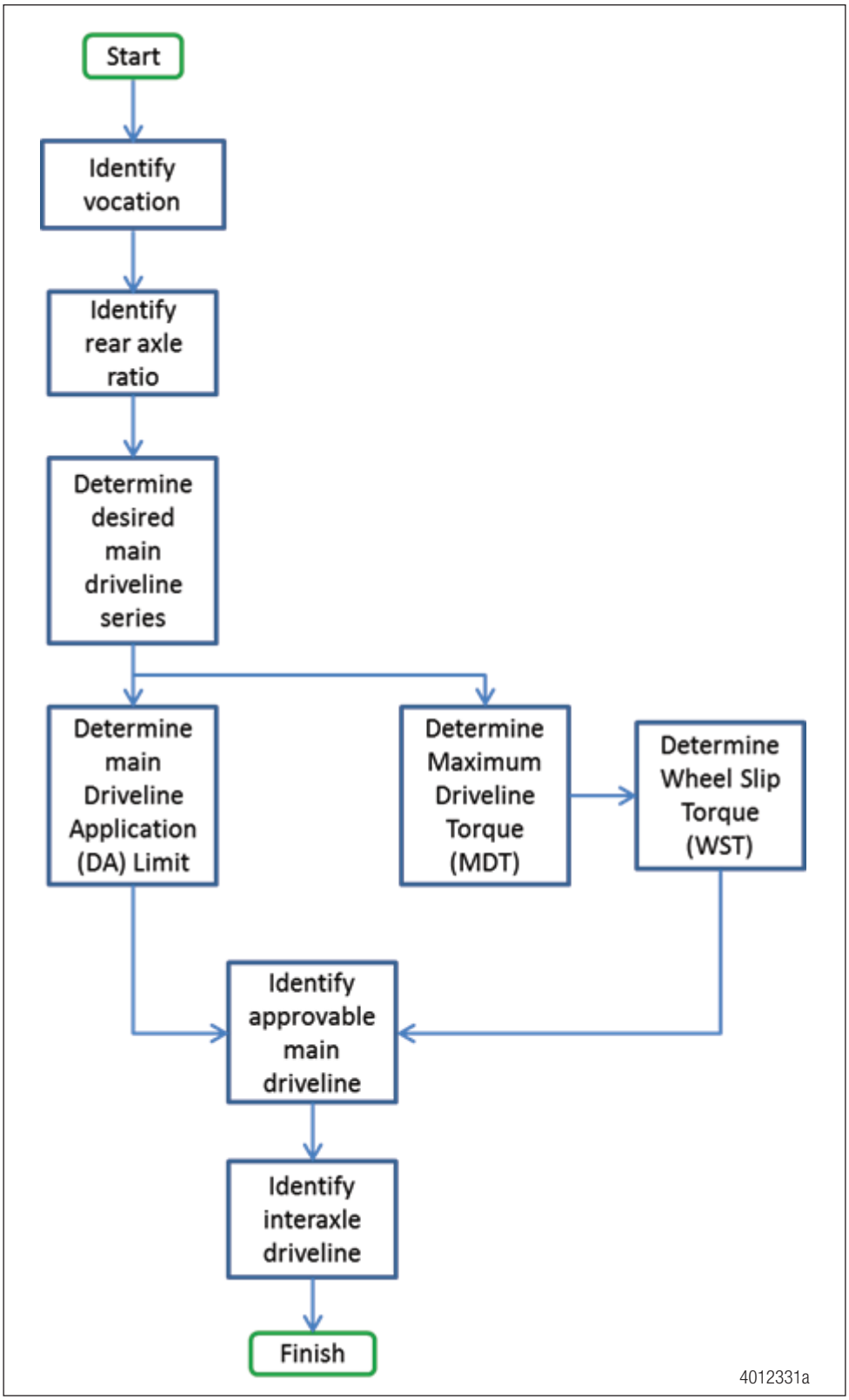


Chart 1 – Driveline Application Process Flowchart

Definitions

LINEHAUL

Linehaul is defined as the long-distance hauling of food, goods and finished materials. Not included are raw ferrous materials, minerals (except oil), logs or log chips. For a vehicle to be considered Linehaul, it must not be used in any type of dual vocation, where part of its duty cycle is outside of the Linehaul definition. Linehaul criteria includes:

- Annual mileage greater than 60,000 miles.
- Start/Stop cycle greater than 30 miles.
- 100% of operation is on paved roads.

NON-LINEHAUL

- A vehicle that does not meet all the conditions outlined in the Linehaul definition. Any vehicle spending any part of its service life performing outside of the Linehaul definition must be considered Non-Linehaul. This includes vehicles used as Linehaul on a part-time basis (e.g. day shift) and serving an alternate vocation (e.g. City Delivery) for part of the day (e.g. night shift).
- Use of fast axle ratios numerically lower than 2.47 in Non-Linehaul vocations require approval by Meritor.

INTER-AXLE SHAFT DRIVELINE

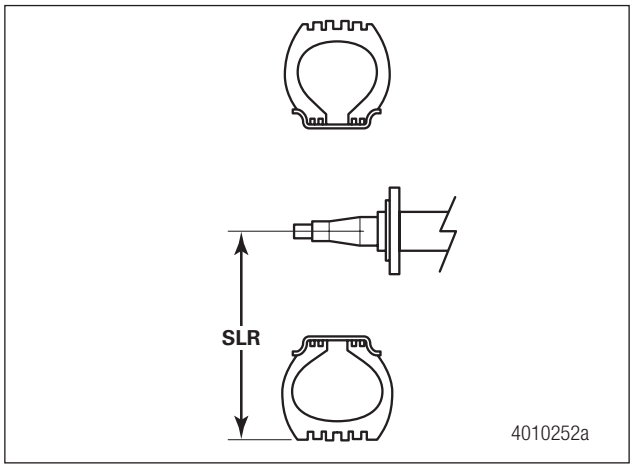
- A driveline that connects one axle directly to another.

