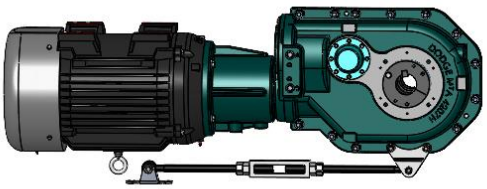
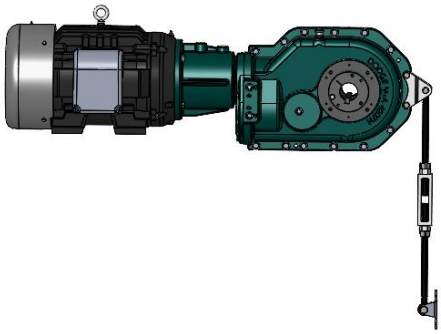
Dodge MTA Reducers: Tie Rod & Shaft Reaction Force Calculations

When a gearbox is installed directly onto the driven shaft of a conveyor or bucket elevator, there must be something that prevents the whole gearbox from rotating around when the motor is started. One way to do this is with a tie rod assembly. It can also be referred to as a torque arm. This arrangement will ensure that the output torque of the gearbox will drive the shaft it is mounted on and not cause the gearbox to spin around instead. Figure 1 shows some common mounting MTA positions and tie rod arrangements.

Position A with Tie Rod Horizontal



Position C withTie Rod Vertical



Position D withTie Rod Horizontal

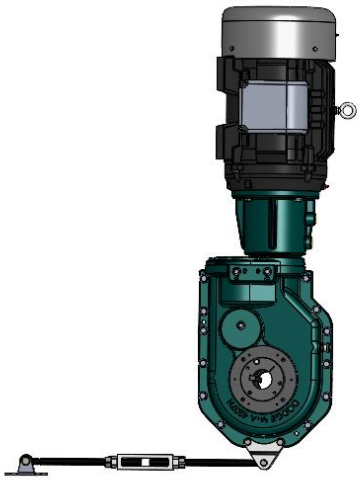


Figure 1: MTA Mounting and Tie Rod Positons

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This white paper will look at the MTA reducers and show how changes in how the gearbox is mounted, the direction of output rotation, and where the tie rod is mounted affect the tie rod and shaft reaction forces. There are calculated examples at the end of this whitepaper for two MTA sizes (MTA4 and MTA8) mounted in two positions (C and D). The examples will show both directions of rotation for these examples with various tie rod postions.

These next couple of sections will show how each of the variables affect the tie rod and shaft force calculations.

Gearbox Output Torque:

For a gearbox delivering its output torque to a conveyor shaft, there must be a equal and opposite reaction moment that the gearbox and its tie rod must counteract. So if a gearbox has a clockwise output rotational direction, its counteracting torque (moment) will be counterclockwise and vice versa.

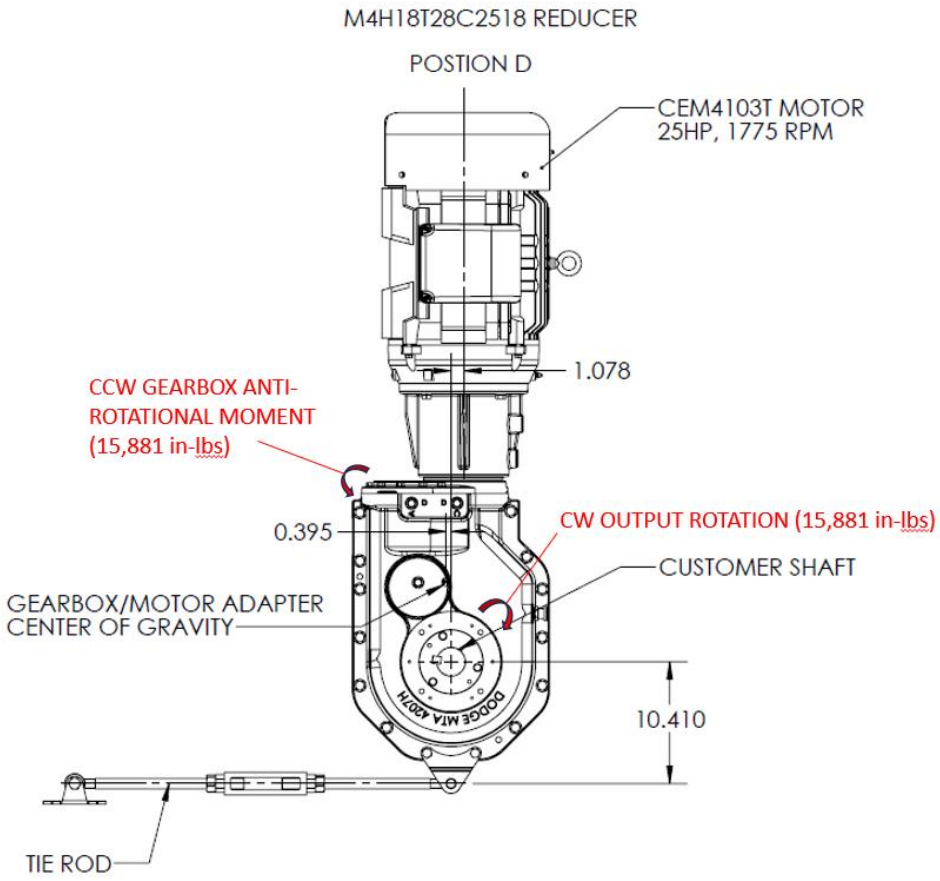

Figure 2: CW Output Rotational Torque and its CCW Anti-Rotational Moment created

Gearbox Mounting Postions:

Typically a motor's weight, when mounted over top of the reducer's output shaft (i.e. Position D), will not create significant additional loads that the tie rod must support because the motor's center of gravity is generally mounted directly over the conveyor shaft's center. The tie rod will only have to support mainly the moment created from gearbox's output torque. However, when a MTA is mounted in Position A or C, the gearbox's output torque may either add or subtract from the gearbox and motor weight moments that are present. This is because the motor's center of gravity is a substantial distance away from the center of the conveyor shaft. This can create considerable forces that both the tie rod and shaft must support.

Figures 3 and 4 show the effects of a MTA4 gearbox/adapter and 25HP motor weight have from moving the reducer from Positon D to Postion C. These calculations are for the tie rod without any power (torque) applied from the motor. Without any power applied to the gearbox, the tie rod force increase by almost 50 times by this change. If the direction of rotation of the gearbox's output adds to this moment, this increase will create more forces that the tie rod and the customer's shaft have to support.

