Installing Coax and Network Connectors

SCOTT HONAKER, N7SS
Agenda

• Coax types (RG-174, RG-58/142u, RG-8x, RG-8/213, LMR-100, 240, 400)
  • Physical characteristics vs. loss specification

• Connector types (SMA, BNC, PL-259/UHF, Mini-UHF, N)
  • Common application and performance

• Connector designs (solder type, clamp/compression type, crimp type)

• Prep tools, crimp tools and toolkits

• Correct coax connector installation methods

• Network cable types, plugs and jacks
# Coax Cable Signal Loss (Attenuation) in dB per 100ft

<table>
<thead>
<tr>
<th>Loss</th>
<th>RG-174</th>
<th>RG-58</th>
<th>LMR195</th>
<th>RG-8X</th>
<th>LMR240</th>
<th>RG-213</th>
<th>9913</th>
<th>LMR400</th>
</tr>
</thead>
<tbody>
<tr>
<td>O.D.</td>
<td>0.100”</td>
<td>0.195”</td>
<td>0.195”</td>
<td>0.242”</td>
<td>0.240”</td>
<td>0.405”</td>
<td>0.405”</td>
<td>0.405”</td>
</tr>
<tr>
<td>1MHz</td>
<td>1.9dB</td>
<td>0.4dB</td>
<td>0.4dB</td>
<td>0.5dB</td>
<td>0.2dB</td>
<td>0.2dB</td>
<td>0.2dB</td>
<td>0.3dB</td>
</tr>
<tr>
<td>10MHz</td>
<td>3.3dB</td>
<td>1.4dB</td>
<td>1.1dB</td>
<td>1.0dB</td>
<td>0.8dB</td>
<td>0.6dB</td>
<td>0.4dB</td>
<td>0.5dB</td>
</tr>
<tr>
<td>50MHz</td>
<td>6.6dB</td>
<td>3.3dB</td>
<td>2.5dB</td>
<td>2.5dB</td>
<td>1.7dB</td>
<td>1.6dB</td>
<td>0.9dB</td>
<td>0.9dB</td>
</tr>
<tr>
<td>100MHz</td>
<td>8.9dB</td>
<td>4.9dB</td>
<td>3.6dB</td>
<td>3.6dB</td>
<td>2.5dB</td>
<td>2.2dB</td>
<td>1.4dB</td>
<td>1.4dB</td>
</tr>
<tr>
<td>200MHz</td>
<td>11.9dB</td>
<td>7.3dB</td>
<td>5.1dB</td>
<td>5.4dB</td>
<td>3.5dB</td>
<td>3.3dB</td>
<td>1.8dB</td>
<td>1.8dB</td>
</tr>
<tr>
<td>400MHz</td>
<td>17.3dB</td>
<td>11.2dB</td>
<td>7.3dB</td>
<td>7.9dB</td>
<td>5.0dB</td>
<td>4.8dB</td>
<td>2.6dB</td>
<td>2.6dB</td>
</tr>
<tr>
<td>900MHz</td>
<td>27.9dB</td>
<td>20.1dB</td>
<td>11.1dB</td>
<td>12.6dB</td>
<td>7.6dB</td>
<td>7.7dB</td>
<td>4.2dB</td>
<td>3.9dB</td>
</tr>
<tr>
<td>Velocity %</td>
<td>74%</td>
<td>66%</td>
<td>76%</td>
<td>78%</td>
<td>84%</td>
<td>66%</td>
<td>84%</td>
<td>85%</td>
</tr>
<tr>
<td>Bend Radius</td>
<td>0.41”</td>
<td>0.98”</td>
<td>0.5”</td>
<td>1.0”</td>
<td>0.75”</td>
<td>4.5”</td>
<td>4.0”</td>
<td>4.0”</td>
</tr>
<tr>
<td>Shield</td>
<td>Braid</td>
<td>Braid</td>
<td>Foil</td>
<td>Braid</td>
<td>Foil</td>
<td>Braid</td>
<td>Foil</td>
<td>Foil</td>
</tr>
</tbody>
</table>
# Common Coax Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-174</td>
<td>0.100”</td>
<td>Small, high loss, limited shielding, good for audio</td>
</tr>
<tr>
<td>LMR-100</td>
<td>0.100”</td>
<td>Small, foil and braid shielding</td>
</tr>
<tr>
<td>RG-58</td>
<td>0.195”</td>
<td>Typical mobile coax, wide variations in construction</td>
</tr>
<tr>
<td>RG-142U</td>
<td>0.195”</td>
<td>100% shield, jumpers at repeater sites, indoor only!</td>
</tr>
<tr>
<td>LMR-195</td>
<td>0.195”</td>
<td>Good for mobile installs with foil+braid shield</td>
</tr>
<tr>
<td>RG-8X</td>
<td>0.240”</td>
<td>Great for mid-power HF</td>
</tr>
<tr>
<td>LMR-240</td>
<td>0.240”</td>
<td>Great for mid power HF and VHF/UHF jumpers</td>
</tr>
<tr>
<td>RG-8U/213</td>
<td>0.400”</td>
<td>Great for high power HF, wide variations in construction</td>
</tr>
<tr>
<td>Belden 9913</td>
<td>0.400”</td>
<td>Very low loss VHF/UHF, air dielectric means water incursion</td>
</tr>
<tr>
<td>LMR-400</td>
<td>0.400”</td>
<td>Very low loss at VHF/UHF but stiff</td>
</tr>
</tbody>
</table>
Connector Types

