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Other Languages:	Français, Español, Portuguese,	**Author**:	Charles Schroeder
Viewed:	26934		

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Title: Driveline Information Center and Troubleshooting Procedures

Applies To: All Vehicles

CHANGE LOG

Dealers: Please refer to the change log text box below for recent changes to this article:

08/25/2020 - Added seat and plate information for Hendrickson HAS with Air Disc Brakes (ADB), specified parts for Henrickson HAS with Drum Brakes
12/23/2019 - No content change. Verified links for worksheets on step 5 are all working.
08/20/2019- Updated author for feedback purposes
12/17/2018- Added IK0300071 link to measure non-IROS air suspension procedure
11/13/2018- Updated ride height adjustment procedure
11/07/2018- Updated article owner
03/16/2018- Updated coding
05/24/2016 - Updated tool PN
02/19/2016 - Updated propshaft coding information for clarity.

DESCRIPTION

This article provides information to properly check driveline angles and driveline runout, and how to use that information to properly repair the vehicle and bring the driveline into specification. The information is to assist in resolving a vibration complaint that may be caused by the driveline. This article does not address other possible vibration issues, such as vibrations caused by the engine.

- For engine vibrations, cab vibrations, or mirror shake issues please refer to IK0300008 - Vibration Troubleshooting

SYMPTOMS

- Vibration

SPECIAL TOOLS / SOFTWARE

Tool Description	Tool Number	Comments	Instructions
Digital Protractor	ZTSE4329		
Dial Indicator		Procure Locally	

INSPECTING AND MEASURING THE DRIVELINE

Troubleshooting

1. Check and record air ride height setting.
    - If the air ride is not adjusted properly then readjust to the proper specifications and road test to determine if problem has now been fixed.
    - Refer to the Truck Manual for proper ride height measurement procedures and ride height settings.
    - For Non-IROS air suspension instructions, if not already in the truck manual, please follow: IK0300071 - Non-IROS Rear Air Suspension Ride Height Specifications and Adjustment Procedures
    - To properly adjust the ride height:

If ride height is higher specification:

- Do not bend height control system brackets or rods to adjust suspension height.
- Loosen lever arm bolt that holds arm to height control valve.
- Pivot lever arm down to exhaust air from suspension, lowering chassis to some point below correct air spring height.
- Final air spring height must be achieved by adding air to suspension, not exhausting.
- Add air until axle travel reaches proper value per truck manual ride height recommendations.
- When correct axle travel value has been achieved, retighten lever arm bolt.

If ride height is less than specification:

- Do not bend height control system brackets or rods to adjust suspension height
- Loosen lever arm bolt that holds arm to height control valve.
- Push lever arm up to add air to suspension, raising chassis, until axle travel reaches proper value per truck manual ride height recommendations.
- When correct axle travel value has been achieved, retighten lever arm bolt.

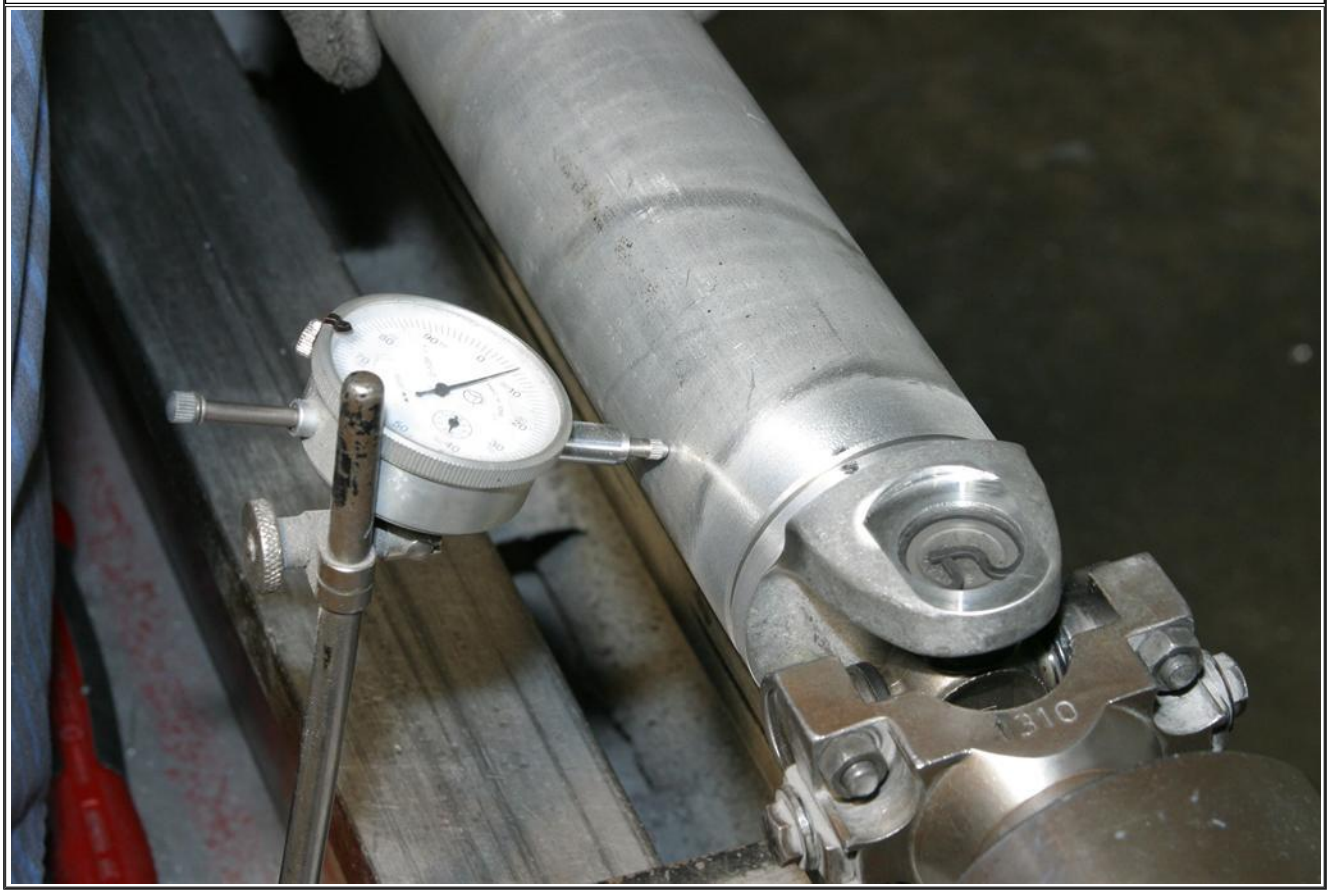
2. Visually inspect driveline for damage

   - Inspect for dents or missing weights.
   - Inspect u-joints and yokes for excessive play. It is important to do this prior to re-lubing the joints.
   - Ensure the u-joint bearing cups are properly seated in the yokes and that the caps are not spinning.

3. Measure driveshaft runout in three locations on each shaft.

   - 3” from each end of and center of the tube.
   - Interaxle shafts can be measured in the center only.
   - For accurate measurements, the paint should be removed first.
   - Mark the “high” spots at each location on the tube.
   - The ends should be less than 0.020”, ideally below 0.010” and the center should be less than 0.025”, ideally below 0.015”.
   - If the measurements exceed the limits at either end, the u-joint at the end of the shaft with the high measurement should be removed from the yoke and reinstalled in the yoke after rotating either the yoke or the shaft 180 degrees.
   - Remeasure the runouts and note the location of the high spots.
   - If the runout is still excessive, check to see if the high spot moved on the shaft approximately 180 degrees or if it stayed in the same spot.
   - Moving of the high spot indicates the yoke is out of round, not the shaft.
   - Although you may have a driveline shop rebalance and/or straighten a shaft, if a vibration remains, it is important to again document the runout and verify it is below the previously mentioned “ideal” limits.
   - Click here for a printable worksheet.

