Home-brew Compact 6dBi Collinear Antenna

(first published September 2005)

自制简易 6dBi 全向天线

（2005 年 9 月首次发表）

This page details the construction of an easy-to-make collinear 360 degrees omni-directional, vertically polarised, antenna for 802.11b/g wireless networking. The antenna is very robust and compact, and has a gain of approximately 5-6dBi.

本文详细介绍一个容易制作的 802.11b/g 垂直极化全向天线，该天线非常坚固耐用，大约有 5-6dBi 的增益。

Background

Various websites detail the construction of a collinear antenna suitable for 2.4GHz wireless networking, including wireless.gumph.org and guerrilla.net. However, these antennas are quite complex to build, being made up of numerous short lengths of coax which must be accurately cut to length. You also need to know the velocity factor of the coax that is being used, as most of the measurements are based on it.

A variation of the coax collinear is constructed from brass rod and brass tubing, but is still just as fiddly to construct.

背景：

很多网站都有制作 2.4GHz全向天线的详细说明，包括 wireless.gumph.org和guerrilla.net。但是，这些天线做起来相当复杂，要用很多切割非常精确的小段同轴电缆。同时你还必须知道所使用的同轴电缆的数据，因为大部分尺寸要以此为依据。

有些改进的同轴电缆全向天线是用黄铜棒和黄铜管制造的，但是它同样需要高精度的工艺。

Some time ago, I made an 8-element coax collinear, using the wireless.gumph.org instructions. Antenna comparison testing confirmed the gain was approximately 8dBi. However, it took many hours to construct, and the antenna has very little physical strength. I resorted to cable-tying a length of dowel to the coax, and then encasing it all inside some 25mm electrical conduit.

不久前，我参照wireless.gumph.org 网站上的说明，做了一个 8 单元的同轴电缆天线。经测试有将近 8dBi增益。制作花了我N多个小时，但是机械强度却不很理想。于是我就给同轴电缆天线缠上加固木条，并把它装进 25mm的绝缘电工套管。

I was particularly intrigued when a friend pointed out a much simpler collinear, consisting of just a length of copper wire appropriately bent, as detailed here, with a claimed gain of about 6dBi.

当一个朋友告诉我，有人把一段铜线弯曲成一个简单的天线，（详见这里），就有 6dBi的增益，我的好奇心被激发起来了。

This version provides a number of benefits over the coax construction, requiring far less effort to construct, and providing a smaller and more robust antenna.
While the 6dBi gain is less than that of an 8 element coax collinear, the gain could be improved by increasing the number of elements. Doubling the number of elements will increase the gain by 3dBi, ie, double the gain.

这个天线有一些超越同轴电缆天线的优点，降低了制作难度，天线更小、更坚固。
虽然 6dBi 的增益小于 8 单元的同轴电缆天线，但是可以通过增加元件的数量来改进。 每两个单元可以增加 3dBi 的增益。

Parts Required

The materials required:

- approx 300mm 2.5mm^2 copper wire
- panel-mount female N-connector
- 250mm length of 20mm light-duty electrical conduit
- 2 end-caps to suit 20mm conduit

and optionally, for mounting of the completed collinear antenna:

- 2 clamps to suit 20mm conduit

or

- metal bracket

所需器件：

需要的原料

- 大约 300mm 长，截面 2.5 平方毫米的铜线

- **N 型母接头**
- **长 250mm ，外径 20mm 的轻型绝缘电工套管**
- **2 个适用于 20mm绝缘电工套管的端盖**

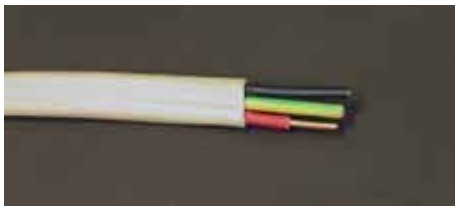
当然，装配天线还需要：

- **2 个适用于 20mm 绝缘电工套管的夹具**

或者：

- **金属支架**

I used a length of copper wire from some scraps of 2.5mm^2 electrical cable I had lying around. This cable has a diameter of approximately 1.6mm, and is flexible enough to bend into the required shape without too much effort or specialised tools.



2.5mm^2 3-core electrical cable

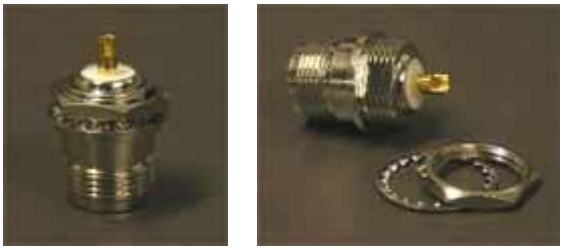
我用的是一段截面 2.5 平方毫米的废旧铜线。这种铜线的直径大约是 1.6mm，不需要借助任何特殊工具就能弯曲到需要的形状。

A panel-mount female N-type connector is also required, to allow the antenna to be connected to a wireless device. Note that other connectors (ie, TNC, SMA, etc) can also be used, depending on the connectors on your pigtails.

