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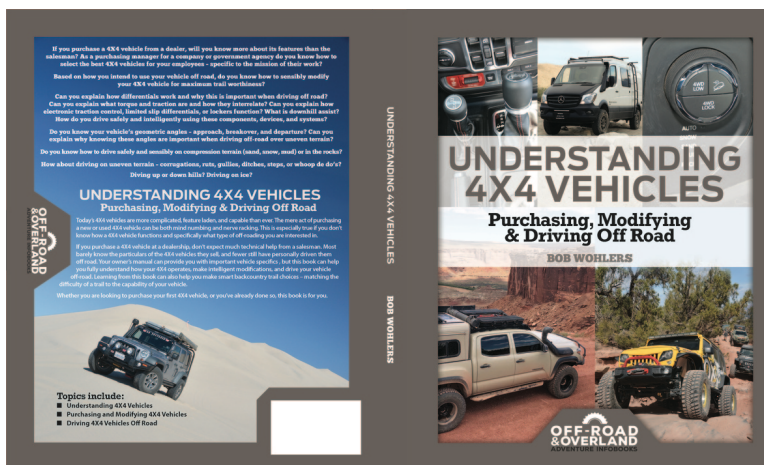
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Sat 6/27/2020 4:17 PM

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Thank you for signing up to receive my newsletters. I hope you've found the previous editions informative and helpful for your vehicle-supported adventures. I trust you will enjoy this month's newsletter. If you have comments, please email me: Bob.Wohlers@discoveroffroading.com. You can access, download, and read previous newsletters on my website here: NEWSLETTERS Look through the Newsletter Reference for a topic that may interest you, or download them all!



To read this newsletter, you are going to need a beer or some coffee. It's a long one, but I believe you will enjoy it.

I want to share with you a small piece from my fourth and newest

book "Understanding 4X4 Vehicles – Purchasing, Modifying & Driving Off Road." This book will be at the printer by year's end. I'm excited about this book as it completes my 4WD series. I'm having a great time crafting this new book's content, photos, and illustrations. After its release, "Understanding 4X4 Vehicles" will be required pre-reading for all those wishing to attend my Introduction to 4WD recreational training courses.

In my new book I am presenting something I call the *Off-Road Trail Worthy Index – Evaluating New 4WD Vehicles Direct from the Showroom™*. This index is designed to give readers an idea of a new (and used) vehicle's off-road capability. It's only a guide, nothing else.

You can download a formative copy of this Index by clicking [HERE](#).

Download the Index now and look it over. Once you've read through the Index, come back here and continue reading.

The Index is still a prototype. I'm continually massaging its content and listed point scores. I want to make the Index the best it can be. Getting this Index right is important to me, and you can help.

Off-Road Trail Worthy Index
Evaluating New 4WD Vehicles Direct from the Showroom

Index Features	Possible Points	Awarded Points
Two Speed Transfer Case with 4-Low Gearing 1) Part-Time 4WD <u>OR</u> 2) Full Time 4WD with Locking Center Differential ¹	15	
Has Terrain Select Dial (e.g. <i>Mogul, Mud, Sand, Snow, Rocks</i>) <u>AND</u> either: 1) Two Speed Transfer Case with 4-Low Gearing <u>OR</u> 2) Full-Time 4WD with Computer-Controlled Coupling with 4-Low Gearing	5	
All-Terrain Tires ²	10	
Rear Axle Locking Differential	10	
Front Axle Locking Differential	5	
Brake Traction Control (Brake Lock Differential) Score = 5 Mechanical Limited Slip Differential (LSD) Score = 3 <small>(Both Do Not Need Driver Input)</small>	7/3	
Sway Bar Disconnects (Front, Rear or Both)	2	
Down Hill Assist	2	
Hill Start Assist	1	
4-Low Speed Progress Control ³	1	
TOTAL TRACTION	59	
Ground Clearance: 9 Inches/23 Centimeters or Greater ⁴	10	
Approach Angle: 25° or Greater	4	
Breakover Angle: 25° or Greater	4	
Departure Angle: 25° or Greater	4	
Water Fording Depth: 20 Inches/51 Centimeters or Greater ⁵	1	
TOTAL CLEARANCE	23	
Underbody Armor – Rock Rails/Sliders/Sill Guards	2	
Underbody Armor – Fuel Tank	1	
Underbody Armor – Transfer Case	1	
Underbody Armor – Differentials	1	
Underbody Armor – Oil Pan	1	
Front or Vehicle Surround-Type Camera	1	
TOTAL PROTECTION	7	
Front Frame-Mounted Recovery Point(s) ⁶	5	
Rear Frame-Mounted Recovery Point(s) ⁶	5	
Winch ⁷	2	
TOTAL RECOVERY	11	
TOTAL	100	