- BNC Plug (Male)
- BNC Jack (Female)
- N-Male
- N Jack (Female)
- SMA Plug (Male)
- SMA Jack (Female)
- PL-259 / UHF Male
- SO-238 / UHF (Female)

- SMA
- N
- TNC
- SMC
- MCX
- BNC
- SMB
- Mini-UHF
- UHF
- 1 GHz
- 2 GHz
- 4 GHz
- 8 GHz
- 12 GHz
- 18 GHz
- 300 MHz
## Common Connector Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMA</td>
<td>Small, typically used on HTs and internal jumpers through microwave frequencies, only spec’d at 500 on/off cycles</td>
</tr>
<tr>
<td>BNC</td>
<td>Small, used on older HTs, bayonet connection is quick and robust, good to several GHz, waterproof with gasket</td>
</tr>
<tr>
<td>PL-259 / UHF</td>
<td>Typical for ham gear, poor impedance stability, worse as frequency increases, bad at UHF</td>
</tr>
<tr>
<td>Mini UHF</td>
<td>Looks like small PL-259, used by Motorola</td>
</tr>
<tr>
<td>N</td>
<td>Used by military/commercial, robust, waterproof good to GHZ</td>
</tr>
</tbody>
</table>
Adapter Options

Interseries adapters are always helpful for temporary use. It's possible to assemble a kit with fixed adapters or use a more versatile multi-adapter kit like the one at right.

This kit provides UHF (PL-259), Mini-UHF, N, BNC, TNC and SMA male and female. Choose two connector ends and coupler in the middle.

This is the RF Connectors Unidapt Adapter Kit RFA-4024
### Connector Form Factors (N)

<table>
<thead>
<tr>
<th>Male</th>
<th>Coupler</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Male" /></td>
<td><img src="image2" alt="Coupler" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Female</th>
<th>Bulkhead</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Female" /></td>
<td><img src="image4" alt="Bulkhead" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Right Angle</th>
<th>Panel Mount</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Right Angle" /></td>
<td><img src="image6" alt="Panel Mount" /></td>
</tr>
</tbody>
</table>
## Installation Types

**Solder Type** –
Requires/power heat to install  
Easy to overhear and melt coax  
Easy to assemble and forget the shell

**Clamp/Compression Type** –
Bulky but only needs cutter/stripper and wrenches to install  
Must be stripped and assembled accurately

**Crimp Type** –
Requires crimp tools but can be done anywhere (no power or heat)  
Professionals use crimps because they are very consistent (foolproof)
One More Option - Centerpin

Available in PL-259, BNC, N and TNC for RG-58/8x sized coax only

Needs little more than pliers to install

Water resistant with O-ring

PL-259 sold through Shakespeare (Marine)
What About F Connectors?

Used primarily in TV; over the air (OTA), cable and satellite

The standard is a compression F which requires some inexpensive tools

Plenty of YouTube videos showing installation of connectors on RG-59, RG-6 and RG-6 quad shield

Installation is simple and reliable

Not generally a ham thing so we won’t discuss further
Preparation Tools - Strippers

Use cutters with curved blades to not squish coax

Cables can be cut with inexpensive strippers
- This supports RG-58/LMR-195 at the ‘8’ position and RG-8x/LMR-240 at the ‘6’ position on the orange block (align with arrow on tool)
- Two blades inside can be adjusted for depth of cut and distance between using set screws and allen wrench on bottom
- This allows variations in coax and requirements for individual connectors
- Tools can be found for under $10
- Get and set one for each type of coax and connector

