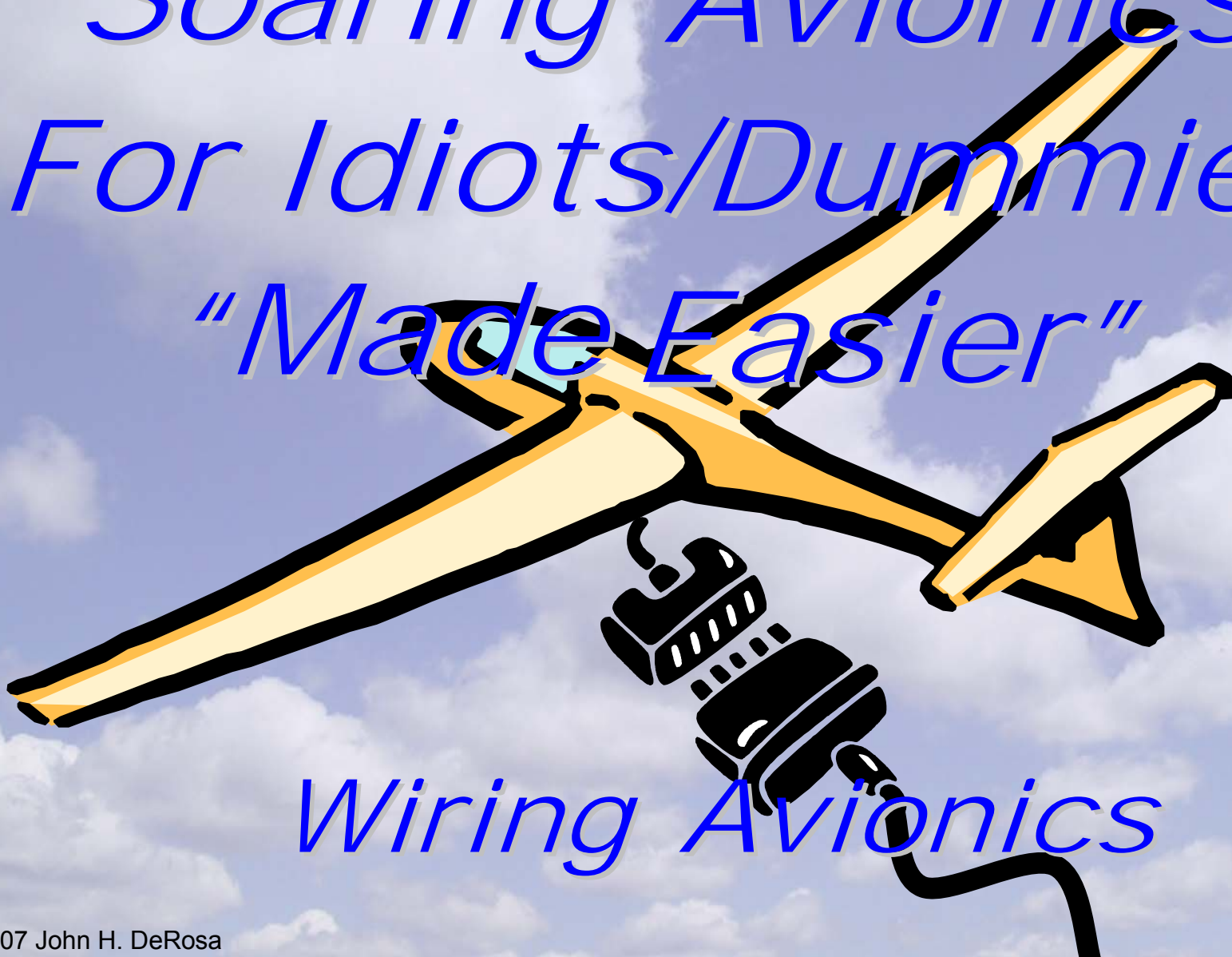


*Soaring Avionics  
For Idiots/Dummies  
"Made Easier"*



*Wiring Avionics*

# To Be Covered

- Wires and wiring
- Batteries, types & testing
- Power control
- Breakers & Fuses
- Switches
- Connectors and connecting
- Securing cabling
- Trailer Wiring
- Antenna connections and Coax
- In flight entertainment systems

# Disclaimers

- I am a BSEE and MSCS
- I am **not** an A&P, an IA or a licensed avionics technician
- Know the difference between Experimental & Standard airworthiness certificates (DG-101 Example)
- Proceed at your own risk
- Get your work inspected and signed off!

# What avionics skills do you have?

...I don't know an electron  
from a photon.

...I've done basic wiring.

...I'm pretty good at wiring.

# Do's and Don'ts

- No Ace H/W, no Radio Shack
- Lacing vs. Nylon Cable Ties
- Use sleeving at wear points
- Use good quality heat shrink
- Connections - Solder vs. Crimp
- Wires - Tefzel only



# Tefzel Wires

Fluorocopolymer thermoplastic material has excellent electrical properties, heat resistance, chemical resistance, toughness, radiation resistance, and flame resistance.



For many years the standard hookup wire in light aircraft has been MIL-W-5086A, which calls for use of tin-coated copper conductor rated at 600 volts and temperatures of 105°C. This basic wire is then coated with various insulating coatings including PVC. There has been much discussion during the past few years about the use of wire with PVC in aircraft. The Air Force does not permit such wire to be used in military aircraft due to the toxic fumes generated in the event of a fire which can disable the crew. Although there is no formal restriction on the use of MIL-W-5086A wire as of early 1991, as our supplies of MIL-W-5086A wire are depleted we will now be supplying MIL-W-22759/16 wire which complies with current military and anticipated future FAA requirements.

