

Our Generator-Free RV - Lithium Battery, Solar, Alternator, and Inverter

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 [James](#)
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I dropped a teaser about this a few weeks ago, so now it's time I finally came clean with all the details. Since that time, a number of folks at [Winnebago's Grand National Rally](#), and on the Lake Superior Adventure have seen Lance in action, so some of this has already leaked out. That's OK, it's all pretty cool stuff.



But most people seemed to be more interested in the curtains I made than in the state of the art power system. I found that strange...

I had been thinking about a system like this for a long time. My interest with it probably began when we visited [Advanced RV](#) in Ohio. These days, there are lots of people adding lithium batteries to RVs. Advanced-RV has been doing it for a while now, and their installs work very well, from all reports. They approach RV power as an integrated system (rather than just installing a bunch of parts and hoping for the best). They put a lot of work into that integration, and I think their success is due to that. I wanted to emulate this systems approach when upgrading our RVs power.

System Goals

I had two major goals here. The first one was the same as many people: I wanted to do away with the generator. In our case though, it wasn't because the generator was loud. (OK. I mean, yes, it *was* loud, but we could deal with that.) It had more to do with the fact that after almost a year, we had only 13 hours on the generator – and 10 of them were just to exercise it. Exercising the generator was pretty much the whole reason I added an [auto-generator-start](#) module. So from a usage perspective, the generator was a big "meh".

The other strike the generator had against it was its unwillingness to start at higher altitudes. I'm thinking of our trip to the [Fishlake National Forest](#) in central Utah. At 9000 feet, the generator just refused to start. We didn't actually *need* the generator, we just wanted to see if it would start (and we could hear a Honda 2000 not too far away). I know there are carburetor kits for high altitude that would have helped. But a couple months later, we were camping on the beach in California at sea level. Considering where the generator was mounted, messing with the carburetor as we changed altitude seemed like a real pain for something we barely used.

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The other major goal I had was that I really don't want to think about it too much. We all know I like to tinker with the RV, but after reading about lithium batteries and inverters for the better part of two years, I'm over it. I want things to work without my having to constantly monitor and tweak them.

Now, that doesn't mean I don't have a healthy curiosity in the data and the results. But you may be disappointed in this post if you're expecting to read things like:

"By decreasing the float voltage from 13.6 to 13.4 volts, I was able to increase the remaining capacity at one year by 3.2%. This translates to an increased lifespan of 4398 full discharge/charge cycles – up from 4261. Those extra 137 discharge/charge cycles will likely be an even greater number since I never let my batteries get below 84.9% full or experience temperatures above 90 degrees Fahrenheit. "

So, fair warning to battery purists: don't gasp in horror as you read about me deliberately draining the expensive battery until the coach went dark. (Yes. I did. And it was awesome.)

System Design

Given my aforementioned apathy toward battery capacity and charging system discussion, it won't come as a surprise that I let someone else design the system for me. (I'm an aerospace engineer – not electrical!) In this case, it was the good folks at Xantrex (a division of Schneider Electric) who did the heavy lifting on the design side. I can't say enough good things about the system they've put together.

They took the lead in contacting suppliers of components that were already on the market and working with them to gather information, size components, adjust parameters, work out communication protocols, and basically make sure everything would work together as a system when it was all said and done. Though the components were all sourced from different vendors, they've so far worked together flawlessly. All they're missing is a catchy name. So just pick one word from the first column and one word from the second, add them together, and let's pretend that's the name. (I'm going with "Amp-Camp!")

Volt	Trip
Amp	Flow
Joule	Camp
Watt	-dango
Power	Journey
Mega	Pulse
Electro	-nator
Dyno	Run

If this sounds like your marketing department... I'm really sorry.

But the folks at Xantrex didn't stop at just designing the system and sending me a parts list. They actually showed up at FitRV HQ and helped me install and remove stuff. This was a good thing. Since the amounts of stored electricity we're talking about can be potentially harmful, I was glad to have the assistance and extra eyes for safety.



They even helped me drop the generator when it was all over!

The system they put together consisted of the following components.

Second Alternator for the ProMaster

This proved to be the most difficult and cautionary piece of the whole puzzle, mainly because this involves messing with the engine of your ProMaster. I'm good with wood, and OK with electrical and plumbing, but I'm no mechanic. So I had to find help to install this – hopefully without blowing up my warranty. Fortunately, the team at [Larry H. Miller Dodge in Sandy, UT](#) agreed to take on the task.

The alternator kit is already used in other ProMaster based RVs. It comes with everything you need to complete the installation. Here is the kit as I unpacked it on my bench and immediately decided there was no way I was going to mess with it.



When I got to step 1, I knew I was in over my head.

The installation is pretty involved. You have to drop the air conditioner compressor, install a pulley; install a bracket; add the second alternator and belt and tensioner; cut and re-route coolant hoses, and somehow get it all back together. Here's what it looked like halfway through, with the bracket installed and the compressor hanging loose.



And when it's all done, it looks like this.



It took a whole day to get it installed, and I was pretty happy with the results for about 50 miles. Then this happened.



While heading up Parley's Canyon toward Park City, Lance's dash lit up like a Christmas tree, and things severely overheated pretty much all at once. We made it up (barely) and coasted down the other side to wait at a gas station until we could get a tow.

What had happened was that the new hose and belt routings were just a bit too close to each other. The belt, after 50 miles or so, cut through the radiator hose, and spewed all the coolant onto the freeway. Boom! Instant overheating.

Fortunately, the crew at Larry H. Miller Dodge are real stand-up folks. They owned the problem and fixed it at no additional charge. They also took ownership of the next two problems which had Lance leaking coolant: a warped thermostat housing, and a damaged water pump. They fixed these as follow-on issues to the original mistake. So, other than having to go back and forth to the dealership a few more times than I had planned, it all worked out well in the end. Since then, we've put about 2000 miles on Lance, and everything has held up, so we're pretty confident that all those problems are behind us.



This alternator also came with a voltage regulator attached. This is a key part of the system, and it does two things. First, it ensures that the alternator's output is properly matched to the lithium batteries. This is a problem for single-alternator systems. The chassis alternator is designed to charge the starting battery, but that charge profile likely isn't optimal for the house batteries – especially if they're lithium. So by having a second alternator with a properly regulated output, the lithium batteries can have it their way, and the rest of your chassis electronics can have theirs. Everyone is happy.

The second important feature of the voltage regulator is that it has a control circuit on it which will allow the [NeverDie Battery Management System](#) (BMS) on the Lithionics battery to "turn off" the alternator when it decides it's full. This did require running a control wire from the battery to the voltage regulator, but it works – I've seen it in action. Working out that bit of communication is why I was glad to have Xantrex designing the system for me. It's not likely that, as an individual, I could have worked that out between the three suppliers involved.

