Soaring Aviation Electrical
"Best Practices" Series
Basic Installation Guidelines

[Part 1 of 3]

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Updated: March 23, 2026

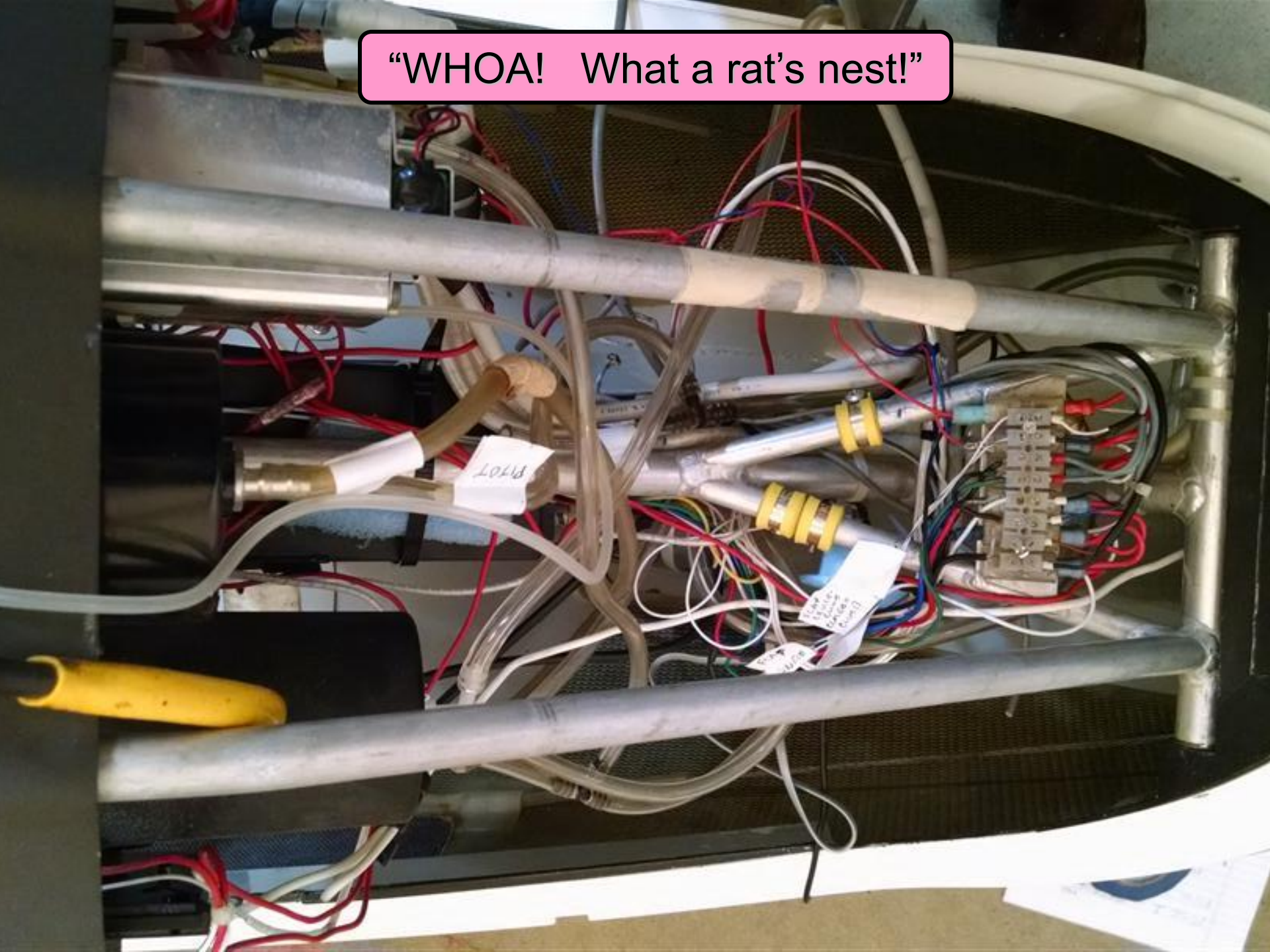
PLEASE NOTE

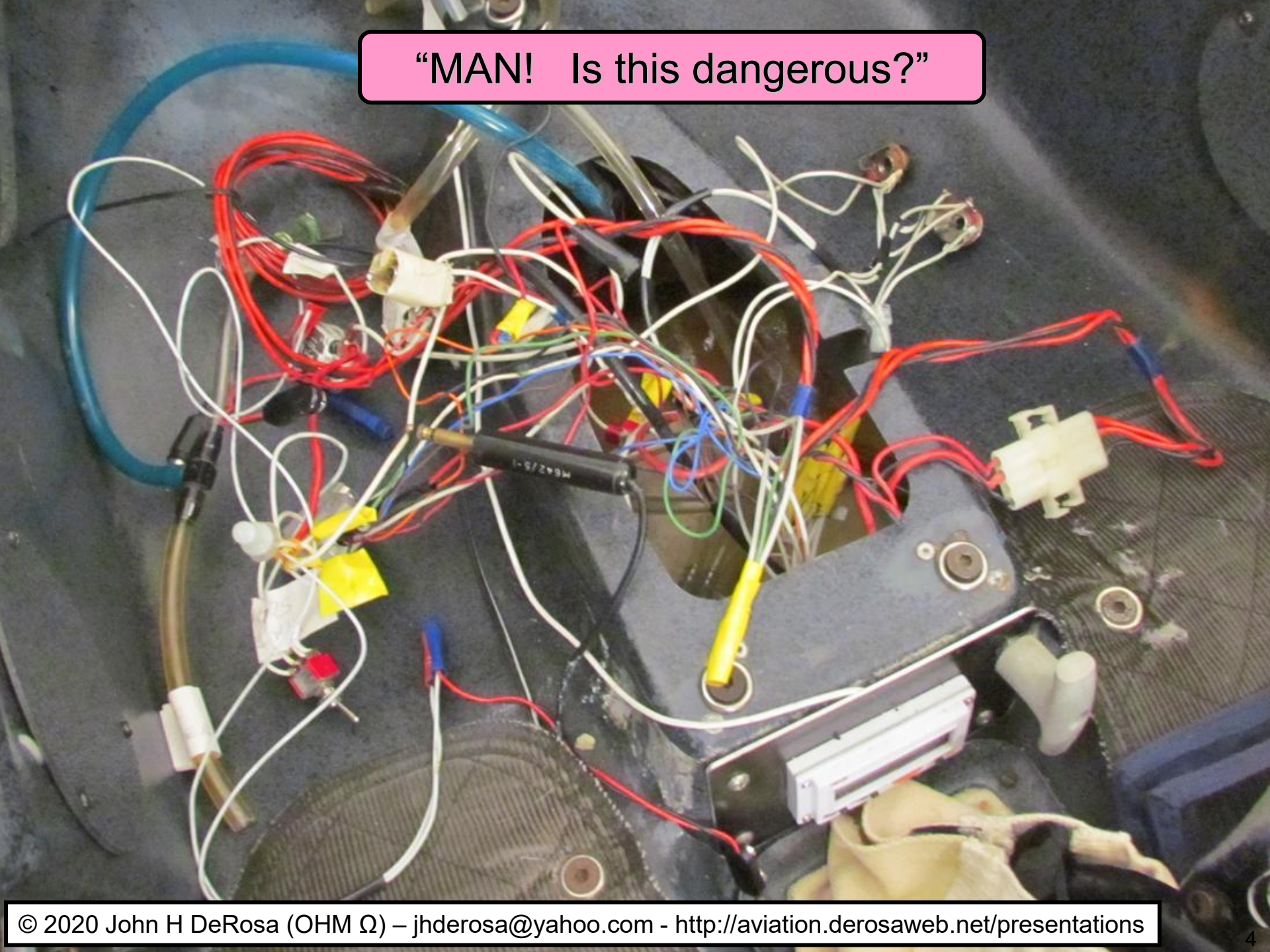
This document **may have been updated** with new information, changes, and corrections.

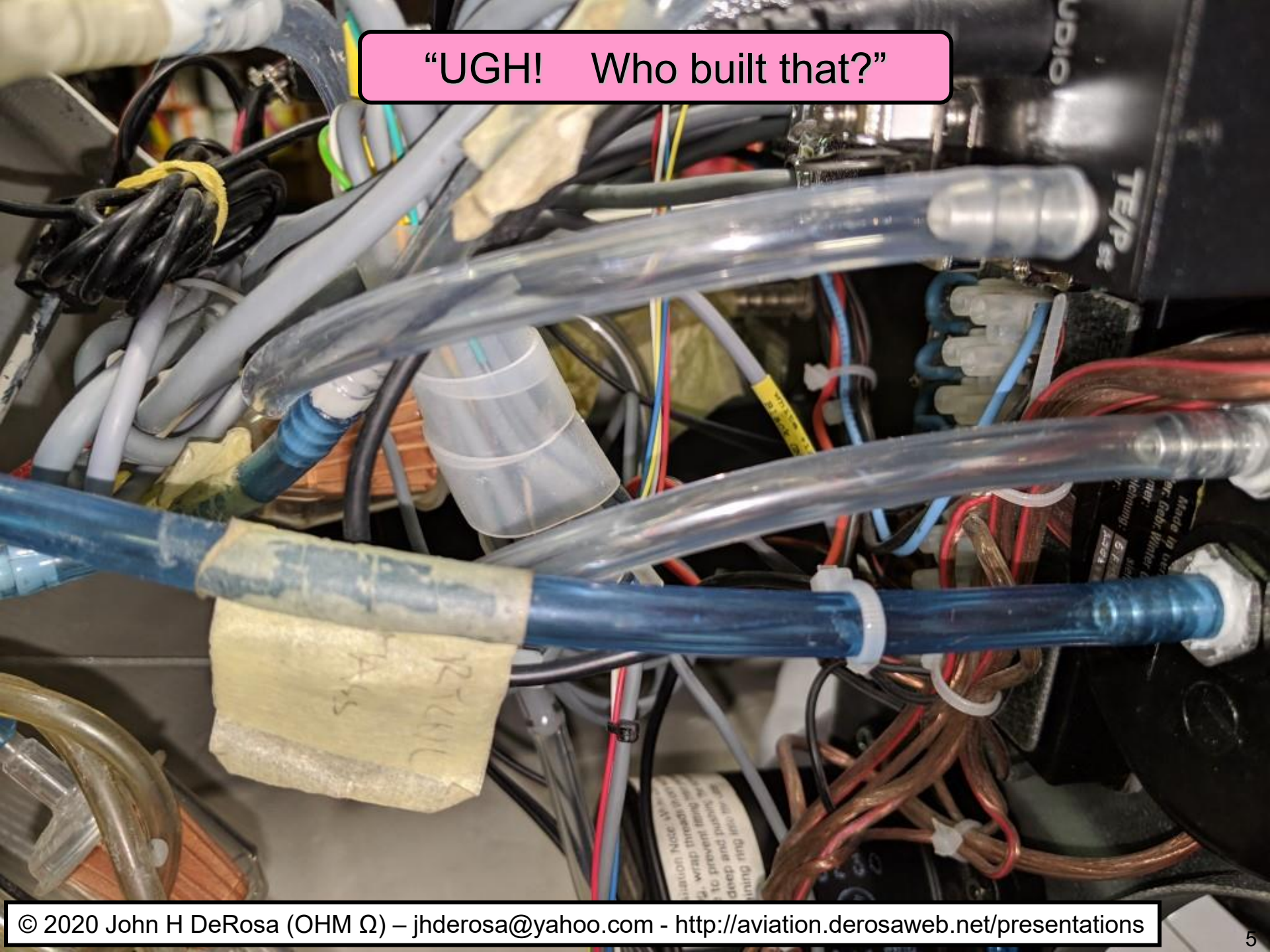
Be sure to visit my presentation web site and download the latest version of this document. It could make an important difference to your work!

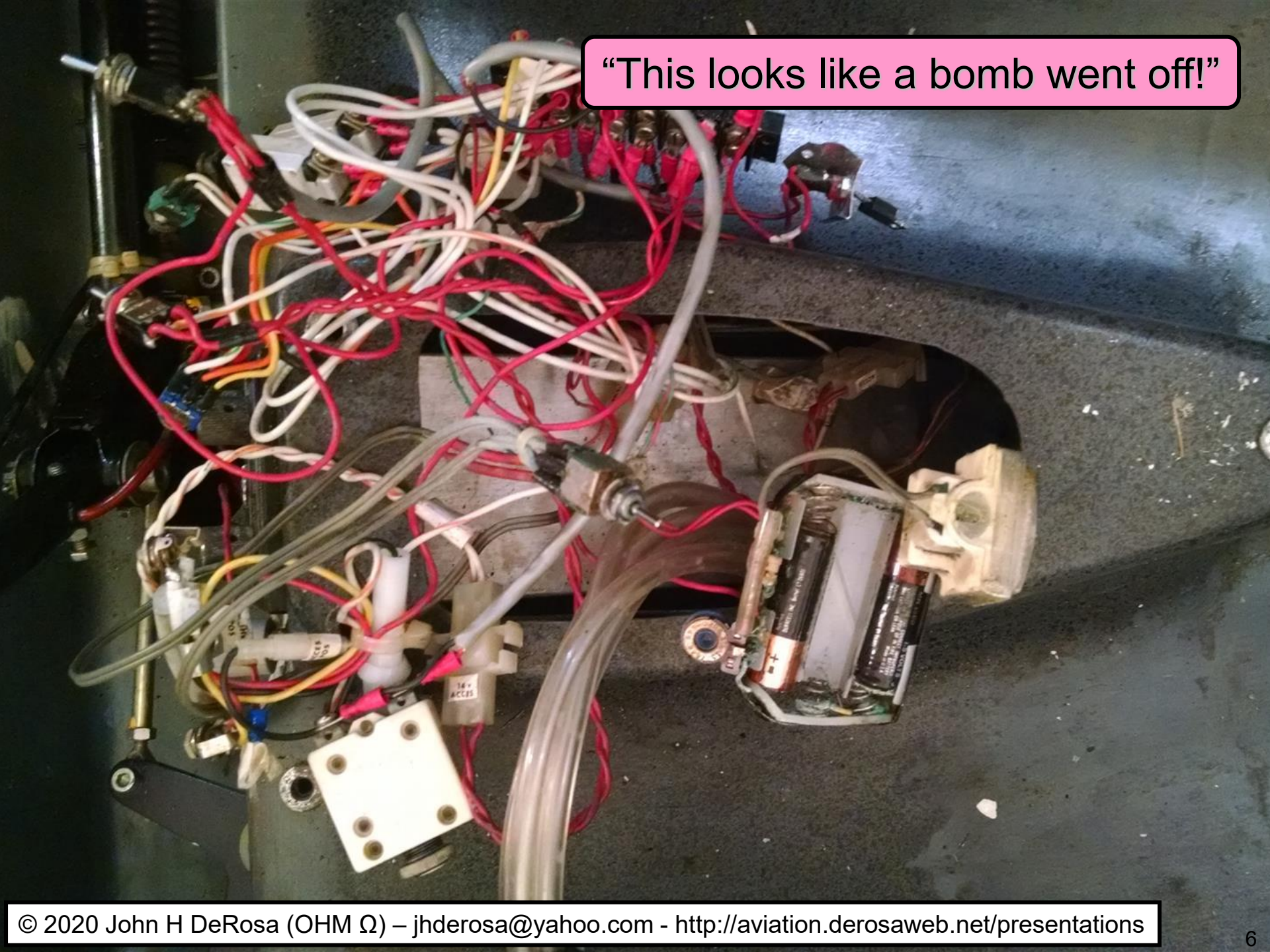
http://aviation.derosaweb.net/presentations

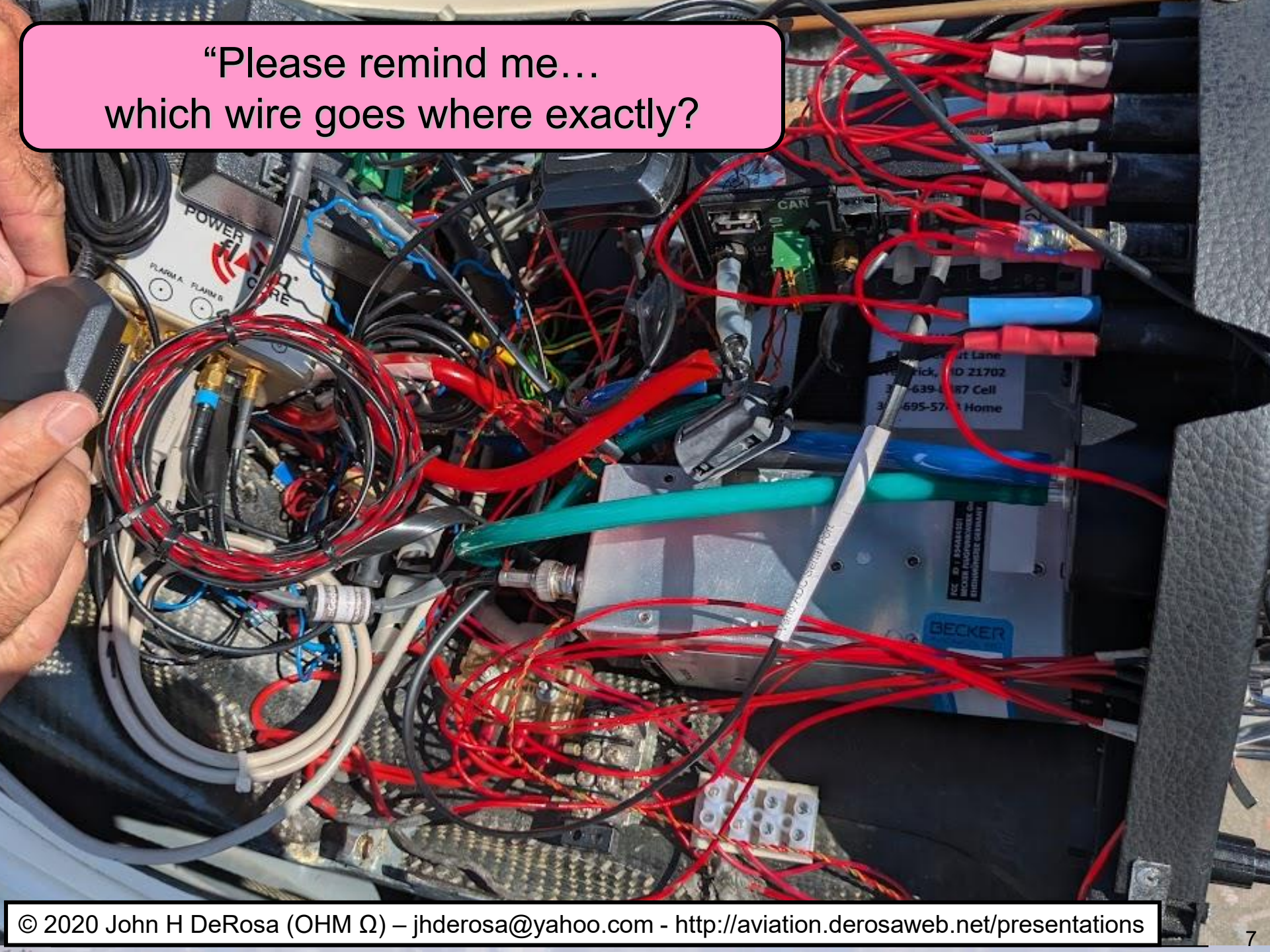
Thank you, John


“WHOA! What a rat’s nest!”









