Extremely shortened Monopoles - they do work

Free translation of an article published in „Funkamateur“, issue July 2000, page 780, ISSN 0016-2833
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Horst W. Knaebel OE7OKJ unexpectedly passed away in May 2000. His article introduces an unconventional antenna design that did lots of enjoyment both to himself and to home-brewers and customers. His monopole antennas make the best out of the physical constrains and yet offer acceptable operation, even in locations where conventional antennas are not feasible due to space restrictions.

The shortened monopole described herein is based on a commercial antenna developed by OE7OKJ, but constitutes a special version , tailored for radio amateurs. Permission is granted for public and private useage and experiments. Commercial applications are covered by patents.

Principle of Operation

This antenna constitutes an open, series resonant, electrical circuit. An inductor is series-connected with a conductive cylinder, together with its associated distributed capacity to the environment. The feedline, a halfwave in electrical length, serves as a counterpoise. The coaxial feedline’s outer conductor is not connected to the monopole - only its center conductor is connected with the antenna’s inductor. On one hand the inductor serves as a base loading coil, on the other hand, as a magnetic field radiator. There is no great benefit in trying for the ultimate Q of the inductor, as this would end in greatly reduced operational bandwidth and increased sensitivity to influences from the antenna’s environment.

The conductive cylinder (radiator) capacitively loads the inductor, assures resonance at the operating frequency and provides for sufficient bandwidth, due to its form-factor. The antenna system described herein was computer optimized, not for optimum Q but for optimum reliability, i.e. for greatest independence from environmental influences.

This antenna offers only 5% of the aperture and 10-15% of the radiation efficiency of a full-sized quarter-wave radiator. From table 3 it is evident that this results in a penalty of 1.6 S-units, quite acceptable for the transmit mode- QRP operators are used to that. In the receive mode, this antenna system delivers slighty weaker signals to the receiver input, but helps receiving equipment somewhat prone to overlead, from QRM and QRN.

Figures 2 through 5 depict the antenna in its sectional plane, together with all its components.

Hints for amateur construction

Cut lengths of cover tube (3), length of coil former (5) according to table 1 (l3 and l5 respectively). Material for both tubes may be purchased from any hardware shop selling building material. Watch out, however, as sometimes material available from such shops may suffer from wide variations from nominal dimensions.

Material with more accurate dimensions are available from shops selling material for electrical wiring (cable tracks etc.).

Machine the mounting block (2), contact ring (6) and top cover (8) on a lathe, according to the dimensions given in figure 2, 3 and 4. Depending on the outline dimensions of the coax connector (1) you have selected, determine the exact and required dimensions of the bore, shown on the lefthand side of figure 3 and labelled Ø15.5 x 15. The connector (1) shall be firmly seated in this hole. It should slide in, without applying undue force.

Push the starting end of inductor wire through hole labelled Ø5 x 45° in figure 3 and push until the wire reaches the left-hand hole Ø15.5 x 15.

Remove insulation from inductor wire over a length of approximately 3 mm and solder the wire to the center terminal of coax connector (1).

Apply epoxy resin glue to the relevant mating surfaces of (1) and (2).
Place connector (1) into the hole of the mounting block (2) until it sits flush with the block's surface. Allow for the glue to harden before proceeding.

Apply epoxy resin glue to the stud Ø18 x 15 on the right-hand side of figure 3 and to the mating inside surface of coil former (5).

Slide coil former (5) over stud Ø18 x 15 and allow for the glue to harden before proceeding.

By rotating the subassembly (1+2+5), place the inductor wire onto coil former (5) with the amount of turns "N" specified in table 1. The individual turns of the inductor coil shall be wound without spacing. Let the last turn spread to the right-hand end (figure 3) of coil former (5).

Cut the inductor wire, remove about 3mm of its insulation for soldering.

Cut an axial slot (1mm wide, 5mm depth) into the contact ring (6) at its lefthand side of figure 4. This will provide for soldering of wire end.

Solder wire end to contact ring (6). Prevent solder from protruding from the slot so that it does not increase its effective outer diameter (Ø22mm).