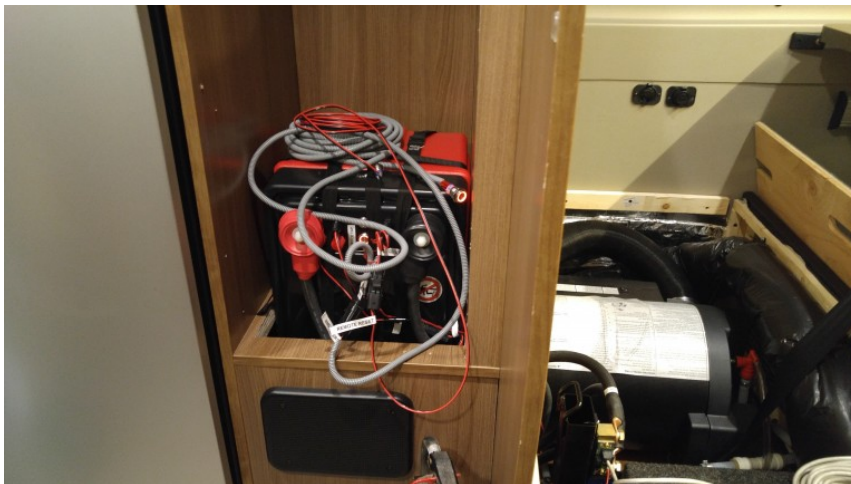
Zamp Solar Charge Controller

Our Travato was already sporting 300 watts of solar panels connected to a [Zamp solar charge controller](#). But that controller was programmed for AGM batteries, which require a different charge profile than our new lithium battery.



Fortunately, Xantrex had been working with the people at Zamp as well. In the year since we purchased our Travato, Zamp had already come out with a lithium-ready controller. But Xantrex had worked with them further to tweak the charge profile to match the other components in the system. When receiving power and set for lithium, the Zamp system delivers bulk and float charges as specified by Xantrex (14.6 and 13.4 volts, respectively). As a bonus, this new charge controller will handle 40 amps as opposed to the previous 30.

Lithionics Battery



This battery is what really makes all this possible. It's a 420 Amp Hour battery from [Lithionics](#), with an on-board battery management system. It's a lithium battery, which brings some special considerations.

I had always been worried, when thinking about lithium batteries, about the potential for damage from the cold. You see, lithium batteries can be damaged by charging them at temperatures below freezing. Since we like to take our RV out in cold weather, and since the stock battery and generator locations in our Travato are underneath the body of the van, this was a problem. I had assumed that we'd be using the generator mounting location for this battery, and was thinking of heating blankets, insulation, and whatnot.



The Xantrex guys actually thought up this mounting location, and we're glad they did. We lost one drawer of storage in the pantry, but what that bought us was automatic climate control for the battery for zero effort or expense. It's genius, and similar to how I passively heat the water lines in the winter.

This did require a bit of cabinet modification, and some angle aluminum that I riveted together to keep things from moving when underway. Also, this battery has two user-operated button controls, which I mounted on the cover I had to build.



The control with the lit circle is the master battery on/off switch. It comes in very handy when you're working on the RV and get nervous about the rather large energy store on your 12 volt system. This is different from the Winnebago-installed coach master switch because this one just controls this one battery. With this switch off and the coach switch on, for example, you would still have power from solar (assuming the sun is out). It's kind of interesting, and I promise you'll only forget the difference between the two once...

The second button is the "reset" switch. I only need it when I drain the battery to the point where the BMS shuts things down. This button is how you get your battery and electrical system "booted up" again. Yes, I've done this already. We're getting to that.

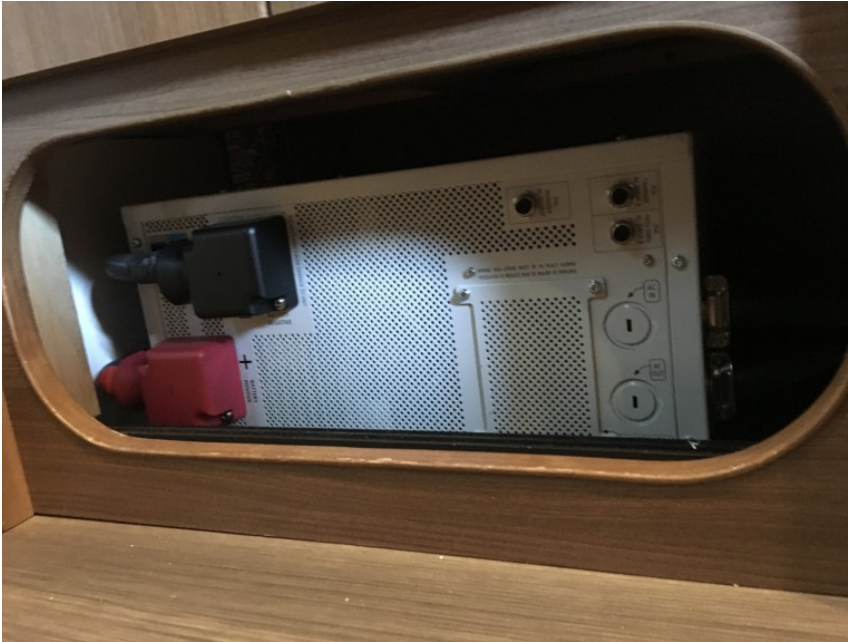
And, since I've mentioned it a few times, let's discuss the on board [NeverDie BMS](#). It protects against overcharging, over discharging, and a host of other things. But it's mainly those first two I'm concerned with. I'd mentioned before that it has a circuit that is tied to the voltage regulator on the second alternator. It does, and it's the BMS that decides "I've had enough charging, thank you," and kills the alternator. That keeps the battery from facing massive overcharging on a long road trip, for example.

On the discharge side, the BMS prevents running the battery all the way into the ground. It shuts down the battery when it's about 90% discharged. Yet it retains enough reserve charge in the battery that it can be re-

booted, as I mentioned above.

Xantrex Freedom SW Inverter

Naturally, Xantrex designed the 120 volt side of things around their own inverter, the **Freedom SW 3012** with their System Control Panel. This is a true sine wave inverter with a 3000 Watt continuous output and a surge current rated at **80 amps**. It's a beast of an inverter/charger, but fortunately, it fits in the space where the previous Magnum inverter lived.



The 80 amp peak rating is the key driver here, as it will reliably start the air conditioner in our Travato. That air conditioner has a "Locked Rotor Amps" rating of 63, which represents the peak cold-start load. With a rating well above that, the Xantrex inverter has started our air conditioner many times now without complaint.

Beyond that, the Freedom SW is also a charger, which eliminates the need for the converter, and so we removed it, along with the transfer switch. The other thing to note is that Xantrex has updated the software in their inverter to work properly with lithium batteries. They updated the inverter on the fly using the ports on it, so we have the very latest revision.



Coleman Mach 10 Air Conditioner

Let's talk about the elephant in the room. This is what it's all about! When everyone talks about using large lithium batteries and large inverters in their RV, all they really care about is powering the air conditioner.

Anything else you typically run in an RV can get by with *much less* battery or inverter capacity. The success of any RV power system is going to be measured by how long it can run an air conditioner.



With this in mind, some time ago, we had swapped our Coleman Mach 8 air conditioner for a **Mach 10**. Besides being just a hair taller, the Mach 10 runs at only 12-13 amps (@120v) versus the 15-16 amps the Mach 8 is rated for. When you're trying to squeeze all the performance you can out of your batteries, those 2-4 amps matter, because they translate to 20-40 amps at 12 volts. That's a 60 to 120 Amp-Hour savings over 3 hours, which is huge.

Our goal with the battery and inverter setup is to run the air conditioner for three hours without having to run the vehicle. Three hours represents the longest race I typically compete in (during which Stef might be stuck hanging back in the RV). It's also about *an hour longer than we ever ran the generator* at once during our first year in the Travato. After three hours, we'd be fine to run the engine for a while to recharge.