“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 in Series

Part 1

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

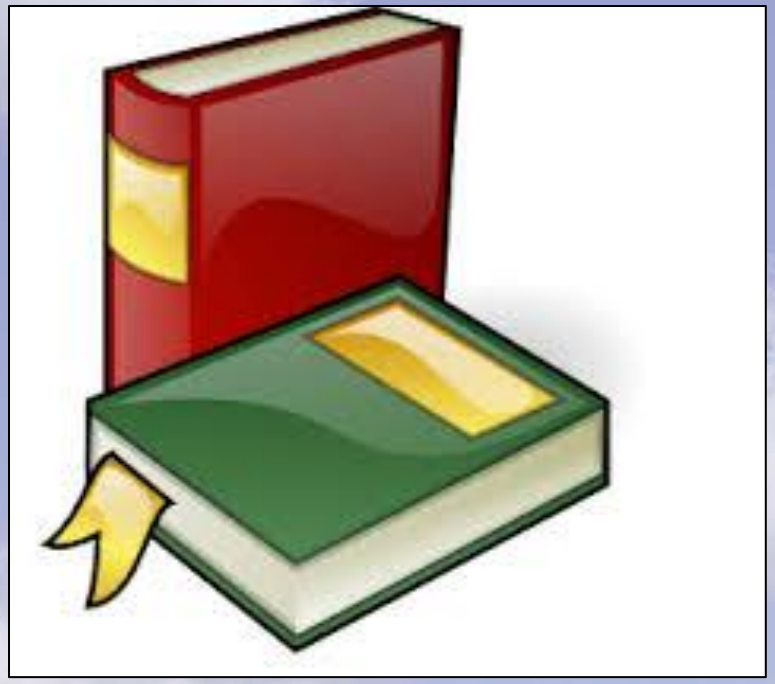
Part 2

6.  Instrument 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

All of the above information is freely available online

Electrical Nomenclature

Type	Name	Symbol[1]	Sample
Voltage	Volt[4]	V	12V
Current	Ampere[3] (Amp)	A	10A
Resistance	Ohm[5]	Ω	12Ω
Power	Watt	W	15W

Type	Name	Symbol[2]	Sample
Voltage	Direct	dc	12Vdc
Voltage	Alternating	ac	120Vac
Resistance	Thousands Millions	K M	12KΩ 100MΩ

1. Always capitalized
2. Case changes – note the examples shown
3. Named after: André-Marie Ampère
4. Named after: Alessandro Volta
5. Named after: Georg Simon Ohm

Electrical Formulas

Type	Symbol2	Sample
Voltage	E	E = I x R
Power	P	P = E x I
Resistance	R	R = E / I
Current	I	I = P / E

Voltage **V = I x R**
Current **I = V / R**
Resistance **R = V / I**
Power **P = V x I or $P = V^2/R$ or $P = I^2R$**

Resistors in series: $= R1 + R2 + R3 \ldots$

Resistors in parallel: $= \dfrac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} \ldots}$

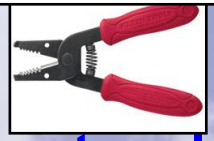
Chapter 2
Your Tool Box

What Basic Tools Do You Need?

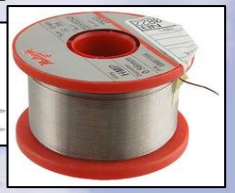
(Approximate Pricing)

- 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)





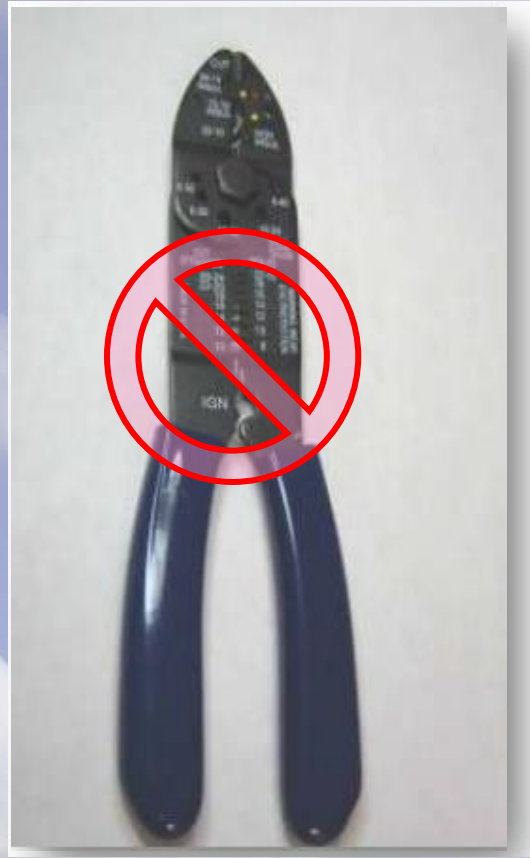





Total Cost: ~$120

Tools – Wire Strippers

Not Recommended!



Good

Better

Tools - Crimping

Not Recommended!

Good

Single Crimping

Better

Ratcheting Double Crimping

Tools - Crimping

Ratcheting "Double" Crimping Tool

Insulated
➔Terminals
Die Set

Klein Tools

Frame: VDV200-010
Die Set: VDV205-035
~$35

Other Interchangeable Die Sets
(more types available)

Non-InsulatedTerminals
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
Fractional 1/6" to 1/2" (by 64ths)
and
Numbered #1 to #60
[Metric is Handy Too]

Step Drill Bits
Great for
drilling
into
Sheet
Metal

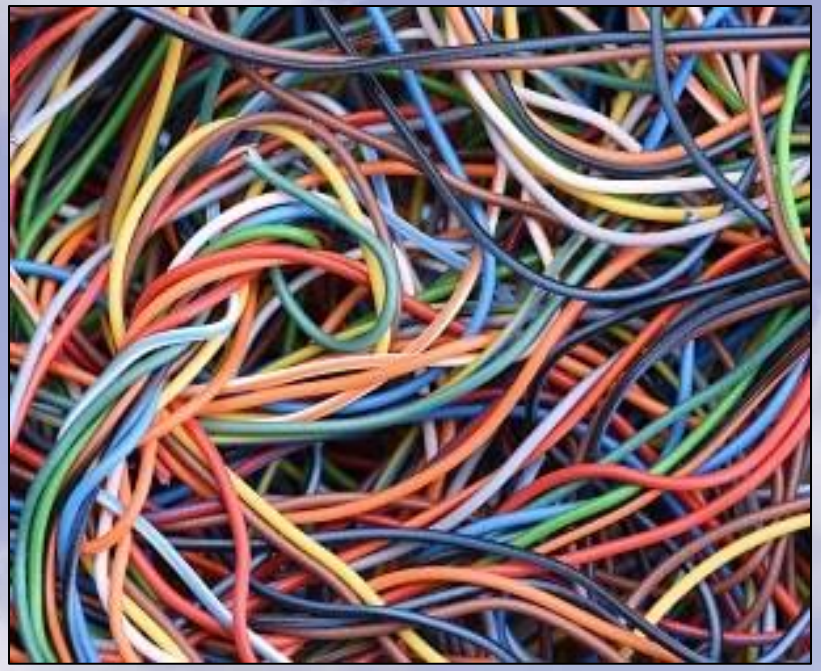
Tools – Hole Saws

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)

Common Non-Metric Sized Instrument Holes	Closest Metric Dimensions (over/under size)
2-1/4” (2.25”)	57mm (2.24”)
3-1/8” (3.125”)	80mm (3.15”)

Common Metric Sized Instrument Holes	Closest Non-Metric Dimensions (over/under size)
57mm	2-1/4” (57.15mm)
80mm	3-1/8” (79.375mm)

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 wiring
- Is labeled with gauge, type & manufacturer along the length
- Using multiple colors to ease identification and maintenance
- 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.

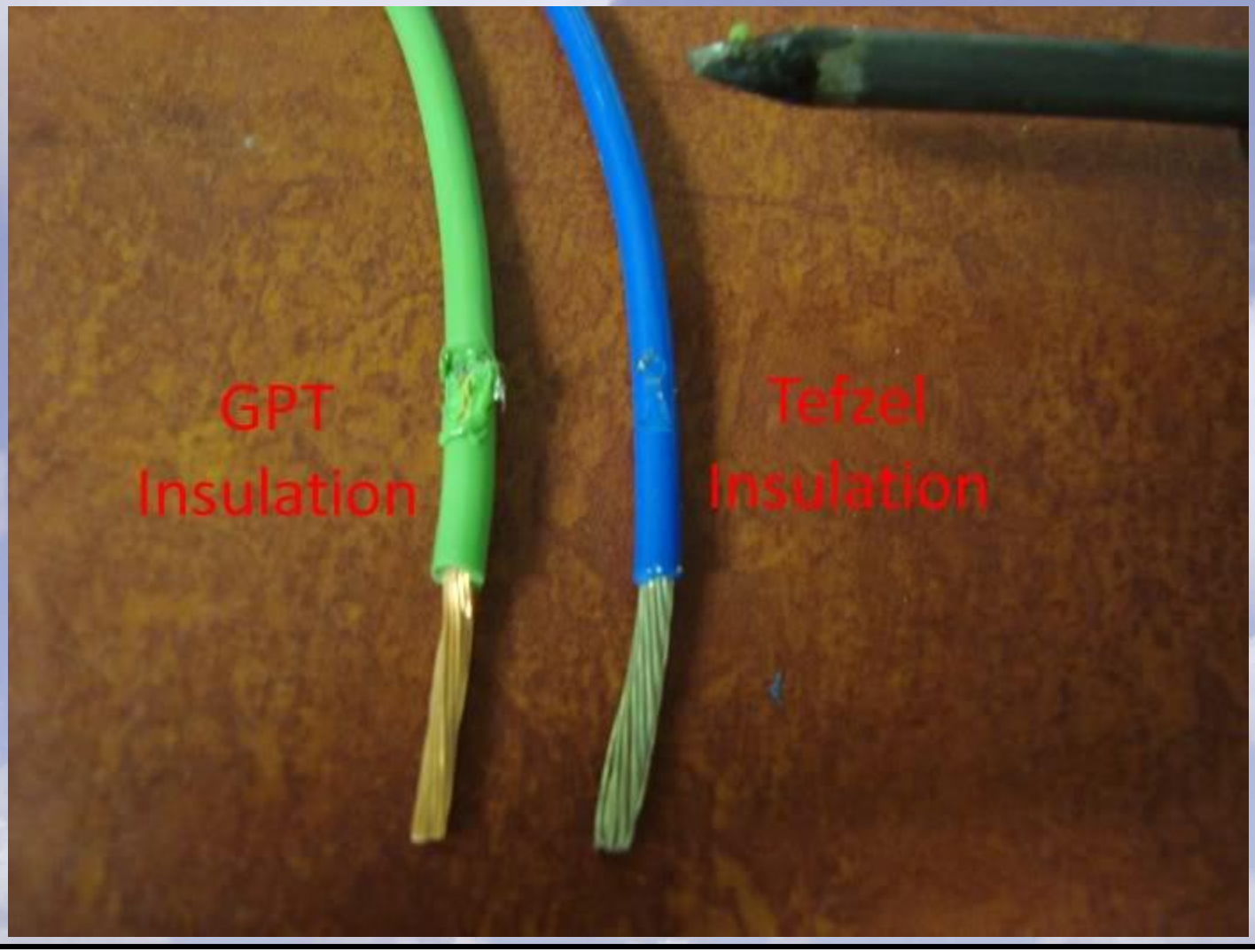
Tefzel Wire – Technical Info

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.

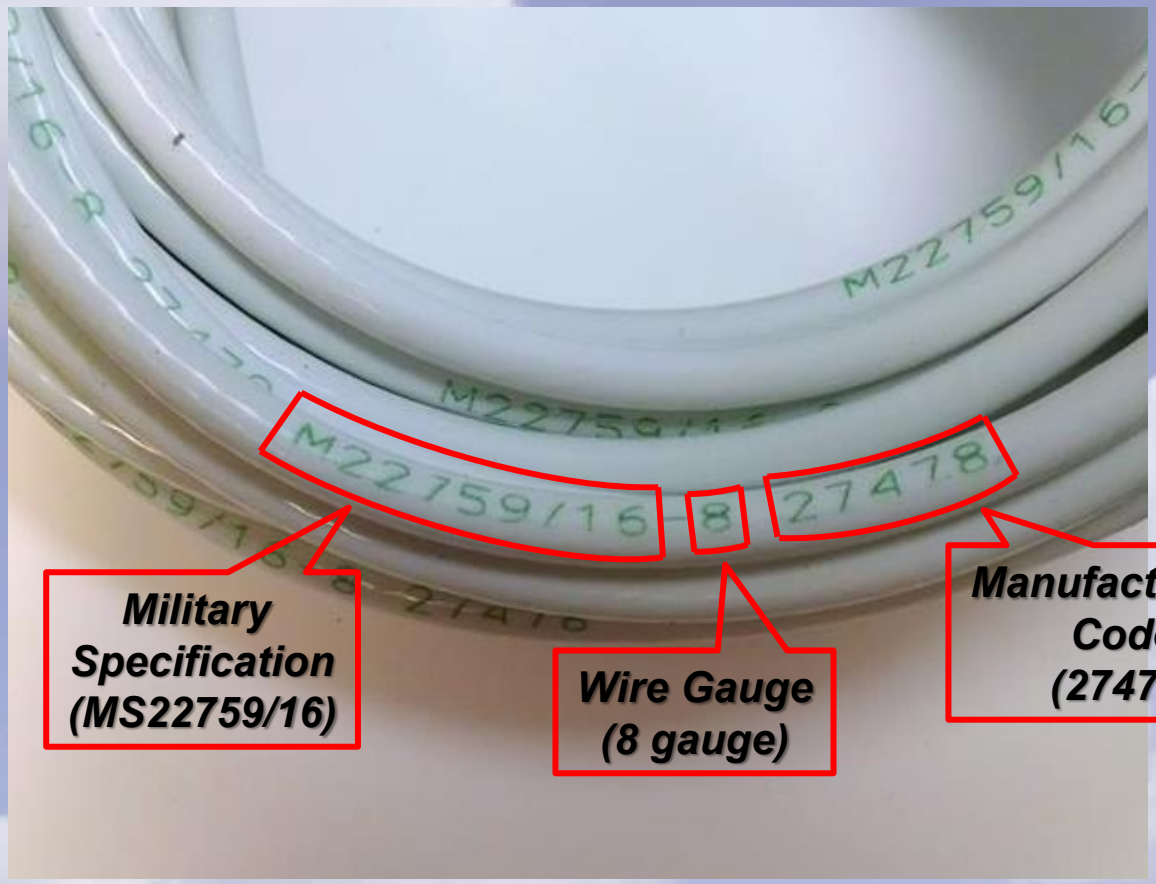
For many years the standard hookup wire in light aircraft has been MIL-W-5086A, which calls for use of tin-coated copper conductor rated at 600 volts and temperatures of 105°C. The Air Force does not permit such wire to be used in military aircraft due to the toxic fumes generated in the event of a fire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

This wire wasreplaced with MIL-W-22759/16 & MIL-W-22759/32 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

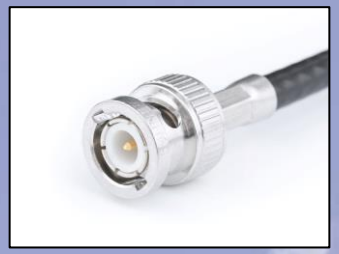
Tefzel - Multi-Conductor

Comes in Shielded and Non-Shielded

For Speakers, Microphones, PTT Switches, etc.