Component	Weight (pounds)	Cg (inches)	Side of Customer Shaft	Moment Direction	Magnitude (in-lbs)
Gearbox/ Motor Adapter	305	0.395	Left	CCW	120
Motor	430	1.078	Right	CW	463
Total	735	0.467	Right	CW	343

The 343 in-lb moment creates
33 pounds of tie rod reaction force
in this Position D configuration

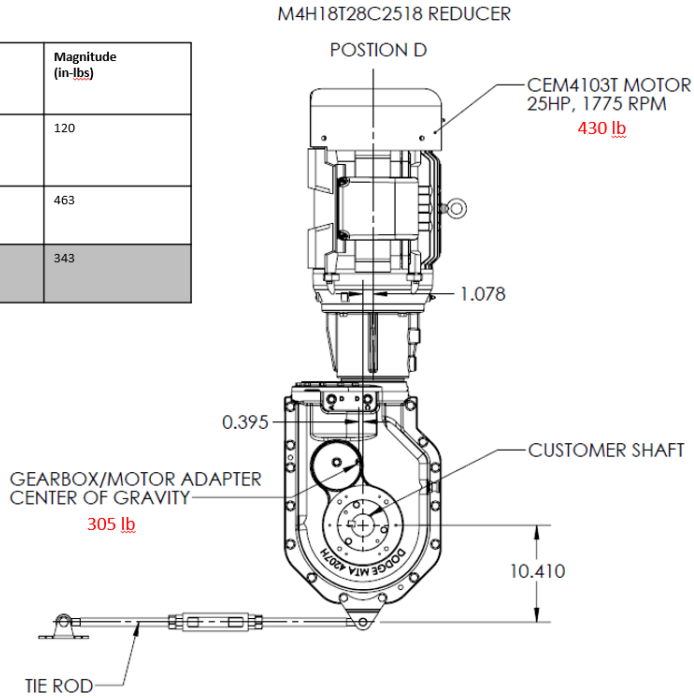

Figure 3: Motor and Gearbox Weights in Positon D (No Power Applied)

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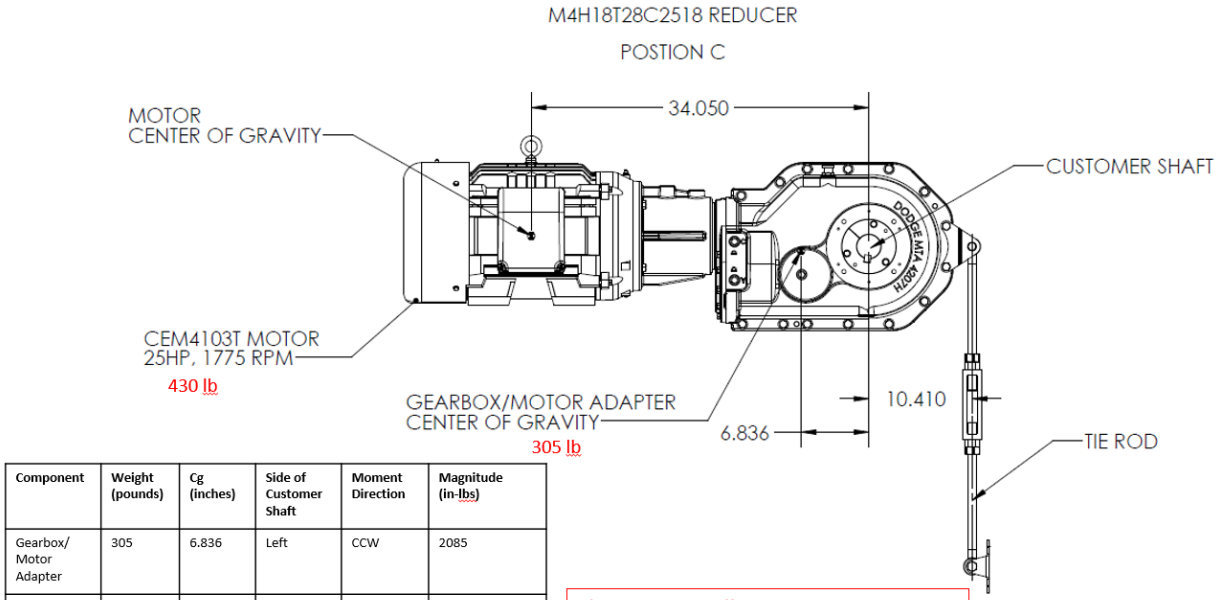


Component	Weight (pounds)	Cg (inches)	Side of Customer Shaft	Moment Direction	Magnitude (in-lbs)
Gearbox/ Motor Adapter	305	6.836	Left	CCW	2085
Motor	430	34.050	Left	CCW	14,642
Total	735	22.748	Left	CCW	16,727

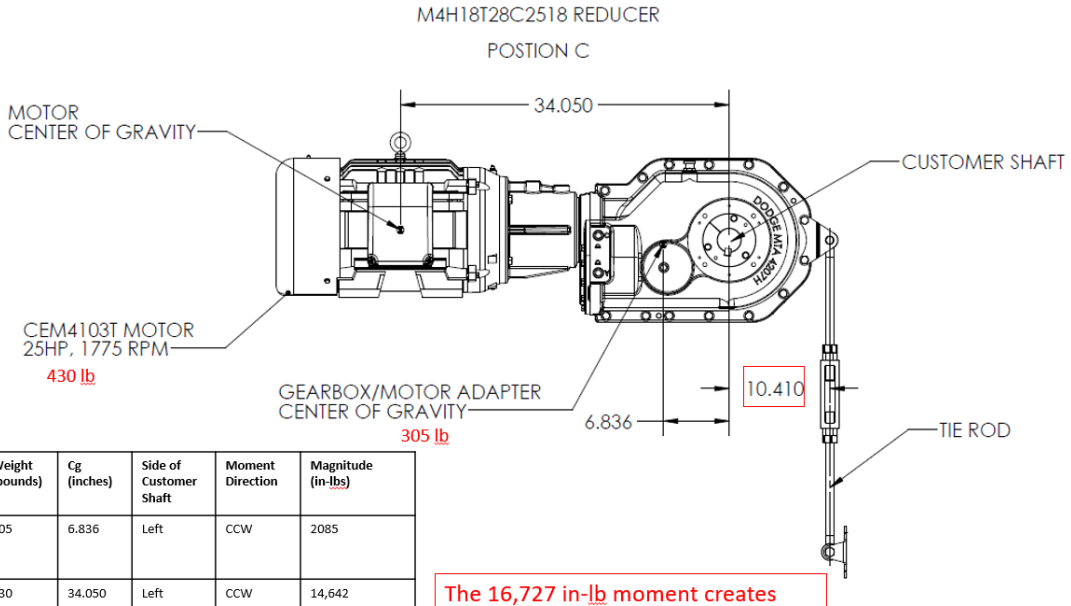
The 16,727 in-lb moment creates 1607 pounds of tie rod reaction force in this Position C configuration