Figure 1 - Measuring Driveline Runout



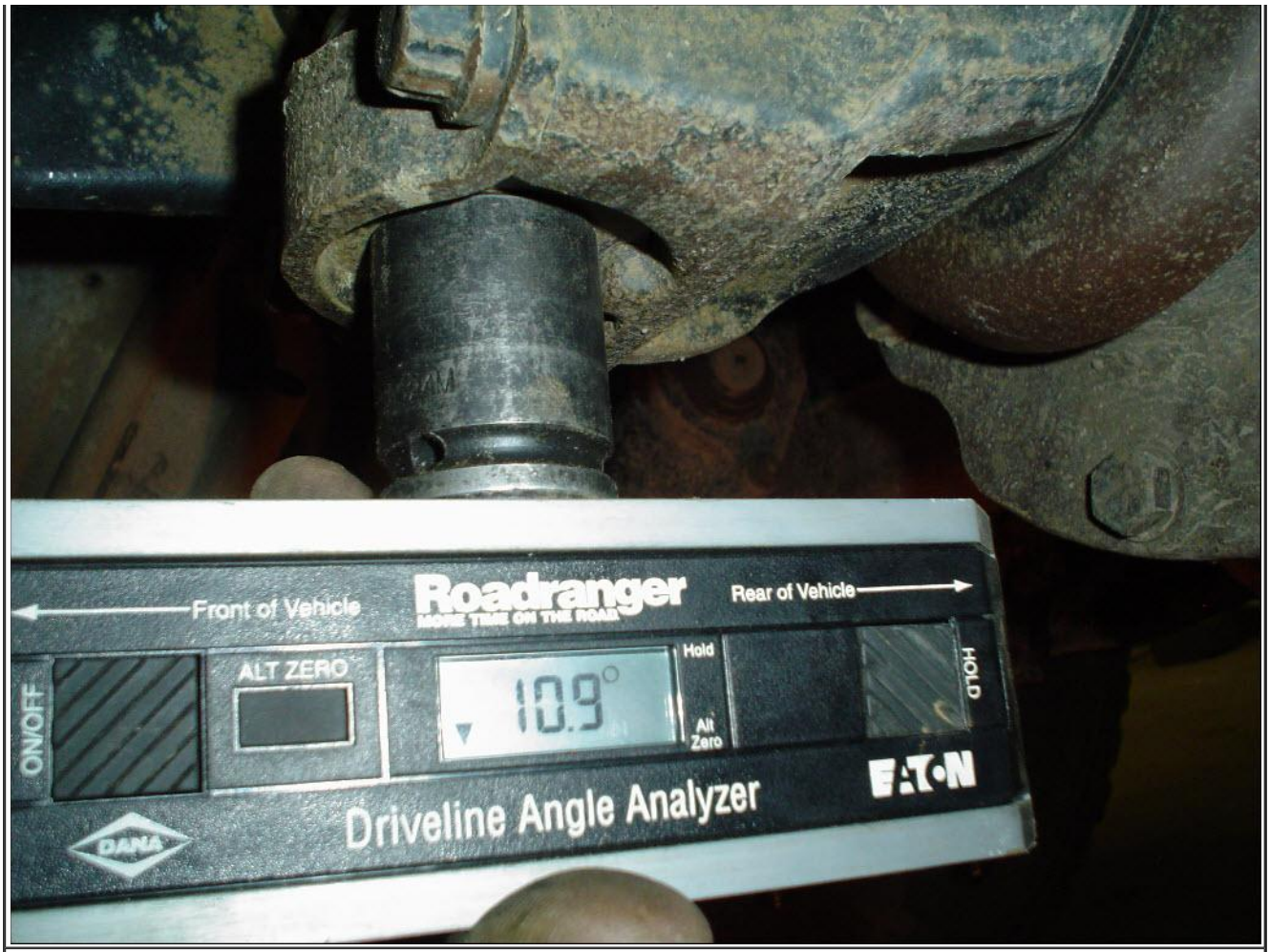
4. Inspect the amount of movement in the spline section of the driveshaft
    - The dial or digital indicator base must be installed on one side of the splines (on the prop shaft), and the needle on the other side of the splines.
    - If the dial indicator base is mounted on a solid surface, erroneous measurements will result.
    - This measurement should read less than 0.015".
5. If the problem still exists then you will need to obtain driveline angle measurements.
    - Choose the appropriate form for the chassis configuration you are working on.

4x2	6x4	4x4 / 6x6	4x2 / 6x4 with Aux Section
1 Piece Driveline	1 Piece Main Driveline	4x4	2 Piece Driveline with 2 Axles
2 Piece Driveline	2 Piece Main Driveline	4x4 with 2 Piece Rear Driveline	3 Piece Driveline with 2 axles
3 Piece Driveline	3 Piece Main Driveline	6x6	
4 Piece Driveline	4 Piece Main Driveline		

Helpful hints for accurate driveline and angle measuring:

- To properly check your digital clinometer, use a two foot level on a workbench; level the level then set protractor on level and press zero, then turn your protractor around 180 degrees to face away from you and recheck to make sure it still reads zero. The two readings should be within 0.1 degrees of each other. This is test is performed to check the accuracy of the digital clinometer.
- Once you have tested the accuracy of the tool, place the digital clinometer on the frame rail and zero it. This is done so you always have the same reference. If you zero the protractor at any other location, you would need to verify the frame angle is the same as the original recorded angle before any adjustments could be made.
- Take all readings from the same surface of the digital clinometer and keep it pointed in the same direction for every measurement. The example photos show this clearly. The orientation of the writing (do not turn the tool upside down from when you started), and the same end of the digital clinometer always facing the front of the vehicle.
- Double check transmission angle measurement which can be obtained from the u-joint cap on the output yoke, engine valve cover, oil pan bolts and sometimes a flat surface on the head of the engine as well as transmission pan or valve body.
- Be very diligent to get a good reading off the rear end housing. The surface of the cup needs to be properly cleaned to insure you get an accurate measurement. Use a socket on the u-joint cap. The caps will not all be vertical when the unit is pulled into the work bay. Removing the wheel chocks and rolling the truck forward or backwards until the u-joint is vertical is the most acceptable method to obtain an accurate reading.
- Due to the short tube length of drive shafts between the rear drive axles, it is highly recommended to use the v-block that comes with the Road Ranger driveline angle analyzer kit to keep the digital clinometer from contacting the welds at the end of the tube.
- Be aware the ARROW in the LCD points towards 0°. The angles in Figure 2 and Figure 3 are positive angles.
    - Arrow pointing down is a positive angle. (Front side of the component is higher than the rear).
    - Arrow pointing up is a negative angle. (Front side of the component is lower than the rear).
    - Example: The transmission will typically have a positive angle.
    - Example: The prop shaft to the steer axle in a 4x4 will typically have a negative angle.

Figure 2 - Measuring Pinion Angle



- This is a positive reading. The arrow points towards 0°. This means the front of the component is higher than the rear.
  - The arrow would point up for a negative reading.
- Use caution with the digital protractor to ensure you do not hit the "Hold" or "Alt Zero" buttons while taking your readings.
- Be diligent to ensure the tool has the same orientation when taking your readings.

Figure 3 - Measuring the Intermediate Shaft

- This is a positive reading. The arrow points towards 0°. This means the front of the component is higher than the rear.
  - The arrow would point up for a negative reading.
- Use caution with the digital protractor to ensure you do not hit the "Hold" or "Alt Zero" buttons while taking your readings.
- Be diligent to ensure the tool has the same orientation when taking your readings.