Coaxial Cables

Aircraft uses 50Ω Coax



BNC Connectors
Typically found on transceivers

TNC Connector
Typically found on transponders

See my Transceiver Troubleshooting presentation for more details on coax cabling
https://aviation.derosaweb.net/presentations/#transceivertrouble

Transceiver Troubleshooting Presentation

https://aviation.derosaweb.net/presentations/#transceivertrouble

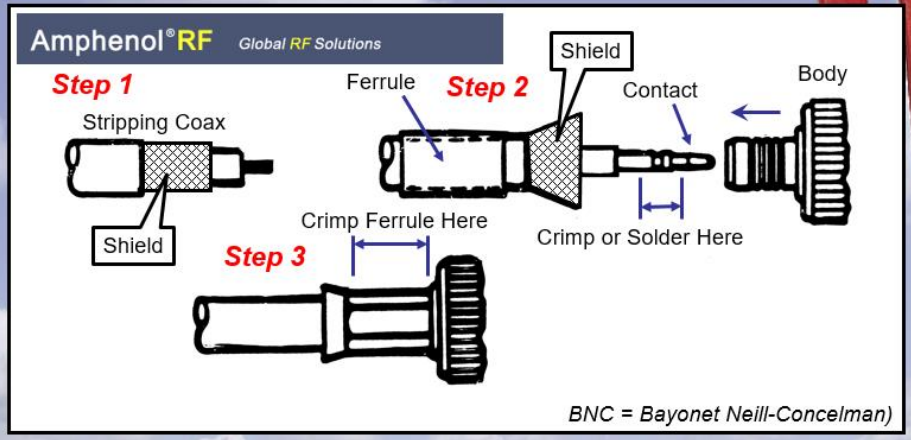
See My Presentation for More Coax Details

BNC Connectors

Coax Crimping Tool
$15-$25

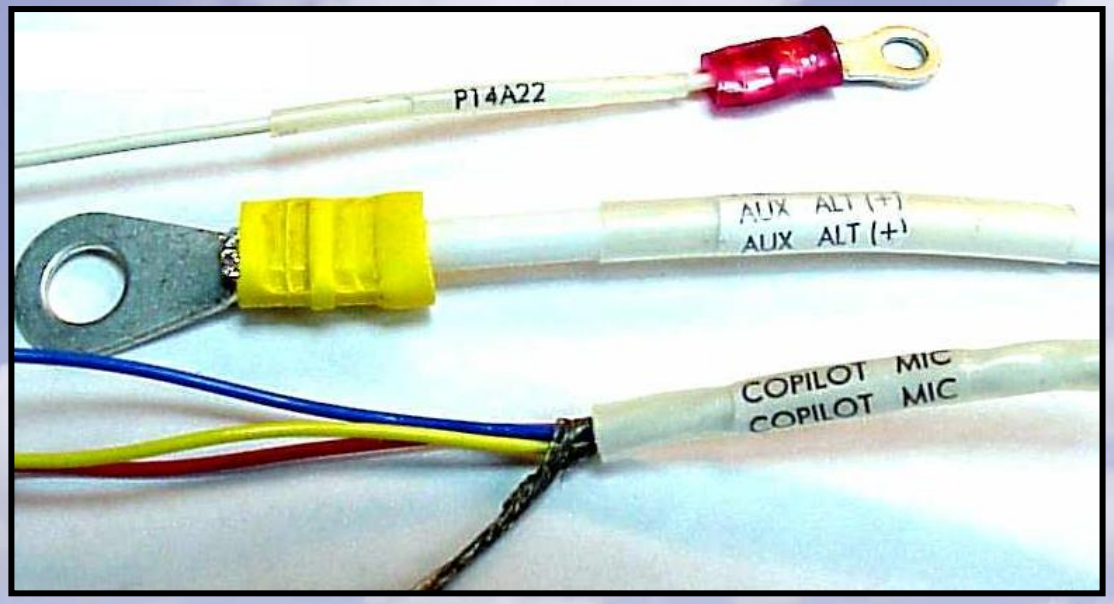
Microaire recommends using only soldered or crimped BNC connectors

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



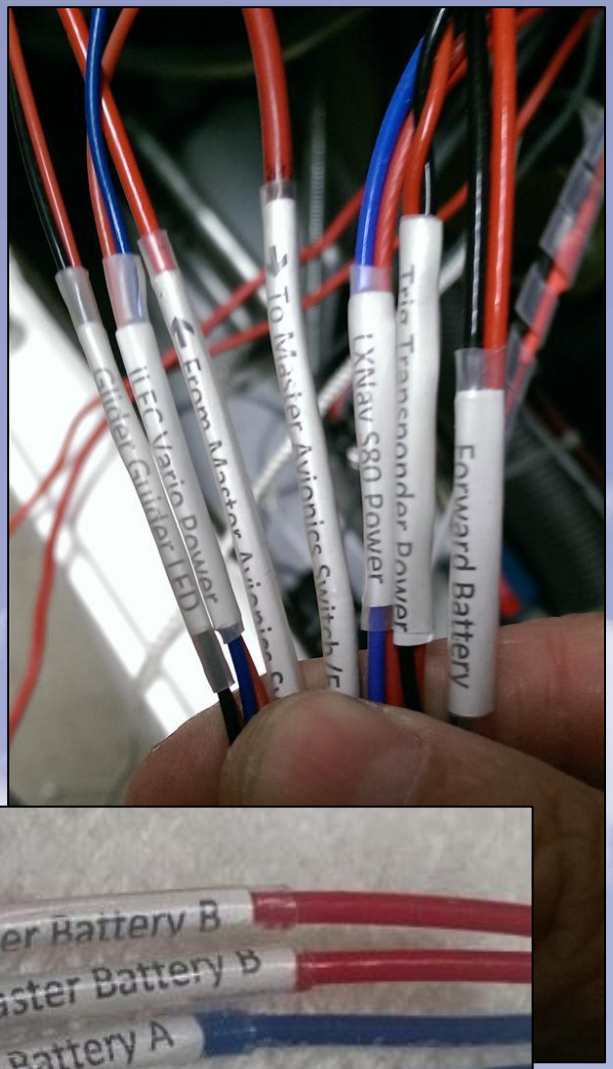
Wire Labeling

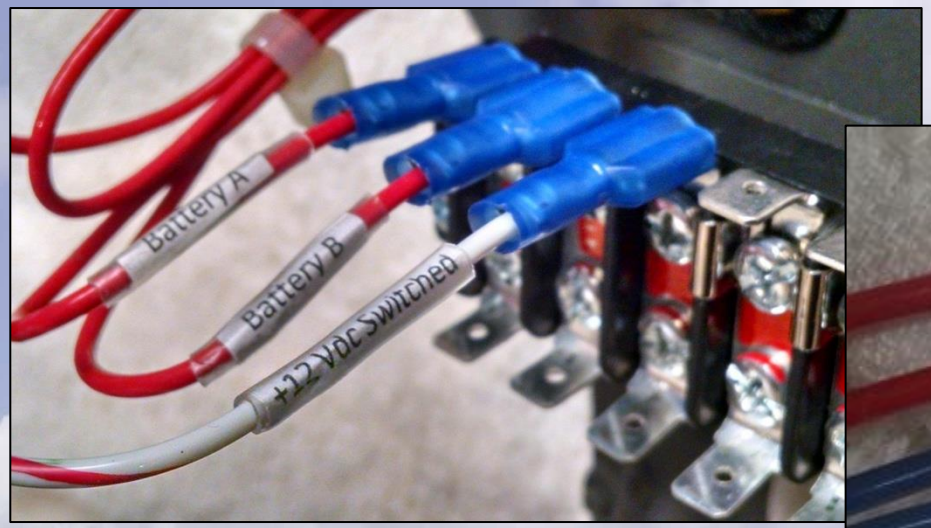
- **FAA AC43-13-1b Par 11-208**
  - *"PLACEMENT OF IDENTIFICATION MARKINGS"*
    "Identification markings should be placed at each end of the wire and at 15-inch maximum intervals along the length of the wire."
- Markings greatly assists the tracing of similarly colored wires which are often all white



Wire Labeling

- **Simplest and 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)

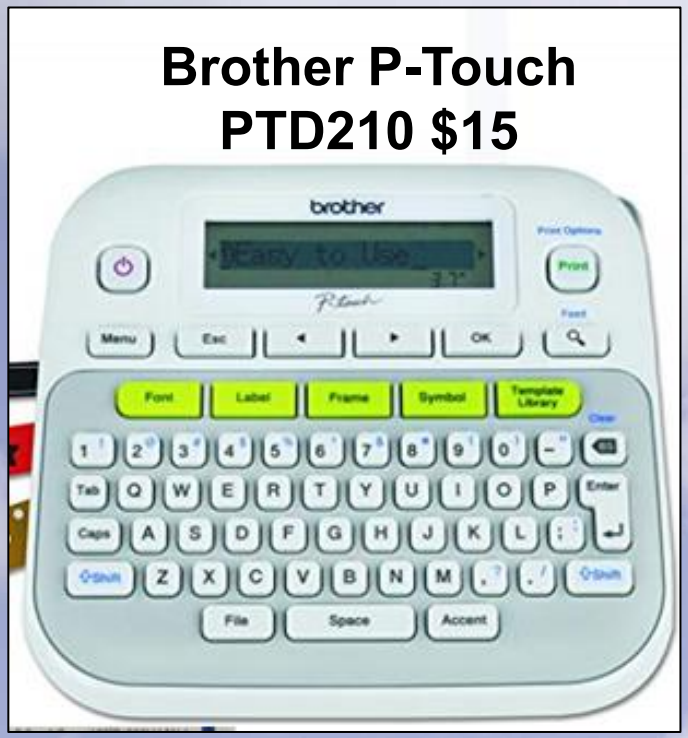
Tape Cartridges ~$25

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

Wire Labeling

Printing Directly on Heat Shrink Tubing

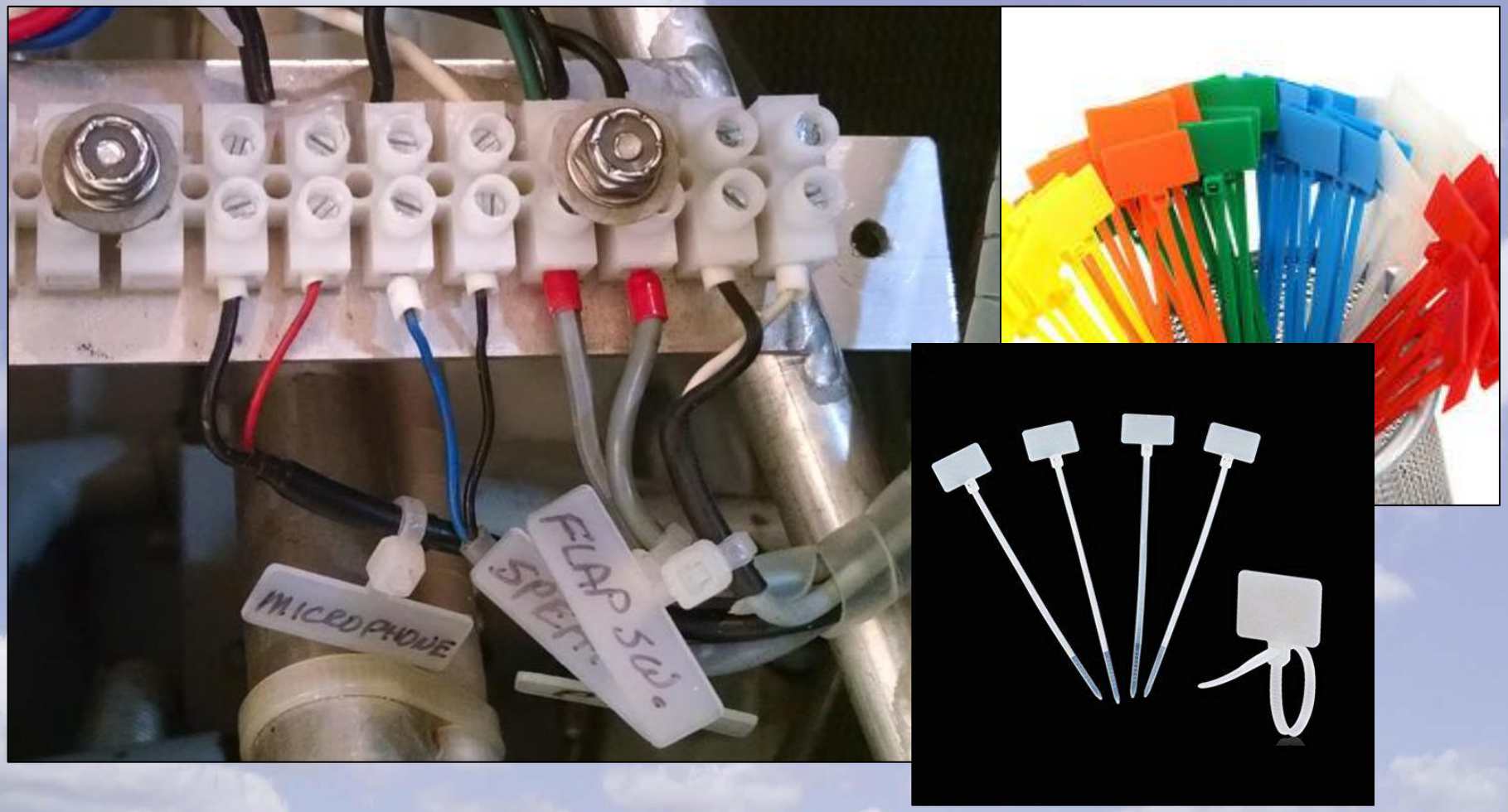
Brother P-Touch
PTD210 $15



Uses TZe
Tape Cartridges
~$25

Wire Labeling

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



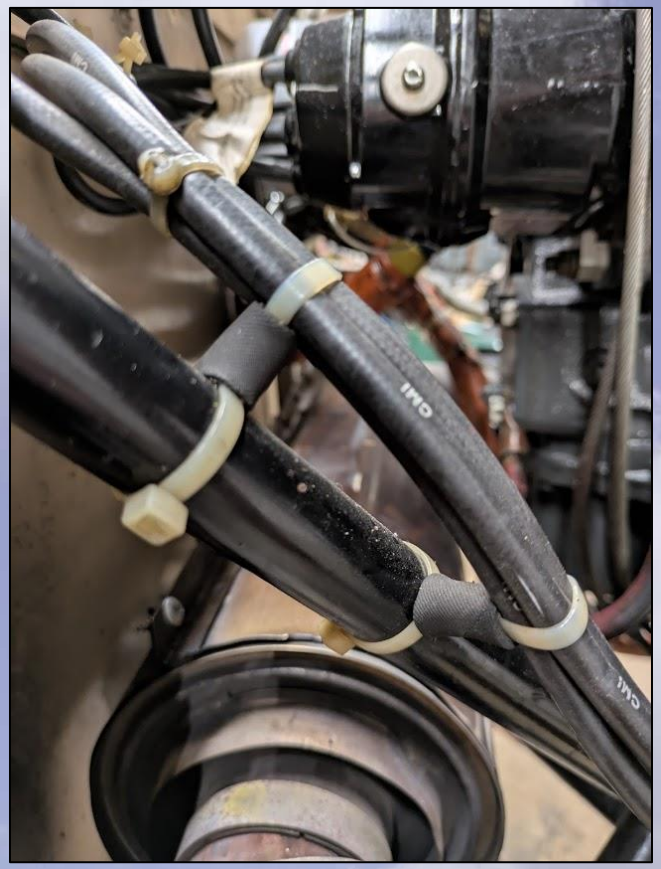
Tying Wires Down – Zip Ties

- "Zip" Ties (Ty-raps®)
  - Quick & easy
  - Use high quality (i.e. Thomas & Betts)
    - Has a Stainless Steel Metal "tang"
  - Use UV blocking black ties for exterior use
  - DON'T cinch tight on coax or air lines!
  - Use a cable tie "gun". $16 at ULINE!

