# Electronics Practical Design Example

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June 23, 2016

### Design Example

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### Design Example

• Cordless lawn mower is kept in a shed with no power.

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### Design Example

• Cordless lawn mower is kept in a shed with no power. The battery for the mower is 24V.

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### Design Example

- Cordless lawn mower is kept in a shed with no power. The battery for the mower is 24V.
- Solution: Use 2 12V solar panels to charge.

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### Lawn mower

### Lawn mower



### Lawn mower



#### Rechargeable mower with 24V battery.

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### "The Shed"

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### "The Shed"



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### "The Shed"



Solar panels on roof at left facing SW

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#### Problem: Solar panel output

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### Solar panel IV curve

### Solar panel IV curve



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### Solar panel IV curve



Not like a battery!

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### Problem: Solar panel output

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# Problem: Solar panel output

• In the dark, panels have no voltage across them.

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# Problem: Solar panel output

- In the dark, panels have no voltage across them.
- With no load, panel voltage can get over 20V for a "12V" panel.
- Solution: Use a charge controller.

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• Charge controller comes with solar panels.

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- Charge controller comes with solar panels.
- Charge controller disconnects from panel when voltage gets *below* 13V.

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- Charge controller comes with solar panels.
- Charge controller disconnects from panel when voltage gets *below* 13V.
- Charge controller disconnects from panel when voltage gets *above* 14.2V.

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- Charge controller comes with solar panels.
- Charge controller disconnects from panel when voltage gets *below* 13V.
- Charge controller disconnects from panel when voltage gets *above* 14.2V.
- Batteries can't over- or under-charge

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### Adding a charge controller

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### Adding a charge controller



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### Adding a charge controller



Problem: Charge controller is 12V.

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• A 12V charge controller can't charge a 24V battery.

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- A 12V charge controller can't charge a 24V battery.
- Work-around: The mower comes with its own charger.

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- A 12V charge controller can't charge a 24V battery.
- Work-around: The mower comes with its own charger.
- Problem: Charger is 110V AC.

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- A 12V charge controller can't charge a 24V battery.
- Work-around: The mower comes with its own charger.
- Problem: Charger is 110V AC.
- Solution: Use an inverter.

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### Inverter

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### Inverter



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### Inverter



### 12V input at other end

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Lawn mower charger

### Lawn mower charger



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### Lawn mower charger



LED is red when charging, green when charged.

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### Adding an inverter

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### Adding an inverter



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### Adding an inverter



Problem: Power draw of charger.

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• Solar panel nominal output is 50W (for both).

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- Solar panel nominal output is 50W (for both).
- Charger draws over 100W.

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- Solar panel nominal output is 50W (for both).
- Charger draws over 100W.
- Solution: Add a battery.

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Ultracapacitor is gold.

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#### Battery and ultracapacitor in parallel shown as single unit

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Problem: Battery and ultracapacitor can't hold enough charge for full 24V battery.

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Problem: Battery and ultracapacitor can't hold enough charge for full 24V battery.

• Secondary problem: Inverter cuts out below 12V input and above 14V input.

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Problem: Battery and ultracapacitor can't hold enough charge for full 24V battery.

- Secondary problem: Inverter cuts out below 12V input and above 14V input.
- Solution: Add a Raspberry Pi to turn charger on and off.

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### Adding Raspberry Pi

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# Adding Raspberry Pi



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# Adding Raspberry Pi



### Pi has wifi.

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### Adding IV monitors

### Adding IV monitors



## Adding IV monitors



One after panel; one after charge controller; one after battery

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### Adding triac control

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### Adding triac control



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### Adding triac control



Neon bulb indicates AC on.

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Complete system (for now)

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# Wiring

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# Wiring



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# Wiring



Needs work ...

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