Filling out the Driveline Angle Worksheet

6. Measure the frame rake. To take the measurement of frame rake find a clean flat surface anywhere on frame. Verify level is on and the arrow on the level labeled facing toward front of vehicle is actually facing toward the front of the vehicle, and the arrow on level labeled facing toward rear is actually facing toward rear. Once this is verified and you have your frame rake angle hit the zero button on level. This will allow level to set the frame rake for calculation of drive line measurements.
   - Zeroing the digital protractor on the frame will allow you to always have the same reference point to zero if multiple measurements are required. (Even if the truck is moved between each set of measurements).
7. Measure the transmission angle. This will rarely need to be changed, a normal measurement for transmission angle is between 3 and 4 degrees. To take transmission angle you will have to get measurements off transmission or engine block surface and sometimes a boss on the bell housing. Take multiple measurements to make sure you are getting the correct reading.
8. Measure the first prop shaft. Take measurements in the middle of the prop shaft, taking several measurements at each component to get as accurate angles as possible. Depending on the model and drive line setup take the remaining drive line angles at each prop shaft until the differential or the transfer case depending on the setup of the truck. Always remember to keep protractor, or level pointed in the same direction on each component measured.
9. Measure the transfer case or rear differential find a flat, machined surface on component and take multiple measurements for accurate reading. If there is no place to take accurate measurement you can turn yoke straight up and down and use level to read the flat of the u-joint bearing cup. (Refer to Figure 2 above). The surface of the cup needs to be properly cleaned to insure you get an accurate measurement. Also, a good socket or machined round socked can be used to space down from the u joint cap and allow for a measurement to be taken.
10. Measure the interaxle driveline angle. There is an attachment in Road Ranger tooling kit used for interaxle shaft due to the prop shaft being so short it is difficult to get good measurement. (Refer to Figure 3 above).

11. Measure the rear differential using the same procedure as forward differential. (Refer to Figure 2 above).

Correcting Driveline Angles

The driveline angles will need to be checked using Eaton Driveline Angle Analyzer Software, or Allison Calc. You must use Allison Calc if the vehicle is equipped with an Allison transmission.

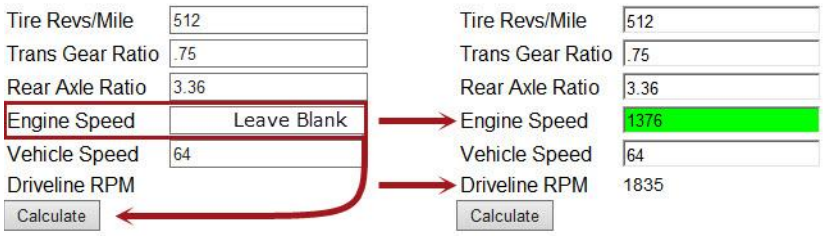
You will need the following information:

- Tire Revs per Mile
- Transmission Top Gear Ratio
- Rear Axle Ratio
- Max Vehicle Speed

Use NED to obtain the 4 items of information. Input this information into IK2600160 - Vehicle Speed Calculator.

- Leave "Engine Speed" blank.
- Hit "Calculate" to find the Max Engine Speed in Top Gear (Refer to Figure 4)

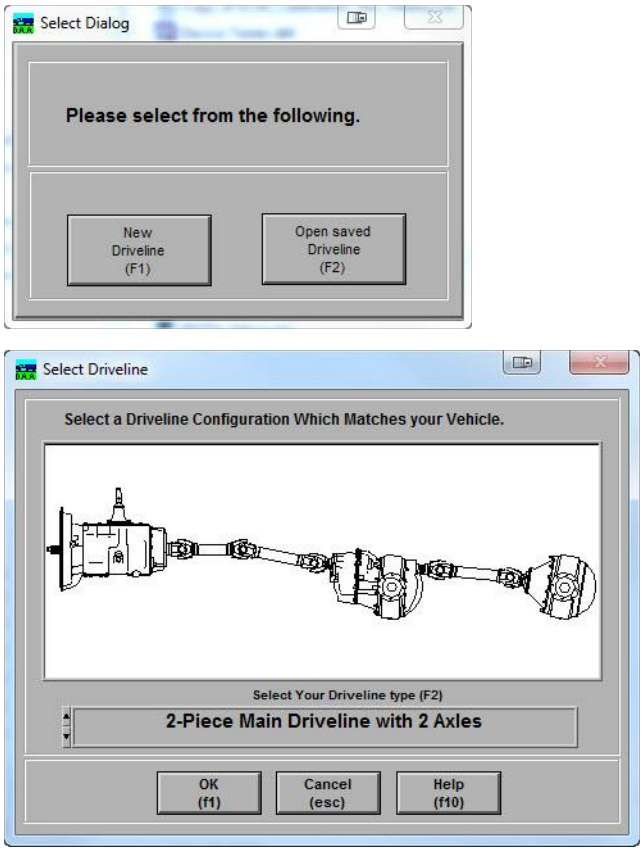
Figure 4 - Vehicle Speed Calculator Example



- This is an example only. You need the information you gathered from NED for accurate calculations.

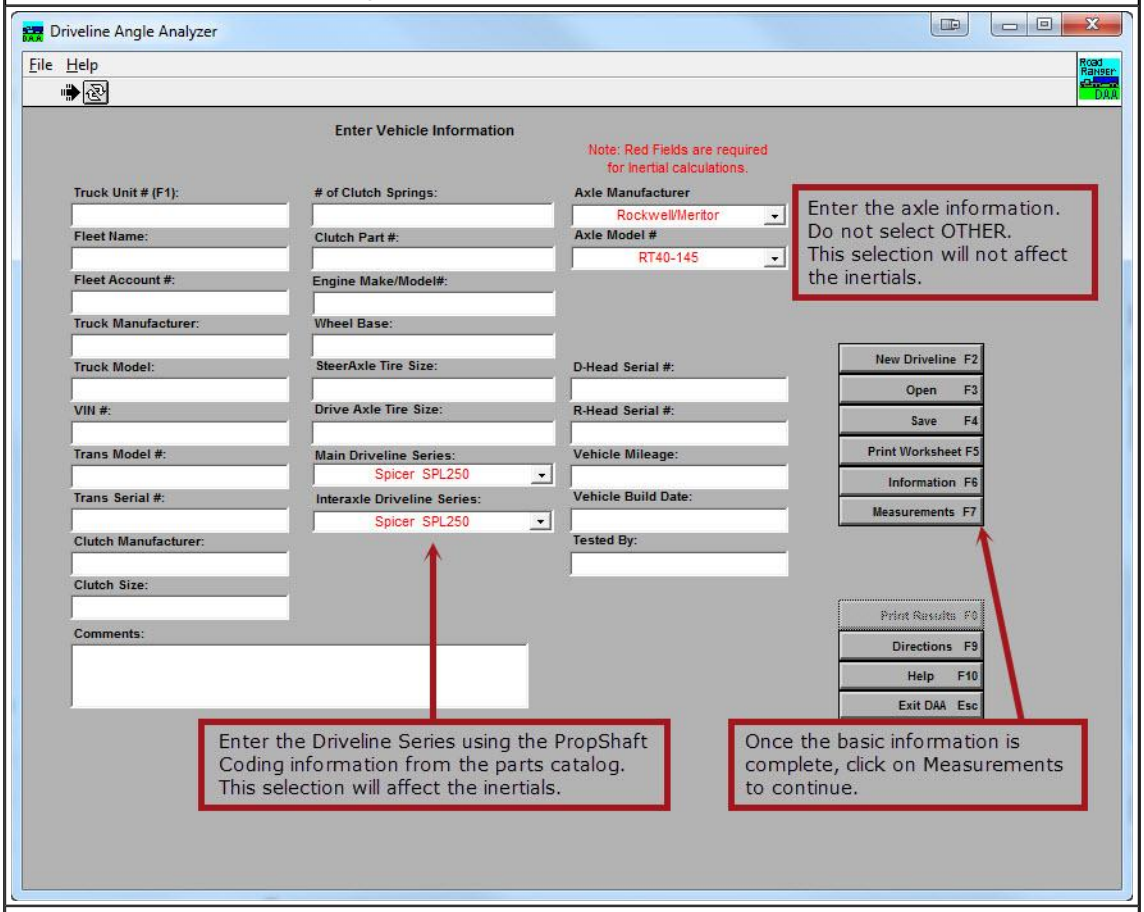
Using Eaton Driveline Angle Analyzer (DAA)

Figure 5 - Open Eaton DAA and Select Driveline Configuration



- Open Eaton Driveline Angle Analyzer, Select New Driveline, Scroll through the Driveline Types until you find the configuration that matches the vehicle you are working on.

