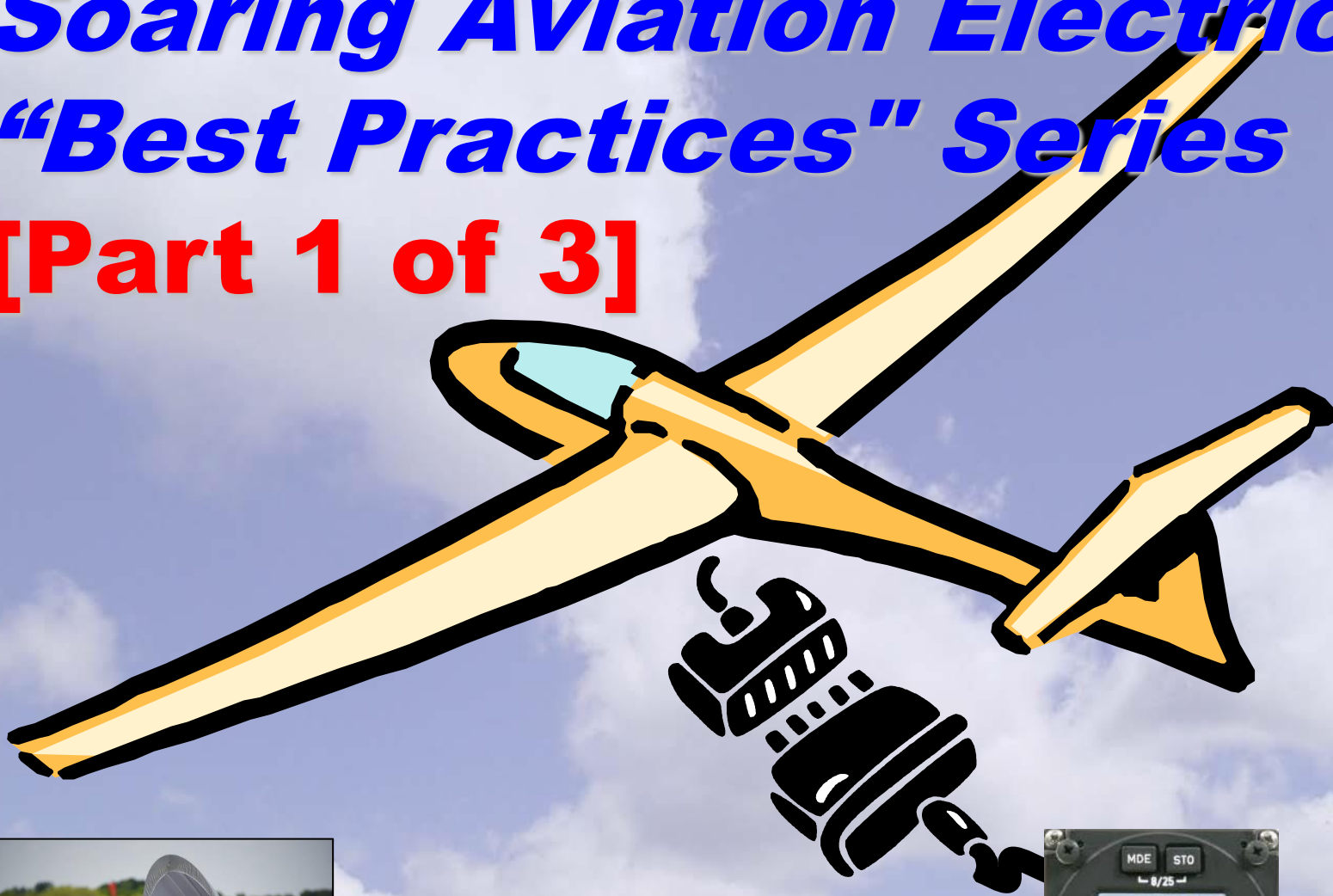


# ***Soaring Aviation Electrical*** ***“Best Practices” Series*** **[Part 1 of 3]**



***John DeRosa OHM Ω***  
***Updated: December 30, 2023***



# PLEASE NOTE

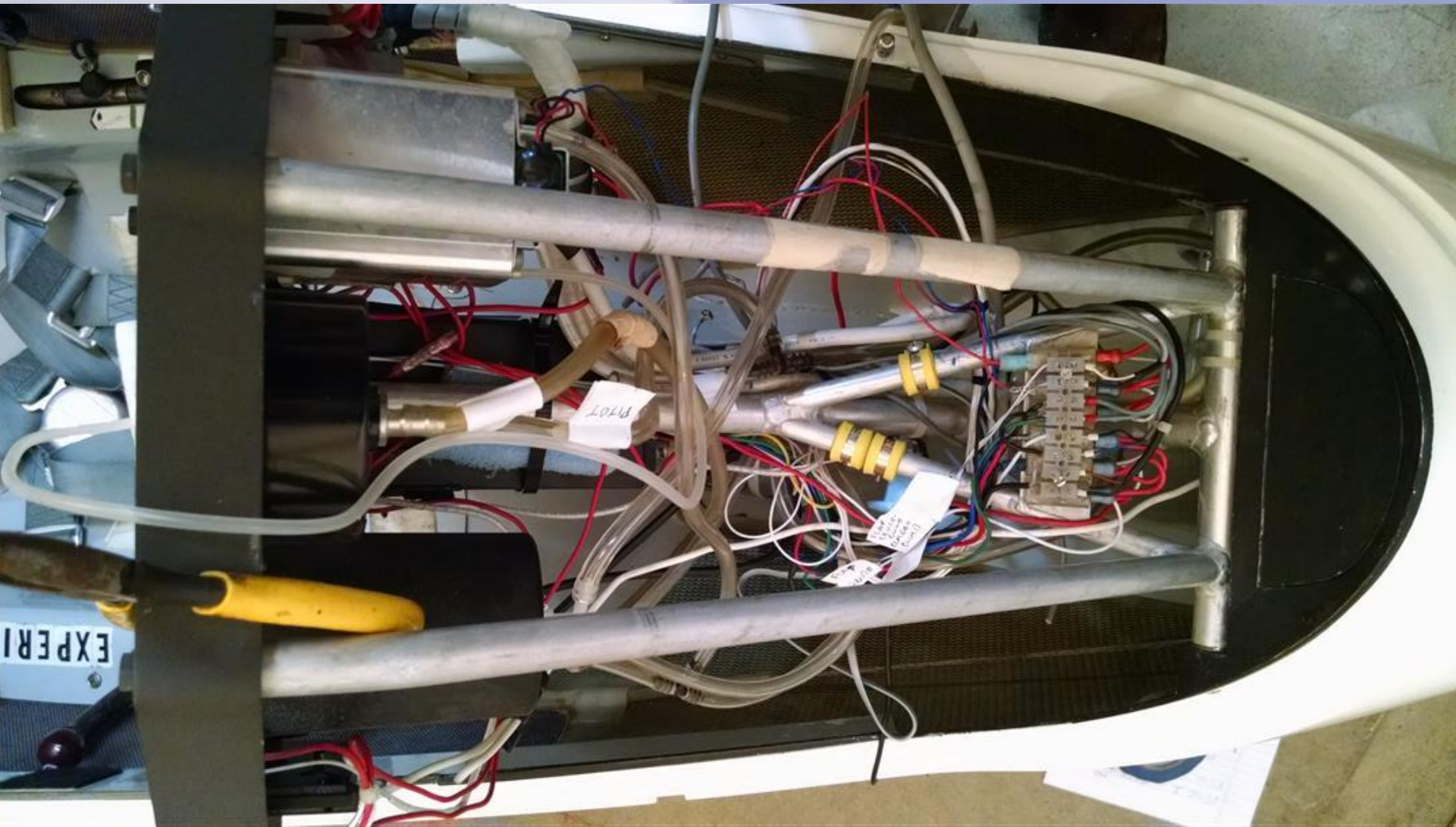
This document may have been updated with new information, changes, and corrections.

Be sure to visit my presentation web site and download the latest version of this document. It could make an important difference to your work!

<http://aviation.derosaweb.net/presentations>

Thank you, John

“WHOA! What a rat’s nest!”



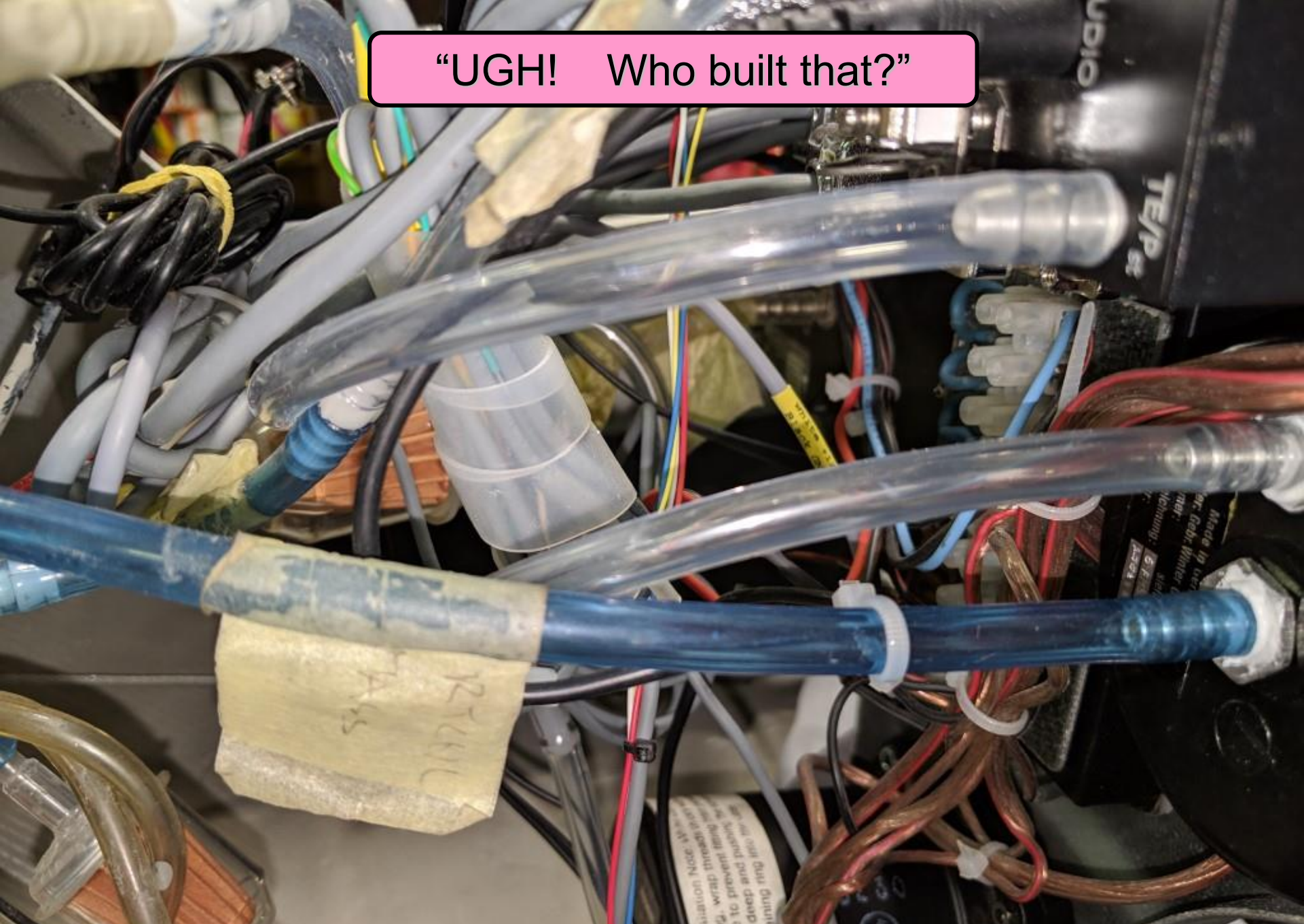


“MAN! Is this dangerous?”





“UGH! Who built that?”



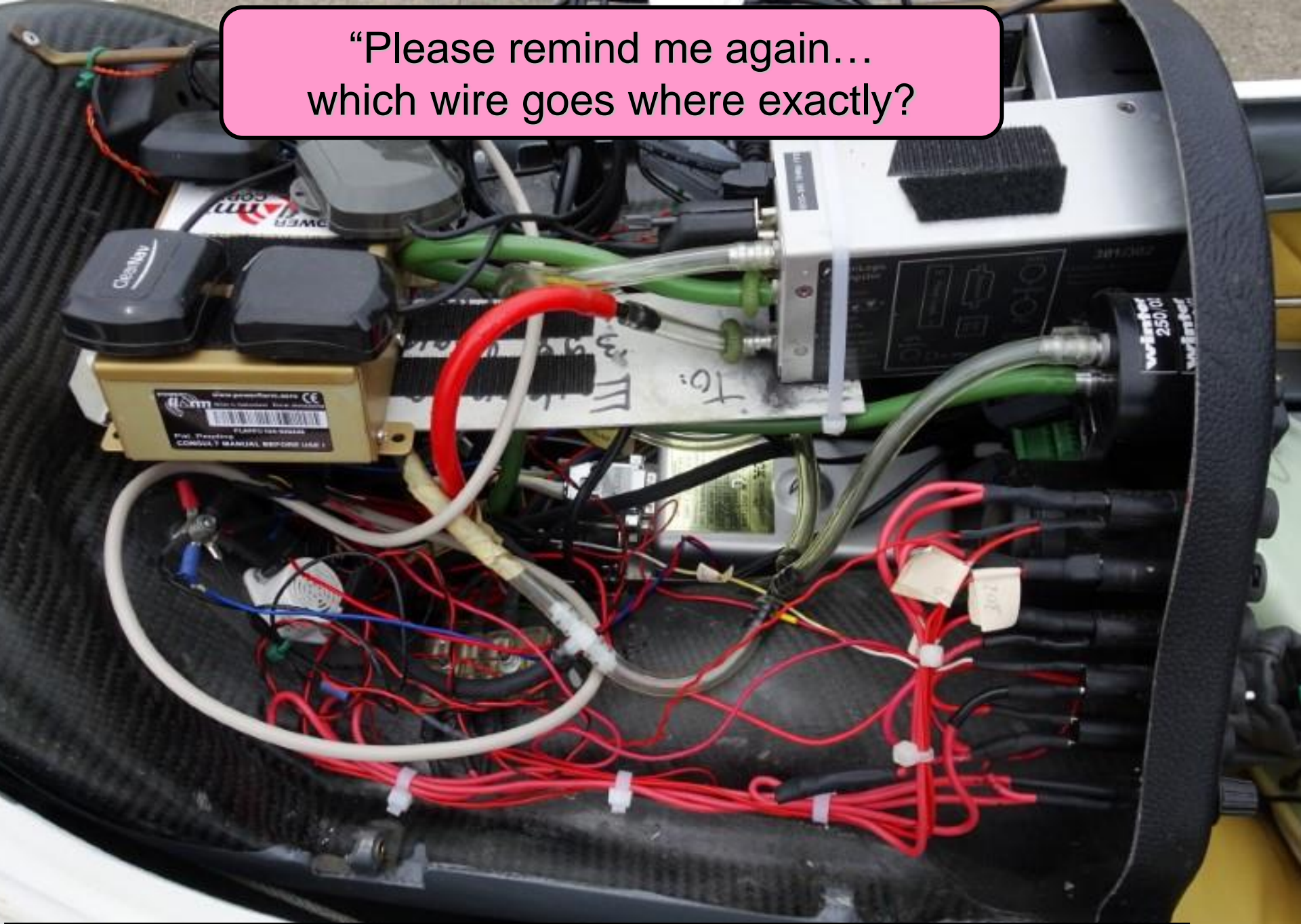


“This looks like a bomb went off!”





“Please remind me again...  
which wire goes where exactly?”





“Ahhhh. This is much better!”





# Disclaimers

- I am **not** an FAA licensed A&P or IA
- I am **not** an approved avionics technician
- You should know the difference between Experimental & Standard airworthiness certification, and what you can and cannot do to your glider
- Work closely with an IA to get your work properly inspected and signed off in your glider's log book
- Proceed at your own risk.