# Suggested Wire Gauges

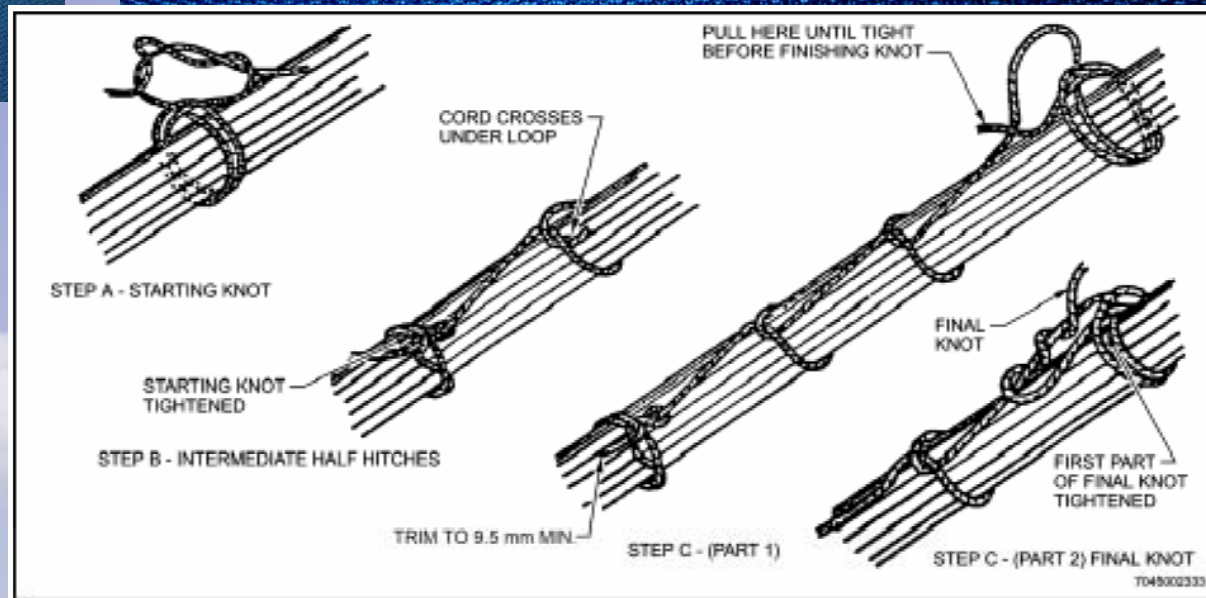
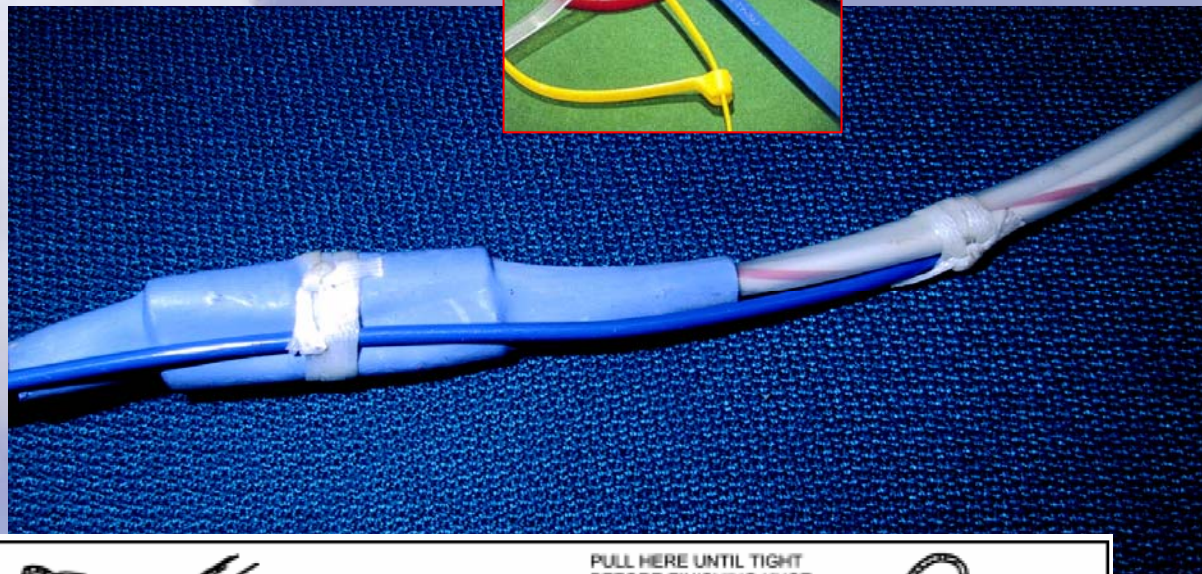
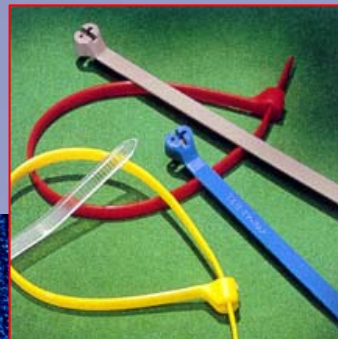


- **12 to 14 gauge** - Main power lead from battery to distribution block
- **16 to 18 gauge** - Power lead from distribution block to individual devices
- **18 to 20 gauge** - Speaker wiring
- **20 to 26 gauge** - Control wires such as push-to-talk, air brake switch, etc

# Cable Lacing



Wax impregnated  
Nylon Tape  
500 yards  
\$15



# Heat Shrink

- Get good quality
- Get several colors and sizes
- High shrinkage
- Sources: Ham radio and electronics parts web sites.
- Use a heat gun slowly to prevent damage to wires



# Protecting Against Abrasion

Vinyl Tubing



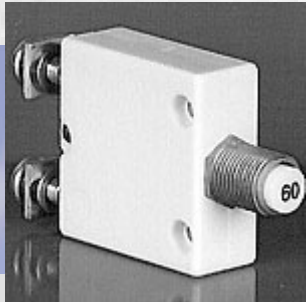
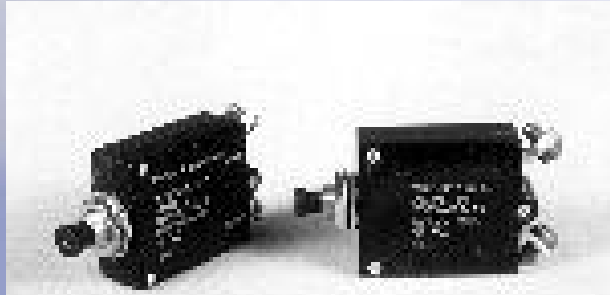
*Meets Spec. MIL-I-631D or MIL-I-7444B*

Rylon Expandable Sleeving

FAR Part 25 flame retardant  
aka "Shark Skin"

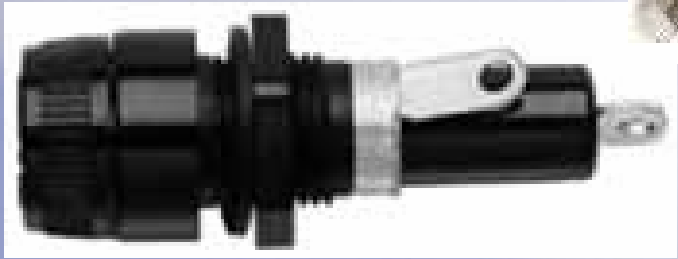


# Breakers Vs. Fuses



- Types of Breakers
  - Old style
  - Manual Trip
  - Integral Switch
- Glass Fuses
  - Typically not allowed
  - Difficult to fix in flight
  - Glass is fragile & dangerous
  - Slow-blow ← don't ever use
- Breakers
  - Must be able to pull
  - Can be reset in flight
  - Excessive Voltage Drop
- Debate: Do fuses protect the wire or do fuses protect the device? Both?

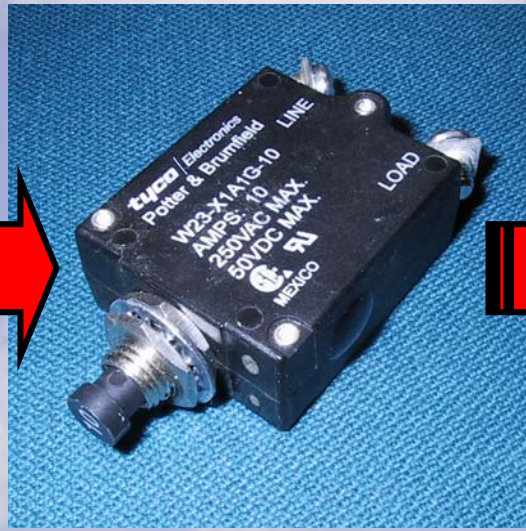
# Fuses and Breakers



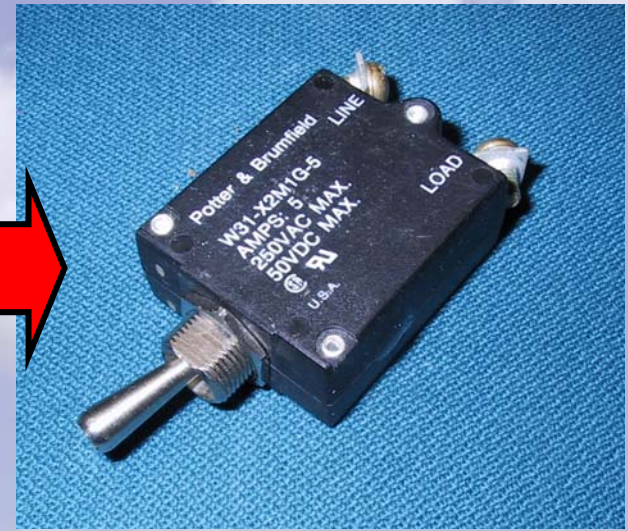
- Sharp Glass
- Hard to change in flight