还需要用 N 型母接头把天线和无线装置连接起来。也可以用其它接头(比如：TNC,SMA 等等)，这取决于你的连接线端的接头。

I used a panel-mount female N-type connector, as shown in the photos below.

我用的是下面的这种



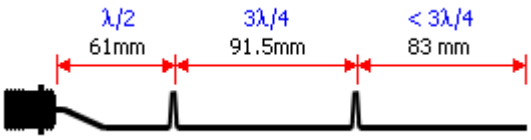
panel-mount female N-type connector

Design Details

This collinear simply consists of a length of copper wire with some loops located at specific locations. The dimensions of the sections of the antenna are important, and are shown in the diagram below.

设计：

一段铜线，在特定位置弯出一些圆环，就组成了天线。各部分的尺寸是非常重要的，参考下面这张图



dimensions of the collinear

The length of the bottom section is 1/2 wavelength, the centre section is 3/4 wavelength, and whip section on the top is slightly less than 3/4 wavelength, apparently to reduce the capacitance effect.

底部是 1/2 波长，中间部分是 3/4 波长，顶部要稍微小于 3/4 波长，以便减少电容的影响。

The 802.11b standard uses 2.412MHz to 2.484MHz frequency range, so at the centre of that frequency range, 1/2 wavelength is 61mm, and 3/4 wavelength is 91.5mm.
These dimensions appear to be consistent with similar commercial antennas.

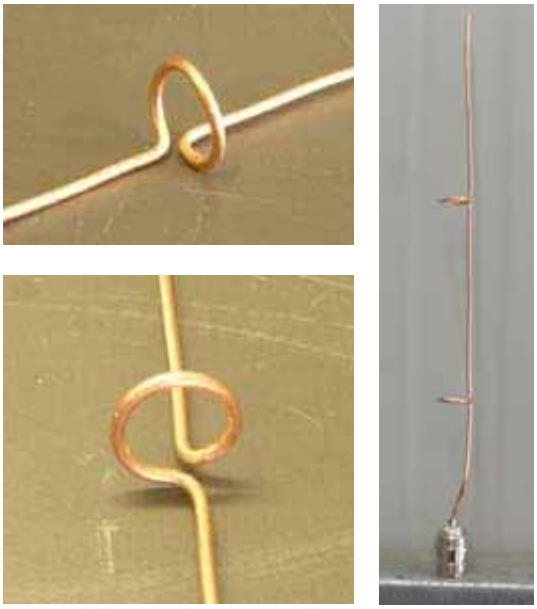
802.11b 标准使用 2.412MHz 到 2.484MHz 频率范围，其中心频率的 1/2 波长是 61mm，3/4 波长是 91.5mm。
这些尺寸看来和外面卖的天线一样。

Construction

Start construction of the antenna from the bottom end, and solder one length of the copper wire into the N connector. Measure 1/2 wavelength from the top of the N connector, and create the first loop.

制作：

先从天线的底部做起，在 N 型接头上焊接一段铜丝。从 N 接头的顶端量出 1/2 波长，做第一个圆环。



loop detail, and completed bare antenna

Note that the loops are offset from the wire which makes the vertical section of the antenna.

注意，圆环要和铜线错位，使铜线保持一条直线。

Then measure an additional 3/4 wavelength, and create the second loop. Trim the whip section on the top so it's the correct length.

然后量出 3 / 4 波长，再做第二个圆环。顶部留够需要的长度，剪断铜线。

If you are intending to use a length of 20mm conduit to house your antenna, be sure to keep the diameter of the coils to approximately 15mm or less, to ensure they will fit inside the conduit (20mm light-duty electrical conduit has an internal diameter of 16mm).

如果你准备用 直径20mm的绝缘电工套管，那么一定要保证圆环的直径等于或小于 15mm，这样才能把它装到绝缘电工套管里（20mm 轻型绝缘电工套管的内径是 16mm）。

completed collinear

However, a length of copper wire isn't particularly robust. One of the easier ways to address this shortcoming is to enclose the antenna inside a radome.

铜线长了终究就不坚挺了，最简单的方法就是给天线装上一个外壳。

Note that you need to use something that's transparent to 2.4GHz, else it will adversely affect the performance and operation of your antenna.

注意，外壳用那些 2.4GHz 容易穿透的物质，否则会影响天线的性能。

I used a 250mm length of 20mm light-duty electrical conduit, with some end caps to suit. The 20mm light-duty conduit has an internal diameter of 16mm, and the loops bent in the copper were a snug fit inside the conduit.

我用的是 250mm 长、带 2 个小盖子的、外径 20mm 的轻型绝缘电工套管。它的内径是 16mm，这样，那些圆环正好适合这种绝缘电工套管。

If you need something a little more roomy, then 25mm light-duty conduit can be used.