Apply epoxy resin glue to the inside surface of contact ring (6) and the mating outside surface of coil former (5). Slide contact ring (6) over coil former (5) until both components' right-hand sides (figure 5) mate. Turn the contact ring relative to the coil former to obtain a flush seat of the inductor wire on the coil former's surface. Allow for the glue to harden before proceeding.

Figure 6 shows the assembled inductor coil and contact ring for 3 antenna versions.

Prepare radiator tube (7). It may be manufactured from copper tubing or alternately from copper sheet material. Wall thickness of copper tubing must not exceed 0.5mm (nominal 0.1mm). Copper sheet thickness shall be 0.1mm (maximum 0.5 mm).

If copper tubing (required length is l7 as per table 1) is used, cut an axial slot along its side, approximately 1mm in width. This will allow the copper tubing to become resilient.

If copper sheet material is used, cut the required length (l7 as per table 1) and width. Using a rigid cylindrical object OD=22.5mm, roll and curl the copper sheet to form a cylindrical (slotted) tube.

The inner diameter of cover tube (3) and outer diameter of radiator tube (7) shall mate, so that the radiator tube (7) holds it in place when mounted inside of the cover tube (3).

Do not yet apply glue to affix (7) with (3), as radiator tube (7) eventually needs pruning for fine tuning at the resonance frequency.

Slide assembly (3+7) over assembly (1+2+4+5+6) until
a) radiator tube (7) overlaps contact ring (6) for about 5mm, and
b) cover tube (3) sits flush on the mounting block's right-hand stud labelled Ø22.6 x 10 in figure 3.

Prepare a coaxial feedline which is exactly a halfwave in length electrically (or an integer multiple thereof). Consult table 2 to find velocity factor "V" for conventional cable types. Find mechanical length "l" in meters for the operating frequency "f0" in MHz, by solving the equation: l=V*150/f0.

Coarse checks of the antenna’s resonant frequency may be performed indoor, but for accurate fine-tuning, it will be necessary to place the antenna outdoors.

Mount antenna atop a non-conducting support tube or pipe, about 3m in height, running the feedline through its inside. Keep the antenna clear of nearby conductive or dielectric objects.

Check the antenna’s resonant frequency with an antenna-scope, SWR Analyzer, or your transceiver and SWR-meter. If required, prune the length of the radiator tube (7) until the resonant frequency is correctly adjusted.

Apply epoxy resin glue to inside surface of cover tube (3), to outside surface of radiator tube (7) and to the mounting block's stud labelled Ø22.6 x 10 in figure 3. Assemble (7) with (3).

Slide assembly (3+7) over assembly (1+2+4+5+6) until
a) radiator tube (7) overlaps contact ring (6) for about 5mm, and
b) cover tube (3) sits flush on the mounting block's right-hand stud labelled Ø22.6 x 10 in figure 3.

Allow for the glue to harden before proceeding.

To make the antenna resistant to weathering and exposure to sea water spray, fill the cover tube entirely with a plastic foam. There are several types of foam available. Do not use the types used in building construction – their hardening requires the presence of moisture, but once moisture is in the antenna, it is quite impossible to remove it. Only use the double component PU foam (polyurethane) for filling.

Practical operation

Start your experiments with the antenna model for the 40m Band. It is compact, yet does not require so much precision in its construction process as do the models for the higher frequencies.

The feedline shall be a halfwave in length electrically at the design frequency, otherwise a matching (tuning) unit becomes indispensable. The latter, however introduces additional losses into the antenna and feedline system which may become excessive (50% of total system loss). A feedline cut for one band may be used as well on harmonically related higher frequencies.

Despite the fact that successful QSOs were made while the antenna was atop a table in the basement indoors, it is always a good idea to mount the antenna in the clear.

Mounting atop a non-conductive tubular antenna support is the most likely one. Dry wooden posts, fibre glass masts or pipes make a perfect antenna support for stationary and portable operation. Suspending the antenna from a non-conducting support line, hung in between trees or buildings is another possibility.

For mobile, portable or experimental operation, the antenna may be simply suspended topside down by its own feedline.

