’85 Toyota 4Runner Alternator Upgrade Project
Al Dolney
Nov. 2004

Content:

Problem:

The ’85 4Runner OEM alternator is Lester P/N 14668 and is rated at 60 amp maximum. In a vehicle primarily intended as a moderate-to-heavy duty 4x4 rock climbing rig with winch, dual batteries, ham and CB radios, auxiliary lights and other electrical and electronic devices, the OEM alternator no longer up to par. The purpose of this paper is to document the decision process in selecting an upgraded high output alternator, installation into my ’85 4Runner and what I learned during the process.

Upgrade Options:

Here are the upgrade options, as I researched the problem:

- Leave stock
- Leave stock and add another alternator (dual alternators)
- Upgrade kit into OEM alternator
- MR2 100 amp alternator
- Aftermarket high output alternator
- Specialty welding alternators

Leaving the stock alternator as-is was not an option, but is added to make the list complete.

A cheap option open to me was to add another alternator. I had an alternator from an ’89 4Runner with the same part number as the ’85. This left me with just designing and installing the custom brackets to add the second alternator and, of course the added wiring. However, the only place left to install another alternator was where the air conditioning unit is currently installed. Living in North Alabama, I wasn’t prepared to give up my air conditioning just yet. Therefore, I dismissed this option.

I looked into upgrade kits that would fit the OEM alternator. Iceberg makes a kit to upgrade GM alternators and despite 2 e-mails, I never heard if they make one for the Toyota alternators. I did call 2 local alternator rebuild shops; both told me that upgrading the OEM alternators were not possible. Mobi-Arc does make a kit to upgrade stock Toyota alternators for $85 that gets the capacity to 85 amps. The combination of cost, marginal upgrade capability and having to rebuild the alternator myself drove me from this option.

There is a paper on the internet that describes the installation of used Toyota 100 amp alternator from a MR2. However, using this alternator requires redesigning and building bracketry coupled with the fact of using an alternator with an unknown history led me to seek other options.

There are several high output aftermarket alternators available, Summit Racing and Jegs are but 2 examples. Prices vary from very reasonable (100 amps for $89) to very expensive (170 amps for $450). Mr. Alternator has a direct replacement for $210 per an e-mail from him (see appendix for sources). Powermaster does make a 170 amp direct Toyota replacement alternator; cost is over $450, however.

The specialty welding alternators from Premier Power and Mobi-Arc, for example, are very expensive (i.e. +$400), far more than I wanted to pay. I dropped this option fast.

I finally decided on a Powermaster PWM-47294 140 amp GM 10SI alternator from Summit Racing for $139.00 plus shipping. This alternator is the small case internally regulated GM alternator that was probably put on +100 million vehicles in the late 70's to late '80s when it was replaced by the CS130 series alternators. See Figures 1 and 2 for pictures that show the difference between this alternator and the OEM Toyota alternator. Of all the options and alternatives, this alternator gave me the most capability with a known high quality unit (i.e. Powermaster) within reasonable cost and modification requirements.