Old Type - Push Only



New Type – Push/Pull



Switch & Breaker

# Breakers - Problem: Voltage drop



## Klixon Breakers Voltage Drop

**Amp Rating**   **Max. Voltage Drop**

1/2                    2.00Vdc

3/4                    1.45Vdc

1                      1.10Vdc

1 1/2                  0.75Vdc

2                      0.70Vdc

2 1/2                  0.50Vdc

3                      0.33Vdc

4                      0.30Vdc

5                      0.25Vdc

7 1/2                  0.20Vdc

10                    0.15Vdc

15                    0.15Vdc

20                    0.15Vdc

## All Electronic Breakers

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

*0.1Vdc Voltage Drop*

*Protection: Over Current,  
Under & Over Voltage*



# Coax and Antennas

## From the Microair M760 Instruction Manual

Antenna - May be  $\frac{1}{4}$  wave whip (23.95"/61cm for 123.3Mhz) or  $\frac{1}{2}$  wavelength dipole.

Coax - Use 50 $\Omega$  (ohm) coaxial cable RG-58C/U is standard. Where the cable length for the coaxial cable exceeds 15m (45 feet), the cable should be replaced with RG-213/U (low loss) cable.

# Coax Connectors

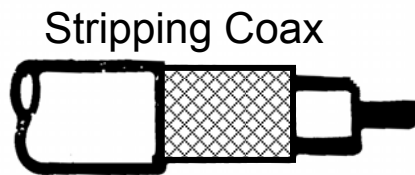
Coax Crimping Tool  
\$15-\$25



Microair recommends using only soldered or crimped BNC connectors. Solderless BNC connectors are NOT recommended, as their performance is substandard...

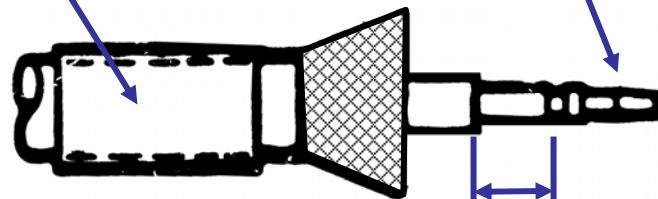
Amphenol® RF Global RF Solutions

**Step 1**



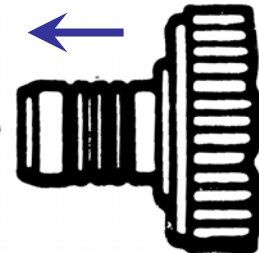
**Step 2**

Ferrule



Contact

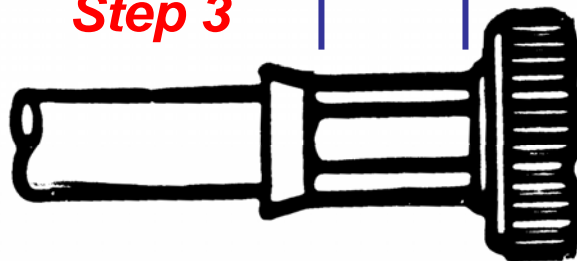
Body



Crimp Ferrule Here

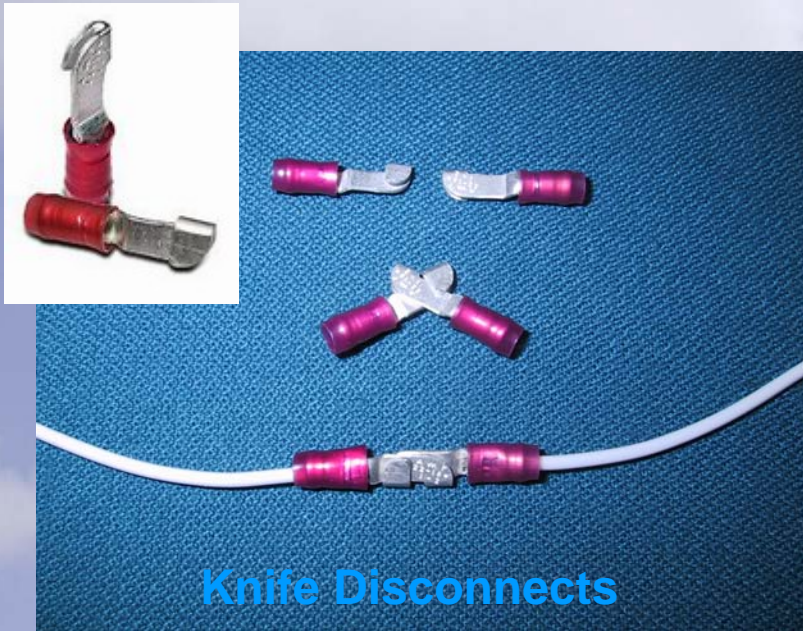
Crimp Here

**Step 3**



BNC = Bayonet Neill-Concelman)

# Compression Connectors



Knife Disconnects



Ring Lugs



Spade Lugs



Coax Crimping Tool \$5-\$15



Butt Splices

# Switches



Master Switch



Momentary for Push to Talk (PTT)



- Sealed Switches
  - Gold Contacts
  - Screw terminals
- Easier repair, less vibration prone




