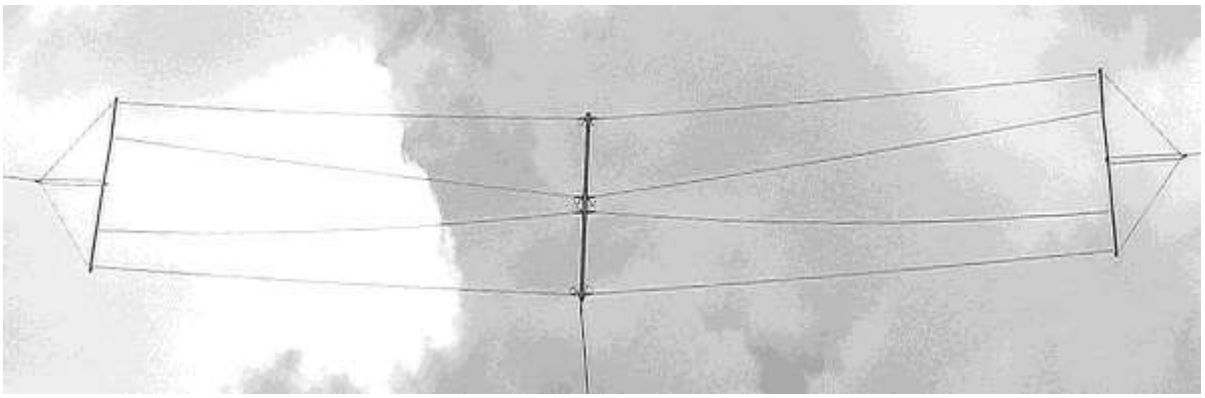
WFL Wideband Folded Loop antenna by RF Systems

Compact, High-Grade Transmitting and Receiving Antenna for the HF Spectrum

The WFL antenna is a wideband antenna for receiving and transmitting on any frequency between 1.8 MHz and 30 MHz, but can be used up to the 6 metres band. The WFL is very compact, measuring only 7.5 x 1 metres, making it possible to hang the antenna in nearly any location. The WFL is a folded loop antenna, which is matched so that the VSWR changes between 1.3:1 and 1.7:1 on all amateur bands when the antenna is mounted as recommended. Most transceivers do not require an antenna tuner at these low VSWR values. The WFL has been designed for transceivers with an output power of 200 Watts. Like the well-known circular magnetic loop antennas, the WFL antenna provides an extremely low noise level and suppression of man-made interference. The antenna has a built-in choke balun in order to prevent radiation of the coaxial antenna cable. This reduces Broadcast Interference (BCI) and Television Interference (TVI).



Features:

*** Antenna length only 7.5 metres, especially suited for confined urban spaces**
*** Transmitting and receiving at any frequency between 1.8 MHz and 30 MHz, no tuning required**
*** Suited for transceivers up to 200 Watts p.e.p. (ICAS)**
*** Impedance 50 Ohms, coaxial antenna cable between antenna and transceiver**
*** Average VSWR in the amateur bands less than 1.7 : 1, usually no antenna tuner required**
*** Ultra low noise and suppression of interference due to loop antenna principle**
*** Protected from static discharges**
*** Built-in choke balun prevents radiation of the coaxial antenna cable**
*** Completely weatherproofed with professional grade construction suitable for any climate**
*** Can withstand wind speeds up to 200 km/h**

Ideal For Small Spaces

Many hams cannot operate on the lower shortwave amateur bands because they don't have enough space for a full-size antenna for the 80 and 40-metre bands. Antennas that need less space, such as verticals, usually have a very limited bandwidth and require a good RF ground. Short wire antennas also need a good RF ground (counterpoise) and require an antenna tuner that often causes considerable losses and needs re-adjustment with every change of frequency.

Most operators ranging from amateurs, commercial, governmental and military organisations, usually suffer these problems. Embassies especially suffer from the problems of limited spaces, lack of RF grounding possibilities and high interference levels typical of their locations. Many professional organisations use also special techniques such as spread spectrum, ALE- and frequency hopping techniques that require true wideband antennas.

Thanks to a grant of the Dutch government, RF Systems was able to develop an antenna with a length of just 7.5 metres that offers wideband operation on any frequency between 1.8 MHz and 30 MHz without the need of an antenna tuner. The loop antenna principle is especially effective for suppression of near-field man-made interference and the atmospheric noise level caused by static's. Originally developed for governmental and military applications, this antenna is now also available for commercial and amateur applications as Wideband Folded Loop (WFL) antenna.

