

Keep your Laptop and other high current-demand electronics working when there is no power. By Terminus © 2008 version 1.06

In order to keep a laptop, short-wave receiver functioning, all the various batteries charged along with some portable lights in a field power situation, I decided to put together something that was backpack-portable using the following designs and components.



Figure 1

The battery is to let you function when there is no sunlight, *or* if you happen to have used a smaller solar panel that is powerful enough to trickle-charge the battery, but not powerful enough to provide the current requirements. . (Whether you're in a shtf or field situation, things will never be optimal and the trade-off will be that the charging time required may extend too long for practical use. You have to size the battery to match your panel and accept less capability. In other words don't expect a 25 watt or smaller panel to charge that 40AH battery in a reasonable amount of time if you've drained it in any significant fashion. For the purposes of what I've found to be practical either with a 25 watt or hopefully larger panel I decided I could handle a 12AH battery weighing approx. 9lbs (Sealed Lead Acid batteries are heavier than Ni-MH or even NI-CD batteries) but they're rugged and can withstand more abuse.



Figure 2

This is a unique product in that it's really a regulated 12vdc power supply with a charge controller designed to be attached to a solar panel and charge a battery (or several batteries). The three inputs/outputs are: Solar Panel, Aux. Battery (for charging other batteries), and 12vdc out.

Here you see a small (10A) charge controller attached to the 12AH battery itself. The charge controller I used is almost an exact match in battery size, so the battery connections on the charge controller are wired directly to the battery terminals and then attached to the case with a screw, two washers at each corner using Velcro strips.

Batteryspace.com has these units already integrated, or you can purchase the charge controller separately using your own battery..

DC-DC converters (for laptops mostly)



Figure 3

The IBM ThinkPad that I use (I love them for their ruggedness and features) requires 16vdc at around 3.4 amps input voltage to charge the internal battery and operate normally. I recommend obtaining this kind of adapter from a place I've used several times doing business as **Powerstream**, their web site is:

<http://www.powerstream.com/>

For the IBM ThinkPad series, see <http://www.powerstream.com/ADC-IBM.htm> I used their **ED1060-09** model for my T23, which produces 16vdc even from as little as 10.5vdc input which is perfect for field conditions when you may face less than optimal power conditions. For Panasonic Toughbooks, see <http://www.powerstream.com/ADC-Panasonic.htm> for compatible converters. For my Toughbook CF-28 I used their **ED1060-87** model which is exactly the same as the IBM version, with a different connector.



Figure 4

I modified the dc-dc converter input connector (removed cigarette lighter plug and installed power-pole connectors) to obtain 12vdc power from various sources. 1. A standard cigarette lighter plug to the power-pole cable. 2. Attach directly to a fused output on the DC Distribution Panel. 3. Attach directly to 12vdc regulated output from charge controller & battery system. 4. In a worst-case scenario I can attach directly to any battery using the heavy-duty battery clip to power-pole cable. You will see the various cable configurations I have made further within this document.

You should look in the “*High Quality Automobile to Laptop DC/DC Converter*” section of their site.

The Panasonic Toughbook I use has a run-time of over 4 hours on one battery and about 7+ hours with the second battery pack installed in a removable drive bay.)

I’ve tested both for use with this solar-powered battery system, but I prefer the cheap unit as I only need to carry one no matter which laptop I happen to be using.

I have alternate dc converters for backup use. One made by Lind for the Toughbook and one from Powerstream for the T23 with model-specific connectors even though it’s “redundant” I feel better having them around...



Figure 5

By using a less expensive dc converter that had a selection of connectors (and a wide selection of voltage outputs) I was able to use ONE device to power either laptop. I was very fortunate that both the Panasonic Toughbook and the IBM T23 need similar voltage levels. (having these interchangeable tips was useful and I only need (2) different tips that can be swapped as needed. The quality and reliability of the batteryspace.com model may be an issue, time will tell as I use it a lot now.

Inverters

Inverters are not really viable with a folding solar panel and a 12AH battery and are *beyond the scope of this document*. Once again, please remember this document was intended to address backpack portable systems.

I don't recommend using any AC-powered devices as a rule unless you have massive battery banks and huge inverters in a stationary installation or plenty of fuel to burn up in your vehicle.

In my experience you can get by on DC alone if you plan on only having DC and choose your equipment wisely.

Use devices that are powered by AA and AAA primary batteries and then use your standalone chargers that can be powered from your panel and 12AH battery.

When you buy equipment look at the input voltage first, choose 12VDC first, then if you have to, obtain dc-dc converters that can produce adjustable outputs in common voltages that use 12VDC as input voltage.

It is not efficient to use an inverter driven from a battery to convert DC to AC only to have to convert it back to DC again to power a laptop (or any other DC-powered device) you lose power in the equation, and you add unnecessary complexity and weight by using an inverter.