Ty-raps®
Thomas & Betts

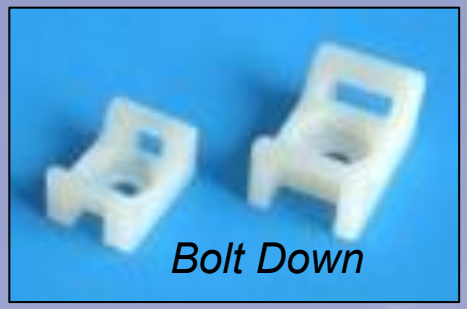
Ty-Rap® brand has a Stainless Steel Metal "tang"

Tying Wires Down - Misc



Standoffs for High Temperature And Vibration Areas

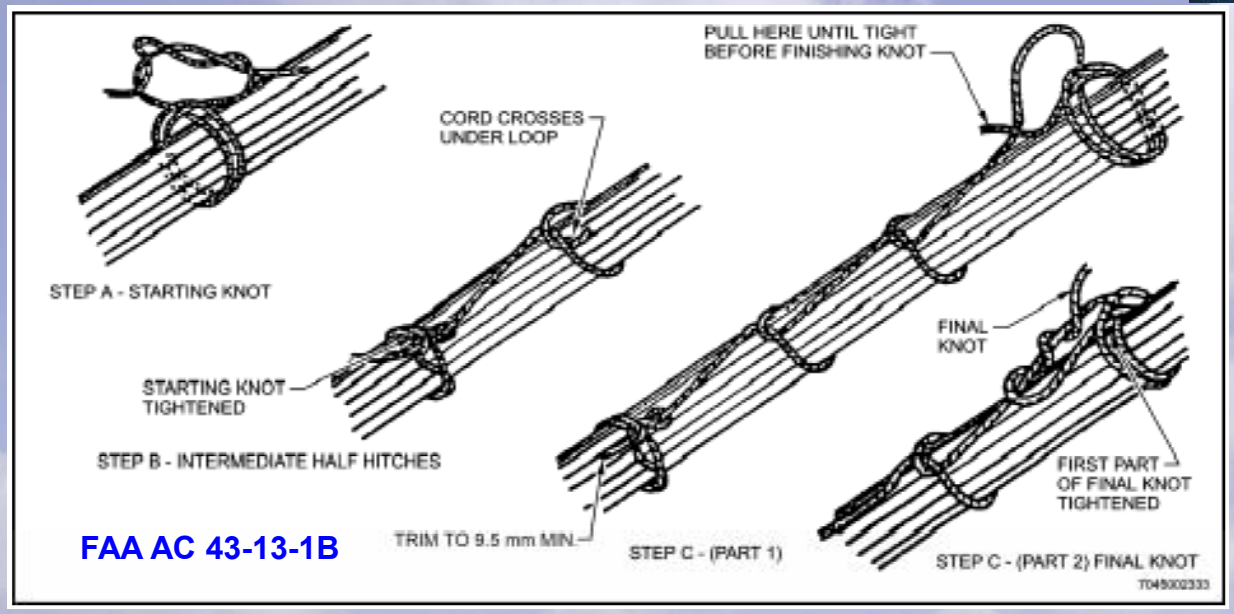
Anchors



Tying Wires Down - Lacing

- Nylon Lacing Cord
  - Old school traditional method
  - Very inexpensive
  - See FAA AC 43-13-1B

Wax impregnated nylon cord - available in white or black.
500 yards
$20



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

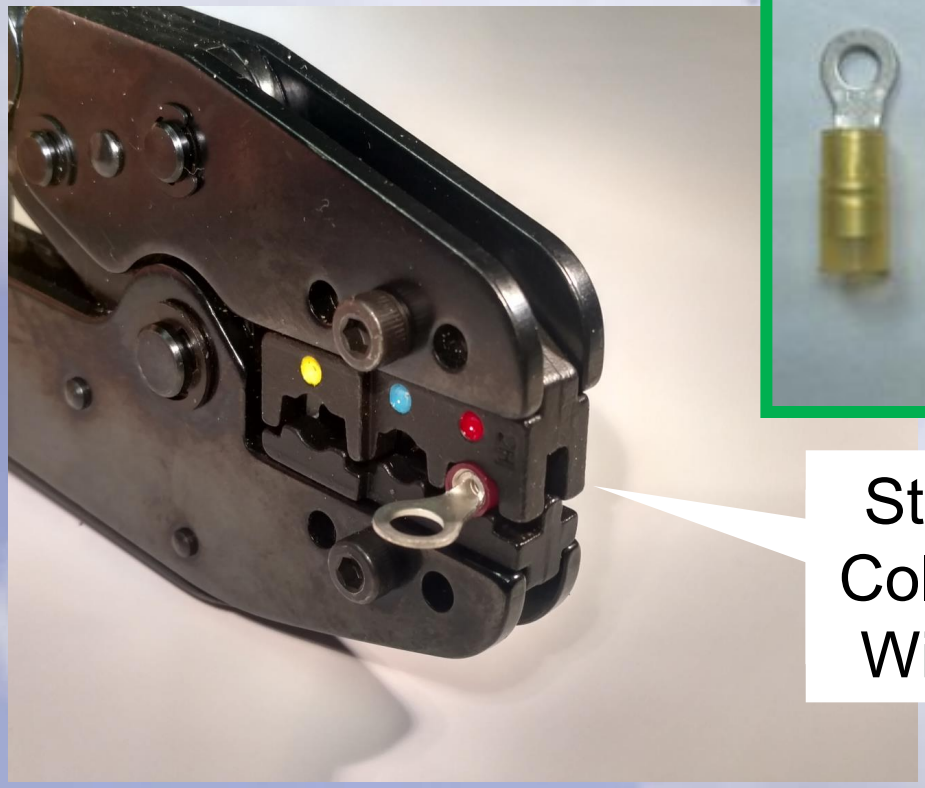
Connections: “Crimp” or “Compression”

- **Nylon Insulation** ➔
  - Translucent
  - Tough
  - Heat resistant
  - Crimp is visible

- **Vinyl Insulation** ➔
  - Opaque
  - Brittle
  - Melts easily
  - Crimp is hidden

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

Connections: “Crimp” or “Compression”



Standard US Color Codes & Wire Gauges

Wire Gauge Color Coded Terminals

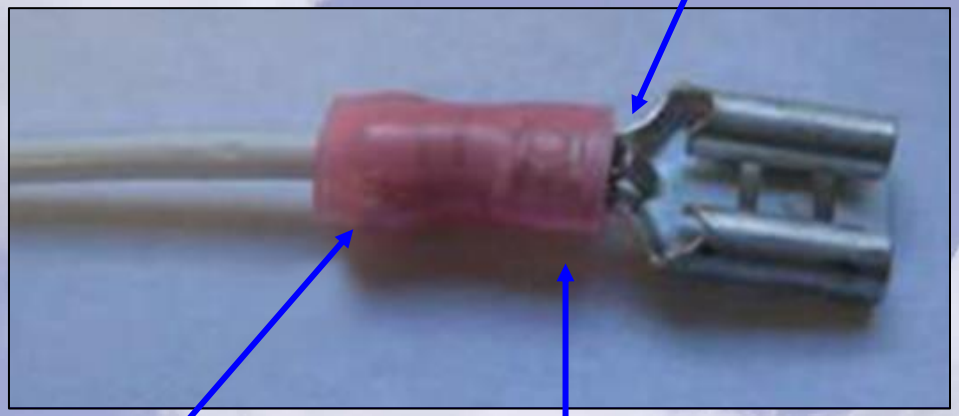
Color	Small	Standard	Large	V. Large
Red		#18-22	#8	#2
Blue		#14-16	#6	
Yellow	#24-26	#10-12	#4	

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 →

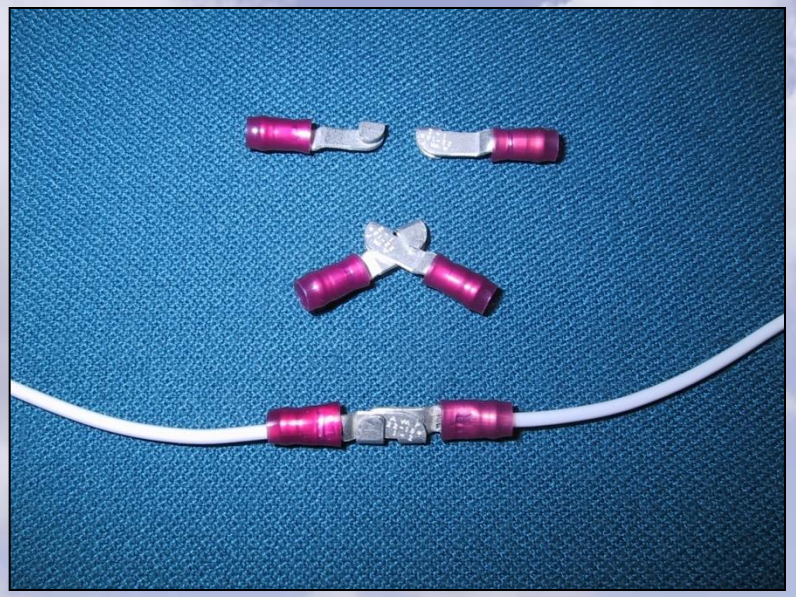
Reference:
http://verticalpower.com/media/attachments/2017/07/20/connector_service_manual.pdf

Joining Wires Together

Splicing Non-shielded Cabling

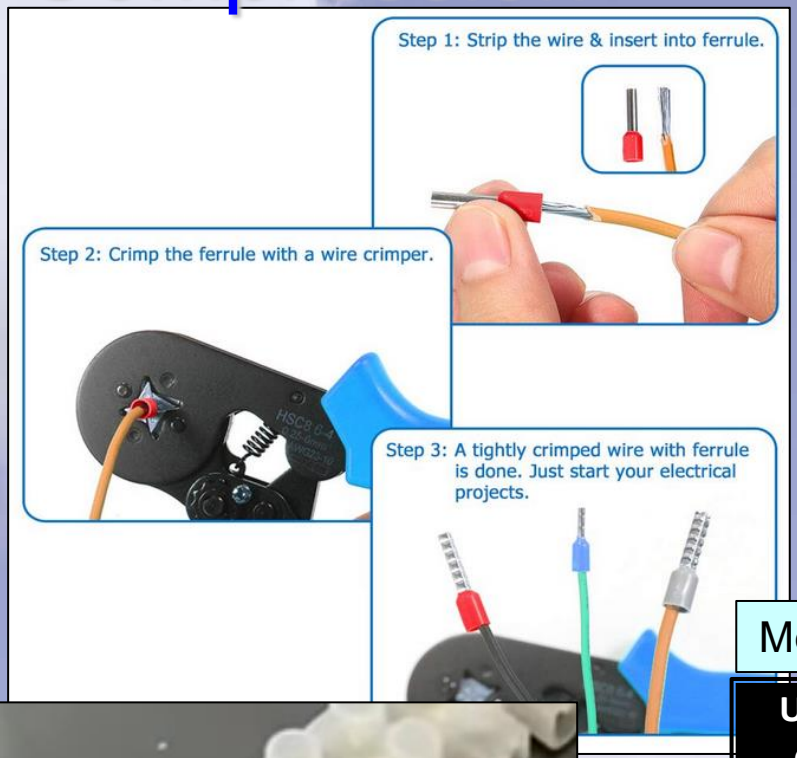
- Butt Splices
- Knife Splices
- Soldering

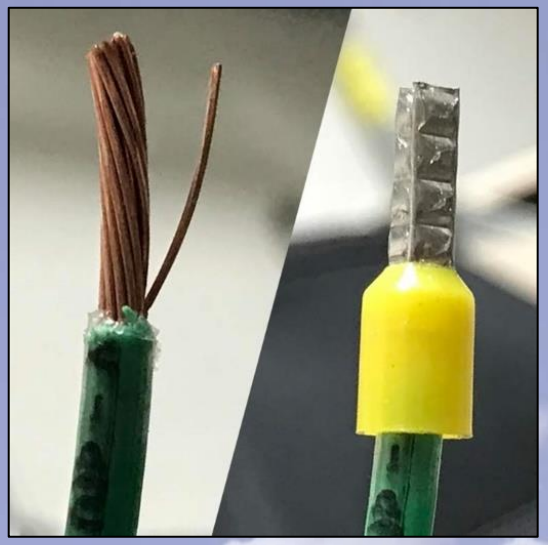
- ***Avoid splicing if possible***
- ***Use one or two layers of heat shrink over the connection***



“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 wring in screw down terminal blocks. These are functionally similar to US type “pin” terminals but more compact.





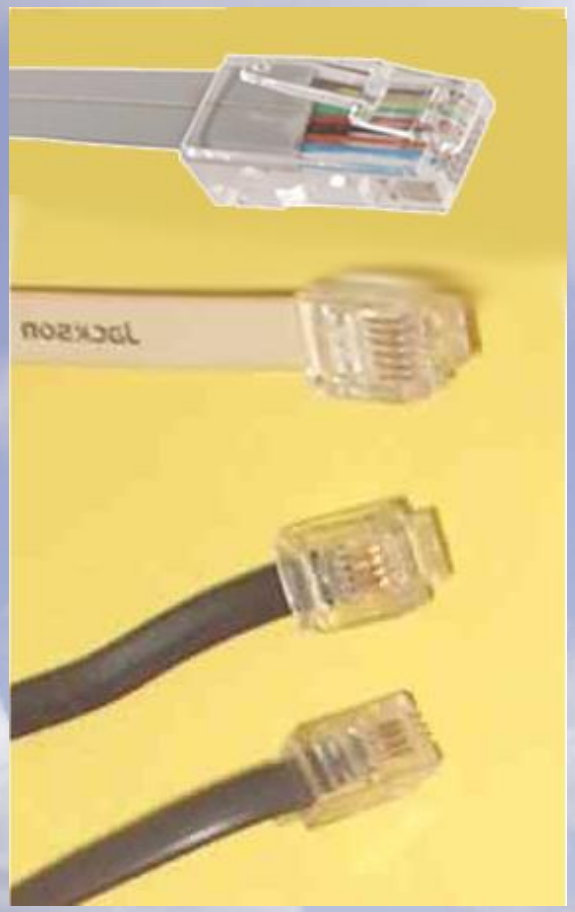
Metric Color Coding (DIN 46226)

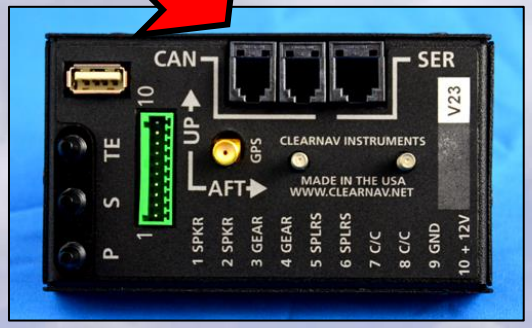
US Wire Gauge (approx)	Wire Gauge (mm^2)	Color Coding
	10	Red
10 AWG	6	Yellow
12 AWG	4	Gray
14 AWG	2.5	Blue
16 AWG	1.5	Black
18 AWG	1.0	Red
20 AWG	0.75	Gray
22 AWG	0.50	White

https://library.automationdirect.com/ferrule-ferrule-ferrule-right/
https://www.youtube.com/results?search_query=ferrule+crimping

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*

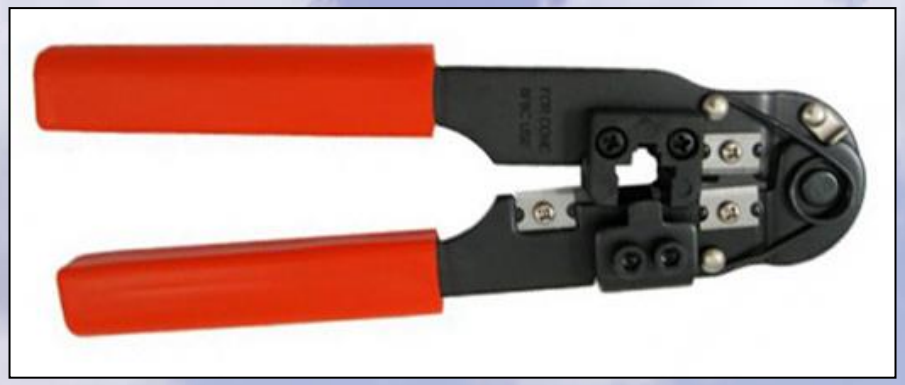
RJ-11
4 Wire
6P4C*

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”

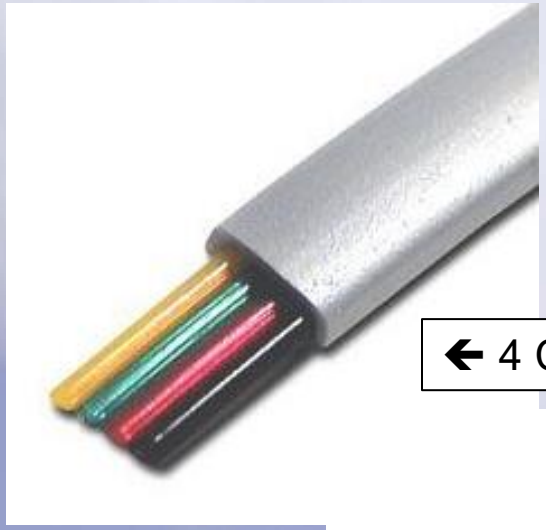
Connections: “RJ” Type

Shown in Yellow are the Commonly Used Code Types and Sizes

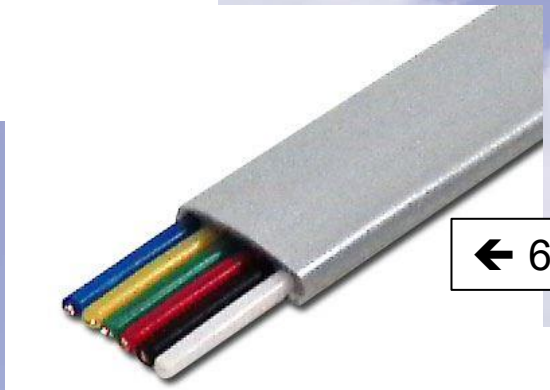
Code	Connector	Positions	Conductors
RJ11	6P4C	6	4
RJ12	6P6C	6	6
RJ13	6P4C	6	4
RJ14	6P4C	6	4
RJ18	6P6C	6	6
RJ22	4P4C	4	4
RJ25	6P6C	6	6
RJ31	8P8C	8	8
RJ32	8P8C	8	8
RJ33	8P8C	8	8
RJ34	8P8C	8	8
RJ35	8P8C	8	8
RJ38	8P4C	8	4
RJ41	8P8C	8	8
RJ45	8P8C	8	8
RJ48	8P4C	8	4
RJ49	8P8C	8	8
RJ61	8P8C	8	8

Details at: https://arcelect.com/RJ_Jack_Glossary.htm

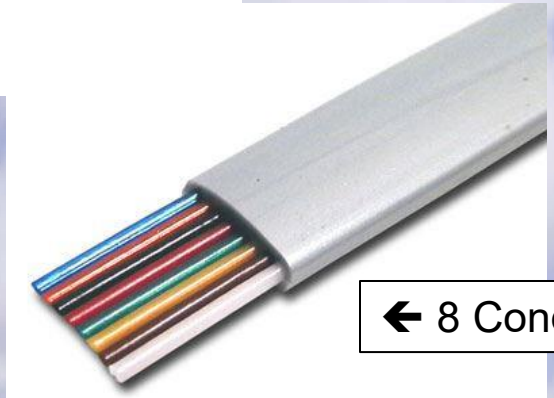
Connections: “RJ” Type Cabling



← 4 Conductor Standard Colors



← 6 Conductor Standard Colors



← 8 Conductor Standard Colors

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

Black sheathing is also available.