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The Index obviously implies a few “opinions” on what a trail worthy feature IS and the feature’s RELATIVE IMPORTANCE to the others listed. That said, there is some “physics” and “engineering” logic behind the trail worthy features listed and their relative scores. The Index isn’t ALL about opinions on what makes one vehicle more trail worthy than another.

The following is some background and insight about my newly invented Index. First, unlike my other three published books, the audience for my new book “Understanding 4X4 Vehicles” focuses primarily on off-road and overlanding beginners. Although I believe that most will learn something from this fourth book, those that will benefit most are individuals thinking of purchasing a new or used 4WD vehicle and those that are worried about taking their 4WD off-road safely.

One of the first topics discussed in my new book is clearly defining how 4WD vehicles are commonly used. There's not a person on the planet that can select and purchase the correct 4WD vehicle without first knowing how they wish to use it off-road. Granted any single 4WD vehicle can be used for multiple types of off-road activities, but there will always be one best vehicle for your particular needs, wants, and budget. This fact is actually the reason why I personally own three off-road 4WD vehicles. I have one vehicle I primarily used for comfortable recreational overlanding, one rock crawling vehicle, and one vehicle for scenic backcountry touring.

To emphasize my point, I don't ever plan on taking my RAM PowerWagon with its attached Four Wheel Camper over the very difficult Rubicon Trail in Northern California. However, I've had my PowerWagon on some pretty difficult sections of a long trail, but I didn't intentionally go looking for challenging terrain. Likewise, I would not choose my highly modified and lifted Jeep TJ for a multistate or international overland adventure. Sure, I've camped out of my Jeep TJ, but my total camping experience from the TJ is not nearly as comfortable as my Four Wheel Camper on my PowerWagon. Also, my rock crawler Jeep TJ isn't very comfortable when driving long hours on the highway. After about a hundred miles or so, it actually feels like I've gone a few rounds with a champion heavyweight boxer. My Jeep JK Unlimited is my "in-between" vehicle. It's minorly lifted, has a rooftop tent and pretty tame all-terrain tires. The JK is my jack of all trades and I can do just about any type of off-roading I want in this vehicle.

In my introductory 4WD course I ask students to share with the group the types of adventures they want to use their vehicle for. When we are finished with the classroom session, we all go outside to audit their actual 4WD vehicle. I can instantly tell if they've chosen the right vehicle or modified it appropriately for their desired adventures. I don't tell them if they've chosen wisely or not, I let them figure this out on their own during the two-day course. Without exception, all that have chosen the wrong vehicle or modified it incorrectly figure this out on their own by the end of the course. I don't have to tell them directly that they've made some bad decisions. I find that very hard to do anyway. Plus, who am I to judge if they've made some bad choices? By the end of the course these students typically come up to me and say, "I got the wrong vehicle... didn't I?" Or, "I really shouldn't have put 40" tires on that light axle, right?" In some cases, their choices are painful to observe from a money-wasted perspective.

Helping readers identify how 1) 4WD vehicles are typically used, and then 2)

how to select the best possible vehicle for their most common and desired off-road adventures is, I believe, two of the most important topics in a 4WD beginners' book. Guess how many 4WD books on the market actually begin their books with these two topics? Zero. Practically all the books out there start by defining what a 4WD vehicle is and how it works. To be sure, defining the various types of 4WD vehicles and explaining how their drivelines function are very important topics. Most of these printed books do an excellent job with covering these topics. That said, my book will also cover this same introductory content, but not in the same way. In my opinion, many of these books are missing what I believe to be some of the most important topics for new and beginner 4WD enthusiasts. When one of my readers goes to a vehicle dealership to purchase a new or used vehicle, they can take the "Off-Road Trail Worthy Index" with them as a guide. I believe the Index will help folks with that initial purchase. The Index will also help 4WD vehicle buyers cut through the BS spoon fed to them by marketing brochures and unknowing salesmen.

