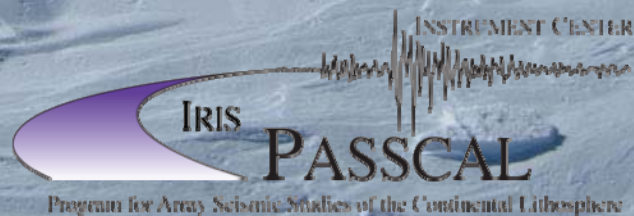
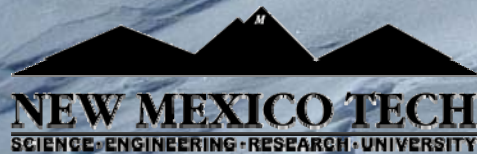


Power Management of Remote Instrumentation at Extreme Low Temperature

Guy Tytgat



Some Background Information

- Year around Antarctic seismic networks
- Current projects: Polenet & AGAP
- AGAP seismic net: ~ Coldest Place on Earth
- Temperature inside enclosure: -50°C to -60°C
- Successful: 88% data return (including one dead station)

Description of Power System

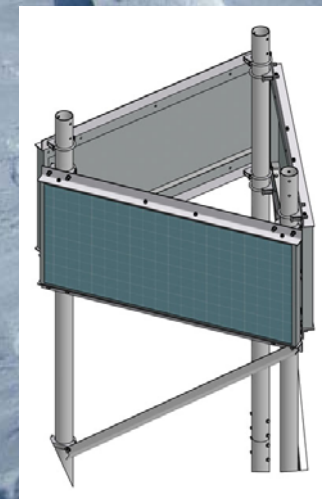


Solar Equipment

