John J. Schultz W1DCG/W2EEY
40 Rossie St.
Mystic, Conn. 06355

# Buried Antennas for Emergency Communications

In this article, W1DCG describes some of the properties of buried antennas, particularly in relation to their usefulness for amateur Civil Defense or other emergency communications installations.

Many experiments have been conducted with sub-surface antennas in recent years to allow construction of bomb-proof communication sites and for communication with deeply submerged submarines.

Some scientists believe in the possibility of a super-conductive medium in the earth's crust so that antennas could be buried in the ground in an upsidedown fashion and communications established using this "earth ionosphere" much the same as surface antennas work in conjunction with the ionosphere.

However, experiments in this field have not been very successful and a buried antenna, for practical purposes, can be treated as having useful propagation only above the surface. The deeper the antenna is buried, the more inefficient it becomes because of the earth's absorption of the radiated energy.

What application do such antennas have for the amateur? Few amateurs are faced with such a drastic situation that they can't put up some form of surface antenna, even if only attic antenna for short whip. However, for those engaged in Civil Defense or other emergency communications work, the installation of a buried, "back-up" antenna at a fixed station should be considered. It is quite a contradiction to see so many times an emergency communications setup in a relatively protected area—the basement of some public building, for instance—and then to see the antennas on which the usefulness of the installation entirely depends, dangling loosely in the open liable to any extreme surface condition, natural or man-made.

The purpose of this article is to review some of the types of buried antennas which might be useful for amateur emergency communications and to present some of the results the author obtained with a buried 40 meter antenna.