Figure 4: Motor and Gearbox Weights in Positon C (No Power Applied)

Tie Rod Locations and Tie Rod Angles:

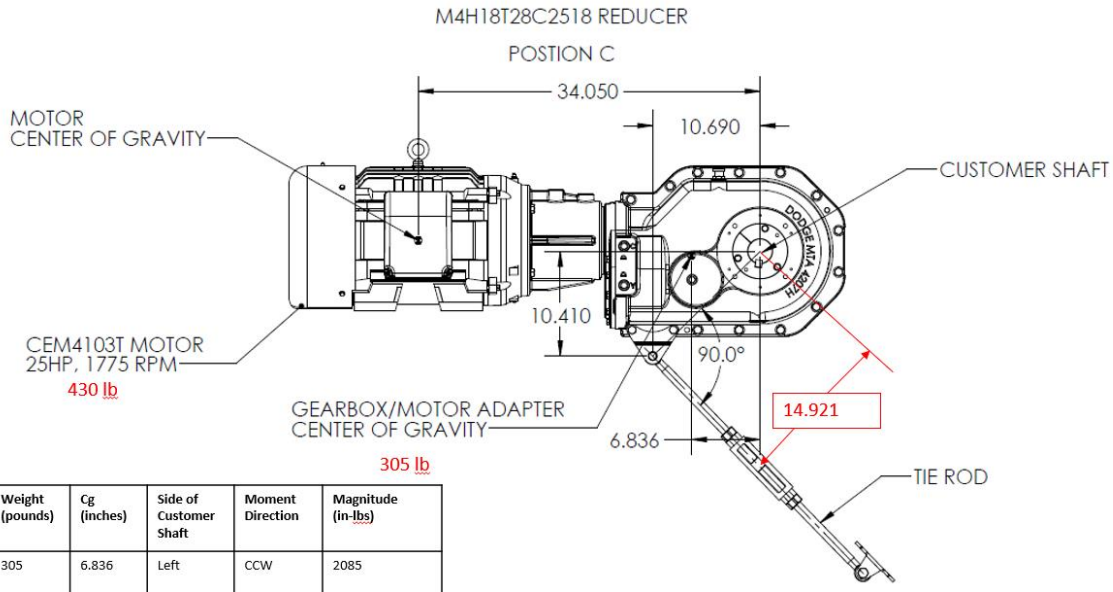
The distance from the output hub to where the tie rod connects to the housing bracket is also important. The larger this distance is, the lower the reaction force will be for the same amount of output torque and gearbox mounting conditions. It is good practice to try and keep this distance as large as possible.

Figures 5 and 6 show the effects of a MTA4 gearbox/adapter and 25HP motor weight mounted in Position C and moving the tie rod location from 10.410" to 14.921". This larger distance reduces the tie rod reaction by 30% over the smaller distance. These calculations are for the tie rod without any power (torque) applied from the motor. Adding power will produce torque that is either added to or subtacted from the moment that the tie rod and the customer's shaft have to support.



Component	Weight (pounds)	Cg (inches)	Side of Customer Shaft	Moment Direction	Magnitude (in-lbs)
Gearbox/ Motor Adapter	305	6.836	Left	CCW	2085
Motor	430	34.050	Left	CCW	14,642
Total	735	22.748	Left	CCW	16,727

Figure 5: Position C Tie Rod Location #1 (No Power Applied)



Component	Weight (pounds)	Cg (inches)	Side of Customer Shaft	Moment Direction	Magnitude (in-lbs)
Gearbox/ Motor Adapter	305	6.836	Left	CCW	2085
Motor	430	34.050	Left	CCW	14,642
Total	735	22.748	Left	CCW	16,727

The 16,727 in-lb moment creates 1121 pounds of tie rod reaction force in this Position C configuration

Figure 6: Position C Tie Rod Location #2 (No Power Applied)

Another factor that comes into play is the angle that is created by the tie rod centerline and an imaginary line from the center of the gearbox's output to the tie rod connection with the housing brackets. This angle needs to be as close as possible to 90 degrees. The further you get away from 90 degrees, the larger the resultant force in the tie rod and bracket will be. Dodge, typically alllows +/- 20 degrees from ths angle for Torque-Arm reducers. However, for some MTA applications with high tie rod reactions, this allowance is best reduced to +/- 5 degrees.

Figure 7 shows correct tie rod angles for an MTA gearbox in Position C. Figure 8 shows incorrect tie rod angles for an MTA gearbox in Positon C.