- Triple Panel Mount w/
Suntech STP 020 20W

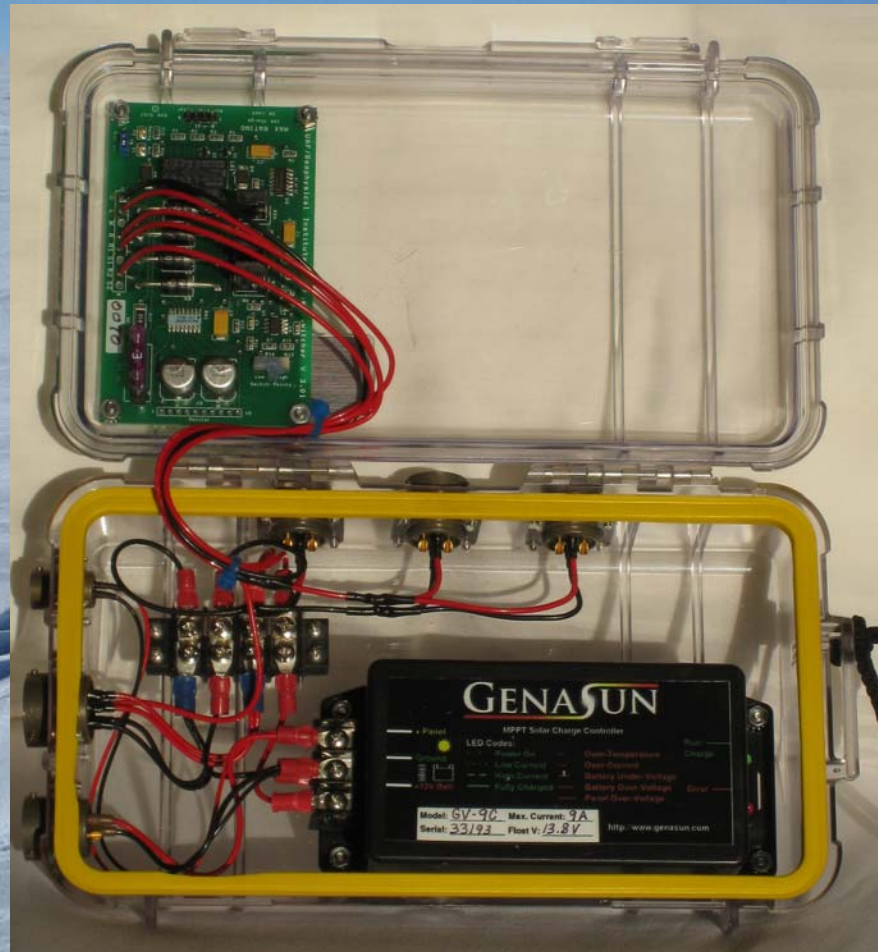
or

- Triple Panel Mount w/ Sharp
NE-80-EJEA 80W



Power Management Module

Power Switcher →



← Solar Charge Controller

Charge Controller



GenaSun GV-4:

- Max. output current: 4A
- Max. solar power: 45W
- Night power draw: 90 μ A
- Fuse protection

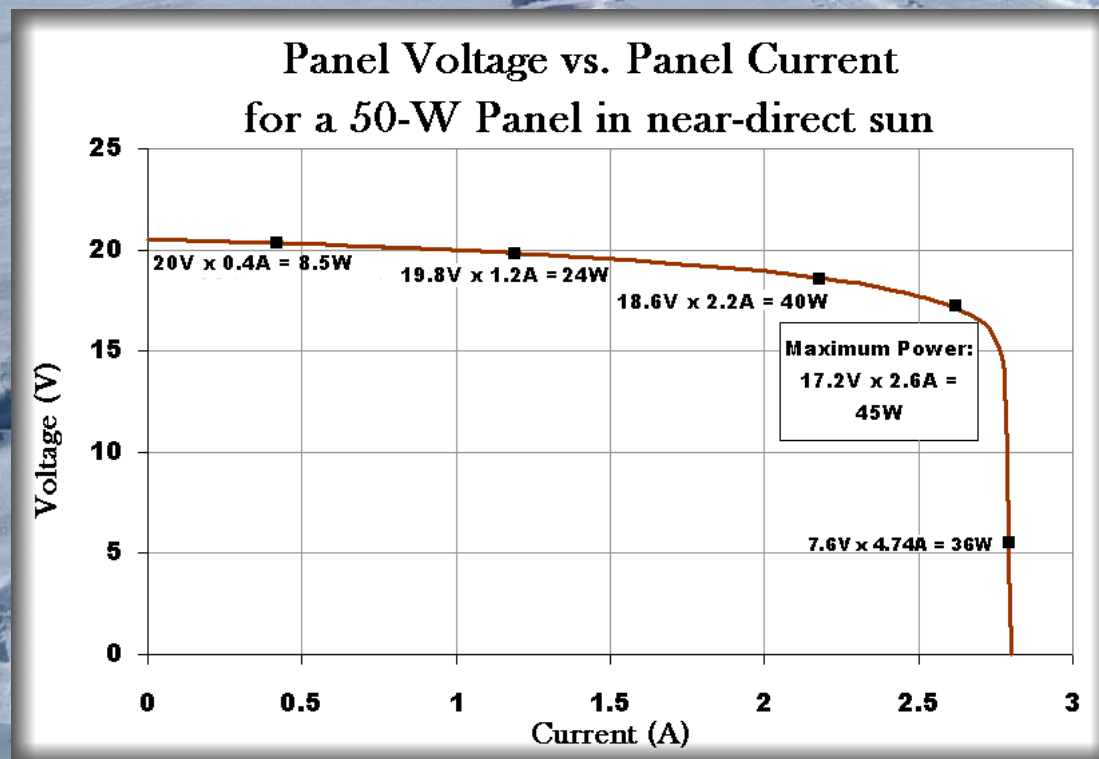


GenaSun GV-9:

- Max. output current: 9A
- Max. solar power: 110W
- Night power draw: 5mA
- Overload protection
- Automatic fault recovery