# Chapters

## Part 1

1.  Reference Information
2.  Your Tool Box
3.  Wires and Wiring
4.  Making Connections
5.  Other Things of Note

## Part 2

6.  Power Management

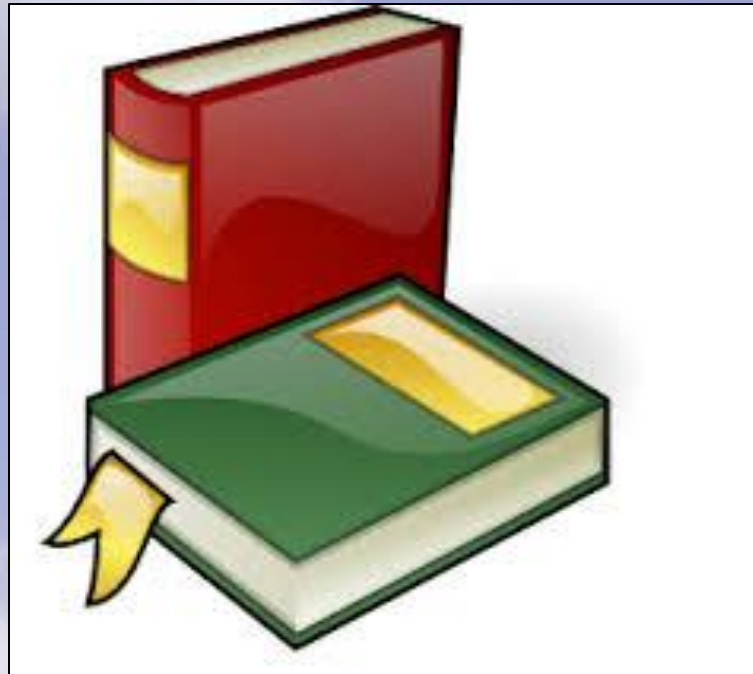
## Part 3

7.  Examples of Battery Circuitry
8.  Minimizing Lost Volts
9.  Providing USB Power

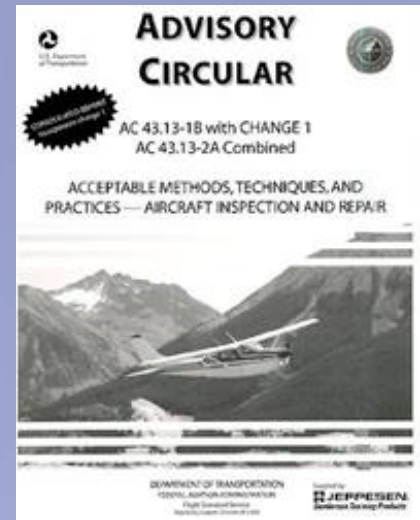


# Chapter 1

# Reference Information



# Reference Information



- **FAA Documentation**
  - The “BIBLE” → AC 43-13-1b
    - Chapter 11 “AIRCRAFT ELECTRICAL SYSTEMS”
  - “Aircraft Electrical Wiring Interconnect System (EWIS) Best Practices”
- **Videos**
  - <https://www.eaa.org/Videos/Hints-for-Homebuilders>
  - <https://www.steinair.com/documents-and-support/videos/>
- **Articles**
  - <http://aeroelectric.com/articles.html>
  - [http://verticalpower.com/media/attachments/2017/07/20/connector\\_service\\_manual.pdf](http://verticalpower.com/media/attachments/2017/07/20/connector_service_manual.pdf)

All of the above information is freely available online



# Chapter 2

## Your Tool Box



# What Basic Tools Do You Need?

(Approximate Pricing)

- Voltmeter (\$10 and up)
- Screwdriver (\$5)
- Wire Strippers (\$10)
- Connector Crimping tool (\$10)
- Small Needle Nose Pliers (\$10)
- Small Diagonal Pliers (\$10)
- Soldering Iron & Solder (\$15)
- Heat (shrink) Gun (\$20)
- Drill bits (\$30)



Small Tip



**Total Cost: ~\$120**



# Tools – Wire Strippers

Not Recommended!



Better



**16 to 26 gauge**

Best



# Tools - Crimping

**Not Recommended!**



**Better**



*Single  
Crimping*

**Best**



*Ratcheting  
Double  
Crimping*

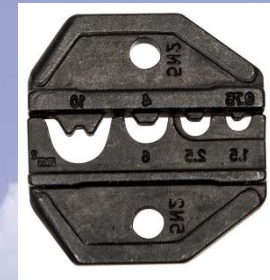




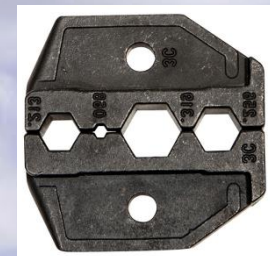
# Tools - Crimping



**Other  
Interchangeable  
Die Sets**  
(more types available)



**Non-Insulated Terminals  
VDV205-044**



**Coaxial Connectors  
RG58, RG59, RG6, RG62  
VDV211-037**

# Tools – Drill Bits

## Spiral Drill Bits

Used for  
Thicker Materials

Its nice to have a set of  
1/6" to 1/2" (by 64ths)

Optional  
#1 to #60  
Metric



## Step Drill Bits

Great for use on  
Thin Sheet Metal





# Tools – Hole Saws

Hole saws are handy for cutting larger holes in thin materials such as with an instrument panel.  
Two common sizes of holes for instruments are  
**2-1/4" (57mm) and 3-1/8" (80mm)**



<b><u>Common Non-Metric Sized Instrument Holes</u></b>	<b><u>Closest Metric Dimensions</u> (over/under size)</b>
2-1/4" (2.25")	57mm (2.24") 58mm (2.28")
3-1/8" (3.125")	79mm (3.11") 80mm (3.15")

<b><u>Common Metric Sized Instrument Holes</u></b>	<b><u>Closest Non-Metric Dimensions</u> (over/under size)</b>
57mm	2-7/32" (56.36mm) 2-1/4" (57.15mm)
80mm	3-1/8" (79.375mm) 3-5/32" (80.17mm)



# Chapter 3

# Wires and Wiring





# Wire

- IN ONE WORD → **TEFZEL**\*

- Required in every type of aircraft
- Flame Resistant
- Abrasive Resistant
- Non-hazardous Fumes
- Mil-spec

- **Costs a bit more, but worth it!**

- \$0.20 to \$0.70 per foot depending on gauge & number of conductors
- Small \$20-\$30 total difference for an entire panel rewire
- Using multiple colors to ease identification and maintenance
- Labeled with gauge, type & manufacturer along the length
- Mil-spec
  - Unshielded - MIL-W-22759/16
  - Shielded - MIL-C-27500



\* Tefzel is a brand name of Dupont and is a Fluorocopolymer thermoplastic material with excellent electrical properties, heat resistance, chemical resistance, toughness, radiation resistance, and flame resistance.

# Tefzel Wire – Technical Info

Tefzel is a brand name of Dupont for the Ethylene tetrafluoroethylene (ETFE) thermoplastic material used to coat aviation wiring which has with excellent electrical properties, heat resistance, chemical resistance, toughness, radiation resistance and flame resistance.



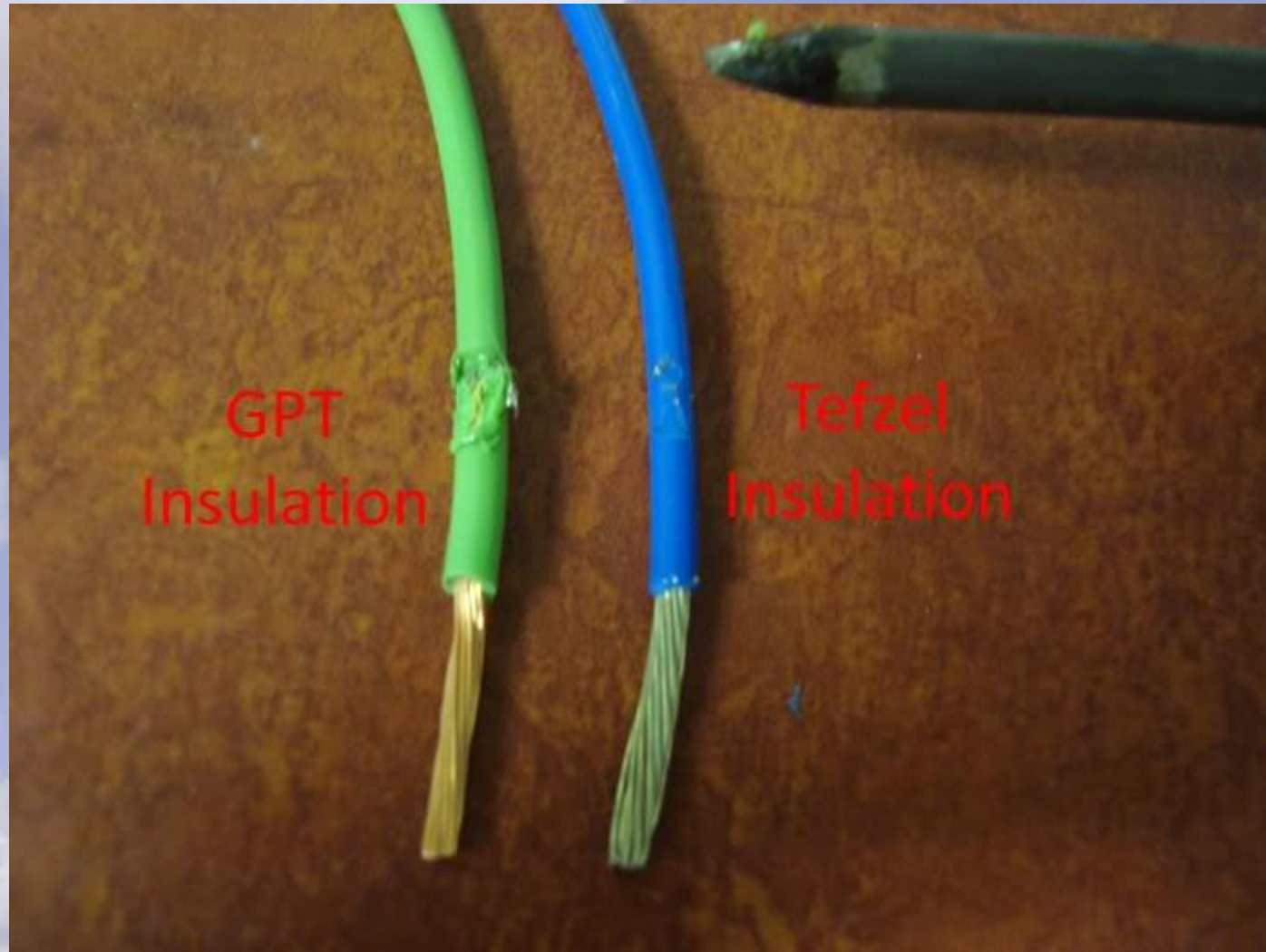
For many years the standard hookup wire in light aircraft has been MIL-W-5086A, which calls for use of tin-coated copper conductor rated at 600 volts and temperatures of 105°C. The Air Force does not permit such wire to be used in military aircraft due to the toxic fumes generated in the event of a fire which can disable the crew.

This has been replaced with MIL-W-22759/16 and MIL-W-22759/32 wiring across the aviation manufacturing landscape. M22759/16 has a thicker Ethylene Tetrafluoroethylene (ETFE) outer jacket and M22759/32 has a thinner Fluoropolymer Cross-linked Modified (ETFE) outer jacket.

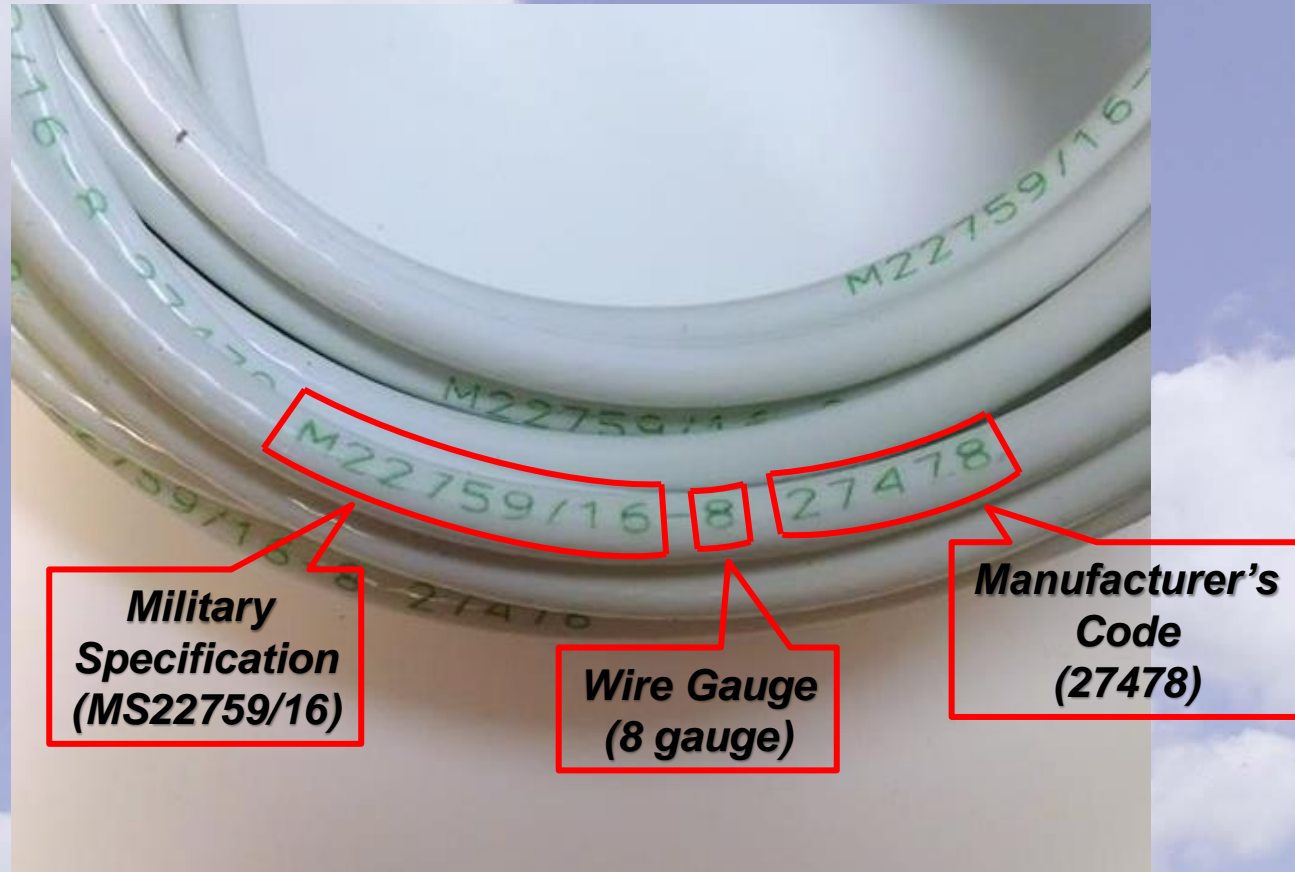


# Tefzel Wire

## Soldering Iron Heat Test



# Tefzel Wire - Markings



Information repeated along the entire length of the cable



# Tefzel - Multi-Conductor

## Comes in Shielded and Non-Shielded

For Speakers, Microphones, PTT Switches, etc.



Outside jacket are not marked with gauge

# Coaxial Cables

*Typically Glider Coax  
RG-58 (50 ohm)*



**BNC Connectors**  
*Typically found  
on transceivers*



**TNC Connector**  
*Typically found  
on transponders*

***See my Transceiver Troubleshooting presentation for more details on coax cabling***



# Transceiver Troubleshooting Presentation

<http://aviation.derosaweb.net/presentations>

## Transceiver Troubleshooting



Issue Date: September 30, 2019

This document is updated quite often!  
Be sure to download the latest version!