Connections: “RJ45” Type

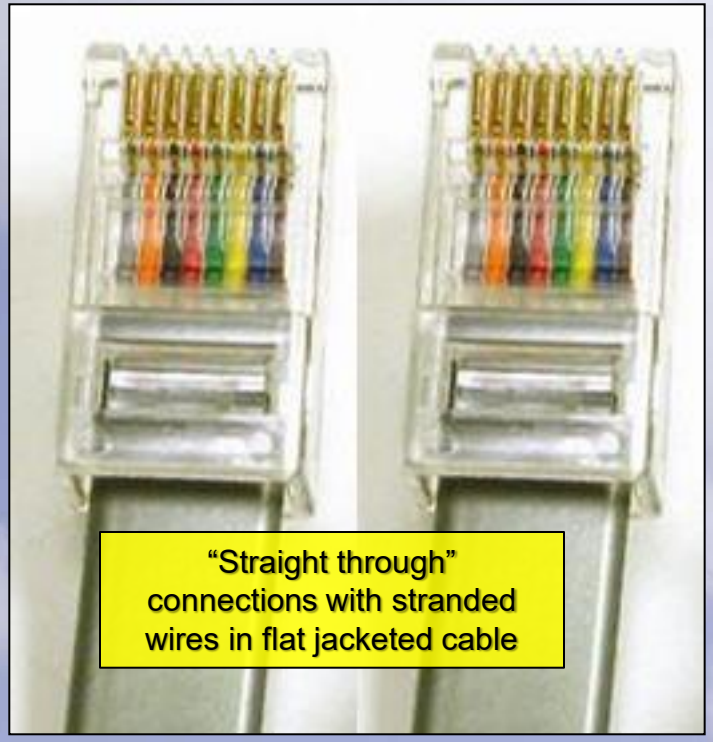
Why **Not** to Use More Commonly Available Computer Cabling?

- 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

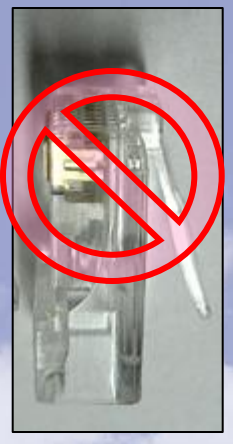
Connections: “RJ45” for FLARM



- 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)

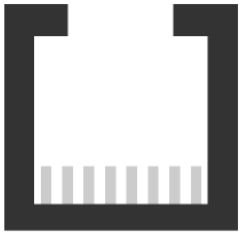
Contacts for stranded wire

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):



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

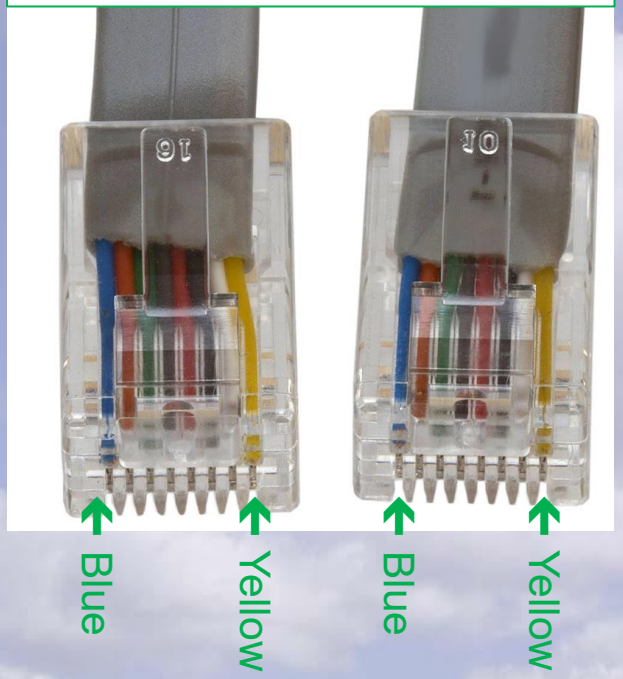
PowerFLARM CORE Manual 3.41 International 11

Connections: “RJ” Type

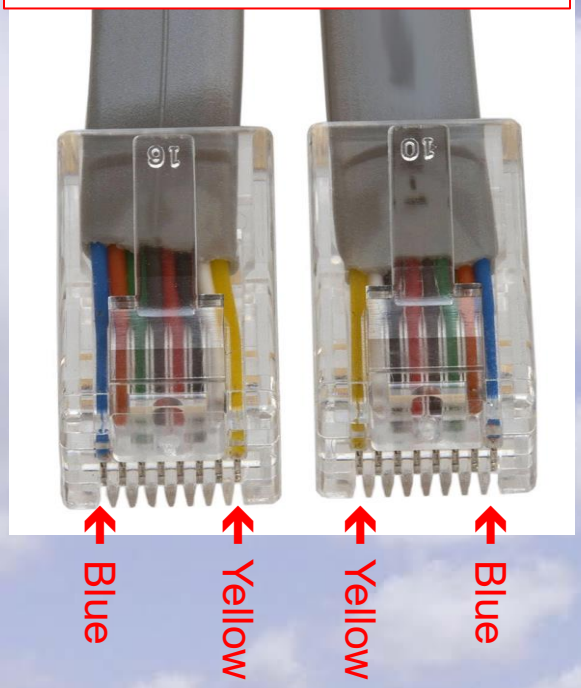
Watch out for this RJ Cable gotcha’!

- **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!!**

Straight Through

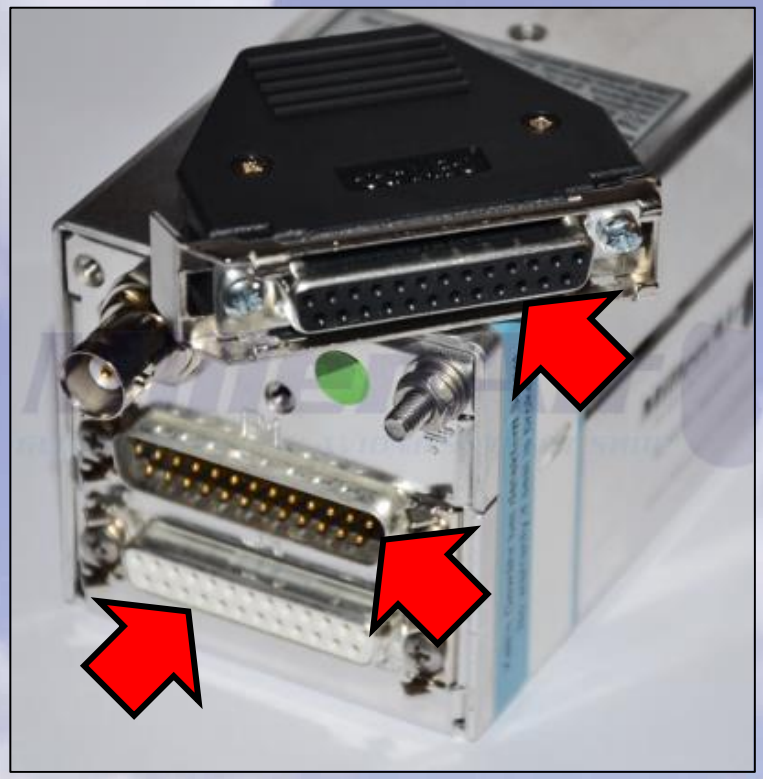


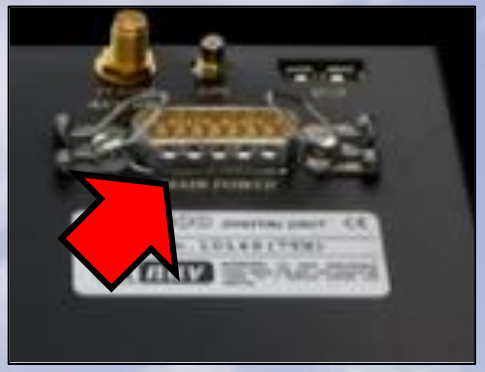
Half-Twist!!



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.



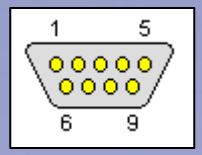


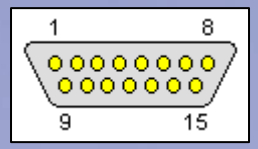
* The “D” in D-Subminiature stand for the “D” shape of the connector’s metal shield

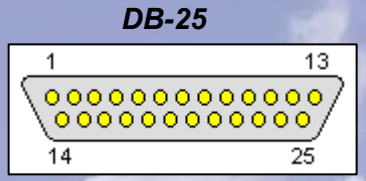
Connections: “D-Subminiature”

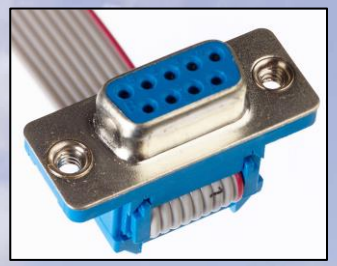
Contact numbering details on the next slides

- Most Common Sizes
  - 9 Pins
  - 15 Pins
  - 25 Pins
- Pin Types
  - Male
  - Female
- Wire Connection Types
  - Crimp & Insert
  - Solder Cup
  - Ribbon Cable





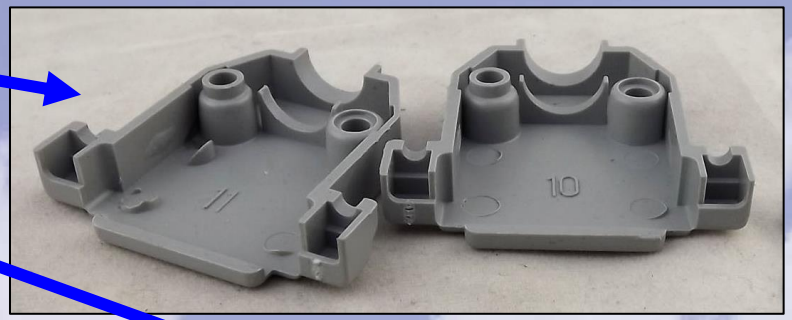




Connections: “D-Subminiature”

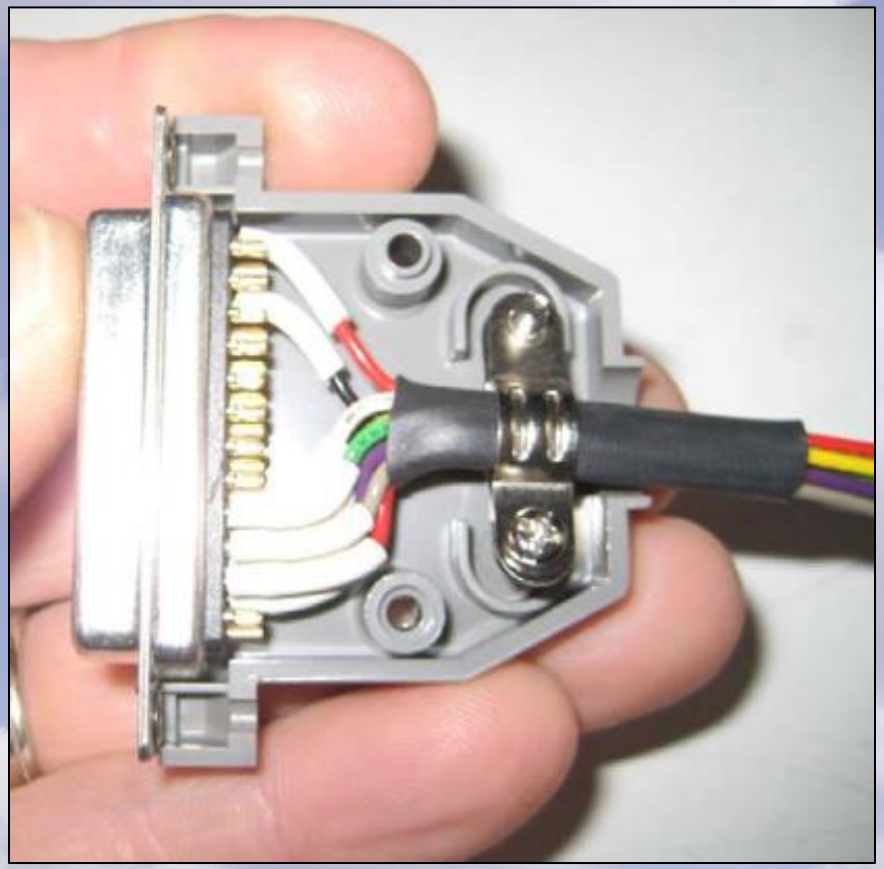
Hood/Cover/Shell Types (plastic and metal)

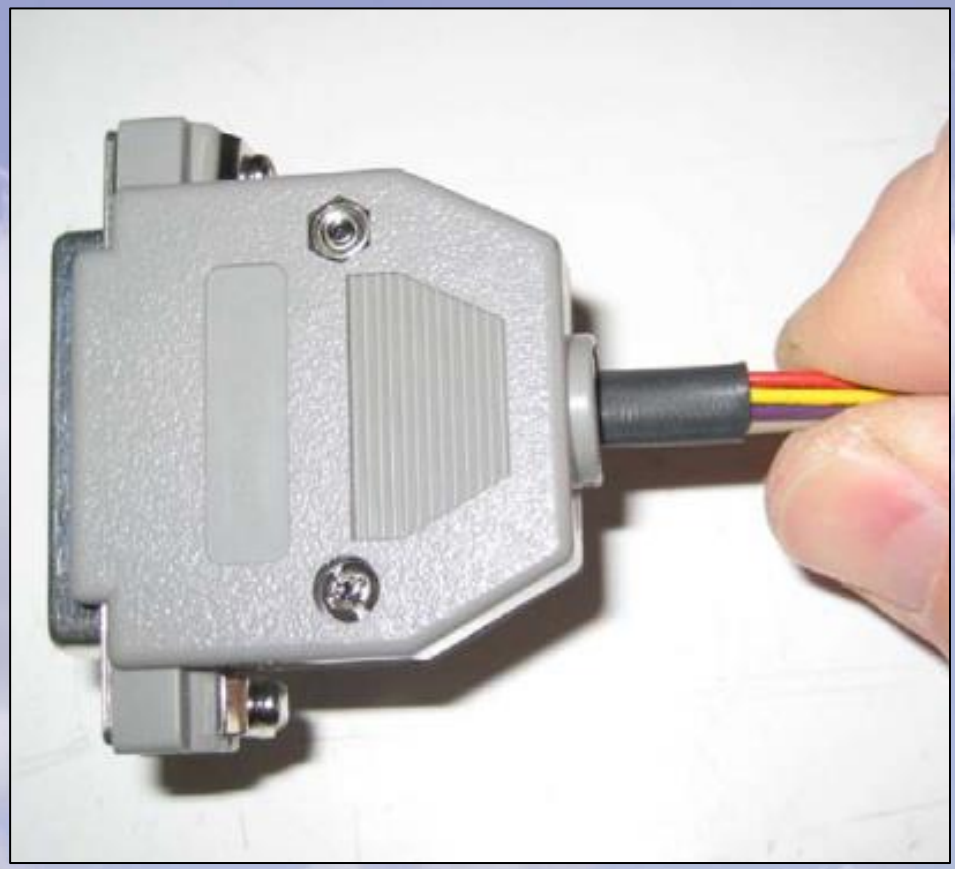
- 180º Exit
- 45º Exit
- 90º Exit
- 180º & 90º Exit