MAIN SHAFT DRIVELINE

- A driveline that connects the transmission to the drive axle or from the transmission to the transfer case and/or from the transfer case to the drive axle.

STATIC LOADED RADIUS (SLR)

- The distance from the wheel axis of rotation to the supporting surface under a given load and tire pressure.



Cross section view of tire to illustrate SLR

Contact your tire manufacturer to obtain actual SLR values. Converting between tire revolutions per mile (Rev/Mile) and SLR can be approximated by using the following equation:

$$SLR = \frac{25{,}210}{\frac{Rev}{Mile}} - 0.75 \; x \; O.D.$$

This equation is an approximation only.

3 Driveline Sizing Process

Methodology

GENERAL

The main shaft drivelines shown in the Terminology section are sized based on a combination of two calculation methods:

- Driveline Application (DA) limit calculation method
- Maximum Driveline Torque (MDT) calculation method

Several factors such as vocation, vehicle weight, engine horsepower, torque, tire size and axle ratio can have great influence on the minimum required driveline sizing.

The driveline selection must meet the sizing based on both the DA and MDT calculation methods mentioned above, use the following guidelines for correct driveline application approval.

The steps to follow when identifying the correct driveline for a given application are:

1. Determine if the vocation meets the linehaul or non-linehaul definition.
2. Identify the axle ratio.
3. Determine the desired driveline series (RPL or MXL).
4. Determine the Driveline Application (DA) limit.
5. Determine the maximum driveline torque (MDT) using the method identified in the guideline.
6. Determine if the wheel slip torque (WST) can be used in lieu of the MDT for sizing purposes (Driveline size cannot be reduced by more than one size when compared to the driveline size identified by the MDT value). If the WST indicates the driveline size can be reduced, the DA limit must be approvable for the final driveline size selected.
7. Identify the appropriate main driveline based on both DA and MDT (or WST if appropriate).
8. Identify the appropriate interaxle driveline based on Table E and Table F.

FOR LINEHAUL APPLICATIONS

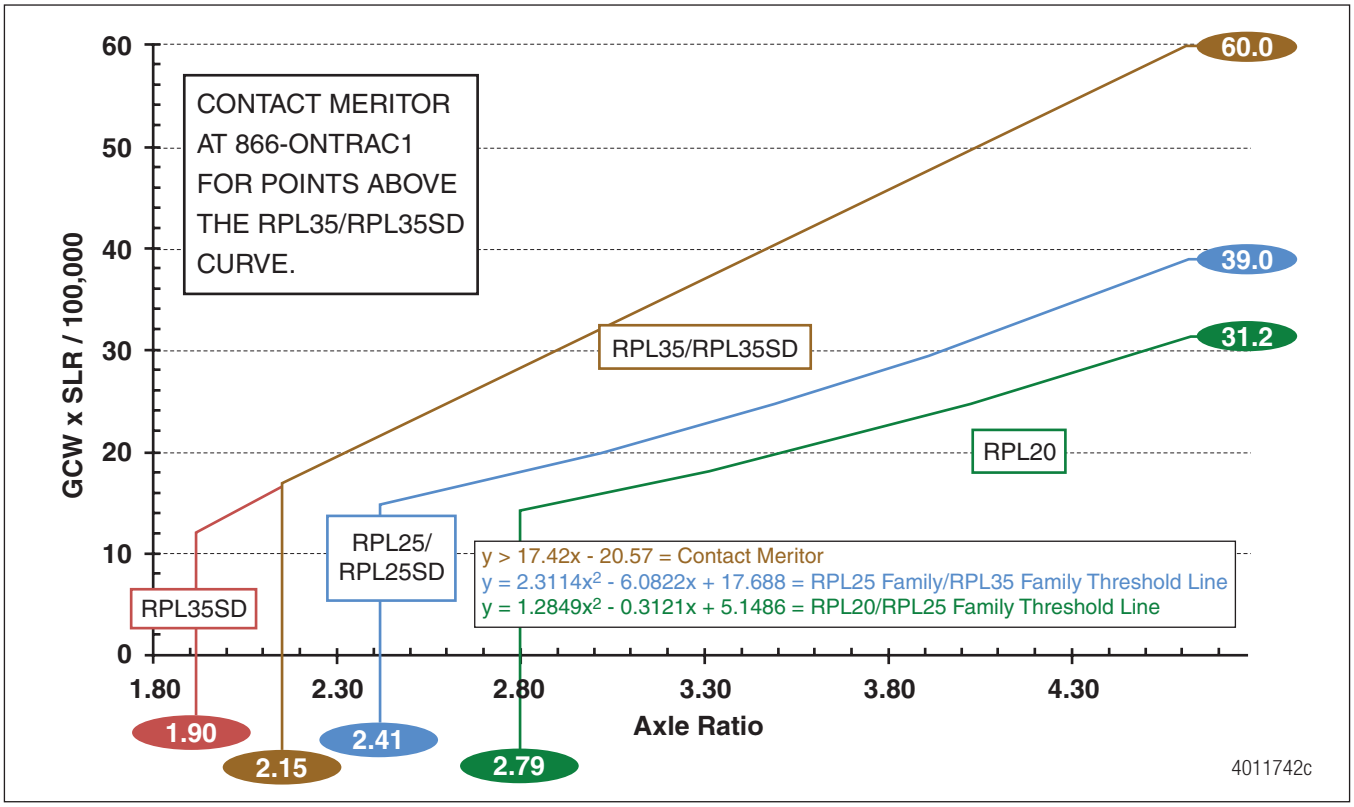
Use the steps described below to determine the minimum required driveline size for vehicles meeting the Linehaul vocation definition.