See My  
Presentation for  
More Coax Details

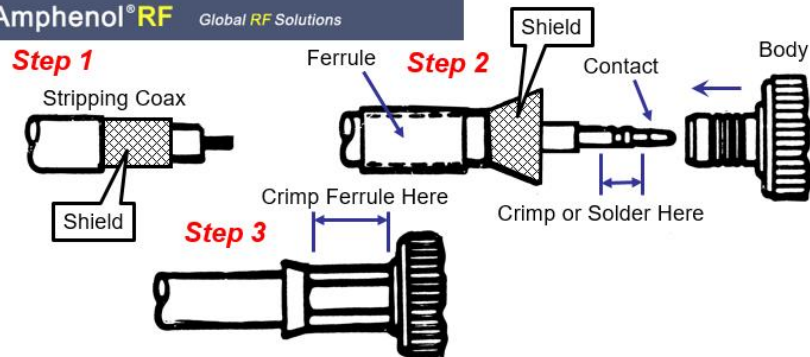
## BNC Connectors

Coax Crimping Tool  
\$15-\$25

Microaire recommends using only soldered or crimped BNC connectors

**Solderless/Crimless/Screw-on BNC connectors are NOT recommended! Their performance is considered substandard!**

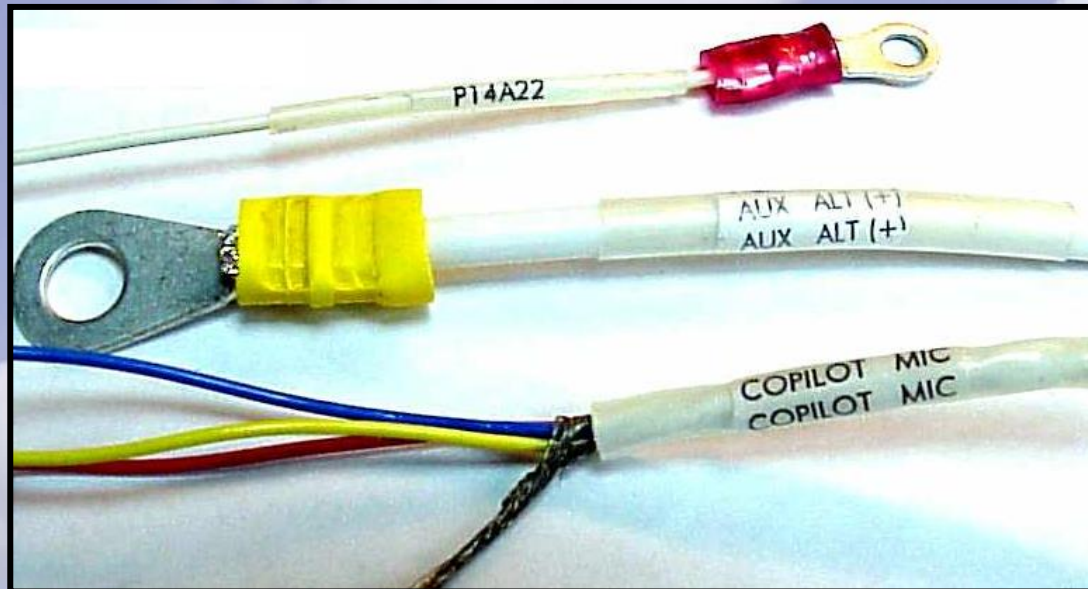
Amphenol® RF Global RF Solutions



BNC = Bayonet Neill-Concelman)

# Wire Labeling

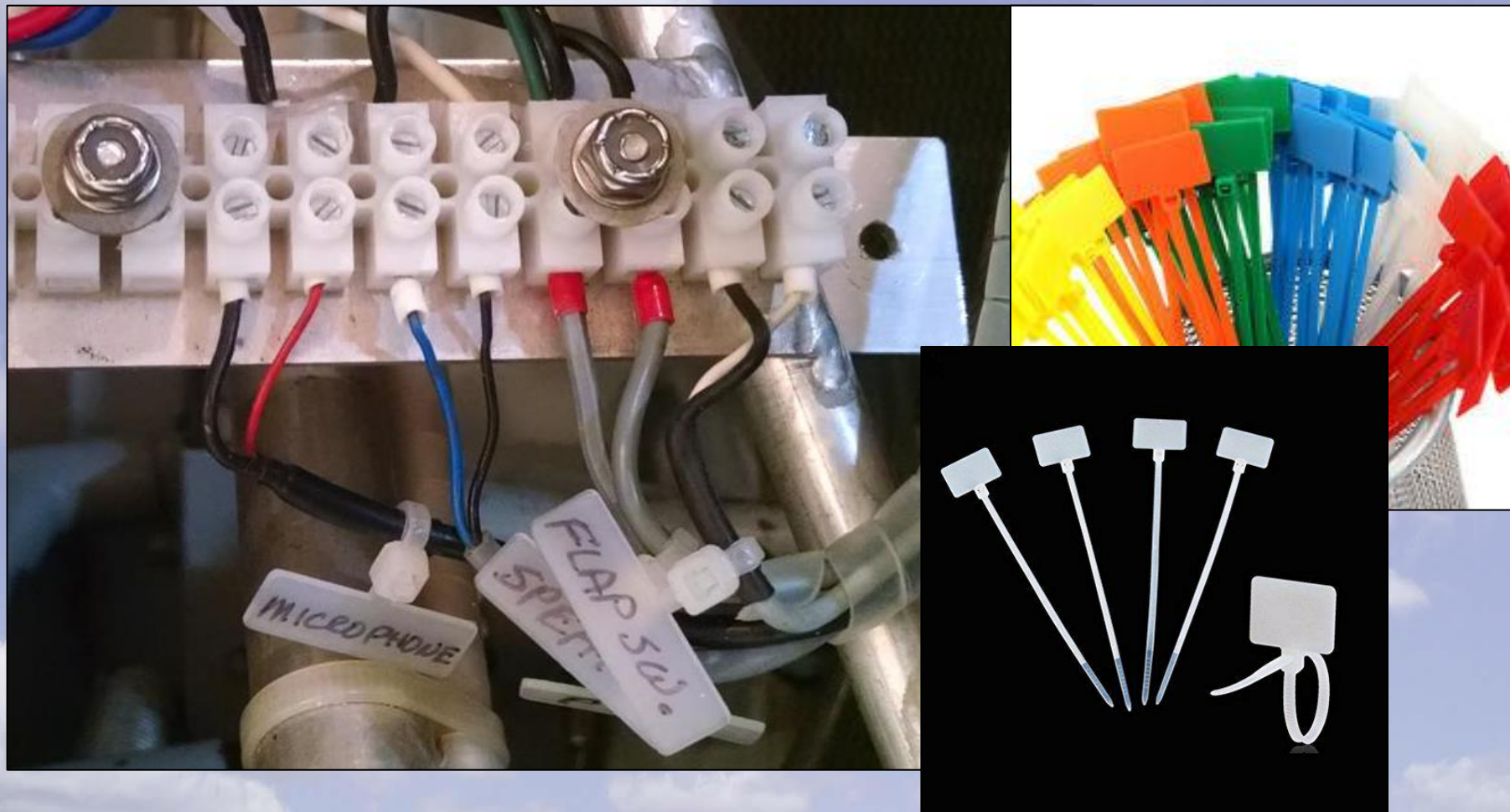
- **FAA AC43-13-1b Par 11-208**
  - **“PLACEMENT OF IDENTIFICATION MARKINGS”**  
***“Identification markings should be placed at each end of the wire and at 15-inch maximum intervals along the length of the wire.”***
- Markings greatly assists the tracing of similarly colored wires which are often all white





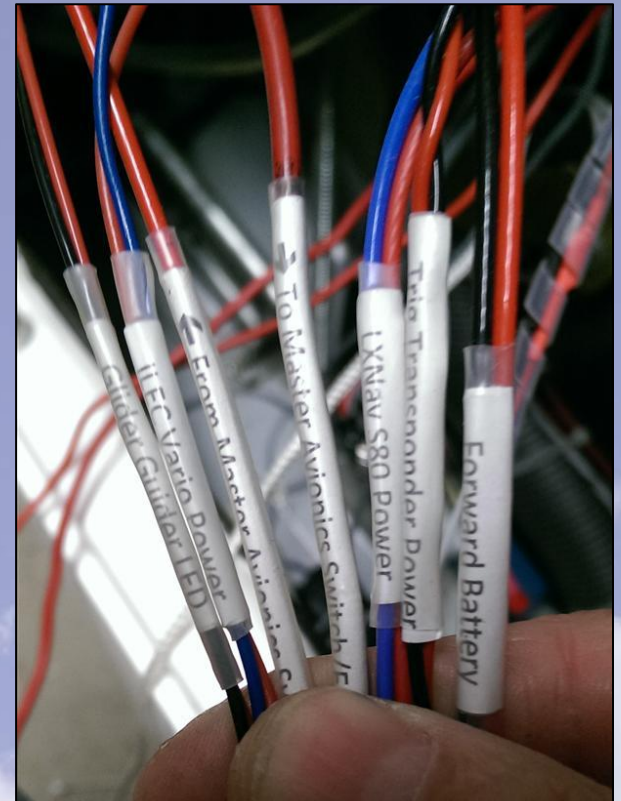
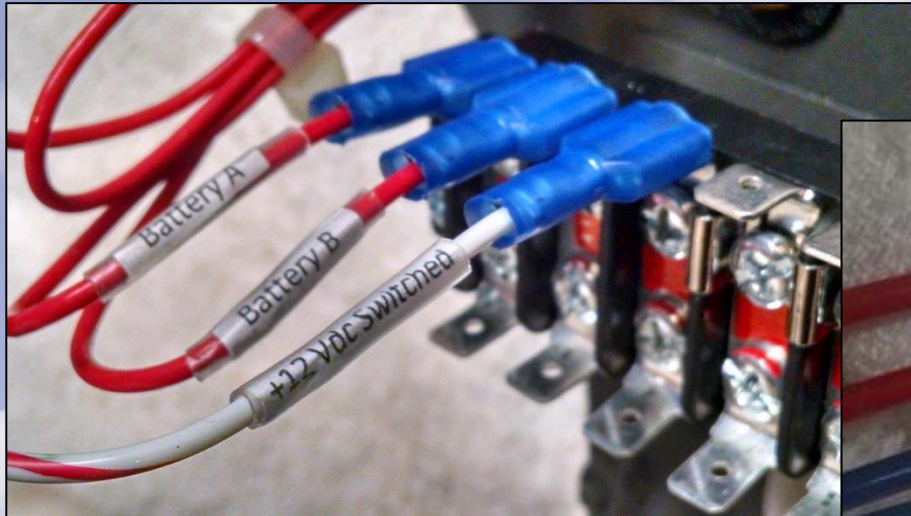
# Wire Labeling

- Print on Flag/Tab Type Cable “Zip” Ties



# Wire Labeling

- **Simple & Effective;**
  - Print function on plain paper
  - Cut out the individual labels
  - Place label under clear heat shrink
  - Apply heat to keep in place!





# Wire Labeling

## Printing Directly on Heat Shrink Tubing



**Dymo  
160  
(~\$30)**



**Tape Cartridges  
~\$25**

IND	LABEL APPLICATIONS	LABEL COLOR	1/4" 6mm	3/8" 9mm	1/2" 12mm	3/4" 19mm
	<b>HEAT SHRINK TUBE</b> Length 5'   1.5m - UL Recognized Component to UL224 - Meets MIL-STD-202G, MIL-M-81531 & SAE-DTL-23053/5 (Class 1 & 3) - RoHS compliant	BLACK ON WHITE	18051	18053	18055	18057
		BLACK ON YELLOW	18052	18054	18056	18058

# Wire Labeling

## Printing Directly on Heat Shrink Tubing

**Brother P-Touch  
PTD210 \$15**



**Uses TZe  
Tape Cartridges  
~\$25**





# Chapter 4

# Making Connections



# Connections: “Crimp” or “Compression”

- No Wire Nuts!!
- Get good quality from reliable sources
- Use Nylon only
- Use Ring not spade
- Brands: AMP, PIDG
- Sources: Waytekwire, Aircraft Spruce, Chief Aviation



Ratcheting Crimping Tool ~\$30



# Connections: “Crimp” or “Compression”

- **Nylon Insulation** →

- Translucent
- Tough
- Heat resistant
- Crimp is visible



- **Vinyl Insulation** →

- Opaque
- Brittle
- Melts easily
- Crimp is hidden





# “Crimp” or “Compression” Gauges, Diameters & Types

**Standard US Wire Gauge & Colors**



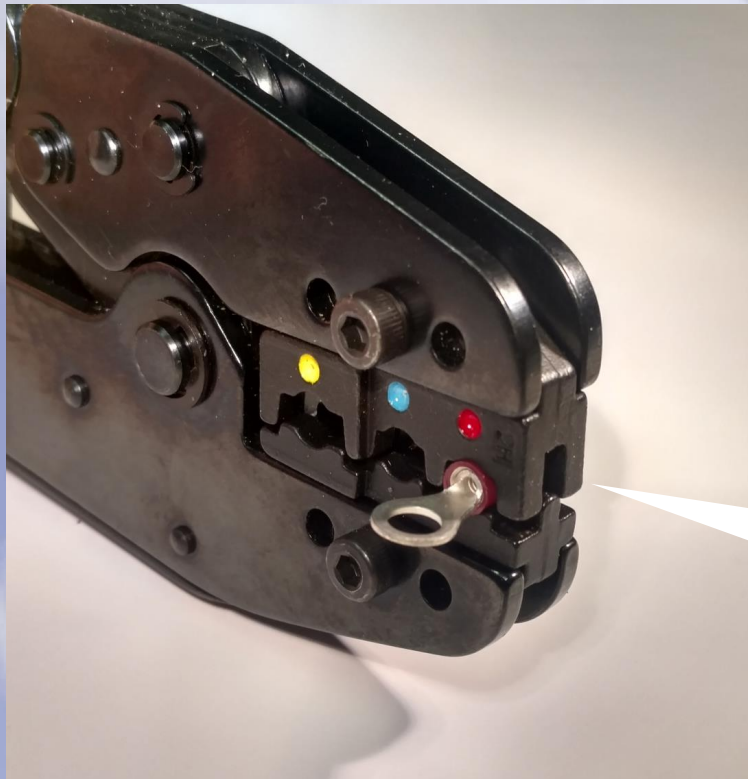
**Various Ring (Bolt) Diameters**



**Various Terminal Styles**



# Connections: “Crimp” or “Compression”



Standard US  
Color Codes &  
Wire Gauges

**Wire Gauge  
Color Coded  
Terminals**

Color	Small	Standard	Large	V. Large
Red		#18-22	#8	#2
Blue		#14-16	#6	
Yellow	#24-26	#10-12	#4	

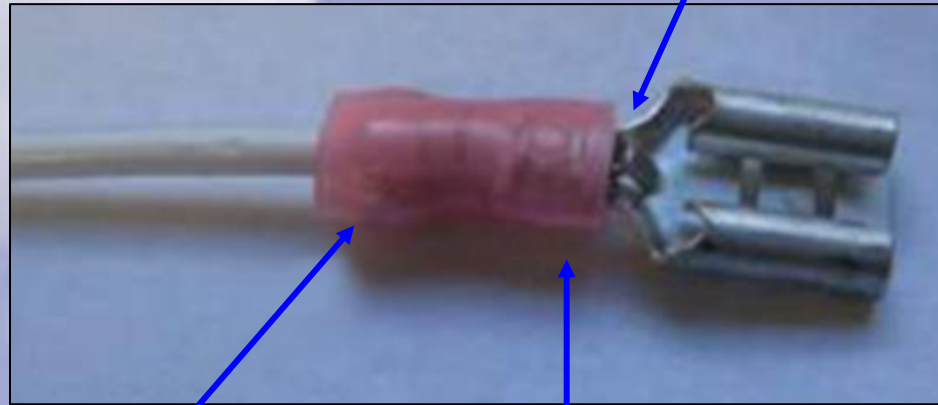
# Connections: “Crimp” or “Compression”

Required: Exposed Wire for FAA Inspection + Double Crimp

Get a Ratcheting  
Double Crimping  
Tool!



End of Wire is Visible



Insulation is  
Crimped

Wire is  
Crimped

Same for Butt Splices →



**Reference:**

[http://verticalpower.com/media/attachments/2017/07/20/connector\\_service\\_manual.pdf](http://verticalpower.com/media/attachments/2017/07/20/connector_service_manual.pdf)



# “Crimp” or “Compression” - Insulated Ferrules

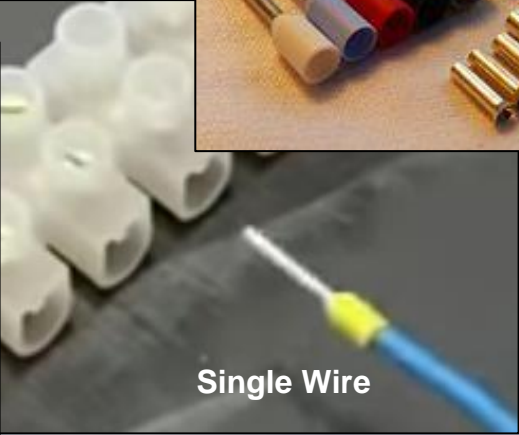
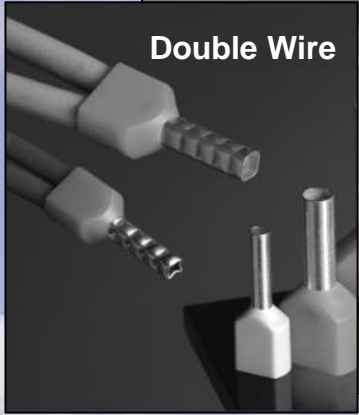
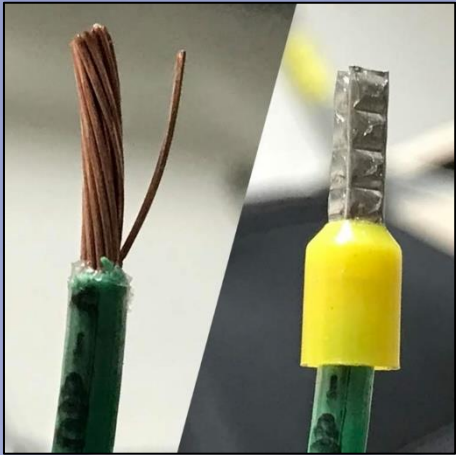
*Commonly used in Europe. Insulated ferrules are crimped onto the ends of wires to prevent loose strands from shorting to adjacent wiring in screw down terminal blocks. These are functionally similar to “pin” terminals.*



Step 1: Strip the wire & insert into ferrule.