# Other Items

Add Cannon plugs



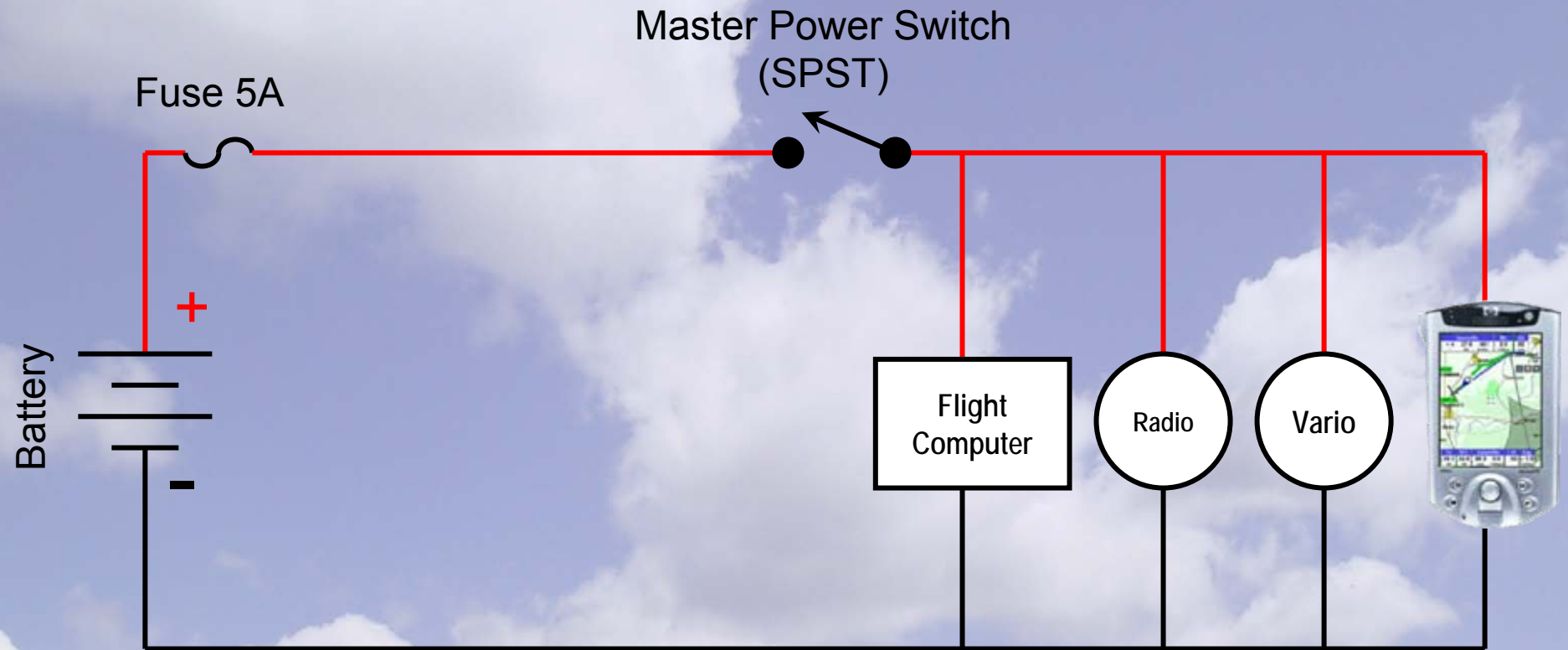
No simple plastic barrier strips

# What Tools Do I Need?

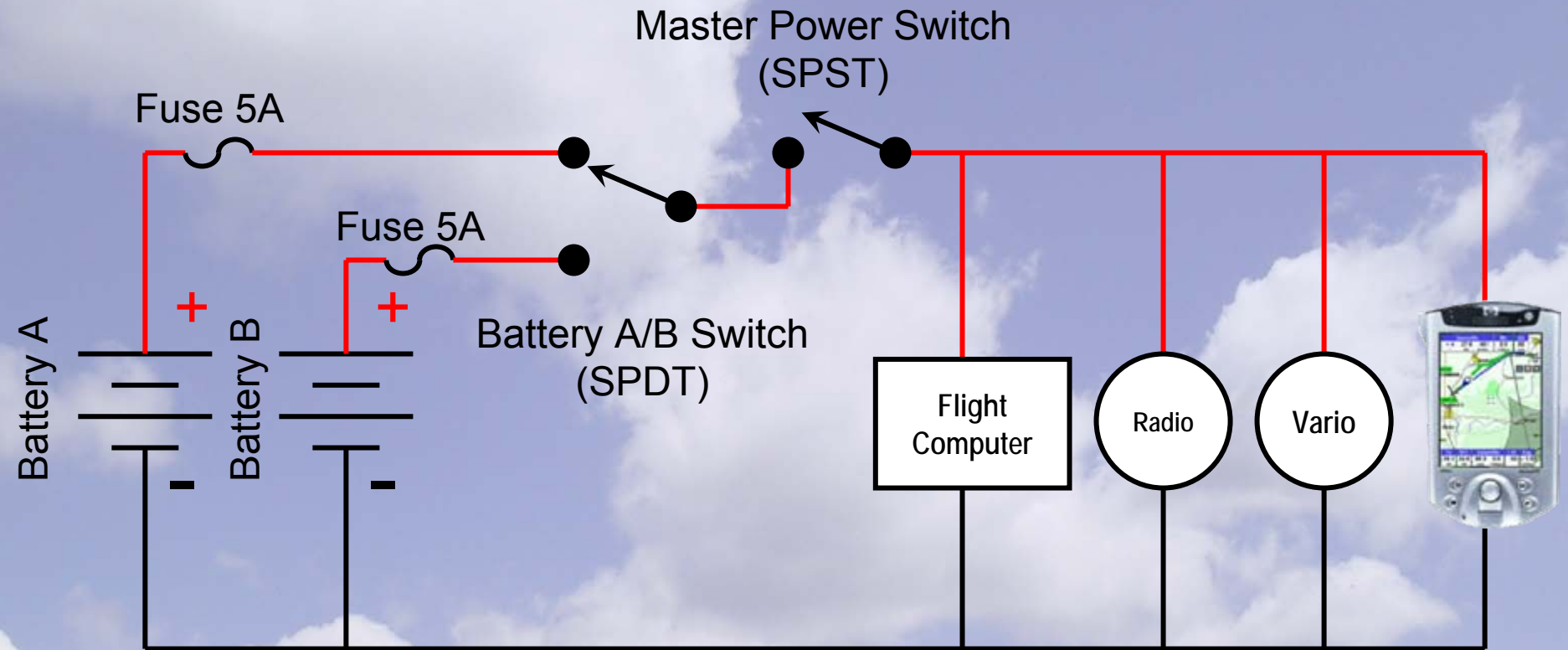
- Voltmeter (continuity and voltage)
- Screwdrivers
- Wire Strippers (sharp)
- Diagonal cutters 
- Crimpers (are bad strippers!) 
- Needle Nose Pliers 
- Soldering Iron and Solder



