

A large yellow rubber duck is the central focus, floating in a calm body of water. The duck is highly detailed, with a prominent black eye and a pink beak. The background is a soft-focus landscape featuring a white boat on the right, bare trees, and a building in the distance under a hazy sky. The water reflects the duck and the surrounding environment.

Rubber Ducky Antennas

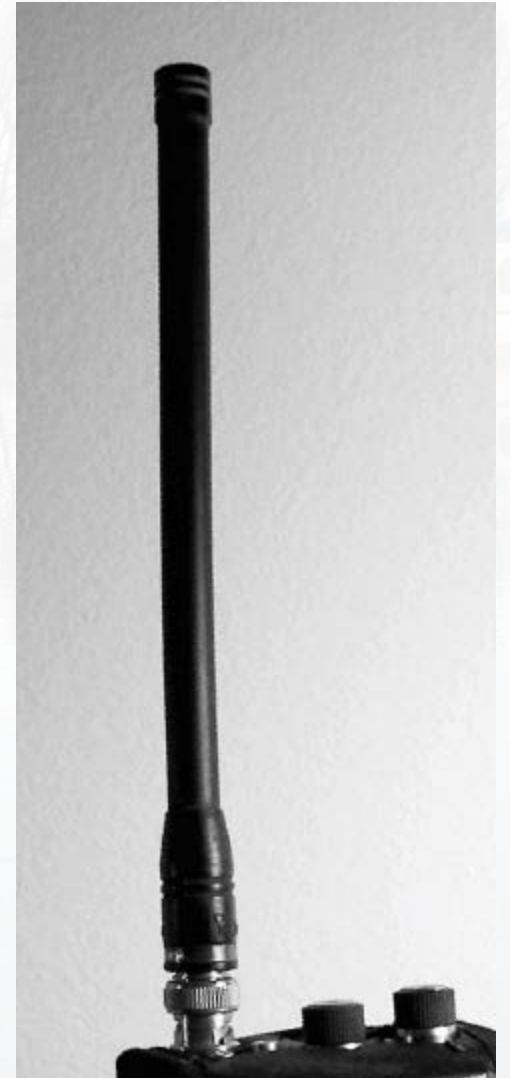
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October 18, 2023

Flathead Valley Amateur Radio Club

What is a Rubber Ducky Antenna?

- An electrically short antenna which functions somewhat like a base-loaded whip or monopole antenna
 - Used because a one-quarter wavelength antenna (3' long for VHF) over a ground plane is too long for easy portable operation
 - Repeater-based operation makes performance less critical
- Very flexible and resistant to damage, unlike the telescoping antennas which were previously used
- Two rumors link its name to the John F. Kennedy family:
 - One claims very young Caroline Kennedy pointed at a Secret Service agent's HT antenna and said, "Rubber Ducky".
 - The other rumor claims a NASA scientist named it after listening to one of Vaughn Meader's comedies about the Kennedys
- A popular alternative name is "stubby antenna"



Origin of the Rubber Ducky Design

- Originally designed for the 6m amateur band by Richard B. Johnson while a student at a reform school, the Lyman School for Boys
 - Johnson was well-acquainted with the harsh realities of the juvenile detention system in the late '50s and early '60s
 - His propensity for being a bit of a firebug got him in trouble
- His design was less than one-third meter long
 - Substituted for a vertical antenna which would have been 1.5m long
 - Wouldn't fit into his locker
 - Used a screen door spring with its length adjusted for resonance
 - Covered with a synthetic rubber hose
- At the time, portable radios used telescoping antennas which were clumsy in use and frequently broken

Anatomy of a Rubber Ducky Antenna

- Electrically short antennas have considerable capacitive reactance
 - An inductor (loading coil) is added in series to make them resonant
 - Antennas with these inductors built into their base are called base-loaded antennas or whips
 - In a Rubber Ducky, the coil is part of the antenna itself
 - The antenna is made of a narrow helix of wire, much like a spring
 - The helix is covered with rubber to protect it
 - Technically, it is a “normal-mode” helix which has broadside radiation which is omnidirectional
 - Maximum radiation is at right angles to the axis of the helix
 - For the typical monofilar design, the radiation is linearly polarized parallel to the axis of the helix
 - Rubber Duckies are typically 4% to 15% of a wavelength long
 - Has much less gain than a quarter-wave whip over a ground plane

