

Sigma-280S

80/75 Meter 54' Sigma 2 element Yagi Antenna

FREQUENCY COVERAGE: 3.500-4.000 MHz , Tunable (40 kHz <2:1 VSWR)



Introduction

Released in the summer of 2003, the *Sigma-280S* is the smallest, finest 80/75 meter Yagi ever put into production. It is the product of about 9 years of development and the Sigma design is the new era in efficient antenna design for both horizontal and vertical antennas. Thanks to the members of Team Vertical and their years of competitive operating that eventually led to this design. *Sigma-280S* is composed of a pair of *Sigma-180S* dipole elements. One is the driver and the other is the reflector. Other than their tuning, they are physically identical. (Note: depending on the customer's available space, sometimes the "S" elements are extended to 58'.) The function of each element is determined by the tuning of each and that the coax feed line goes to the driver. This manual describes building each dipole element, the attachment to the boom of both and how to tune the antenna.

The *Sigma-280S* covers several segments of the 80/75 meter band with the 2-relay external switch box. The antenna is composed of two elements. Each has T-bar capacitive loading about 18' out on each side, plus large diameter, Hi-Q coils on each side of the feed point, providing the highest efficiency of any shortened antenna to date. The antenna is designed to present a low profile and withstand winds in excess of 90 mph.

The Sigma design uses elements that are about 44% mechanically full size and are made electrically full size with T-bar end loading, plus two center loading coils. The *Sigma-180S* dipole element is about 54' long, plus two (2) T-bars mounted part way out on the antenna. Each T-bar is 18' long and these add to the length of the dipole so that the equivalent length is about $54' + 18' = 72'$, or 56% of full size which is 25% more than without the T-bars – a

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significant enhancement. The dipole is made electrically resonant by adding inductance at the center using a pair of large coils, each made of 3/8" diameter tubing on a 5" core. This type of loading is quite effective, with an efficiency >93%. This is an excellent short antenna for 80/75 meters and when used in the *Sigma-280S* 2 element Yagi, the efficiency of the array still is good, dropping slightly to about 89%.

The *Sigma-180S* dipole design is superior to other shortened 80/75 meter antennas that employ mid-point loading. Mid-point placement of the coils on the element creates a current distribution that is not as favorable as the Sigma design. Additional disadvantages of using mid-point coils is the potential for arc-over at the coil, the covering can become ineffective over time (due to sunlight and weather) and the structure itself (the coil form) is vulnerable to fatigue from the ever-present wind, stress and vibration. The inboard, center loading location is superior in both electrical and mechanical aspects. The operating bandwidth of the *Sigma-180S* dipole is narrow, because of its high Q. For its short physical length, the bandwidth is about the same as though it were 72' long.

The construction of the *Sigma-180S* dipole uses all tubing. The coils are in series with each side of the dipole and are enclosed with a large diameter styrene cover. The elements are also trussed using non-conductive line for added strength.

The power limit for this antenna is in excess of 5KW, with the limiting factor being the balun used to feed the driver. The next limiting factor is the 30 amp relay contacts in the CW/SSB switch box. To date, these relays have been used in many applications for more than 10 years with no failures except for a lightning strike. The feed point is matched to 50 ohms using a hairpin (coil) match.

The *Sigma-280S* is not a large antenna, but care should still be taken during installation. The T-bars add another dimension, so be aware of their presence. Knowing it is possible that not everyone who has acquired the *Sigma-280S* is necessarily familiar with shortened dipoles, it is suggested that a good book, such as the [A.R.R.L. Antenna Book](#) be utilized for further information. Of course, one can always proceed directly and assemble the *Sigma-280S*!

Feed System and Antenna VSWR

The *Sigma-280S* feed system is straightforward. The feed point is less than 50 ohms and is stepped up using a simple hairpin coil across the feed point. The hairpin and balun are connected to the feed point end of the relay box and the other end of the box is connected to the feed point terminals on the driver element on the antenna. Since this is a balanced antenna, it should be fed through either a 1:1 balun (such as the Force 12 B-1, B-1/C), or a suitable RF choke. The reflector element has a similar relay box in series at the center. The far side of the box (where the balun is attached on the driver) is jumpered across with a short wire. The relays (i.e. relay #1 in each box) in both boxes are switched simultaneously (in parallel).

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The VSWR curves for the *Sigma-280S* allow coverage of about 40-50 kHz at the 2:1 points. Adding the flexibility of the relay box, this gives the antenna 4 segments of about this width. Two (2) are normally on CW and two (2) are normally on phone; however, all four (4) segments can be set for phone. As a short note, a low or high VSWR does not necessarily mean that an antenna works or not. A fine book addressing this is Reflections, published by the A.R.R.L.