The kind of DC-DC converters I use also accept a wider range of input voltage thus allowing me to be more flexible.

Powerstream sells many types of DC-DC converters and I have used them for various projects around my observatory and in my vehicles. See

<http://www.powerstream.com/dcdc.htm>

for various types of dc-dc converters. You can also check <http://www.batteryspace.com>

for low-cost "laptop adapters" and selectable output (1.5v -9v) converters for cellphones, pdas, ipod/mp3, etc, MURS/GMRS, or 2m HT, etc... as well.

If you have a high enough capacity solar panel you don't need the weight of the battery but you may wish to operate your equipment at night. Most 12vdc batteries of the type I recommend don't weigh that much and can easily be adapted to fit into small equipment pouches that can be carried in a backpack or whatever. Whether or not you use a gel-cell or sealed-lead-acid battery doesn't matter that much with modern battery designs. If you use a large enough laptop bag, you could carry the battery within. My shortwave receiver (Yaesu FRG-100) can be powered directly from 12vdc and my solar panel can produce up to 16vdc so I use the battery to keep the voltage well regulated. The radio draws less than an amp so I can monitor news stations quite a while just on the battery itself. Sources of this type of battery could be any small office/home UPS (battery backup) replacement battery, or perhaps even scavenge one from a bad UPS. You can find dandy batteries that are lightweight and still have a decent rating.

Battery (12VDC/12AH)



Figure 6

Here is a typical 12VDC 12AH SLA battery, weighing approximately 9 lbs, is about 6 inches long, 4 inches wide, and 4 inches high.

Charge Controllers



Figure 7

This is a 12vdc-only 7A charge controller that was inexpensive, offering very few features besides charging the battery from a solar panel, with some basic over-charge protection capability built-in.

This is about as minimalist as you can get. I keep one around in case I need to charge other batteries and as a backup. As you can see it has no “load” outputs so in this case you’d connect any DC loads to the battery directly or via my power distribution panel.

This unit weighs about 2 oz. and you can find it at www.brunton.com and elsewhere.

I crimped on some Andersen power-pole connectors on the solar-panel terminals and now it’s part of my modular backpack power system.

If you need something heavier, but still fairly minimalist, see the ICP 21Amp Charge Controller.

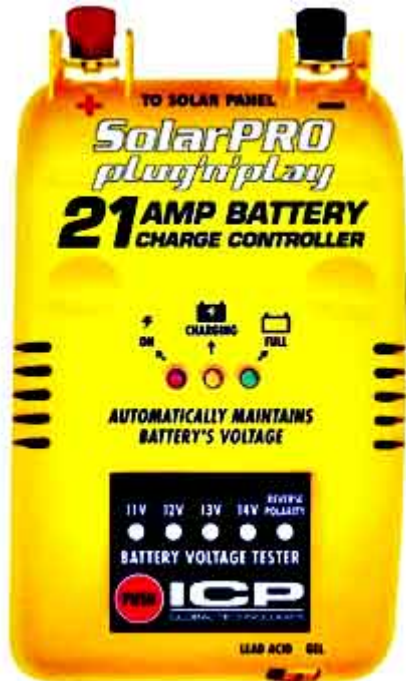


Figure 8

These used to be available on amazon.com as the “**ICP Solar 21 Amp Charge Controller**” but the only place I know that still sells them is Innovation House <http://www.innovationhouse.com/products/21amp.html> (I have not obtained this unit)

One of the things I like about this 21 amp charge controller (besides the fact it can handle 21 AMPS) is that it can be used with gel-cell batteries (yes, the charging voltage IS different!) unlike the Brunton unit which should only be used with SLA batteries.

Folding Solar Panel

Here is the 55 watt panel sitting in the afternoon sun, gathering about 26vdc at 2 amps according to my DVM (unloaded, when charging expect voltages to drop to about 17-18vdc) Global Power P3 55 watt folding solar panel. (military version, see “SunLinq” for their civilian models)



Figure 9

As you can see this panel hasn't been used that much as the folds are still quite pronounced. Each corner has sturdy grommets, so when you stretch it in the sun on 550 cord to vehicles or trees, it quickly heats up and becomes flexible. The material is not vinyl, but a coated cordura-type fabric that is also waterproof. There is a thin protective (transparent) layer over the CIGS cells to also seal them from moisture. In the foreground you can see the “trailer” plug.

There are many sources for folding solar panels. One of my favorite vendors is <http://www.ctsolar.com> they provide power systems for expeditions and sell a lot of useful equipment. As an example, they sell a 32 watt folding solar panel for around \$300 and this would work well as long as you used a battery as a “buffer” to maintain a stable voltage even though the panel may not be able to meet the charge demand. Thus you can use a smaller panel (nothing less than 25 watts). You can also find folding panels on Ebay for around the same price. **Sunling** is the name brand Global Solar is selling their “civilian” models for in case you can’t locate a reasonably priced panel. The prices have come down a lot since I obtained my 55 watt panel as well.