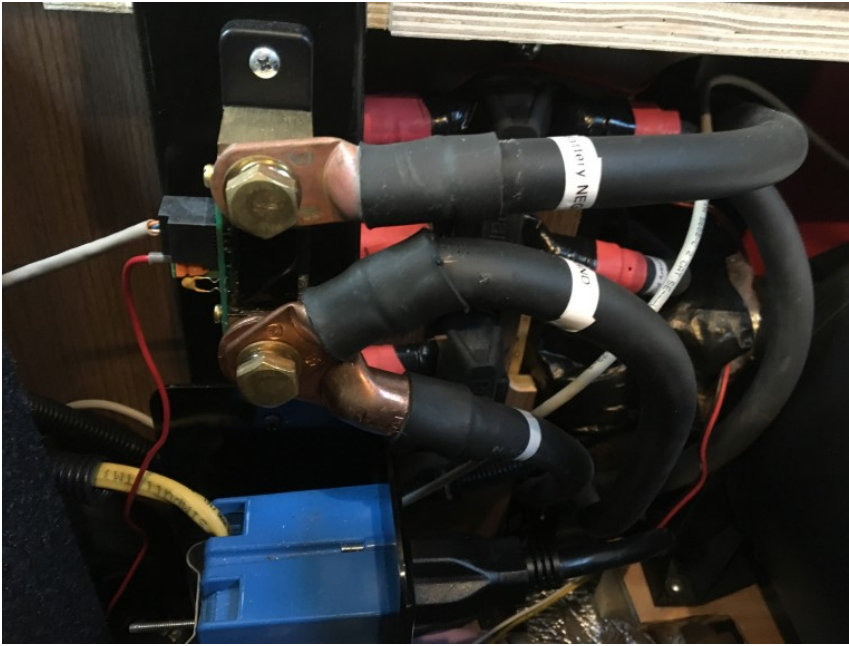
One additional benefit of the Mach 10 vs the Mach 8 is that it's approximately 50 billion times quieter*. The reduced volume is very noticeable on the outside, but not so much when you're trying to sleep 18 inches from the air distribution box inside.

* Claim is pure hyperbole, and not verified.

Wiring and Monitoring



We wired all of the high-amp runs in the van with 4/0 welding cable, and used 300 amp fuses where appropriate. This is thick copper, and with the battery at mid-ship, none of the runs are super long, so I'm not worried about any voltage drops. Also, the welding cable is extremely flexible, so we had no difficulties in fishing it where it needed to go.



And have a look at that! To me, it looks something like what I imagine the first electric chair looked like. But what I do want you to notice is the presence of the shunt, which is part of what provides extremely accurate battery monitoring via this:



Our monitoring needs are met by this [Victron battery monitor](#). I'm a big fan of hyper-accurate battery monitoring. If you're going to monitor the battery, you might as well do it right. I installed a Trimetric in Das Bus. Our Magnum setup also had a shunt-based battery monitor, and now we have this Victron.

In addition to the basic amps in/amps out monitoring, it also gives state-of-charge (SOC), and estimated runtime based on the current load. I've also set it to alarm at 10% of *usable* capacity remaining.

The other item we have is this switch.



This switch performs a very important function: it keeps the two 12 volt electrical systems (chassis and house) separate. You see, from Winnebago, the house and chassis batteries are connected when either of two conditions occurs:

1. The engine is running.
2. The "Battery Boost" switch is pressed.

With a highly regulated lithium battery setup, I pretty much NEVER want the first condition to connect the batteries. But I may one day briefly want the second. This switch interrupts the circuit that activates the solenoid at the rear of the coach that connects the batteries. As long as the switch is off, the batteries will never be connected. If the switch were "on", the two electrical systems could be connected and I could then use the boost switch.

There is also the potential that if one or the other of my alternators fails, I could turn on the switch and run both the vehicle and house with the other alternator. It's kind of like a weird backup alternator. I don't know if I'd ever do that unless it was a huge emergency, but it's interesting to think about. Realistically, what I'll probably do is put some sort of [covered missile-launcher-style switch](#) there instead so we never accidentally turn it on.

The Electric Travato in Daily Use

So when you hook all this stuff up, how does it run, day to day? In a word, fantastic! In normal use, you really never need to pay much attention to things, so if you've been overwhelmed reading this far, never fear. About the only thing you really need to know is which button to push to turn the inverter on and off. I've taught Stef which one it is, so life is good.



The new inverter has the Stef Seal of Approval

We've tried things like running the rear air conditioner while driving. That works just fine, and we're still charging the battery when we do. The one problem we did encounter was traveling across Montana in 100+ degree heat. After running the rear AC from the inverter for a few hours, it got pretty hot cooped up in its little cabinet. Eventually, it shut itself down. But five minutes later, it turned back on again and everything was humming along. It was a pretty graceful recovery in my opinion. I'm considering some sort of venting for that cabinet – but it's not a high priority since it only happened one time under extreme conditions.

I've run the inverter all day while I worked and Stef drove. No problems encountered, and I have no concerns about running the inverter hard for extended periods.

We've run the microwave and the air conditioner at the same time from the inverter, and that worked just fine, too. In the event we ever really did start using lots of juice, the EMS built into the coach by Winnebago would shut something down before we got into trouble, if the inverter itself didn't stop the foolishness first.

I did weigh the RV before and after. There was not much change. Here we are "before". But remember, I already had a smaller inverter installed.

90462134
TICKET NUMBER

CAT SCALE
CERTIFIED AUTOMATED TRUCK SCALE

CAT SCALE COMPANY
P.O. BOX 630
WALCOTT, IA 52773
(563) 284-6263
www.catscale.com

SCALE LOCATION: 1515
PUBLIC WEIGHMASTERS CERTIFICATE OF WEIGHT & MEASURE

DATE: 5-13-2016

STEER AXLE	3780 lb
DRIVE AXLE	4280 lb
TRAILER AXLE	00 lb
* GROSS WEIGHT	8060 lb

WEIGHMASTER OR WEAVER SIGNATURE: *Debra Xantus*

WEIGH NUMBER: 2134
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And here's the weight after. 20 pounds lighter overall, and some of that weight shifted forward a bit.

90263933
TICKET NUMBER

CAT SCALE
CERTIFIED AUTOMATED TRUCK SCALE

CAT SCALE COMPANY
P.O. BOX 630
WALCOTT, IA 52773
(563) 284-6263
www.catscale.com

SCALE LOCATION: 1535
PUBLIC WEIGHMASTERS CERTIFICATE OF WEIGHT & MEASURE

DATE: 7-12-2016

STEER AXLE	3880 lb
DRIVE AXLE	4160 lb
TRAILER AXLE	00 lb
* GROSS WEIGHT	8040 lb

WEIGHMASTER OR WEAVER SIGNATURE: *After Xantus*

WEIGH NUMBER: 3933
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In the big scheme of things – that's not much of a change, weight wise. We lost the generator, converter, transfer switch, and two AGM batteries. We added a big battery, a larger inverter, and quite a bit of 4/0 cabling. I would have thought the weight would have changed more.

As far as charging, without paying much attention to it, the batteries stay pretty close to full the entire time we use the rig. The combination of solar and driving keeps us pretty topped off. So I'm well on my way to meeting that "don't pay much attention to it" goal. And I think Stef's already there.

Some Actual Testing Results

All right, all right. What fun would it be if I didn't share some real numbers and results? The litmus test of this whole thing is "how long can it run the air conditioner?" So let me get this out of the way.

3 hours and 19 minutes.