Each element is set to the correct operating frequency by adjusting the spacing between turns on the two, large coils. The hairpin match is adjusted for the best match (usually 1:1) on the driver at the desired frequency. The input impedance at the feed point is much less than 50 ohms (about 16 ohms) and is stepped up to 50 ohms by using the hairpin match mounted across the feed point. This hairpin is in the form of a "helical hairpin", or coil, as a typical hairpin would be physically too large. The match to 50 ohms is adjusted by making the spacing on the coil wider or narrower. Adjustment at the low phone position is normally sufficient for all operating segments.

Mechanical Overview

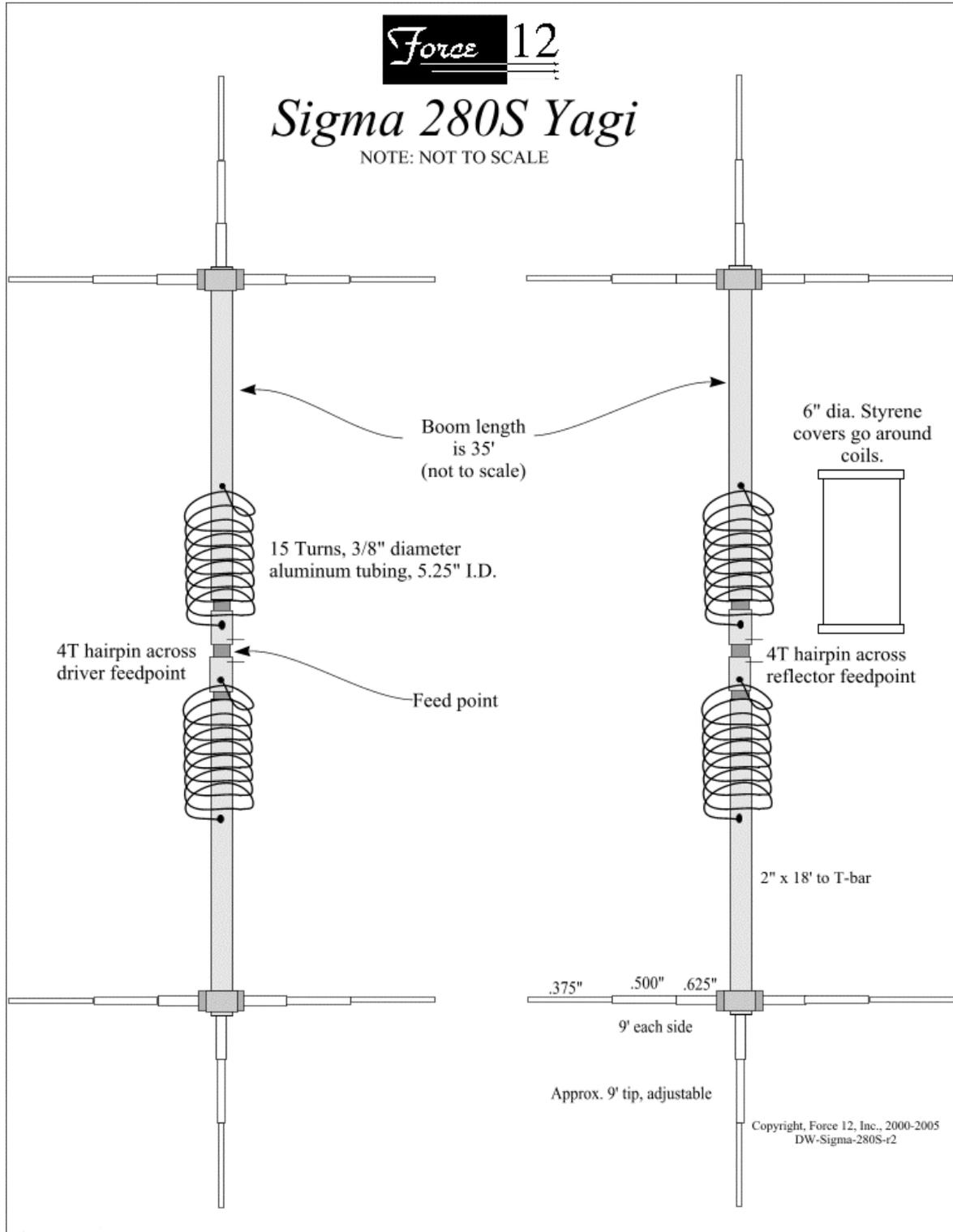
The mechanical design of the *Sigma-280S* is a pair of *Sigma-180S* dipoles attached to a mounting plate on each end of the boom. The non-conductive truss is attached to the element and to the center riser post on the element mount. The element tubing segments are both bolted and riveted. The bolted joints are on the larger tubing and the riveted joints are on the tips and the T-bars. The riveted element is a Force 12 "first" and identifies the product. The antenna can be fully assembled, tuned at a reasonable height (20-25' minimum) and then mounted in place.

