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Cubic Astro 102BXA Transceiver

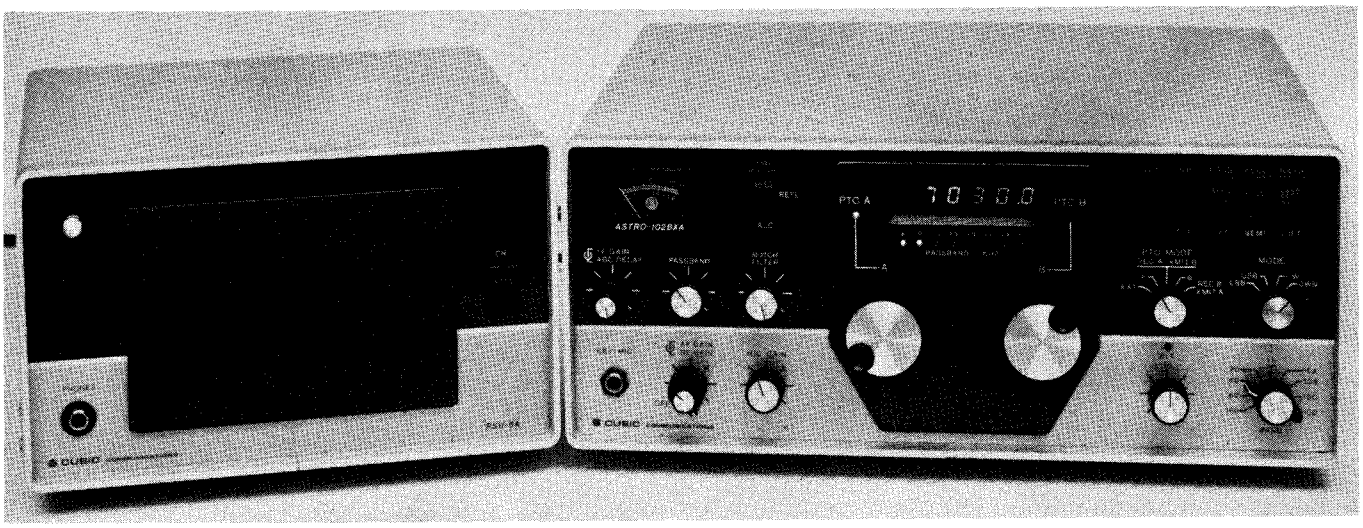
Cushcraft 20-4CD Skywalker 20-Meter Monoband Yagi Antenna

Kenwood TR-9000 Multimode 144-MHz Transceiver

Product Review

Conducted By Paul K. Pagel,* N1FB

Cubic Astro 102BXA Transceiver



American made? Yes, indeed! The Astro 102BXA (formerly Swan/Astro) is built by a tenured engineering firm, Cubic Corporation, of Oceanside, California. The manufacturer once stated that "75 of our engineers were involved in the design of the Astro." Those who subscribe to the "buy American" doctrine should be pleased with this product.

If your buying urge is stimulated by the presence of dazzling geegaws, this rig may not be for you. But if truly functional and important operating features inspire you, the 102BXA might be what you've been waiting for. It has what the operator needs, and nothing more.

Coverage is from 160 through 10 meters in six bands. This transceiver is completely transistorized (inclusive of ICs and diodes). Twin PTOs are included to provide split-band operation when desired. Other features are variable agc time constant, passband tuning, and separate controls for rf and i-f gain. It also has RIT, selectable break-in delay or full QSK, noise blanker and speech processor. The panel meter indicates forward and reflected power in watts, alc level and the relative strength of incoming signals.

A large red digital display provides readout of the operating frequency to six places, such as 21,025.3 kHz. An eight-level LED string shows the status of the passband tuning from 0.6 to 2.7 kHz. There is also a notch filter that is adjustable from the front panel of the transceiver.

The passband-tuning control sets the i-f bandwidth with either a high-pass or low-pass cutoff. Clockwise rotation of the control attenuates low-frequency audio, while counterclockwise rotation reduces the high-frequency response. The LEDs mentioned earlier indicate the effective audio passband of the receiver. I learned that the control needs to be set for approximately 1.0 kHz or higher when the sharp cw accessory filter (300 Hz) is being used. Otherwise, no cw beat note is heard.