Here are the particulars of the test:

- Outside Temperature: 88-82 degrees
- AC Run Time: 3 hours 19 minutes (Some cycling of AC in second hour and after. But never less than 80% duty cycle even in those hours.)
- During this time, 2.6 Amp-Hours were contributed by the Zamp solar system. (I had parked in the shade to keep that to a minimum.)
- Ending event: Lithionics BMS shutdown. The coach went completely dark.
- Voltage was 11.87 Volts according to the Victron monitor approximately 10 minutes before shutdown. I didn't catch it right at shutdown.
- Amp-Hours extracted: Greater than the 377 AH drawn from battery according to Victron monitor approximately 10 minutes before shutdown.

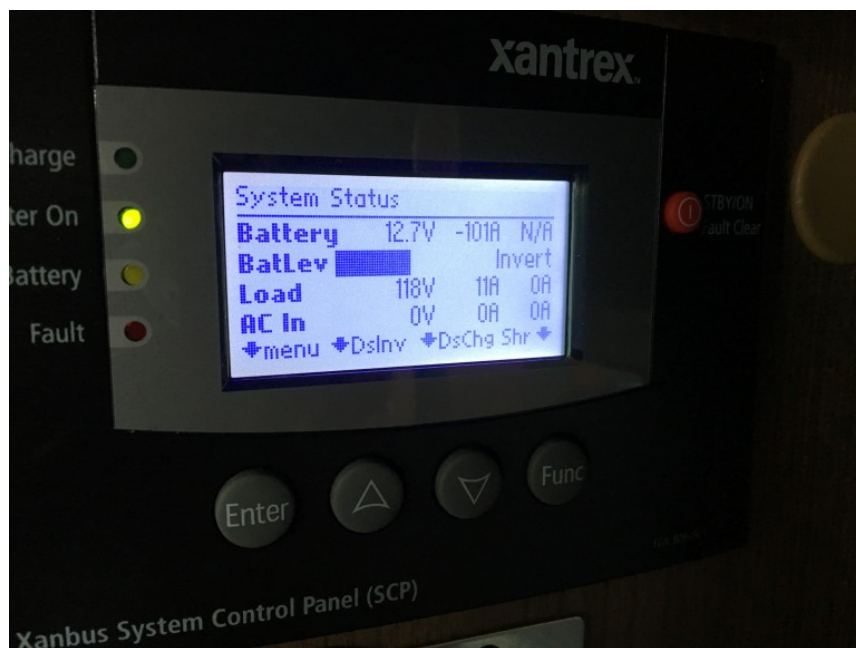
So basically, the BMS called the show over with just less than 10% of charge remaining, as expected. I'd like to be able to say I was surprised about something here, but everything worked exactly as advertised.

Restarting the coach from that dark state was very simple. I plugged in the coach. Everything is still dark at that point, because with the battery off, the inverter/charger didn't recognize that there was anything to charge. Then a quick press of the reset button, and everything lit up and the battery started charging. It's a good thing that the BMS leaves itself a little room to restart on shutdown. I suppose I could have attempted the startup with the engine and second alternator running instead, if shore power was not available.

During this test, the Victron battery monitor was *very accurate* as it counted down, both in time remaining and in percentage. Both of those hit zero just before the shutdown event. And it alarmed at 10% of usable capacity remaining just as programmed. If I hadn't been determined to see how far I could go, I would have applied some charging when that alarm went off.

But besides that one test, here are some other data points for those who want to know.

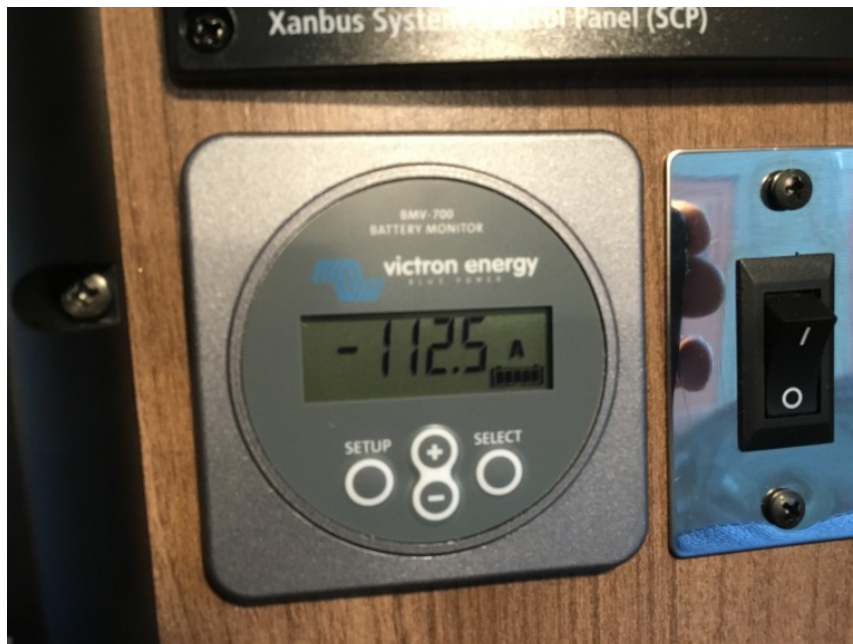
The Coleman Mach 10, running through the Xantrex inverter, burns 11amps AC, which translates to 101 amps DC, according to the Xantrex Control Panel. I would have said 102 ((118 x 11)/12.7), but whatever.



When I took this picture, the Zamp solar charge system was contributing about 1.0 amps. (Again, parked in the shade.)

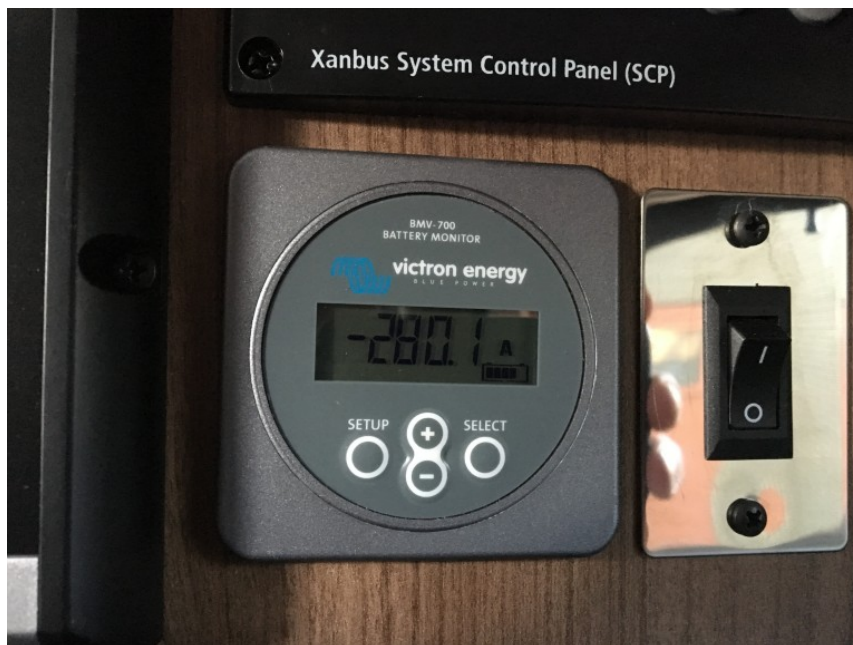


The battery monitor at this moment was showing 112.5 amps going out of the battery



So with a little math, we can calculate: Amps out of the battery + Amps Contributed by Solar – Inverter Output – 2.5 amps for lights, etc = losses. $112.5 + 1 - 101 - 2.5$. I come up with 10 amps of losses when running the AC. With just the inverter on and no AC running, it uses about 3.8 amps. So all that means, it would seem, is that the system is *over 90% efficient*. Xantrex only claims 90%, so it seems they're actually better than they claim.