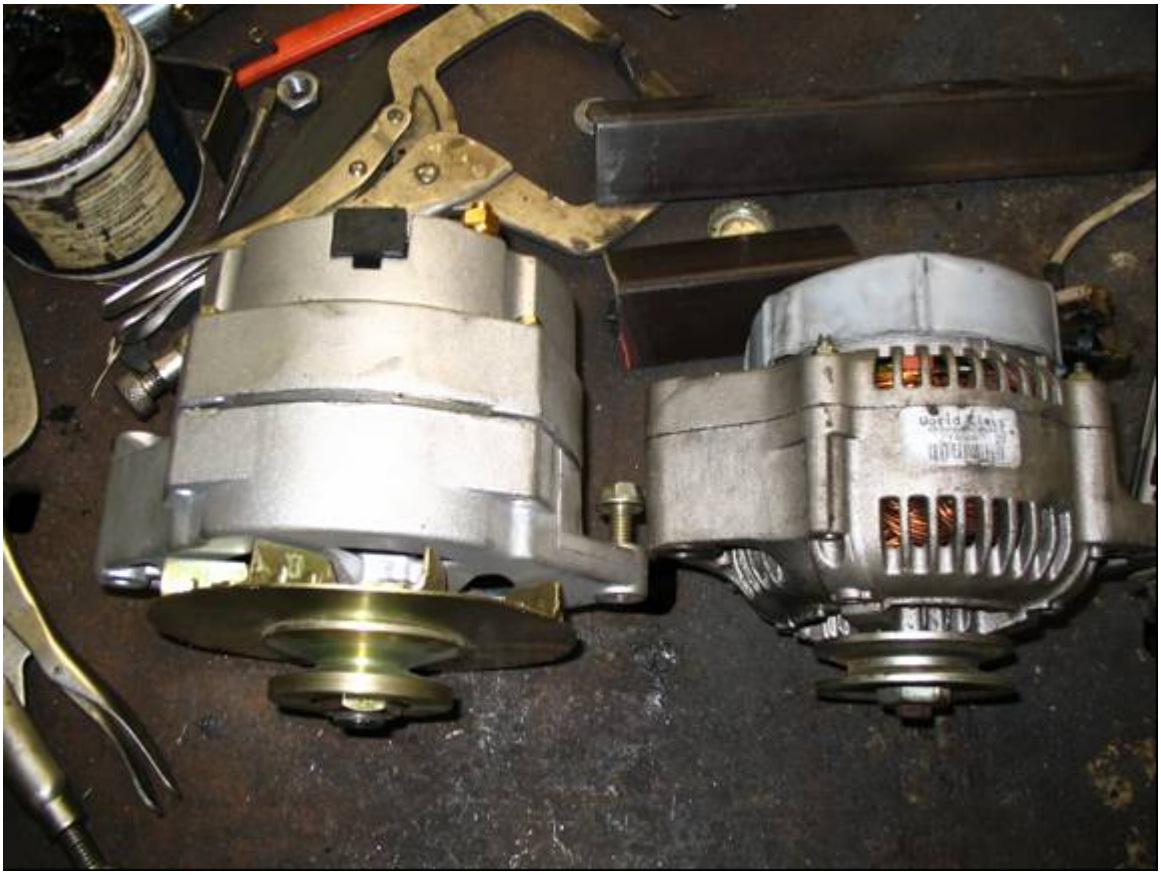

Figure 1. OEM Toyota alternator (Lester P/N 14668) on the right; Powermaster PWM-47294 GM 10SI 140 amp alternator of the left. Note the pulleys are almost lined up and the difference in mounting tab location, length and distance from the pulley.

Figure 2. OEM alternator on the left; Powermaster PWM-47294 on the right. Note that the Powermaster is about ½" larger diameter than OEM and location difference between the upper tabs (shown on the bottom of the alternators in this photo).

Installation:

The first and most important thing to do when you receive your replacement alternator, assuming it's not a direct replacement, is to make up a simple measuring jig for it. This is nothing more than a 1' or 1 ½" angle with 2 holes drilled to simultaneously hold both alternators by the rear of the lower (i.e. longer) mounting tab. See Figure 3 for the one I built in about 1 minute. This fixture allowed me to line up the pulleys, and then measure the difference between the back of the lower mounting tab and the front of the tab, giving me the new measurement for the lower mounting bracket.