Here are a few more notes on the Index:

- **Guide Only.** This Index is designed to give readers an idea of a vehicle's off-road capability. Because off road capability is complex and ratings are subjective, it is not possible to create precisely defined criteria. Therefore, this sheet should only be used as a guide for a conceptual discussion and comparison between new vehicles. It is recognized that a vehicle's true abilities off-road are: 1) subject to a driver's skill level and abilities, plus 2) how each trail worthy feature performs on the vehicle as a whole.
- **Features that Help You Get Where You Want to Go.** The only features listed on the Index are those that universally help all vehicles get over and across challenging off-road terrain. The Index feature categories are: 1) Traction, 2) Clearance, 3) Protection, and 4) Recovery. The Index does not include important features such as towing capacity, maximum payload capacity, roof payload capacity, fuel tank size, horsepower, torque, road visibility from the driver's seat, etc.
- **Itemized on Showroom Floor.** The features listed on the Index are those that can be itemized/scored at a vehicle dealership or from a factory Build Sheet, sales sheet, or brochure. For example, an axle articulation "Ramp Travel Index" (RTI) score is not included on the Index since it cannot typically be determined at a vehicle dealership.
- **Scoring Less Than 100 Points.** Vehicles can be extremely trail-worthy without scoring a total 100 points. In fact, almost no vehicles will score 100 points as assembled at the factory. Depending on how a vehicle is designed, many cannot

score 100.

- Used Vehicles. This Index can also be a guide when purchasing a used vehicle.
- Vehicle Cost. Vehicle cost is not a factor on the Index. Cost is a metric having nothing to do with the trail worthiness of a 4WD vehicle. Cost is a personal consideration.
- Aftermarket Product Support. New vehicles with considerable aftermarket product support can be made more trail worthy by adding some features listed on the chart after initial purchase.
- Brake Traction Control. The Index score for this feature is based on modern Brake Traction Control systems. Newer iterations of Brake Traction Control are excellent for enhancing traction over challenging terrain. Older systems on used vehicles could be scored lower in this category.

Trail Worthy Feature Definitions

In my new book I will clearly define and explain all the listed features on the Index. At this time, you do not have access to that content. Therefore, if you do not know how to measure such features as “ground clearance” or “breakover angle” on a vehicle you may need some help. See below, I’ve provided you with a few tips on how to take the vehicle measurements listed on the Index. This is content from my new book.

The same is true for the definition of certain Index features, such as “Limited Slip Differential,” “Full-Time 4WD with Locking Center Differential,” and etc. If you are struggling with understanding any of the features on the Index, you’ve just discovered that YOU are a perfect candidate for purchasing my new book. You might be able to find most of the features on the Index listed on a “Build Sheet” for your vehicle. To secure a printed Build Sheet for your vehicle, visit your vehicle manufacturer’s website and search within the site for “Build Sheets.” You will need your all your vehicle’s information including VIN number. Of course, you can do an internet search for individual features listed on the index as well.

Help Me Help Others

In the spirit of helping my readers and students select the most appropriate vehicle for their needs, I present my *Off-Road Trail Worthy Index – Evaluating New 4WD Vehicles Direct from the Showroom*™. Since you are a seasoned off-roader, I’m asking you for a favor. Go out and score your existing 4WD vehicle (or a vehicle you want to purchase) using the Index exactly as written. Score your

vehicle exactly as it sits right now - modified or unmodified. Do the best you can and don't sweat the details if you don't understand one of the trail worthy features on the Index or you can't determine if your vehicle has or doesn't have one of the listed features. I'd like to see each individual category and how you scored it. Download the PDF version and send it back to me filled it. Also, please provide me the year, make, model, and sub-model of your vehicle. If you have an opinion about the features listed on the Index, the wording, the points given, or if you believe any important features are left off, I'd like to hear about all that also. This information from you would be most valuable.