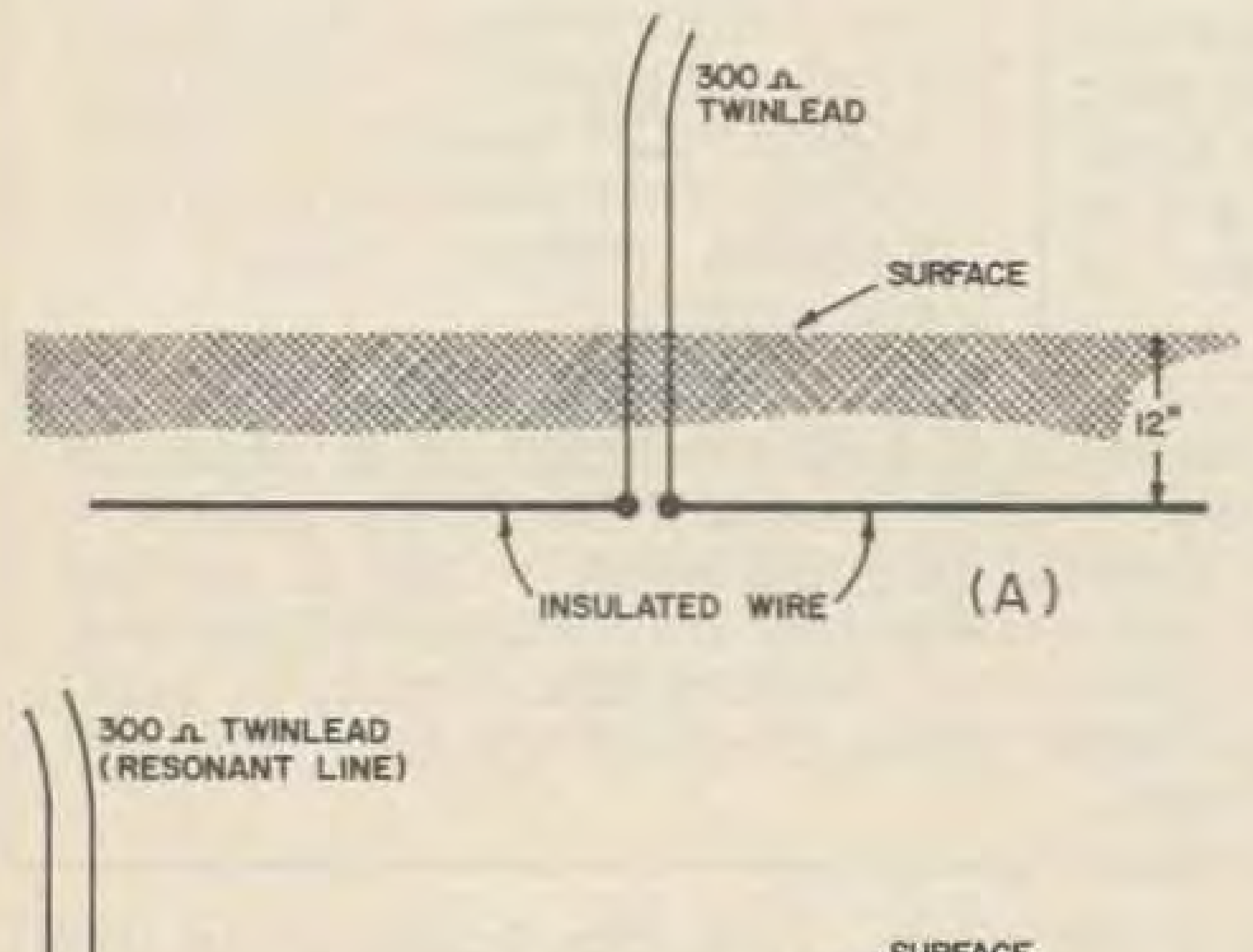


Fig. 1. The dipole (A) and 100 ft. long wire types of buried antennas. Constructional details are given in the text.

## Buried antenna properties

Because a buried antenna is immersed in a very lossy medium and because of the sudden difference in medium which, a radiated wave encounters at the interface of earth and air, a number of factors are drastically different for buried antennas as compared to an antenna in air.

Because of the antenna being in a different medium, the length/impedance versus frequency characteristics are different. For instance, a simple dipole buried 1′ in soil of moderate conductivity would be about 17½′ long for 20 meters and have a center impedance of about 450 ohms. As may be imagined, these figures are very dependent upon the exact conductivity of the soil.

Because of the interface between earth and air, the radiation from a horizontal, buried antenna when it reaches the surface sets up a vertically-polarized ground wave. This factor, of course, is ideal for emergency communications work with vertically-polarized mobile stations.

### Antenna forms

Many different forms have been tried for buried antennas and even complex directive arrays have been constructed. However, for amateur purposes, the dipole and 100′ long wire are probably the most useful forms. (Fig. 1.)

The formula for the length of a dipole depends upon ground conductivity as well as other factors and would not be of much use to the average amateur. The best procedure for constructing a dipole is simply to cut it to 80% of the free-space length and then trim the ends equally until the lowest SWR is achieved. If buried in an area where ground conditions remain stable, the length does not have to be changed again.

In areas where ground conditions and surface conditions (snow, extreme changes of vegetation) are not stable, the 100′ long wire should be used. Although an antenna coupler, such as a transmatch, is required to allow compensating for impedance changes with varying ground conditions, the antenna can then also be used for multiband operation. In typical soil the input resistance of such an antenna will vary from 50 to 600 ohms and the reactance from ± j400 ohms over the 2-20 MHz range. The first resonance will be between 750 and 1800 kHz, which makes it effective from 80 meters on down. This type of antenna has been used by the Army in Viet Nam with good results over short tactical distances.

### Construction

Whether a dipole or 100′ long wire is used, the wire used for construction must be insulated along its length from the soil and care must be taken that moisture does not penetrate the tips of the wire or the connection to the feed line. Teflon insulated wire, numbers 22 to 26, is particularly suitable. Perhaps a less expensive method is to run plain rubber insulated wire inside plastic hosing. The ground connection for the 100′ long wire can be a standard 4 or 5′ TV type ground rod.

### Efficiency

Many methods have been used for measuring the efficiency of buried antennas. Perhaps the most realistic for amateur purposes is to compare the field strength from a buried antenna to a good, surface quarter-wave vertical. Experiments made on this basis have showed buried antennas of the dipole and 100′ long-wire variety, when compared to a surface antenna resonant at the same frequency, to be about 4O db down for a burial depth of 1′. Roughly, this is about twice the order of magnitude reduction in signal strength as would take place between a 8′ loaded 80 meter whip and a full-size quarter-wave 80 meter vertical.

### Experimental results

The author constructed a 100′ long-wire buried about 8″ and operated on 40 meters. No impedance measurements were made but proper loading could be easily achieved with the use of a transmatch-type coupler, although some retuning was necessary periodically depending on whether the soil surface was moist or dry.

No surface, vertical 40 meter antenna was available to make signal comparisons but comparisons were made with a 40 meter dipole elevated about 40 feet. On local and short-skip contacts, the buried antenna was never better than 7 "S" units below the dipole with the average being around 8-9 "S" units.

### Conclusion

Buried antennas still offer many possibilities for experimentation. The main caution to observe is that the length, impedance and other parameters of surface antennas cannot be used.

Buried antennas are terribly inefficient as compared to almost any type of surface antenna except perhaps extremely short, unloaded whips. But, for emergency communications installations, they do offer the possibility of having a standby antenna which is easily installed and which can be pre-tuned and immediately available for use should something happen to the installation's primary antenna.

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**Reference**

For those who would like further detailed, engineering data on buried antennas, the following compilation of articles is extremely useful: IEEE Transactions, Vol. AP-11, May, 1963. Special Issue on Electromagnetic Waves in the Earth. IEEE, Box A, Lenox Hill, New York 21, New York.