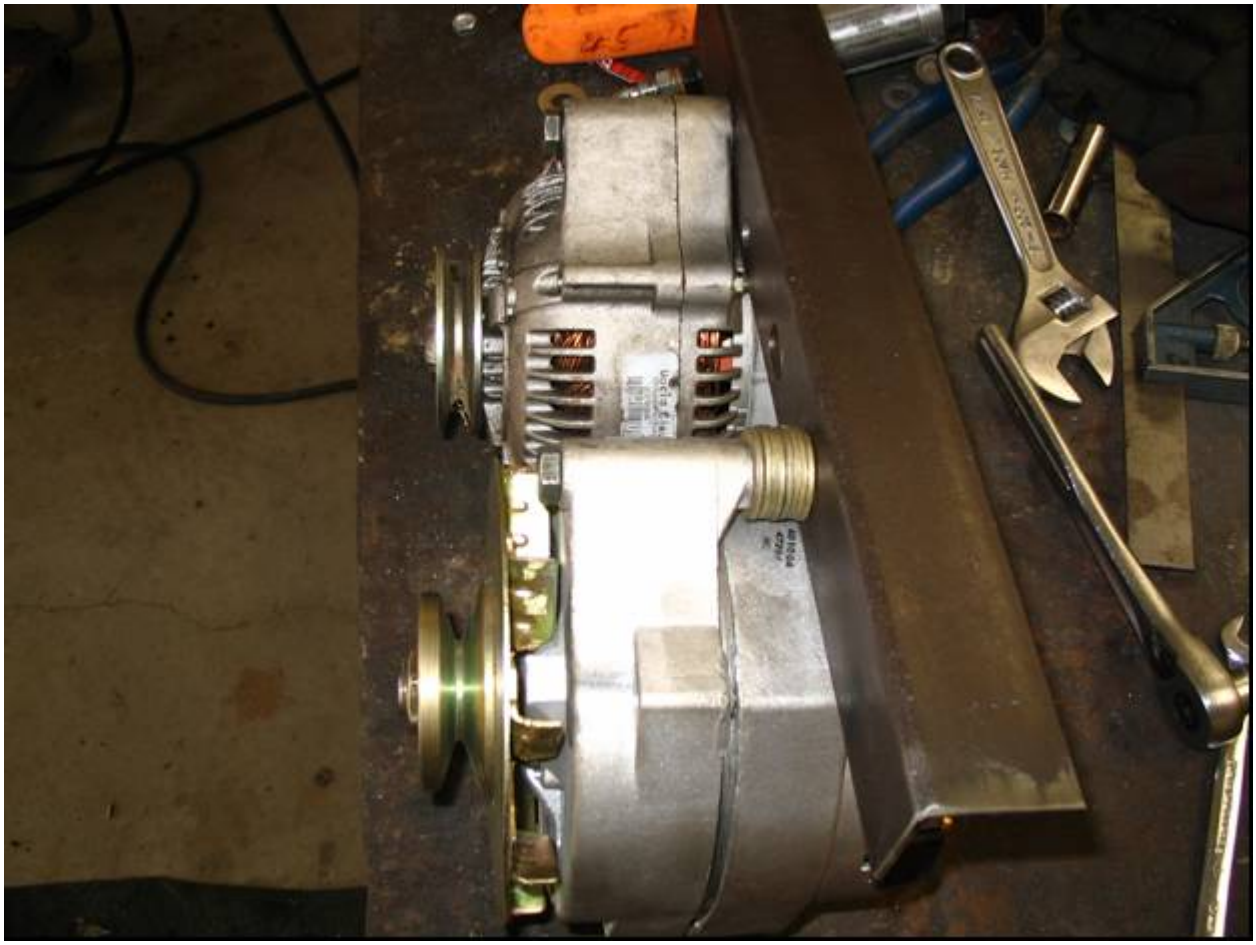

Figure 3. Measurement fixture; OEM alternator in the rear, Powermaster PWM-47294 alternator in front. Pulleys are lined up; note how easy it is to measure the distance from measurement fixture (the 1 ½" angle) to the front of the lower mounting tabs of both alternators. The difference in this distance is the measurement that the lower mounting bracket needs to be lengthened. Note the use of the 8 washers to move the Powermaster alternator forward.

