RF Connectors and Adaptors for Amateur Radio

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Common Connectors in Amateur Radio

- UHF
- N
- BNC
- SMA

UHF Connector

- Commonly, referred to as PL-259/SO-239
- Developed in 1930s for RF above 30 MHz
  - At the time these frequencies were called UHF
  - Frequency bands later renamed such that above 30 MHz became VHF until UHF starts at 300 MHz
  - These connectors were never renamed
- PL-259/SO-239 nomenclature comes from MIL-STD
- PL-259 are the male connectors
- SO-239 are the female connectors
- PL-258 are female to female (barrel) connectors

UHF – PL-259 Male

- There are 3 types
  - Crimp center connector and crimp shield
  - Solder center connector and crimp shield
  - Solder center connector and solder shield
- There are 3 sizes
  - Outside diameter of cable is 0.405 inches
    - e. g., RG-8/U, RG-213/U, LMR-400
  - Outside diameter of cable is 0.242 inches
    - e. g., RG-8X, LMR-240
  - Outside diameter of cable is 0.195 inches
    - e. g., RG-58/U, LMR-195

UHF – PL-259 Male Variants

- There is a right-angle variant useful for tight spaces where a 90° turn is needed

- There is a push on quick disconnect variant when you need to disconnect because of lightning, etc.

- There is male to male connector, if needed

UHF- SO-239 Female

- There are SO-239 connectors made for RF Cable – pay attention to outside diameter (size) and type (crimp or solder)
- Chassis SO-239 connectors are seen on equipment

UHF – SO-239 to SO-239

- **Bulkhead connectors for walls or panels – there are different lengths available**

- **PL-258 are short SO-239 to SO-239 (barrel) connectors – connect RF cables together**

UHF Caps

- **PL-259 Plug Cap**

- **SO-239 Cap**
  (Also, works on ICOM microphone connectors on transceivers)

Where do Hams find UHF?

- **PL-259**
  - **Both ends of RF Coaxial Cable**
  - **In line equipment like RF Chokes**
    - **One end has PL-259**
    - **One end has SO-239**
- **Chassis SO-239 is found on equipment, e. g., transceivers, amplifiers, antenna tuners, meters, etc.**
- **Bulkhead SO-239 to SO-239 is used to go through walls, patch panels, etc.**
- **PL-258 (SO-239 to SO-239)**
  - **Connect RF Coaxial Cables**
  - **Connect the ends of a coiled RF Coaxial Cable to protect from:**
    - **Dirt**
    - **Crushing PL-259 end connectors**

N Connector

- **Developed in 1940s for RF to 1 GHz; today up to 11 GHz**
  - **Better mechanical connection than UHF**
  - **Waterproof whereas UHF were not**
- **Called N Connector after Paul Neill at Bell Labs**

Type N Connector – Male

- **There are 3 types**
  - **Crimp center connector and crimp shield**
  - **Solder center connector and crimp shield**
  - **Solder center connector and solder shield**
- **There are 3 sizes**
  - **Outside diameter of cable is 0.405 inches**
    - **e. g., RG-8/U, RG-213/U, LMR-400**
  - **Outside diameter of cable is 0.242 inches**
    - **e. g., RG-8X, LMR-240**
  - **Outside diameter of cable is 0.195 inches**
    - **e. g., RG-58/U, LMR-195**

Type N Connector – Male Variants

- There is a right-angle variant useful for tight spaces where a 90° turn is needed

- There is a push on quick disconnect variant when you need to disconnect because of lightning, etc.

- There is male to male connector, if needed

Type N Connector - Female

- There are N female connectors made for RF Cable – pay attention to outside diameter (size) and type (crimp or solder)

- Chassis N female connectors are seen on equipment

Type N – Female to Female

- **Bulkhead connectors for walls or panels – there are different lengths available**

- **Short Type N Female to Female (barrel) connectors – connect RF cables together**

Where do Hams find Type N?

- Some Ham transceivers in Europe use Type N
- Commercial radios use Type N
- Found on test equipment like antenna analyzers and Vector Network Analyzers (VNAs)
- Chassis Type N female is found on equipment, e. g., transceivers, amplifiers, antenna tuners, meters, etc.
- There are UHF to N Connector Adapters

BNC Connector

- **Full name is: Bayonet Neill-Concelman**
  - **Paul Neill at Bell Labs helped invent**
  - **Carl Concelman at Amphenol helped invent**

- **Developed in late 1940s**
  - **Quick connect using bayonet principle**
  - **For RF below 4 GHz**

- **Usually, BNC Male is crimped on**

- **Usually, BNC Female is chassis mounted**

- **Two types: 50 Ohms and 75 Ohms – use 50 Ohms for Amateur Radio**

BNC Connectors – Male & Female

- **BNC Male is available for .195” and .240” outside diameter cable**

- **BNC Female is available for chassis mount**

- **BNC Female is available for bulkhead installation for panels**

Where do Hams find BNC?