Step 2: Crimp the ferrule with a wire crimper.

Step 3: A tightly crimped wire with ferrule is done. Just start your electrical projects.



Metric Color Coding (DIN 46226)

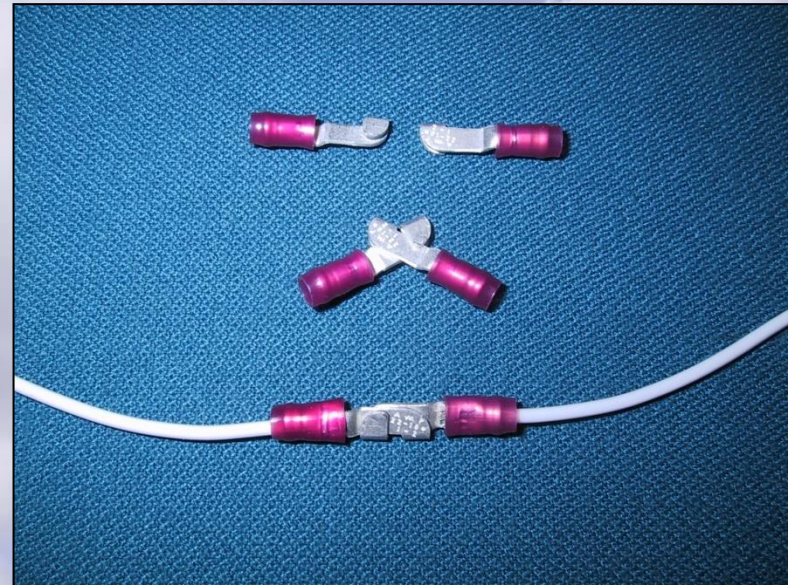
US Wire Gauge (approx)	Wire Gauge (mm <sup>2</sup> )	Color Coding
	10	Red
10 AWG	6	Yellow
12 AWG	4	Gray
14 AWG	2.5	Blue
16 AWG	1.5	Black
18 AWG	1.0	Red
20 AWG	0.75	Gray
22 AWG	0.50	White

<https://library.automationdirect.com/ferrule-ferrule-ferrule-right/>  
[https://www.youtube.com/results?search\\_query=ferrule+crimping](https://www.youtube.com/results?search_query=ferrule+crimping)

# Joining Wires Together

## Splicing Non-shielded Cabling

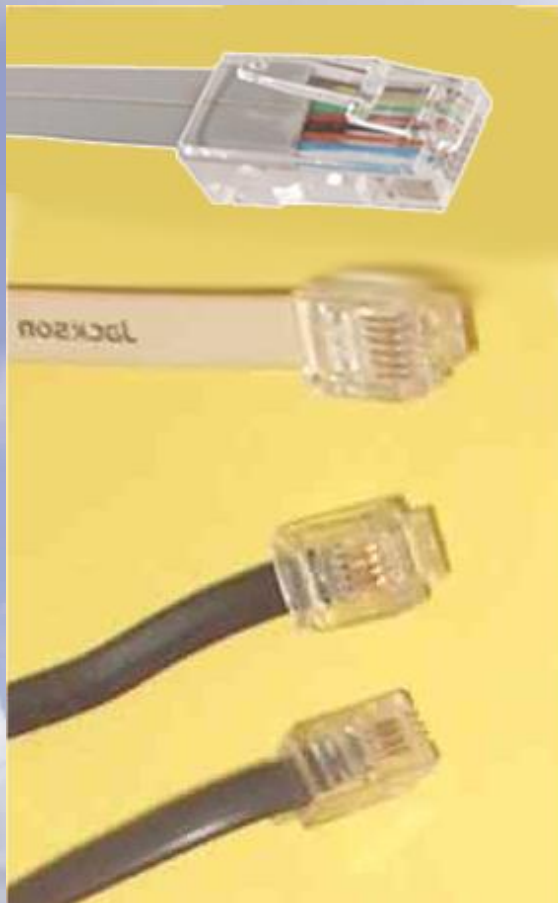
- Butt Splices
  - Knife Splices
  - Soldering
- *Avoid splicing if possible*
  - *Use one or two layers of heat shrink over the connection*





# Connections: “RJ\*” Type

You may have seen these cables used glider avionics using connectors from the international telephony industry. You will often find them on the rear of GPS flight computers for serial communications, power, and control. While these connectors all look similar to one another there are multiple sizes and contact counts.



\* RJ stands for “Registered Jack”



# Connections: “RJ” Type

## Common Connector Types



RJ-22  
4 Wire  
4P4C\*

RJ-11  
4 Wire  
6P4C\*

RJ-25  
6 wire  
6P6C\*

RJ-45  
8 wire  
8P8C\*

- Connector types are shown at left
- RJ cabling uses 26 gauge AWG stranded wire
- Flat cabling sheath colors are commonly “silver-satin” and black

RJ-type Connector Crimp/Strip Tool \$15



\*Note: The connector’s type – For Example: “6P4C” = “six positions with four metal contacts”

# Connections: “RJ” Type

Shown in  
Yellow are the  
Commonly  
Used  
Code Types  
and Sizes

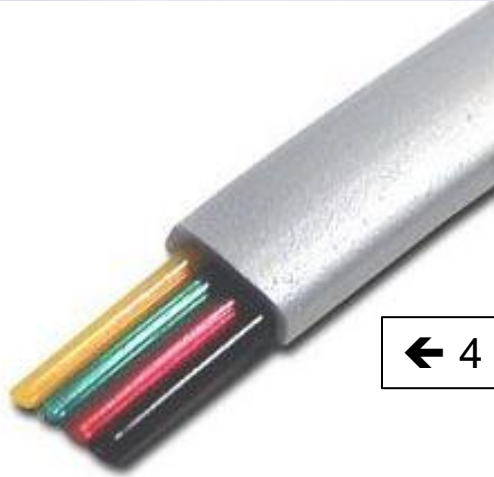
Code	Connector	Positions	Conductors
RJ11	6P4C	6	4
RJ12	6P6C	6	6
RJ13	6P4C	6	4
RJ14	6P4C	6	4
RJ18	6P6C	6	6
RJ22	4P4C	4	4
RJ25	6P6C	6	6
RJ31	8P8C	8	8
RJ32	8P8C	8	8
RJ33	8P8C	8	8
RJ34	8P8C	8	8
RJ35	8P8C	8	8
RJ38	8P4C	8	4
RJ41	8P8C	8	8
RJ45	8P8C	8	8
RJ48	8P4C	8	4
RJ49	8P8C	8	8
RJ61	8P8C	8	8

*Details at:*  
[https://arcelect.com/  
RJ\\_Jack\\_Glossary.htm](https://arcelect.com/RJ_Jack_Glossary.htm)

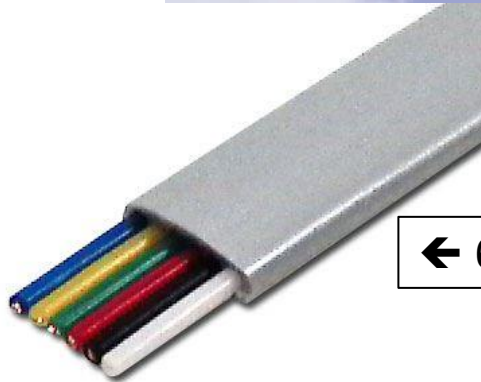
# Connections: “RJ” Type Cabling

The sheath color of RJ cabling is most often “silver-satin”.

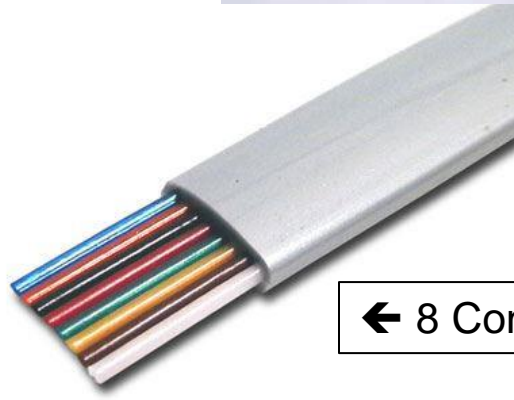
Black sheathing is also available.



← 4 Conductor Standard Colors



← 6 Conductor Standard Colors



← 8 Conductor Standard Colors

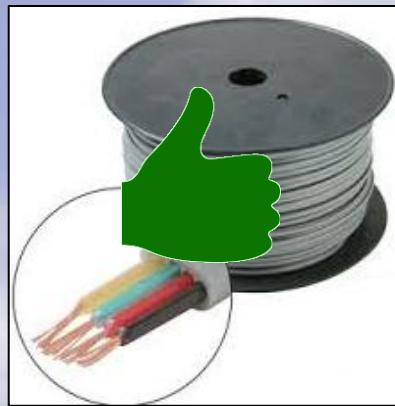


# Connections: “RJ45” Type

## Why Not to Use More Commonly Available Computer Cabling?

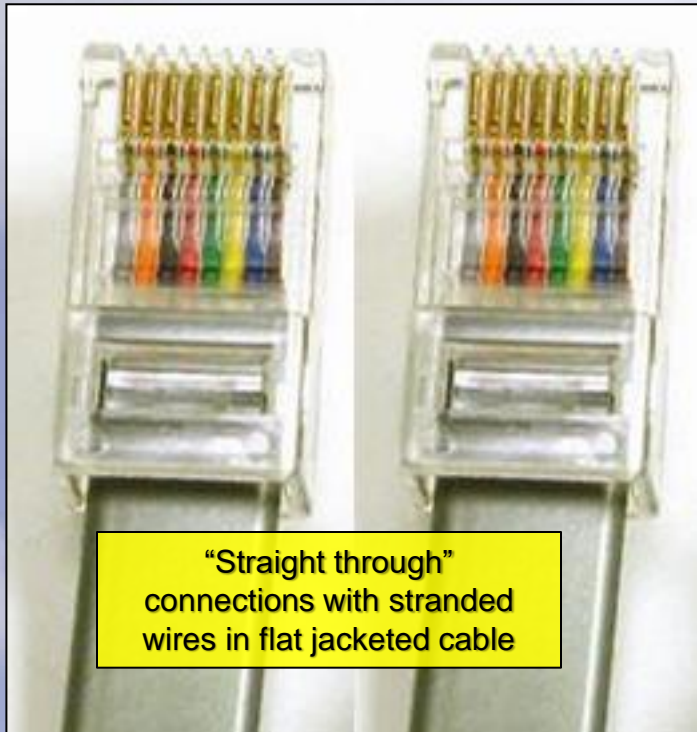
- Most people are familiar with RJ connector and cabling for networking (ethernet) for connecting to their computers (rapidly being replaced with Wi-fi).
- The reason not to use solid wire ethernet cabling is the concern over the effects of vibration. While these cables are robust, they are made to be used in non-moving (static) situations.
- Aviation suffers from vibration (powered types especially) which causes fatigue over time in avionics, connections and wires which needs to be protected against. The wire will fail over time.
- This is especially an issue if; 1) solid wire is used and 2) the cabling is not properly secured allowing increased vibration of the wiring during flight. The preferred flat telephone cabling uses multi-stranded (not-solid) wires and has been designed for the telecommunications industry for "mis-use" allowing for repeated bending without breaking.
- All manufacturers of (glider) avionics using RJ connectors use the flexible "telephone" cabling.

**Telephony Flat  
Cabling  
With Stranded  
Wire  
OK to Use**



**Ethernet Cabling  
With Solid Wire  
Do not Use**

# Connections: “RJ45” for FLARM

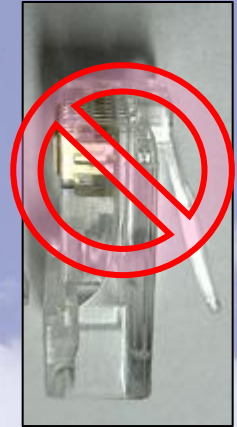


- FLARM cables are straight through connections
- Avionics cables use 26 gauge stranded wire in flat cables
- Do not use solid wire Ethernet cables
- Contacts for stranded wire are different than solid wire (shown at left)

Contacts for stranded wire

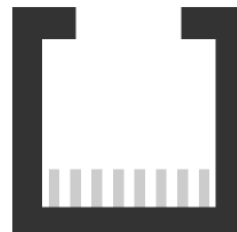


Contacts for solid wire (ethernet)



## ***RJ45: Power and Data Connections***

The 8-pin RJ45-socket is in accordance with IGC GNSS FR specifications, except for pin 3. Pin numbering follows IGC’s convention (<http://www.fai.org/gnss-recording-devices/igc-approved-flight-recorders>):



Pin 1 Pin 8

- 1: +12 to +28VDC power supply
- 2: +12 to +28VDC power supply
- 3: CORE supplies +3VDC for display
- 4: GND
- 5: TX, CORE sends (RS232)
- 6: RX, CORE receives (RS232)
- 7: GND
- 8: GND

**FLARM**

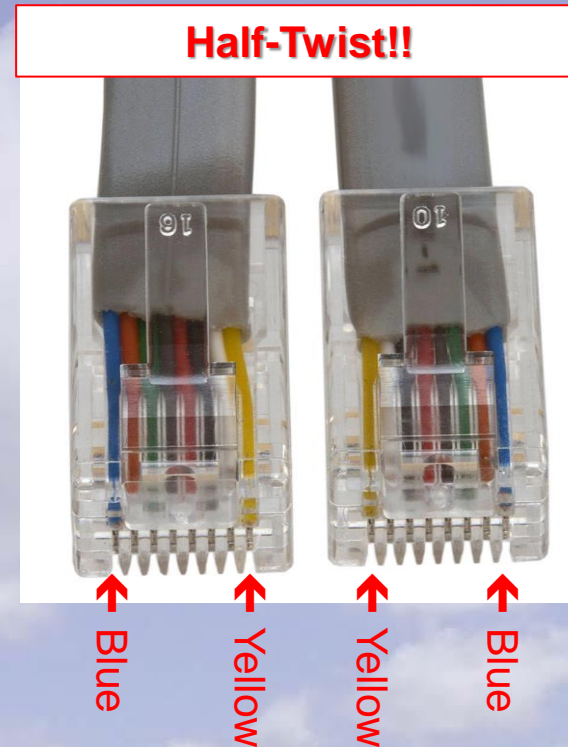
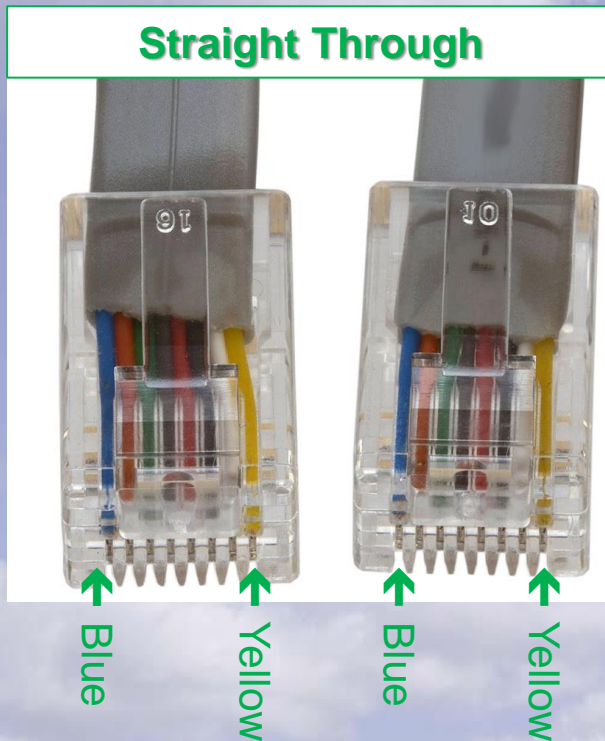
PowerFLARM CORE Manual 3.41 International

11

# Connections: “RJ” Type

## Watch out for this RJ Cable gotcha’!

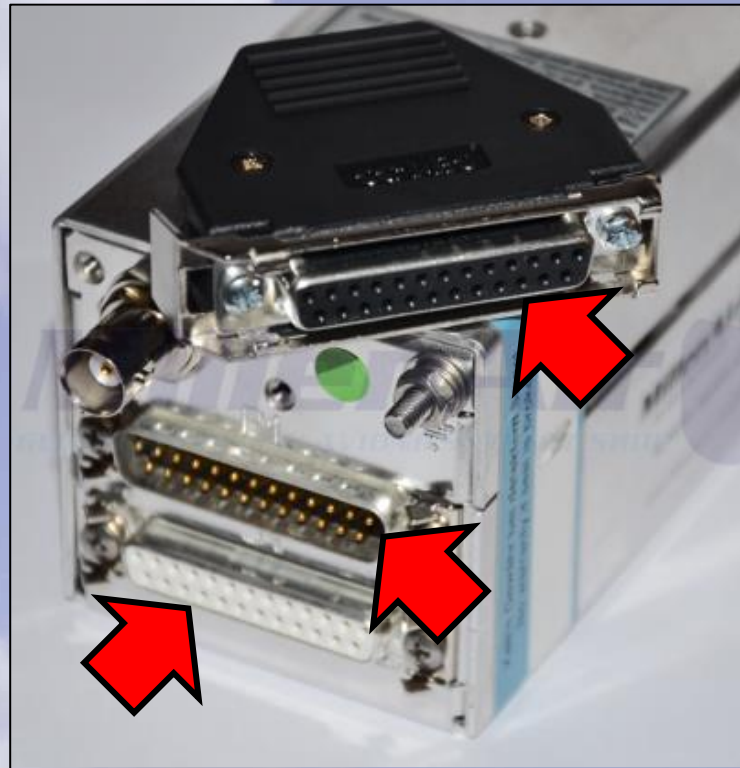
- Most avionics RJ cabling is made with the wire colors **STRAIGHT THROUGH** and aligned end-to-end.
- HOWEVER, some cabling is made with a **HALF TWIST** and the wire colors are reversed end-to-end!!