I've mentioned that we've run the microwave and AC with no problems. But just to see how far I could push it, while the air was on, I plugged in an *1800 watt* induction cooktop and turned it up to 10. Besides boiling water in 90 seconds, I got a peak of 280.1 amps being drawn down from the batteries!



That's a crap-ton of juice. All the other loads are minor compared to the air conditioner and that cooktop, and I've [already written a post where I explore the other 12 volt loads](#) in the coach, so that's as far as I'm going on the load side for now.

On the charging side, when the Xantrex is plugged in, it delivers its programmed 100 amps to charge the battery.



OK. OR, 101.3 amps. Slightly weird, but whatever.

With the Xantrex unplugged, and the alternator running at idle, I get 172.6 amps in.



That's not quite the 280 amps at idle in the brochure, but it's pretty darn good.

And if I rev up to 2000 rpm, we get this for a charge from the second alternator:



And finally, if I need to charge the batteries in a big hurry, I can always power the Xantrex charger *and* run the engine. When stacking this way, at idle, I get a pretty substantial charge of 234 amps from the two combined. If I rev the engine, the charge seems to peak at about 250 amps, and it won't easily go higher. I suspect there's a limit somewhere of a 250 amp charge rate, though I don't know exactly where that's coming from. Perhaps the BMS. I don't know that I'd ever really NEED to charge things that quickly, but it's cool that I can. This would charge the batteries in about an hour and a half-ish I guess.

Next Steps

Well, it's an RV, so it's never really "done". So what do I plan to do now? Well, the first thing I intend to do is something with this:



This is a **True Induction cooktop**. It's the same kind Winnebago uses in some of their coaches. We're going to have a "boil-off" of sorts, and assuming the induction cooktop wins as we expect, I'll be mounting it up in place of the propane cooktop. Stef and I rarely use more than one burner at a time, so I doubt we'll miss the second burner.

This cooktop is rated at 1800 Watts. That's actually a larger load than the air conditioner if we crank it all the way up, as I did in this testing. It's still well within the capabilities of the Xantrex inverter, so I'm not worried there. That will leave just the Truma (which is staying, for sure) and refrigerator (hmmmm... maybe...) as consumers of propane on board. Propane capacity is the limiting factor on our winter camping now, so every little bit should help.

The other thing I really want to do is to rig up something to protect the second alternator. As you can see, it sits sort of low up front:



I'm a bit worried that I may pull into a parking space with one of those cement curbs in front of it and whack it. Either that, or run over a tire snake on the freeway or any number of careless scenarios that would have me damaging the very precious second alternator. As cool as Lance's nose ring is, I think I may have to swap it out for something more substantial that hangs a bit lower.



I'm also not too crazy about the plastic splash guard under there. I do want something there to protect from spray and particularly salt in the winter, but I'm not sure that piece of plastic is it. I also wonder what the plastic is doing to airflow around that alternator. More research needed here.

Anyway – now you know what I know. The generator's out, and we don't miss it, so we met objective one. And now that I've written this post, I'm even further down the road on the "don't think about it" objective. Thanks for reading!

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James

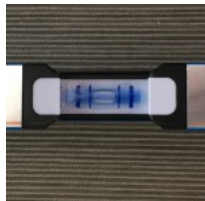
James is a former rocket scientist, a USA Cycling certified coach, and lifelong fitness buff. When he's not driving the RV, or modifying the RV (or - that one time - doing both at once), you can find him racing bicycles, or building furniture, or making music. In his spare time, he's also an IT consultant.

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65 thoughts on "Our Generator-Free RV - Lithium Battery, Solar, Alternator, and Inverter"

1. Larry

November 14, 2016 at 3:37 am

Just curious if you purchased the Bluetooth Dongle for the Viltron Battery Monitor, or decided to monitor what you needed to directly from the monitor?

Reply ↓

1. James - Post author

November 14, 2016 at 8:43 am

No Bluetooth. We're talking a Class B here. It's never more than 8 feet to the monitor, which is in plain sight.
I think the Bluetooth might be good if everything was mounted away in a storage compartment or something.

Reply ↓

2. John Bennett

November 9, 2016 at 8:28 pm

Hello, enjoy your videos and blog.

Based on your experience with the manufacturer, can you advise if the Travoto line will soon be available from the factory with modifications similar to those you have made to your van?

This would be something long the lines of Etrek by Roadtrek.

It seems there is a great deal of consumer interest in units that offer the maximum live-ability while "boondocking".

Thanks,

John

Reply ↓

1. James - Post author

November 10, 2016 at 11:03 am

I obviously don't speak officially for Winnebago. But I can say that they are interested in and looking at this kind of technology. And they're aware of the market interest.

Exactly when, and in what rig the technology might show up is something only they can say for sure.

Reply ↓

3. Steve

November 9, 2016 at 11:03 am

Great info (and cautionary tale), James! We are in the early stages of planning a DIY Sprinter conversion. I am also thinking lithium and a second alternator. You mention your system "kills" the alternator when the battery is charged. Is that done via an alternator clutch?

Reply ↓

1. James - Post author

November 9, 2016 at 3:44 pm

I don't actually know how it does it. There is a field control circuit on the battery, which communicates with the Balmar charge regulator. We didn't install any mechanical parts like a clutch – though I suppose that could have been part of the alternator as shipped from the manufacturer.

Reply ↓

4. Reid

November 6, 2016 at 1:26 pm

Hi James. Excellent writeup and it really covered the bulk of the questions I have, except for one. Now that you've experienced the lithium, and presumably feel more comfortable with it, would you do solar again if you were starting from scratch? We have a Sprinter 4x4 144WB on order and Sportsmobile is doing the conversion (with lithium). Generally speaking, it'll be about the same setup as what you have. Our difference is that we don't have the need to run the AC that long without idling the van. We have a ton of outdoor gear, and with space already being a premium inside the van (full shower, Espare D5, lithium bat, etc), our need for roof space is going to be pretty high. With how fast the van recharges the batteries, would you ever consider just purchasing more battery capacity and skipping solar all together? SMB indicated it might be wise to have solar purely for resale, but we really need that space. And, long-term I just don't see the need for solar with the charge profiles lithium batteries can take when you have two alternators. Short of the long backpacking trips where we want the fridge going the whole time, I can't really see the need to have solar with such good amps coming from the alternator. Wasn't sure if you

had some feedback or thoughts on that. The benefits of not having solar would be more roof space, less complexity, and that investment could be put towards more AH. Long-term, even an auto start that runs the van to could be used for situations like that.

[Reply ↓](#)

1. James - Post author

November 6, 2016 at 7:03 pm

Well, the solar really isn't all that expensive, so it's nice extra insurance. But I get your point. A good rule of thumb for solar is that you can expect 30 Amp Hours of energy per 100 Watt panel per day in ideal conditions. So, from our three panels, we could expect 90 AH per day. But conditions are never really ideal, so it will always be less.

Running the engine at idle can generate up to 170 Amps of charging from the second alternator. So another way to look at it is that running the engine for a half an hour or so can produce more stored energy than all day of perfect solar generation. Kinda makes you wonder...

So, I'd suggest you look at your usage profile. If you want to sit for a few days and not run the engine at all, then solar (and conservation) is the way to go. If you envision yourself driving most days, then the solar may not be as important.