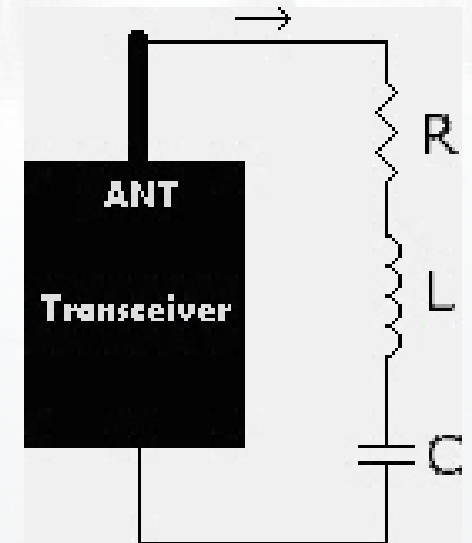


Performance and Design Considerations

- Has somewhat better performance than an equal length base-loaded antenna
 - With the inductance distributed throughout the antenna, there is somewhat greater current flow in the antenna
 - Difficult to fully characterize electrically because the current distribution is not sinusoidal as it is with a thin linear antenna
- Has a high “Q”, thus a narrow bandwidth
- Can be designed to cover a wide frequency range (e.g., 100-500 MHz)
 - If the coils have a large diameter relative to the length of the helix, the antenna will have narrow bandwidth
 - If resonant, the impedance will be well below 50 Ω
 - Narrow diameters will increase bandwidth
 - Performance declines significantly with wider bandwidth
 - If resonant, the impedance will increase towards 70 Ω
 - Tapered helix design can improve bandwidth while providing a better impedance match at the feedpoint
 - A good design can achieve an effective aperture comparable to a larger antenna
 - Aperture is the measure of the antenna’s ability to ‘capture’ power radiated towards it
- In general, single band Rubber Duckies work better than multiband

Performance and Design Considerations (cont.)

- Like most monopoles, a ground-plane or counterpoise is required
 - With HTs, the ground-plane is often only the metal chassis in the body of the HT
 - Modern HT construction typically uses nonconductive plastic/polymer for the case, reducing the effectiveness of the antenna by eliminating a conductive path to the user
 - Johnson mounted his design to a metal paint can to which there were four radials soldered to the can
 - Depicted here is the equivalent electrical circuit:
 - Lack of a good counterpoise seriously affects performance
 - A wire counterpoise can sometimes be added by the user
 - Make a loop of exposed wire around the HT's antenna connector
 - Screw the Rubber Ducky down good to hold it in place
 - With some quality HTs with OEM antennas, a counterpoise isn't helpful