Figure 10

Here you see the 55watt panel folded up, it’s quite easy to carry in a backpack, or a gear bag, along with 100 feet of paracord, the battery and charge controller(see note), and cables/adapters you need to keep things going.

I specifically didn't specify using a charge controller because it's not really needed, you can get by without one. If you have multiple panels and are producing that much current you should probably use one. There are low cost models (around \$40) that can be obtained on Ebay or at batteryspace.com. I've used panels to charge batteries directly without charge controllers but you do have to be careful and understand what you're doing. If you happen to have a DVM (volt meter) you should disconnect the solar panel and measure the voltage across the positive and negative terminals of the battery. If it reads above 13 volts you're almost fully charged. You also need to make sure that the input voltage requirements of the device you want to directly charge with a panel won't be exceeded. I've blown up things once in awhile by not being careful. What I mean by this is to not try to connect a 12v device when the panel may be producing 18v without making darned sure the device can handle the increased voltage. Otherwise it's better to use an inexpensive charge controller¹ that has a regulated output.

Charging Batteries

You can obtain "rapid" chargers that will charge up to 10 AA/AAA batteries that are designed to be used in an automobile. In my case, I use a 10-cell iSun "BattPak" NiMH/NiCD battery charger that came with both an AC-adaptor and automotive adapter, I discarded the AC adapter, removed the cigarette lighter plug and installed Andersen power-pole connectors, which allows me to either connect it to a solar panel directly (don't do this unless you load the batteries first) or directly to a battery that you're also charging at the same time. I use a power distribution panel which allows me to do more at the same time if power is available. By this, I mean use a radio or laptop while I am charging batteries from the main battery (in this case a 12V12AH SLA) and being charged by a solar panel hung from the tree, or tied to the top of a vehicle. I realized that when I'm charging AA batteries this way, I can really only charge 6 cells at a time from a 12vdc source (battery, or other power supply). If I connected the charger directly to the solar panel, however I'm able to charge 10 AAs at the same time – because the panel is producing about 18-27vdc open-circuit, and about 16-17 vdc with a load attached.

(insert picture of my modified iSun "BattPak" here instead) **Figure 12**



Figure 11



¹ See Brunton 12vdc charge controller mentioned above.

Most of the panels either come with a cigarette lighter socket or “trailer” plugs.

Anyone with minimal skills with crimp-on connectors or a soldering iron can create adapters and cables needed in order to charge batteries, power devices, or even use multiple panels (in parallel to increase your current output.).

I also recommend the use of Andersen powerpole style connectors. (see below)



Figure 13

BEFORE

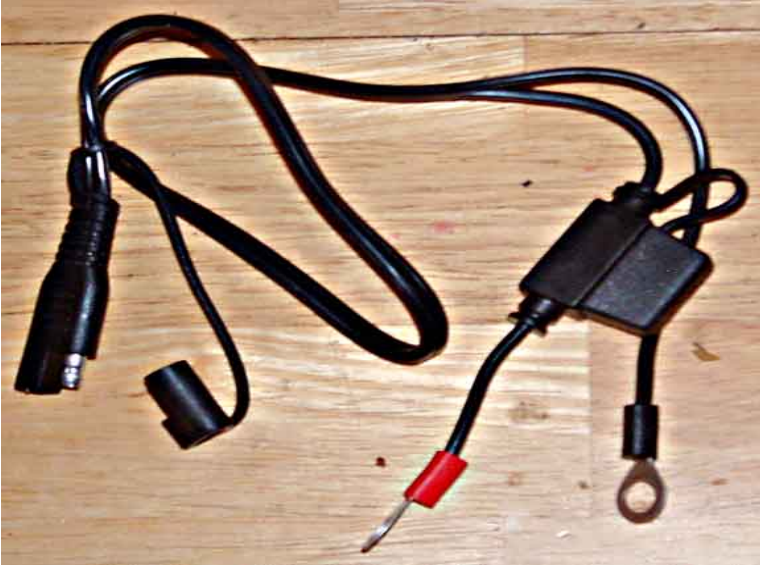


Figure 14

AFTER



Figure 15

Here is a cable I purchased at an RV supply place for \$2.99 that I use with my panel and a battery. I inserted a 3 amp automotive fuse and I am able to protect the folding solar panel, the battery or a charge controller (whatever I'm attached to the solar panel via the "trailer plug" connector)

The second picture shows my modification (power pole connectors) which allows me to attach the panel to either the power distribution panel or the battery/charge controller.

Basically I just snipped off the terminal lugs and soldered/crimped on the Andersen Power Pole connectors.