Us – we wanted all options available to us, so we have the solar.

[Reply ↓](#)

5. Allan Kirch

October 24, 2016 at 5:06 pm

Thanks for this great article. It rolled around in my mind for a while, and I have a question. Love the idea using the engine alternator as a replacement for the generator. Obviously the standard alternator charges the engine battery. Is it possible to also electrically route some of the output of the alternator to the solar controller and make use of it's built in charging cycle for lithium batteries? Might that eliminate the need for a second alternator?

[Reply ↓](#)

1. James - Post author

October 24, 2016 at 5:50 pm

Interesting idea, but I don't know of any solar charge controllers that are built to handle that. The alternator could hit it with a lot of amps, and at a particular voltage. I'm not saying it would never work, but you'd really want to do your homework with the manufacturer of the charge controller.

[Reply ↓](#)

6. t jones

October 19, 2016 at 3:44 pm

Very interesting write up. Thank-you

Question 1. You have installed a control wire back to the alternator to shut it off when the batteries are full. What happens with your solar panels? They will continue to charge?

Question 2. When you discharged your battery to 10% it shut off. When you plugged into shore power the coach was still dark until you pressed the reset. You removed the 120v / 12v converter? Did you leave the 120V system alone? Are you still able to use 30amp shore power?

Enjoy your web page.

[Reply ↓](#)

7. mike

October 6, 2016 at 12:04 pm

Mike M.

As an auto technician I would look into modifying or adding an adjustable Potentiometer to raise the RPM at idle. Actually simple modification as you can use OE connectors in between the potentiometer too keep warranty in effect. Just remove before a major service or warranty repair. As without research on your diesel Travato I would say it is a fly by wire setup. As your an engineer so I know you could do it. Plus with your skills I am sure you would make it top notch.

If it is manual cable then even an old style of wire setup used for cruise control and vacuum would also work to adjust the throttle through the gas pedal linkage.

If all else fails get a piece of wood that keeps that RPM higher at the gas pedal. But I know that's not your style.

Just ideas as seeing a 25% loss of Amps or more would drive me crazy as think of all that lost fuel. Maybe that will get your OCD cooking.

Great articles as my wife enjoys them too as been watching for over 2 years now. THank YoU

[Reply ↓](#)

1. James - Post author

October 6, 2016 at 11:08 pm

Yeah, the "piece of wood on the accelerator"... not my style. lol!

To date though, we've actually NEVER run the engine just to charge the batteries, so the extra amps on the table hasn't been much of an issue.

Our batteries have always stayed pretty close to full just from our normal driving and the solar panels.

We're at the tail end of a 3+ week road trip, and we've had ZERO issues with the setup. We're totally happy with it so far.

[Reply ↓](#)

8. Mike Neal

October 2, 2016 at 9:37 pm

Great website you two have!

Any concerns about fire if there is a short in that powerful battery?

With your skills, why did you choose to not start with a bare van body and build the RV yourself?

Thanks for the education both of you provide!

Mike

[Reply ↓](#)

1. James - Post author

October 3, 2016 at 1:53 pm

I could have built my own, but finding the time to do so (and to do practically nothing else) would have been problematic.

Plus, the Travato offers a good value for the money. That made the decision easier.

As far as fire danger – I'm not too worried. The battery itself has safeguards built in, and I've double and triple-checked all the high-amp connections for tightness. I do pay extra attention now when I work in areas around the battery cables though...

[Reply ↓](#)

9. Dan Morean

September 28, 2016 at 7:43 pm

Stick a Tesla battery under the floor...that'll power ya up!

[Reply ↓](#)

1. James - Post author

September 30, 2016 at 12:19 am

I know they were going to start selling a wall-mount battery for solar installations. Do they sell their regular automotive batteries?

[Reply ↓](#)

10. Ben

September 21, 2016 at 7:42 pm

Hi James, great post as usual. I was wondering, come winter in freezing temperatures with this set-up you have now will you be able to recharge the lithium batteries? Many read I find indicates

either you can't recharge below 32F or only charge at 0.02 which could take days to get the batteries full. Do you plan to wrap the batteries with blanket heater ?

[Reply ↓](#)

1. James - Post author

September 21, 2016 at 10:46 pm

Recharging the lithium battery will be no problem. It's inside! I don't plan on keeping the inside of our RV below 32 degrees. At least not while we're camping in it. 😊

[Reply ↓](#)

11. Reid Rechel

September 15, 2016 at 8:41 am

Question for you. Did you ever consider a soft-start for the AC unit so you could get by with a smaller inverter? We've got a Sprinter 4x4 on order with Sportsmobile doing the conversion, and your spec is essentially what we're wanting to do. Dometic has a soft-start for their Penguin II AC unit (almost same specs as your Coleman) that brings down the locked-rotor amps to mid 30's. I believe other manufacturers have something similar. May not have enough residual power for both the AC and induction cooker, though.

We'll have a 2nd alternator, same lithionics battery, same victor monitor, etc – so it's great to see some actual numbers, especially in regards to idle performance from the alternator. We ordered the sprinter with the adjustable high-idle option, so I'm happy to see you're getting close to rated power from the alternator when above idle. We're thinking of just having a single 100 watt panel for solar to keep the battery up a bit with the fridge in the summer while we're backpacking. Otherwise, we'll idle the van as needed. If you had to start from scratch with this lithium setup, would you still have gone with 300 watts of solar?

[Reply ↓](#)

1. James - Post author

September 15, 2016 at 9:14 am

If I were to do it over again, I'd probably still put 300 watts of solar up there. Just because I have the room, and don't need the roof space for anything else. It's nice to always have full batteries.

We never considered a soft-start for the AC. The folks from Xantrex assured us that their inverter could slap the AC hard enough to start it, and they've been absolutely right. We used to have a Penguin II on our last RV and loved it. If you can get the soft-start built in from the factory, that would be a nice way to go.

[Reply ↓](#)

12. Bob Dory

September 11, 2016 at 4:41 pm

Great write up as usual. Might be more than I need for the reasons you stated: don't need to run A/c off battery. I would like to know whether you are happy with the 300 watts of solar for normal non-A/C use? I have a K model and I'm planning my upgrade project now but I need a real target wattage to support the fridg , tv, 12v devices etc. I'm thinking approx. 300 but you are the only one I know who has actually lived with 300 for while. Any advice? Thanks Bob

[Reply ↓](#)

1. James - Post author

September 11, 2016 at 5:48 pm

300 Watts is, realistically, more than enough for a standard-issue Travato. When we were actually out and using the RV, except for first thing in the morning, it seemed the batteries were never less than completely full. 200 watts would likely be enough – that'd be my guess.

[Reply ↓](#)

13. Kim Garrett

September 3, 2016 at 10:32 pm

Hi. I'm the girl (well I'm 45) planning on dry-camping NYC streets in a class B for a year to save rent and pay down grad school loans.

My major concern is not killing my small dog while I'm in the hospital during my 8-12 hour shifts. If it goes below zero maybe 10 days out of the winter, and goes above 100 the same (about 10 days), The remaining days are more manageable with temperature, I'm think. I can also street park near the hospital to check on the dog as needed.

Am I nuts? Please share your thoughts.

I too am an outdoor enthusiast. I will be taking frequent trips biking and skiing. I also live in SLC (Sugarhouse), but currently I am retng while in NYC for school.

Reply ↓

1. James - Post author

September 4, 2016 at 10:34 am

The winter would be fine. RV heaters can be relatively quiet. If you get a model with a Truma heater, better still.