# Connections: “D-Subminiature\*”

These commonly found connectors are sometimes called “D-Sub” or “DB” for short and come in a variety of pin counts. They are used for communications, power and control, and are found on the rear of transceivers, transponders, GPS flight computers, FLARM devices, etc.



\* The “D” in D-Subminiature stand for the “D” shape of the connector’s metal shield

# Connections: “D-Subminiature”

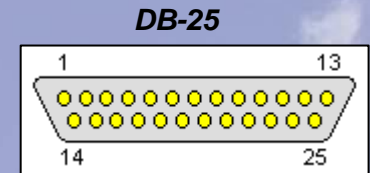
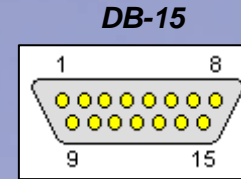
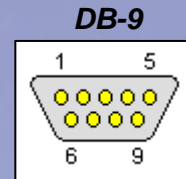
Contact numbering details  
on the next slides

- Most Common Sizes

- 9 Pins

- 15 Pins

- 25 Pins



- Pin Types

- Male



- Female



- Wire Connection Types

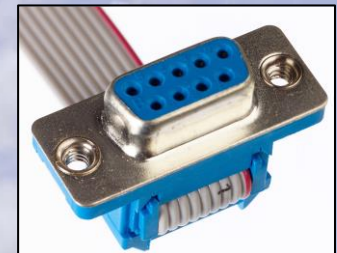
- Crimp & Insert



- Solder Cup



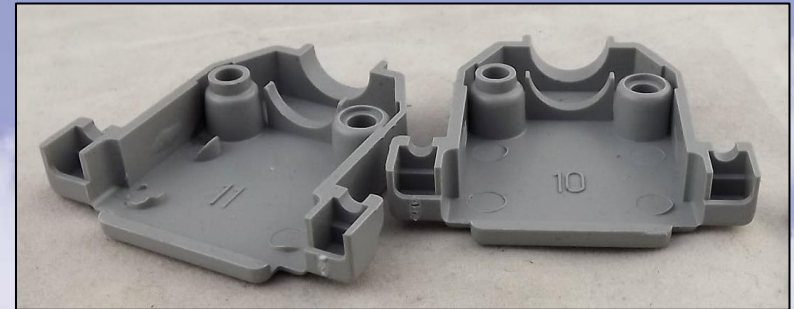
- Ribbon Cable



# Connections: “D-Subminiature”

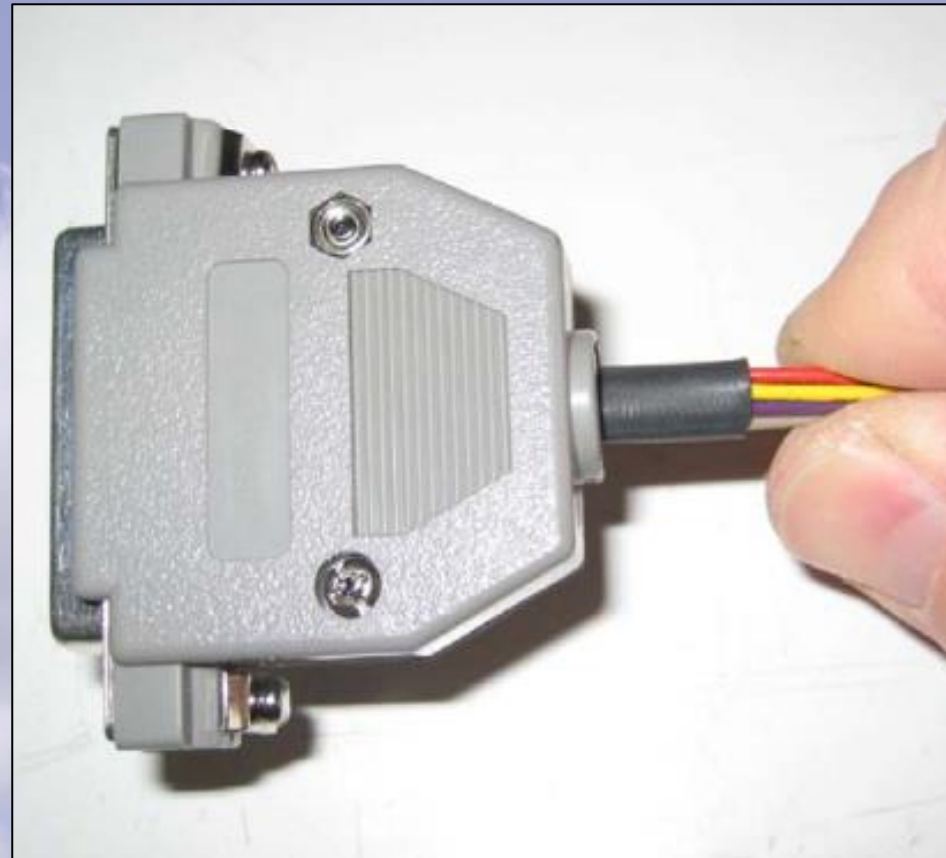
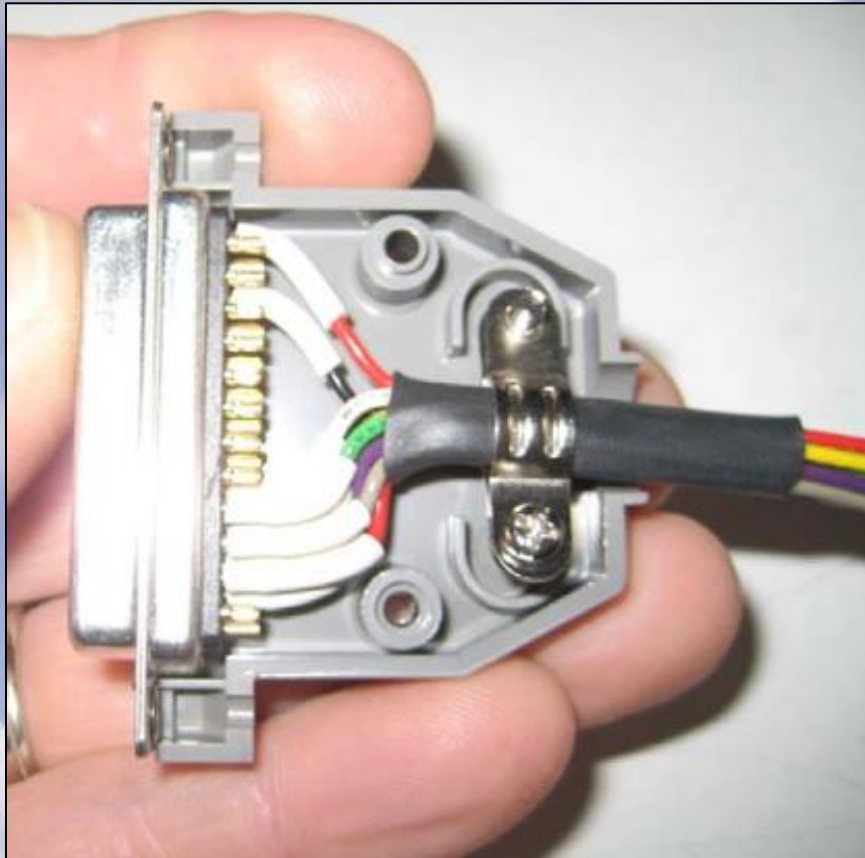
## Hood/Cover/Shell Types (plastic and metal)

- 180° Exit →
- 45° Exit ↘
- 90° Exit ↙

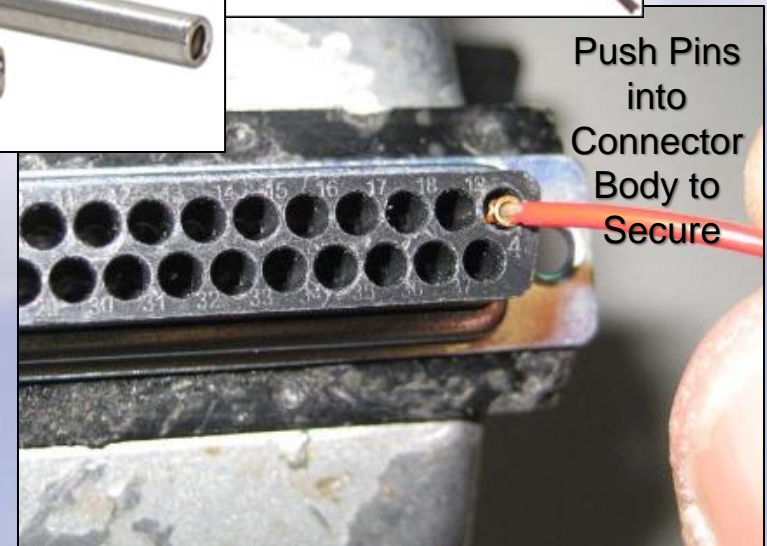
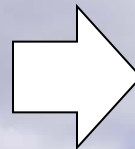
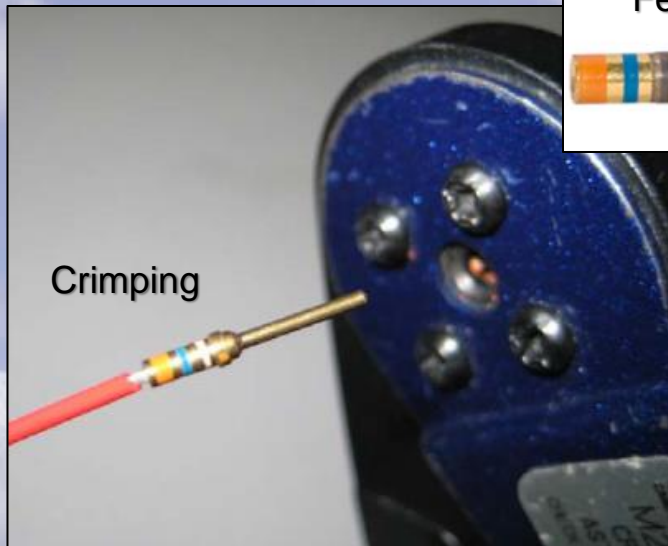
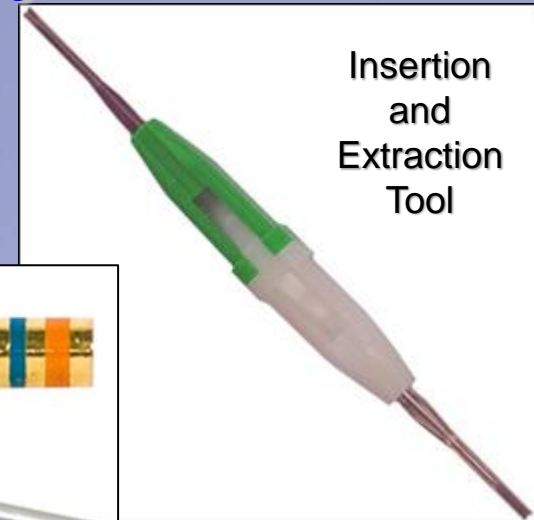




# Connections: “D-Subminiature Solder Style Connections with heat shrink tubing



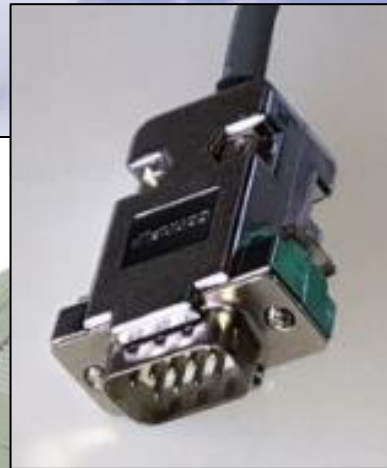
# Connections: “D-Subminiature” Crimp Pins Style



# Connections: “D-Subminiature”

## Securing/Latching Types

- Threaded (4-40) Screw/Nut Type  
Most common





# Connections: “D-Subminiature”

## Securing/Latching Types

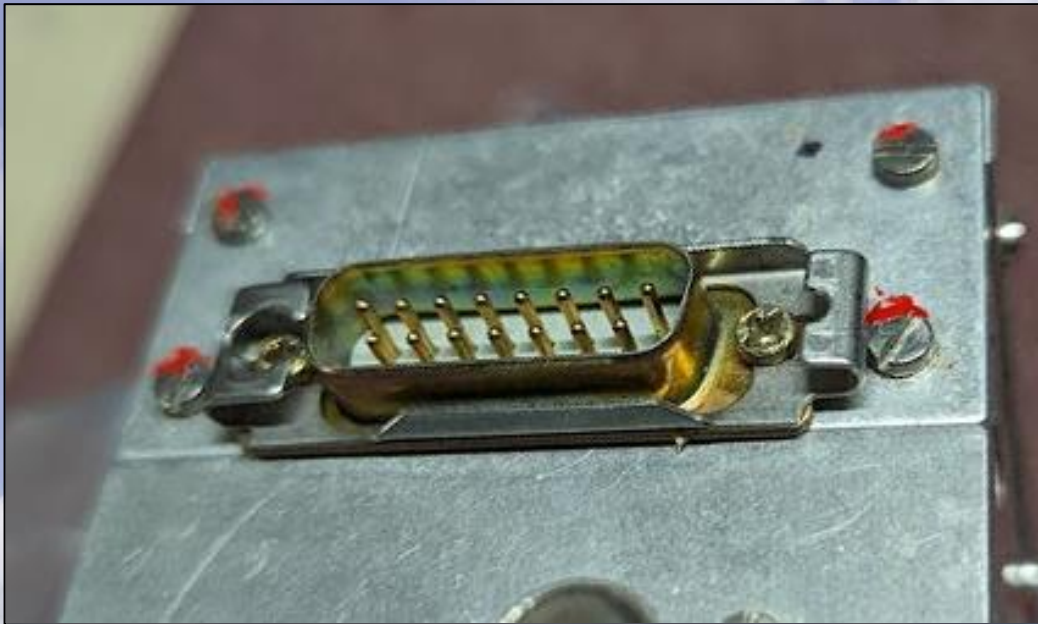
- Sliding Bar Type I  
for Becker models 4201 6201