Figure 6 - Enter Driveline and Axle Information



- Enter the basic information for the Driveline and Axle.
- Choosing the incorrect driveline series will affect the inertials when the measurements are inputted.
- Choosing the axle does not affect the inertials. You must not choose "other" or Corrective Mode will not work properly.

Prop Shaft Information

English	Metric	Series Number
209	409	SPL55
207	407	SPL70
210	410	SPL100
210	410	SPL100
214	414	SPL140
217	417	SPL170
225	425	SPL250
235	435	SPL350
259	459	SPL90
249	449	1480
255	455	1550
259	459	1590
259	459	1590
260	426	1610
270	427	1710

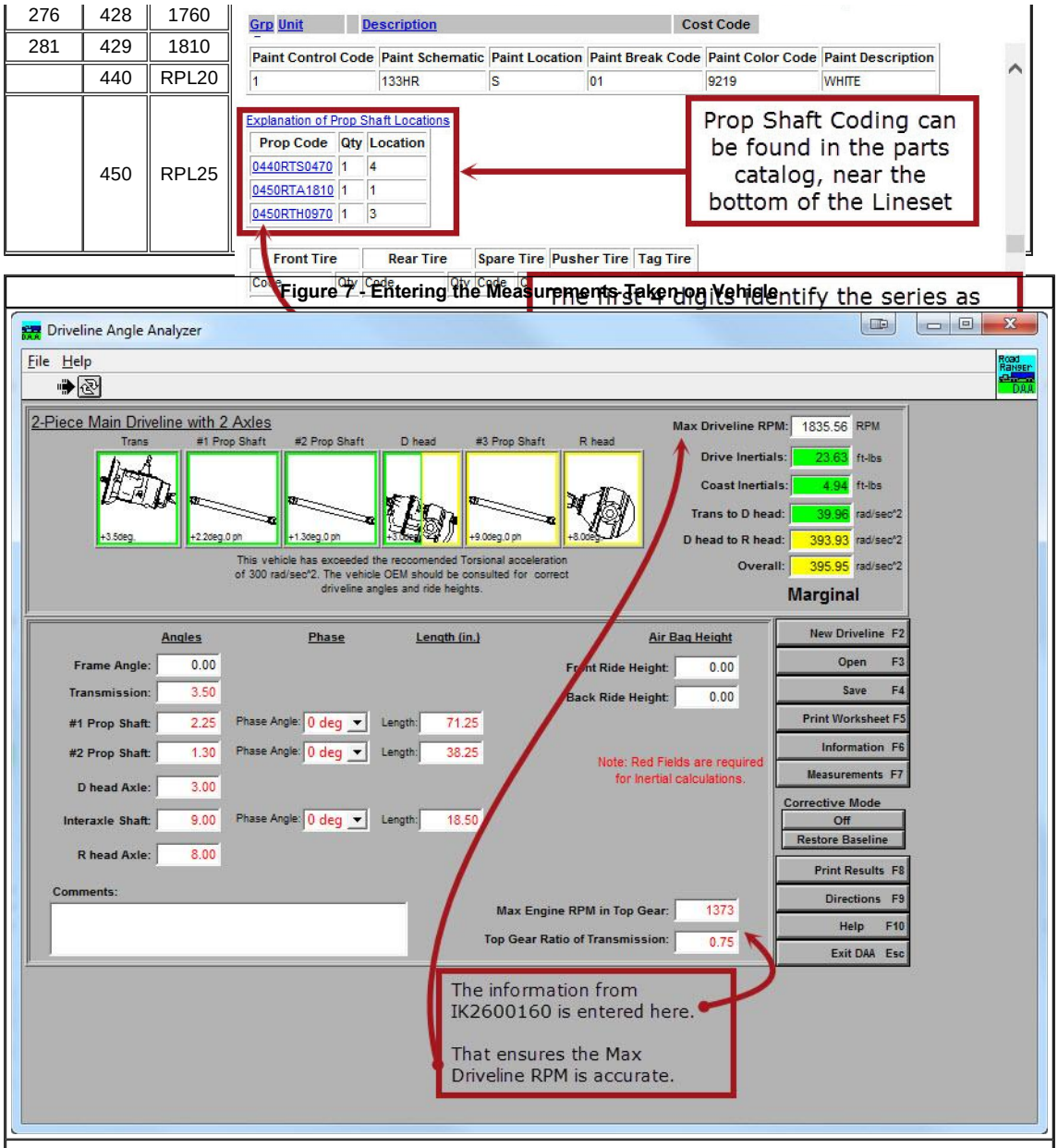
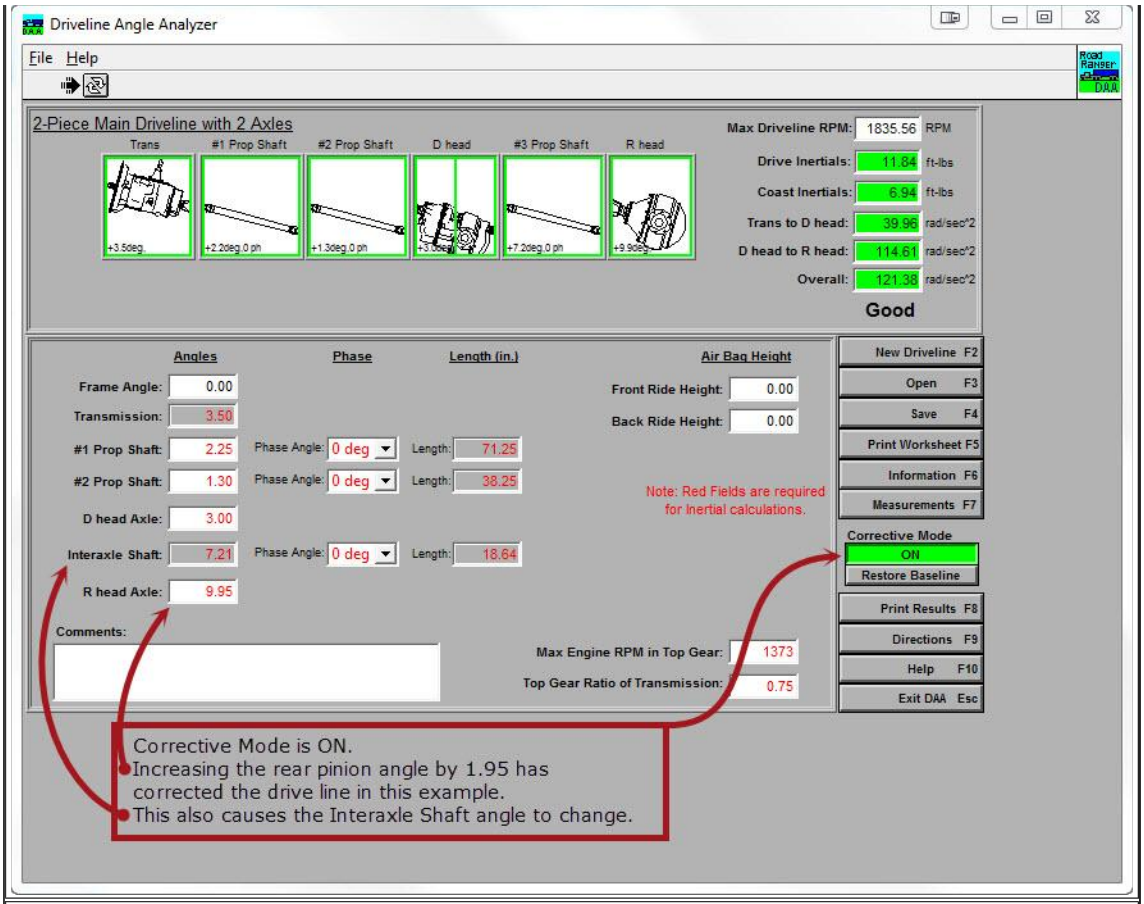


Figure 7 - Entering the Measurements Taken on Vehicle

- Enter the measurements you took on the vehicle and see if any adjustment is required.