1. Verify the vehicle will be used exclusively in Linehaul vocation.
2. Identify the desired axle ratio for the vehicle.
3. Determine the desired driveline series (RPL or MXL).
4. Determine the Driveline Application Limit:
   A. Multiply vehicle gross combined weight (GCW in pounds) by tire static loaded radius (SLR in inches). Then divide the product obtained by 100,000.

$$\frac{GCW \times SLR}{100{,}000}$$

   B. Use the Linehaul chart that corresponds to the desired driveline series (Chart 2 for RPL or Chart 3 for MXL). Plot the result from step 3 along the Y-Axis and the desired axle ratio along the X-Axis. Find the intersecting point on the appropriate chart. Identify the curve above the intersecting point on the chart. The intersecting point must lie on or below the curve for the appropriate driveline.
5. Determine the MDT described later in this document to identify the maximum torque the driveline will be subjected. Compare this value to the values listed in Table B. Select a driveline with a Maximum Rated Torque from Table B that is equal to, or greater than, the maximum torque calculated using the MDT calculation method.

6. Determine the WST using the process described later in this document. Follow the instructions in the WST section to determine if the driveline size can be reduced.
7. Select a driveline that meets all the requirements described in this process.
8. Identify the appropriate interaxle driveline using Table E if appropriate.

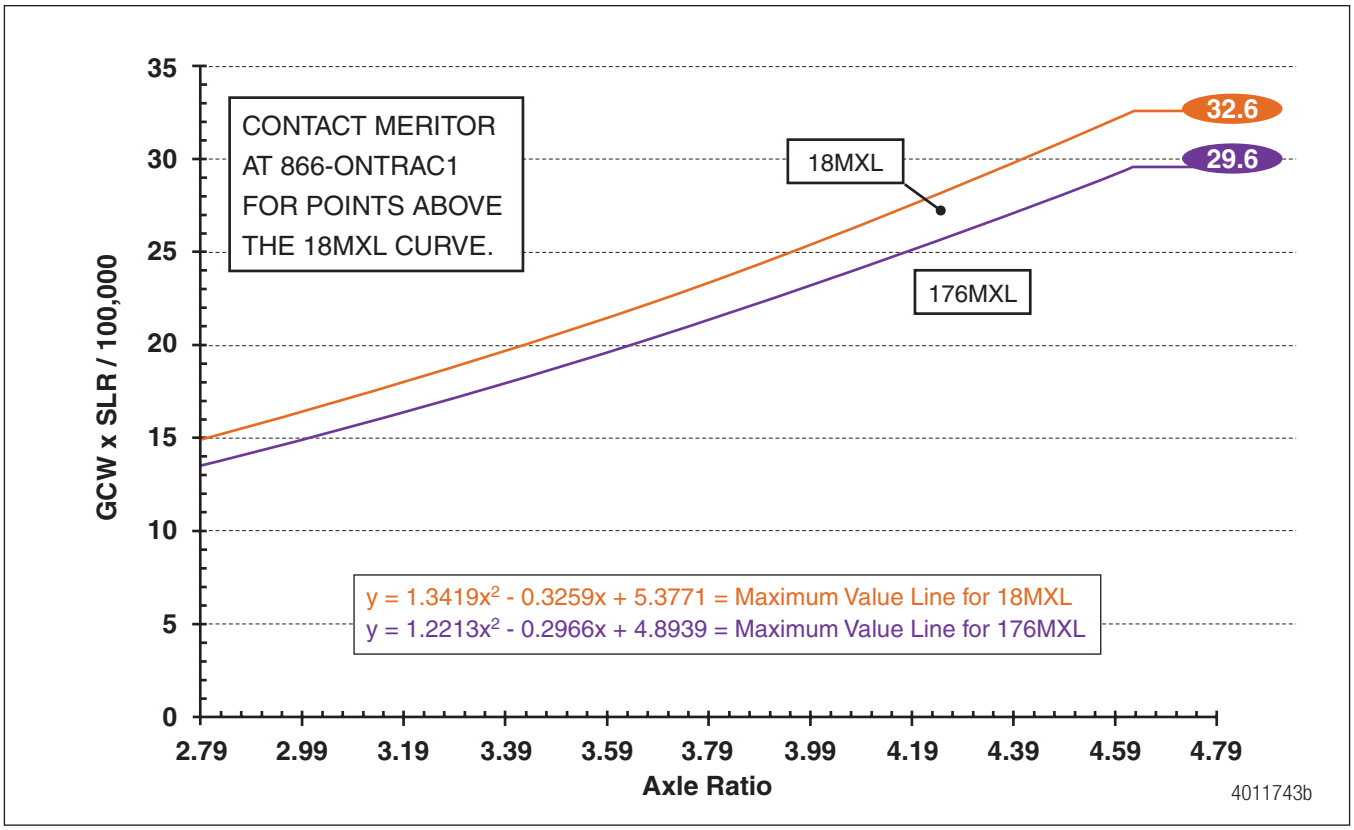


1. In the equations provided, "x" represents the axle ratio.
2. Axle ratios numerically lower than 2.28 require Meritor approval.

Chart 2 – RPL Series Linehaul Sizing

To correctly use Chart 2, multiply the GCW and SLR and divide the product by 100,000. Plot the resultant value against the axle ratio on the chart. If the intersecting point falls on or below the curve, the RPL25 series of drivelines should be used for the main driveline. If the point falls above the curve, the RPL 35 series of drivelines should be used.

3 Driveline Sizing Process



1. In the equations provided, "x" represents the axle ratio.
2. Axle ratios numerically lower than 2.79 require Meritor approval.

Chart 3 – MXL Series Linehaul Sizing

To correctly use Chart 3, first multiply the GCW and SLR and divide the product by 100,000. Plot the resultant value against the axle ratio on the chart. The intersecting point must fall on or below the curve for the desired driveline series and angle.