The microphone impedance is specified as 47,000 ohms. A key jack is located on the rear panel of the transceiver, but the PTT line (accessible at the mike jack) can also be used as a keying-control line.

Other connection points on the rear apron of the equipment are EXT RELAY, EXT MODULATION, EXT LO, ANTENNA, GND and EXT SPEAKER. There is a built-in speaker, plus provision for an external one. The EXT MODULATION jack provides an interface for AFSK, and the MIC GAIN control on the front panel is used in that mode to control the level.

The speech-processor action is determined automatically by the setting of the MIC GAIN. There is no separate external adjustment for the processor. Similarly, the noise blanker is factory-adjusted. It has no external threshold control. Carrier-level control during cw operation is provided by the MIC GAIN control.

I am mystified by the presence of a SOFT/HARD keying switch qn the transceiver front panel. The keying waveform in the "hard" position is what we at ARRL consider objectionable in terms of clicks (see Fig. 3). The "soft" position yields an excellent waveform, closely approaching the desired 5-ms rise and fall times that result in click-free keying. That panel switch might have been put to better use as a CARRIER LOCK control, which has not been included in the design. This makes tune-up difficult unless the keyer has a "carrier hold" switch.

Other features that aren't present in the Astro 102BXA are a crystal calibrator or WWV band-switch position. Fortunately, the 40-meter coverage is from 7.0 to 7.5 MHz, which permits reception of Canada's CHU time/standard station in some areas of the country.

The internal switching feature for an external amplifier is compatible with the manufacturer's Astro 1200Z and 1500Z amplifiers. Unfortunately, the internal solid-state switching circuit is limited to a maximum of + 200 V and 200 mA. Therefore, most amplifiers of different manufacture can't be switched by the Astro 102BXA — at least not directly. I had to interface the transceiver with my Heath SB-221 by means of an external relay that was actuated by the solid-state switch in the Astro. A 12-V dc relay can be used (low-current coil), and power for it can be borrowed from the + 12-V bus in the transceiver. If an external relay is used, it will negate the use of full QSK since many control relays will not follow the cw speeds that are used by most operators.

I was impressed with the skirt selectivity of the i-f system. The variable passband tuning of the receiver complements the i-f filters to reduce wideband noise and enhance the effective selectivity. In fact, acceptable cw selectivity can be had when using the ssb i-f filter by ad-

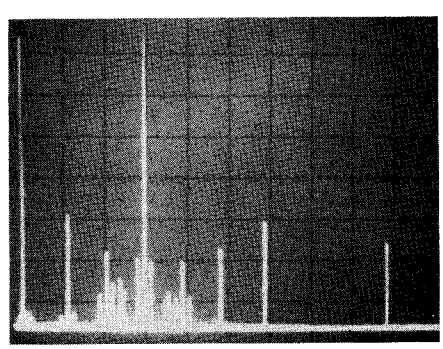


Fig. 1 — Worst-case spectral display of the Cubic Astro 102BXA. Vertical divisions are each 10 dB; horizontal divisions are each 10 MHz. Output power is approximately 100 watts at a frequency of 28 MHz. Spurious emissions are at least 49 dB down from peak fundamental output. The Astro 102BXA complies with current FCC specifications for spectral purity.

*Assistant Technical Editor

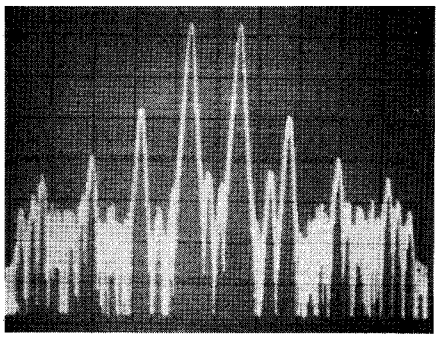


Fig. 2 — Spectral display of the Astro 102BXA output during transmitter two-tone IMD test. Third-order products are 28 dB below PEP, and fifth-order products are 39 dB down. Vertical divisions are each 10 dB; horizontal divisions are each 1 kHz. The transceiver was being operated at rated input power on 14 MHz.