When using PVC tubing for the construction of the antenna, apply painting with epoxy paint or acrylic paint, as the PVC (poly vinylic chloride) is not UV resistant. Do not use paint or laquer filled with metallic particles.

Two identical monopoles may be arranged end-to-end and operated as a dipole antenna. One monopole is connected to the center conductor, the other monopole to the outside conductor (shield) of the coax feedline.

Monopoles for different bands may be operated from one and the same feedline. Arrange them in quadrature with respect to each other and use coaxial T-adaptors for connection. Different monopoles may be arranged in parallel, if a spacing of at least 1 meter is preserved.

The author hopes that radio amateurs and CB operators will be successful in constructing this type of antenna. For the activity-challenged ones (read = “lazy”), orders may be placed to [2] Traxel company exclusively, as the stock of antennas manufactured by OE7OKJ himself is completely sold off.

List of items according to figure 5

(1)	coaxial connector	SO239 or equivalent
(2)	mounting block	PE or PVC, OD=25mm, length=100mm (fig 3)
(4)	inductor coil	enameled copper wire, 0.5mm for the 160m version, otherwise 1mm
(5)	coil former	PE or PVC tubing, OD=20mm, ID=18mm, length=l5 in table 1
(6)	contact ring	brass tubing, OD=22mm, ID=20mm, length=18mm (fig 4)
(7)	radiator tube	copper tubing (axial slot), OD=22mm, wall=0.1mm (0.5mm max.), copper sheet curled, thickness=0.1mm (0.5mm max.), length=l7 as per table 1
(8)	top cover	PE or PVC, OD=25mm, length=22mm (fig 2)

Table 1 dimensions

Band	L3 [mm]	L5 [mm]	N	d [mm]	L7 [mm]	Ltotal [mm]	f0 [MHz]
160m	1540	370	564	0.5 (AWG24)	1230	1740	1.84
80m	1460	370	358	1 (AWG18)	1075	1560	3.7
40m	720	205	175	1 (AWG18)	470	820	7.05
20m	310	120	88	1 (AWG18)	170	410	14.1
15m	220	75	47	1 (AWG18)	115	320	21.1
10m	140	65	38	1 (AWG18)	55	240	28.3
11m	170	85	38	1 (AWG18)	90	270	27.0

Table 2 properties of conventional coax cables

cable type	velocity factor V
Aircell	0.83
Aircom plus	0.85
Ecoflex 10	0.86
H155	0.79
H2000	0.83
RG 58 C/U	0.662
RG 213 U	0.662
RG 142, -400	0.69

Figures

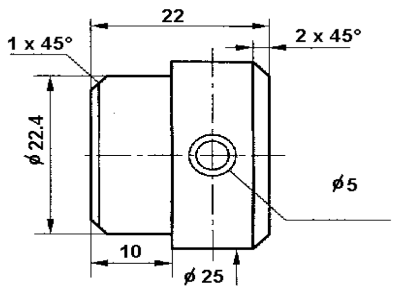

Fig 2 top cover (item 8)

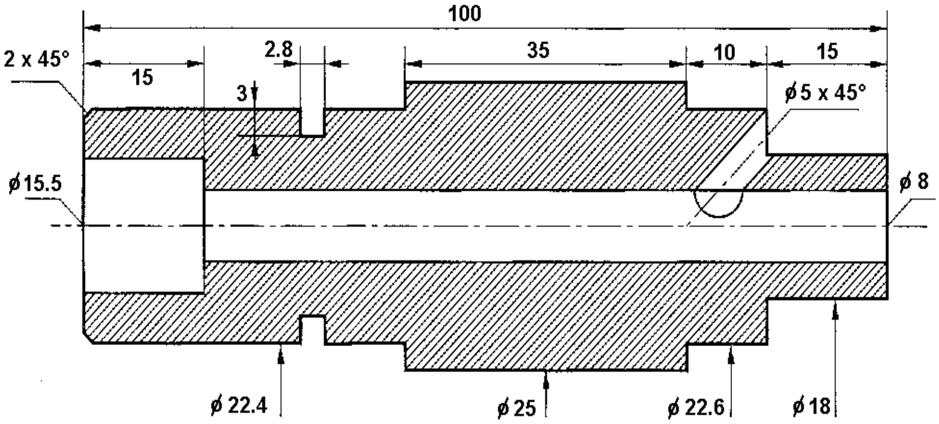

Fig 3 mounting block (item 2)