Maximum Driveline Torque and Sizing Values

Table B: Driveline Properties

Driveline Series	Swing Diameter		Tube Size		Maximum-Rated Torque	
			Outside Diameter	Wall Thickness		
	in.	mm	in.	in.	lb-ft	Nm
155N	6.0	152.4	4.000	0.083	3,800	5,152
16MXL	7.0	177.8	4.000	0.109	6,000	8,135
17MXL	7.8	198.1	4.095	0.180	10,000	13,558
176MXL	8.4	213.4	4.095	0.180	12,000	16,270
18MXL	9.1	231.1	4.590	0.180	16,500	22,370
92N	8.62	218.9	4.590	0.180	17,200	23,320
RPL10	7.0	177.8	4.000	0.109	6,000	8,135
RPL14	7.8	198.1	4.095	0.180	10,000	13,558
RPL20	7.8	198.1	4.095	0.180	12,000	16,270
RPL25	9.1	231.1	4.590	0.180	17,200	23,320
RPL25SD	9.1	231.1	4.690	0.230	18,500	25,082
RPL35	8.1	205.7	4.690	0.230	21,600	29,286
RPL35SD	8.1	205.7	5.204	0.236	25,820	35,000

FOR NON-LINEHAUL APPLICATIONS

Use the steps described below to determine the minimum required driveline size for vehicles that do not meet the Linehaul vocation definition.

1. Verify the vocation is non-linehaul.
2. Identify the desired axle ratio for the vehicle.
3. Determine the desired driveline series (RPL or MXL).
4. Determine the Driveline Application Limit:
   A. Multiply vehicle gross combined weight (GCW in pounds) by tire static loaded radius (SLR in inches). Then divide the product obtained by 100,000.

$$\frac{GCW \times SLR}{100{,}000}$$

   B. Using the Non-Linehaul chart that corresponds to the desired driveline series (Chart 4 for RPL or Chart 5 for MXL), plot the result from above along the Y-axis and the desired axle ratio along the X axis. Find the intersecting point on the chart. Tables C and D identify the minimum approvable axle ratios by driveline series as well as the equations that define the curves in Charts 4 and 5 respectively.
5. Identify the curve above the intersecting point on the charts. The intersecting point must lie on or below the curve for the appropriate driveline.
6. Determine the MDT described later in this document to identify the maximum torque the driveline will be subjected. Compare this value to the values listed in Table B. Select a driveline with a Maximum Rated Torque from Table B that is equal to, or greater than, the maximum torque calculated using the MDT calculation method.
7. Select a driveline that meets all the requirements described in this process.
8. Identify the appropriate interaxle driveline using Table F if appropriate.