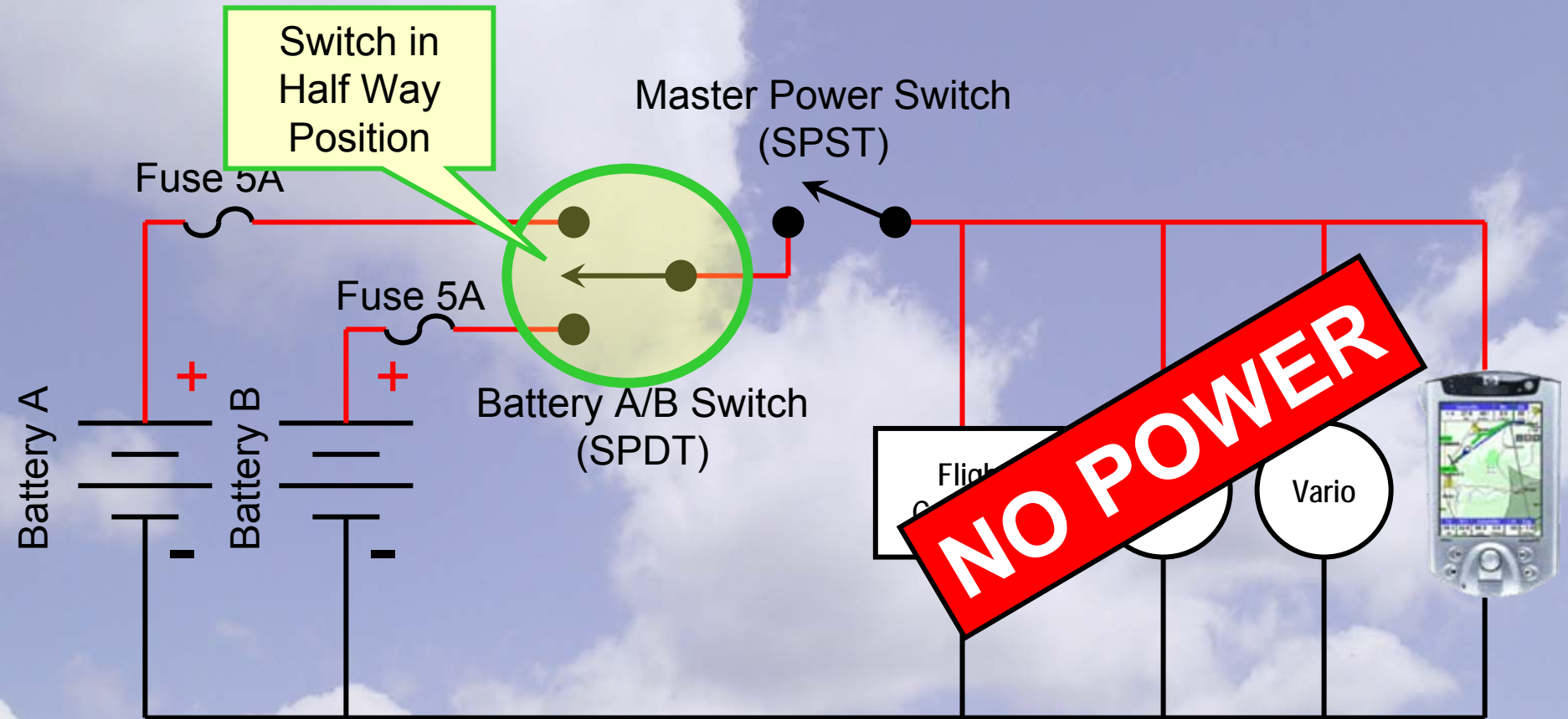
# Simple Power Circuit



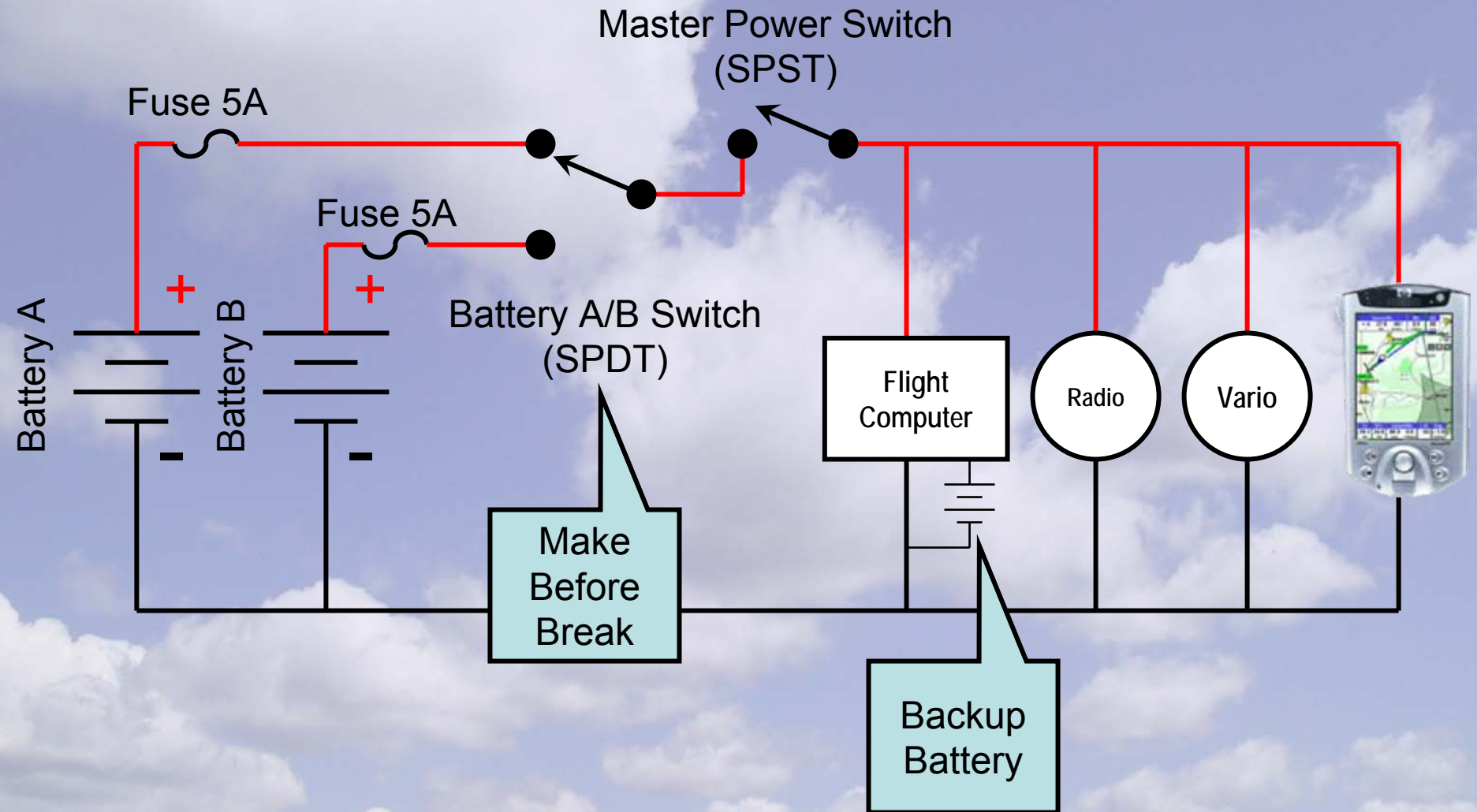
# Simple Power Circuit



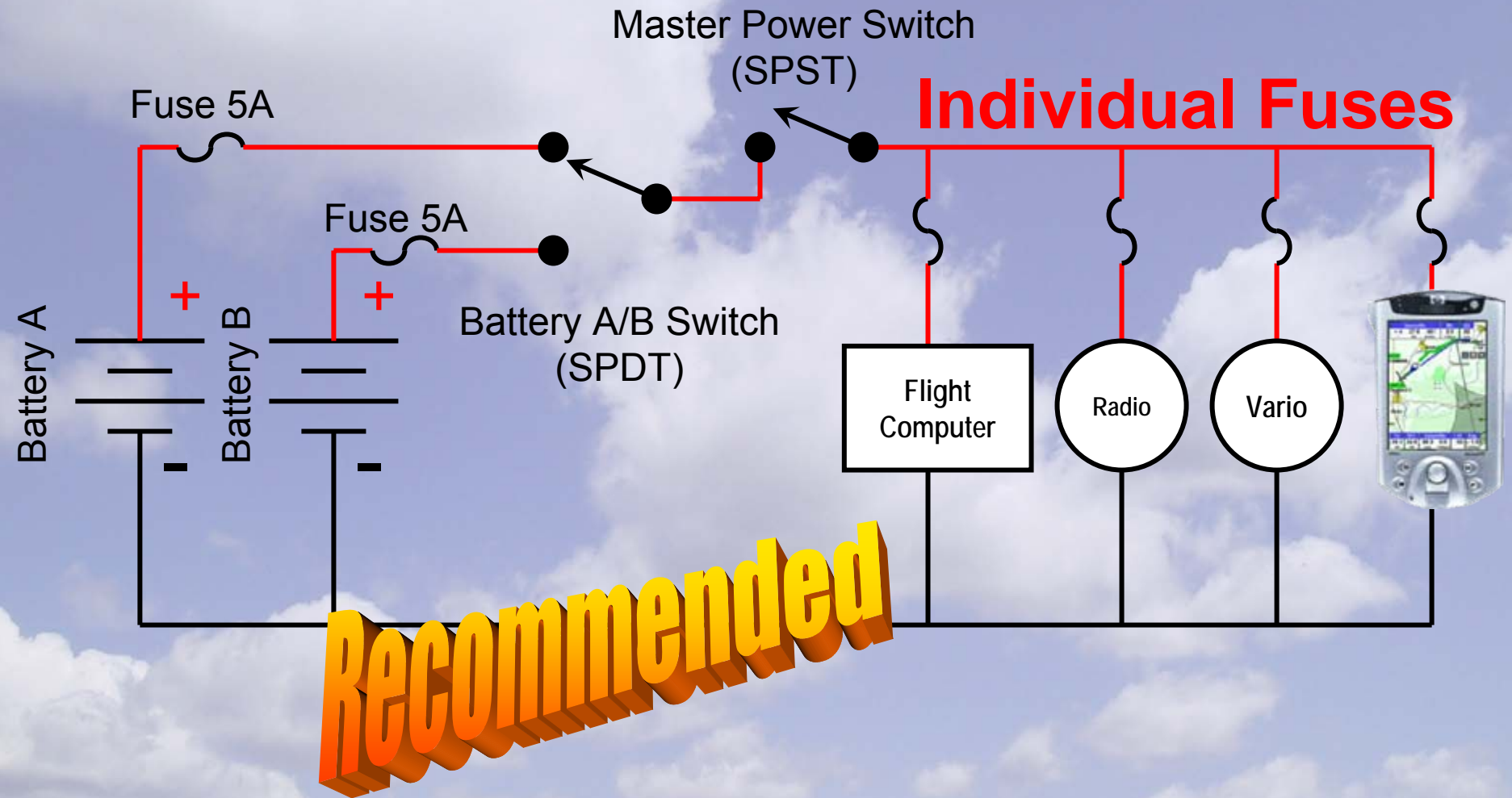
# Simple Power Circuit



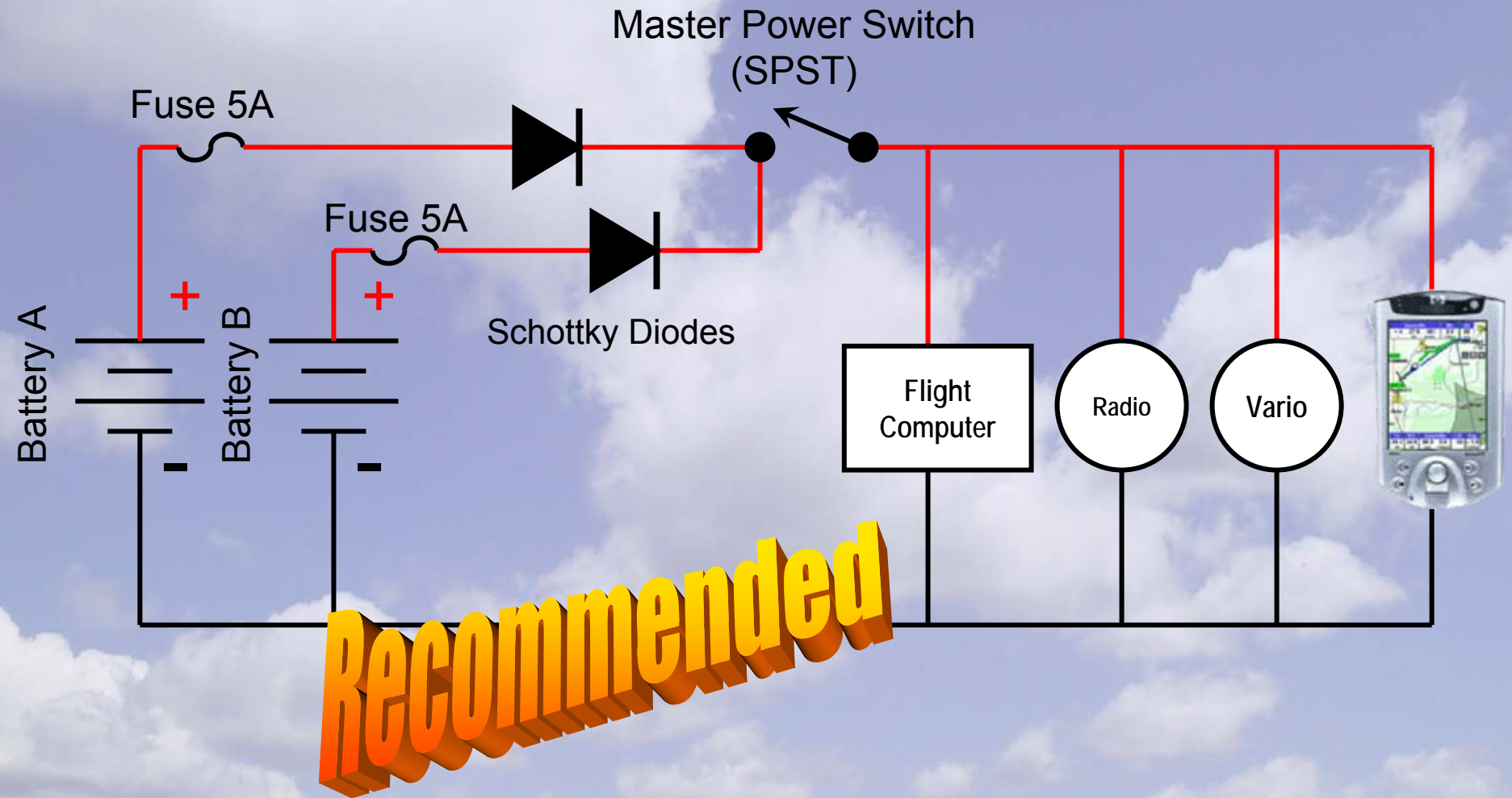
# Simple Power Circuit



# Simple Power Circuit



# Simple Power Circuit



# Surviving a Power Outage

	<b>Cambridge</b>	<b>Garrecht Volkslogger</b>	<b>LX Navigation</b>	<b>New Technologies</b>	<b>Borgelt</b>	<b>EW</b>
During a power interruption, will IGC file be maintained?	Yes	No, new file	Yes	Yes	Yes	Yes, if internal battery charged
How long of a power interruption can be survived?	2 hours with aux battery, otherwise ???	0.1 sec	Approximately 1 min	few seconds	hours to weeks	N/A
Start new log file?	5 mins before starting new log file	Yes	1 min before starting new log file.	5 mins before starting new log file		No
Require secondary power source?	CAA-117 auxillary battery	Yes	No	No	Internal "super" capacitor	No
Other information maintained?	Yes	Yes	Yes	Yes	Yes	Yes
Minimum operational voltage?	8Vdc is guaranteed but 6Vdc is possible	7Vdc	8Vdc	8.9Vdc	10.0Vdc	3.5Vdc internal

# Power and Batteries

- Voltages needed
  - In the past systems needed multiple voltages
  - Modern equipment needs only 12Vdc (~11-15Vdc)
- Voltage X Amperage = Power
  - Water volume versus water pressure
  - Voltage Drop – shorter, bigger wires
- Types of Batteries...