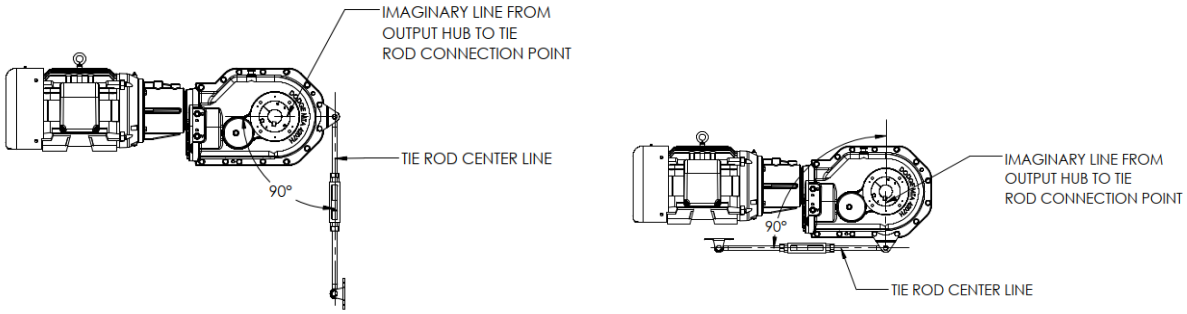


Figure 7: Correct Tie Rod Angles

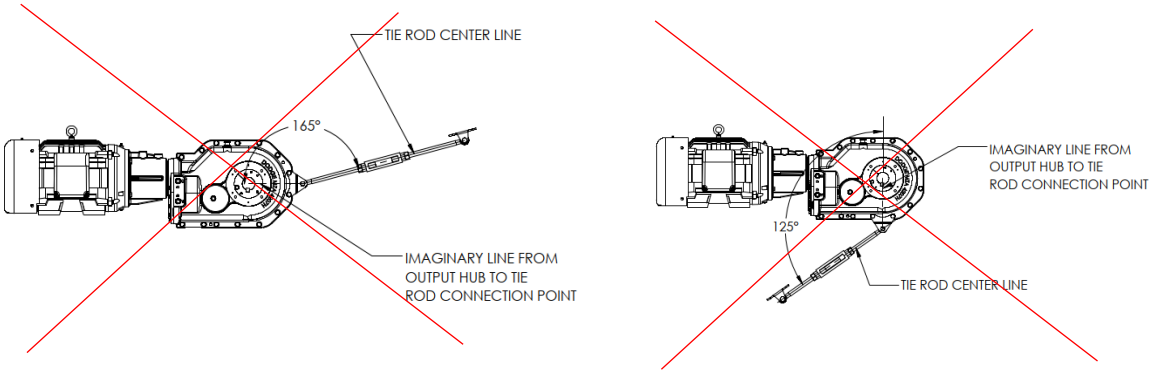


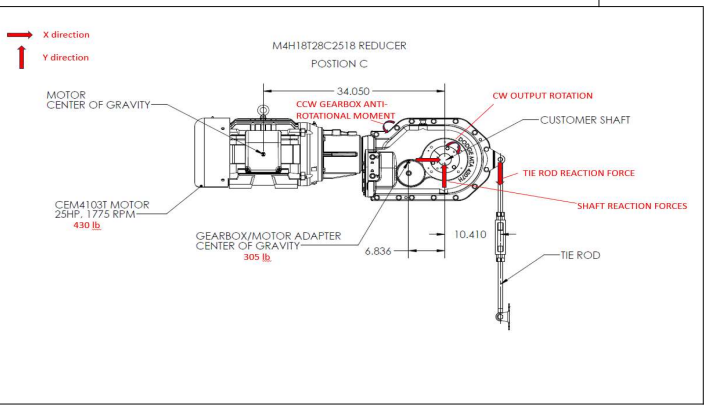
Figure 8: Incorrect Tie Rod Angles

Tension vs Compression on Tie Rod

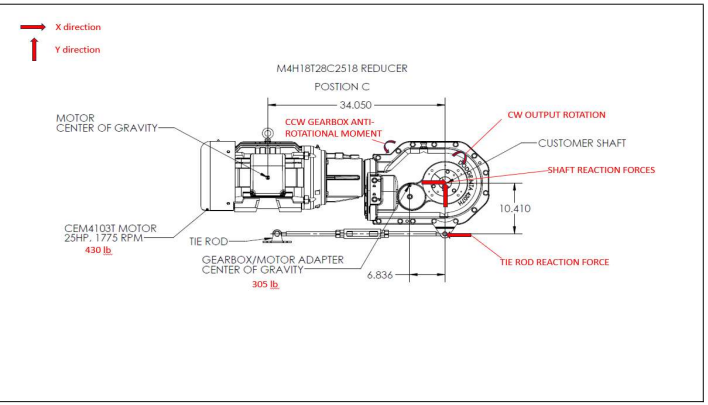
Dodge tie rods can be mounted in either tension or compression. Tension is preferred so that the tie rod does not buckle under the resultant force. The way to determine if the tie rod is in either tension or compression is to first determine which way the output hub of the gearbox is rotating. The resultant reaction will want to turn the gearbox in the opposite direction. Not only how the tie rod is mounted comes in to play on if is in either tension or compression, but the MTA mounting position has a significant effect as well. The added moments created from gearbox and motor weights in Position A or C can add more tension (or compression) of the tie rod. It can also be setup differently where the weights and output torque have more of a cancelling out effect. Look at the examples at the end of the white paper to see the magnitudes of the tie reaction force and whether it is in tension or compression.

MTA4 - POSITION C (Clockwise Output Rotation)

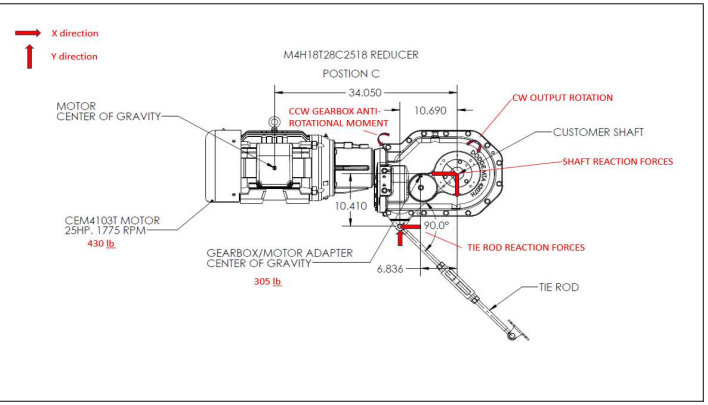
Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CCW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	6.836	Left	CCW	2085
Component	Motor	430	34.05	Left	CCW	14642
Tie Rod Distance from Customer Shaft (X-Direction)	10.410	inches		Tie Rod Distance from Customer Shaft (Y-direction)	0.000	inches
Tie Rod Reaction (X-direction)	0	lbs		Shaft Reaction (X-direction)	0	lbs
Tie Rod Reaction (Y-direction)	3132	lbs		Shaft Reaction (Y-direction)	3867	lbs
Total Tie Rod Reaction	3132	lbs		Total Shaft Reaction	3867	lbs
Tie Rod	In Tension					



Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CCW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	6.836	Left	CCW	2085
Component	Motor	430	34.05	Left	CCW	14642
Tie Rod Distance from Customer Shaft	0.000	inches		Tie Rod Distance from Customer Shaft (Y-direction)	10.410	inches
Tie Rod Reaction (X-direction)	3132	lbs		Shaft Reaction (X-direction)	3132	lbs
Tie Rod Reaction (Y-direction)	0	lbs		Shaft Reaction (Y-direction)	735	lbs
Total Tie Rod Reaction	3132	lbs		Total Shaft Reaction	3217	lbs
Tie Rod	In Tension					