The Folded Loop

The Wideband Folded Loop antenna is a loop antenna with a circumference of 32 metres. By folding the sides to the centre, the antenna is converted to a rectangular loop of 7.5 x 1 metres. The advantage of these small dimensions means that the WFL antenna can be placed nearly anywhere:

in the back-yard or garden, between trees, from the chimney or gutter to a tree or fence, between two chimneys or even in balconies. Ground space of only five metres is sufficient if the antenna is mounted at an 30 degree angle. The recommended minimum height of the lowest point of the antenna is four metres, although the antenna can also be used at lower heights with reduced performance.

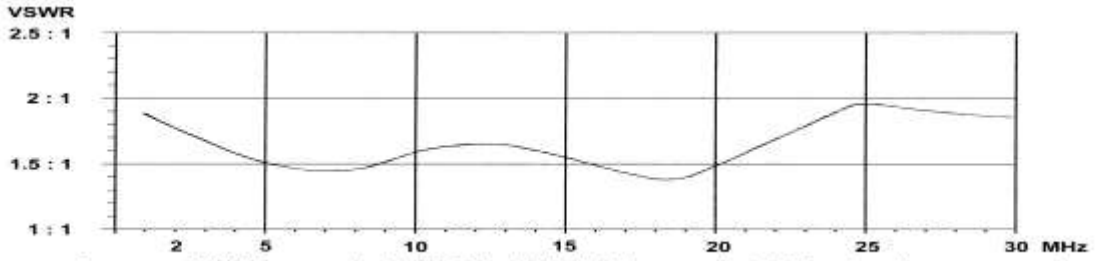
Low noise and reduced man-made interference
Interference from atmospheric noise caused by static's, as well as near-field interference caused by household appliances and machinery, is very high on frequencies below 10 MHz. In cities and industrial areas during daytime a noise and interference level of between S 4 and S 6 on the 80-metre band with a long wire antenna is common. This prevents the reception of weaker stations. Atmospheric interference from static's and near-field man-made noise and interference has a distorted ratio between the electrical-field (E-field) and magnetic-field (H-field) components of the radio waves and comprise mainly E-field components.

The advantage of a loop antenna is that on lower frequencies, where the outer dimensions of the loop are small with respect to the wavelength, the antenna responds mainly to the H-field component of the radio waves. Thus, a small loop antenna (magnetic loop) is much less sensitive to near-field man-made interference and noise compared to a monopole antenna such as a random wire or vertical antenna. In common with popular circular magnetic loop antennas, the WFL antenna offers an extremely low noise and interference level for reception. Depending on the local situation, the noise level in the lower shortwave bands can drop to S1 or S2, which improves the reception of weaker stations.

Wide band transmitting and receiving without an antenna tuner
The impedance of the WFL antenna differs from the circular magnetic loop antennas due to the rectangular shape and back-folded sides. The back-folded sides come together in the centre making it possible to match the antenna over the whole frequency range to the 50 Ohms impedance required for the transceiver. All matching, tuning, and phase correction elements are mounted inside the tubular centre part of the WFL antenna.

The lower part of the centre tube, near the connector, comprises a high-power matching transformer based on the Magnetic Transfer technology. The transformer is wound with Teflon insulated silver wire on a special ferrite developed by RF Systems. This ferrite is also used in the RF Systems´ Magnetic Longwire Balun (MLB), the T2FD antenna and the Power Isolator lightning protector. This transformer ensures wideband matching and a perfect symmetry of the loop antenna. A built-in current choke prevents radiation of the coaxial antenna cable. This greatly reduces the chance of BCI and TVI. One of the remarkable features of the Magnetic Transfer technology is that there is no conducting connection between the antenna and the transceiver. Only RF signals are transferred by a magnetic field with ultra-low loss (< 0.3 dB). The separation between the antenna and the transceiver ensures that static discharges from thunderstorms in the vicinity cannot harm the transceiver. A built-in 10,000 Ampere gas-arrestor short-circuits high voltage spikes between the centre core and the screening of the coaxial antenna cable for enhanced protection of the transceiver or receiver.