Summer will be a problem. To run an air conditioner for 10 hours straight, you will need to either plug in, or run the generator. The generators are loud.

I don't know how the police in NYC are, but that seems likely to draw attention.

Reply ↓

2. Juan

September 8, 2016 at 12:15 pm

Kim Garrett , we must both be crazy as I have the same idea. In my case I want to cut down on commuting every day(NJ to NY) and "work camp" 2-3 nights a week.

Reply ↓

14. Georges Labrecque

September 1, 2016 at 6:47 am

This is Everything I wanted to know about Power ...but was afraid to try!

Thanks for sharing your courageous overhaul of Lance's power plant. No wonder rocket-scientists are always at the forefront of innovation!

And it works!

The second alternator/engine generator seems like the most valuable new element in the system. Some manufacturers will now be offering it in their standard configuration. It's logical for "motorhomes" to take advantage of the quiet and powerful engine and fuel source they already have. Apart from finding a way to protect the alternator with a new housing (custom roto-molded ABS (<http://www.customroto.com> ?) with a steel protection bar?) it looks like a winning combination with the Xantrex Inverter/ Lithionics Battery/ Nations Alternator with the Balmar controller.

Congrats to the Fit RV team! You know how to present information in simple terms and make it accessible to technological neophytes.

Reply ↓

1. James - Post author

September 1, 2016 at 10:24 pm

Glad you liked the write-up, George!

I'm intrigued by the custom roto molding, but building a mold would probably be prohibitively expensive for a one-off.

Steel bar seems a more likely route, but I'm still figuring it out.

Reply ↓

15. Johnny

August 31, 2016 at 7:01 am

Gee ! Everything you did comes from the factory on a Zion. Might have been easier to just have traded it in. At least in a Zion everything was designed from the ground up and should be mostly

problem free.

Reply ↓

1. James - Post author

August 31, 2016 at 9:44 am

Yeah, but:

- 1.) Mine works! 😊
- 2.) The Zion floor plan is completely unacceptable for us.
- 3.) The folks from Winnebago and Xantrex have been fantastic to deal with.
- 4.) Our rig has indoor plumbing, and is winter proof.
- 5.) My craftsmanship is better.

Reply ↓

16. Drew

August 29, 2016 at 11:57 am

What an animal you are James....running your induction cook top while the gen is on. I would have put on a face shield just in case. About the alternator- when your mishap occurred shortly after the install I was sure you were going to mention that you had run into rain or drove through puddles just before it happened. That thing looks perilously close to the ground- skid shield or not.

Reply ↓

1. James - Post author

August 29, 2016 at 3:27 pm

Welding mask!

I wonder about the splash aspect, but I mean... surely they've thought of that, right?

Reply ↓

17. Ed Rudder

August 26, 2016 at 1:26 pm

Excellent project for RV's of all types. As we continue to enjoy our 2016 Era, I see this as a similar project in 2017... There will always be the pioneers who show others the way.... Thank you for all you do!

Reply ↓

18. Tom

August 25, 2016 at 6:39 pm

Fascinating stuff. Hoping that someday you try out a compressor refrigerator.

A decidedly low-tech question: does removing the generator create enough room underneath for a spare tire?

Reply ↓

1. James - Post author

August 26, 2016 at 8:22 am

We had a compressor refrigerator in Das Bus. We're already sold. Loved it. Miss it. (The compressor, not the size... it was tiny!) I think ten years from now, absorption fridges in RVs will be museum pieces. Can't wait.

As far as the spare tire, I haven't tried it, but I think there's *almost* enough room now. You might have to move or remove some other things to get it working. I see a few mounting holes, but I don't see any remnants of a winch system or anything. And I think you'd have to move the solenoid and relays in the box toward the rear as well.

Reply ↓

19. Jesus Garza

August 24, 2016 at 7:55 pm

Full retail price and labor? Beta tester? I would of definitely done the install differently.

Reply ↓

1. James - Post author

August 25, 2016 at 8:36 am

It's not available as a "system". At least not yet. But prices for the individual components are available online. I believe I've linked to them all.

It did run about \$800 to have the alternator installed. It was a whole day of labor, so that may depend on what your local Ram service rates are. If they were to install a second one, it would take them a lot less time.

Reply ↓

20. Alain

August 24, 2016 at 6:31 pm

I plan on using an induction cooktop like you, but I think I will just find a way to attach it to the propane cooktop cover, so it wont move in transportations. The induction cooktop is not very thick and the usable space saving by imbedding it in the place of the propane cooktop will probably not be that great. Especially since you will be keeping the propane anyway for the Trauma. It's good to have the backup. Also, by keeping the induction cooktop mobile, its easy to cook outside.

And if you're really looking into optimizing your electrical autonomy, look into pressure cooker cooking. Small water quantity to heat + shorter cooking time + induction efficiency give a big win-win.

But I have yet to find a way to make good "camping toast" (burnt on the outside, uncooked in the middle) on the induction cooktop...LOL

Reply ↓

1. James - Post author

August 25, 2016 at 8:38 am

Right now it's just sitting on the propane one as you describe. It doesn't move much. Cooking outside is an interesting idea. I think we'll take a trip with it like it is now and see if we're motivated to cook outside with it. (But we're pretty lazy, so I don't know.) Depth of the cooktop and the propane one are similar. By mounting it, we don't have to store it, so there's that...

Reply ↓

1. Alain

August 25, 2016 at 8:00 pm

I notice a small spark when I pull the plug on my induction cooktop even if it is off, which leads me to believe there is a constant small current draw even when off. If you mount it you might still want to have access to pull the plug (or put a switch) if that current is significant in the long run.

2. James - Post author

August 26, 2016 at 8:26 am

Interesting. There is a light that stays on, even if it's not on. We hope to have our "boil off" this weekend. I can test the current draw then. For us though, unless that draw is huge, it won't be a big issue. We don't leave the inverter on all the time – only when we're actively using 120 volt appliances.

21. Steve Bartolucci

August 24, 2016 at 5:37 pm

James,
Exceptional write-up and detail. Thank you for revealing all of the behind-the-scenes issues and

solutions!

Have you considered some sort of “high idle switch,” that would allow you to hold that 2000 RPM engine speed without having to sit there with your foot getting numb? I think that would be a great feature, even for the mostly-stock RV.

Also, on the need for a “Skid Plate,” that does not have to be metal, and can be fabricated from high-impact thermoplastic (ABS, for example) and heat-bent easily to keep it snug to the chassis. It would not increase weight that much, depending upon the overall size you select.

GREAT WORK!!

[Reply ↓](#)

1. James - Post author

August 25, 2016 at 8:41 am

If it were a factory option, I might install a high idle switch. But honestly, I don't think we'll need it. An extra 50 amps of charging on top of 170 already isn't terribly motivating. I'm not set on any particular material for a skid plate. I'd be open to plastic. Someone at WGO suggested UHMW. I can't fabricate either myself, so it's a hire-out job either way.

[Reply ↓](#)

22. Tom Cahill

August 24, 2016 at 11:11 am

I'm sorry if I missed it but it in the post but is there a cost figure for this? And, what was the original cost of your generator? I'm trying to get an idea if I skipped a generator and just had this installed what the cost difference would be.

[Reply ↓](#)

1. James - Post author

August 24, 2016 at 11:28 am

I didn't include a cost figure for this, because it's not currently available as a complete “system”. You'd need to source the components yourself – prices and suppliers are online and I've linked to them.