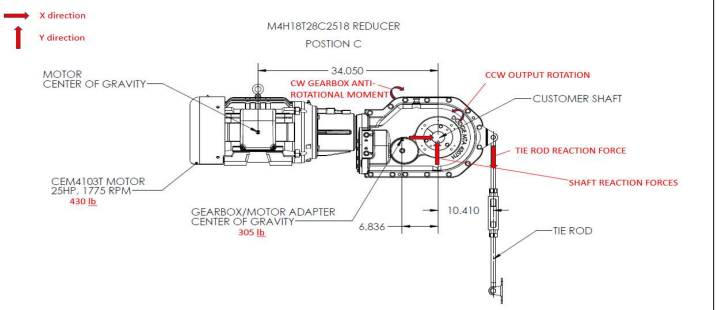


Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CCW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	6.836	Left	CCW	2085
Component	Motor	430	34.05	Left	CCW	14642
Tie Rod Distance from Customer Shaft (X-direction)	10.690	inches	2185.270547	Tie Rod Distance from Customer Shaft (Y-direction)	10.410	inches
Tie Rod Reaction (X-direction)	1525	lbs		Shaft Reaction (X-direction)	1525	lbs
Tie Rod Reaction (Y-direction)	1566	lbs		Shaft Reaction (Y-direction)	831	lbs
Total Tie Rod Reaction	2185	lbs		Total Shaft Reaction	1736	lbs
Tie Rod	In Compression					

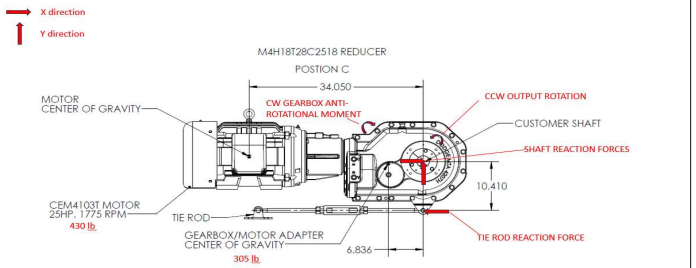


MTA4 - POSITION C (CounterClockwise Output Rotation)

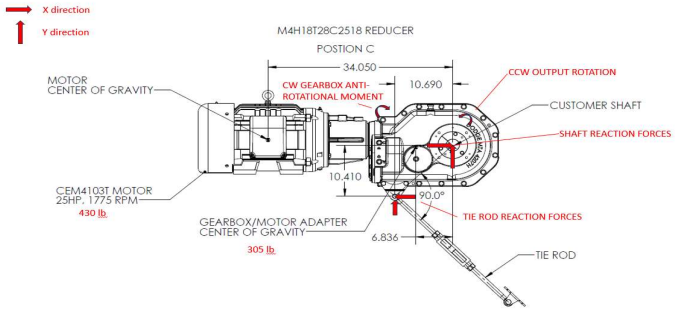
Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CCW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	6.836	Left	CCW	2085
Component	Motor	430	34.05	Left	CCW	14642
Tie Rod Distance from Customer Shaft (X-Direction)	10.410	inches		Tie Rod Distance from Customer Shaft (Y-direction)	0.000	inches
Tie Rod Reaction (X-direction)	0	lbs		Shaft Reaction (X-direction)	0	lbs
Tie Rod Reaction (Y-direction)	81	lbs		Shaft Reaction (Y-direction)	816	lbs
Total Tie Rod Reaction	81	lbs		Total Shaft Reaction	816	lbs
Tie Rod	In Tension					



Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CCW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	6.836	Left	CCW	2085
Component	Motor	430	34.05	Left	CCW	14642
Tie Rod Distance from Customer Shaft (X-Direction)	10.410	inches		Tie Rod Distance from Customer Shaft (Y-direction)	0.000	inches
Tie Rod Reaction (X-direction)	81	lbs		Shaft Reaction (X-direction)	81	lbs
Tie Rod Reaction (Y-direction)	0	lbs		Shaft Reaction (Y-direction)	735	lbs
Total Tie Rod Reaction	81	lbs		Total Shaft Reaction	739	lbs
Tie Rod	In Tension					

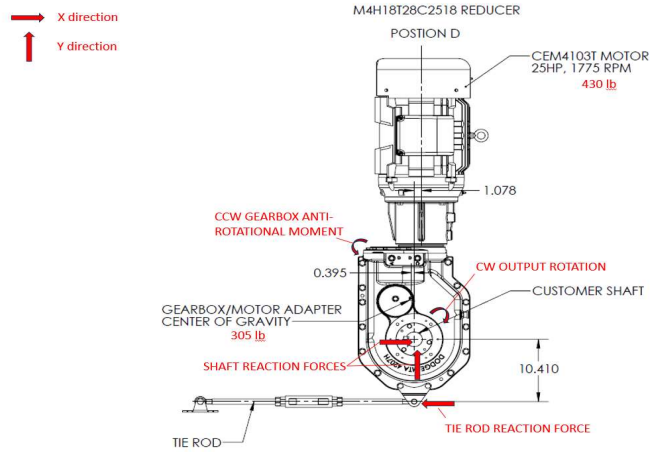


Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CCW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	6.836	Left	CCW	2085
Component	Motor	430	34.05	Left	CCW	14642
Tie Rod Distance from Customer Shaft (X-direction)	10.690	inches		Tie Rod Distance from Customer Shaft (Y-direction)	10.410	inches
Tie Rod Reaction (X-direction)	40	lbs		Shaft Reaction (X-direction)	40	lbs
Tie Rod Reaction (Y-direction)	41	lbs		Shaft Reaction (Y-direction)	694	lbs
Total Tie Rod Reaction	57	lbs		Total Shaft Reaction	696	lbs
Tie Rod	In Compression					

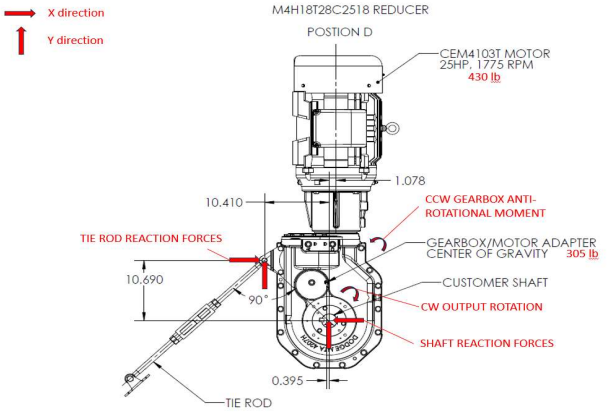


MTA4 - POSITION D (Clockwise Output Rotation)

Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CCW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	0.395	Left	CCW	120
Component	Motor	430	1.078	Right	CW	464
Tie Rod Distance from Customer Shaft	10.410	inches				
Tie Rod Reaction (X-direction)	1493	lbs		Shaft Reaction (X-direction)	1493	lbs
Tie Rod Reaction (Y-direction)	0	lbs		Shaft Reaction (Y-direction)	735	lbs
Total Tie Rod Reaction	1493	lbs		Total Shaft Reaction	1664	lbs
Tie Rod	In Tension					

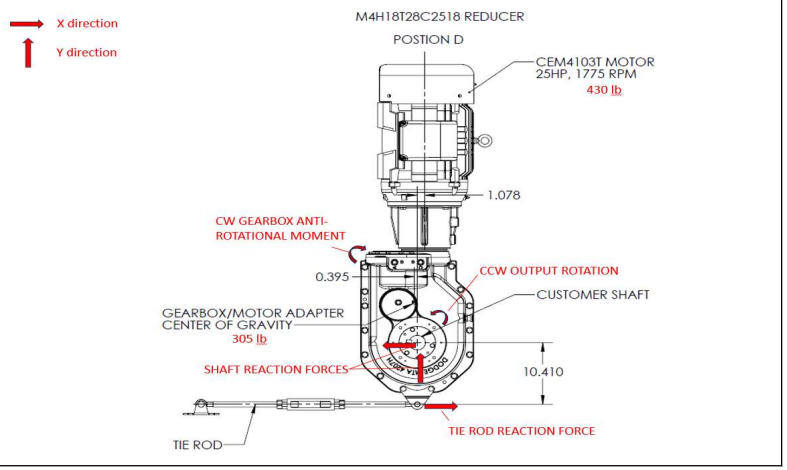


Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CCW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	0.395	Left	CCW	120
Component	Motor	430	1.078	Right	CW	464
Tie Rod Distance from Customer Shaft	10.410	inches		Tie Rod Distance from Customer Shaft (Y-direction)	10.690	inches
Tie Rod Reaction (X-direction)	746	lbs		Shaft Reaction (X-direction)	746	lbs
Tie Rod Reaction (Y-direction)	726	lbs		Shaft Reaction (Y-direction)	9	lbs
Total Tie Rod Reaction	1041	lbs		Total Shaft Reaction	746	lbs
Tie Rod	In Compression					

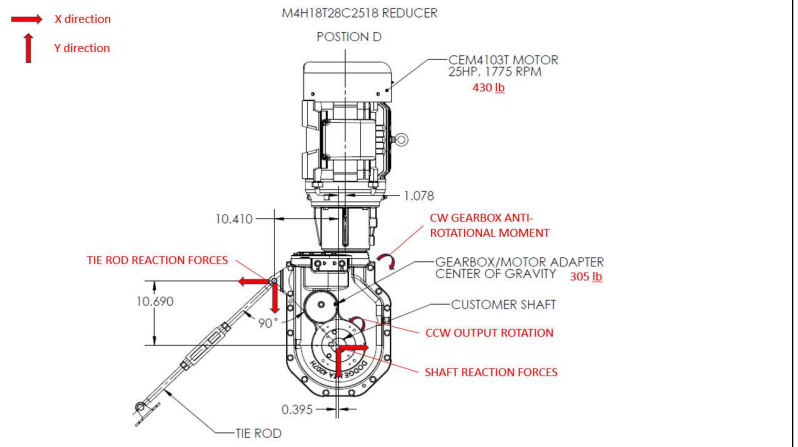


MTA4 - POSITION D (CounterClockwise Output Rotation)

Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CCW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	0.395	Left	CCW	120
Component	Motor	430	1.078	Right	CW	464
Tie Rod Distance from Customer Shaft	10.410	inches				
Tie Rod Reaction (X-direction)	1558	lbs		Shaft Reaction (X-direction)	1558	lbs
Tie Rod Reaction (Y-direction)	0	lbs		Shaft Reaction (Y-direction)	735	lbs
Total Tie Rod Reaction	1558	lbs		Total Shaft Reaction	1723	lbs
Tie Rod	In Compression					

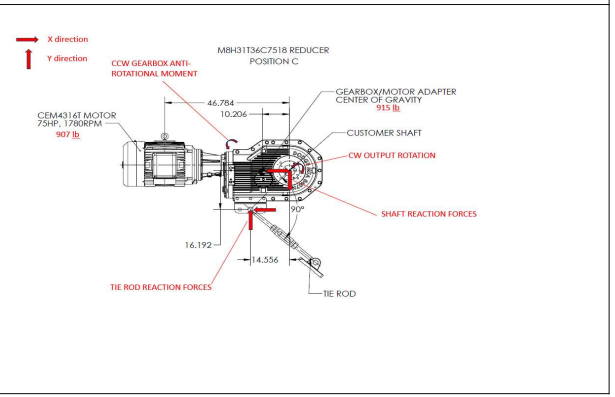


Gearbox	M4H18T28C2518					
Actual Ratio	17.89					
Motor HP	25					
Motor RPM	1775					
Gearbox Output RPM	99.2					
Gearbox Output Torque (jn-lbs)	15881	CCW				
Gearbox Anti-rotational Moment (in-lbs)	15881	CW				
Gearbox	**M4H18T28C2518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	305	0.395	Left	CCW	120
Component	Motor	430	1.078	Right	CW	464
Tie Rod Distance from Customer Shaft (X-Direction)	10.410	inches		Tie Rod Distance from Customer Shaft (Y-direction)	10.690	inches
Tie Rod Reaction (X-direction)	779	lbs		Shaft Reaction (X-direction)	779	lbs
Tie Rod Reaction (Y-direction)	759	lbs		Shaft Reaction (Y-direction)	1494	lbs
Total Tie Rod Reaction	1087	lbs		Total Shaft Reaction	1684	lbs
Tie Rod	In Tension					

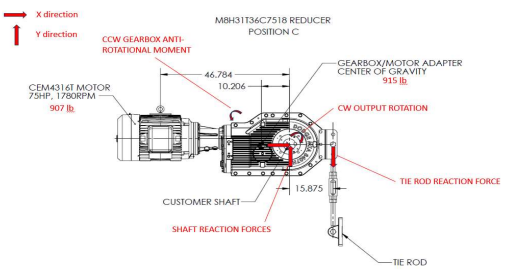


MTA8 - POSITION C (Clockwise Output Rotation)