There's no such thing as incorrect scoring or opinions here. I will listen and review everything sent back to me. In advance, thanks for helping me help others.

Vehicle Measurement Information

The Index lists several measurements you need to make on your vehicle. Here's the definition of these Index features and how to take the measurements. Have fun! You should have these measurements firmly embedded in your brain as you sit in the driver's seat and navigate your vehicle over challenging terrain. It's all a part of, as I call it, "pouring your vehicle into your brain."

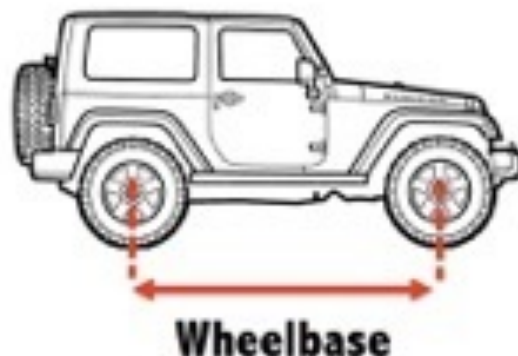
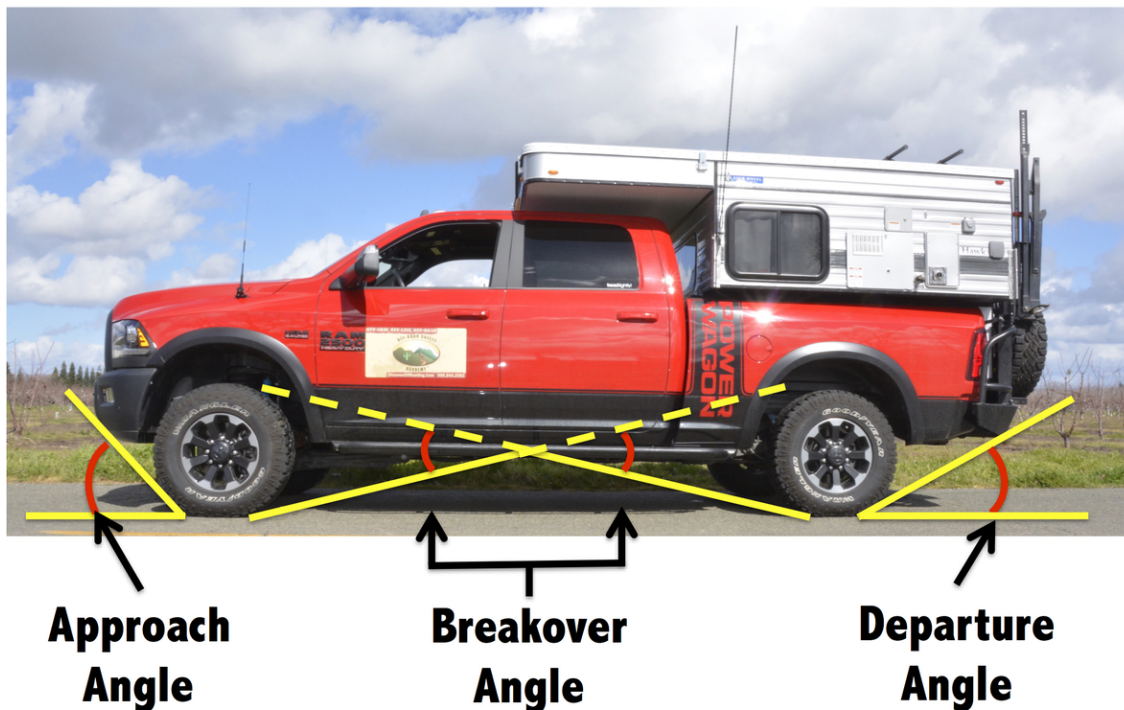


FIGURE 1

- **Ground Clearance.** This measurement may be defined several ways. For the purposes of this Index and repeatability we define it as described here. Take a 90° vertical measurement from ground to body, just under door or up to frame, door panel, or rock rails/sliders/running boards – whichever is lowest. Some vehicles have driver-input and/or automatic ground clearance adjustment through the use of airbags. Take ground clearance measurements at full extension or at a pre-set off-road height. This measurement is also used in part to determine a vehicle's breakover angle.
- **Wheelbase.** Left or right side; the distance between the center of the front and

rear wheels. This measurement is also used in part to determine a vehicle's breakover angle. Figure 1.