3 Driveline Sizing Process

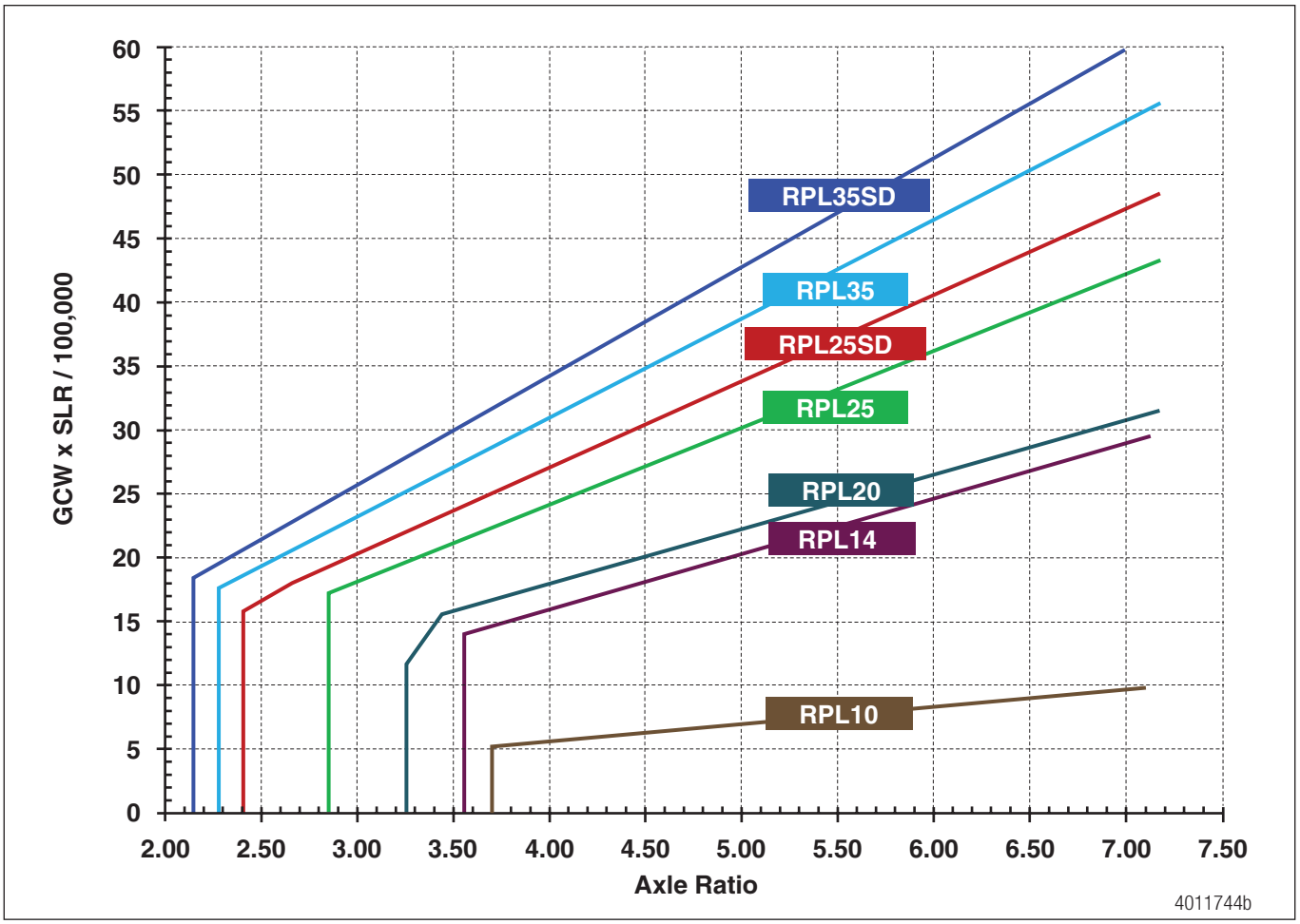


Chart 4 – RPL Series Non-Linehaul Sizing

Table C: RPL Series Non-Linehaul Curve Limits

	Lowest Numeric Ratio Axle Approvable	Curve Segment 1		Curve Segment 2	
		Ratio Range	Equation	Ratio Range	Equation
RPL10	3.70	3.70-7.17	y=1.3850x	Not Applicable	
RPL14	3.56	3.56-7.17	y=4.1152x		
RPL20	3.25	3.25-3.55	y=12.5380x-28.8970	3.55-7.17	y=4.3860x
RPL25	2.64	2.64-7.17	y=6.0241x	Not Applicable	
RPL25SD	2.41	2.41-2.64	y=8.5959x-4.8609	2.64-7.17	y=6.7568x
RPL35	2.28	2.28-7.17	y=7.7519x	Not Applicable	
RPL35SD	2.15	2.15-7.17	y=8.5470x		

In the equations provided, “x” represents the axle ratio.

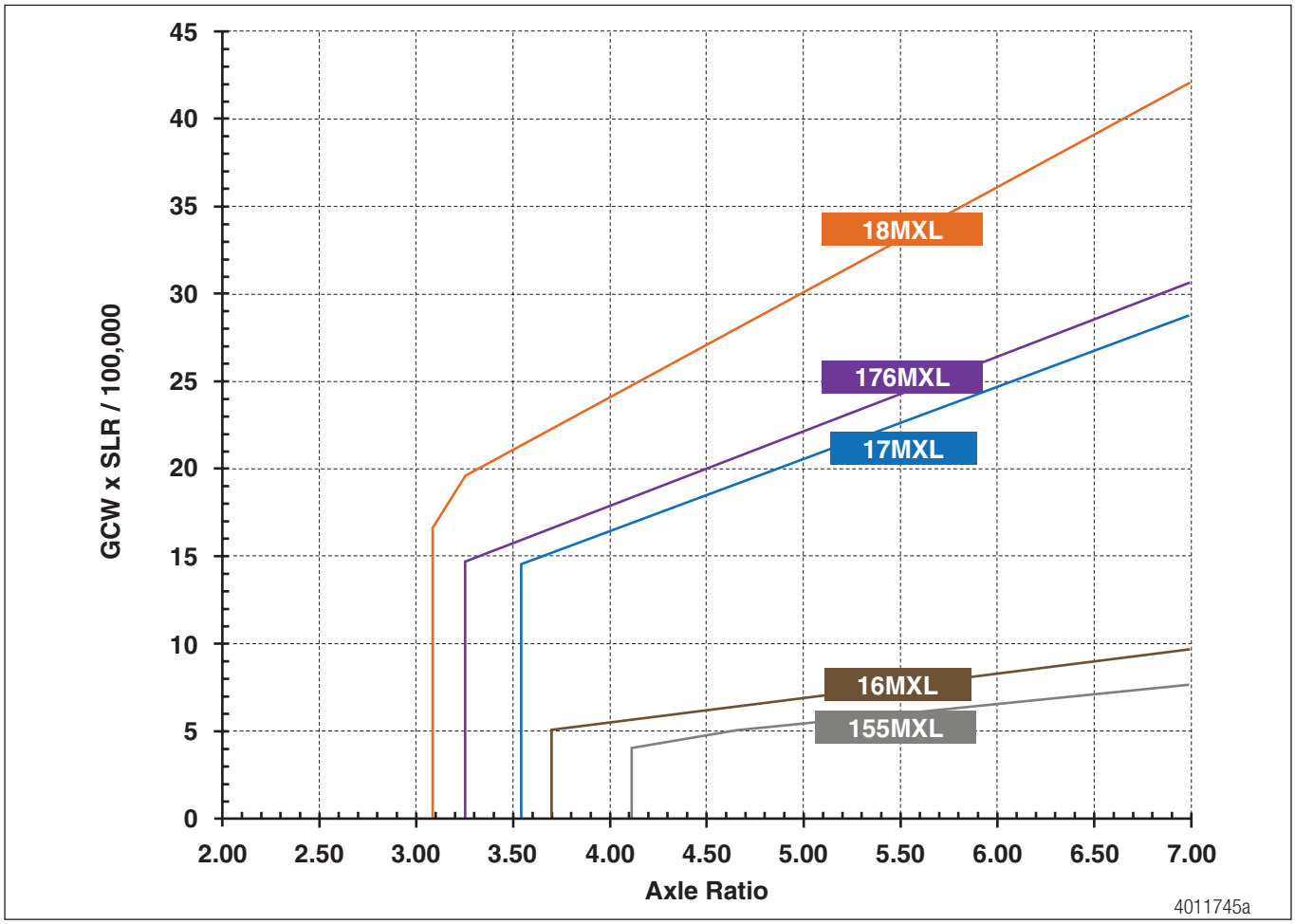


Chart 5 – MXL Series Non-Linehaul Sizing

Table D: MXL Series Non-Linehaul Curve Limits

	Lowest Numeric Ratio Axle Approvable	Curve Segment 1		Curve Segment 2	
		Ratio Range	Equation	Ratio Range	Equation
155MXL	4.11	4.11-4.63	y=1.9672x-4.0383	4.63-7.17	y=1.0941x
16MXL	3.70	3.70-7.17	y=1.3850	Not Applicable	
17MXL	3.56	3.56-7.17	y=4.1152x		
176MXL	3.25	3.25-7.17	y=4.3860x		
18MXL	3.08	3.08-3.25	y=16.9380x-35.4710	3.25-7.17	Y=6.0241X

In the equations provided, “x” represents the axle ratio.