To use, simply clamp on coax and spin
Both cuts are made at the same time
Slide off and jacket will be removed, exposing center and shield
Prep Tool Kit

Larger coaxes can use radial stripper
- End #1 strips down to center conductor
- End #2 strips outer insulation
Solder Type Connectors

• Slide coupler ring (and reducer if required) over cable
• Strip cable per instructions (make center conductors long on PL-259, trim later)
• Fold braid over reducer, if used
• Slide connector on cable and thread/tighten onto reducer, if used
• Solder center conductor then braid with large (50-80 watt) pencil iron
  • Silver or gold connectors work best
  • Drilling out solder eyes exposes copper
  • Tinning end of reducer helps
  • *Don’t overheat!*
Clamp/Compression Connectors

- Slide nut, washers and gasket on
- Trim coax to the correct dimensions
- Slide braid sleeve on and trim
- Install insulator and center contact
- Solder center contact
  - Often easier if coax already tinned
  - Pin may not insert with solder blob
- Tighten with wrenches
  - Gasket will compress and hold tight
Crimp Kit

Ratcheting crimp tool with dies, screwdriver, cutter and stripper

Crimp tools, dies and strippers are available separately (check eBay)

Also crimps standard wire disconnects and Powerpoles

Kits available from HRO, eBay, Amazon and others

Handle and dies are available separately
## Die Sizes

<table>
<thead>
<tr>
<th>Type</th>
<th>O.D.</th>
<th>Collar Die Size</th>
<th>Center Pin Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-174, LMR-100</td>
<td>0.100”</td>
<td>0.128” (3.25mm)</td>
<td>0.047” (1.19mm)</td>
</tr>
<tr>
<td>RG-316, RG-188</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RG-58, RG-142U, LMR-195</td>
<td>0.195”</td>
<td>0.213” (5.41mm)</td>
<td>0.067/0.068” (1.73mm)</td>
</tr>
<tr>
<td>RG-8X, LMR-240</td>
<td>0.240”</td>
<td>0.255/0.256” (6.50mm)</td>
<td>0.079” (2.00mm)</td>
</tr>
<tr>
<td>RG-8, RG-213, Belden 9913, LMR-400</td>
<td>0.400”</td>
<td>0.429” (10.90mm)</td>
<td>0.100/0.105” (2.70mm)</td>
</tr>
</tbody>
</table>
Crimp Connectors

- Slide crimp ring on cable
- Strip as shown, separate braid a little
- Solder/crimp tip
- Slide connector under braid/over foil
- Slide collar up and crimp
Ethernet Speeds

10BASE-T (10MBit, Baseband, Twisted Pair)
  ◦ Category 3 or 5 network cable, 2 pairs required
  ◦ 100 meter maximum length

100BASE-TX (Fast Ethernet)
  ◦ Category 5 network cable, 2 pairs required

1000BASE-T (Gigabit Ethernet)
  ◦ Category 5e or 6 network cable, 4 pairs required

10GBASE-T (10Gigabit Ethernet)
  ◦ Category 6 or 7 network cable, 4 pairs required
Network Cable/Connector Types

• CAT5, CAT5e and CAT6 are most common
  • Shielded variants available
  • CAT5 is 24ga and CAT6 is 23ga and physically larger
  • CAT6 connectors generally work on CAT5, not the reverse

• RJ-45 (8P8C) is the standard connector

• Hoods are a separate piece and make connectors snagless and protect locking tab
RJ-45 Wiring

RJ-45 Plug
Pin 1

Clip is pointed away from you.

T-568A

T-568B
Other Connectors

RJ-45 EZ
- Wires poke through end
- Easy with crimper/cutter
- Can also use knife

Multi-part
- Available in 2 or 3 piece
- Divider splits pairs
- Comb holds wires in order and allows cutting to length
Network Jacks

• Jacks generally need a #110 punch tool
  • Punch tools can be plastic to impact
  • Impact tools generally to cut the wire flush to the jack
  • Make sure the cutter is oriented correctly

• Keystone jacks are most common and snap into wall plates, wall boxes and rack panels and can also support other connector types; RJ-14, RCA, HDMI, F, TOSLINK, etc.
Resources

Installing Solder Connectors
https://www.youtube.com/watch?v=InBNyWI1-Ys

Tools, Connectors and Data Sheets
https://www.amphenolrf.com/
http://www.l-com.com/