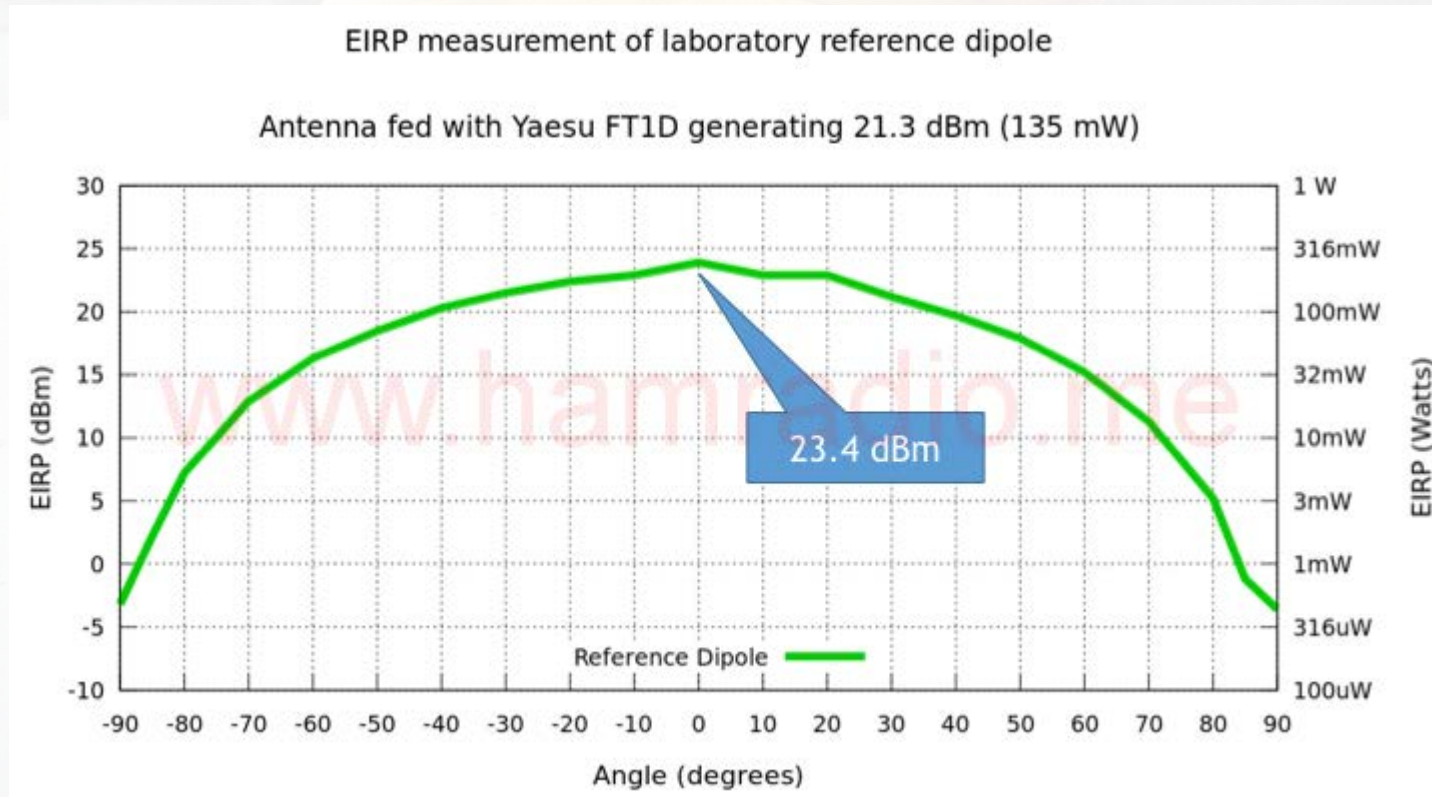


Real World Amateur HT Rubber Duckies

- Choosing an HT antenna often comes down to what sucks the least
- Measuring Effective Isotropic Radiated Power to compare antennas
 - EIRP is essentially equal to the power input to the transmitter's antenna multiplied by a theoretical isotropic antenna's gain which is '1' (0 dB)
 - Measure of the radiated power in the direction of the real antenna's "main lobe" when compared to the theoretical isotropic antenna which radiates equally and omnidirectionally
 - Measurements were taken by KX4O (John Huggins) in an antenna chamber with RF absorptive insulation using a laboratory reference dipole tuned to 146 MHz
 - A half-wave dipole has a gain of 1.64 (2.15 dB) compared to an isotropic radiator
 - As we'll see, Rubber Duckies all have negative gain compared to our reference antenna
 - KX4O tested the following antennas using the FT1D as the transmitter:
 - Laboratory reference dipole
 - Stock Yaesu FT1D antenna
 - Diamond SRH7&CA ¼ wave whip
 - MFJ-1714 ½ wave antenna
 - Tests were done using the FT1D packet beaconing mode on 2m
 - 135 mW (21.3 dBm)