# Batteries

- Types

- Lead Acid Jell Cells
  - Heavy, no 0Vdc, high power, voltage decay
- Nickel-Cadmium (Ni-Cd)
  - Memory, no maintenance, flat voltage profile
- Nickel-Metal-Hydride (NiMH)
  - No memory, no maintenance, flatter voltage profile
- Lithium (Ion or Polymer)
  - Light weight, fire risk if shorted, expensive, flattest voltage profile

- Chargers – Smart type

- Not simple brick style

- Amp hour rating

- 9AH = 9 amps of current draw for one hour



**Frank Pascale Battery Speech?**

# How Long Will My Battery Last?

- Current Draw of Equipment

- Radio – 1.6A (during transmit)
- Variometer – 0.2A (with audio)
- Flight Computer – 0.4A (with audio)
- PDA – 0.5A (during charging with backlight)
- **Total maximum current draw = 2.7A**

Never  
all on  
at the  
same  
time

- Battery Capacity = 9.0Ah

- Battery Charge Life Span

- $9.0\text{Ah} \div 2.7\text{A} = 3.33$  hours  
(with everything running at once)

- Transponder?

- Very heavy power draw – Transmits ident code quite often

# Battery Load Testing

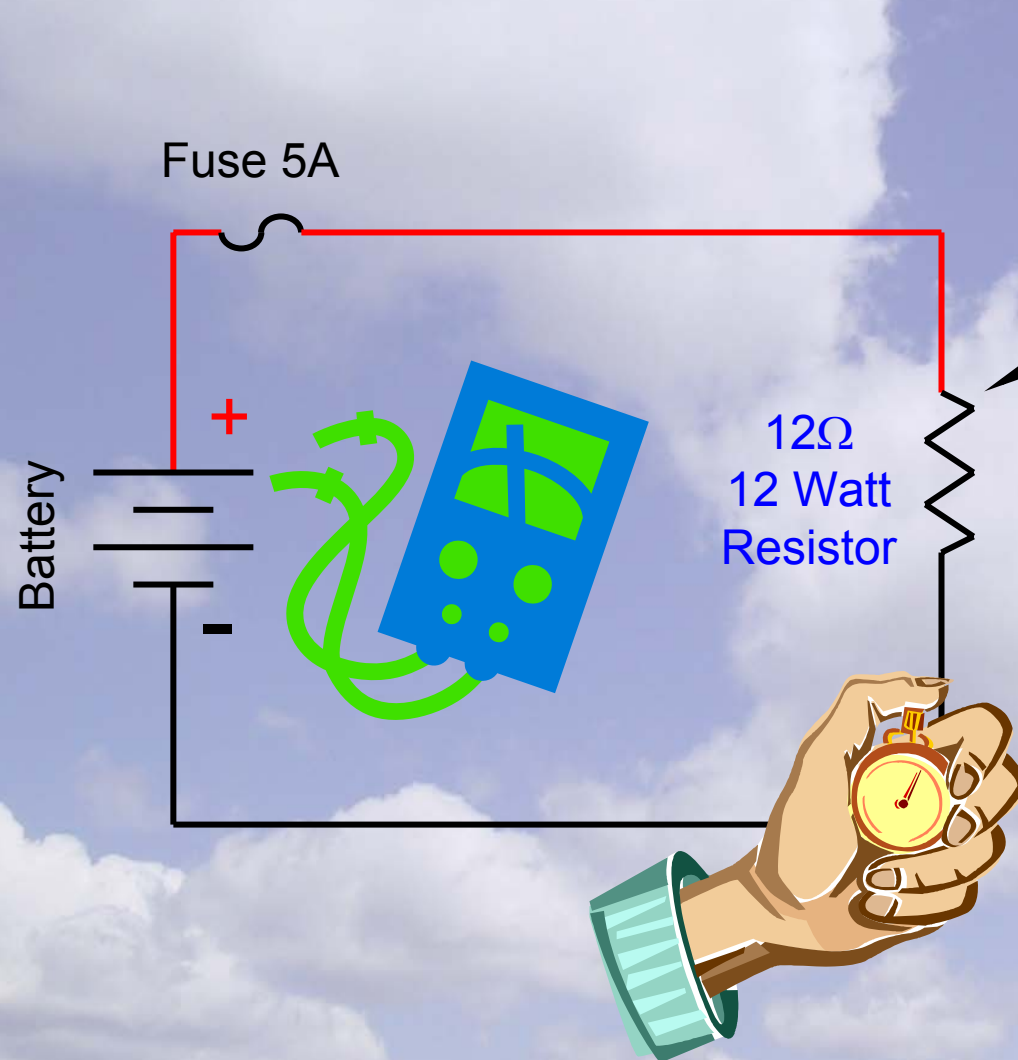
- Find a load resistor to simulate a realistic current draw to test capacity of battery. Reasonable example is  $\approx 1$  Amp.
- Steps to determine size of resistor
  - Determine total maximum current draw
  - Divide 12VDC by the total power draw is the resistor size;  $I=E/R$

Example:  $12\text{VDC}/1\text{A} = 12\Omega$

- Need a “Power” Resistor
  - Wattage of resistor =  $E \times I = 12\text{VDC} \times 1\text{A} \approx 12\text{W}$
- Therefore need a  $12\Omega$ , 12 Watt “power” resistor