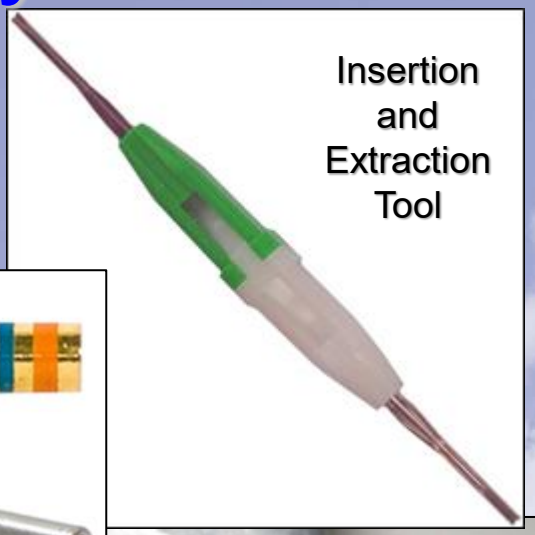
Connections: “D-Subminiature

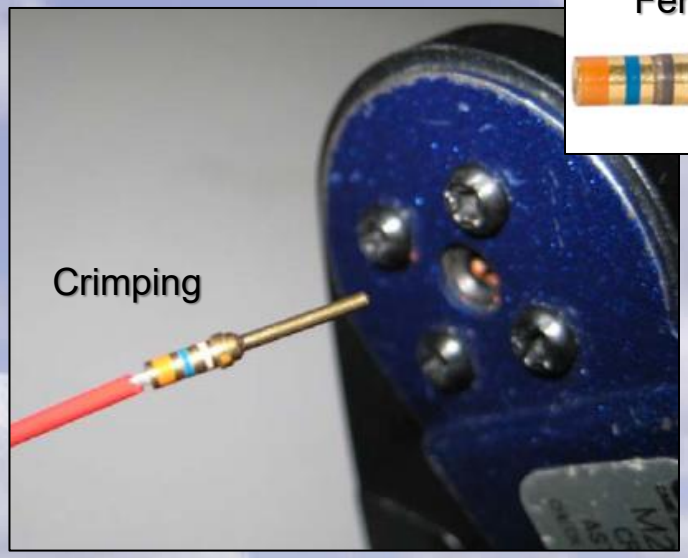
Solder Style Connections
with heat shrink tubing

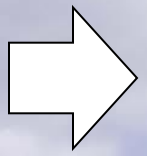


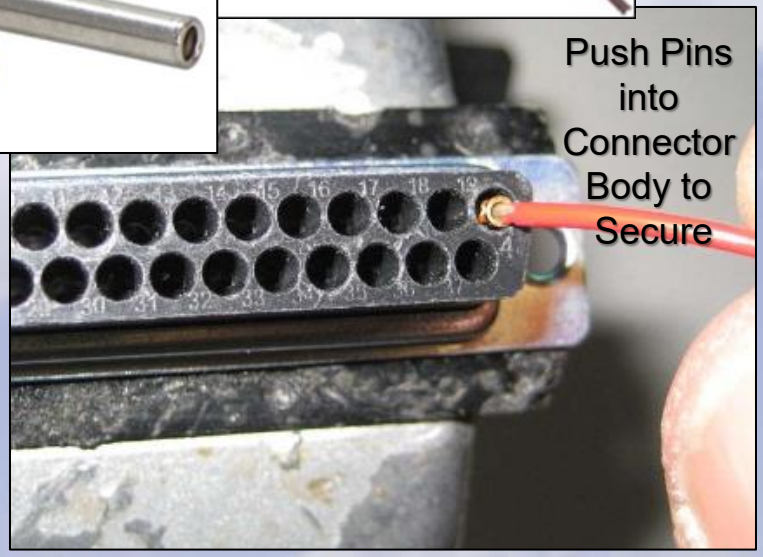


Connections: “D-Subminiature” Crimp Pins Style









Connections: “D-Subminiature”

Securing/Latching Types

- **Threaded (4-40) Screw/Nut Type**
  Very common
  Used on Microair

Connections: “D-Subminiature”

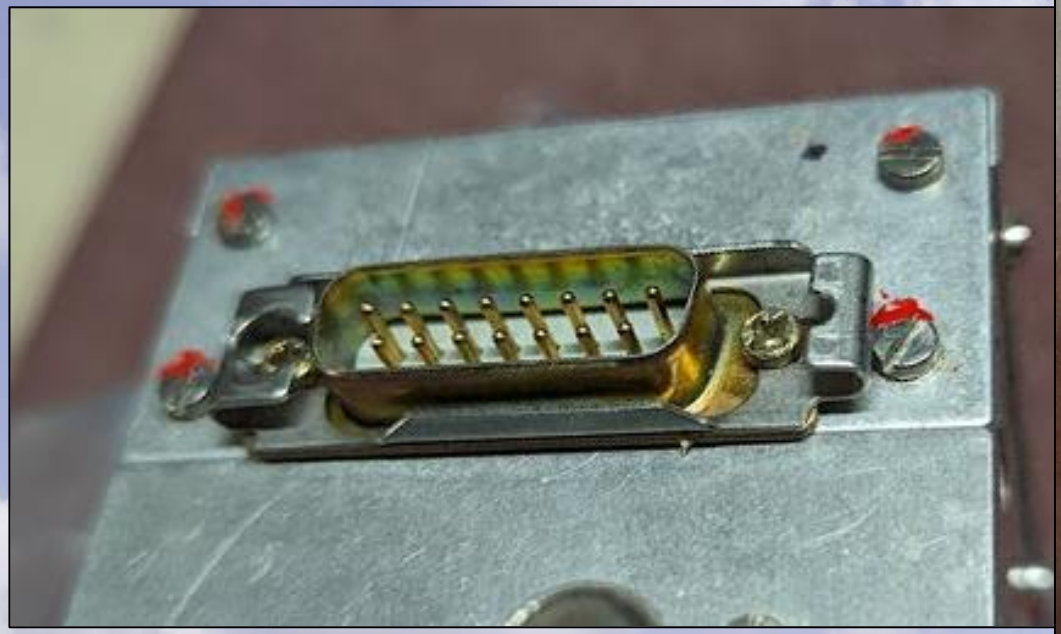
Securing/Latching Types

- **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



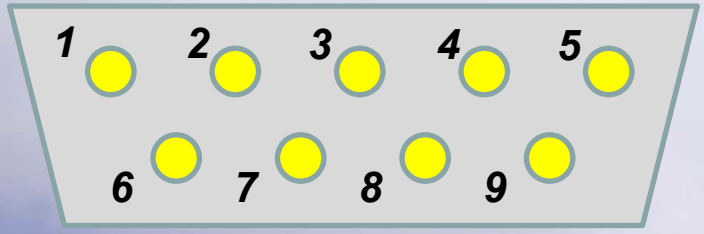
Connections: “D-Subminiature”

Securing/Latching Types

- **Bail Type**
  for LXNav Devices

Connections: “D-Subminiature”

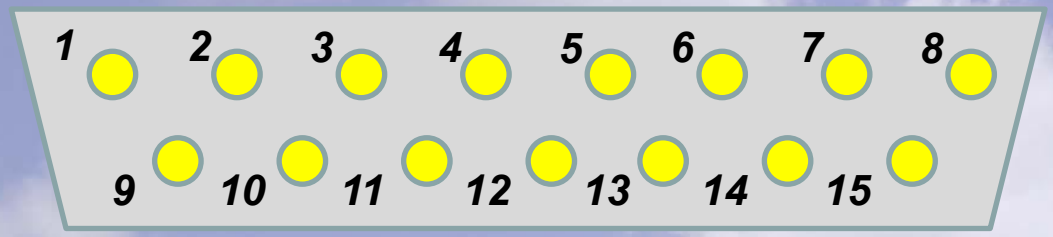
DB-9



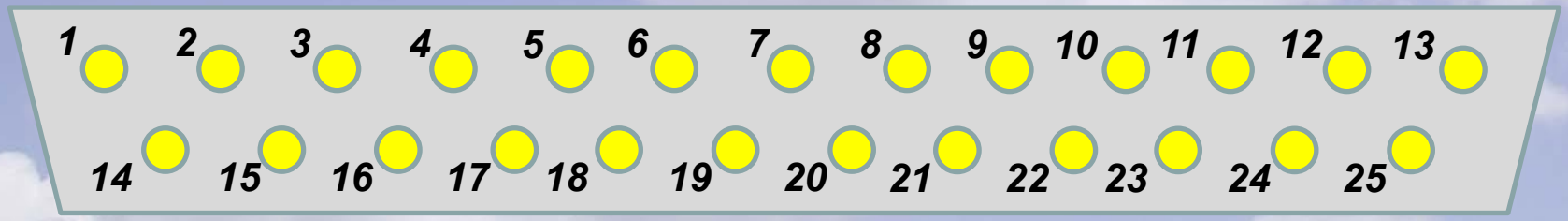
Pin Numbering View For

Female – Wiring/Solder Side
& Male – Pin Side

DB-15



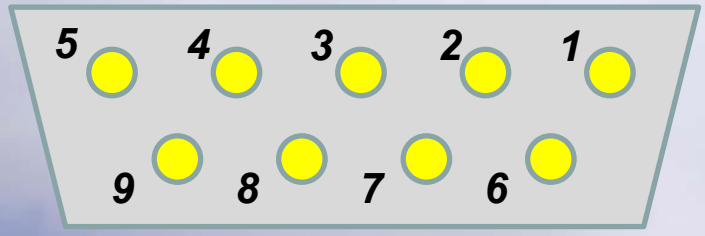
DB-25



To See an Expanded D-Sub Connector Worksheet See:
http://aviation.derosaweb.net/presentations/documents/D-Sub_Connector_Worksheets_Wiring_Solder_Side_Only.pdf

Connections: “D-Subminiature”

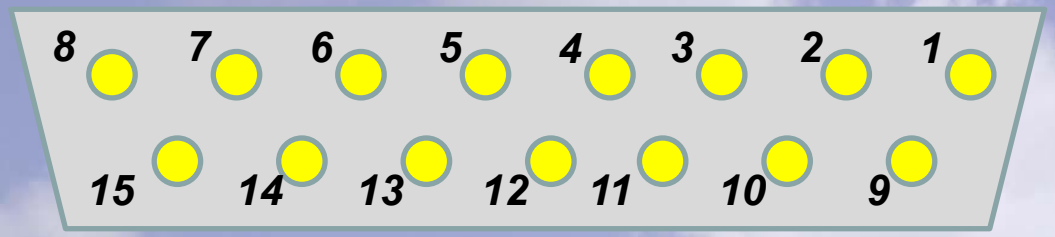
DB-9



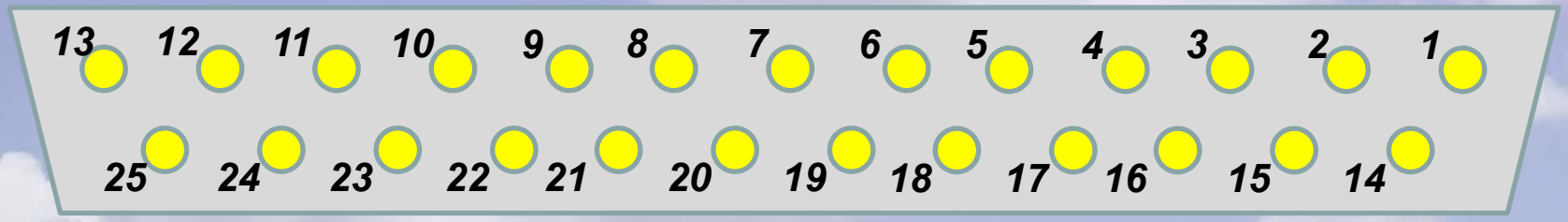
Pin Numbering View For

Male – Wiring/Solder Side
& Female – Socket Side

DB-15



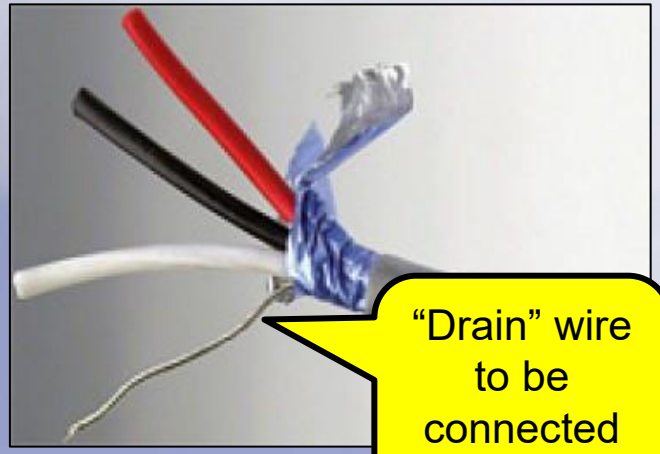
DB-25

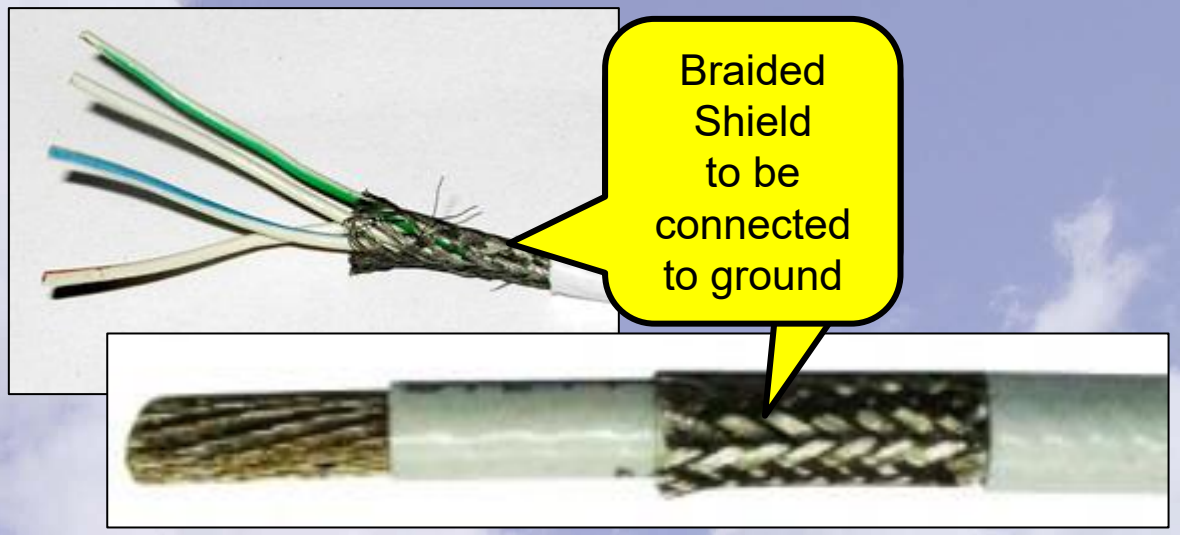


To See an Expanded D-Sub Connector Worksheet See:
http://aviation.derosaweb.net/presentations/documents/D-Sub_Connector_Worksheets_Wiring_Solder_Side_Only.pdf

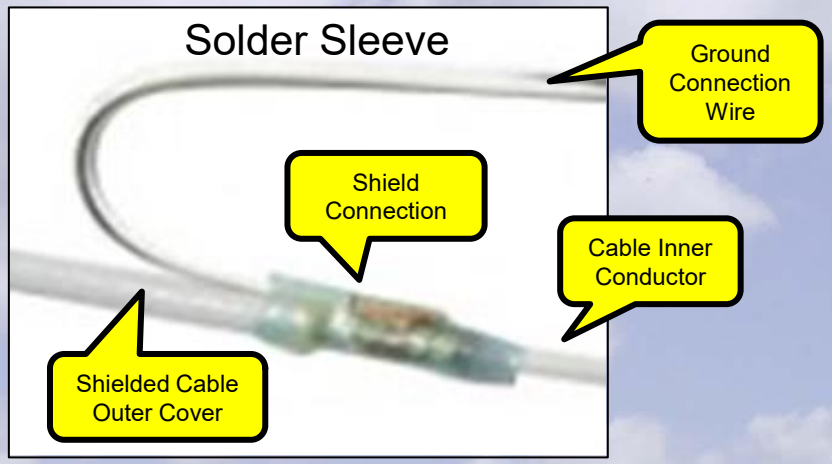
Connections: Shielded Wiring

(Typically for Microphones and some Speakers)