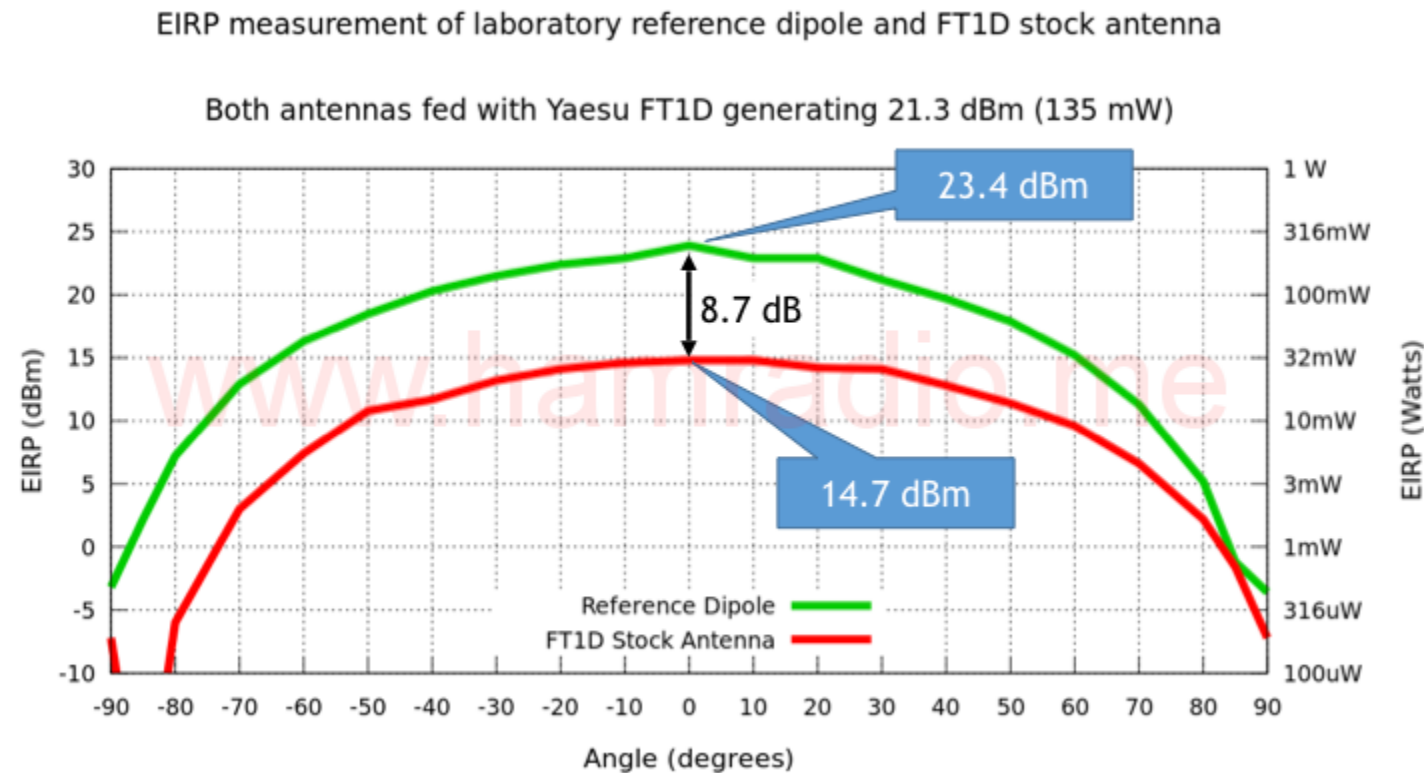
Laboratory Reference Dipole

- FT1D TX power used was 21.3 dBm (135 mW); Dipole gain = 2.15 dBi
 - Expected EIRP = 21.3 dBm + 2.15 dBi = 23.5 dBm
- Actual measured EIRP:



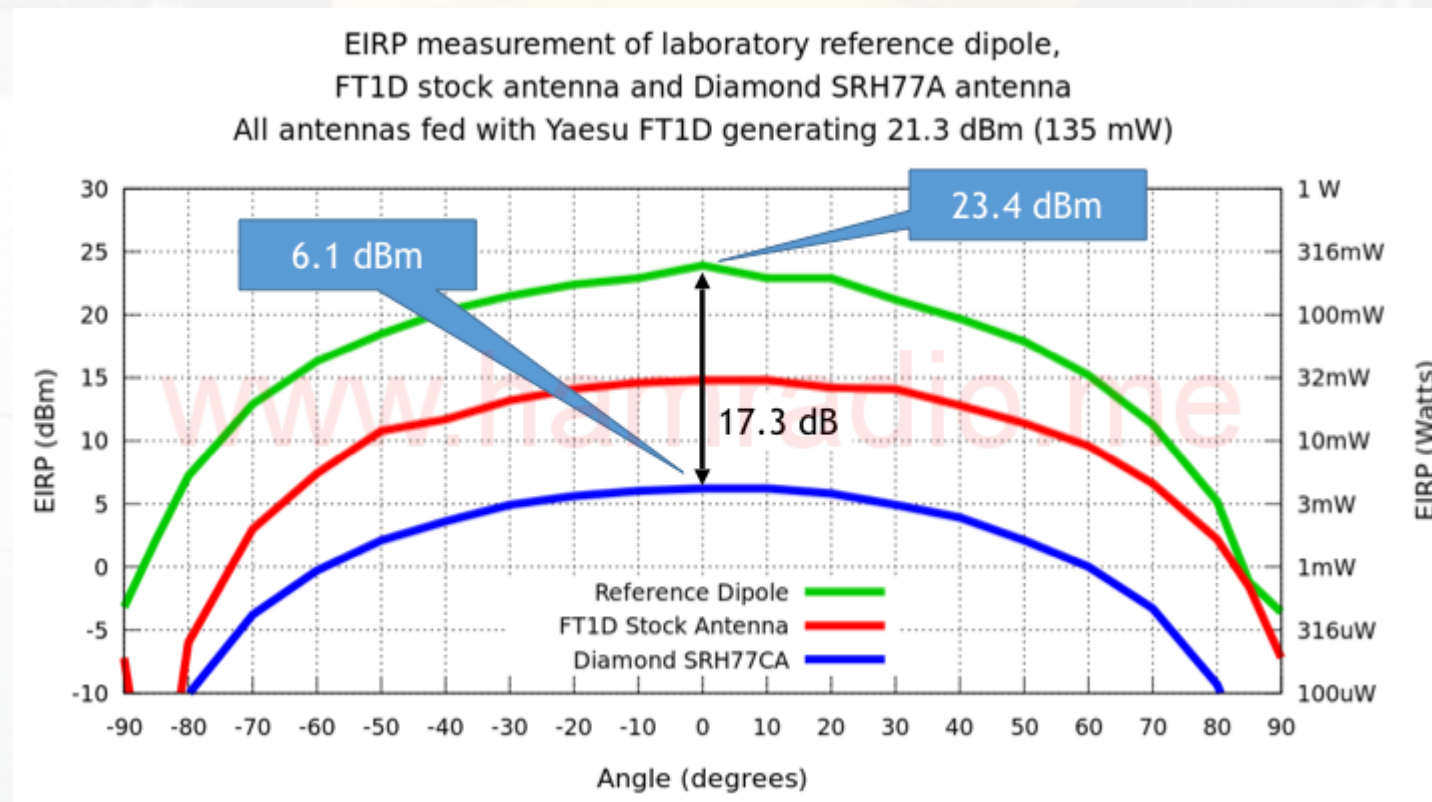
Yaesu FT1D Stock Antenna

- At almost 9 dB below the reference dipole, it can be seen that smaller antennas mean lower efficiency and less signal:



