(Some) Truck Electrical Modifications For RV Use

Enhancing Your Truck Electrical Capabilities

Jack Mayer, 2013 Heavy Duty Truck Rally Jackdanmayer.com

Typical Modifications

- Shore Power aux outlets
- Inverter some trucks come with them
- Refrigeration 12 volt or 120 volt
- Battery Maintenance / Charging
- RV Trailer Light Support *Jackalopee*
- Battery Charging
- Adding a "House" Battery Bank to the Truck
- Miscellaneous Electrical: video, aux lighting

Ambitious Mod: move all *trailer* auxiliary power sources to the truck!

Truck Auxiliary Electrical

- Not really any different than RV Electrical systems.
- Generally smaller in size/capacity.
- Wiring practices and components are the same, for the most part.
- You can choose where your primary power sources reside – truck or trailer.....or, you can replicate them.
- Choosing the truck as the power "host" can complicate design, but has some advantages.



Truck Auxiliary Electrical System The *Complete* "House" System – NOT Chassis System





Jack Mayer

HDT Rally

Charge Sources Storage Charging - BatteryMinder

- Easiest way is with a hardwired trickle charger like a BatteryMinder
 - Wire directly to battery or distribution lugs
 - Power from shore power
 - Has desulfation mode
 - Model 12117 is adequate <u>http://batteryminders.com/details.php?prod=12117</u>
 - Model 12248 is shown. Higher output.
 http://batteryminders.com/details.php?prod=12248
- Dual banks: look at Genius <u>http://www.geniuschargers.com/GEN2</u>
- Wiring BatteryMinder
 - Make sure to power only when on shore power/genset
 - Wire source power before inverter
 - I usually wire in a shore power-only receptacle



Charge Sources Storage Charging - Solar

- Minimum 100 watt system recommended
- BatteryMinder has a smaller system, or can take up to 180 watts on their charger

http://www.batterystuff.com/solar-chargers/charge-controllers/bmscc180.html

- Mount panel on top of drom, or back of cab with tilt bracket
- Controller and fusing size and sophistication determine cost; \$45-500; BatteryMinder IS a controller
- Wire to distribution lugs can charge all the time
- Dual output controllers available if you have a house and chassis bank <u>http://www.batterystuff.com/solar-chargers/SSDuo-25RM.html</u>

Charge Sources Truck "House" Battery Bank

- Do you really need it? Starting bank is usable in most instances.
- How will you charge it?
 - Inverter/charger on shore power
 - Alternator charging needs additional equipment: simple relays/isolators are possible; "smart" relays are best.
 - Solar
- Instrumentation: Trimetric, around \$170.

2013

Charge Sources Alternator w/House Battery Bank

- Most truck alternators are 130 amp (about)
 - Adequate power available, but may not handle continuous service (heat)
- Need to "combine" battery banks for charging
 - Solenoid
 - Solenoid/diode (smart solenoid)
 - Isolator w/charging circuitry
 - "Smart" voltage regulators like the Balmar Max Charge
- Ample Power Autoswitch http://www.amplepower.com/products/autosw/
- Blue Sea ML-series relays

http://www.bluesea.com/products/category/Automatic Charging Relays/ML-ACRs http://www.bluesea.com/articles/69

• Hellroaring isolator - <u>http://www.hellroaring.com/bic75300.php</u>

2013



Truck Auxiliary Electrical System "House" System – NOT Chassis System



Hosting Your Power Systems in the Truck The Advantages

- All primary power sources including solar are on the truck
- House (or "hotel") battery bank in the truck
 - No weight issues
 - Must convert to AC to feed trailer
 - Lots of accessible power for truck
- Generator
 - Generally diesel unlimited capacity
 - Easy support of truck aux HVAC
- Inverter
 - Must be on truck, since battery bank is there
 - ONLY AC power is sent to trailer via inverter or generator
- The obvious issues....
 - How does trailer obtain 12-volt power?
 - What happens when truck is not "local" to the trailer?

2013

Hosting Your Power Systems in the Truck The Issues....

- How does trailer obtain 12-volt power?
 - Ship it over via heavy (2/0 or so...) cables and Anderson connectors.
 - Not really an acceptable solution: voltage drop, cost, complexity.
 - No availability when truck not present; trailer is "dead".
 - Use a converter only: not really practical; you need a battery too.
 - Small battery bank/converter supporting trailer only.
 - Recharge battery when boondocking/towing using AC from truck – which is inefficient but the simplest solution.

2013

• Supplement charging with solar - one panel on trailer.

Hosting Your Power Systems in the Truck The Issues....

- What happens when truck is not "local" to the trailer?
 - If boondocking, you are dependent on the minimal 12-volt system in the trailer.
 - BIG issue with a residential refrigerator
 - *Perhaps* viable for other systems for short periods...half day.
 - When on shore power, virtually no effect as long as you have power.....

Remember...the aux power systems are only for boondocking

Inverters For the Truck

- First: evaluate use; long term camping, overnight, charger? Simple "point of use" or wired in?
- Generally need less than 2000 watts, and MSW is usually OK
- Want a remote switch wire a reminder light or you will forget the inverter is on!
- For small inverters look at the Xantrex Xpower line; reliable and cheap
- For inverter/chargers I like the Tripp Lite series
- If you buy a \$150 Sam's Club "big inverter" (e.g., 3000 watts) expect issues. You get what you pay for.....