Figure 8 - Entering Corrective Mode to Make Adjustments

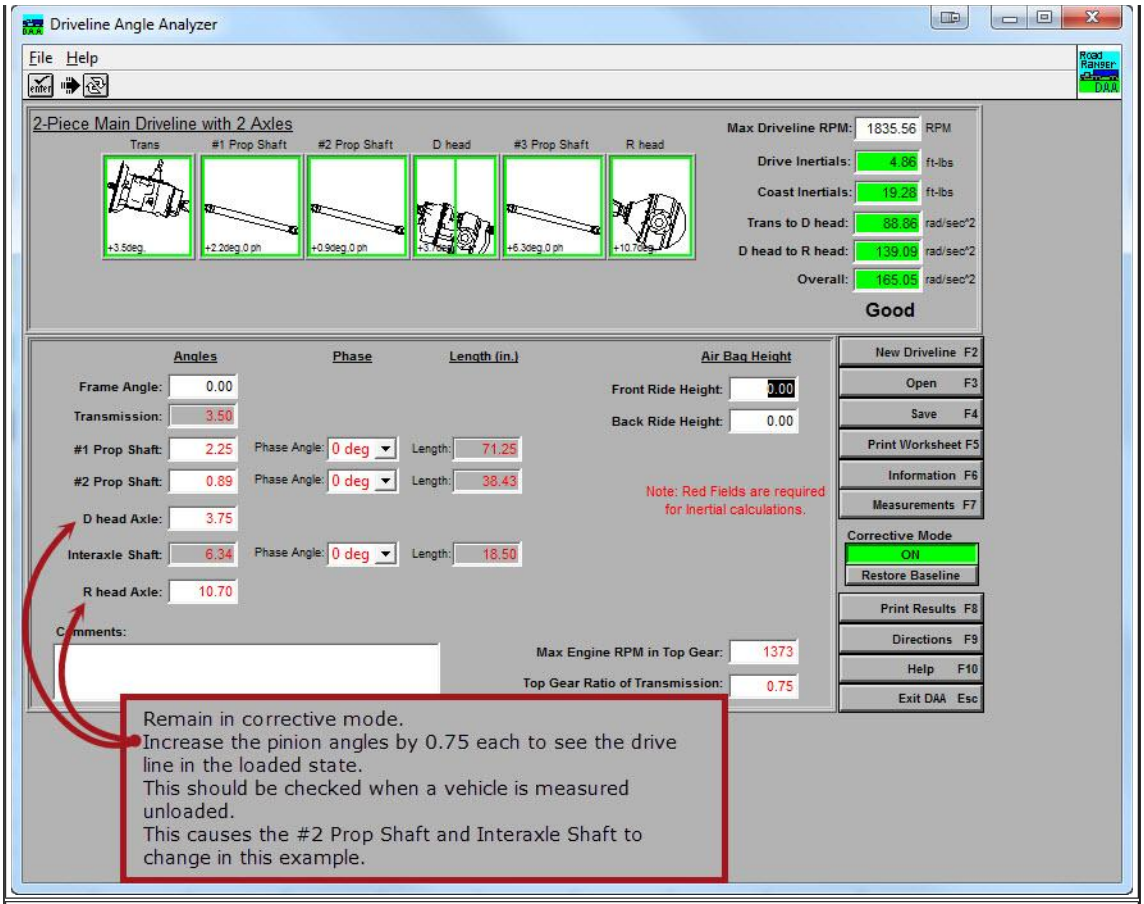


- Enter Corrective Mode.
- Attempt to correct the drive line angles with the least amount of changes.
- Correcting by adjusting the prop shafts is less labor intensive than changing seats and plates.
- If the seats and plates need to be changed to make the correction, you must use the chart below and calculate the difference in pinion angle from the measured pinion angle.
  - Example:
  - 8° was measured on truck. Truck had 3548298C1 Seats installed.
  - Truck is unloaded, 7.58° on the chart. Changing to a 3548299C1 Seat shows 9.53° unloaded.
  - That would give you 1.95° of pinion angle change (9.53 minus 7.58).
  - The 8° measured plus 1.95° increase is 9.95° and brings the driveline into specification.
  - You must also check that when the vehicle is loaded, the angles will stay within specification. (Refer to Figure 9).

NOTE:

0 working angles are not acceptable. Eaton DAA will not catch this error.

Figure 9 - Using Corrective Mode to Check Loaded Angles (If Required)

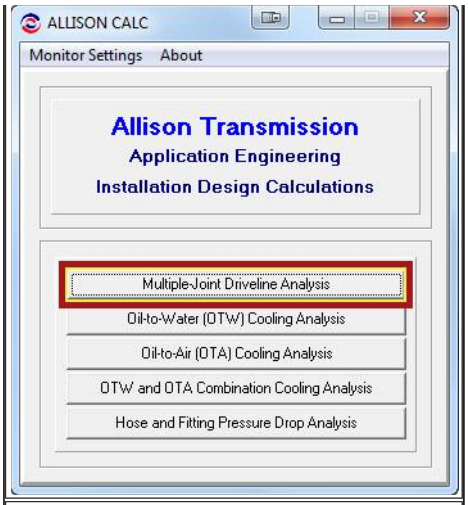


- Verify the angles remain in specification when loaded. (If Required)
  - Example Continued:
  - Front Drive Axle Seats installed: 3548297C1. Pinion angle will increase 0.75° when loaded. (4.45 minus 3.70)
  - Rear Drive Axle Seats now installed: 3548299C1. Pinion angle will increase 0.75° when loaded (10.28 minus 9.53)
  - Increase both pinion angles in corrective mode to see the reaction.
  - In this example the drive line is within specification when loaded.
  - Every seat is 0.75° difference between loaded and unloaded.

Using Allison Calc

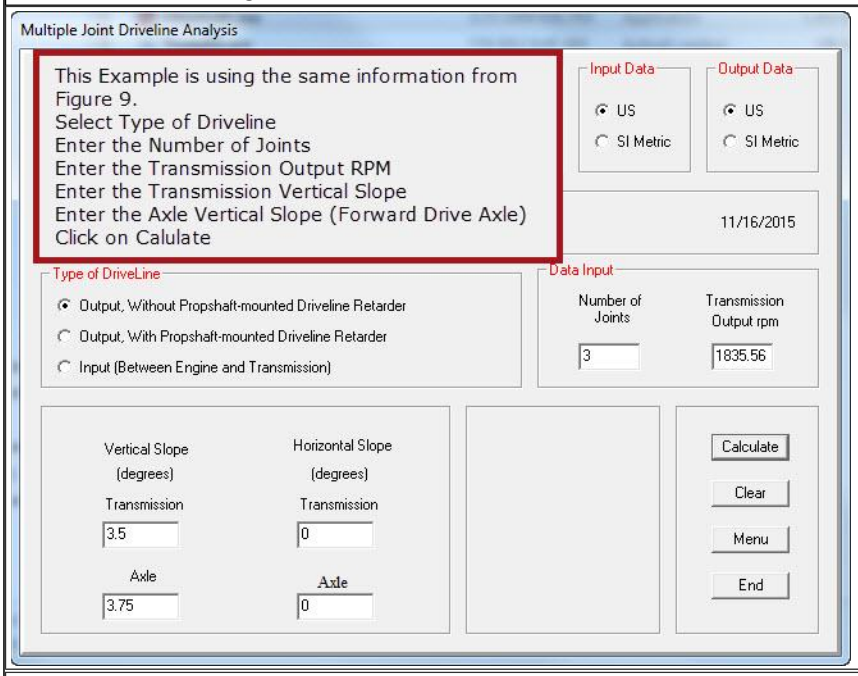
- Allison Calc will only check one single axle at a time.
- For 6x4, 4x4, 6x6 or Drop Box applications you will need to run multiple analysis.
- Refer to the information below which uses the 6x4 from Figure 9 as the example.
- If a drive line needs to be adjusted it is easier to run the adjustments in Eaton DAA, then check using Allison Calc before making any changes to the vehicle.