Note from Figure 2 that the OEM lower mounting tab is slightly longer than the Powermaster 47294 (2.285" vs. 2"). From the measurements taken from the fixture, I then cut the lower mounting bracket and rewelded it, making it approximately ¾" longer. For strength, I added a ¼" x 1" x 2.5" long steel flat bar to the side of the bracket. See Figure 4 for a picture of the lower mounting bracket as modified and installed. When I rewelded the lower bracket, I made it approximately one 3/8" washer (~.085") longer than I thought I needed. As it turned out, this was fortuitous since when tightening the lower bracket, it pulls the front tab and therefore the alternator and its pulley, to the rear by a very slight amount. This added length was just enough to keep the alternator pulley lined up with the crankshaft pulley.

Figure 4. Lower mounting bracket cut, lengthened, rewelded and installed (in green). Alternator belt is installed and lined up with the crankshaft pulley. Note that the mounting bearing surfaces on the front and rear tabs are cleaned of all dirt, paint, etc. to ensure a good ground. The grade 8 mounting bolt head can be seen in front of the mounting tab. Note the two 9/16" nuts acting as a spacer on the rear tab. Untightened bolt near the rear tab is for the lower radiator hose mount to be installed later.

To make up space behind the 47294 and the rear mounting tab, I added 2 9/16” nuts as a sleeve. Pipe or tubing cut to fit will work also; I used the nuts since their width was almost perfect (I had to remove about .01 to make them fit snugly but not too tight). To make them fit easily over the 3/8” grade 8 bolt, I drilled them out to 13/32” (3/8” + 1/32”). I replaced the OEM lower mounting bolt with a 3/8” x 5” grade 8 bolt; the bolt head can be seen installed in Figure 4.

When mounted in the lower bracket, the upper alternator mounting tab interferes with the OEM adjusting bracket and won’t fit directly; the alternator tab is about ½” in front of the adjustment bracket. To fix this, I designed and installed a simple adjustment bracket extender out of 2 pieces of ¼” x 1” flat steel. See Figure 5 for a picture of the upper bracket installed.

One piece was 2” long, the other approximately 4” long. They were welded together on the flat sides at approximately a 30 degree angle to each other to make a very shallow “V”. The curved adjustment slot on the OEM upper bracket was marked on the longer piece and a 11/32” hole (5/16” + 1/32”) was drilled about halfway of the longer 4” piece. Another 11/32” hole for the alternator upper tab was drilled in the shorter piece. After a trial fit, I had to grind a clearance at the bottom of the shorter piece so that it would not bind or interfere with the alternator case or pulley fan as the alternator was rotated when the belt is being tightened.