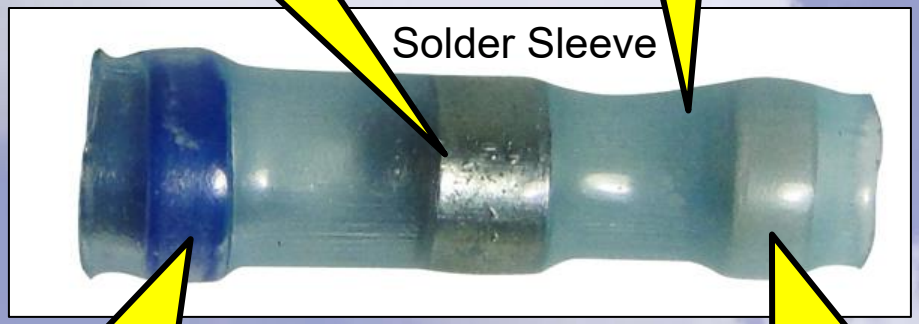


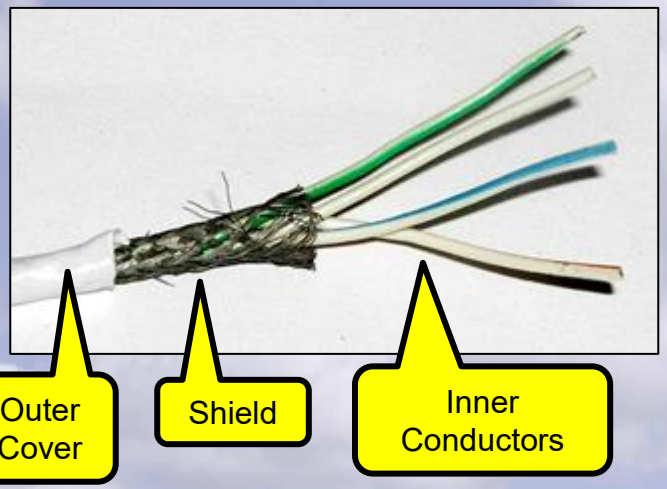


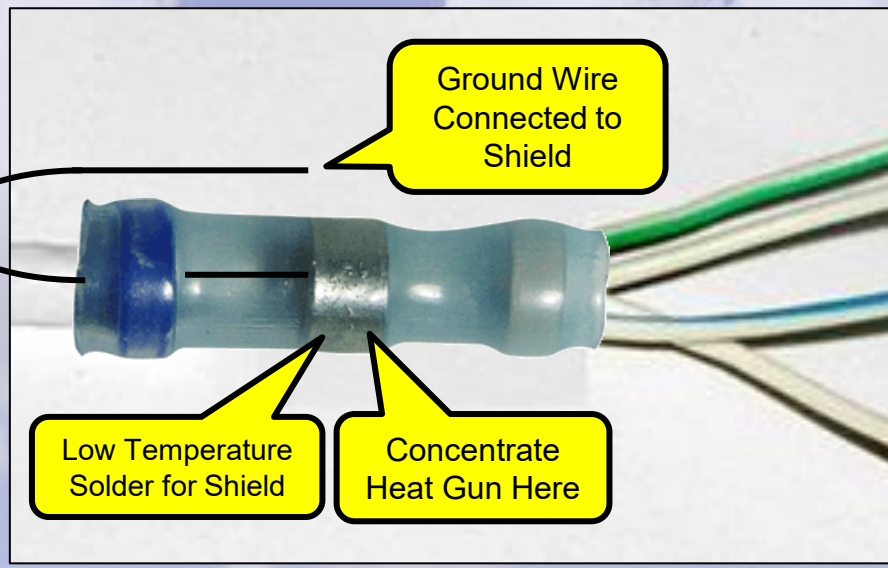
Use of Solder Sleeves Shown in Following Slides



Connections: Shielded Wires

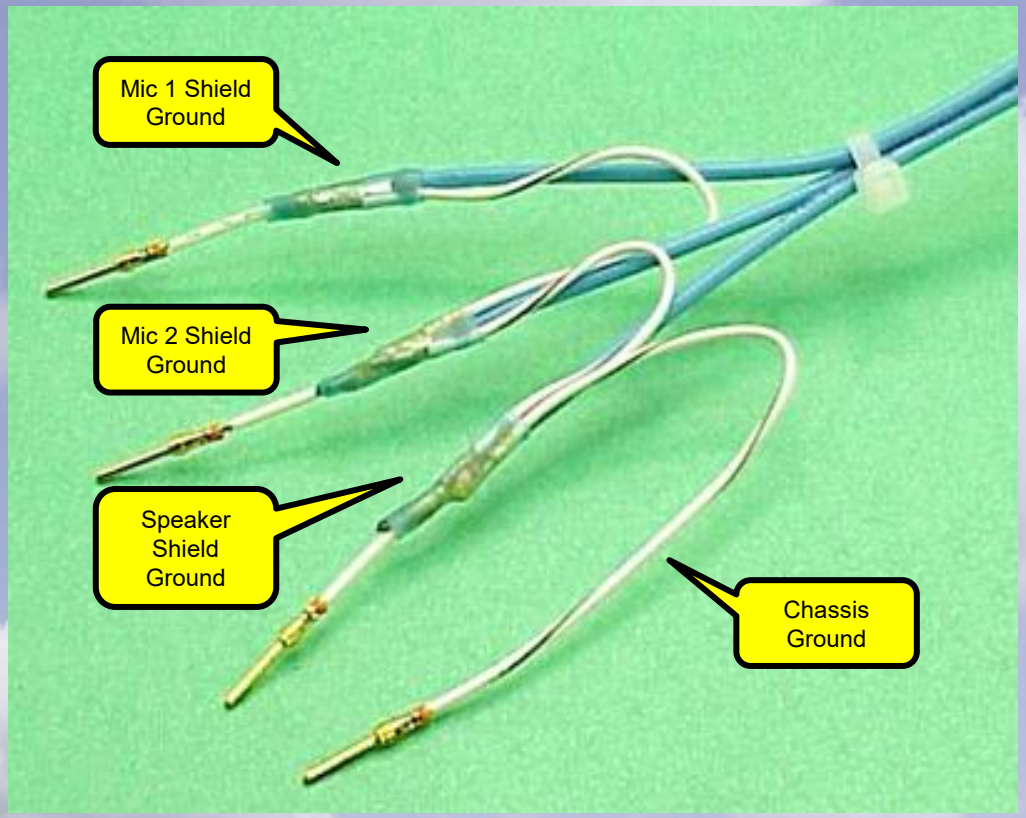


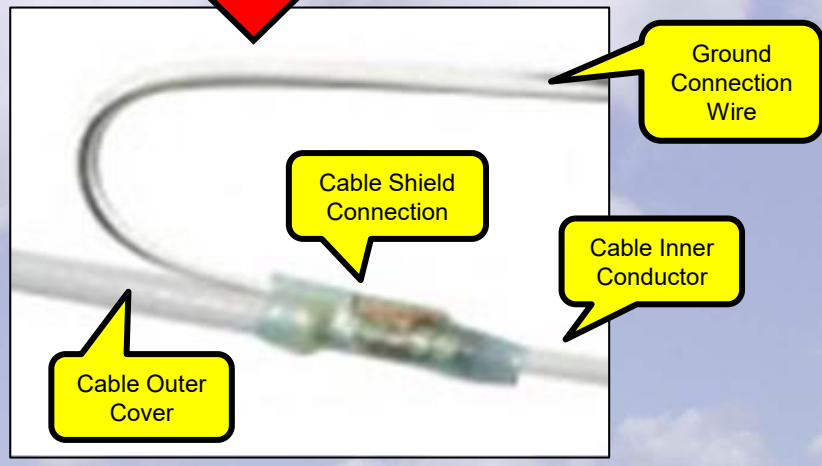




Connections: Shielded Wires

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 linking of pins
- Rugged (10K+ cycles)
- High temperature housing
- Cons – Somewhat expensive and are bulkier than other types of multi-pin connectors

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

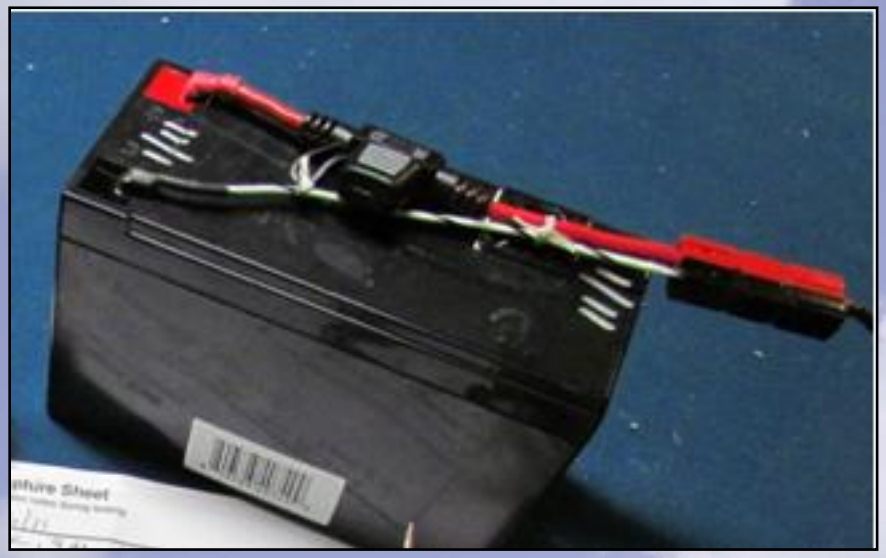
Wiping action on make and break keeps conducting surfaces clear

Low resistance silver-plated copper contacts

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

Connections: Powerpole

Battery Connectors with Inline Fuse

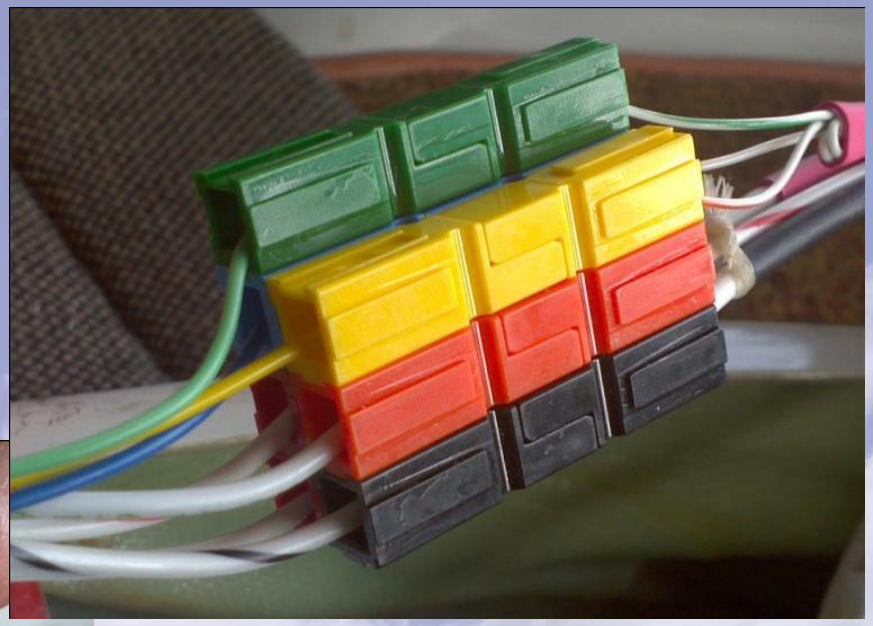


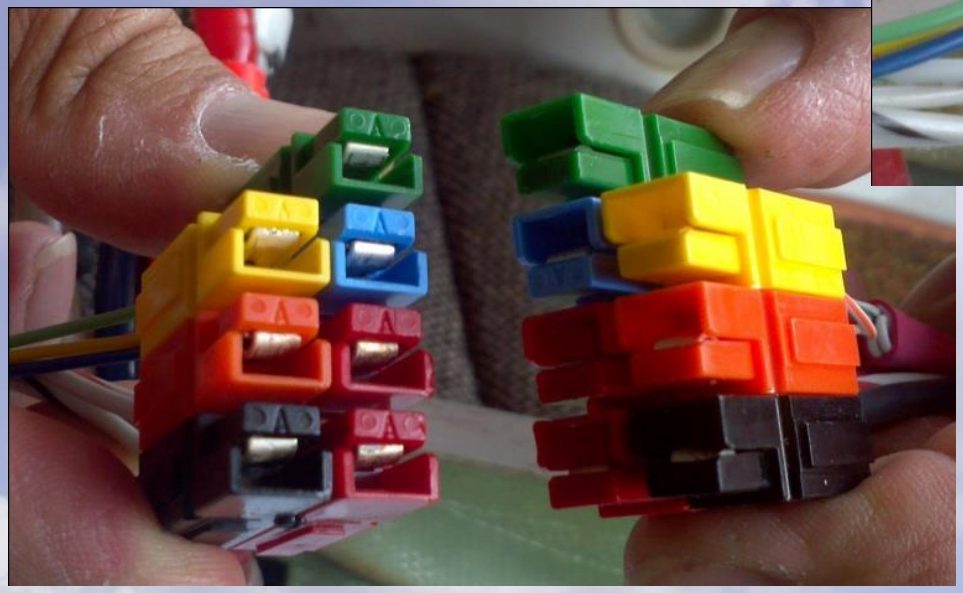
Standard Two Pin Orientation Known as "RRTT" or "Right Red Tongue Top"

Source: http://www.powerwerx.com

Connections: Powerpole

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





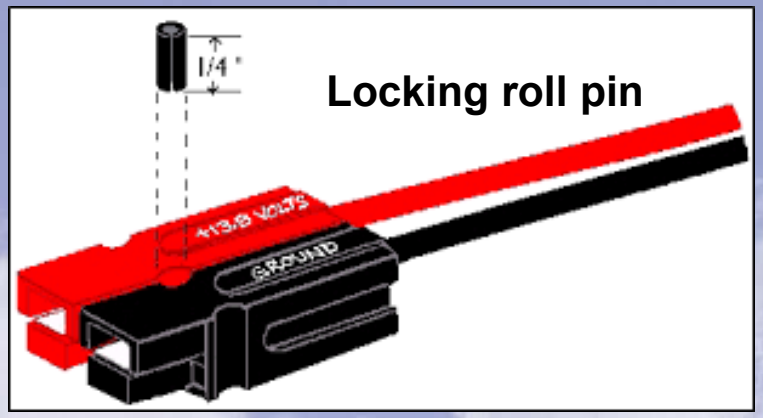
Source: http://www.powerwerx.com

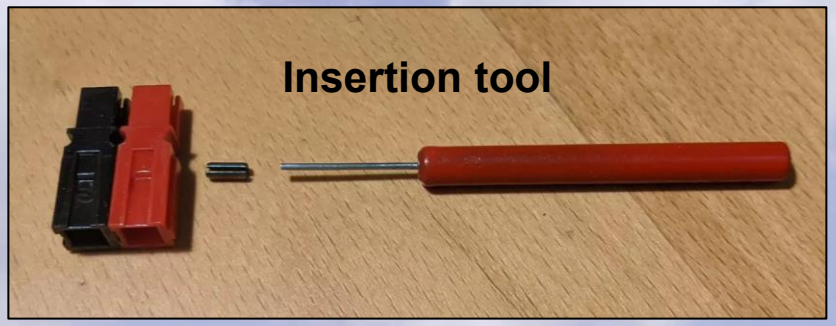
Connections: Powerpole

Powerpole Tools

Crimping Tool

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



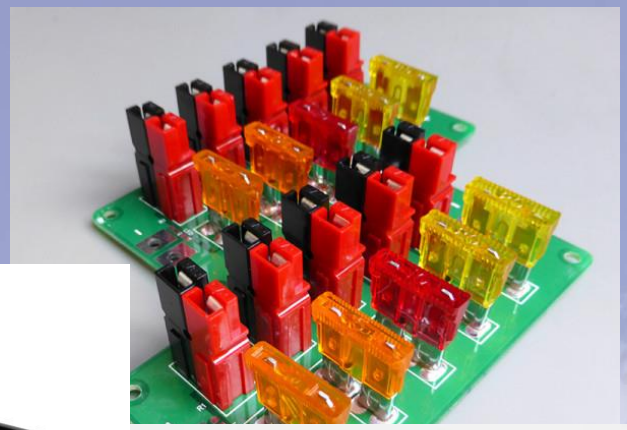


Source: https://www.ebay.com/itm/224592426698

PowerPole Accessories

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

Connections: PowerPole Buses



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

Joining Wires Together

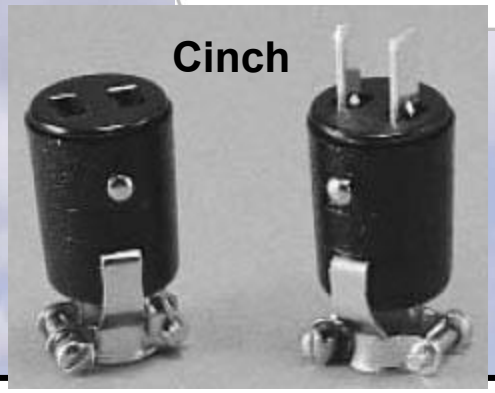
Splicing Shielded Cabling

- 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: Inline Disconnects

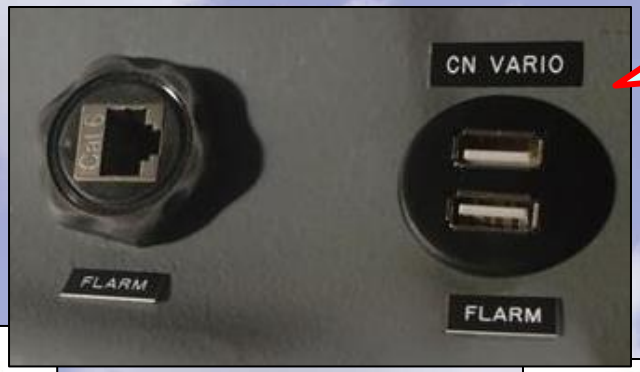
Faston



Connections: “Bulkhead” Jacks

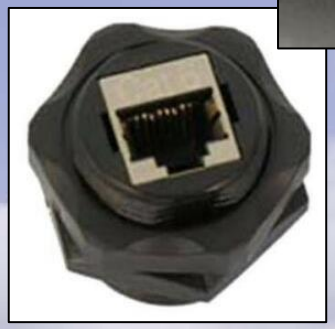
RJ-45 and USB-A Connections

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

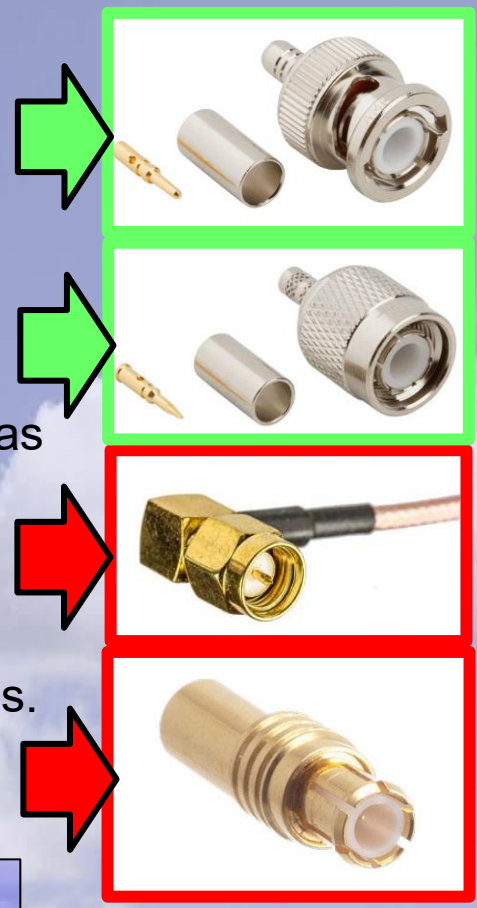
<u>RJ-45</u>
Typical use is to access an avionics instrument’s FLARM data port. Other RJ connector types are available.