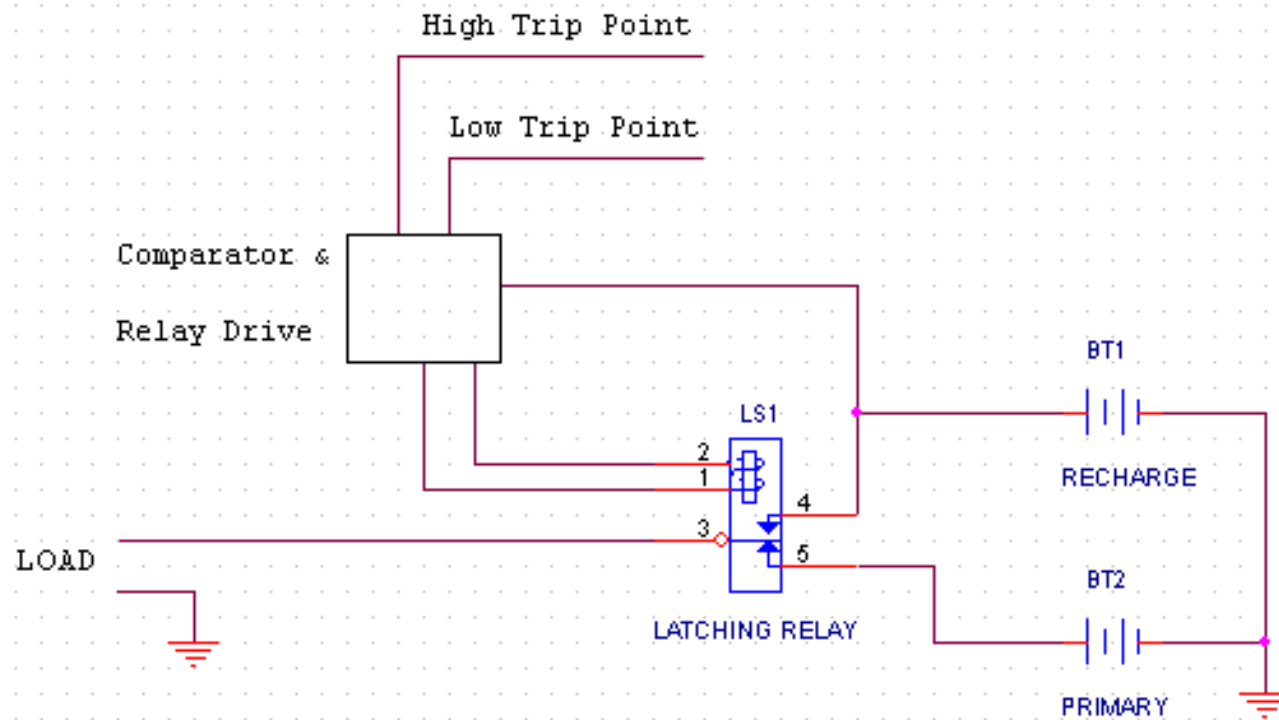
Charge Controller (cont'd)

- MPPT (Maximum Power Point Tracking) provides 10% to 30% more energy from same solar input
- Low power draw
- Low temperature operation