Instrumentation What Really Matters?

- Cumulative amphours into the battery bank (Magnum BMK, Trimetric, LinkPro, Blue Sky IPN ProRemote, etc) If you have a house bank – you want this.....
- Instant amp hour measure; power use *right now*
- DC Voltage
- AC line voltage/amps on truck only if large system
- Control Functions: Inverter off/on, charger off/on, Genset off/on

Lots more monitor functions are available, but the above are critical

Video Monitors / Cameras

- Most HDTs use at least a backup camera
- We use five cameras
 - Truck right side
 - Truck backup/high
 - Truck hitch
 - Trailer right side
 - Trailer backup
- Recommend 7" or 9" monitor with multiple inputs
- Or....7" dedicated right side truck, all others on 9" monitor

Video Monitors Wiring

- Bring it all together in the drivers storage compartment
- Route a single multi-line cable to the cab dash area
- Run all video feeds over this single cable
- Use a switch for extra connections

Video Monitors Diagram – One Possible Wiring





Jack Mayer

HDT Rally











Camera facing to rear for hitch up.

Camera facing forward to watch smart car.



Jack Mayer

HDT Rally

Magnetic ground block used to hold camera





HDT Rally





Completed camera stand



Jack Mayer



Jack Mayer

HDT Rally

Wiring

- Solar panels to combiner
 - #10 tray cable; individual "home runs"
- Combiner to solar controller
 - #4 welding wire
 - Probably #2 between controller and batteries
- Control wires: instrumentation-to-sensors
 - Generally telephone cable or cat5
- DC cables between inverter and battery bank
 - 2/0 or 4/0 welding cable; treated lugs; adhesive heat shrink
- AC wiring between inverter and AC loadcenter
 - You "should" use stranded wire in a mobile environment....but...RV's are all wired with romex-type wire
 - #6 conventional AC wire for 50A, #10 for 30A; use AC wiring techniques; tape wire nuts to wires (vibration)

Note: these size recommendations may not apply to a small installation in a truck. You need to size appropriate for the loads.

Wiring Techniques

- Coat wires with anti-oxidant before crimping
- Do not solder large lugs (arguable my opinion); if you do, use Fusion lugs
- DO solder any brake controller connections, and you can solder any small wires
- With wire nuts, tape them to the wires after twisting on (vibration issues)
- Use adhesive heat shrink, color coded; use colored tape if no colored heat shrink
- Use welding wire for battery/inverter connections; never less than 2/0
- Power posts upstream of shunt for all load connections
- Always install a DC fuse center, fed from power posts/bussbar; convenience
- In trucks: always isolate interface to truck electrical with relays
- Use a ratchet crimper on small lugs less than \$30 at auto stores; on large lugs hammer crimper will work IF used correctly
- Always use a catastrophe fuse near battery
- Battery cables: build to length, but leave slack (batteries change)
- If adding a subpanel for inverter circuits make sure to keep neutral and ground wires separate – NO BONDING

12-Volt Fuse Block

- Always use a fuse block for all added circuits.
- Supply from battery directly via distribution lugs
- IGNITION on vs. ALWAYS on
 - I use both via two fuse centers
 - Video cameras on the Ignition block
 - Use 30A relay controlled by trailer umbilical to trigger Ignition block
- I like the Blue Sea fuse centers



ST Blade Fuse Block - 12 Circuits with Negative Bus and Cover

Relays

- Use relays to control high power devices
 - Ignition fuse block
 - Lighting
 - Drom box 12-volt



- Regular auto relays are fine...order pigtails on Amazon.
- Put all your relays together in the drivers storage box if you can.

Parts Sources

- Power Posts, Blue Sea distribution centers, other marine components: <u>http://dogbytecomputer.com</u>
- Lugs, adhesive heat shrink, hammer crimpers, DC fuses/breakers, Trimetric, lota transfer switches, fuse blocks, distribution blocks, battery post connectors/extenders, Anderson connectors, misc. components: <u>http://solarseller.com/</u>
- Battery isolators/combiners, Solid state relays: <u>http://www.hellroaring.com/</u>

2013

Lighting

- Auxiliary backup
 - Mounting options: rear bumper insert, top of drom, side of cab faring
- Front HID/Projector/DRL
 - HIDs are tricky, depending on truck year and headlight assembly
 - Add-on projector lamps work well instead of HID
 - DRL LED strips are brighter than OEM
- Interior LED

Solar Modules So, How Many Do You Need?

- For the truck
 - Typically used only to charge while in storage
 - One panel is sufficient
 - BatteryMinder makes a charger/controller

2013

Solar Modules So, How Many Do You Need?