With SAE "trailer plug" connectors, the exposed connector is always ground.



Figure 16

Examples of power packs could be something like this **Carport Handheld Device Charger** which would allow you to charge the batteries with your standalone charger then detach to be used to charge any other device that accepts a “cigarette” lighter input. I believe you can obtain this for about \$15

There are some very expensive “power centers” that you can also purchase, some with built-in inverters (See my note on Inverters below). The sky is the limit I suppose, or rather what you/and your team can carry in a backpack. This is important to consider, just how much can you and your team carry?

If you need to power something that is less than 12vdc you could use one of those power packs that provide multiple voltage outputs that hold rechargeable batteries that you have charged from your backpack solar panel

Once the power pack is fully charged you then use it to charge your gps, phone, ipod, etc. internal batteries by using that device’s “car charger” ... Otherwise you can use a small, lightweight dc-dc converter to produce common voltages in the range of 1.5vdc up to 9vdc (typically selectable output devices) such as the ones from

<http://www.batteryspace.com>

... these would typically power chargers for squad-level communications devices (GMRS, MURS, etc), standalone battery chargers (AA/AAA), PDA’s, MP3 players, etc.

I recommend the iSun “BattPak” which is both a charger and a “power pack”, it can handle direct solar panel input (wide range of input voltages) and can be used as a portable battery pack as it has a built-in cigarette lighter socket.

I have used the following components so far:

- (1) 12vdc 12AH SLA (Sealed Lead Acid battery) (generic UPS-style replacement)
- (1) 12vdc 7.2AH SLA (Sealed Lead Acid battery)
- (1) 10A Solar Charge Controller
- (1) 7A Solar Charge Controller
- (1) DC-DC converter (10-16 vdc to 16vdc) for both the Toughbook CF-28 as well as the IBM T23 laptops (see both powerstream.com and batteryspace.com for these DC-DC converters (in this case having these interchangeable tips is useful as the less expensive versions that use these modular connectors are versatile and allow me to use ONE dc converter for both laptops interchangeably. Their quality and reliability may be an issue though, I have several alternate dc converters for backup use.. One made by Lind for the Toughbook and one from Powerstream for the T23...I've tested both for use with this solar-powered battery system.)
- (1) 25 watt folding solar panel (Sunling)
- (1) 55 watt folding solar panel (Global Solar)
- (1) iSun "BattPak" battery charger (AA/AAA NiMH/NiCD)
- (1) IBM T23 laptop (can draw up to 3.2 amps if charging internal Li-Ion battery)
- (1) Panasonic Toughbook CF-28 (can draw up to 4 amps if charging internal Li-Ion battery)
- (1) Yaesu FRG-100 shortwave (draws about .8 amps, or more precisely 800ma.)
- (1 pair) 12vdc 5w compact fluorescent lights (CFL)..

I no longer own cell phones so I don't much care about stepping the voltage down to charge a phone, but you could use some of the low-cost dc-dc converter models on batteryspace.com for smaller voltage requirements. (i.e. from 12vdc →1.5vdc-9vdc)

As you might guess, sun is an abundant resource in the desert southwest which is my AO, so this solution makes sense for me, but even if you're in a less "radiated" place solar can still be a viable energy source when you have nothing else.

Reminder, the article is about a *backpack portable system and what I power with it may be different than what you need it for*. I can think of radios (re-charging squad-level communications devices, "Shortwave" or "Ham" (i.e. 2m HT) radios , PDAs, mp3 players, battery chargers (AA/AAA), etc... Since I'm a bit of a radio person I by shortwave I mean something more like a professional general purpose communications receiver such as the Yaesu FRG-100.

I also realize that you may not want to cart around a 9lb battery but you can split it up among the members of your team, and it's easy enough to make a battery pouch with strap to carry if it's not in your backpack.

This is why I don't use anything larger than 12AH because the weight is prohibitive.... If you could carry larger batteries you also need more power to charge it and a folding solar

panel even at the largest (55watts) size would not be able to recharge larger capacity batteries in a reasonable amount of time.

If you need more power or wish to be able to rotate charged batteries in a high demand situation I recommend carrying multiple 12AH batteries spread among your group. This would also work better if each team member had a folding panel and separate battery systems but I think one or two panels and 12AH batteries among a group would be sufficient to keep the group supplied with sufficient energy to keep their radios, gps, whatever going on a daily basis.

Many of these sub-components should be purchased with an eye towards also using them in your vehicle, having both solar and vehicle power sources is useful.

Here is a set of power cables I made using Andersen power-pole connectors and simple crimp-on lugs.

This cable is designed to handle up to 40 amps.

If you are not familiar with the Andersen PowerPole “*connector technique*” then I highly recommend learning about it, as the connector system is ingenious, and can be used for extremely high current applications as well as *smaller* applications like this 40-amp cable.