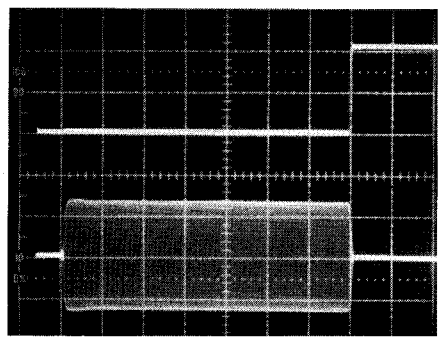


Fig. 3 — Cw keying waveform of the Astro 102 with the selection switch in the "hard" keying position. The upper trace is the actual key closure; lower trace is the rf output envelope. Each horizontal division is 5 ms. This waveform will generate key clicks.

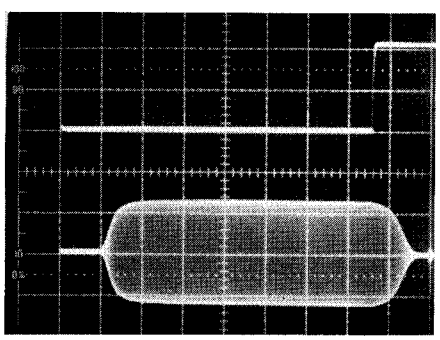


Fig. 4 — Cw keying waveform of the Astro 102 with the selection switch in the "soft" keying position. The upper trace is the actual key closure; lower trace is the rf output envelope. Each horizontal division is 5 ms. This waveform is essentially click-free.

justing the variable passband control to the counterclockwise end of its range.

Cw offset is 800 Hz. In the sharp cw mode (300-Hz accessory filter installed), the cw filter is operated in series with one of the two 8-pole ssb filters. This greatly reduces wideband noise from the i-f amplifiers and provides an apparent improvement in overall receiver signal-to-noise ratio. During ssb operation the two 8-pole filters are in use. The ssb filters have a bandwidth of 2.4 kHz, and the shape factor is 1.4, referenced to the 6- and 100-dB points on the response curve.

Cubic Astro 102BXA HF Transceiver Serial No. 659

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 160, 80, 40, 20, 15, 10 meters.	As specified, plus additional coverage above and below each band: 1378-2106 kHz; 3379-4106 kHz; 6879-7606 kHz; 13,878-14,606 kHz; 20,878-21,606 kHz; 27,878-30,106 kHz.
Operating modes: Cw and ssb.	As stated.
Readout: Digital (red LEDs).	
Resolution: 100 Hz.	25 kHz per 360° turn of tuning knob.
Backlash: Not specified.	Nil.
Power requirements: 12-14 volts dc, negative ground, 20-A peak.	As stated.
Transmitter rf power output: 100-W PEP into 50-ohm load at 13.5 V dc.	80/40 m = 125 W; 20/15 m = 108 W; 10 m = 100 W.
Transmitter third-order IMD: Not specified.	Approximately −28 dB (worst case) on 20 m (see photo).
Spurious suppression: 55 dB below peak power.	Approximately 49 dB (worst case), 10 m (see photo).
Harmonic suppression: 45 dB below peak power.	Approximately 50 dB (worst case), 10 m (see photo).
Frequency stability: Not specified.	80 Hz from cold start to one hour later.
Receiver audio output power: Greater than 3 W into a 4-ohm load.	Not measured.
RIT range: Not specified.	±1 kHz.
S-meter sensitivity (μV/S9): Not specified.	160 m = 85; 80 m = 65; 40 m = 55; 20 m = 50; 15 m = 50; 10 m = 75.
Receiver sensitivity: 10 dB S + N/N, 0.35 μV typ.	Receiver dynamics measured with optional 300-Hz crystal filter installed:

	80 m	*20 m*
Noise floor (MDS) dBm:	−125	−129
Blocking DR (dB):	*	*
Two-tone, third-order: IMD DR (dB):	90	84
Third-order input intercept (dBm):	−10	−3

Size (HWD): 6-3/8 × 14-1/4 × 13-1/4 in.
Weight: 23-1/2 lb.
Color: Not specified.