The mid and upper part of the centre tube comprise matching and phase networks which, in combination with the matching transformer, match the antenna over the whole frequency range (1.8 - 30 MHz) to 50 Ohms. Tuning the antenna is not necessary with the WFL, unlike the popular magnetic loop antennas that require additional tuning with every change of frequency. The matching networks use high quality components such as high current capacitors with 10 kV working voltage. All parts are sealed in poly-urethane resin for moisture protection and insulation. If the antenna is placed according to the instructions in the manual, (at least four metres high and well clear of metallic roofs or other conducting structures), the VSWR in the amateur bands will vary between 1.3 : 1 and 1.7 : 1 (see graph). This is low enough to make an antenna tuner superfluous with most amateur transceivers. If the transceiver has a built-in tuner, then the corrections for matching to 1: 1 are so small that the antenna tuner does not cause much loss.

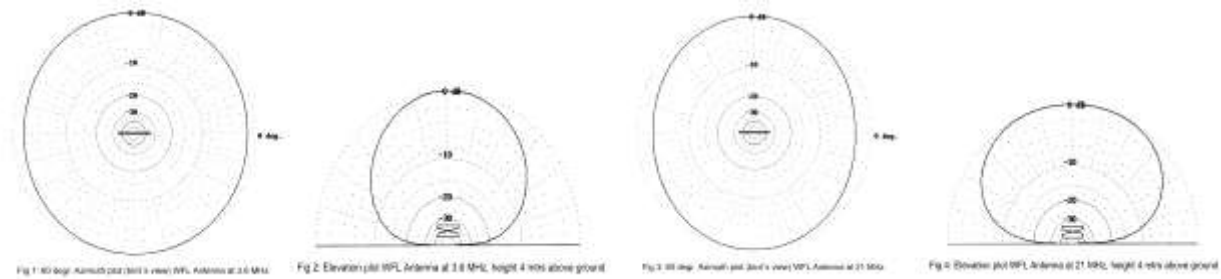


Average VSWR curve (ref. 50 Ohm) WFL Antenna, height 4 mtrs above ground

Professional construction
Originally, the WFL antenna was designed for governmental and military use in any climate from polar to tropical and in maritime environments. Only high quality parts are used, such as UV light and weather resistant plastics. Metal parts are stainless steel. The woven Dracon span lines are proofed against UV sunlight and have a breaking force of more than 400 kg. The antenna can withstand wind speeds of more than 200 km/h. The centre tube is filled with poly-urethane foam and is waterproof. The antenna wire is made of pre-stretched, oxygen-free copper litze-wire with 50 x 0.25 strands. This litze wire, specially made to RF Systems specifications, is covered with a transparent UV light and air-pollution resistant poly-urethane cover. The advantage of oxygen-free copper is that it does not oxidise and so the resistance of the wire remains low. To protect the SO 239 - PL 259 antenna connection, a plastic sleeve and seawater resistant grease is included. The centre tube of the WFL antenna is relatively heavy; however, the antenna can be spanned with a force up to 100 kgf to reduce sagging in the middle to a minimum.

Radiation patterns
The outer dimensions of the WFL antenna are extremely small compared to the wavelengths of frequencies below 10 MHz. This results in a near omni-directional radiation/reception pattern on the 1.8 MHz and 3.6 MHz bands. On the 80 metres band the anomaly is less than 2 dB (see fig. 1). At higher frequencies, the outer dimensions of the WFL antenna are less small with respect to the wavelength and the radiation/reception pattern becomes more or less oval (see fig. 3) but retain a respectable omni-directional characteristic if compared with a dipole or trap antenna like a W3DZZ.

For the typical circular magnetic loop antennas, it is often claimed that they can be placed near or even on the ground. This is a purely theoretical claim and only valid for a perfect conducting ground, such as metal or seawater. With a real ground, a part of the radiated energy is dissipated in the ground. This is also the case for the WFL antenna and therefore it is recommended to hang the antenna as high as possible above the ground. In some situations high placement is not possible and this will influence the vertical radiation pattern. Figure 2 gives the vertical radiation/reception pattern for the 3.6 MHz band where the antenna is hung at a height of 4 metres. On the lower amateur bands, most energy is radiated directly upwards and at high angles. That is not a disadvantage. For communication within Europe (within a range of 600 km), one hop ionosphere reflection (NVIS) is always used on these frequencies. Long distance (DX) signals come in at low angles. In figure 2 it can be seen that signals with an angle of 15 degrees are approximately 12 dB (2 S-points) less strong compared to high angle signals. That is not only the case for your reception; the counter station receives your signal with 2 S-points less signal strength as well. For this reason, we indicate that the WFL antenna is not a DX antenna, although many long distance stations are still strong enough to work with even with a 2 S-point reduction in signal strength. On the higher frequency bands the radiation pattern becomes somewhat better for low angle DX signals. On the 21 MHz amateur band a signal which comes in at a 15 degree angle is just 7 dB (a little bit more than 1 S-point) less strong compared to a high angle signal (see figure 4).