Here is an old female cigarette lighter plug I scavenged from a junk drawer after I installed the powerpole connectors. This will allow me to use an automotive charger to

Connecting it all together

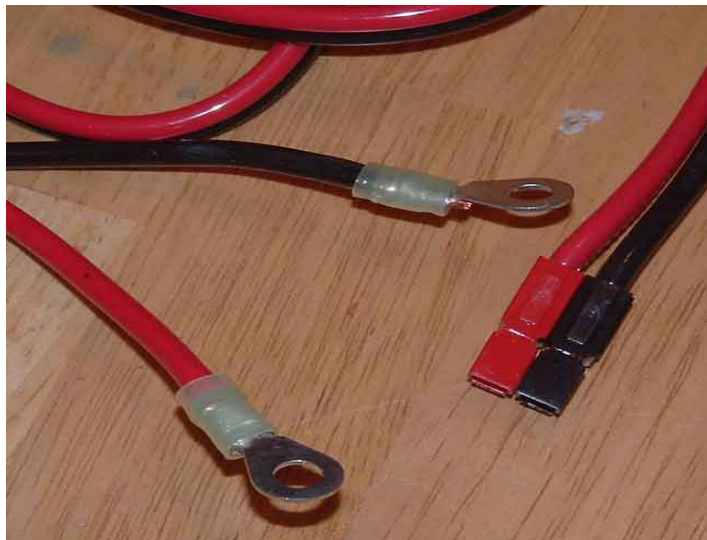


Figure 17

recharge small electronics from either the solar panel itself or the battery/charge controller, or from the power distribution panel.

Powerpole to Clip Leads:

If you need to attach your solar panel to a battery directly

If you need to power/charge your battery/charge controller from a battery directly

If you need to connect external power to the power distribution panel



Figure 18



Figure 19

Here is a 12 vdc 3.0 amp supply that I salvaged from an old Microsoft force-feedback joystick.

Shortwave Radio Dual Power (the Yaesu FRG-100 receiver requires 12vdc @ 1Amp)



Figure 20 I cut the power cable a few inches from the potted adapter and crimped on the Andersen power-pole connectors. This would be when I'm on commercial power or where inverting AC is feasible. This power supply was perfect for powering my Yaesu FRG-100 shortwave receiver when AC power is available.

Male cigarette lighter to powerpole.



Figure 21 Because every cable created can be attached to the power distribution panel feeding power in, or out as needed allowing us to store or produce power, or consume power to and from the battery/charge controller package. I also wanted to power the radio from vehicles I made a cable that I can plug into a cigarette-lighter socket. Of course, all of these cables have multiple uses as they can be used in several different configurations linking the battery/controller or the solar panel to whatever device needs power, as the situation requires.

Finally I made a cable to connect to the Yaesu receiver 12vdc input that could be used with the wall transformer, the cigarette-lighter cable, or the battery / charge controller via the power distribution panel or directly in a modular manner. I can pick and choose how to power the receiver no matter what power options I have I know I can get it working.

I keep all these cables (along with a bunch of spare fuses for both external and internal replacement) with the Yaesu FRG-100 radio which normally lives within a foam-padded 20mm ammo can.

I also keep the receiver's instruction manual, the multi-band antenna and 100' of paracord to help string the 25 foot antenna.