- **Approach Angle.** The steepest grade a vehicle can begin to climb or descend without scraping the front bumper or a component attached to the bottom of your front bumper. A vehicle's Approach Angle depends on ground clearance and the length of engine compartment between the front bumper and front wheels. In Figure 2 you see a vehicle driving off of a large rock. The approach angle at the front of the vehicle is so good that it doesn't scrape on the ground after dropping off the rock.

- **Departure Angle.** The steepest grade a vehicle can ascend or descend without scraping the rear bumper or any portion of its underbody (like a tow hitch) behind the rear wheels. A vehicle's Departure Angle depends on ground clearance and the length of the vehicle behind the rear wheels. In Figure 3 you see a vehicle driving off of a large rock. The departure angle at the rear of the vehicle is so good that it doesn't bang on the rock after driving off the slope. Imagine if this vehicle was a truck with a long bed behind the rear wheels.

- Breakover Angle. The breakover angle provides you with a clue as to the steepest ridge (quick up, quick down) you can venture over without high centering on a ridge, berm, log, or rock under the middle of the vehicle. Due to a poor breakover angle, most trucks can easily get high centered on even small berms of sand, dirt, or large rocks. Figure 4.



FIGURE 2



FIGURE 3



FIGURE 4



FIGURE 5

How to Calculate Approach, Departure, and Breakover Angles

You measure your vehicle's Departure AND Approach Angles using exactly the same method.

To take these measurements you need a long stiff flat rod (preferably metal) and an analog or digital clinometer (AKA

Inclinometer, Angle Locator, or Protractor; Figure 5 and 6). It helps if you have an angle iron long enough to lay on the ground from tire to tire.



FIGURE 6

ONE: Place the angle iron on the ground, against the tires. This angle iron provides a way to position the flat rod where the tires meet the ground. Raise this flat rod up to where it contacts the lowest point on the front bumper. Place the clinometer on the flat rod and note the measured angle on the needle. This is the Approach Angle measurement. Figure 7.



FIGURE 7

TWO: Do the same at the rear of the vehicle. In the rear, the rod may contact the vehicle's trailer hitch first. If so, that's the angle you need to measure. See Figure 8.



FIGURE 8

THREE: The Breakover Angle can be measured several ways, but practically all vehicle manufacturers use two measurements – Ground Clearance and Wheelbase – with the formula shown to the right.

Breakover Formula

$$\beta = 2 \cdot \tan^{-1} \left(\frac{2 \cdot gc}{wb} \right)$$

Beta (β) is the Breakover Angle, gc = Ground Clearance, and wb = Wheelbase.

Now don't get excited. This formula is actually easy to use. You don't need to be a calculus major. Since you already know your vehicle's Ground Clearance and Wheelbase measurements, you don't need to measure your vehicle again to arrive at its correct Breakover Angle.

To use the Breakover Angle formula, you'll need the scientific calculator available on all smartphones (iPhone or Android).

To get the scientific (more elaborate) calculator, FIRST find your standard calculator on your phone. SECOND turn your phone horizontally to get a scientific calculator. THIRD push the "2nd" button on the scientific calculator. Now you should get a button that says "tan-1" (tangent to the -1 = ArcTangent which is what you need). Look carefully for this button. Once you see a button labeled tan-1, then you can proceed with punching in your numbers and using

the formula. See Figure 9.