Figure 10 - Open Allison Calc



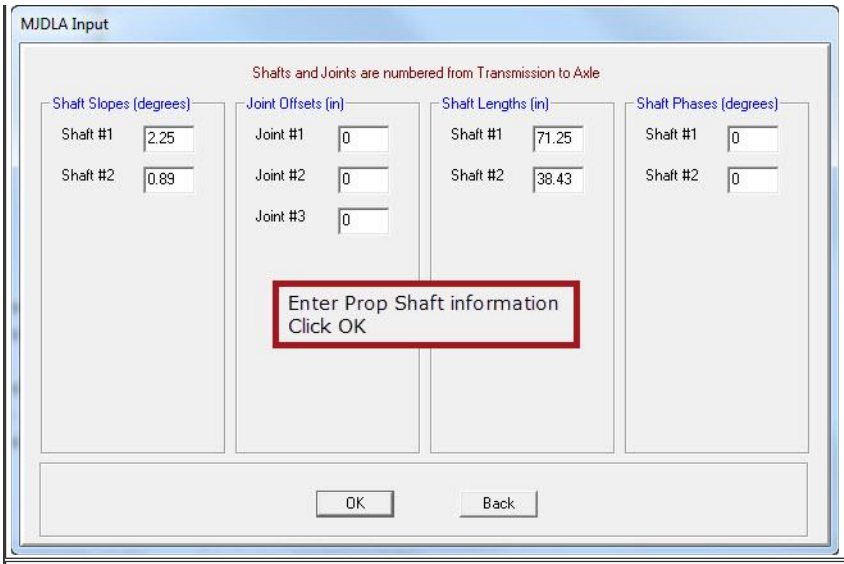
- Open Allison Calc
- Select Multiple-Joint Driveline Analysis

Figure 11 - Transmission and Axle Information



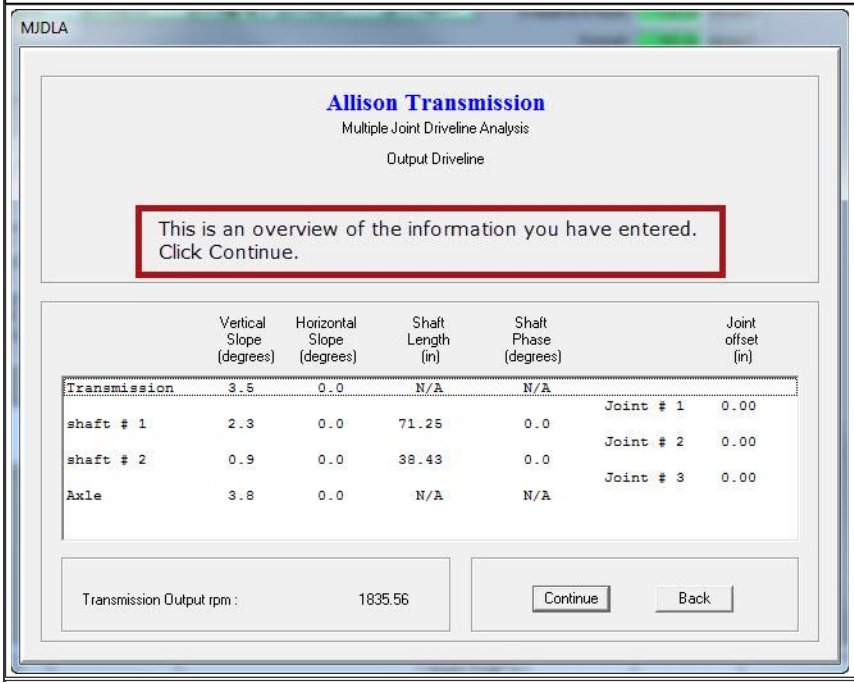
- As this checks to a single axle at a time, the axle vertical slope in this example is the Forward Drive Axle.
- Enter all required information.
- Use 0 for Horizontal Slope.
- There are 2 prop shafts between the transmission and forward drive axle in Figure 9. This gives you 3 joints.
- Transmission Output RPM is calculated using IK2600160 - Vehicle Speed Calculator the same way it is calculated for Eaton Driveline Angle Analyzer.

Figure 12 - Prop Shaft Information



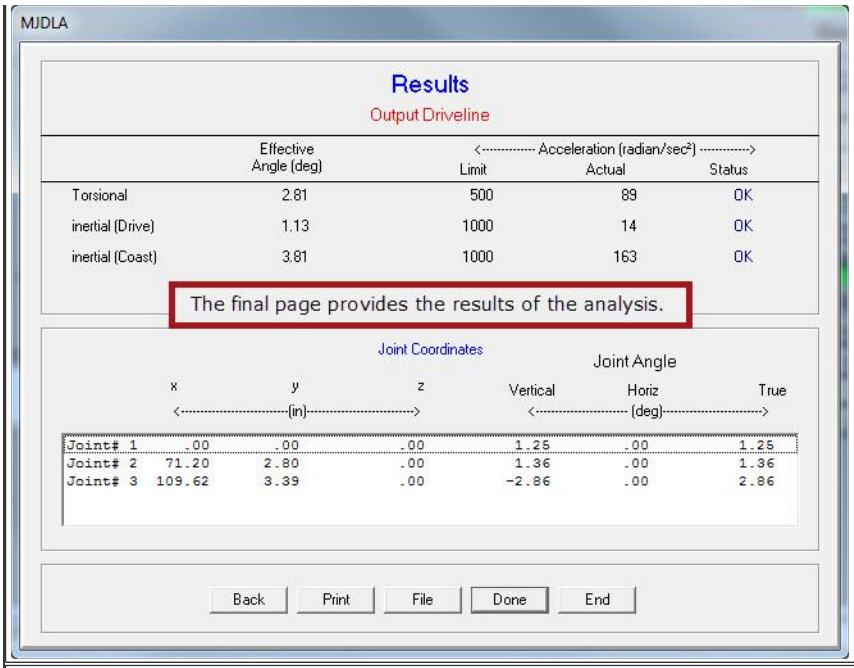
- Enter Prop Shaft angles and lengths.
- Joint Offset is 0.
- Shaft Phasing should match the phasing on the truck.