# Connections: “D-Subminiature”

## Securing/Latching Types

- Sliding Bar Type II  
for Filser/Dittel  
for Becker model 3201

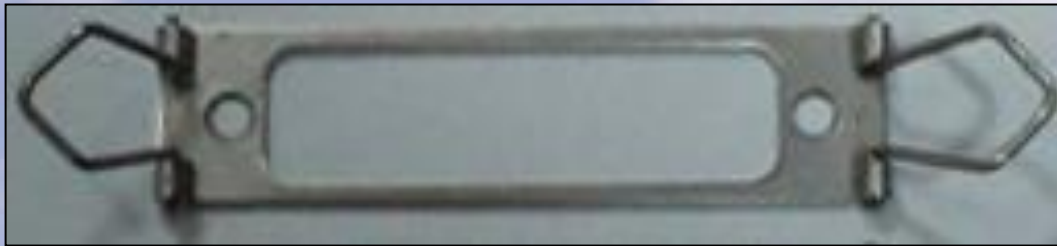




# Connections: “D-Subminiature”

## Securing/Latching Types

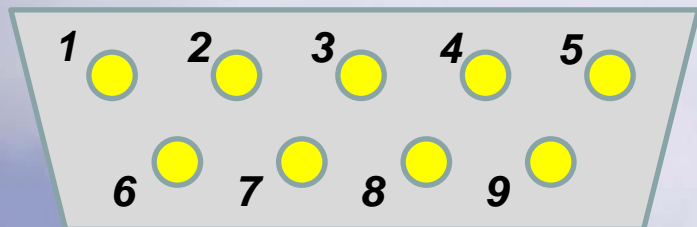
- Bail Type  
for LXNav Devices



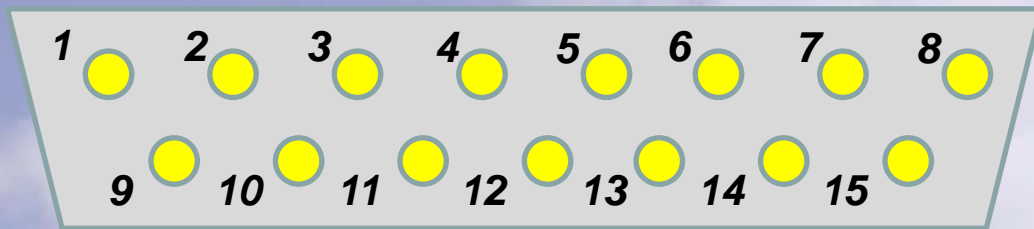


# Connections: “D-Subminiature”

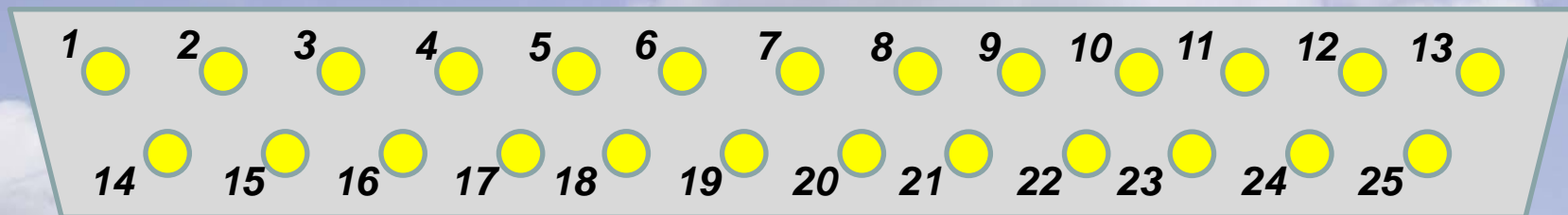
**DB-9**



**DB-15**



**DB-25**



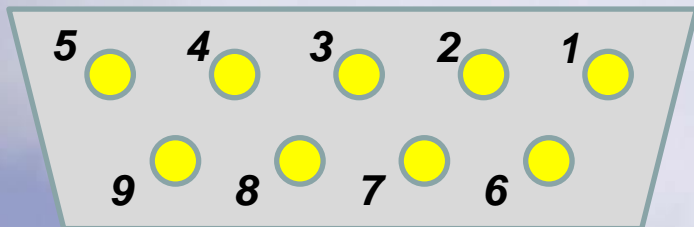
## Pin Numbering View For



Female - Wiring Side  
and  
Male – Pin Side

# Connections: “D-Subminiature”

**DB-9**



## Pin Numbering View For

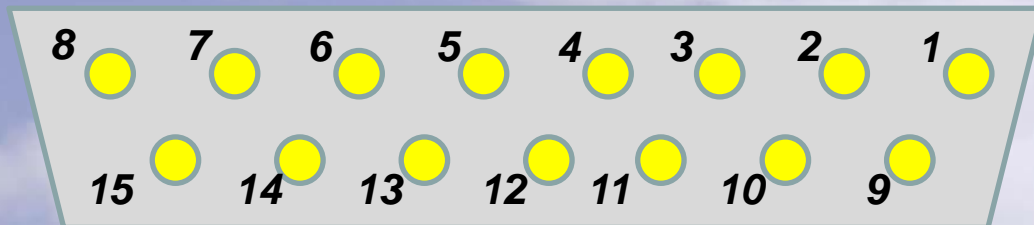


Male - Wiring Side  
and

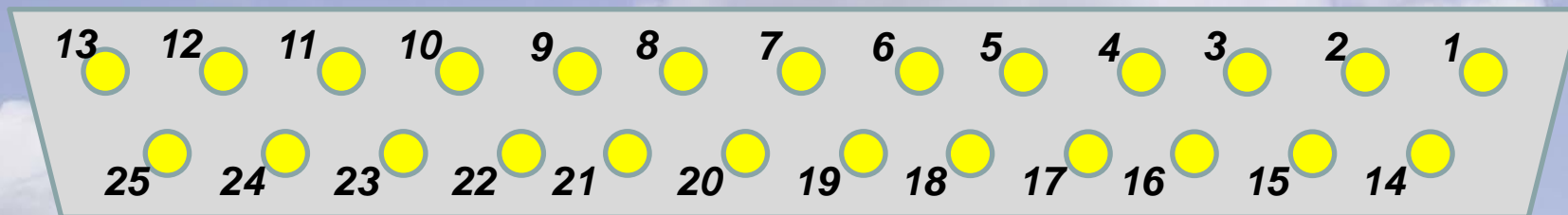


Female – Socket Side

**DB-15**

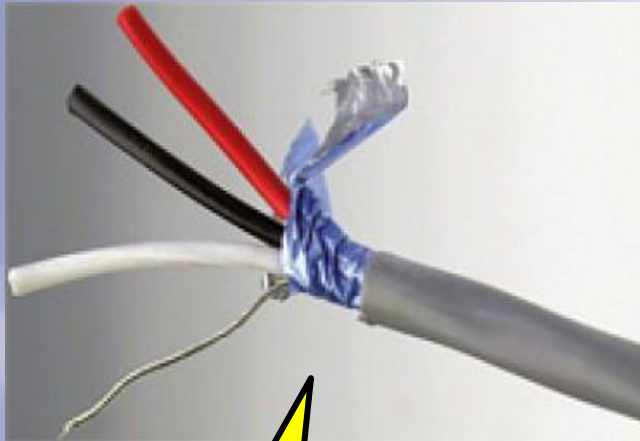


**DB-25**

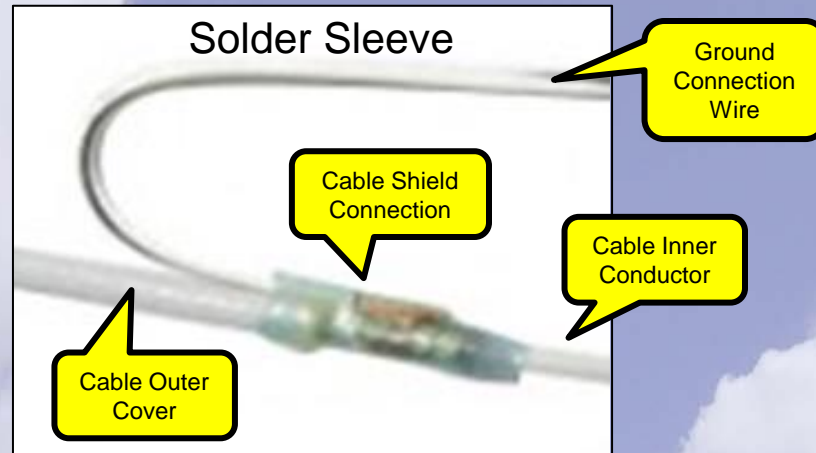


# Connections: Shielded Wiring

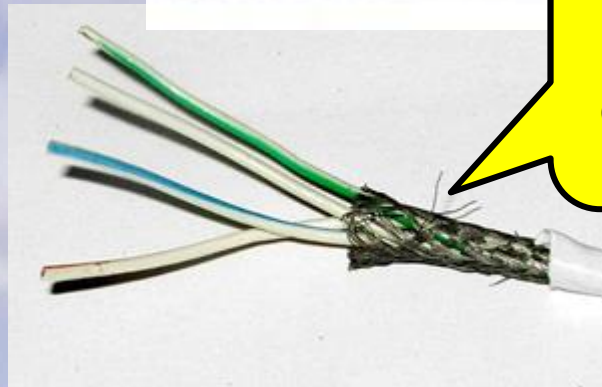
(Typically for Microphones and some Speakers)



Drain wire  
to be  
connected  
to ground

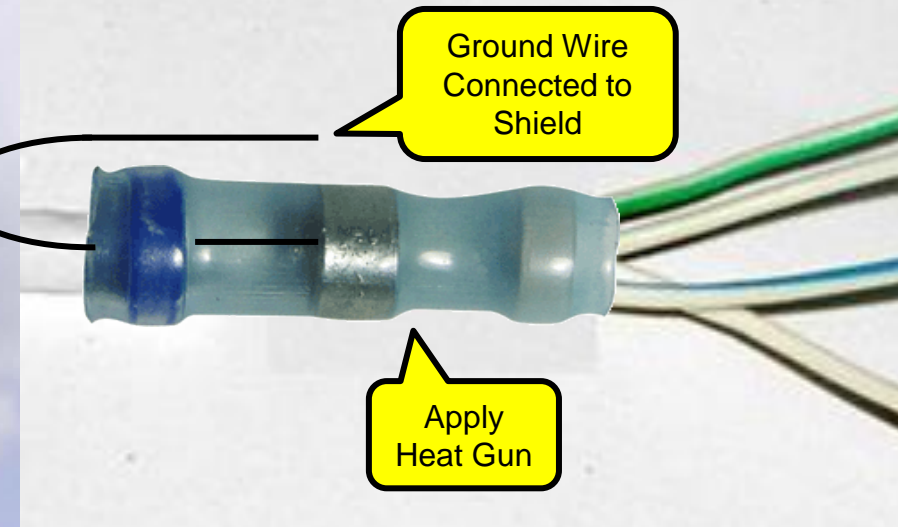
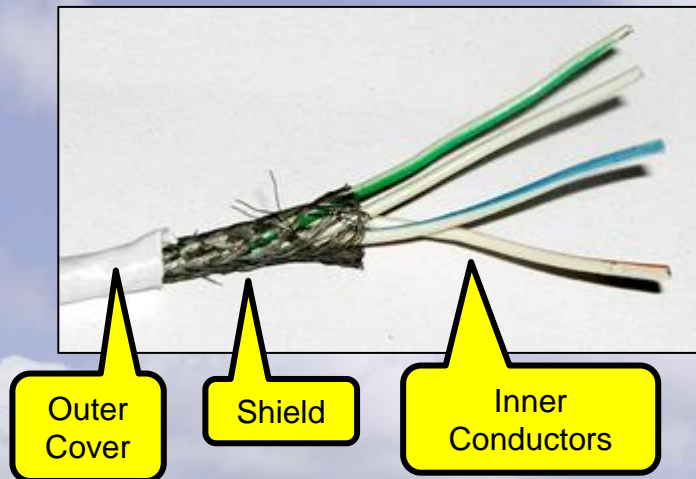
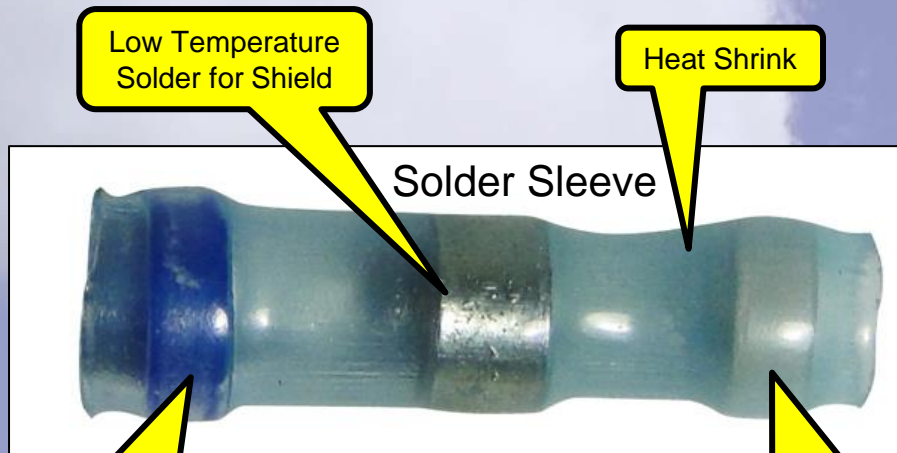


Braided  
Shield  
to be  
connected  
to ground



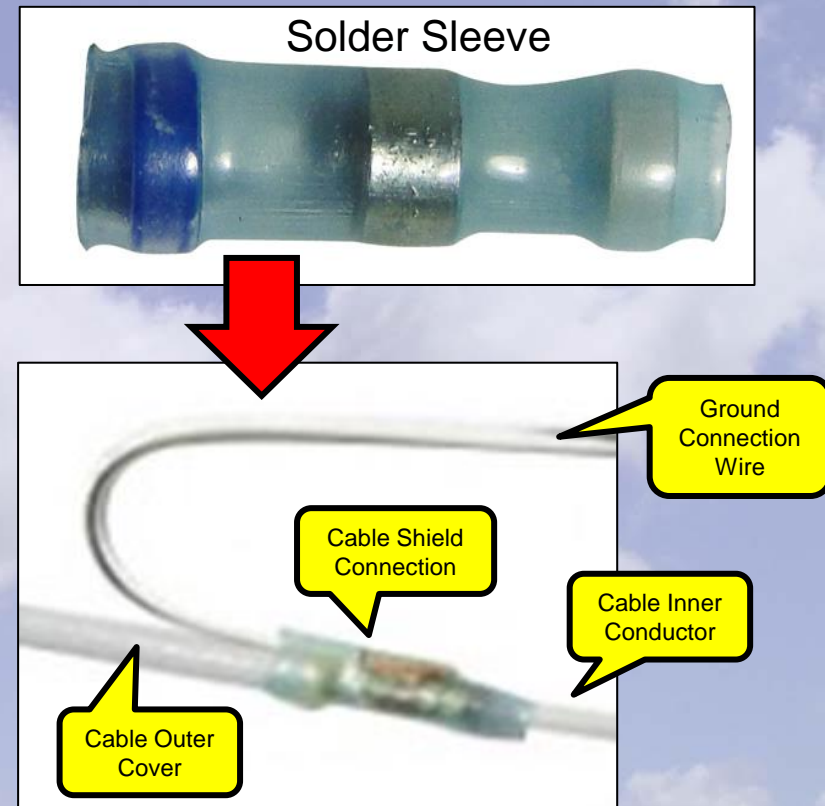
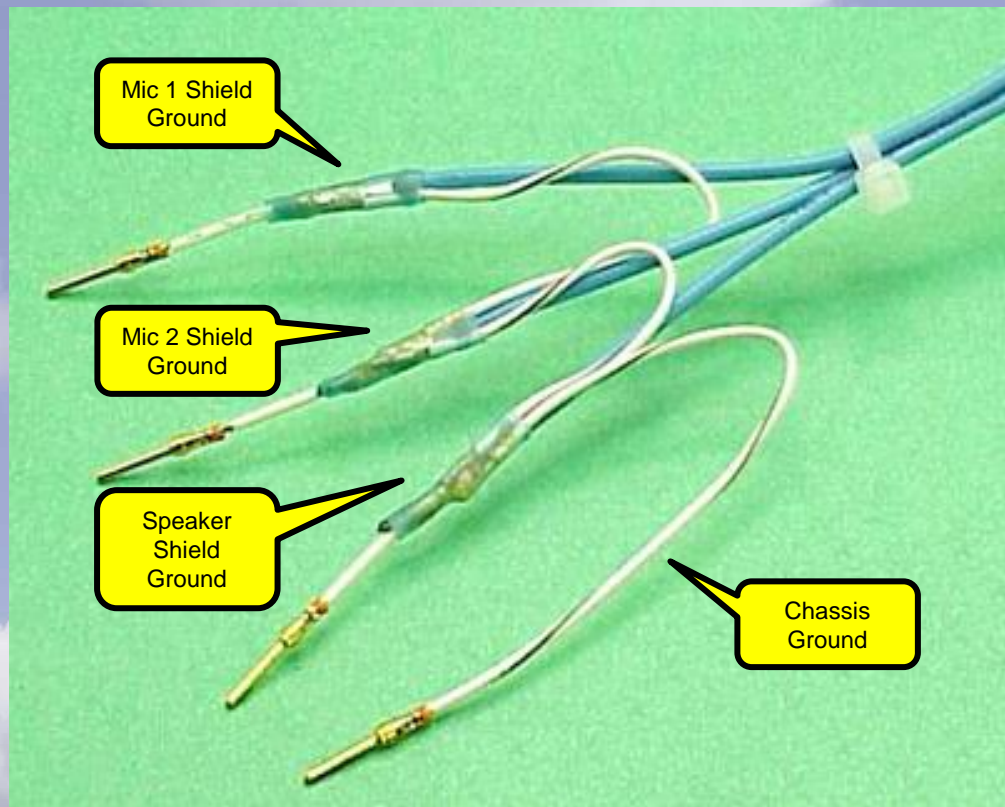


# Connections: Shielded Wires



# Connections: Shielded Wires

These “solder sleeves” are used to make a connection from the outer shield to a small gauge (“drain”) wire typically used to make several ground connections. These sleeves have a heat-shrinkable, transparent cover, low temperature solder and two sealing inserts. When heat is applied, the solder melts and flows to provide a connection between the ground lead and the shield. At the same time, the two sealing inserts melt and the outer sleeve shrinks to provide a protected termination.