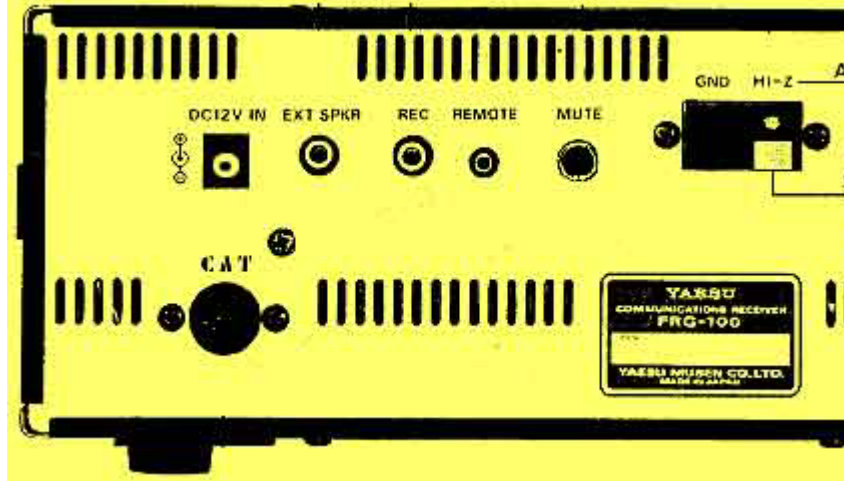


Figure 22

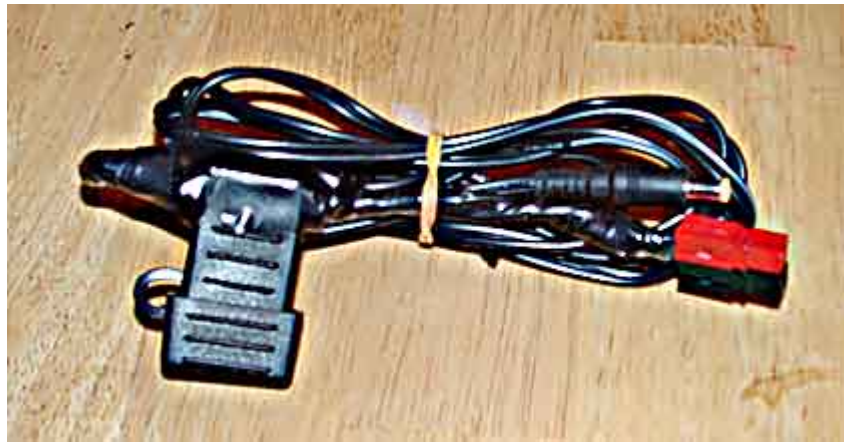


Figure 23

Thus allowing me to use AC power or solar/vehicle sources (any 12vdc source that had a cigarette lighter socket). As you can see I also put an external fuse on the cable as I desperately need to protect the receiver and it's easier to change an external fuse than the internal fuse within the Yaesu FRG-100. I used an automotive-style fuse as I suspect they will be easy to come by when you need a fuse. In this case, the fuse is 1.0 amp

Power Distribution on a backpack scale

Small, lightweight fused distribution panel (40A)



Figure 24

The main input on the left connects to the charge-controller output or directly to battery terminals. These fuses are standard automotive fuses.

The entire panel weighs about 3 ounces, not including all various adapter cables I have fabricated..

These are Andersen power-pole chassis connectors, and each socket is wired to the main input line so each are independent of the other.

The main input fuse of 40A is on the left, with varying fused connections to the right with ranges from 30A to 1A displayed.

Really Portable Computing. Indefinitely.

The IBM T23 laptop, and the light are being powered by the 12VDC/12AH battery/charge controller combination as shown.

The regulated 12vdc output of the charge controller is connected to the fused power distribution panel which protects the charge controller output as well as providing a way to connect independent, multiple loads to the charge controller's output at the same time. The loose cables lying off to the side are for the solar panel charge input and the second battery charger output.

You can connect any 12VDC source to the "solar panel charge input" and that could be where you plug in the cigarette lighter plug into a vehicle, or even a 12VDC wall transformer such as the one I used for the shortwave.

As you can see I have power to the laptop (which requires 16VDC, but all we have is 12VDC so we convert from 12VDC to 16VDC by using a DC-DC converter).



Figure 25

The view is with the battery and charge controller on it's side with the power distribution panel attached to the side of the battery using Velcro strips...