3 Driveline Sizing Process

MDT For Linehaul and Non-Linehaul Applications

Calculate the Maximum Driveline Torque (MDT). A sample formula is provided in this section. Compare the value to the Meritor Maximum-Rated Torque values in Table B. Select the Meritor driveline with a rating that meets or exceeds the value calculated for your application.

The Maximum Rated Torque is the short-duration input torque capacity of the driveline assembly. Input torque greater than the Maximum Rated Torque can permanently damage driveline components. Maximum Rated Torque values in the table should not be exceeded under any conditions.

The maximum torque the driveline is exposed to for any vehicle application depends on several parameters such as engine torque, transmission ratio, axle ratio and GVW/GCW. Additionally, drivetrain and vehicle inertia can significantly contribute to transient driveline torque spikes, especially at low vehicle speeds. These torque spikes tend to be more severe in vehicles equipped with lower numeric axle ratios and/or larger displacement engines. Vehicles equipped with large displacement engines, even those utilizing torque limiting strategies, have been shown to greatly exceed the maximum driveline torque ratings due to inertial torque spikes.

The MDT formula below, estimates the steady-state torque to which the driveline will be subjected. Current vehicle systems are capable of generating transient torque spikes that significantly exceed the calculated steady-state torque estimates. The Maximum Rated Torque values in Table B apply to both steady-state and transient events.

MAXIMUM DRIVELINE TORQUE (MDT) CALCULATION METHOD

The steady-state maximum driveline torque (MDT) generated by the engine in lower gear is obtained as follows:

$$MDT = T \times TLGR \times TE \times SR \times TCR \times C$$

MDT = Maximum Driveline Torque in Low Gear
T = Net Engine Torque or 95% of the Gross Engine Torque
TLGR = Transmission Low Gear Ratio (highest numerical forward gear ratio)
TE = Transmission Efficiency (automatic = 0.8; manual = 0.85)
SR = Torque Converter Stall Ratio (if applicable; if not then SR=1)
TCR = Transfer Case Ratio (if applicable; if not then TCR=1)
C = Transfer Case Efficiency (if applicable use 0.95; if not then C=1)

Some transmissions have gears specifically intended for positioning. These gears are characterized by large numerical ratios and large step increases between the gears. These positioning gears do not need to be considered when determining the MDT. To qualify for omission from the MDT calculation, a gear must meet all of the following three criteria:

1. Be numerically larger than 18.0.
2. Have a step increase between gears greater than 55%.
3. Provide startability 25% when using the following equation:

$$S = \frac{T_{800} \times R_T \times R_A \times N}{10.7 \times GCW}$$

S = Startability
T_{800} = Clutch Engagement Torque (lb-ft)
R_T = Transmission Gear Ratio
R_A = Axle Gear Ratio
N = Number of Revolutions per Mile of the Tire
GCW = Gross Combined Weight

If a transmission gear ratio meets all three of these requirements, the next gear ratio in the transmission may be used to determine the MDT.

WHEEL SLIP TORQUE

In some instances, the wheel slip torque (WST) is lower than the MDT. If this is the case, the WST can be used for driveline sizing in lieu of MDT. If WST identifies a smaller driveline than MDT, the driveline size can be reduced by no more than one size when compared to the driveline size identified by the MDT.

$$WST = \frac{W \times SLR}{16.06 \times R_a}$$

WST = Wheel Slip Torque (lb-ft)
W = Gross Axle Weight Rating (lb)
SLR = Static Loaded Radius of Tire (inches)
R_a = Axle Ratio (includes wheel end reduction)

INTERAXLE DRIVELINE SIZING

Table E: Linehaul Interaxle Driveline Sizing

	Inter-Axle Driveline Size		
		Tridem Axle	
Main Shaft	Tandem Interaxle Shaft	First Interaxle Shaft	Second Interaxle Shaft
176MXL, 18MXL	17MXL	18MXL	17MXL
RPL14, RPL20, RPL25	RPL14[1], RPL20, RPL25	RPL25	RPL20
RPL35	RPL20[2], RPL25	RPL25	RPL20, RPL25
RPL35SD	RPL25	RPL25	RPL25

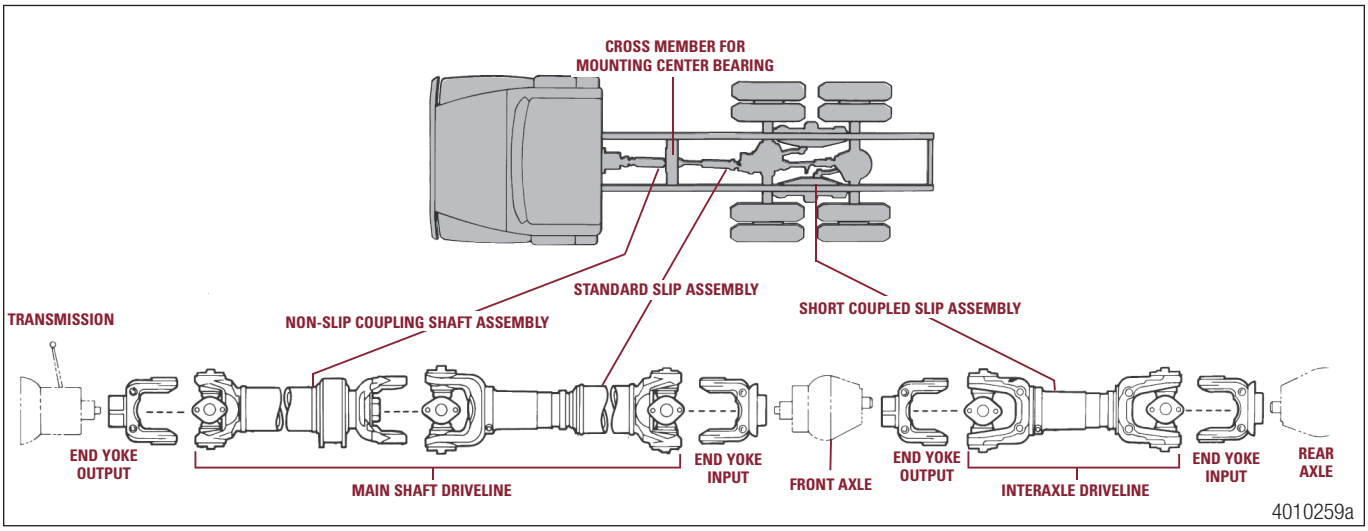
[1]RPL14 interaxle driveline use requires the main driveline torque be limited to a maximum of 16,500 lb-ft and the axle ratio must be numerically larger than 3.08.
[2]RPL20 interaxle driveline use requires the main driveline torque be limited to a maximum of 20,000 lb-ft and the axle ratio must be numerically larger than 2.40.