<u>USB (Type A)</u>
Typical use to connect a memory stick to an avionics instrument’s USB data port. Other USB connector types are available (i.e. micro, mini, C).

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 as you might with stranded wire.

If absolutely necessary then 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.

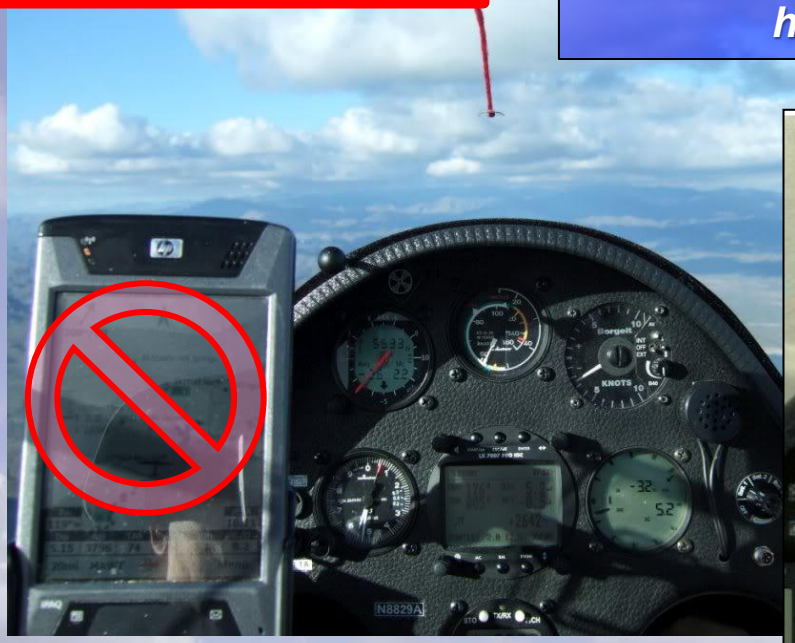
DG/LS Tech Note DG-G-07

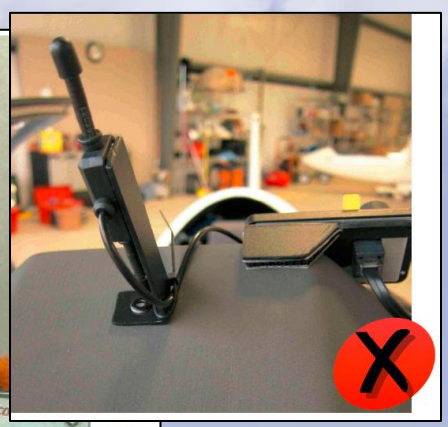
4.1.2 Equipment mounted on the canopy

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!

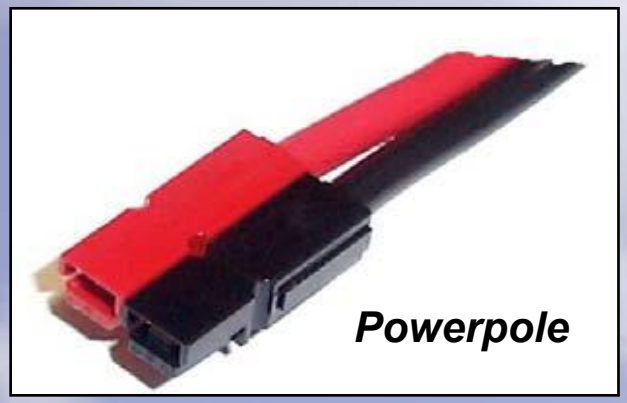
AAIB report said: "…it is probable that the wiring to the components installed on the canopy frame and glare shield would have prevented the canopy from being successfully jettisoned and the pilot would not have been able to leave the glider."

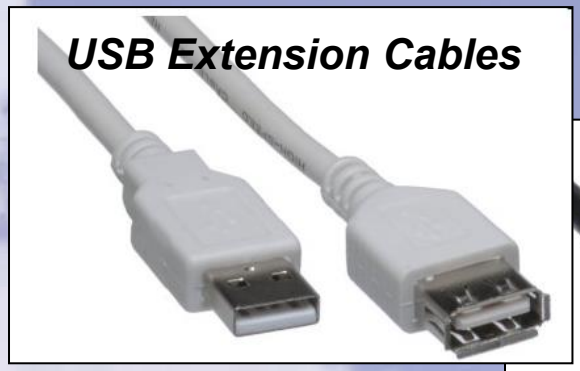


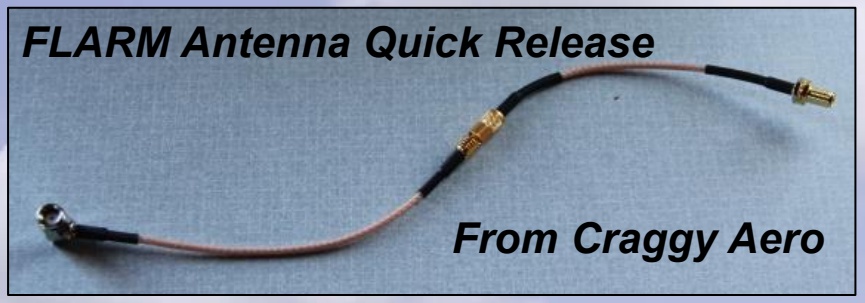


Connections: Canopy Disconnects

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

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!

Type #1 Inexpensive

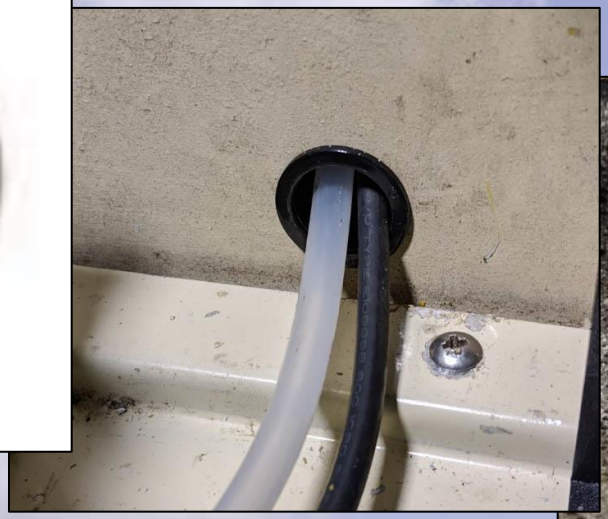
Type #2 - portable

Type #3 industrial

Protecting Wires Against Abrasion

Heyco-type 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 snap out fingers holds these in place. Many sizes available."



Source: https://www.aircraftspruce.com

Protecting Wires Against Abrasion

Heat Shrink

Nylon Expandable Sleeving

aka “Snakeskin”

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

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

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

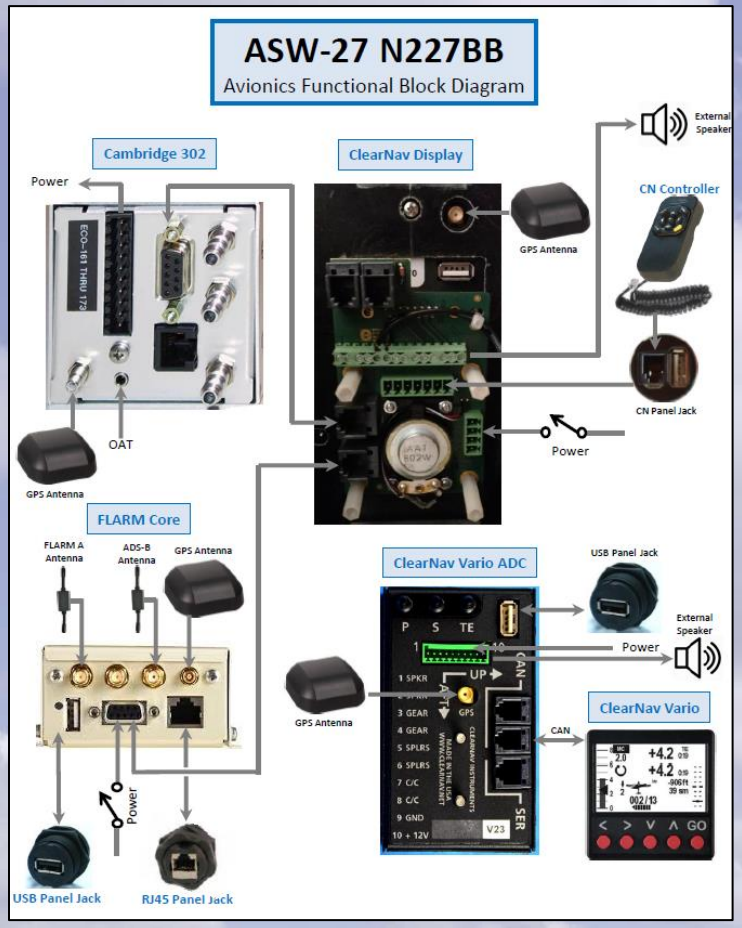
“Industrial”

Pros: Strongest bond
Cons: Somewhat Expensive

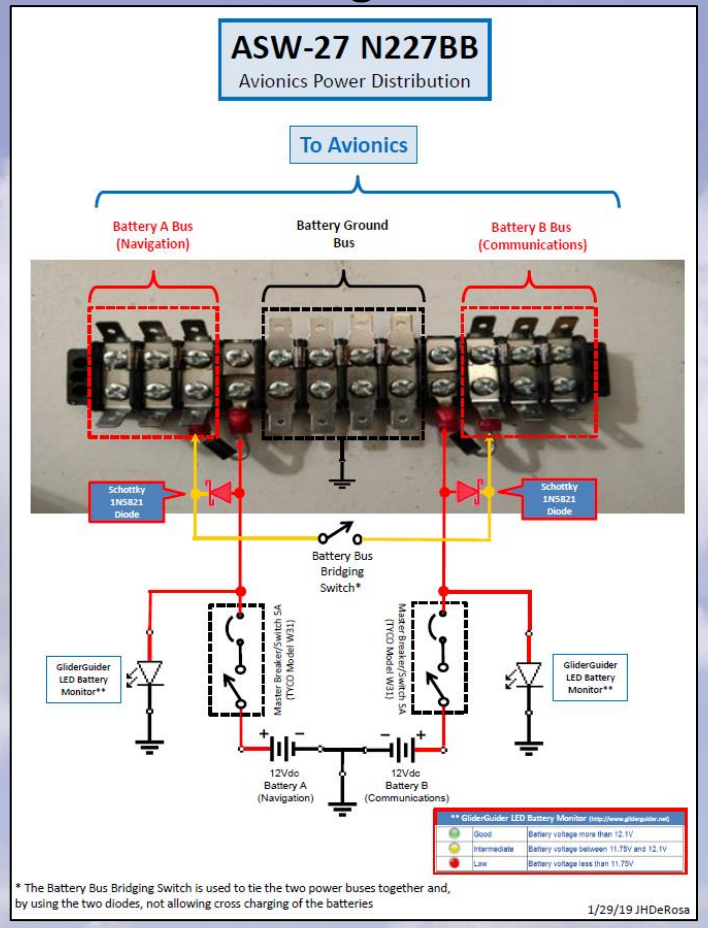
Wiring Documentation

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

Functional Wiring Diagram



Power Wiring Schematic

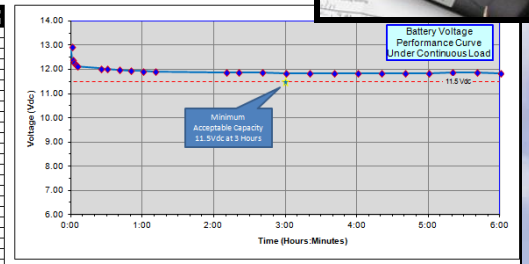


Important Take Always

- **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

Testing Description: 2V15 - N101BP Lithium #1 - labeled Jan, 2015

Time (HH:MM)	Voltage (Vdc)	Duration (HH:MM)
00:00	12.53	0:00
00:01	12.37	0:01
00:02	12.26	0:02
00:03	12.20	0:03
00:04	12.15	0:04
00:05	12.14	0:05
00:25	12.04	0:25
00:30	12.03	0:30
00:40	11.97	0:40
00:50	11.95	0:50
01:00	11.93	1:00
01:10	11.90	1:10
02:10	11.89	2:10
02:20	11.89	2:20
02:40	11.86	2:40
03:00	11.85	3:00
03:20	11.84	3:20
03:40	11.83	3:40
04:00	11.83	4:00
04:20	11.83	4:20
04:40	11.83	4:40
05:00	11.85	5:00
05:20	11.88	5:20
05:40	11.86	5:40
06:00	11.85	6:00
06:20	11.78	6:20
06:30	11.74	6:30
06:40	11.55	6:40
06:50		6:50
07:00		7:00
07:10		7:10
07:20		7:20
07:30		7:30
07:40		7:40
07:50		7:50
08:00		8:00
08:10		8:10
08:20		8:20
08:30		8:30



Enter data in the yellow cells only

How to Use this Spreadsheet

Hint: For ease of identification, uniquely mark each battery, i.e. the date it was purchased.

1) Note the date, battery type, unique identifier and other details in row 3.
2) Save-as the spreadsheet and indicate the battery type, unique identifier and test date in the filename.
3) Delete the contents of the yellow colored cells (select the contents and hit "delete").
4) Fully charge the battery. Connect a resistive load to the battery and a voltmeter.
5) Take a voltage reading and note the time the reading was taken.
6) Enter the voltage reading in column D.
7) Enter the clock time of your voltage reading in column C in HH:MM 24-hour format (i.e. 9AM = 09:00, 9PM = 21:00).
8) Repeat steps 5 through 7 every 10-15 minutes until the voltage of the battery drops to approximately 11.5Vdc or low. (NOTE: 11.5Vdc is a reasonable minimum voltage for avionics use - refer to your avionics owner's manuals).
9) Save the spreadsheet and print it for your records.

WARNING Do not leave the battery connected to a load for an extended period of time. This can damage the battery.

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

https://aviation.derosaweb.net/presentations/documents/Soaring_Aviation_Electrical_Best_Practices_Part_2.pdf

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

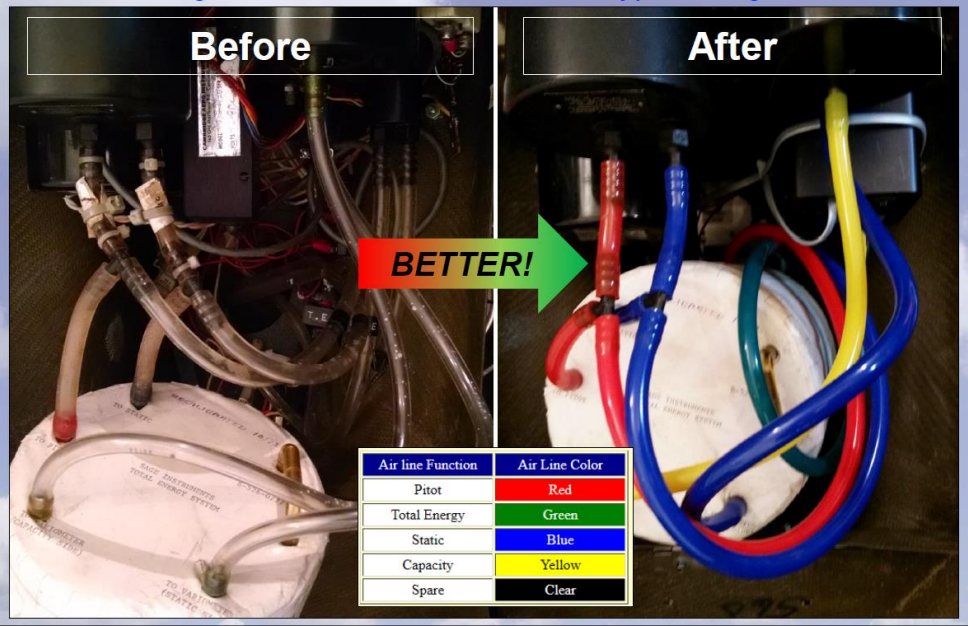
Working with Air Lines

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
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