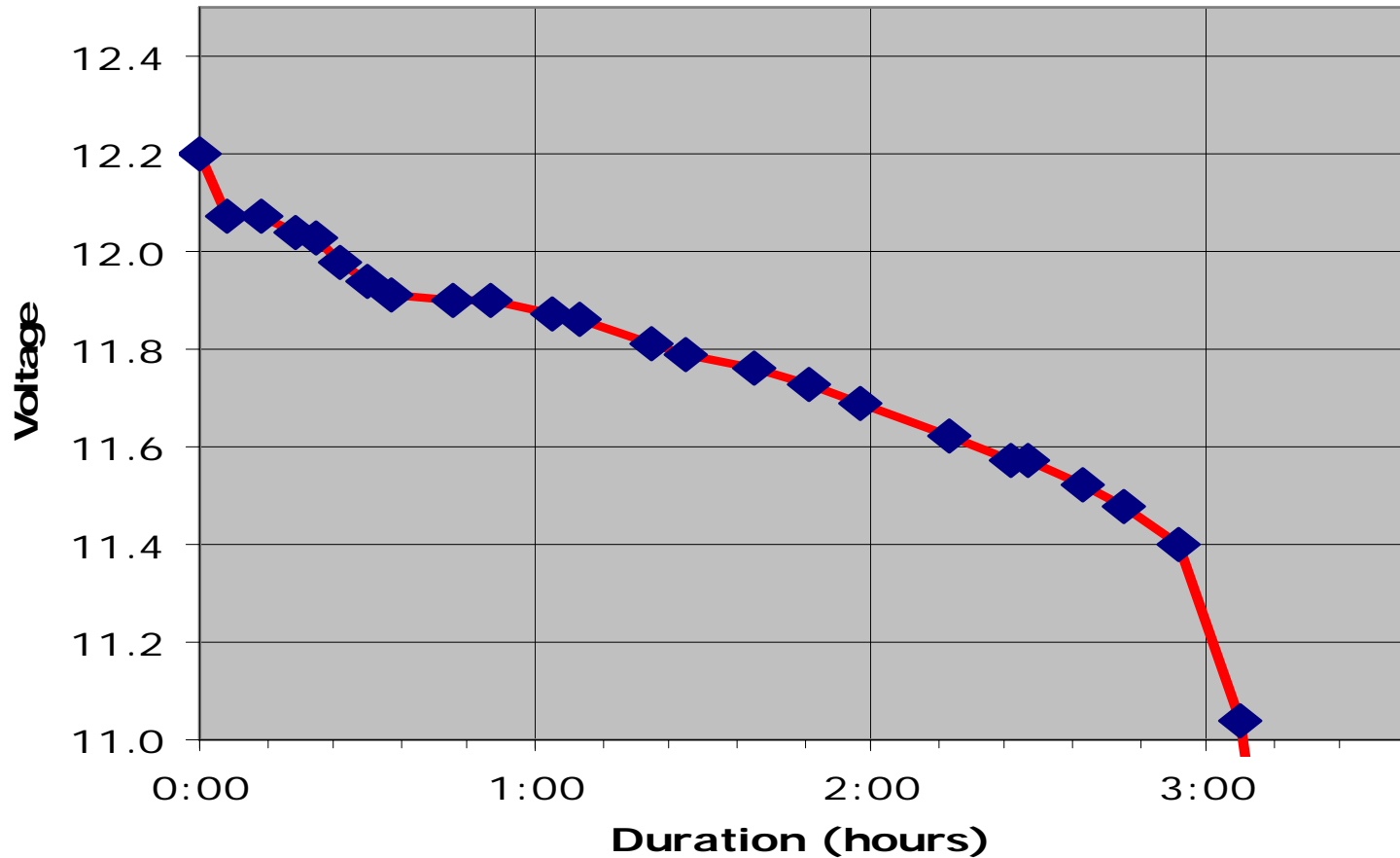
# Battery Load Testing



- 1) Charge Battery
- 2) Connect Voltmeter Across Battery
- 3) Connect Resistor Across Battery
- 4) Use Stopwatch to time until drops to ~11.5VDC

# Sample Load Test

**Gell Cell 12Vdc Battery 9Ah - ~1A Load**



# ***Warning!***

# ***HOT!!***



**Power resistors can get very hot  
when used as a battery load**

# Trailer Wiring

Trailer wiring and harness plugs are available in a variety of sizes and configurations. The most common and basic of designs is the color coded **4-wire** system. The "Flat-4" harness plug is found on almost all boat trailers and many smaller utility trailers that do not have brakes.

## "Flat-4" or "4-Flat" Wiring



Green – Right Stop/Turn  
Yellow – Left Stop/turn  
Brown – Tail/Marker Lights  
White - Ground



Vehicle

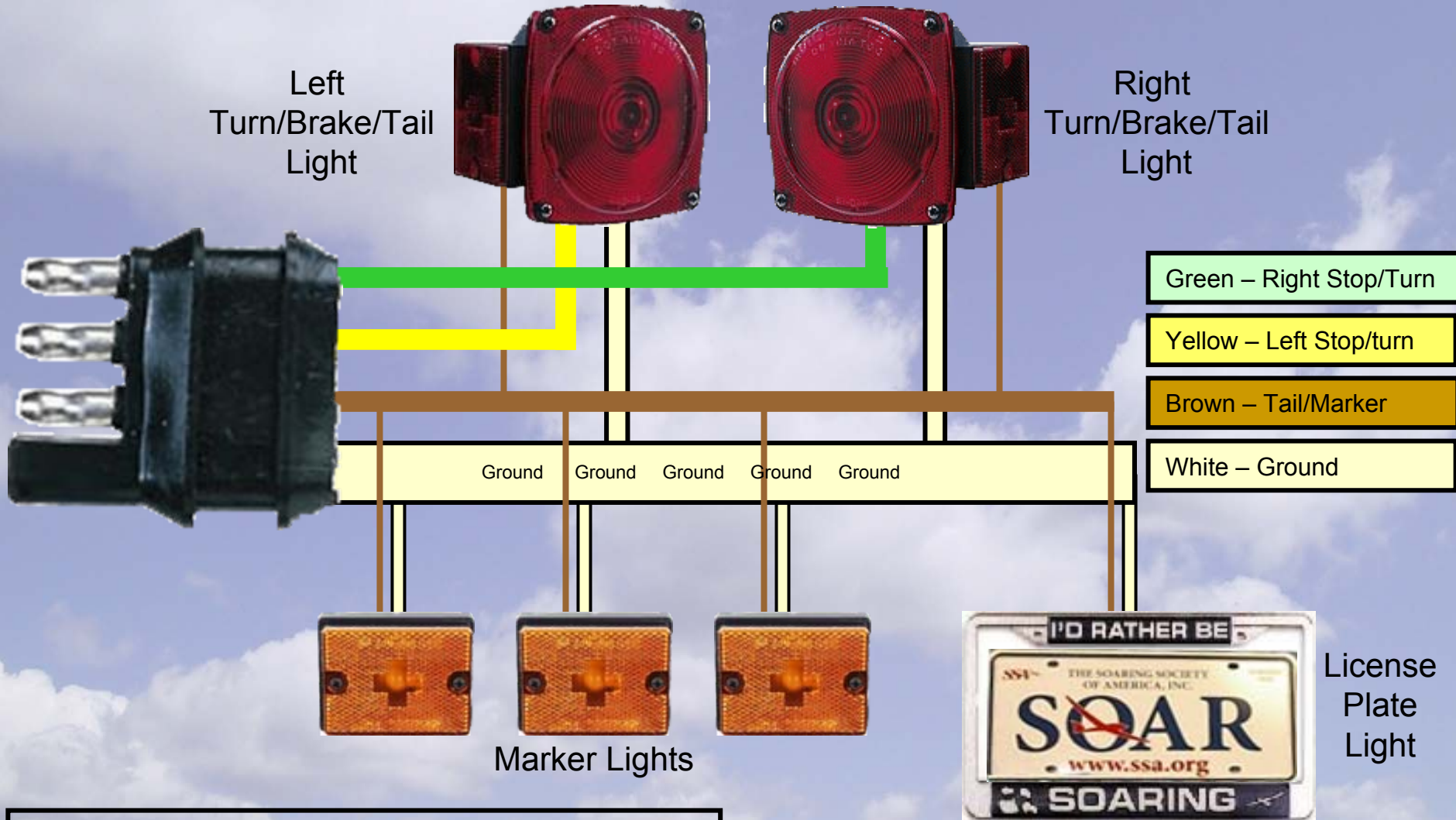
Trailer



# Trailer Wiring

Left  
Turn/Brake/Tail  
Light

Right  
Turn/Brake/Tail  
Light



Green – Right Stop/Turn

Yellow – Left Stop/turn

Brown – Tail/Marker

White – Ground

Ground Ground Ground Ground Ground

Marker Lights

License  
Plate  
Light

White – Ground – Usually connected to the metal trailer frame

# Trailer Hints

- Use good quality lights
  - LED Lights are expensive but the best choice
- Crimp all connections
  - No solder or wire nuts
- Good Ground Connections
  - Remove all rust
- Use Dielectric Grease
  - Dow Corning #4 on all connections
- Use covers on the 4-Flat connectors
- Run wires inside of trailer or frame for as much protection as possible



# Aviation Electrical Parts Sources

<http://www.wicksaircraft.com> - Illinois (near St Louis)

<http://wingsandwheels.com> - New York

<http://aircraftspruce.com> - California & Georgia

<http://wagaero.com> - Wisconsin

<http://www.steinair.com> - Minnesota

<http://www.airsuppliers.com> - Texas

<http://www.hi-line.com> - Texas

<http://www.kleintools.com> – Illinois (near Chicago)

Hamfests  
<http://arri.com>

**The End**

**Questions?**

# ChicagoLand Glider Council

## 2007 Spring Seminar

Saturday, Feb 24, 2007



### Speakers

Dean Carswell  
John Cochran  
Curt Lewis  
John Good  
Derek Piggott  
Karl Striedieck



Registration Forms Available at Front of Room  
See <http://chicagolandglidercouncil.com> for details