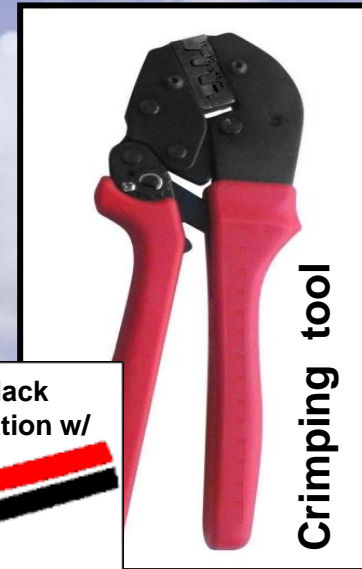
# Connections: Powerpole

<http://www.powerwerx.com> & <http://cumulus-soaring.com>

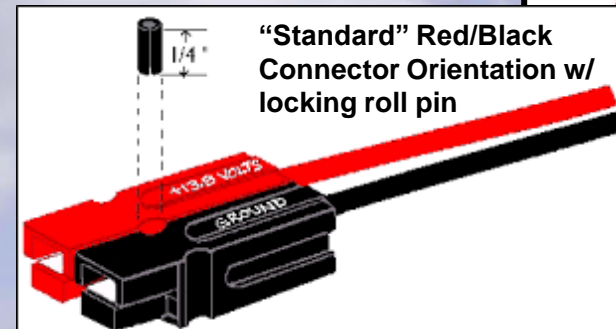
- High current capacity (up to 45 amps!)
- Wires from 10 to 20 gauge
- 11 colors available
- Silver “wiping” contacts
- Can be soldered or crimped
- Polarized - Can't be reversed!
- Genderless
- Dovetailed Fittings
- Rugged (10K+ cycles)
- High temperature housing
- Cons – Somewhat expensive and are bulkier than other types of multi-pin connectors



**Crimp/Solder Contact**



**Crimping tool**



**Source:** <http://www.powerwerx.com/>



# Connections: Powerpole

<http://www.powerwerx.com> & <http://cumulus-soaring.com>

Molded-in dovetails lock modules into multipole units

If broken under load arcing is confined to tip, a non-conducting area

Detent keeps connectors mated and provides quick break snap action upon disconnect

Stainless steel leaf spring provides constant contact pressure

Rugged lightweight polycarbonate housing

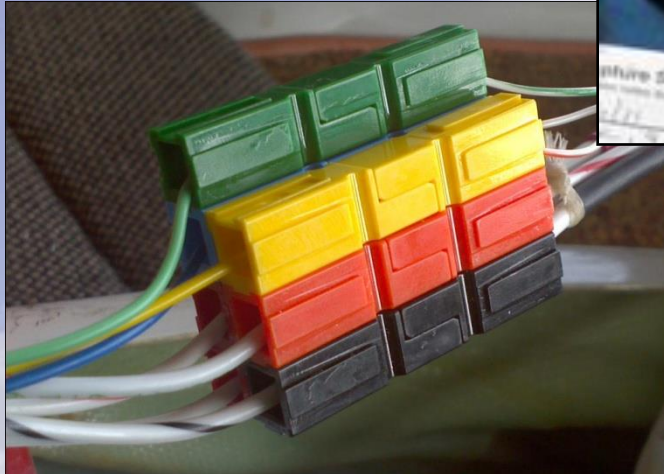
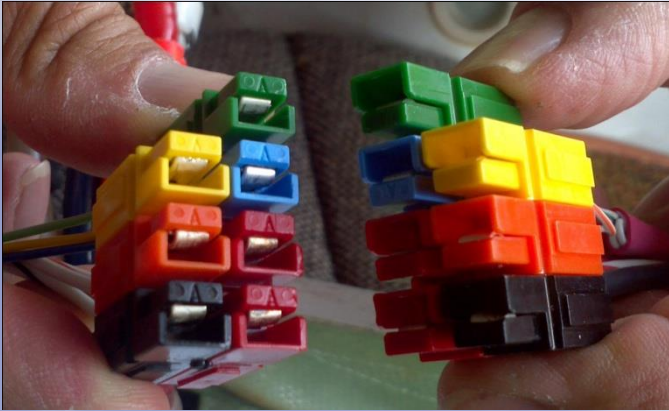
Wiping action on make and break keeps conducting surfaces clear

Low resistance silver-plated copper contacts

**Source:** <http://www.powerwerx.com/>

# Connections: Powerpole

Multi-colored connector bundle for power, audio, PTT, etc



Battery Connections



Source: <http://www.powerwerx.com>

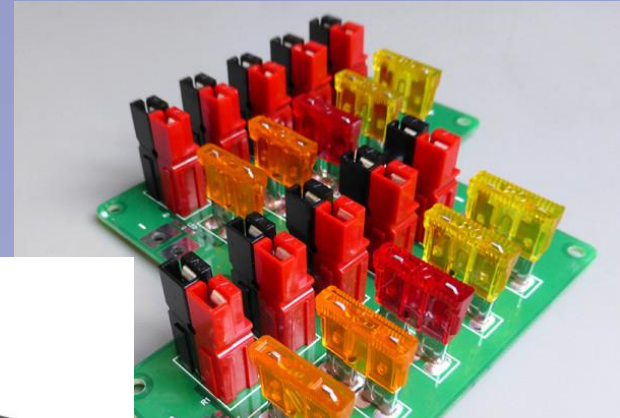
# Connections: PowerPole



Source: <http://www.powerwerx.com/>



# Connections: PowerPole Buses



Source: <http://www.powerwerx.com/>

# Joining Wires Together

## Splicing Shielded Cabling

- Often needed for Microphone cabling as the lengths provided are seldom long enough.

1. Put about 4" of heat shrink onto one of the cables to be spliced. Do not shrink it.
2. Strip the outside insulation back about 1-1/2" on each cable.
3. Untangle the shielding from the inner conductors.
4. Cut off about 1/4" of the inner conductors.
5. Strip the inner conductors' insulation back about 1/4".
6. Put one 3/4" piece of heat shrink onto one inner conductor. Do not shrink it.
7. Overlap and solder the two ends of the inner conductors to each other.
8. Shrink the heat shrink over the inner conductors' solder joint.
9. Take each cable, one at a time, and twist its individual shielding strands into a wire bundle.
10. Overlap the two twisted bundles of shielding and solder the overlapping portion.
11. TEST THE CONNECTION! Especially if a microphone cable.
12. Shrink the 4" piece of heat shrink over the spliced area.



# Connections: Disconnects



**Knife Disconnects**  
(Commonly used on GA wing roots)



**Faston**



**Cannon**



**DIN**



**Cinch**





# Connections: “Bulkhead Jacks”

## RJ-45 and USB-A Connections

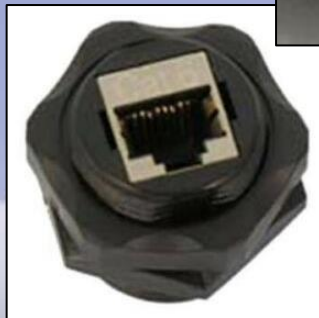
Many current avionics utilize USB and RJ data ports for programming (turnpoint and SUA data file uploads), data retrieval (IGC files, etc), and interconnection to other devices. While these ports need easy access they are often located behind the instrument panel. Using these jacks, and the appropriate jumper cable, can make the ports become more readily accessible.



ASW-27 located on the underside of the instrument panel just above the knee

### RJ-45

A typical use is to access an avionics instrument's FLARM data port. Other RJ connector types are available.



### USB (Type A)

A typical use to connect a memory stick to an avionics instrument's USB data port. Other USB connector types are available.



# Common Radio Frequency (RF) Coaxial Connector Types

- **BNC** – Typically used to connect an antenna to an aircraft transceivers (“radio”).
  - Connection Type: Quarter-turn
  - Coax Attachment Difficulty: **Medium**
- **TNC** – Typically used to connect an antenna to a transponder.
  - Connection Type: Threaded
  - Coax Attachment Difficulty: **Medium**
- **SMA** – Found on most GPS antennas. Also found on the antennas for FLARM devices. There are also “reverse polarity” varieties known as SMA-RP.
  - Connection Type: Threaded
  - Coax Attachment Difficulty: **High**
- **MCX** – Found on some GPS antennas such as for FLARM devices.
  - Connection Type: Push-on
  - Coax Attachment Difficulty: **High**



NOTE: All connectors shown are male. There are female versions for each type.

More details are available in my “Transceiver Troubleshooting” Presentation

# Joining Wires Together

## Splicing Shielded Coax Cabling (Antenna Cabling)

- **DO NOT splice coax if avoidable**
- If absolutely necessary the only join coax with male and female BNC connectors.





# Connections: Canopy Disconnects

Cables for all devices mounted on the canopy, canopy rails, or canopy attached glare shields, must have a quick release so nothing will prevent the emergency ejection of the canopy.

**DG/LS**  
**Tech Note**  
**DG-G-07**

## 4.1.2 Equipment mounted on the canopy

If equipment is mounted on the canopy special care must be taken that canopy jettison is not impaired. To accomplish this any wire must be equipped with a plug in the vertical part. All plugs must be able to disconnect with low force, max. 10 N (2 lbs.).

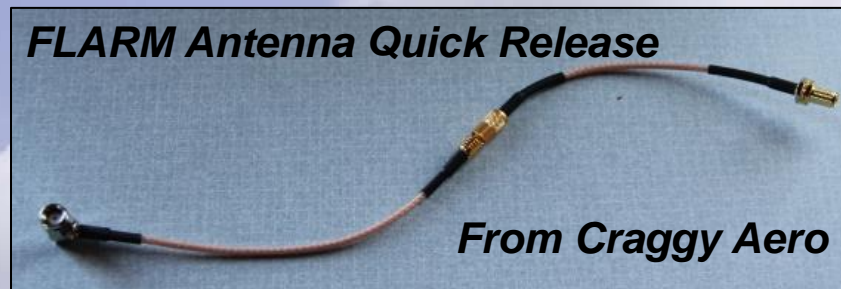
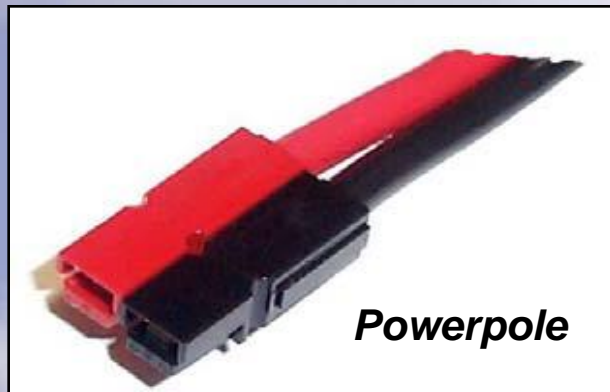
***Cabling may cause the canopy to fail to jettison during a bail out!***

***AAIB report said: "...it is probable that the wiring to the components installed on the canopy frame and glare shield would have prevented the canopy from being successfully jettisoned and the pilot would not have been able to leave the glider."***



# Connections: Canopy Disconnects

Cables for all devices mounted on the canopy, canopy rails, or canopy attached glare shields, must have a release of some type so nothing will prevent the emergency ejection of the canopy!



# Chapter 5

## Miscellaneous Things of Note





# Tying Things Down

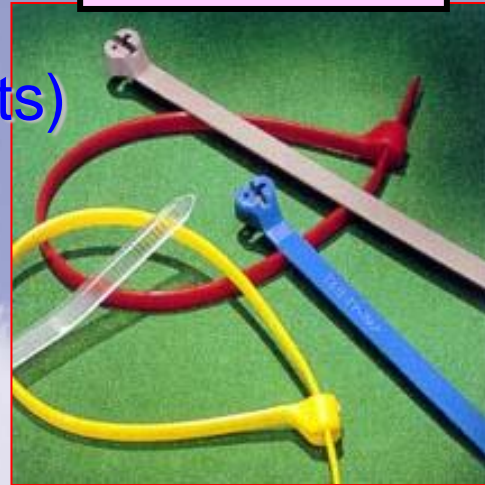
- “Zip” Ties (Ty-raps®)
  - Quick & easy
  - Use high quality (Thomas & Betts)
  - Black for exterior use
  - Don't cinch too tightly
- Nylon Lacing Cord
  - Old school traditional method
  - Very inexpensive
  - FAA AC 43-13-1B

Wax impregnated  
nylon cord -  
available in white  
or black

500 yards  
\$20



**Ty-raps®**  
**Thomas & Betts**



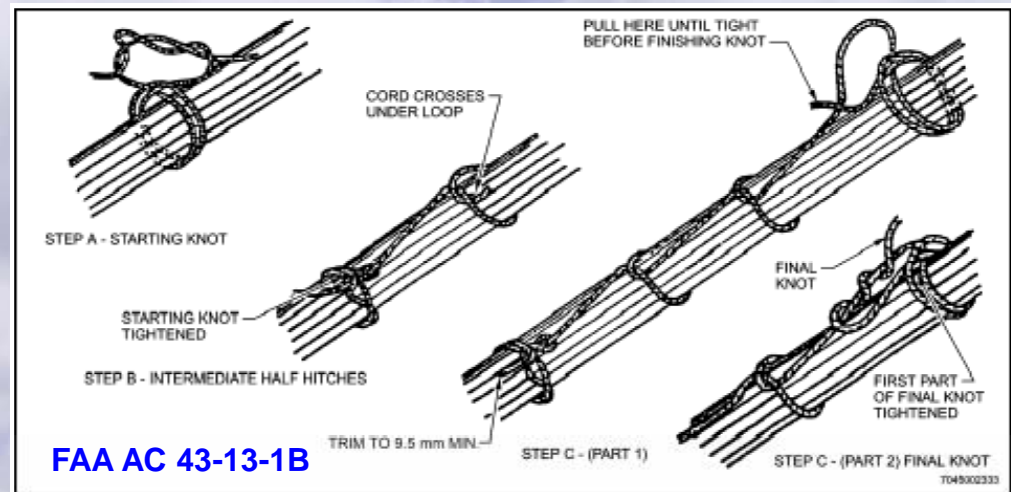
**Anchors**



*Bolt Down*



*Adhesive*



# Protecting Wires Against Abrasion

- Obtain good quality heat shrink
  - Finish is dull looking, not shiny
  - High shrink ratio and flexibility
  - Best Brands: 3M, ???
- Slowly & carefully use a heat gun
  - Too much heat causes brittleness and damage to wires inside
- Get multiple colors & sizes
  - Minimum: Clear, Black, Red
  - Minimum: 1/8", 1/4", 3/8"
- Sources:
  - Waytek
  - Ham radio parts sites
  - Frys Electronics stores
  - Standard Electronics
  - RA-Elco