Table F: Non-Linehaul Interaxle Driveline Sizing

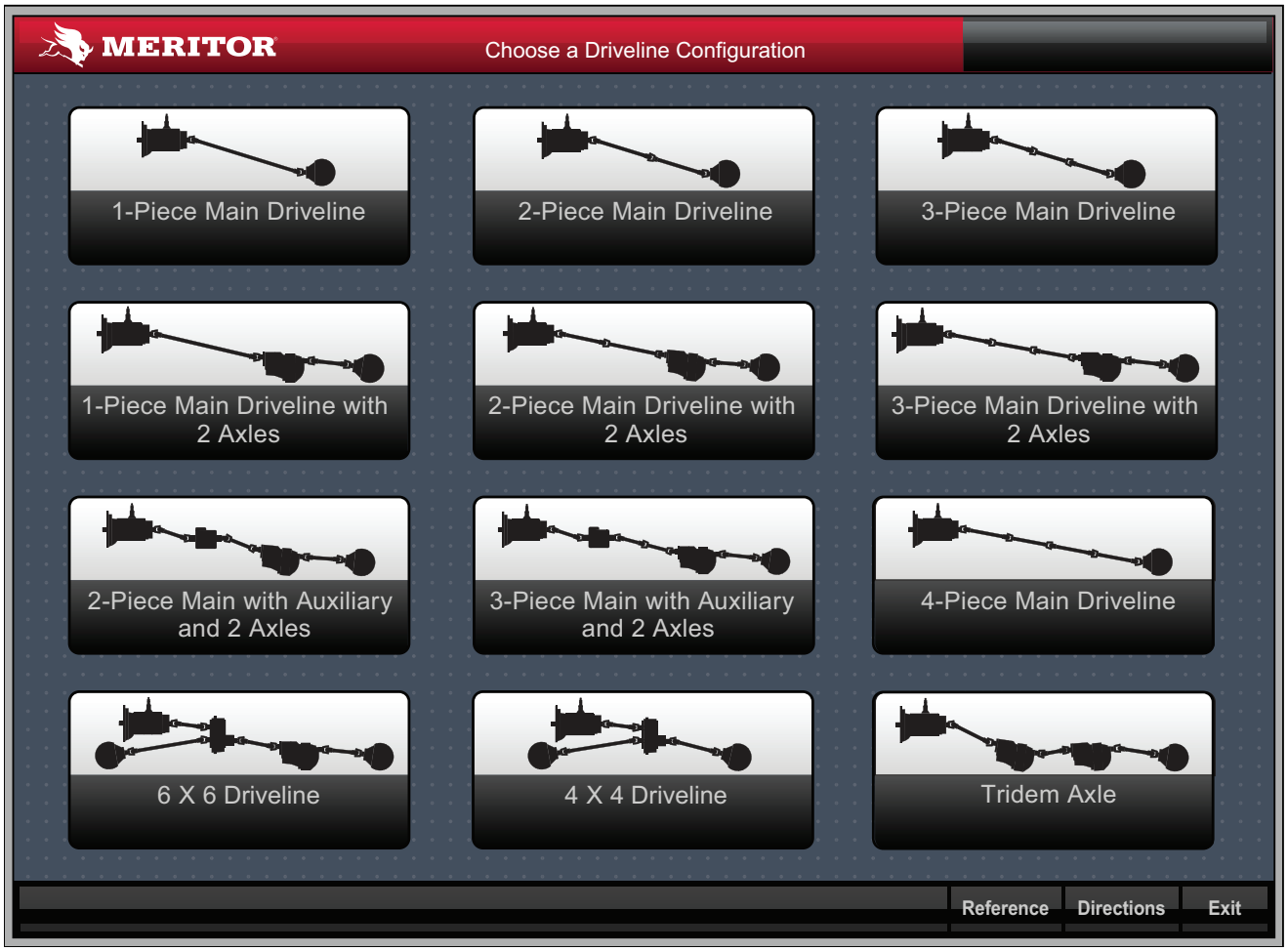
	Inter-Axle Driveline Size		
		Tridem Axle	
Main Shaft	Tandem Interaxle Shaft	First Interaxle Shaft	Second Interaxle Shaft
17MXL, 176MXL, 18MXL	17MXL	18MXL	17MXL
RPL14	RPL14	RPL14	RPL14
RPL20, RPL25, RPL25SD	RPL14, RPL20, RPL25	RPL25	RPL20
RPL35, RPL35SD	RPL25	RPL25	RPL20, RPL25
92N	17MXL, 18MXL, RPL20	92N	92N

Terminology

Driveline Components



Meritor offers an online Driveline Angle Analysis that is recommended to be used as a verification tool for all truck configurations. Visit meritor.com to access the program.