Power Switcher

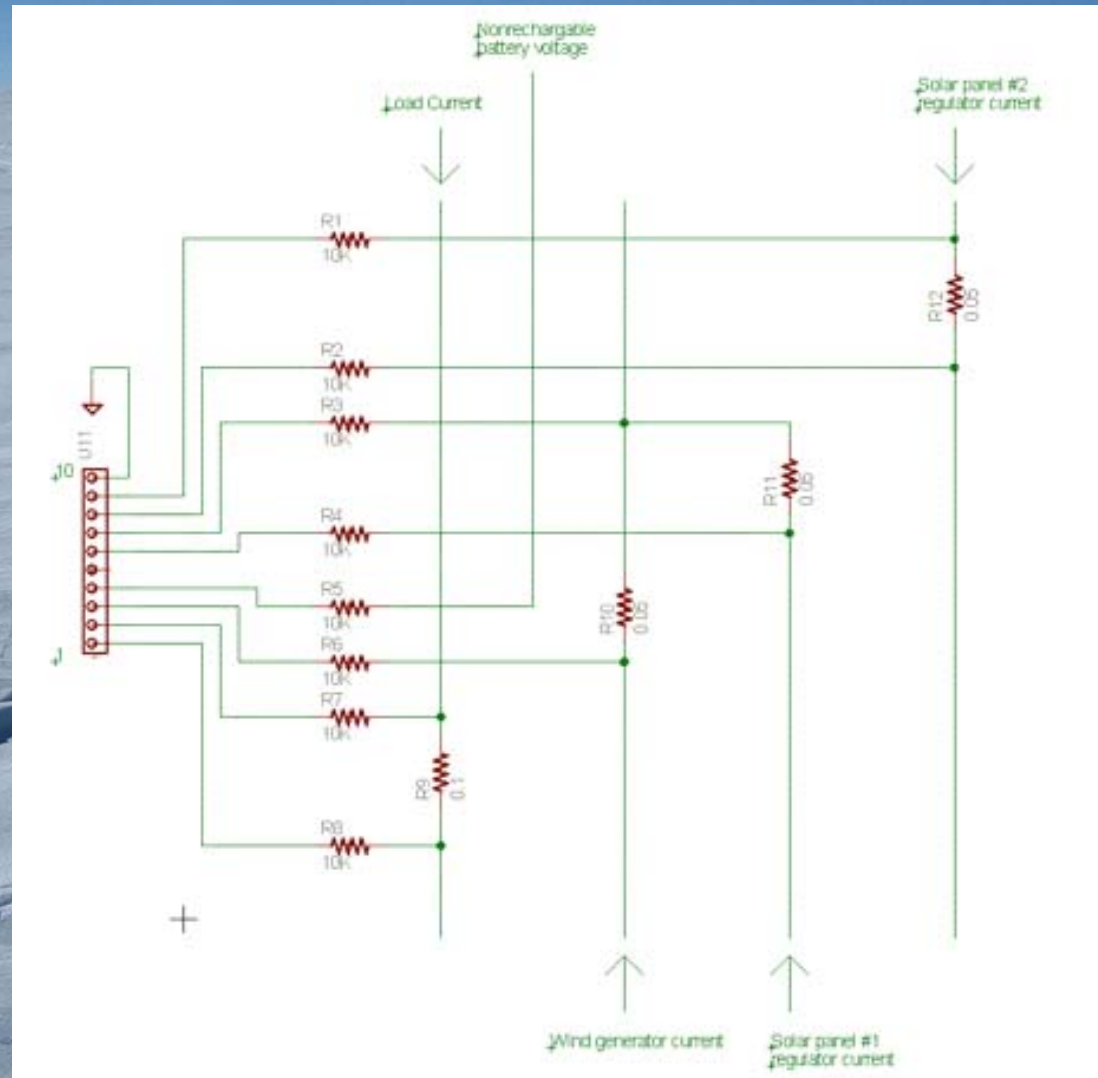
Simplified Power Switcher Block Diagram



Power Switcher (cont'd)

- Switches loads from AGM to Primary batteries when AGM volt. is too low and vice versa.
- Built for dual (independent) battery bank and solar
- Low power consumption: $< 250\mu\text{A}$ @ 12V
- Low Temp: Tested at -55°C after -70°C
- Power meter optional, to tally time on primary batteries
- Multiple SOH output for monitoring: Load, Batt., Solar, Wind (voltage + current)