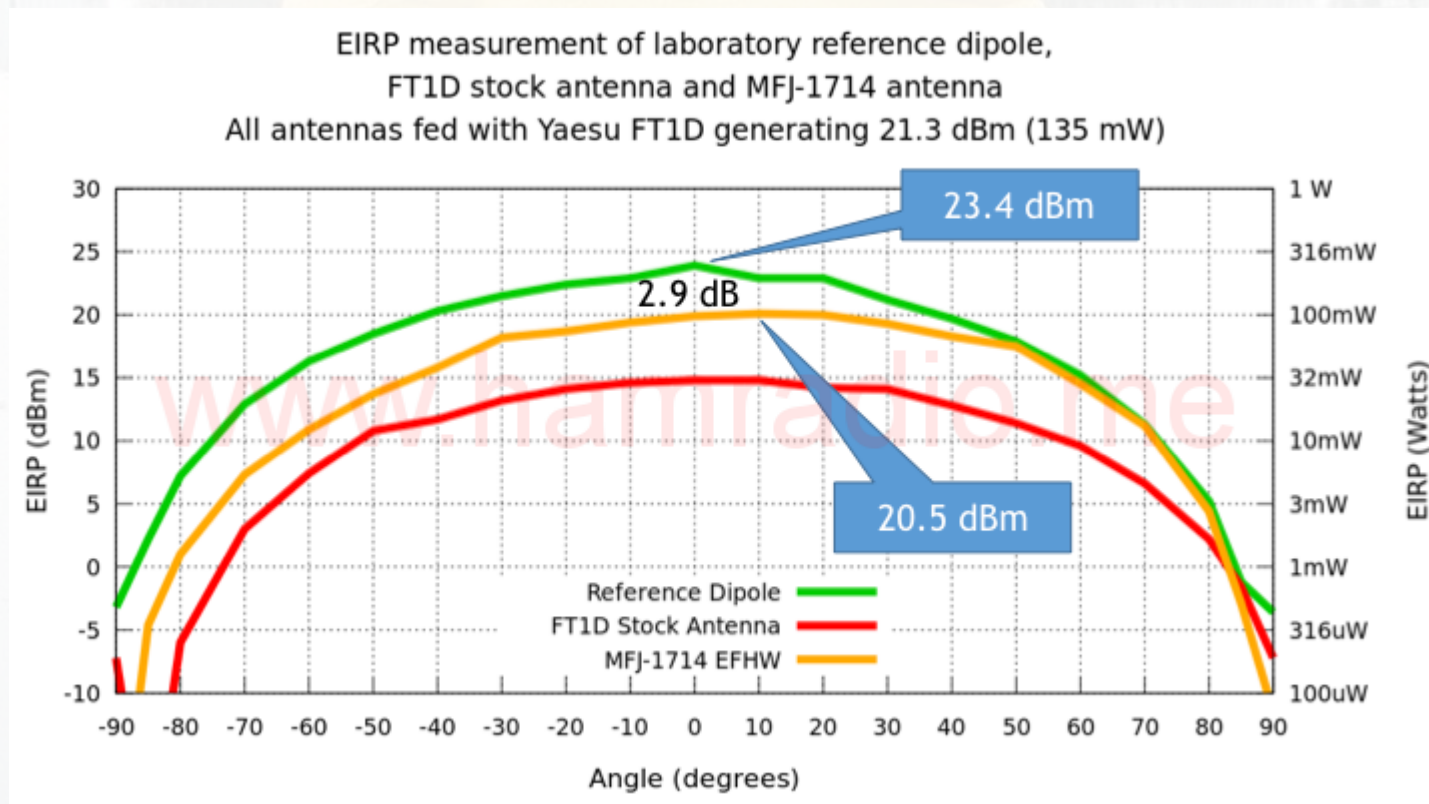
Diamond SRH77CA $\frac{1}{4}$ Wave Whip

- An obvious aftermarket antenna to test is the $\frac{1}{4}$ wave whip
 - The popular Diamond SRH77CA was chosen for this test
- The test results were pathetic, with a decline in gain of 17.3 dB relative to the dipole
 - The antenna seems to 'crave' the missing $\frac{1}{4}$ wave section
 - Holding the body of the FT1D improved reception of a distant repeater, versus setting the HT on a wood table
 - Diamond lists its gain as +6 dB, but relative to what, a dummy load?