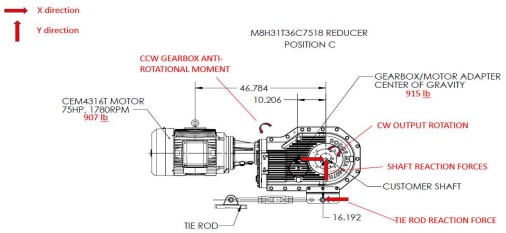
Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CCW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	10.206	Left	CCW	9338
Component	Motor	907	46.784	Left	CCW	42433
Tie Rod Distance from Customer Shaft (X-Direction)	14.556	inches		Tie Rod Distance from Customer Shaft (Y-direction)	16.192	inches
Tie Rod Reaction (X-direction)	4558	lbs		Shaft Reaction (X-direction)	4558	lbs
Tie Rod Reaction (Y-direction)	4098	lbs		Shaft Reaction (Y-direction)	2276	lbs
Total Tie Rod Reaction	6129	lbs		Total Shaft Reaction	5095	lbs
Tie Rod	In Compression					



Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CCW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	10.206	Left	CCW	9338
Component	Motor	907	46.784	Left	CCW	42433
Tie Rod Distance from Customer Shaft (X-Direction)	15.875	inches		Tie Rod Distance from Customer Shaft (Y-direction)	0.000	inches
Tie Rod Reaction (X-direction)	0	lbs		Shaft Reaction (X-direction)	0	lbs
Tie Rod Reaction (Y-direction)	8407	lbs		Shaft Reaction (Y-direction)	10229	lbs
Total Tie Rod Reaction	8407	lbs		Total Shaft Reaction	10229	lbs
Tie Rod	In Tension					

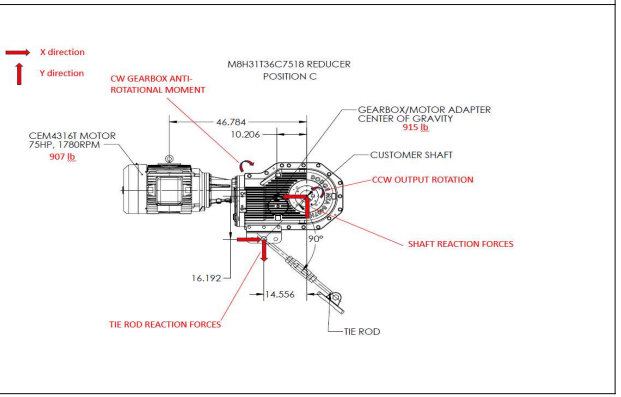


Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CCW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	10.206	Left	CCW	9338
Component	Motor	907	46.784	Left	CCW	42433
Tie Rod Distance from Customer Shaft (X-Direction)	0.000	inches		Tie Rod Distance from Customer Shaft (Y-direction)	16.192	inches
Tie Rod Reaction (X-direction)	8242	lbs		Shaft Reaction (X-direction)	8242	lbs
Tie Rod Reaction (Y-direction)	0	lbs		Shaft Reaction (Y-direction)	1822	lbs
Total Tie Rod Reaction	8242	lbs		Total Shaft Reaction	8441	lbs
Tie Rod	In Tension					

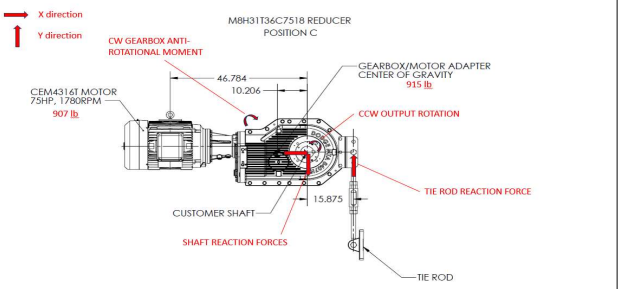


MTA8 - POSITION C (CounterClockwise Output Rotation)

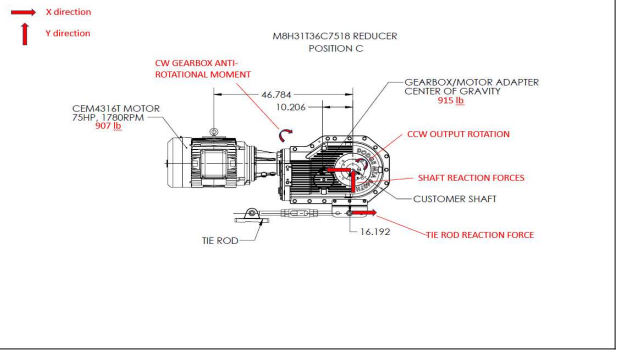
Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CCW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	10.206	Left	CCW	9338
Component	Motor	907	46.784	Left	CCW	42433
Tie Rod Distance from Customer Shaft (X-Direction)	14.556	inches		Tie Rod Distance from Customer Shaft (Y-direction)	16.192	inches
Tie Rod Reaction (X-direction)	1022	lbs		Shaft Reaction (X-direction)	1022	lbs
Tie Rod Reaction (Y-direction)	918	lbs		Shaft Reaction (Y-direction)	2740	lbs
Total Tie Rod Reaction	1374	lbs		Total Shaft Reaction	2925	lbs
Tie Rod	In Tension					



Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CCW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	10.206	Left	CCW	9338
Component	Motor	907	46.784	Left	CCW	42433
Tie Rod Distance from Customer Shaft (X-Direction)	15.875	inches		Tie Rod Distance from Customer Shaft (Y-direction)	0.000	inches
Tie Rod Reaction (X-direction)	0	lbs		Shaft Reaction (X-direction)	0	lbs
Tie Rod Reaction (Y-direction)	1884	lbs		Shaft Reaction (Y-direction)	62	lbs
Total Tie Rod Reaction	1884	lbs		Total Shaft Reaction	62	lbs
Tie Rod	In Compression					