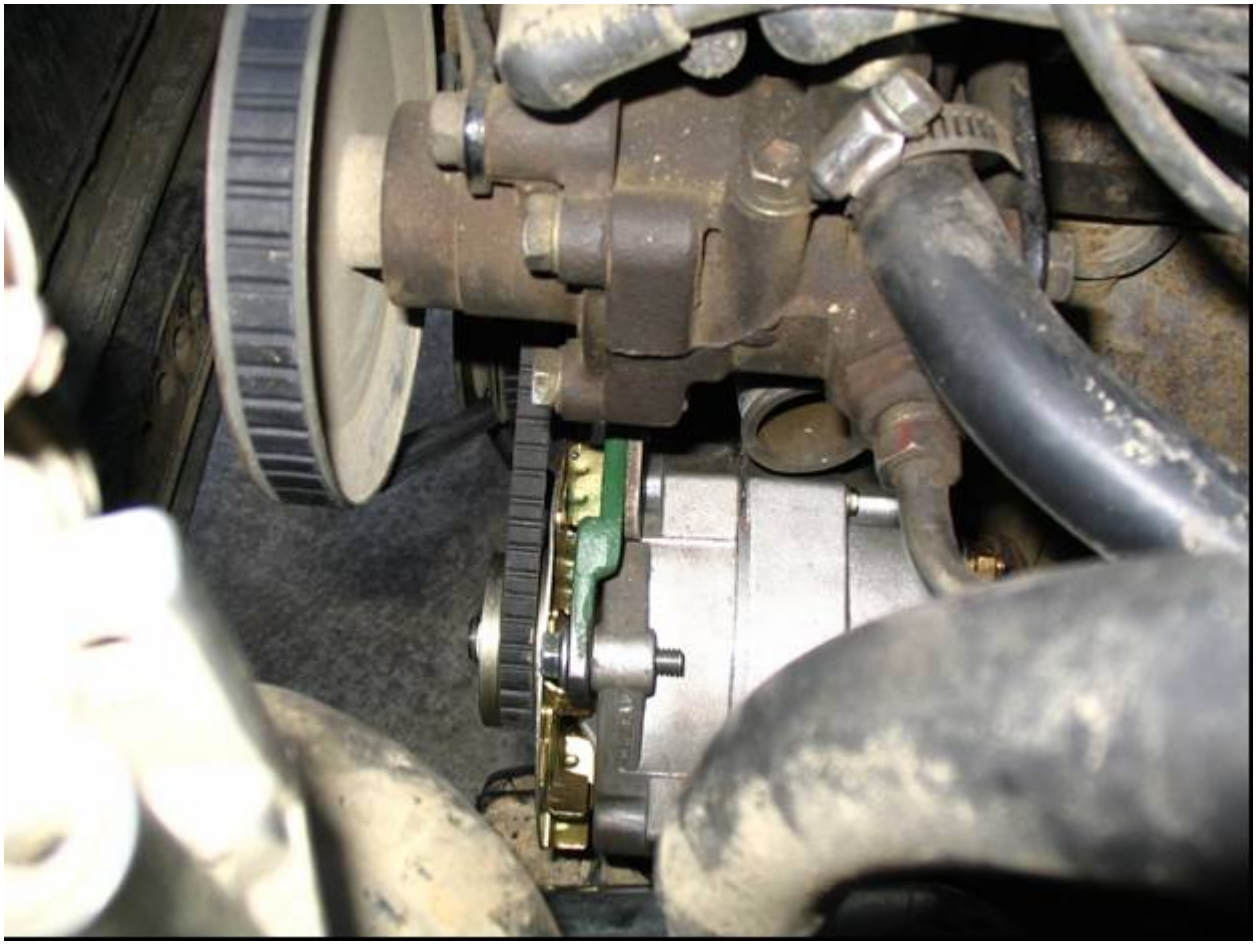

Figure 5. Upper bracket extender (green) installed. Note that it mates with the upper mounting tab in the front. Just to the right of the extender is the OEM adjustment bracket. Note that in this position, the belt has not been tightened and the OEM bracket prevents the alternator from moving any closer to the engine. Unseen under the power steering pump is the second 5/16" x 1" grade 8 bolt that is used to adjust and keep the alternator belt tight. Note clearance between the alternator and the upper radiator hose outlet.

With the alternator installed and moved to its closest position relative to the engine (i.e. shortest belt), a 15355 belt can just be installed. I used a ¾" breaker bar on the crankshaft pulley to "walk" this belt onto the pulleys. This ensured the tightest belt possible due to very small adjustment length with this alternator. Tightening this belt takes up about 1" of the approximately 2" of travel available. See Figure 6 for a picture of the alternator installed and the resulting clearances. Although it's not clear from Figure 6, there is room for the upper radiator hose.

Figure 6. Powermaster PWM-47294 alternator installed and the belt tightened. Note the clearance between the alternator and the power steering cover on the left. Just barely visible in the extreme upper center is the upper radiator hose outlet. Although it's not clear from the photo, the alternator does clear the radiator outlet and hose. Note the large gold battery connection and the black dust cover at the ~2 o'clock position covering the #1 and #2 field and sensing connections respectively. The threaded hole just visible at the bottom of the alternator is for another mounting configuration, not for grounding.