Figure 13 - Overview



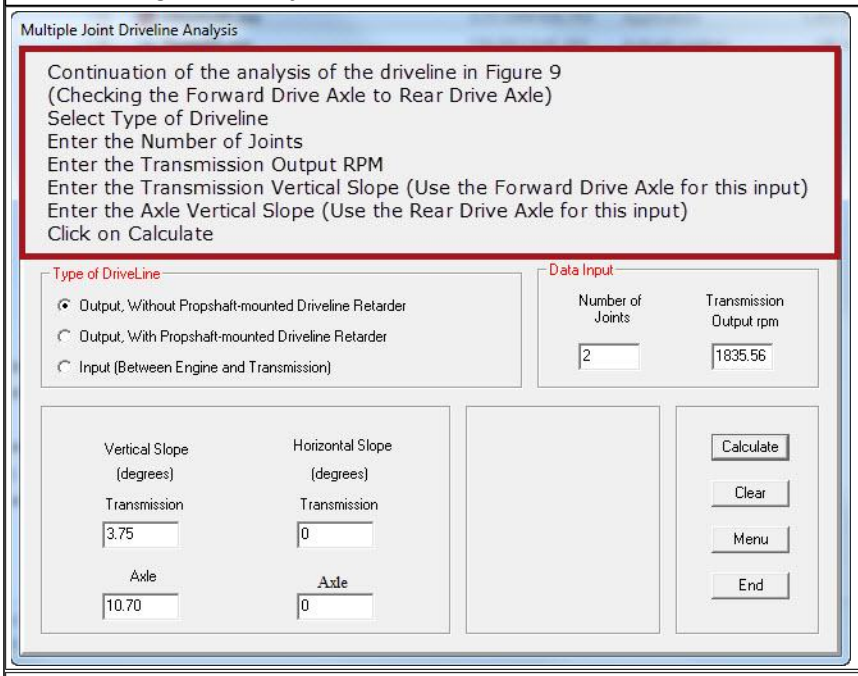
- This provides an overview of the information you have entered.
- Click Continue.

Figure 14 - Results



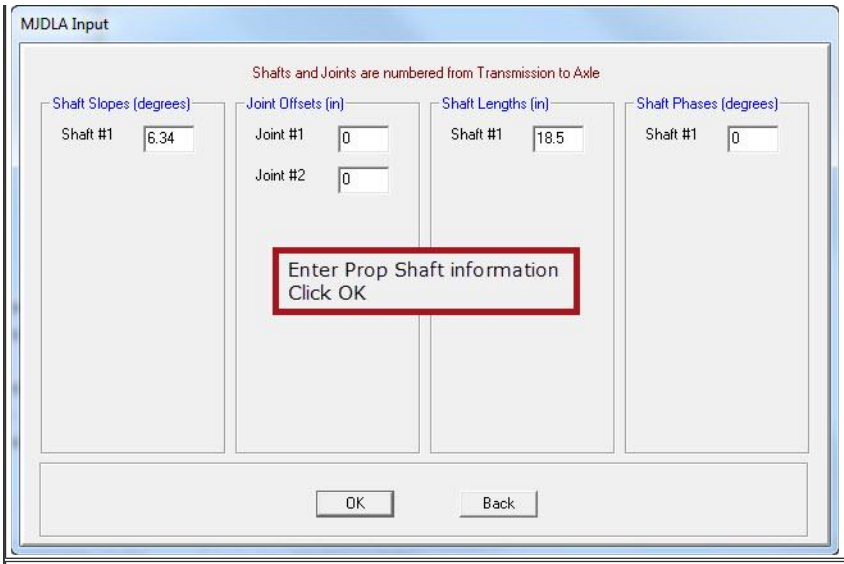
- Results of the First Section of the driveline analysis.
- This example is for a 6x4 and the process have to be completed twice.

Figure 15 - Analysis of the Forward Drive Axle to Rear Drive Axle



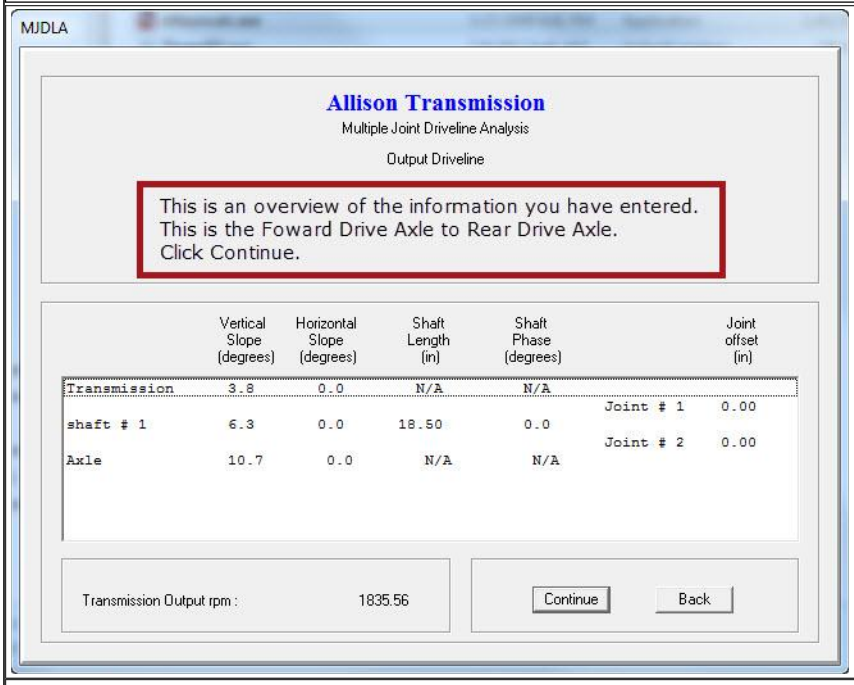
- Still using the drive line example from Figure 9.
- The Forward Drive Axle to Rear Drive axle must be checked.
- There is only 1 prop shaft. This gives you 2 joints.
- The slope of the Forward Drive Axle is entered in the Transmission Vertical Slope box.
- The slope of the Rear Drive Axle is entered in the Axle Vertical Slope box.

Figure 16 - Prop Shaft Information (Interaxle Shaft)



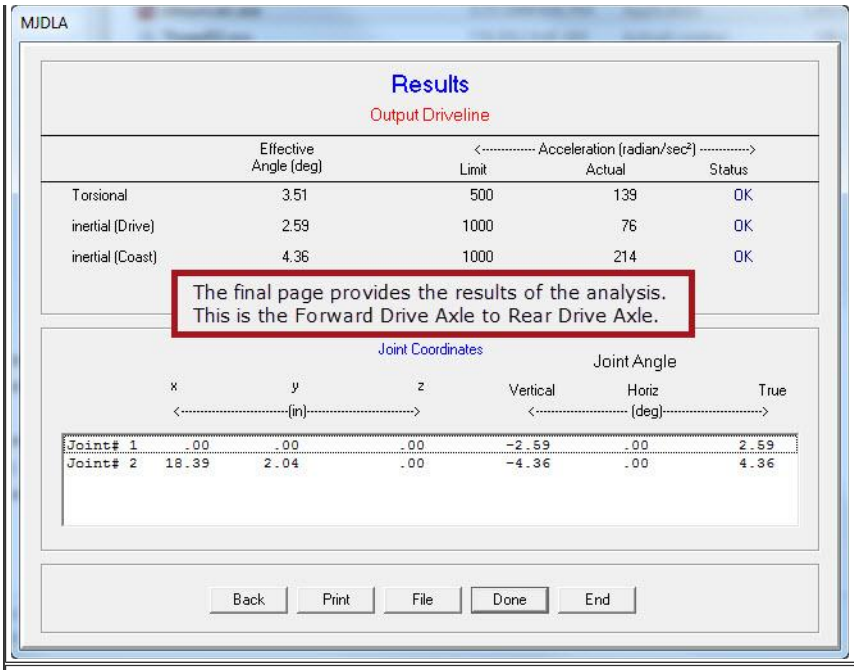
- Enter Prop Shaft angle and length. (This is the Interaxle shaft from Figure 9 in this example)
- Joint Offset is 0.
- Shaft Phasing should match the phasing on the truck.