MFJ-1714 ½ Wave End-fed Dipole

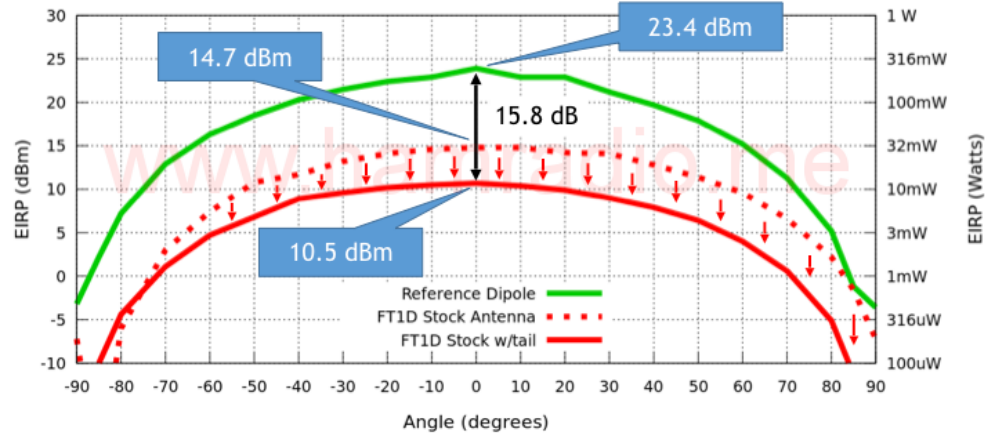
- The ½ wave antenna beats the FT1D stock antenna, but is it worth the trouble, given its size?
 - FT1D's stock antenna looks pretty good at this point
 - It and the MFJ-1714 put the Diamond SRH77CA to shame



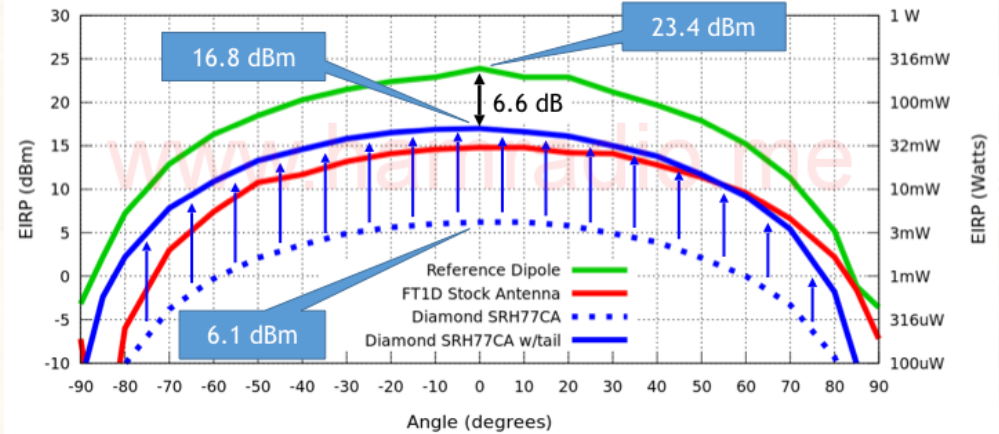
Results with 1/4 Wave HT "Tiger Tails":

EIRP measurement of laboratory reference dipole and FT1D stock antenna

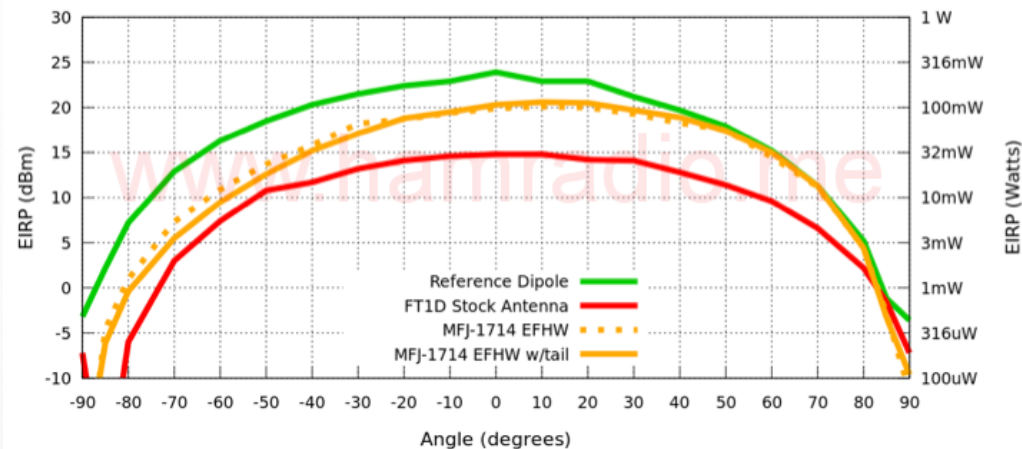
Both antennas fed with Yaesu FT1D generating 21.3 dBm (135 mW)