[1]mm = in. × 25.4, kg = lb × 0.454.

*unmeasured — noise limited.

Other Features

The transmitter is rated at 100 watts output for peak ssb and cw. Power output is limited to this level by the alc circuit. Available output power is 100% of this amount with VSWR values up to 1.7:1 at 50 ohms. It drops to 60% when the VSWR is 3:1. During an open or short condition the factor is 25% (equivalent voltage). A built-in VSWR sensor causes the foregoing shutdown power amounts to protect the PA transistors from damage.

Mobile operation is possible from the automotive dc-voltage system. The safe operating range is specified as 10 to 15 volts dc. Apart from the fairly large dimensions of the Astro 102, it is well suited to mobile use because it employs broadband tuning in the receiver and transmitter sections. Only minor adjustments are necessary when changing bands. The receiver is a single-conversion type with a 9-MHz i-f. Five weak birdies were noted in the receiver tuning range.

Those wishing to have full RTTY capability, plus inclusion of the WARC-sanctioned 10-, 18- and 24-MHz amateur bands, may want to consider purchasing the Astro 103BXA transceiver. The 102 and 103 models are otherwise identical. Price class: $1200. Manufactured by Cubic Communications, Inc., 305 Airport Rd., Oceanside, CA 92054. — *Doug DeMaw, W1FB*

KENWOOD TR-9000 MULTIMODE 144-MHz TRANSCEIVER

☐ If you read the survey article in March 1981 *QST*[2] carefully, you may have been surprised to learn how much activity was reported on "vhf/uhf, a-m/cw/ssb." Of the survey respondents active in Amateur Radio, 18% said they averaged at least an hour of such activity per week. For comparison with other vhf/uhf figures, the percentage for fm was 48%, for "other modes" 3% and for satellite communications (where cw and ssb are also used), 2%. Numbers like that make it easy to understand why new vhf transceivers with multimode capability keep popping up in the marketplace. (Less easy to understand is why Japanese manufacturers have totally dominated this particular market, but that's another story.) Not surprisingly, 2 meters has been the most popular band for the vhf multimode rigs, as it has been for fm rigs.

In the past, these multimode transceivers generally could be characterized in two ways: whether they were designed primarily for fm or for ssb, and whether they were designed primarily with fixed station or mobile operation in mind. If a rig is intended mainly for ssb, it will give the operator a "feel" very similar to a conventional high-frequency transceiver; if for fm, it will have the features you have come to look for in a sophisticated fm rig — ease of selection of the most frequently used channels,

[2]D. Sumner, "Survey of Amateur Radio, 1980," *QST*, March 1981, pp. 11-18.

Kenwood TR-9000 Transceiver Serial No. 0121075

Manufacturer's Claimed Specifications	*Measured in ARRL Lab.*
Frequency coverage: 144.0000 to 147.9999 MHz.	143.9000 to 148.9999 MHz.
Modes of operation: Fm, usb, lsb, cw.	As specified.
Frequency readout: Digital; 5-digit, red LED display, 100-Hz resolution.	0.3 inch digits.
kHz/turn of knob: Not specified.	5 kHz or 500 kHz (cw/ssb); 5, 250 or 500 kHz (fm).
RIT range: ± 1 kHz.	± 2.5 kHz.
S-meter sensitivity: Fm—Full scale occurs at 15 μV; ssb — S9 = 5 μV.	As specified. S9 = 2.5 μV. S9 = 6.5 μV.
Receiver sensitivity: Fm—0.5 μV for 30 dB signal-to-noise; ssb — 0.25 μV for 12-dB SINAD.	0.26 μV for 20-dB quieting. As specified.
	Noise floor (MDS) dBm: −132
	Blocking DR (dB): 122
	IMD DR (dB): 76
	Third-order input intercept (dBm): −18
Transmitter power output: 10 W.	Fm: 14 W. Ssb: 10 W PEP.