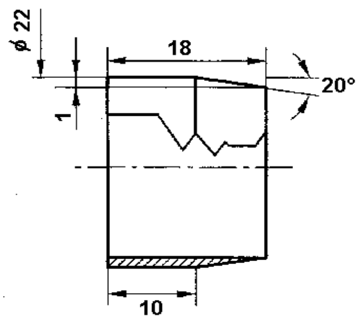

Fig 4 contact ring (item 6)

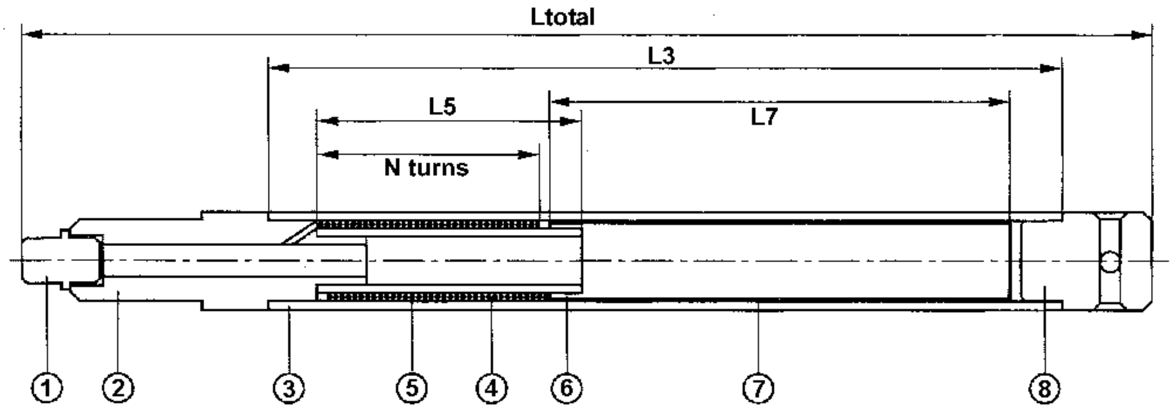

Fig 5 monopole antenna assembly

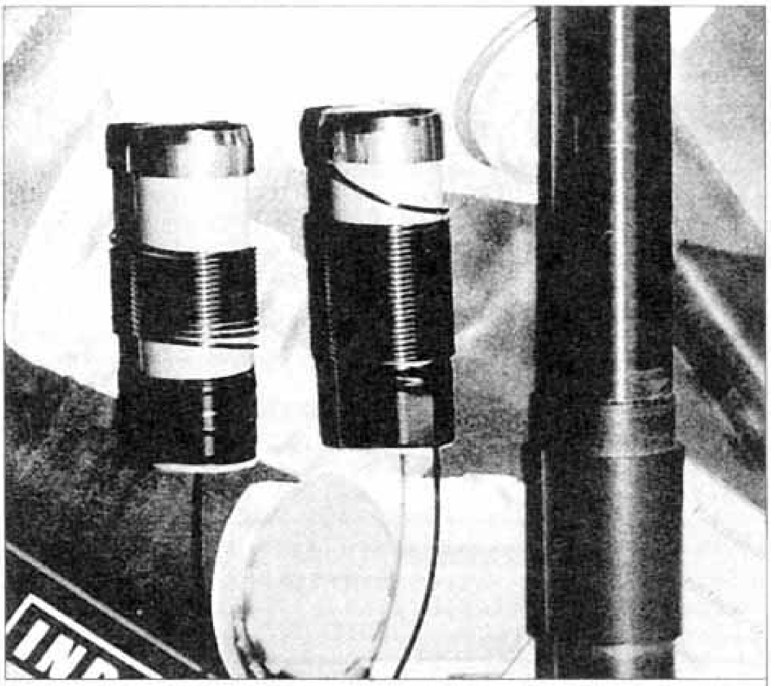

Fig 6 10m, 20m, 80m inductor coils