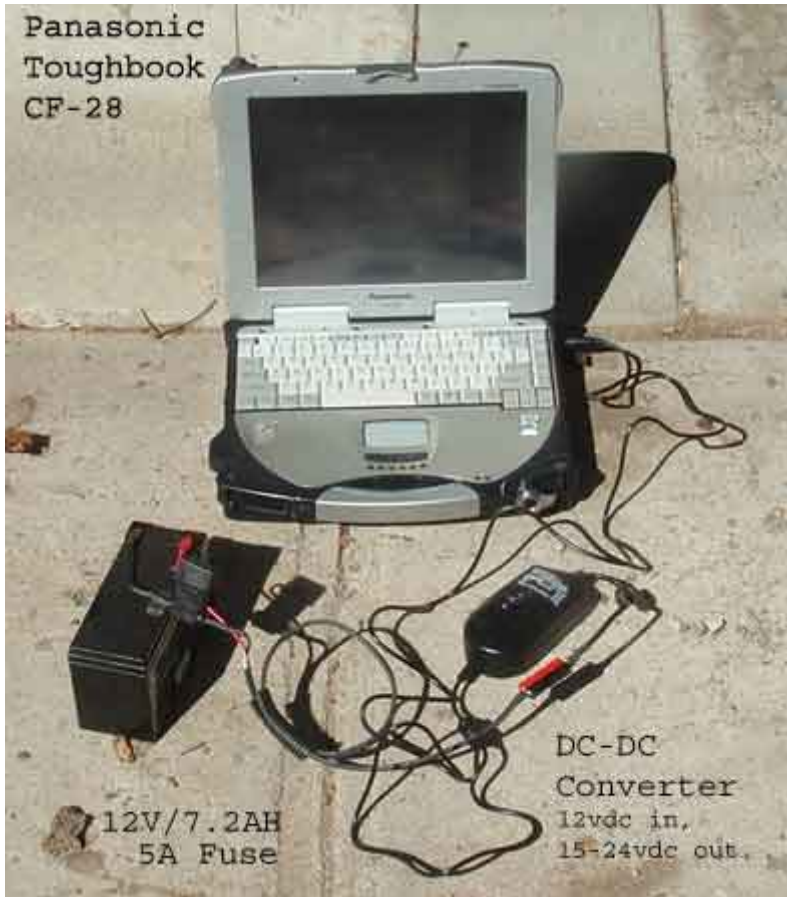


Figure 26

Here is a simplified power configuration using a DC-DC converter (from batteryspace.com) to charge a Panasonic Toughbook, using a cheap SLA (Sealed Lead Acid) battery. By using a folding solar panel to charge the 7.2ah battery you can keep the laptop going under almost any circumstances. This Toughbook has built-in WIFI (802.11AB), GPS so it's the perfect backpack combination. These are military-grade rugged laptops.



Figure 27

As you can see, the receiver is powered up, and I have a 5W light running off the same supply. Everything here fits into the padded 20mm ammo can perfectly. I hope it will protect everything from the elements and perhaps even EMP.

Field Lighting

I wasn't going to include this as the document originally began life as a tutorial on how to keep your laptop and a radio alive in the field but someone asked me how I'd do it if I needed lighting from a backpack. I recommend using LED lighting but you could also use 12vdc fluorescent lights.



Figure 28

I used 12VDC CFL lights which are widely available. They are very cheap and sometimes LED lights just don't have the lumens. These lights only consume 5 Watts each which is more than an LED array would but these are very bright. The light sockets are standard cheap "lamp" style sockets you can pick up anywhere, and the lights themselves are designed to use the standard "light bulb thread" socket. (Just remember they're DC and do not plug them into AC!)

LED Lighting

The sky is the limit, you can obtain so many variants of LED lighting in almost any color. For this light, I used (1) 12vdc LED auto signal light in RED, about 23 feet of 14ga (2 conductor) wiring, a 3 foot long piece of stiff wire, a re-cycled dishwasher hose, 2 Andersen powerpole housings, 2 Andersen powerpole pins, (1) 1A fuse (not shown) and fuse holder (not shown), some shrink-tubing, about 8 small tie-wraps and a bit of solder. This light draws less than 300ma which means you could power it about 20 hrs with a 7AH battery. I chose red because if I am using this light, it's at night, and I need to help preserve whatever night vision I have. It provides enough light to read/write and to operate equipment or type on a laptop. I plan on adding a switch as soon as I can find one sturdy enough to become part of this design.

Flexible, sturdy light (Red-only LED) with 22 feet of power cord.



Figure 29

Details

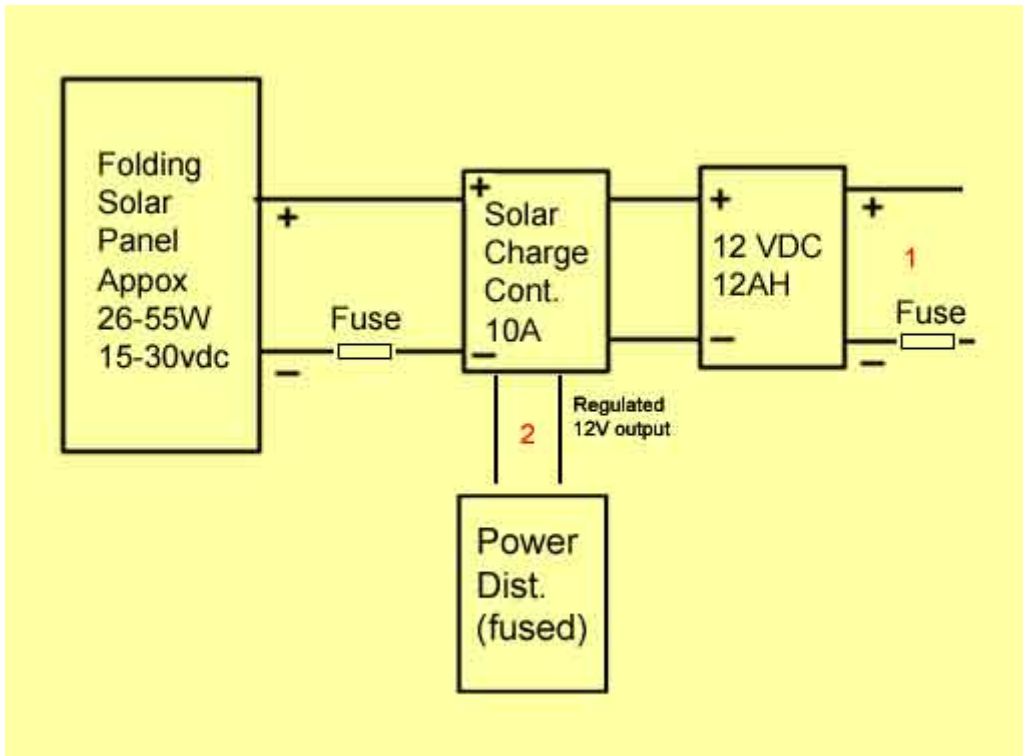


Figure 30

This is really very simple stuff.