- Must do an energy audit at start of design process
 - Kill-a-watt meter
 - Appliance Electrical-plate calculation
 - Actual use with battery monitor
 - Category guidelines
- Typical users
 - Low end: under 75-100 amp hours
 - Mid: 100-130 amp hours
 - Energy hog: over 150 amp hours (we know people who use over 800)
- Most Rvers are in the Mid category
 - 400 amp hours of battery
 - 4x140 watt panels
- Battery Storage Estimate
 - One "rule of thumb" is bank size in amps is "about" as big as solar array size in watts.

Solar Charge Controllers

- Types
 - Shunt, or ON/OFF controllers; not really used anymore
 - PWM (pulse width modulation); rapidly "pulses" the power on/off holding battery voltage constant
 - MPPT (maximum power point tracking); extracts "extra" power from the solar array by using excess voltage to increase charge current

2013

Solar Charge Controllers What to Look For

- MPPT unless on budget
- Remote mount near batteries
- Remote panel is interesting and useful, especially with MPPT
- Always buy bigger than you need future expansion. Consider networked controllers
- Remote Temperature Sensor required feature
- Input/output voltage
 - MPPT controllers take in high voltage (up to 150 volts) and output lower voltage (down to 12-volt, depending)
- Charge stage set points user configurable esp. Bulk Stage
- Wire terminal input/output size (you *can* trim down wire size)

Solar Charge Controller/Panel Installation Considerations

- AM Solar has good panel mounting system worth the \$60; or build own out of aluminum
- If roof is solid use VHB Tape or 3M Fast Cure 5200 Marine adhesive
- Stainless 1" #10 or #12 screws only need 1 per leg embed in caulk puddle
- Attach wiring to roof with puddles of caulk; when dry overcoat puddle with more caulk
- Roof wiring #10 tray cable homerun to combiner box
- Combiner-to-controller use #4 welding wire; protect exposed wire on roof from UV
- Consider fusing individual panel runs at combiner input (debugging is easier)
- Use vent to run wire to basement area
- Put controller as close to battery bank as possible
- Use 14.8V as bulk charge for flooded cell batteries
- Use A/C (air conditioner) disconnect box for fusing IN/OUT of controller; or Midnight Solar "Baby" breaker box

Solar Charge Controller/Panel Installation Considerations

- AM Solar has good panel mounting system worth the \$60; or build own out of aluminum
- If roof is solid use VHB Tape or 3M Fast Cure 5200 Marine adhesive
- Stainless 1" #10 or #12 screws only need 1 per leg embed in caulk puddle
- Attach wiring to roof with puddles of caulk; when dry overcoat puddle with more caulk
- Roof wiring #10 tray cable homerun to combiner box
- Combiner-to-controller use #4 welding wire; protect exposed wire on roof from UV
- Consider fusing individual panel runs at combiner input (debugging is easier)
- Use vent to run wire to basement area
- Put controller as close to battery bank as possible
- Use 14.8V as bulk charge for flooded cell batteries
- Use A/C (air conditioner) disconnect box for fusing IN/OUT of controller; or Midnight Solar "Baby" breaker box



How do you effectively charge two battery banks?
Where do you put the second bank?
What type of batteries do you use?

Three Stage Charging



- **Bulk**: Current supplied at constant (max) rate while voltage rises to absorption setpoint; Often 14.2-14.6V; should be 14.8V for flooded cell
- Absorption: Voltage remains constant, while current is reduced as battery charges
- Float: After batteries reach charged state, voltage reduced and maintained. Usually 13.2-13.6V
- Good info at: http://www.batterystuff.com/kb/articles/battery-articles/

Battery Types

- RV batteries are Lead-acid (vs.. Lithium, NiCd, etc)
 - Flooded-cell (wet cell)
 - Sealed Flooded (maintenance free)
 - Gel (sealed) no longer used
 - AGM (sealed)
 - Lithium in near future
- Starting (SLI)
 - High starting current for short time
 - Thousands of low discharge cycles (10% discharge or less is typical)
 - Only capable of 30-50 deep cycles (50-80%)
- "Deep Cycle" (golf cart, L-16, etc.)
 - Thicker and heavier plates allow deeper discharge levels
 - Designed for "lots" of 50% or more discharges
 - Weigh much more than starting batteries

2013

Battery Characteristics

- Golf Cart
 - Last 3-5 years, sometimes as long as 8 years
 - Must be vented
 - Need to be monitored and "watered"
 - Charge at C/3 or C/4 (where C is the total Ah of the bank)
 - Cheap & readily available: \$65-125
- AGM
 - Last 4-7 years
 - Resist vibration better than golf cart
 - Do not outgas can be placed anywhere
 - Zero maintenance no attention at all (other than terminals)
 - Can be charged faster and at higher rate (C*4, or more)
 - Cost far more: 2-4 times as much

2013

Random Battery Stuff

- Check flooded cells water level every month
- Charge only with solar when you can; easier on the batteries no constant float
- Use proper size wires for interconnect; anti-oxidant, proper crimps, adhesive heat shrink
- Diagonal taps
- Catastrophe fuse based on inverter size
- Equalize only if needed AGMs not generally equalized
- No direct load attachments to battery; attach loads at power posts
- Always use temperature compensation for charging
- Design system for a 25-30% depth of discharge (DOD)

You WANT a battery monitor that uses cumulative amphours