

A 433 MHz Range Extender for EcoWitt Soil Moisture sensors

This document outlines a technique I have used to increase the range of 433 MHz EcoWitt Soil Moisture sensors. It may be useful for other types of 433 MHz transmitters.

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Introduction

I have an EcoWitt HP2553 weather station installed at my home. Its connected to Weather Underground and others and is visible at

<https://www.wunderground.com/dashboard/pws/IGOLDC1157>

My experience has been generally very good with this system. I have the optional lightning detector, and 3 optional Soil Moisture sensors model WH51. However, the soil sensors have had a number of problems.

The first is that unless the battery sealing cap is in place, you can expect water ingress and the sensor will eventually fail. Make sure the sealing cap is in place and is tight. Caution: if you rotate the sealing cap anti-clockwise when sliding it on, you might accidentally unscrew the battery cap, causing the unit to have no power.

Secondly, the transmission range of the sensors is not great. All 3 of mine are installed in garden beds within 17 m of the (indoor mounted) main station. 2 are quite reliable, since the signal only goes through 1 or 2 brick walls. The third has been very unreliable: the signal penetrates 4 walls diagonally, and the main station frequently cannot receive signals from this sensor, or at best shows 1 bar.

I have developed an external range extender for this 3rd sensor which works very well, as described below.

Construction

The sensors look like this:



Figure 1: EcoWirtt H51 in situ



Figure 2: External view

I have disassembled several failed units. The internal construction is like this:



Figure 3: Internal construction: disassembly

The single internal board contains a 433 MHz transmitter (in my models: other frequencies are apparently available), with a helical antenna:



Figure 4: Antenna

The antenna in this model has these characteristics:

Internal Diameter: 3 mm

External Diameter: 4 mm

Wire Diameter: 0.3 mm

Coil Length :15 mm

Number of turns: 20

My Nano VNA indicates that this antenna (without a ground plane) resonates at about 510 MHz:



Figure 5: Antenna resonance

Extender tests

I fabricated a number of range extenders and tested them for effectiveness. The $\frac{1}{2}$ wavelength antenna for 433 MHz is 43.6 cm, for $\frac{1}{4}$ wavelength 17.3 cm and for $\frac{1}{8}$ wavelength is 8.7 cm. Each length was tested by soldering a straight copper wire of appropriate length to one of the desoldered helical antennas:



Figure 6: Example extender

The extender was taped on the outside of a working sensor and the received signal strength measured when the sensor is restarted.

The received signal strength for each length extender was measured with a Tektronix 492 spectrum analyser, connected to a 433 MHz tuned antenna, and compared against the original unextended sensor signal:

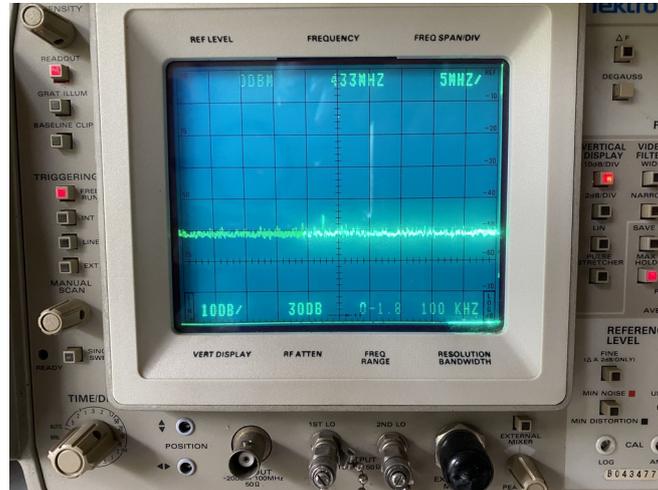


Figure 7: Unextended signal strength

The sensor signal is the small response just to the left of the centreline. For the extended range tests, the extender was taped to the outside of the sensor, so that the extender's helix was adjacent to the transmitter's helix inside the case.