The bracket modifications described herein do not prevent you from retrofitting the OEM alternator back into its original location except for adding spacers to the front of the alternator on the lower bracket, removing the upper bracket extender and, of course, installing the original length belt.

Specific installation procedure:

- Drain radiator and remove the lower radiator hose and pipe.
- Remove radiator, radiator shroud and fan
- Disconnect the OEM alternator wires.

- Remove OEM alternator.
- Install OEM and replacement alternator on your measuring fixture such that the pulleys are in exactly the same plane; measure from the rear of each alternator's lower mounting tab to the front of each lower mounting tab. Note the difference; this difference is the length that your lower mounting bracket needs to be lengthened. NOTE: make sure to NOT include the small raised area on the front tab of the lower mounting bracket; you'll be taking this off later.
- Cut lower mounting bracket about an inch from the front tab, extend length and reweld. I used a 3/8" bolt with enough washers to act a sleeve to get the correct length and to keep the mounting holes lined up. Add additional metal as needed to ensure strength and grind generous bevels on the cut edges to ensure good penetration of your welds. Have someone do it for you if you aren't qualified. While the bracket is cut, grind away the raised area on the rear of the front tab: the OEM alternator has a steel insert in its forward tab, the replacement probably won't and I didn't want this raised area to crack my brand new Powermaster alternator since it wasn't designed for it.
- Prime and paint the lower bracket; let dry.
- Clean all bearing surfaces for the alternator tabs and mounting bolt areas of all paint: the alternator is grounded through these bearing areas and a good ground will be compromised with paint on the surface.
- Bench install the alternator onto the bracket; fit a 3/8" x 5" bolt; push the alternator forward as far as possible and measure the difference between the rear of the alternator tab and the front of the rear mounting bracket tab. This measurement is the bolt spacer/sleeve length you will need. For me, this was two 7/16" nuts side by side (see Figure 4).
- Install the lower bracket
- Make sure the alternator is in the "3 o'clock position. From the rear of the alternator, the black dust cover over the #1 and #2 connections should be in the 3 o'clock positions. If not, remove the four small fasteners on the rear of the alternator, lift the rear cover about ½" and rotate as needed. If you lift the cover more than ½" or so, then the brushes will pop out and you'll have to reinstall them, and then put the cover back on.
- Install the alternator; it will need to go up from the bottom, towards the front and then back into its area.
- Install a 3/8" x 5" grade 8 bolt and your spacers/sleeve. Use a straight edge to ensure the alternator pulley lines up (i.e. in the same plane) as the crankshaft pulley. Modify/add/delete spacers as necessary. Torque the mounting bolt just enough that the alternator will stay in place but can still be moved while you work from the top of the engine. Reconfirm your pulley alignment.
- From the top, measure the difference between the OEM adjustment bracket and the front of the alternator upper mounting tab. Make a bracket extender to fit. See Figure 5 for ideas.
- Install the upper bracket with 5/16" grade 8 hardware and the upper mounting tab hardware supplied with your alternator (mine was a 5/16" grade 8 cap screw)
- Install a 15355 belt; you'll probably need a ¾ breaker bar to rotate the crankshaft pulley to "walk" the belt around to fit. This belt needs to be pretty tight as installed due to having less than 2" of belt adjustment travel.

- Adjust the alternator until the belt is tight; tighten the adjustment bolt, the alternator upper mounting bolt and then the lower mounting bolt. Reconfirm that the alternator pulley is lined up with the crankshaft pulley.
- Install the fan, shroud and radiator. Install the lower radiator hose and add antifreeze and water.
- Make your wiring connections as noted below.

Wiring

The OEM alternator comes with four connections: B, IG, S and L. The Powermaster PWM-47294 alternator comes with three: B, #1 and #2. The Powermaster alternator is one-wire or three-wire capable. One wire capable is just that: you attach one large wire from the B connection to the battery POS terminal and you're done. However, there are several advantages to wiring your alternator with the three wire capability; namely you keep your alternator lamp active plus you won't have to rev your engine to get your alternator to start working. See the Mad Electrical site for a detailed discussion on the differences and advantages of each.