'Miracle' antennas do not exist
As a professional antenna manufacturer, RF Systems strives for precise and realistic information about our products to avoid raising expectations beyond what is possible in practice. The WFL antenna is certainly no 'miracle' antenna. In the world of antennas, one cannot gain something without a ‘cost’ in some other aspect of performance. Every small antenna is a compromise. The antenna with the highest efficiency is a dipole, fed with open ladder line at a minimum height of ¼ wavelength (better still, a ½ wavelength) above the ground because at lower heights the losses due to ground dissipation increase sharply. For the 80-metre amateur band, this means a dipole length of approximately 41 metres at a height of at least 21 metres. Any reduction in this size or height means a reduction in the efficiency. Reduction of the size means a smaller capture-area and requires matching of the low radiation resistance and capacitive reactance to 50 Ohms; this causes losses. The smaller the antenna is, the greater the losses, and usually, the smaller the bandwidth of the antenna. It is well known that the helical whip antennas for the 80-metre and 40-metre bands have an efficiency in the order of 2% to 5% but if they do not have a good RF ground these efficiency figures become even lower. A good antenna tuner can match even a small antenna to 50 Ohms but at the cost of the transmitting power, which is lost in the tuner. However, the loss of transmitting power is not as

bad as many amateurs think it is. You can reduce, for instance, 100 Watts transmitter output power to 25 Watts (75% loss) and the counter station will notice only a one S-point drop in the signal strength. Of course, everybody strives for S 9 reports but communication is also possible with S 6 or S 7 signal strength.

6-metre Band Operation
For military applications, the WFL antenna is in fact matched up to 54 MHz for a VSWR less than 2 : 1, so operation in the 30 – 54 MHz (lower VHF band) is possible. However, the WFL antenna is larger than required for the 6-metre band and due to the matching to 50 Ohms the efficiency is lower compared to a dipole antenna. As a dipole antenna for the 6-metre (50 – 52 MHz) amateur band needs to be only 3 metres long, we recommend the use of a separate dipole for this band.

The WFL is a 'small-space antenna'-, not a DX antenna
The WFL antenna is one of the smallest all-band, no tuning antennas in the world with its compact 7.5-metre length. The antenna is wideband matched to 50 Ohms so there is no limitation in working frequency between 1.8 and 30 MHz. Tuning the antenna to the working frequency as required with the well-known circular magnetic loop antennas, is not necessary. Many military and amateur transceivers reduce their output with high VSWR values in order to protect the power amplifier. With most transceivers the output reduction starts at VSWR values above 2 : 1. With the WFL antenna, the VSWR values are below this value in the amateur bands so an antenna tuner is not required with most transceivers. If however an antenna tuner is present, then only small corrections which cause minor losses are required to bring the VSWR for the transceiver back to 1 : 1.

Compared to verticals and end-fed wire antennas, a loop antenna like the WFL has the advantage of being a balanced antenna, which makes an earth net or radials superfluous. Certainly on the 160-metre, the 80-metre and 40-metre bands, the WFL antenna is extremely small compared to the wavelengths of these bands and so the efficiency of the WFL antenna is considerably lower in comparison with a full-sized dipoles or other large antennas.
However, given the loop antenna principle (magnetic loop), the noise and interference level of the WFL antenna is extremely low so that the signal-to-noise ratio of the received station is often much better when compared to a vertical or short end-fed wire antenna, even if the signal strength is lower. The WFL antenna is a true low-noise antenna and despite the lower S-meter readings, many weak signals will become understandable thanks to the lowered noise-floor. With the WFL the old amateur saying holds true: "If you can hear them, you can work them."

On the lower amateur bands the WFL antenna is not a replacement for a full-sized antenna.
Operators who have the possibility to hang 25 to 40 metres wire at a sufficient height do not need the WFL antenna! However, if you have no space for the long antennas required for the 80-metre and 40-metre bands, you will be surprised with the all-band performance of the WFL antenna.

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