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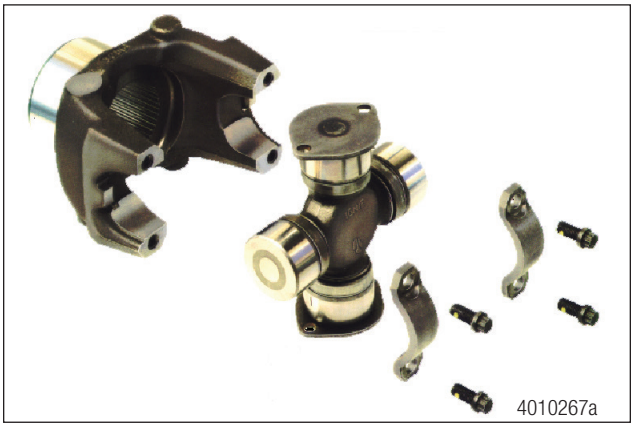
End Yoke Designs

WING-STYLE PERMALUBE™

They are identified with wing-style bushings that are retained.

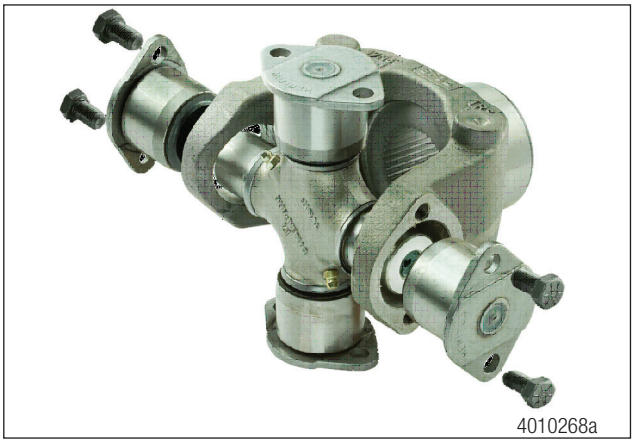
EASY SERVICE™

Also called half-round, they are identified by two semi-round straps and four bolts for easy assembly and removal.



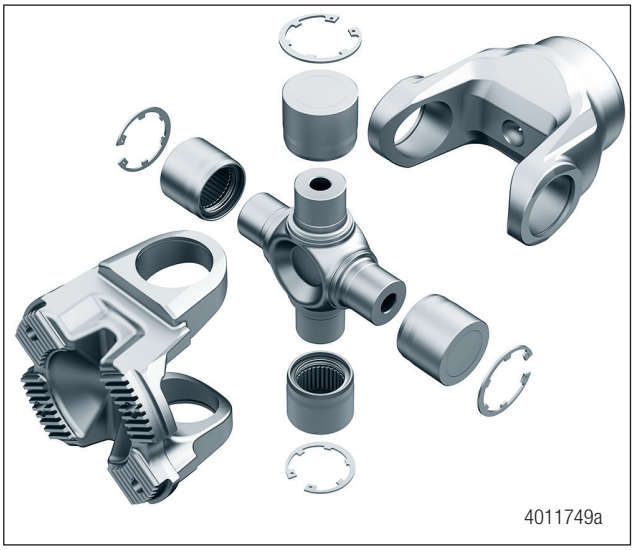
FULL ROUND

They are identified by a full-round yoke connection surrounding the cup that requires correct alignment when assembling.

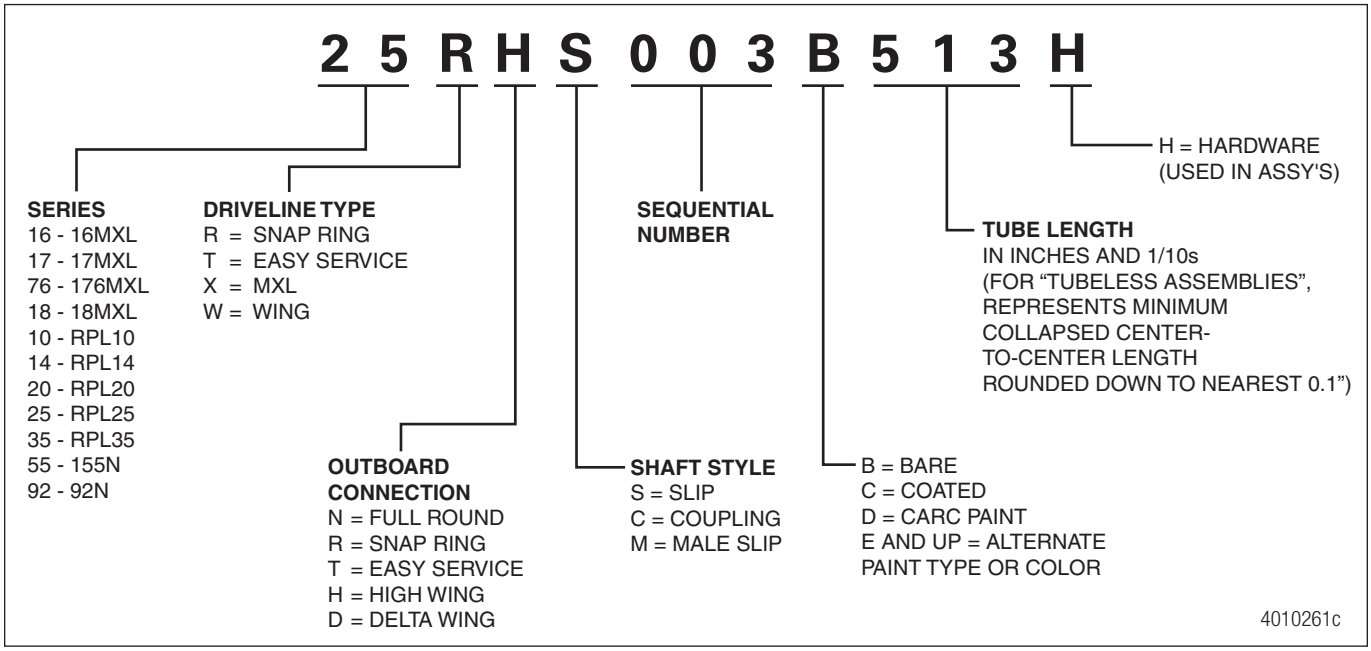


ISO FLANGE

They are identified by the round flange with serrations on the mounting face.



Meritor Driveline Assembly Number



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