Size: (HWD) 3 × 6-7/8 × 9-3/4 in.
Weight: 5.5 lb.
Manufacturer: Trio-Kenwood Communications, Inc., 1111 West Walnut St., Compton, CA 90220.
Price class: $500.

adjustable output power level, scanning and the like. If the manufacturer expects you to put the rig under the dashboard of your car and leave it there, it will be a lightweight, low-profile package sans ac power supply.

Kenwood was one of the earliest and most successful of the entrants into the vhf multimode fray. The TS-700A was introduced to North America in 1975[3] and was soon followed by the TS-700S[4] and TS-700SP. There was no question but that these rigs were intended primarily for home-station use and that they had been designed with ssb operation in mind.

It is much more difficult to classify Kenwood's current entry, the TR-9000, in the multimode sweepstakes. It appears that Kenwood designers hoped to make the rig be all things to all people. The basic rig is much smaller, and is quite a bit less expensive, than the TS-700 series, and it has features undreamed of just a few years ago. On the other hand, these improvements have not come without a penalty, especially for the operator whose main interest is something other than fm.

[3]"Kenwood TS-700A 2-Meter Transceiver," Product Review, *QST*, March 1976, p. 38.
[4]"Trio-Kenwood TS-700S 2-Meter Transceiver," Product Review, *QST*, Feb. 1978, p. 31.

Description

The TR-9000 is all solid-state and is rated at 10 watts rf output on fm, cw and ssb (upper or lower sideband). It is designed to operate from a nominal 13.8-V source; an external ac power supply is an option. Other options available include a "system base" for added convenience in fixed-station operation and an external speaker (although the internal speaker, mounted in the bottom of the transceiver case, is entirely adequate unless the bottom of the case is blocked). There is no provision for VOX operation.

Frequency coverage is 143.9000 to 148.9999 MHz, in steps of 100 Hz, 5 kHz or 10 kHz. The step rate is selectable from the front panel (you'll figure out how to do it in the first few minutes you use the rig, but two switches, neither one adequately labeled, are involved, and explaining the maneuver is something else again!). The 100-Hz step rate translates to 5 kHz per revolution of the main tuning knob, which is much too slow for casual tuning around on ssb or cw, but the 10-kHz step rate (5 kHz is not available in the ssb and cw modes) will cause you to miss stations on these two modes.

The frequency control selects the receiver frequency, the transmitter being on the same frequency or 600 kHz higher or lower depending on the position of the TX OFFSET switch. Five memories are provided, one for operation with any split (e.g., something other than 600 kHz). A useful feature on many fm rigs is the ability to swap the receiver and transmitter frequencies at the flick of a switch to permit monitoring of a repeater input or to make it easy to use "inverted" repeaters; this is not a feature of the TR-9000. Rapid switching from fm to ssb, or between frequencies that are not programmed into memory, is facilitated on this Kenwood rig by a pushbutton that shifts the VFO between two independently selected settings.

The main tuning knob is not the only way to select the operating frequency. Two push buttons on top of the hand-held microphone are used to move the frequency up or down one step at a time, or more rapidly if a button is held down for a couple of seconds. A "beep" will be heard each time a button is depressed, which may be annoying under some circumstances. Unfortunately, in mobile operation the "beep" may be the only indication you have of your operating frequency, because the red LED frequency display is unreadable in bright sunlight.

An interesting feature of the TR-9000 is its scanning capability. The normal method of operation is to put the transceiver in the fm mode and to let it scan up in frequency to the first busy channel. It takes about 90 seconds to scan its entire range in 5-kHz steps. Narrower limits cannot be set; you must scan the entire range. The memories cannot be scanned. On ssb/cw there is no provision for stopping automatically on a busy frequency, and because it takes so long to scan in 100-Hz steps, you are more likely to use a special feature that permits the scanning of a 10-kHz segment than to scan the whole band. This feature lets you scan between, for example, 144.190 and 144.200 MHz, but not between 144.195 and 144.205 MHz; the limits must be integral multiples of 10 kHz.