The elements are insulated from the plates and the mast. Connection to each element is through a pair of 10-24 stainless machine screws. **As previously mentioned, since this is a balanced antenna and coaxial line is unbalanced, a means to choke off antenna current from the outside of the coax feeding the driver element should be used.** Two devices are fine: one is an RF choke, made by winding several turns of the coax in a circle close to the feed point; or, a 1:1 balun, such as the Force 12 B-1, can be used.

Most of the hardware is stainless steel. It is type 304, not 18-8, which is only rust resistant. The plated hardware is used for the element-to-boom bracket installation, with stainless lockwashers and nuts to enable removal. Stainless U-bolts are not necessary, except in extreme environments and a preferred method is to paint these parts. Stainless hardware is easy to gall, meaning to freeze the nut on the shaft, rendering the bolt useless. If all stainless is required, please contact the factory. The entire antenna can be painted to eliminate any glint in the sun, although methods have been employed to limit glint already. For example, the tubing is all 6061-T6, with a matte finish.

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Principle Design





Sigma-180S

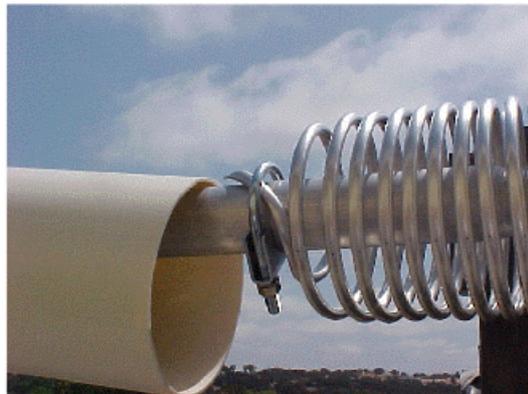
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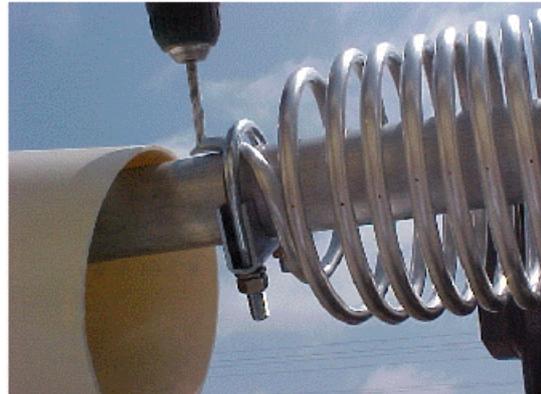
Feed point bolts are at 45 degrees.
(Other set of holes is production use.)



U-bolt around PVC without saddle.
Note slot in PVC is in air gap.



U-bolt and saddle around far end of coil for
coil adjustment. Coil length of approx 12" will
set to CW and expanding to 14-15" for phone.



After setting frequency, drill through with 1/4"
drill and secure end with 1/4-20 bolt, lock washer
and nut. Fine tuning can be done by compressing
and expanding coil after being secured.



Drill drain holes in bottom of cover. Seal around tubing and
around cover with silicone sealer.

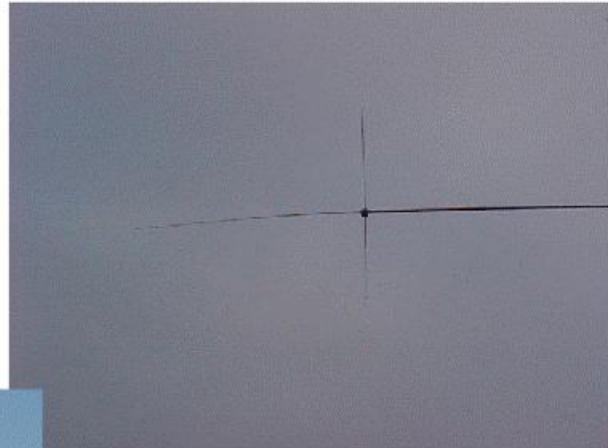
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Assembly Photos - Page 4



T-bars at end of element.



180S element on Sigma 280S Yagi.
Covers are painted gray.
Relay box is at center of element.
Non-conductive element truss
is above.



Sigma 280S Yagi
(Two Sigma 180S elements.)

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Center of driver element on Sigma 280S



T-bar at end of element on Sigma 280S