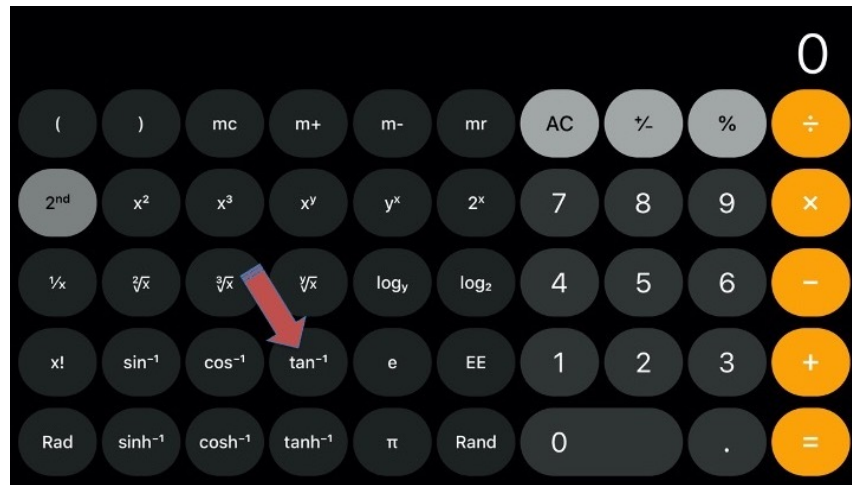


FIGURE 9

Breakover Calculation Example: 2018 PowerWagon. Here's an example of using the calculator and formula. My PowerWagon has a Ground Clearance (gc) of 14 inches and a Wheelbase (wb) of 149 inches. I simply place these numbers in the formula:

$$\beta = 2 \times \tan^{-1} [(2 \times 14'') / 149'']$$

A rule of math says to complete all calculations inside the parenthesis (2 x 14'') first:

$$\beta = 2 \times \tan^{-1} [(28'') / 149'']$$

A rule of math says to complete all calculations inside the brackets [] second.

$$\beta = 2 \times \tan^{-1} [.1879]$$

Once you get .1879 on your calculator, simply PUSH the tan-1 button. This will give you: 10.64 degrees.

Multiply 10.64 degrees by 2 and you get:

$$\beta = 2 \times 10.64^\circ$$

$$\beta = 21.28^\circ$$

The Breakover Angle of my RAM PowerWagon is 21.28 degrees. This is a fairly terrible number for general off-road Trail Worthiness. The Index wants a Breakover Angle of 25° or Greater for an Index score of 4 points. My PowerWagon would not get ANY points on the Index for its Breakover Angle.

But here's what the Index is not telling you... For a LONG WHEELBASE truck, that 21.28° breakover angle is really GREAT. Most trucks have breakover angles in the teens off of the showroom floor. Okay, the PowerWagon didn't get any points on the Index for its breakover angle, but it did okay for what type of vehicle it is. Remember, the Index is just a GUIDE. Not an ultimate authority of whether you should or should not purchase a 4WD vehicle.

Now, compare my PowerWagon's Breakover Angle with that of my lifted and big tire two-door rock-crawler Jeep TJ. See the example calculation below. This will give you some indication as to why I take this Jeep on really hard rocky trails and NOT my PowerWagon. My Jeep has a Breakover Angle of very respectable 42.3 degrees. This vehicle pretty much "walks" over challenging terrain while rarely high centering. Because this vehicle has a Breakover Angle of 25 degrees or greater, it scores 4 total points on the index.

Breakover Calculation Example: Jeep TJ

Ground Clearance = 18 inches

Wheelbase = 93 inches

$$\beta = 2 \times \tan^{-1} [(2 \times 18") / 93"]$$

$$\beta = 2 \times \tan^{-1} [(36") / 93"]$$

$$\beta = 2 \times \tan^{-1} [.3870]$$

$$\beta = 2 \times 21.16^\circ$$

$$\beta = 42.3^\circ$$

Now, let me hear from each of you that receive my newsletters. Upload your completed Index to me and share with my your thoughts about the Index itself and the process. Send responses to Bob.Wohlrs@DiscoverOffRoading.Com. Yes... THIS IS HOMEWORK! HA!

THANKS

A last note here... I'd like to thank Scott Brady, Robert Pepper, Christopher Walker, and Brent Baker for their review of the prototype Index and their fine suggestions that helped make it much better. Cheers my friends. I appreciate you all.



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