Other features of interest include an rf gain control, noise blanker, receiver incremental tuning, combination signal strength and relative power output meter, and rear-panel jacks for a tone pad and back-up power supply (to retain memory when the main power is disconnected).

All on-the-air reports received during the testing period were complimentary. On receive, the time constants in the agc circuit switch automatically from slow, for ssb, to fast, for cw; the recovery time on ssb is slower than many operators would prefer. While it's difficult to quantify, the "feel" of the controls and the ruggedness of the physical package give the impression that the rig should provide years of trouble-free operation.

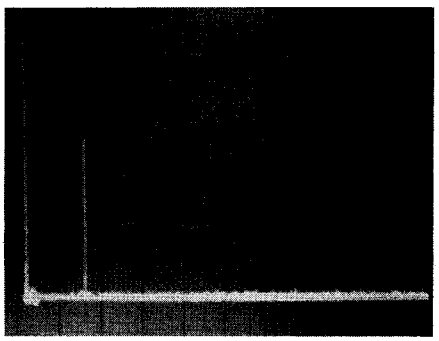


Fig. 5 — Spectral display of the Kenwood TR-9000. Vertical divisions are each 10 dB; horizontal divisions are each 100 MHz. Output power is approximately 10 watts at a frequency of 146 MHz. The fundamental has been reduced in amplitude approximately 32 dB by means of notch cavities; this prevents analyzer overload. The TR-9000 complies with current FCC specifications for spectral purity.

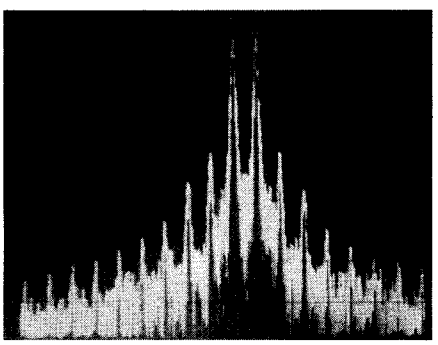


Fig. 6 — Spectral display of the TR-9000 output during transmitter two-tone IMD test. Third-order products are approximately 33 dB below PEP, and fifth-order products are 43 dB down. Vertical divisions are each 10 dB; horizontal divisions are each 2 kHz. The transceiver was being operated at 10 watts of PEP output on 146 MHz.

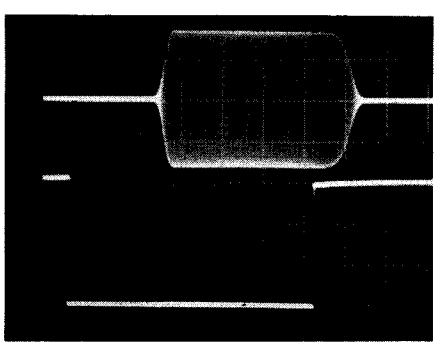


Fig. 7 — Cw keying waveform of the TR-9000. The lower trace is the actual key closure; upper trace is the rf output envelope. Each horizontal division is 5 ms.

Summary

If you're interested primarily in fm but would also like to have ssb and cw capability in a box no larger than most single-mode rigs, you will want to give serious consideration to the TR-9000. On the other hand, if you're interested mostly in OSCAR or in the low end of the band, you're likely to be disappointed at what has been left out of the box in the interests of compactness and economy. — *David Sumner, K1ZZ*

CUSHCRAFT 20-4CD SKYWALKER 20-METER MONOBAND YAGI ANTENNA

☐ Regardless of attempts to improve the triband Yagi, monobanders are still accepted as "the way to go" for top performance. Cushcraft's most recent offering in this category is the new Skywalker line of computer-designed 3- and 4-element Yagis. The 20-4CD tops the line, providing 4 elements wide-spaced on a 32-foot, 8-inch boom. As expected, the Skywalker is quite a large antenna; it weighs 55 pounds and has a wind surface area of 8.1 square feet. The longest element is 36 feet, 1 inch, and the turning radius is 23 feet, 8 inches. Because of its massiveness, it is recommended that the Skywalker be mounted only on towers of considerable loading capacity, and that a heavy-duty rotator and braking system be used as well.