# Protecting Wires Against Abrasion

## ❖ Various Types of Heat Shrink Guns Available:

1. Inexpensive \$10-\$20
  2. Portable \$30-\$40
  3. Industrial \$100-\$200
  4. ~~Propane Torch~~
  5. ~~Paint Stripper~~
  6. ~~Lighter~~
- Too Hot!**

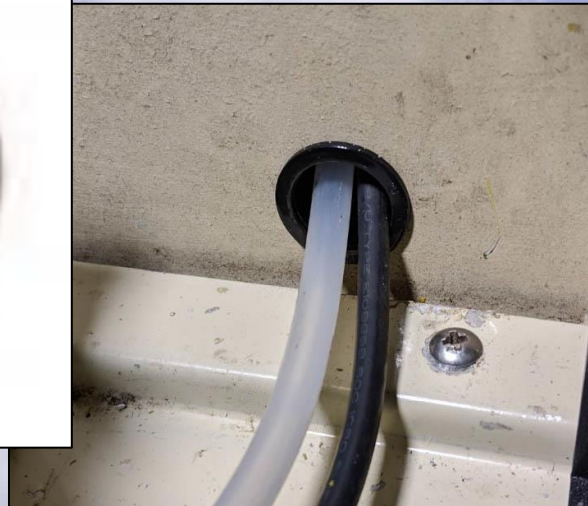




# Protecting Wires Against Abrasion

## Heyco Snap Bushings

*“These snap bushings are ideal for abrasion and cutting protection of wiring, antenna leads, tubing, cables, etc. that are routed through bulkheads, ribs and other internal aircraft structures. Made of hard black nylon, the bushings convert thin sheet metal raw-edged holes to smooth, neat insulated ones. Spring-like fingers snap out to hold it in place. Many sizes available.”*



Source: <https://www.aircraftspruce.com>

# Protecting Wires Against Abrasion

## Heat Shrink



## Nylon Expandable Sleeving aka "Shark Skin"

*"Flame retardant & light weight, self-fitting, monofilament sleeveings designed to encapsulate and protect cable bundles and wire assemblies. These expandable sleeveings adjust to irregular surfaces and contours, providing abrasion resistance and protection with a minimum of bulk and weight."*



*Cut on the diagonal preferably with a hot knife to prevent fraying*



**Source:** <https://www.aircraftspruce.com>

# Hook-and-Loop Fasteners (A.K.A Velcro®)

## Advisory Circular AC 20-173

### “Installation of Electronic Flight Bag Components”



U.S. Department  
of Transportation  
**Federal Aviation  
Administration**

## Advisory Circular

**Subject:** Installation of Electronic Flight Bag  
Components

**Date:** 09/27/11

**AC No:** 20-173

**Initiated by:** AIR-130



1. Purpose

a. To provide guidance to flight bag components element

5. Guidance for Installed EFB Components
  - a. Mounting Devices

**(5) Use of Hook-and-Loop Fasteners.** We do not recommend use of hook-and-loop fasteners, such as Velcro®, for mounting or securing EFB components to a mount, or the aircraft, because the closure strength of hook-and-loop fasteners degrades with each use. The cycle life, which is the number of times the hooks and loops can be engaged and disengaged before the closure strength is reduced to 50% of original values, cannot be accurately tracked without a maintenance action. However, if using hook-and-loop fasteners for installed EFB mounts to ensure crashworthiness: (more)



# Hook-and-Loop Fasteners

Special Airworthiness Information Bulletin HQ-12-32

“Hook and Loops Style Fasteners as a Mounting Mechanism for Emergency Locator Transmitters (ELTs)”



**FAA**  
**Aviation Safety**

## **SPECIAL AIRWORTHINESS INFORMATION BULLETIN**

**SUBJ:** Hook and Loop Style Fasteners as a Mounting Mechanism for  
Emergency Locator Transmitters (ELTs)

**SAIB:** HQ-12-32  
**Date:** May 23, 2012

*This is information only. Recommendations aren't mandatory.*

### **Introduction**

This Special Airworthiness Information Bulletin (SAIB) informs emergency locator transmitter manufacturers as well as installers and aircraft maintenance personnel of a concern with the ability of hook and loop style fasteners to retain their designed capability to restrain emergency locator transmitters during accident impact. In several recent aircraft accidents, ELTs mounted with hook and loop style fasteners, commonly referred to as Velcro®, have detached from their aircraft mounting. The separation of the ELT from its mount caused the antenna connection to sever, rendering the ELT ineffective.

# Hook-and-Loop Fasteners

A.K.A. Velcro®

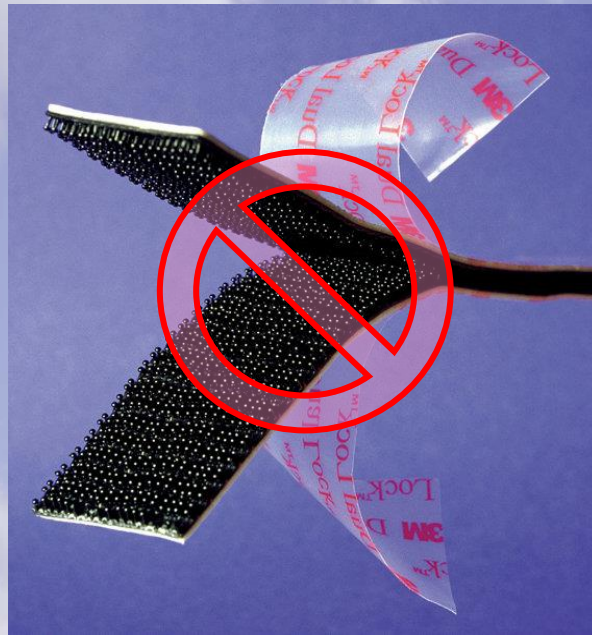
## “Standard”

*Pros: Inexpensive*  
*Cons: Weak bond*



## “Dual Lock”

*Pros: Hermaphroditic*  
*Cons: Expensive, Weak Bond*



## “Industrial”

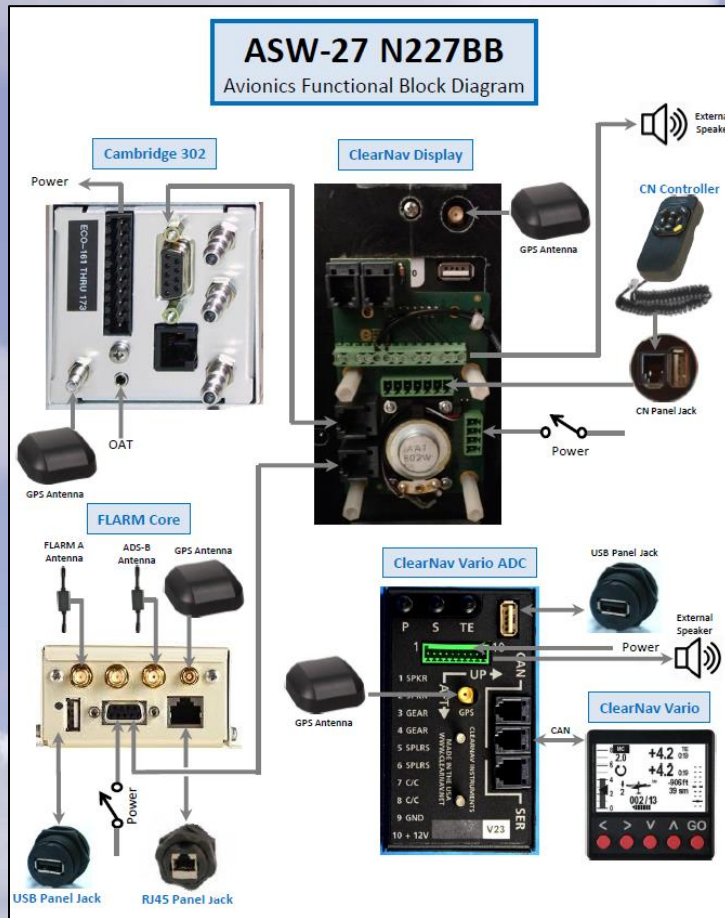
*Pros: Strongest bond*  
*Cons: Somewhat Expensive*



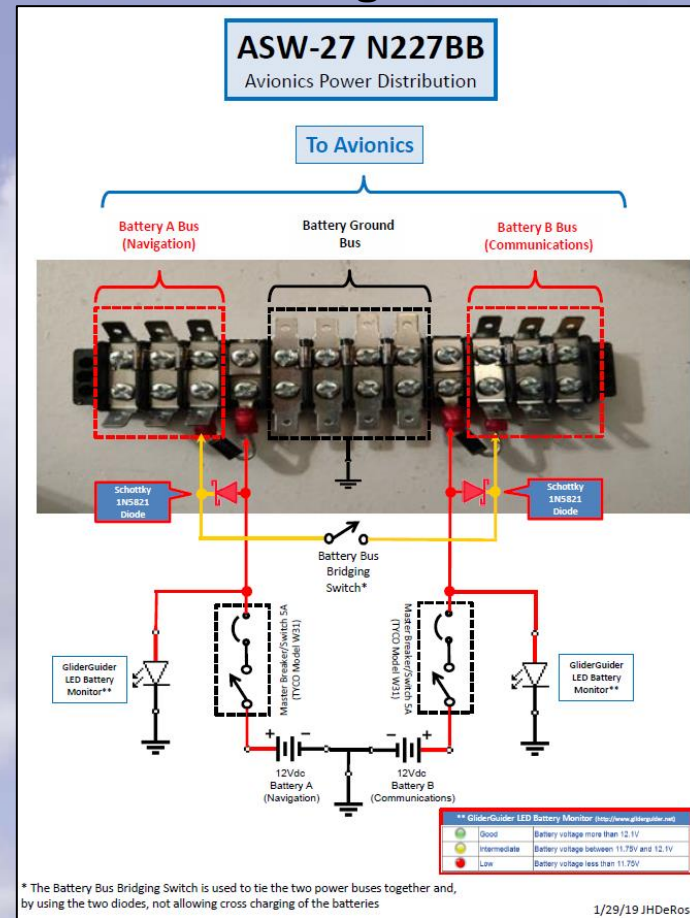
# Wiring Documentation

Creating paper wiring diagrams is critical for ease of maintenance and troubleshooting

## Functional Wiring Diagram



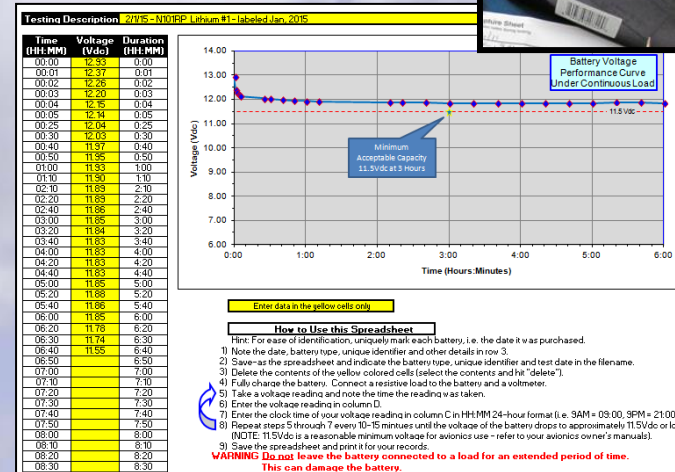
## Power Wiring Schematic





# Important Take Always

- Fuse at the positive Battery Terminal!
- Wires = Tefzel + Bigger is Better
- Compression Fittings of Nylon
- Use No Hardware Store Parts
- Use Sleeving at Wear Points
- Use High Quality Heat Shrink
- Label Your Wiring
- Document Your Wiring
- “Industrial” Velcro if needed



# Hints & Tricks on Rebuilding a Panel

Adding one device at a time to your panel can, over the years, leads to a confusing “rat’s nest” of wiring and tubing. It is often easier to just start over from scratch by removing everything and rebuild the panel from ground zero.

**Document Everything! Start Slowly! Remain Calm!**

- **Before Starting take pictures of the panel from every possible angle, including the front of the panel. Closeups. Panoramic. 3-D. 4K. Whatever you got! You only have one chance at this!**
- Get some paper and pencil and Draw a representative box for each device in your panel; radio, transponder, GPS, vario, flight computer, FLARM, fuses/breakers, switches, antennas, etc, etc, etc.
- Slowly remove just one cable/wire at a time. Draw exactly where the cable/wire started from and exactly where it ended. Include the color of each wire, type of connector, and any labeling.
  - HINTS: On the back side of some instruments/devices there may be multiple and similar jacks that cables are plugged into. Write down the exact label on the device’s jack and add a diagram of all the ports.
- Obtain a manual for all avionics in your panel.
- Air Lines – Document each air line before removing. Wrap colored\* electrical tape around each line and label the line’s purpose (static, pitot, TE, capacity) and which device’s port it connects to (vario, GPS, flight computer, transponder, etc.).
  - HINTS: On gliders having TE “multi-probes” (e.g. double or triple TE probes) there will be multiple (within the fuselage and at the TE) static, pitot, etc. tubing. Determine/mark which air line is which. There may be multiple fuselage pairs of static ports, some utilized and others may not be. Check it out.
- Optional: Remove each mechanical instrument. Might be a good time to have them checked.
- When in doubt, label everything you can! And read the manuals!

\* See my presentation “**Working with Glider Air Lines**” for air line color coding and lots of other information

# Continued in Part 2...

## Chapter 6 Power Management





# Electrical Parts Sources

<http://aircraftspruce.com>

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

<http://wagaero.com>

<http://wingsandwheels>

<http://www.wicksaircraft.com>

<http://craggyaero.com>

<http://cumulus-soaring.com>

<http://www.steinair.com>

<http://www.airsuppliers.com>

<http://waytekwire.com>

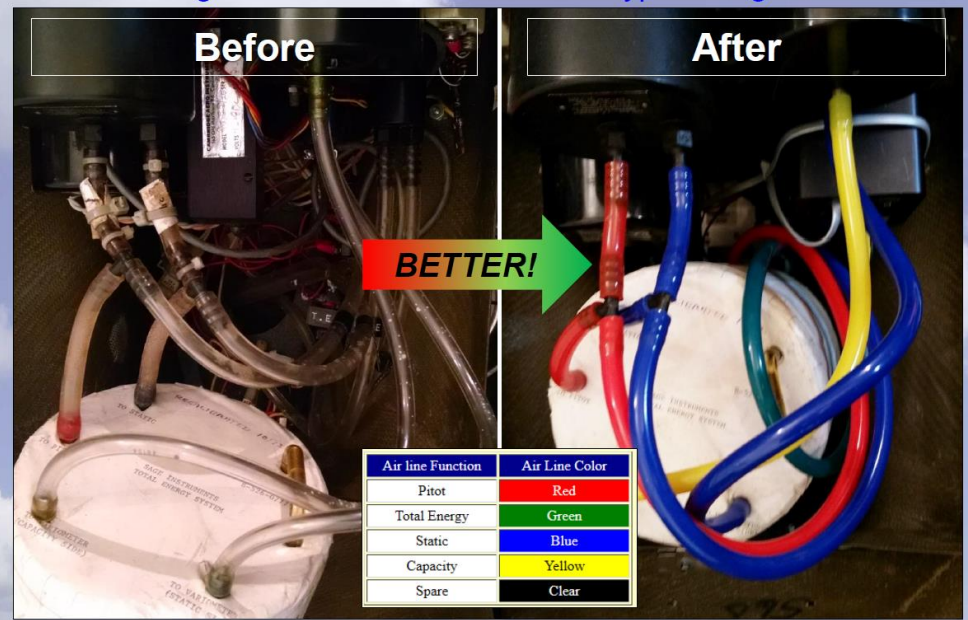
# Working with Air Lines

## *Working With Glider Pneumatic Air Lines*



*See My  
Presentation for  
More Details*

### Air Lines – Use of Colored Tubing Using color coded airlines eases type recognition



# See My Other Presentations

- Transceiver Troubleshooting
- Oxygen Systems
- Working with Glider Air Lines
- Sailplane Wiring
- Trailer Wiring & LED Lights
- Pilot Relief Systems
- Battery Testing
- Open Glider Network (OGN)
- Spar Alignment Tool
- L'Hotellier Fittings
- Carbon Fiber Panels
- IGC Filename Decoding
- Blanik L-23 Strut Work
- Landout Survival Kits
- Removing Painted Lettering
- Emergency Location Devices

**<http://aviation.derosaweb.net/presentations>  
[jhderosa@yahoo.com](mailto:jhderosa@yahoo.com)**