As far as the Travato generator, as of right now, it's not “optional” or something you could delete. I don't know if that will change in the future.

[Reply ↓](#)

23. Mike Neundorfer

August 24, 2016 at 6:25 am

James; Thanks for your power work and write up and for mentioning the work done by ARV on Lithium powered Class B motor homes. I learned from your experience and power blog. We are on our 4th major design improvement in lithium battery/engine alternator systems installed in over 50 ARV custom Sprinter coaches. There is always more to learn and improvements to be made as technology improves. I look forward to further discussions with you about your power project so we can learn and push the technology forward together. We have installed Xantrex inverters and have also experienced excellent support for a well designed inverter.

[Reply ↓](#)

1. James - Post author

August 24, 2016 at 7:59 am

Thanks, Mike! It's always a treat to visit your facility and see what improvements you guys are up to. Here's to the next chapter!

[Reply ↓](#)

24. James

August 23, 2016 at 6:55 pm

Why not add a circuit to the inverter that puts a 120v a/c charge to Lance's skin as a bear defense?

If the inverter can be bridged you could put 220-240v.

I have done similar with a 1farad capacitor with 12v d/c. The results were a very effective anti-theft system.

[Reply ↓](#)

25. Wayne

August 23, 2016 at 6:36 am

Another great write up James! For an engineer (I'm a Civil) your write ups are better than a novel! I would share your concerns about the exposure of the second alternator. It could be a critical point of failure should it be damaged. Some sort of steel skid plate in place of the plastic splash guard comes to mind, but that might further reduce ground clearance. I see that lift kits are available for the ProMaster. Would that be an option? Or would the resultant rise in C.G cause handling issues? I'm sure you'll come up with some sort of imaginative solution. Can't wait to read about it! Thanks for a great read!

[Reply ↓](#)

1. James - Post author

August 23, 2016 at 9:46 am

Well, as far as a lift kit – I can't see how you could raise the rear axle with one – and that's really the low point in back. Raising the front might help a little though.

[Reply ↓](#)

26. Carl

August 22, 2016 at 7:43 pm

I know you like the engineering challenges of it all. Why didn't you buy a Roadtrek Zion and it would all have been done for you?

[Reply ↓](#)

1. Matt

August 23, 2016 at 6:16 am

I would guess floor plan and price. I really want to like the Zion, but I really can't get around the floor plan.

[Reply ↓](#)

1. Richard

August 23, 2016 at 7:37 am

And, he probably wanted his to actually work!

2. James - Post author

August 23, 2016 at 9:36 am

LOL!
And, the floor plan in the Zion would so *never* work for us either.

27. Marian

August 22, 2016 at 7:16 pm

Ok how realistic is this for a person that is just a regular person with no mechanical abilities? Is it expensive. If I were to buy for example a Travato or class C that comes with a generator what would it entail to convert or would they just leave off the generator and parts I do not need? What if I buy a used one? Or do I have to by certain motor homes? It does not sound like you can just

buy a kit and drop it in and off you go. It sounds like a lot of things can be done wrong. Also do you know anything about the Tesla Powerwall battery pack you can just hang on the wall? Thanks for all the great research and information. Marian

[Reply ↓](#)

1. James - Post author

August 23, 2016 at 9:40 am

Well, if you have no mechanical abilities, this is definitely a project you want nothing to do with. The installs are difficult, time consuming, and require some background to make sure you don't create an unsafe situation.

HOWEVER – if you're asking from the point of an end user – this is an extremely friendly system from that perspective. Stef is completely fine with it.

Don't know much about the Tesla product. I'm sure it's top-shelf though. As far as RV manufacturers adding this for you – you'd be best to go with an Advanced-RV. They've been doing similar systems for quite a while now.

[Reply ↓](#)

28. Jonathan Miller

August 22, 2016 at 7:05 pm

This is an awesome write up...almost too detailed and I'm an aerospace engineer as well.

But two things I don't understand is why all RVs don't come optioned with integrated electrical systems instead of those antiquated generators. And second I don't understand folks that never use their generators. You must either always be in a campsite with full hookups or camp in moderate climates or both. In my experience I run my generator all the time to feed the a/c unit as I'm driving or dry camping or both.

Over three hours of battery powered a/c is good but my goal would be to run it all night off batteries. It scares me but I have slept with the generator running. In hot climate you don't have much choice. With some help I think I could build an integrated system but it's not cheap. Thanks.

[Reply ↓](#)

1. James - Post author

August 23, 2016 at 9:51 am

In time, I think we'll see RV generators play less and less of a role in smaller RVs. There will probably always be a place for them in the larger, stay-in-one-place rigs.

As far as our generator use: We like to travel more in the spring, fall, and winter. Summers are hot and crowded everywhere. I mean, yes, we do travel in the summer, But we're more likely to head north at those times.

As far as getting more than three hours running the air, I think this system would certainly do it. All you need is additional battery capacity. 1200 amp-hours should get you 8 hours (roughly). Finding space for the batteries is the only remaining concern.

[Reply ↓](#)

29. Matt

August 22, 2016 at 1:01 pm

Amazing work!! This is a top notch setup you've got there.

[Reply ↓](#)

30. Gary

August 22, 2016 at 12:37 pm

1) Great writeup. I love these deep dives of James' and recognize the work that goes into them. Thank you.

2) Great news in those results. When I asked the local BAD (big something dealer) shop about retrofitting a unit to run the air conditioner off of battery, they literally swore that it was impossible. I was so insulted by the way the salesman spoke to me that I reported him to national headquarters.

3) Love the shout out to Advanced RVs. Those guys seriously impress me on a regular basis. I only wish it didn't take a year to get one made at AR; but then it is their personalized approach and small shop environment that contributes to their greatness.

4) Stef, how many times did you doze off while proof reading this for James?

Reply ↓

1. James - Post author

August 23, 2016 at 9:52 am

Hearing "impossible" would bug me as well.
Maybe you should go back to the dealer and refer them to this post!
(and Stef didn't doze off, but she did edit in shifts...)

Reply ↓

1. Gary

August 24, 2016 at 7:19 am

I'll bet, like me, "that's impossible" is to you as "sick em" is to a dog. In fact, I did refer them to your review of the Advanced RV rig.

31. juan

August 21, 2016 at 11:43 am

Hello James Great write up . You answered my first question which is can this setup handle an induction cook top. I was also curious as to whether or not it can run the Truma combi system (I get the feeling you are going to find out sometime in the near future!). One day when I get my Van I would like to go all electric(not a big fan of propane or the loud generators)I am interested in the 59K so the Fridge is already electric .

On a side note do you have any plans for the space gained by ditching the generator? I read that Roadtrek has an air conditioner that is mounted under the van, I believe it was on the CS, No roof top AC more room for solar panels oh yeah baby!

Reply ↓

1. James - Post author

August 22, 2016 at 9:06 am

Don't know if you caught it, but it can run the induction cooktop WHILE also running the air conditioner!
Running the Truma would be interesting, but not really very efficient compared to propane. I'll try it, and I'm sure it will work, but I don't see wanting to run the batteries for that regularly.
I have no idea what to do with the extra space. It's not very accessible. I've thought of a below-decks storage hatch, which would be interesting. But other than that, haven't thought much about it.

Reply ↓

1. Alain

August 22, 2016 at 7:14 pm

The generator was the low clearance point according to one of your blogs, if I remember correctly, so I would have thought you would like to leave that space free with all the back roads you do.

Leave a Reply

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Comment



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