Construction

The 20-4CD is shipped in two boxes. All small parts are neatly packaged in plastic bags, making a check of the contents quite painless. The materials used are all first quality — 6063-T832 aluminum for the elements and boom, with cadmium-plated hardware used throughout. Element clamps are stainless steel, excluding the worm gear, leaving some potential for corrosion after extended periods in harsh-weather areas.

Construction is quite simple using Cushcraft's method of assembly. All elements and boom sections are premeasured and marked at the factory. All one must do for assembly is slide matching pieces together up to the proper mark, then tighten the clamps. Just to make sure, the element lengths were checked with a tape measure and found to be exactly as specified.

The 20-4CD Skywalker is fed with 50-ohm coaxial cable through a gamma match, which Cushcraft refers to as its "Reddimatch." Adjustment is carried out with the aid of an SWR indicator or wattmeter. A single aluminum slider is moved to achieve the best possible match. The adjustment must be carried out with the antenna elevated above ground level. Even though this is a full-sized antenna, construction time was only four hours.

Testing

Following assembly, the antenna was installed atop a 60-foot self-supporting tower. During installation, the Yagi had to be moved from a horizontal position to a vertical one, and considerable flexing was noticed in the boom. Cushcraft has chosen to use small-diameter tubing for the boom to keep weight and wind loading to a minimum. While the vast majority of antennas this size have 3-inch O.D. booms, the Skywalker has 2-1/8 inch O.D. tubing for the boom. Although the antenna has held up to summer thunderstorms, heavy winter icing and high winds may leave a small mechanical safety factor. It should be noted that the boom *is* strengthened by the use of two struts that join it to the mast above. This is standard procedure on long booms; however, it is not a good substitute for larger diameter aluminum tubing. The additional strength offered by a 3-inch boom overrides the disadvantages of added weight and windloading in this antenna class.

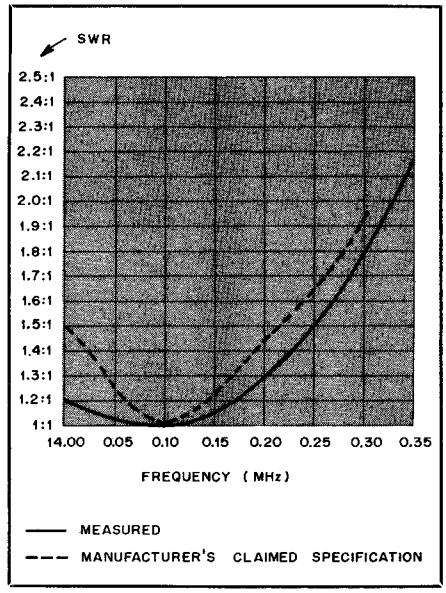


Fig. 8 — SWR curve of the Cushcraft 20-4CD.

An initial test was gratifying. Reflected energy was within manufacturer's specifications in the cw band for which the antenna was set. (The antenna may also be optimized for the low or high end of the phone band.) No additional tuning of the gamma match was necessary in this case. Although optimized for cw, the Skywalker provided a good match across the entire band.

Performance

It has been a couple of months since the Skywalker was put into use, and the performance has been exceptional. Practically any DX pileup can be cracked with very little effort — many with only one call. Repeated testing with other local amateurs using triband Yagis at the same height has shown the superiority of the Skywalker. Signals emanating from the monobander are consistently louder than those from the tribanders, and often by a considerable margin. At no time did the tribanders provide a superior signal report while working DX stations.

Overall the 20-4CD Skywalker provides exceptional gain, front-to-back and front-to-side ratios. It should provide all the "muscle" even the most critical operators require. The 20-4CD Skywalker Yagi is manufactured by the Cushcraft Corporation, P.O. Box 4680, Manchester, NH 03108. Price class: $320. — *Dennis Lusis, W1LJ* QST

'm = ft × 0.3048; $m^2 = ft^2 \times 0.093$; mm = in. × 25.4; kg = lb × 0.454.