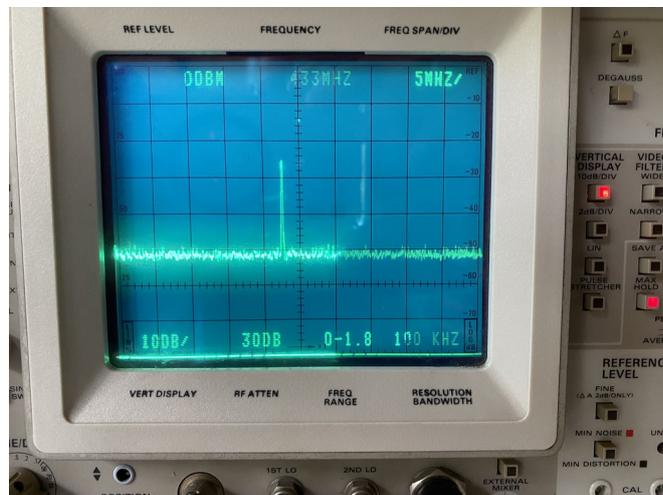


Figure 8: 1/8 wavelength antenna signal strength

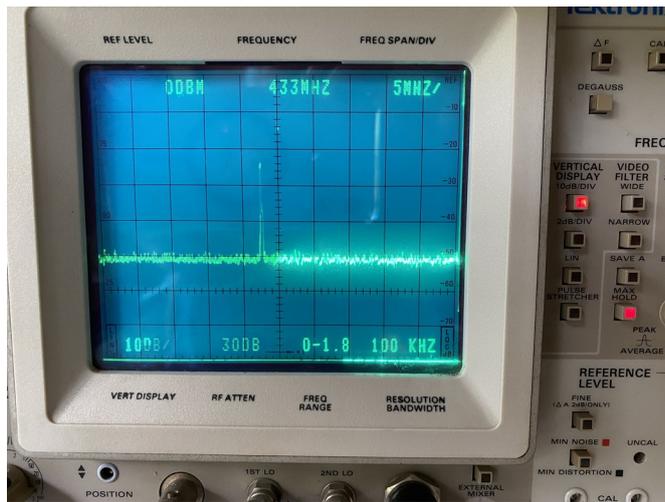


Figure 9: 1/4 wavelength antenna signal strength

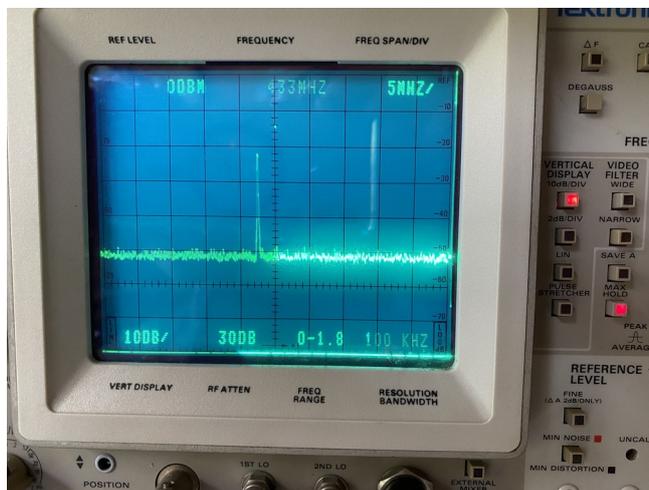


Figure 10: 1/2 wavelength antenna signal strength

As can be seen, the $\frac{1}{2}$ wavelength antenna provided the strongest signal, approximately 4 dB stronger than the $\frac{1}{8}$ wavelength, and all at least 20 dB stronger than the unextended sensor.

I made a more permanent extender by enclosing the $\frac{1}{2}$ wavelength version in a plastic tube, sealing it and mounting it to the side of previously unreliable 3rd sensor. Now the main unit shows a signal strength of 4 bars for this sensor (after waiting an hour: the main unit has some sort of signal strength averaging algorithm), and my problem is solved.



Figure 11: 1/2 wavelength extender mounted for testing

I have also tested hand wound helical antennas using copper wire, and with the same dimensions as the ones from the sensors, and measured the same resonant frequency and behaviour, so you can practically wind your own helical antenna. Be sure the turns are evenly spaced, and not touching each other.



Figure 12: Hand wound helical antenna (bottom) compared to original from a sensor