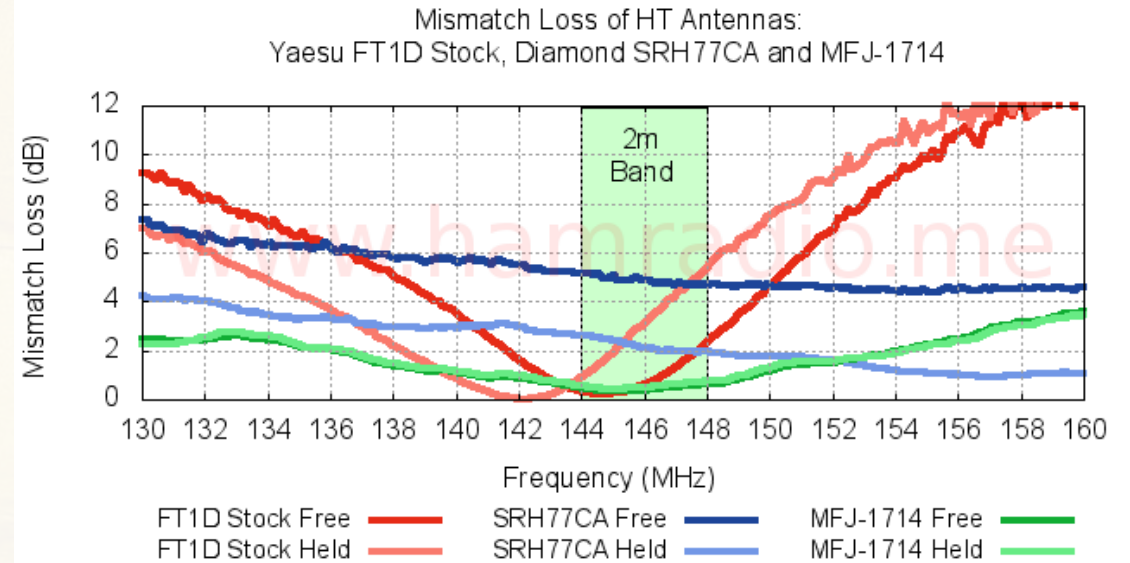
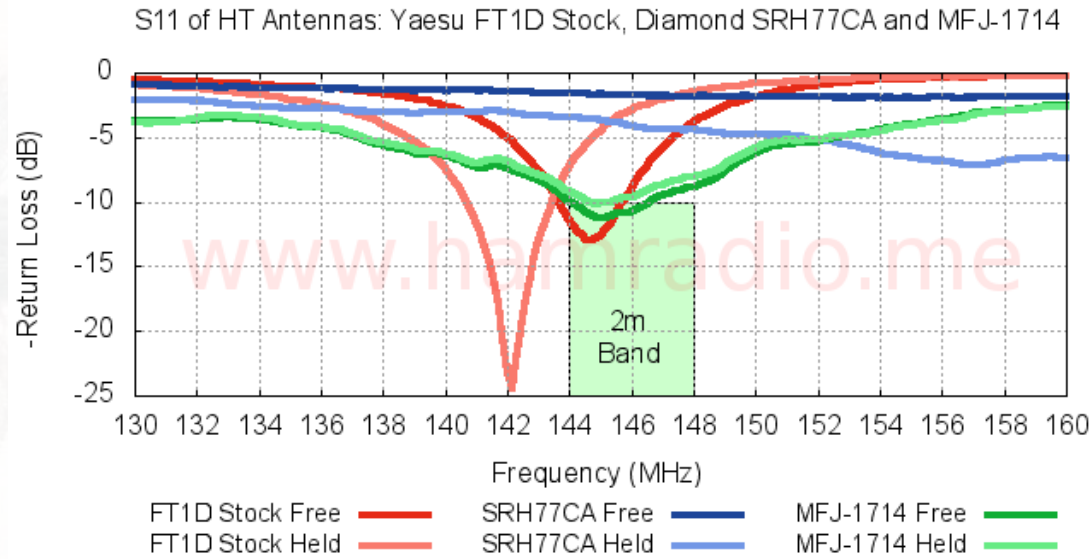
EIRP measurement of laboratory reference dipole, FT1D stock antenna and Diamond SRH77A antenna
 All antennas fed with Yaesu FT1D generating 21.3 dBm (135 mW)



EIRP measurement of laboratory reference dipole, FT1D stock antenna and MFJ-1714 antenna
 All antennas fed with Yaesu FT1D generating 21.3 dBm (135 mW)



Loss Factors



- **Observations:**

- HT antennas live a tough life electrically
- The best performer tested was the cumbersome MFJ-1714
 - Passable return loss across the band
 - Good resistance to variations in performance due to counterpoise effect
- The FT1D's stock antenna is a surprisingly good performer for its size
- The Diamond SRH77CA is a pathetic performer
 - It gained 10 dB in performance with a Tiger Tail, putting it in the range of the FT1D's much smaller Rubber Ducky without a Tiger Tail
 - Mismatch loss is high, likely due to transmitter foldback from its high SWR

Using an External Antenna with Your HT

- The “Slim Jim”
 - Essentially a flexible J-pole antenna which can be rolled up
 - Use thin coax such as RG58 or even smaller coax to connect it to your HT
 - Can be suspended from a tree or other object or taped to a wooden dowel
 - Keep at least two feet away from metal objects
 - Easy to build and tune
 - Good emergency antenna for your “go bag” and car

2 Meter Slim Jim
Using 300 Ohm
Twinlead

Trim off insulation at feed point down to bare wire. Do not cut conductor! Feed point located about 4" from bottom.