Figure 17 - Overview of the Forward Drive Axle to Rear Drive Axle



- Open Allison Calc
- Select Multiple-Joint Driveline Analysis

Figure 18 - Results of the Forward Drive Axle to Rear Drive Axle



- Open Allison Calc
- Select Multiple-Joint Driveline Analysis

Other Resources

- S06001 - Propeller Shaft
- S06002 - CF500, CF600 Driveshaft

Pinion Angle			IROS Seat Parts Information				Plate Parts Information		
Loaded	Unloaded	1/3 Load	Part Angle	Machined Part Number	Cast Part Number	Cast Pinion Angle (As listed in parts catalog)	6x4 & 4x2 HD Plate	4x2 MD Plate (with Shock Mount)	
								Left Side	Right Side
0.60	-0.15	0.05	-6.00	3601570C2	3548295C1	2	3541719C3	3541725C3	3541726C3
2.26	1.51	1.71	-4.25	3601571C2			3541720C3	3541727C3	3541728C3
2.50	1.75	1.95	-4.00	3601572C2	3548296C1	4	3541720C3	3541727C3	3541728C3
2.75	2.00	2.20	-3.75	3601573C2			3541720C3	3541727C3	3541728C3
3.23	2.48	2.68	-3.25	3601574C2			3541720C3	3541727C3	3541728C3
3.47	2.72	2.92	-3.00	3601575C2			3541721C3	3541729C3	3541730C3
4.45	3.70	3.90	-2.00	3601576C2	3548297C1	6	3541721C3	3541729C3	3541730C3
5.42	4.67	4.87	-1.00	3601577C2			3541721C3	3541729C3	3541730C3
7.36	6.61	6.81	1.00	3601578C2			3541722C3		
8.33	7.58	7.78	2.00	3601579C2	3548298C1	10	3541722C3		
9.31	8.56	8.76	3.00	3601580C2			3541722C3		
9.55	8.80	9.00	3.25	3601581C2			3541723C3		
10.04	9.29	9.49	3.75	3601582C2			3541723C3		
10.28	9.53	9.73	4.00	3601583C2	3548299C1	12	3541723C3		
10.52	9.77	9.97	4.25	3601584C2			3541723C3		
11.49	10.74	10.94	5.25	3601585C2			3541724C3		
12.20	11.45	11.65	6.00	3601586C2	3548300C1	14	3541724C3		
12.46	11.71	11.91	6.25	3601587C2			3541724C3		

Hendrickson HAS Seat Information - Air Disc Brakes (ADB)		
Degree	International P/N	Required Plate P/N
Forward Axle Seats		

2	HUD56501001	H50216000
2.5	HUD56501002	H50216000
3	HUD56501003	H50216000
3.5	HUD56501004	H50216000
4	HUD56501005	H50216000
5	HUD56501007	H50216000
5.5	HUD56501008	H50216000
6	HUD56501009	H50216000
6.5	HUD56501010	H50216000
7	HUD56501011	H50216000
Rear Axle Seats		
10	HUD56505005	H50222000
10.5	HUD56505006	H50222000
11	HUD56505007	H50222000
11.5	HUD56505008	H50222000
12	HUD56505009	H50222000
12.5	HUD56505010	H50222000
13	4102339C1	H50222000
13.5	4102340C1	H50222000

Hendrickson HAS Seat Information - Drum Brakes			
Degree	**Hendrickson P/N**	**International P/N**	**Required Plate P/N**
Forward Axle Seats			
2	50970-1	H50970001	H50216000
2.5	50970-2	H50970002	H50216000
3	50970-3	H50970004	H50216000
4	50970-5	H50970005	H50216000
4.5	50970-6	H50970006	H50216000
5	50970-7	H50970007	H50216000
5.5	50970-8		H50216000
6	50970-9		H50216000
6.5	50970-10		H50216000
7	50970-11		H50216000
Rear Axle Seats			
7	50973-13	H50973013	H50222000
8	50973-1	H50973001	H50222000
8.5	50973-2	H50973002	H50222000
9	50973-3	H50973003	H50222000
9.5	50973-4	H50973004	H50222000
10	50973-5	H50973005	H50222000
10.5	50973-6	H50973006	H50222000
11	50973-7	H50973007	H50222000
11.5	50973-8	H50973008	H50222000
12	50973-9	H50973009	H50222000
12.5	50973-10	H50973010	H50222000
13	50973-15	H50973015	H50222000
13.5	50973-14	H50973014	H50222000
14	50973-16	H50973016	H50222000

Rear Leaf Spring Seat Information	
Degree	**Part Number**
1	520339C2
2	495364C1
3	3552912C1

6	3518107C1

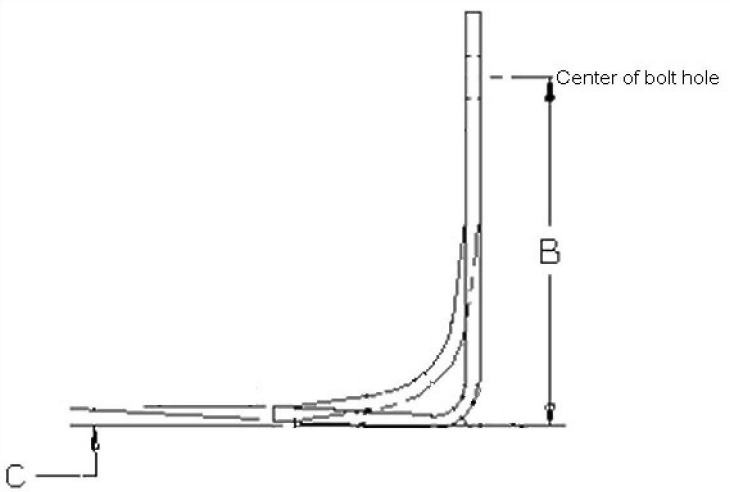
Center Bearing Brackets

- Here is a list of commonly used Center Bearing Brackets.
- If the center bearing bracket your truck was built with is not on this list it has a different width or offset. If you need a longer bracket you will need a case file.
- If you need a shorter bracket you can move the prop shaft up to the desired angle, then mark and drill new holes in the existing bracket.

Common Center Bearing Brackets

***Min Height for Clearance = 3.00"**

B" Length	C = 0° Angle	C = 3° Angle	C = 6° Angle
2.50		997986C1	547681C1
3.00	3517669C1	484963C1	2031864C1
3.30	1613108C1	484964C1	3579785C1
3.60	3527899C1	484965C1	3573130C1
3.90	3573124C1	484966C1	3573131C1
4.20	3573125C1	484967C1	484975C1
4.50	546260C1	484968C1	3573132C1
4.80	3573126C1	483973C1	1689958C1
5.10	3573127C1	484969C1	537433C1
5.40	3573128C1	485877C1	3573133C1
5.70	3573129C1	484970C1	484976C1
6.00	1620406C1	484971C1	3530579C1
6.30	1688060C1	484972C1	483971C1
6.60	3530576C1	484973C1	3530580C1
6.90	3517670C1	484974C1	571510C1
7.20	3579776C1	494657C1	496866C1
7.50	3579777C1	485157C1	494667C1
7.80	3527900C1	485158C1	483972C1
8.10	3741398C1	494658C1	494668C1
8.40	3527901C1	494659C1	494663C1
8.70	3527902C1	494660C1	494669C1
9.00	3530577C1	494661C1	494664C1
9.30	3527903C1	3527904C1	494670C1
9.60	3530578C1	3527905C1	3530581C1
9.90	3579778C1	494662C1	494670C1
10.20	3579779C1	3527906C1	2037330C1
10.50	3579780C1	998235C1	2037330C1
10.80	3579781C1	546173C1	3530582C1
11.10	3579782C1	2003081C1	
11.40	3579783C1	3527907C1	
11.70	3579784C1	594555C1	
12.00	2025234C1	546707C1	
12.30	2025269C1	546345C1	
12.60		3527908C1	
12.90		3527909C1	
13.50	3741400C1	3527910C1	
13.80		546708C1	
14.10		3527911C1	
14.40		3527912C1	
14.70	3741401C1		
15.00	3741402C1		
15.30	3741403C1		
15.60	3741404C1		



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