如果你想更宽松一点的话，可以用外径 25mm 轻型绝缘电工套管。

Two small bends are required in the wire near the base of the antenna, to ensure that the loops are centrally located above the N connector, thus allowing the entire antenna to be inserted into the conduit.
Testing indicates these bends to not have any noticable impact on the performance of the antenna.

在接近电线的底座的地方，要弯 2 个小弯。这样，当天线放入绝缘电工套管的时候，就能保证那些圆环位于 N 型接头上方正中央。
实验证明这 2 个小弯不会对天线的效果有任何影响。

20mm conduit and end caps

To mount the antenna, a suitably sized hole was drilled in one of the end caps, and after discarding the N connector's nut and washer, the N connector was screwed into the end cap from the outside.

组装天线的时候，要在一端的盖子上钻一个大小合适的小孔，把 N 型接头穿过小孔，用螺帽和垫圈从外面把 N 型接头拧在盖子上。

N-type connector screwed into an end cap

The antenna can now be inserted into the conduit, and the other end cap can be installed.

天线装进了绝缘电工套管，另一端的盖子也盖好了。

enclosed collinear

If the antenna is to be used outdoors, the end caps should be glued on with appropriate conduit glue, to ensure a weather-proof seal.
Note that the antenna should be tested before gluing the end caps in place.

如果这个天线是在室外使用的，那么两端的盖子还要用专用的绝缘电工套管胶水粘好，确保密封防雨。
注意，要在粘胶水之前测试天线。

Mounting

The conduit radome provides a robust and sturdy enclosure for the antenna, and if required, it can be mounted outside in the weather.
If mounting it outside, be sure to wrap the N-connector appropriately in self-amalgamating tape to prevent any moisture ingress.

安装：
绝缘电工套管为天线提供了一个坚固耐用的外壳，如果需要，它可以安装在室外。
如果安装在室外，一定要给 N 型接头缠上自合并胶带以防止潮气浸入。

Plastic clamps made specifically for conduit can be used to attach the antenna to a vertical surface. As these clamps are plastic, they will not interfere with the operation of the antenna, while all-metal mounts placed in the radiation pattern could affect the operation of the antenna.

塑料卡子可以把天线固定在垂直的墙上。因为这些卡子是塑料的，所以它们不会对天线造成干扰，而所有金属托架都会影响天线的辐射。

20mm conduit clamps

After attaching the clamps to the surface where the antenna is to be mounted, the antenna can easily be clipped into the clamps, and can also be easily removed.

把卡子安装在准备装天线的地方，就可以很容易地把天线卡到卡子里，天线移动起来也很方便。

sample mounting using clamps

An alternative method of mounting the antenna is with a short length of right-angle galvanised steel. A suitable hole needs to be drilled in one side, and the antenna can be attached to the galvanised steel by removing the N-connector and attached copper antenna, and passing it through the hole in the galvanised steel. The antenna will be firmly attached between the N-connector and the end cap.

另一种安装方法是用一小段直角的电镀钢片，在钢片上钻一个合适的孔眼，N 型接头穿过那个孔眼固定在钢片上。

using a metal bracket

If you just want to use the antenna for casual stumbling or wardriving, there is no need to mount it, and it can just be used as a handheld antenna.

如果你想随意移动天线的位置，那就不需要固定它，而是像手持天线那样使用。

demonstrating just how small it is

Testing

When building my first collinear using this design, I made the loops in a similar way to those seen on many commercial antennas which have multi-loop coils, with the wire above and below the coil being centrally located with regards to the loop.

测试：

我用这个方案做第一个天线的时候，像外面卖的那些天线一样，把铜线盘绕到圆环的中心，使铜线在圆环的中心保持一条直线。

first attempt at the loops

However, after doing some further research, I realised this was incorrect, and made another collinear using the loops as per the approach described above.
Some quick comparison testing indicates the collinear with the offset loops performs much better than the collinear with the centered loops.

但是后来我又做了一些研究，发现这是不对的。在做另一副天线时，就按照上面描述的每一步来制作了。
测试表明，比起那些铜线位于圆环中心的天线来，圆环偏移的天线性能更好。

Future Plans

When I get the time to do so, I'm intending to do some further experimentation with this antenna design, to see what sort of additional gain can be achieved by adding additional segments, more coils, etc.

下一步计划

等有了时间，我打算对这个方案做进一步的实验，看看增加圆环的数量和圈数，等等，是不是可以提高增益。

References

参考书目：

- Cheap home-made collinear
- How To Make a cheap Wireless LAN 6dbi collinear Antenna
- Easy Homemade 2.4 GHz Omni Antenna
- A 2.4GHz Vertical Collinear Antenna for 802.11 Applications
- A 2.4GHz Low-Power 5dBi Vertical Collinear Antenna for 802.11 Applications

Credits

版权：

last updated 25 Jun 2006

2006 年 6 月 25 日更新

2009 年 5 月 23 日　激情无线（lijiqing）　翻译。