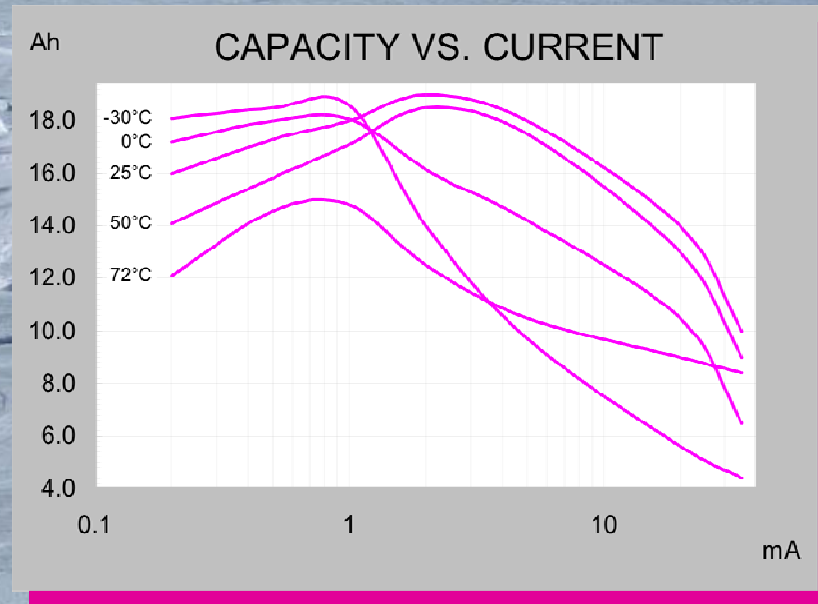
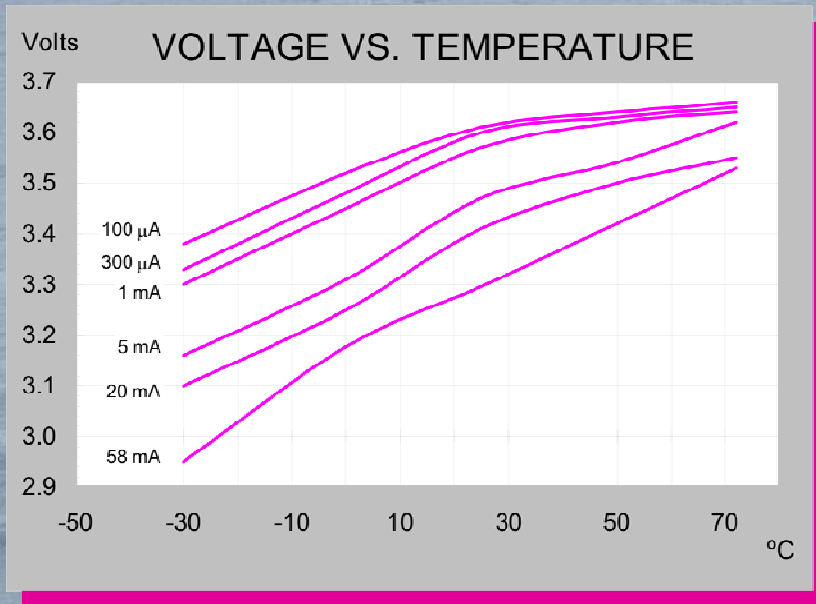
Power Switcher (cont'd)



Primary Batteries

- Brand: Tadiran TL-4930 + HLC-1550A
- Lithium Thionyl Chloride
- Highest energy density of all commercial lithium types
- Very long shelf life (very low self discharge)
- Excellent performance at low temp. ($<-55^{\circ}\text{C}$)
- Pricey! (\$10K / station)
- Low current: max. 100mA per cell
- Use of Hybrid Layer Capacitor batteries to provide short burst of higher current when needed.

Primary Batteries (cont'd)



Primary Batteries (cont'd)

- Come in D-cell format
- 3.6V/cell when full
- 19Ah/cell
- Each pack has 5 D-cell in series (to get 18V) x 10 in parallel per packs, plus HLC batteries for high current
- 10 of these packs per station to get 18V and 1900Ah

Heat Pads

- 1W, 1.5W or 3W heat pads
- Powered by solar panels only → only on when sun is up
- Meant to heat batteries to improve charge capacity in the spring.
- Since instrumentation draws $\sim 1\text{W}$, this doubles it → double the temp. difference between ambient T° and enclosure(?)

Conclusions

- This is a robust and reliable power system considering the extreme condition.
- Minimize Power Usage \leftrightarrow Too Little Heat
- Considering powering heat pad with primary batteries during winter \rightarrow Use more energy, but batteries more efficient at higher temp. and equipment operates more reliably