As you can see in the diagram (Figure 26) at point “1” the power is fed directly from the battery instead and anything attached there will have *bypassed* the charge controller. You will still be able to obtain a well conditioned 12vdc but as the battery discharges the voltage will drop unless you’re charging it at the same time with something able to keep up with the load.

If you connect your DC loads in this mode, you are merely using the charge controller as a “charge regulator” only charging the battery. Which is all that most charge controllers really do anyway.

The very inexpensive charge controller (10A max) that I used has a “load” output that provides a regulated 12vdc @ 10A. By using the charge controllers load output (Figure 21, point “2”), we are able to offer over-discharge protection to the battery, if the battery voltage drops to 11.1v the controller will shut off the load output of the battery but will continue to charge the battery if the solar panel (or any other suitable source of power is connected)

If you want to detach the solar panel and instead attach the “powerpole to clip leads” cable directly to the charge controller you can recharge your battery in a hurry from a

vehicle battery (vehicle running or not) fairly rapidly. You could perhaps use a cigarette lighter cable to attach to the charge controller and charge your battery while driving in your vehicle.

Once again, if you always use a charge controller to handle charging your battery, you can protect the battery from over-charging (the controller will merely stop supplying voltage to the battery when it's fully charged) but did you know you could use a battery charger or even perhaps a 12vdc wall transformer instead of the solar panel and still keep your battery fully charged when you have access to AC power. I use this method when storing the backpack power system for long periods.

By attaching an alternate power source to the charge controller's "solar panel inputs" you are able to charge the battery, utilizing all the features of the charge controller including over-voltage protection as well as automatic charging shut off having it remain in a trickle-charge mode. Most of even the cheapest charge controllers do automatic equalization as well as PWM.

If you don't use a charge controller, it will pay to have a DVM with you to monitor the battery voltage while you are charging. I am currently checking out this very interesting unit that allows you to monitor input/output voltage, along with current (in and out), that gets installed *inline* permanently as a monitor or with power-pole connectors to allow you to use it as a diagnostic tool where ever you may need it.

Powerwerx' Watts Up

This is one useful device, is lightweight, powered from the line, and draws very little current. It measures quite a lot of information about your power use and capacity. It almost completely negates the need to keep a DVM around for monitoring your power generation and consumption.



Figure 31

<http://www.powerwerx.com/product.asp?ProdID=3809>

Features

Measures energy (**Wh**), charge (**Ah**), power (**W**), current (**A**) and voltage (**V**). Can use an optional aux. battery for measurement down to 0vdc.

Precision: 0.01A and 0.01vdc

It measures peak Amps, peak Watts and voltage minimum (sag)

This unit will handle *50A continuous and 100A peak at 60vdc*

What is also nice about this is it's low power usage. It draws only 7 mA

Made in USA to ISO 9001:2000 quality standards



Figure 32 If you purchase from PowerWerx you can even get it in black.

From reading the manual, it's based on a DSP which allows the Watts Up to have better A/D (analog to digital) resolution as well as using differential amplifiers to improve noise immunity.

Each Watt's Up is factory calibrated with constants stored in the internal EEPROM to correct for component tolerance issues.

Caution: please do use a fuse on the output side of your battery, or the load side of your charge controller.. This will help to protect your battery and charge controller from possible disaster.

Summary

If you scrounge well, this won't cost much. The major expenses were the solar panels, the 12V/12AH battery, and the charge controllers. Getting started using Andersen power-pole connectors can be somewhat pricey as you obtain a crimping tool, a lot of 15,30,45 amp enclosures, crimp pins, rolling pins, and connector locks. Once you've used Andersen power-poles, you won't want to use anything else!

I expect to write a similar document for powering larger systems, so please remember as you look at this, my intent was to keep it at a backpack level. You can use these ideas as a starting-point; the key is to come up with a modular set of cables, chargers, panels, and adapters (dc-dc converters) to handle small power requirements when in the field that match your equipment.

Many of these ideas can be scaled-up to provide much larger amounts of power by using larger capacity batteries (sets of batteries), charge controllers, and more solar panels with higher output. However this is completely beyond the scope of this document.

Best wishes to everyone, looks like the next few years are going to be critical for the Republic, Good Luck, and God Speed! *Terminus 2008-01-22*

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