Per a conversation with a Powermaster Technician on their toll-free tech line, here is how your wire the Powermaster PWM-47294 alternator for use as a three wire alternator:

PWM-47294	**Goes To**
B →	battery POS terminal via 4 ga cable & 175 amp fuse
#1 →	"L" wire on the OEM wiring harness (turns field on)
#2 →	"B" terminal on the 47294 alternator (senses voltage for the regulator)

Note that except for the "L" connection, you don't use anything else on the OEM wiring harness, at the alternator end. Carefully terminate and isolate the connections and locate them out of the way.

At the other end of the 8 ga OEM alternator wire to the fuse box, however, you have to keep it connected since it splices into the input of the 40 amp OEM fuse.

However, due to the limited connections space on the back side of the fuse block, I installed the OEM 8 ga alternator wire on the "downstream" side of the 80 amp fuse and installed a new 6 ga wire from the POS terminal of the battery in its place upstream of the 80 amp fuse. On the 80 amp fuse block, the upstream or unfused connection only has one terminal screw; while the upstream or fused end has 2 screw connections. This means that the 40 amp fuse power also goes through the 80 amp fuse, which is ok, since there is no longer any alternator current going through the 80 amp fuse. See figure 7 for simplified wiring diagram on how I did my '85 4Runner alternator wiring.