- Some antenna cables and baluns when using lightweight components for hiking
- Some transceivers, e. g., Elecraft K4
- Receiving Antenna connections on some HF transceivers, usually high end
- Transverter connections on some HF transceivers, usually high end

SMA Connector

- **Full name is: SubMinature version A**
- **Developed in 1960s**
  - **Bendix Scintilla Corporation**
  - **Omni-Spectra Corporation. For RF below 4 GHz**
- **For RF up to 26.5 GHz; originally to 12 GHz**
- **Originally used in microwave applications**
- **Now used when a small connector is needed**

SMA – Male and Female

- **SMA Male is usually for cables, but appears on small antennas**

- **SMA Female is usually a "chassis" (maybe circuit board) mount**

Where do Hams find SMA?

- Some antenna cables
- Antennas that screw on to hand transceivers
- Test equipment like NanoVNA

RP-SMA

- **Reverse Polarity-SMA (RP-SMA) does exist**

	SMA	RPSMA
Male		
Female		

- **Most often seen on Chinese radios, e. g.**
  - **Baofeng**
  - **Anytone (DMR)**

Solder or Crimp

From ARRL's QST March 2022:

Coax Connectors: Crimp or Solder?

Q Gene McPherson, NØMHJ, asks: "For years I've resisted the temptation to crimp my coax connectors, in favor of soldering, but it might be time to change. What is your advice on crimping versus soldering, for hams putting on their own connectors?"

A You're asking whether one thing that can lead to problems is better than something else that can lead to problems. When either is done properly, you have a fine connector that you can use for many years. But each approach has its drawbacks.

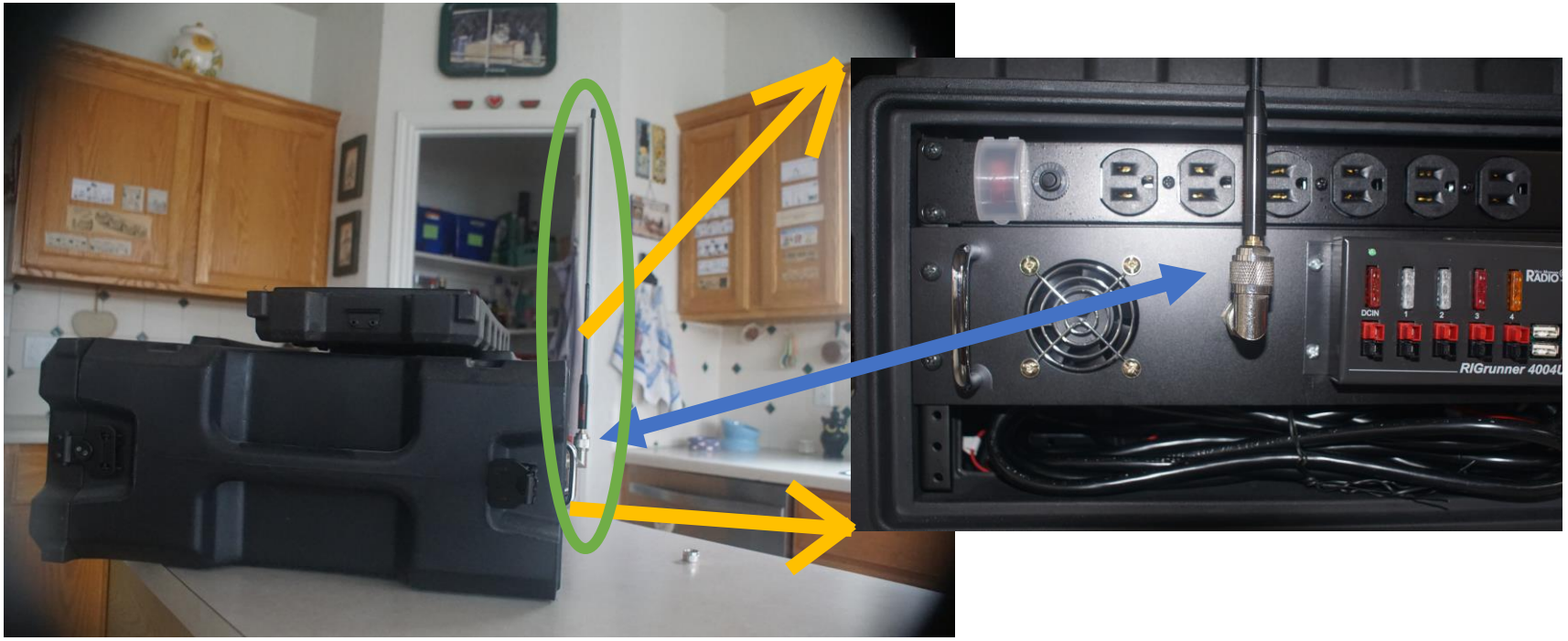
For Real, Solder or Crimp

- **Crimp**
  - **Anything you solder together that gets hit by lightning runs a serious risk of vaporizing the solder.**
  - **Solder requires electricity or a real steady hand with a torch.**
  - **Crimping in the field to repair/replace a bad connector requires the right tools, but no electricity – flat easier in the field to crimp.**