Center conductor of coax connected to longest side and Shield to short side. Adjust up or down equally for lowest SWR. Seal coax ends from water
Not drawn to scale

Use Rg58 style coax at antenna connections and from there use Rg8 type to xmtr

Twist and solder both wires together on each end! (Top and bottom)

Remove 1" of conductor for notch. This creates the lower J tuning stub.

58"

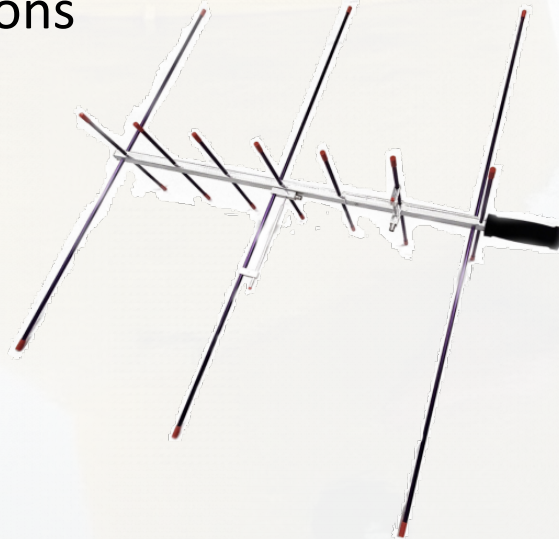
19"

Due to spacing of conductors with twinlead, small type coax suggested using short runs to transceiver

N4UJW

Using an External Antenna with Your HT (cont.)

- An HT can be used with any external 2m/70cm antenna with an adapter to connect it to the HT's antenna port
- To really extend the range to a distant repeater, use a directional antenna such as the hand-pointed Arrow Antenna
 - 2m monobander and 2m/70cm dual band versions
 - 3-element to 7-element versions
 - LEO satellite version



Arrow II Hand Held Portable
If Simple is Good, then this is Truly
Simply the Best

The Boom & Elements have plastic end caps for Safty.

The boom is square, but has rounded corners. The handle has a thick black foam grip for easy holding.

Assembly Instructions
Attach the elements to the boom, by screwing the elements together through the boom. Attach feed line to the BNC connector. That's it. The Antenna is pre-tuned and ready to go.

SPECIFICATIONS
No. Elements 7
Element spacing is .2 wavelength.
SWE 1.2:1
Maximum Power (because the antenna is hand held power should be kept to ~20 Watts)
Boom 3/4" Sq. (T6061 Aluminum)
Elements, Easton Aluminum Arrow Shafts
Gamma Match, Is attached to half of the driven element (comes pre-tuned).
Connector, BNC Only

UHF Gamma Match & Shorting Bar

Connector Block

Boom

How Good/Bad are Your HT Antennas?

- EIRP measurements are the most informative and require a sophisticated measuring environment unavailable to most amateurs
- SWR measurements are helpful to characterize relative performance differences between different HT antennas on the same HT
 - VSWR meter should permit the antenna to be close to the body of the HT for the most meaningful measurements
 - Surecom SW-33 Plus is small and inexpensive
 - About 4" long and around \$45
 - Weighs 5.65 ounces
 - Measures up to 100W forward power
 - Measures 1:1 to 19.99:1 SWR
 - 125-525 MHz frequency range
 - Rechargeable Li-ion battery
 - NOTE: A dummy load will present a good SWR
 - Some Chinese HT antennas have a 50Ω resistor inside
 - Always measure a newly purchased antenna, especially 'Nagoyas'



References

- 2 Meter Slim Jim Antenna Using 300 Ohm Twinlead
 - [2 Meter Slim Jim Antenna - 300 Ohm Twinlead Version \(hamuniverse.com\)](http://hamuniverse.com)
- The Survival Antenna (Kalispell Manufacturer – KF7AGO)
 - [Survival Antenna - Portable HAM Radio Antenna > Store \(thesurvivalantenna.com\)](http://thesurvivalantenna.com)
- N9TAX prebuilt Slim Jim antennas: [Shop \(n9taxlabs.com\)](http://n9taxlabs.com)
- Arrow II yagi antennas
 - [Arrow Antennas II Yagi 2m 70cm Portable Handheld Satellite](http://arrowantennas.com)
- Surecom SW-33 Plus
 - [SW-33 PLUS | SURECOM](http://surecom.com)
 - [Amazon.com: Mcbazel Surecom SW-33 Plus 100W 125-525 MHz Mini Digital VHF UHF Two-Way Radio Handheld Power & SWR Meter Black : Electronics](http://amazon.com)
- BAOFENGTECH is the official U.S. distributor for Nagoya
 - [Nagoya Antennas - BaoFeng Radios \(baofengtech.com\)](http://baofengtech.com)

A large yellow rubber duck is the central focus, floating in a calm body of water. The duck is highly detailed, with a prominent black eye and a pink beak. Its reflection is clearly visible in the still water below. In the background, a white boat is docked on the right, and a shoreline with trees and a building is visible on the left. The overall scene is peaceful and serene.

Q & A