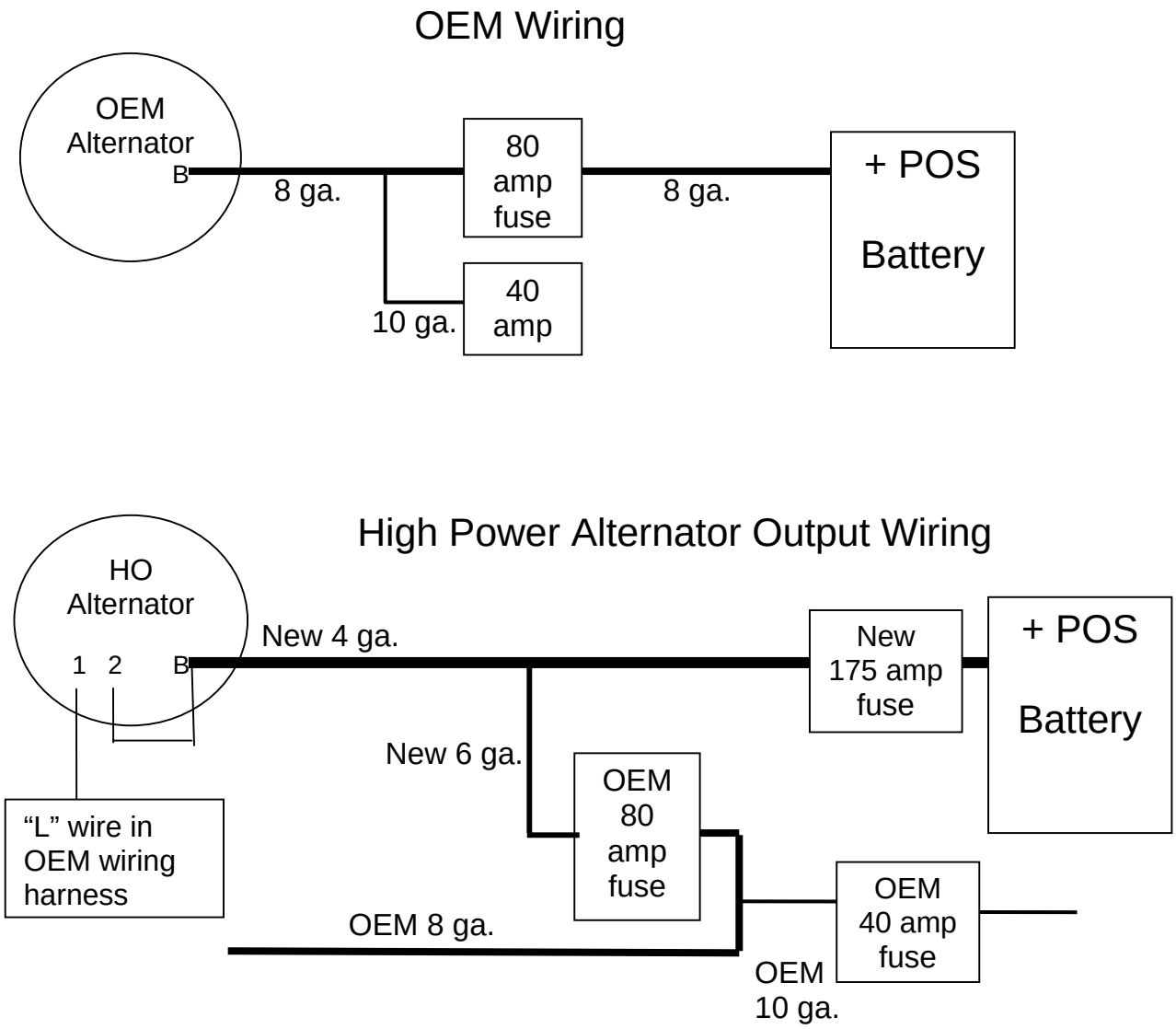

Figure 7. Simplified wiring diagram for wiring high output alternator to '85 Toyota 4Runner. Note that the "I", "S" and "IG" connections are not shown in the OEM diagram. Only the "L" wire is used from the OEM wiring harness at the alternator end in the high power output wiring. Note also that the 8 ga. battery wire is not used at the alternator end, but is used to provide power to the 40 amp fuse at the fuse block end by switching it from upstream/unfused side of the 80 amp fuse to the downstream/fused side.

Epilogue

Voltage test results after the installation are shown in the table below. Unfortunately, I don't have any "before" measurements. All measurements were taken with a digital multimeter and at the battery terminals unless otherwise noted.

Condition	Voltage (dc)
Engine off	12.91
Idle	14.70
Fan low	14.68
Fan medium	14.65
Fan high	14.63
+ running lights	14.62
+ headlights – low	14.56
+ headlights – high	14.54
+ front interior light	14.53
+ rear interior light	14.52
+ CM & ham radio – receive only	14.51
+ Air conditioning	14.47 (maximum average running load)
Air conditioning off	14.51 (confirm measurement)
Fan high	14.63 (confirm measurement)
Idle	14.70 (confirm measurement)
Idle at alternator	14.72 (.02 voltage drop to battery)
+ air conditioning at alternator	14.58 (.11 voltage drop to battery vs. 0.4 target voltage drop)

Powermaster Proof of Performance tag provided with PWM-47294 alternator:

Set voltage:	14.8 vdc
Output at idle:	101 amps (stock pulley, 2400 dyno RPM*)
Output at highway speed:	151 amps (stock pulley, 6000 dyno RPM*)

Maximum pulley RPMs should not exceed 18,000 RPM.

* Pulley RPMs. For a 3:1 pulley ratio (i.e. crankshaft pulley diameter/alternator pulley diameter), 2400 pulley RPM = 800 engine RPMs; 6000 pulley RPMs = 2400 engine RPMs

Appendix: Sources

Summit Racing: www.summitracing.com High power alternators, other racing hardware
Jegs: http://jegs.com/ High power alternators, other racing hardware

Powermaster:	http://powermastermotorsports.com/ High power alternators
Mr. Alternator:	http://mralternator.com/ High power alternators
Mad Electrical:	http://www.madelectrical.com/index.shtml Alternator information and electrical accessories