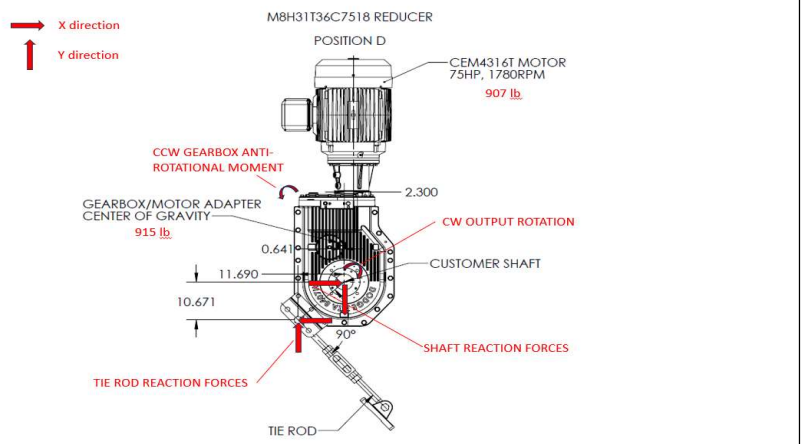


Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CCW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	10.206	Left	CCW	9338
Component	Motor	907	46.784	Left	CCW	42433
Tie Rod Distance from Customer Shaft (X-Direction)	0.000	inches		Tie Rod Distance from Customer Shaft (Y-direction)	16.192	inches
Tie Rod Reaction (X-direction)	1847	lbs		Shaft Reaction (X-direction)	1847	lbs
Tie Rod Reaction (Y-direction)	0	lbs		Shaft Reaction (Y-direction)	1822	lbs
Total Tie Rod Reaction	1847	lbs		Total Shaft Reaction	2595	lbs
Tie Rod	In Compression					

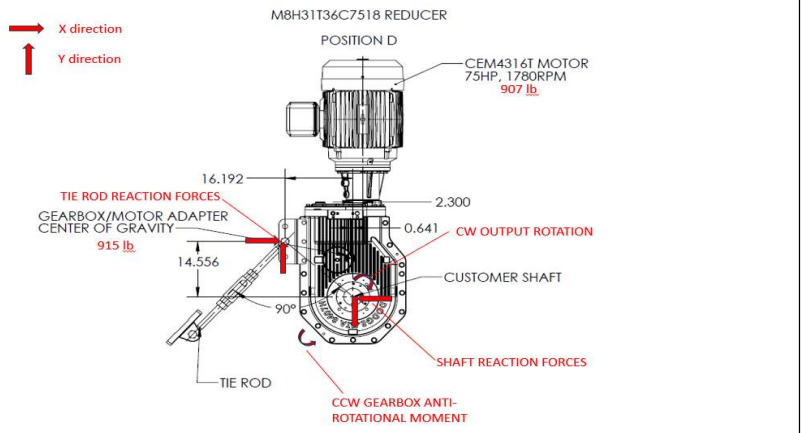


MTA8 - POSITION D (Clockwise Output Rotation)

Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CCW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	0.641	Left	CCW	587
Component	Motor	907	2.300	Right	CW	2086
Tie Rod Distance from Customer Shaft (X-Direction)	11.690	inches		Tie Rod Distance from Customer Shaft (Y-direction)	10.671	inches
Tie Rod Reaction (X-direction)	3415	lbs		Shaft Reaction (X-direction)	3415	lbs
Tie Rod Reaction (Y-direction)	3742	lbs		Shaft Reaction (Y-direction)	1920	lbs
Total Tie Rod Reaction	5066	lbs		Total Shaft Reaction	3918	lbs
Tie Rod	In Compression					

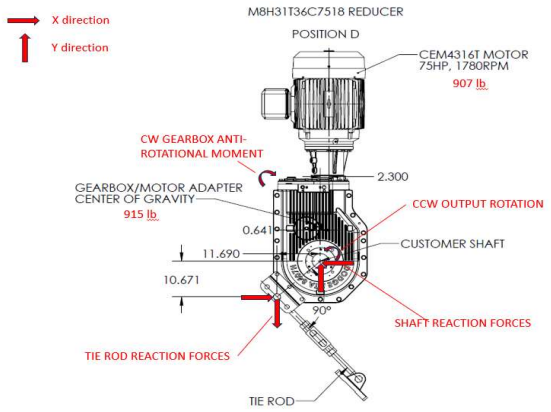


Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CCW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	0.641	Left	CCW	587
Component	Motor	907	2.300	Right	CW	2086
Tie Rod Distance from Customer Shaft (X-Direction)	16.192	inches		Tie Rod Distance from Customer Shaft (Y-direction)	14.556	inches
Tie Rod Reaction (X-direction)	2462	lbs		Shaft Reaction (X-direction)	2462	lbs
Tie Rod Reaction (Y-direction)	2739	lbs		Shaft Reaction (Y-direction)	917	lbs
Total Tie Rod Reaction	3683	lbs		Total Shaft Reaction	2627	lbs
Tie Rod	In Compression					



MTA8 - POSITION D (CounterClockwise Output Rotation)

Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CCW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	0.641	Left	CCW	587
Component	Motor	907	2.300	Right	CW	2086
Tie Rod Distance from Customer Shaft (X-Direction)	11.690	inches		Tie Rod Distance from Customer Shaft (Y-direction)	10.671	inches
Tie Rod Reaction (X-direction)	3543	lbs		Shaft Reaction (X-direction)	3543	lbs
Tie Rod Reaction (Y-direction)	3882	lbs		Shaft Reaction (Y-direction)	5704	lbs
Total Tie Rod Reaction	5256	lbs		Total Shaft Reaction	6714	lbs
Tie Rod	In Tension					



Gearbox	M8H31T36C7518					
Actual Ratio	30.76					
Motor HP	75					
Motor RPM	1780					
Gearbox Output RPM	57.9					
Gearbox Output Torque (jn-lbs)	81685	CCW				
Gearbox Anti-rotational Moment (in-lbs)	81685	CW				
Gearbox	**M8H31T36C7518**	**Weight (lbs)**	**Center of Gravity (inches)**	**Left or Right of Customer Shaft**	**Moment Rotational Direction**	**Moment Magnitude (in-lbs)**
Component	Gearbox/Motor Adapter	915	0.641	Left	CCW	587
Component	Motor	907	2.300	Right	CW	2086
Tie Rod Distance from Customer Shaft (X-Direction)	16.192	inches		Tie Rod Distance from Customer Shaft (Y-direction)	14.556	inches
Tie Rod Reaction (X-direction)	2554	lbs		Shaft Reaction (X-direction)	2554	lbs
Tie Rod Reaction (Y-direction)	2841	lbs		Shaft Reaction (Y-direction)	4663	lbs
Total Tie Rod Reaction	3821	lbs		Total Shaft Reaction	5317	lbs
Tie Rod	In Tension