Adapters

- There are adapters that change
  - Gender inside the type
  - Between types
- You are just about guaranteed to get two pieces of equipment that you can not connect sooner or later
- Recommend you assess what connectors you are using and get gender benders for all and type converters for all

Adapter Example



- Connector to get a right-angle turn
- UHF to SMA adapter to mount a 10W antenna

Example Stockage List

Top Tray

Right Angle PL259 to SO239 SL 2 ea OH 2 ea		Crimp Connectors PL259 for LMR400 SL 4 ea OH 5 ea	Dummy Load MFJ-261 (ZMF-261) 100 watts PL259 - 2 ea		Adaptor SMA M to PL259 SL 2 ea OH 2 ea	Adaptor SMA F to PL259 SL 2 ea OH 2 ea	
Adaptor BNC M to SO239 SL 2 ea OH 4 ea	Adaptor BNC F to PL259 SL 4 ea OH 4 ea	Crimp Connectors PL259 for RG8 and RG213 SL 4 ea OH 5 ea	Connector SO239 to SO239 SL 4 ea OH 4 ea	Connector PL259 to PL259 SL 4 ea OH 6 ea	Adaptor SMA M to SO239 SL 4 ea OH 4 ea	Adaptor SMA F to SO239 SL 2 ea OH 4 ea	Adaptor SMA F to SMA F SL 2 ea OH 4 ea
Adaptor N Male to SO239 SL 4 ea OH 4 ea		Crimp Connectors PL259 for RG8X and RG58 SL 4 ea OH 10 ea	Adaptor PL259 to N Female SL 4 ea OH 4 ea	Quick Conn Adaptor PL259-SO239 SL 1 ea OH 1 ea	Cap for PL259 SL 4 ea OH 4 ea	Cap for SO239 SL 4 ea OH 4 ea	

Example Stockage List

Bottom Tray

Coax Cable Cutter	PL259 for RG8X/RG58 Die	MFJ-252	Power Pole Crimper
Klein PL259 Crimper	Klein	Analyzer Calibr	Power Pole Crimper Instruct
Coax Cable Stripper	ATC Fuses (RIGrunner)	Open Load	
Cable Ties	SL/OH - 40A x 4, 25A x 2,	Short Load	Common Mode Filter
	10A x 2, 5A x 2, 1A x 2	50 ohm Load	CMC-154-3K
	Rack Screws > 50 ea		1-54 MHz
	Power Pole Multimeter Test Leads with F to F Banana Conn - 2 es		3KW maximum power
	Power Pole Y-Cable for Multimeter Testing - 1 ea		
	Female Banana Connector - 2 ea		
	Female to Female Banana Conectors		
	Black SL 0 ea / OH 3ea and Red SL 0 ea / OH 3 ea		
	Audio Y Cable	Power Pole	
	1/4" Splitter Plug - 1 ea	Crimper Dies	
	1/8" Splitter Plug - 2 ea	58502-1050 Insul Term	
	1/8" M to 1/4" F Adpt - 5 ea	58502-1051 Non-Insul Open Barrel Term	
	1/4" M to 1/8" F Adpt - 5 ea	58502-1052 Non-Insul Term	

Loss Insertion

- **Every connector and adaptor inserts transmission loss.**
- **What is the correct number of connectors and adaptors in the transmission path?**

The fewest possible;
preferably, one on each end,
or
two.

Quality Connectors

- **When seeking to minimize insertion loss in a transmission path, the quality of the connectors and adaptors.**

- **The author of the *The Care and Feeding of Transmission Lines* make the same point about quality connectors. They recommend the ones made by Amphenol because of their long reputation in making quality RF components.**

- **There may be other quality RF components, but with some sources, e. g., eBay, internet sites, etc., what you get can be a problem.**

Summary

- **Over time, I have encountered more and more connectors in Amateur Radio.**
- **I expect that most Hams as they progress in their pursuit of Amateur Radio knowledge will encounter the same phenomenon.**
- **As your number of types expands, get spares and tools for them *and* get adaptors.**

References

- **Hallas, Joel R., W1ZR. 2012. *The Care and Feeding of Transmission Lines.* Newington, CT: ARRL.**

- **Chapter 22.9: RF Connectors and Transmission Lines from 2014 *The ARRL Handbook for Radio Communications*. Newington, CT: ARRL.**