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Kenwood TM-255A 2-Meter Multimode Transceiver

Force 12 C-3 "Classic" Triband Yagi Antenna

Kenwood TM-255A 2-Meter Multimode Transceiver

Reviewed by Steve Ford, WB8IMY
Assistant Managing Editor

When you're considering a 2-meter radio, chances are an all-mode rig is not at the top of your list. Most 2-meter activity is FM, and all-mode (SSB/FM/CW) transceivers are priced substantially higher than FM-only radios.

But the day finally comes when you grow tired of being tied down to packet and repeaters. You know that 2 meters has more to offer, but that "more" is primarily SSB. Now you feel the twinge of buyer's remorse. If you had saved a little more, or stretched the budget a bit, you would now be able to explore 2 meters to your heart's content. With an all-mode rig, you would have had it *all*—repeaters, packet, long-range SSB, meteor scatter, satellites, moonbounce.

So, let's turn back the clock. You haven't spent your wad yet. You think you can spring for an all-mode radio, but you're not sure which one is right for you. When you're talking about this much cash, it isn't a choice to make lightly. You're buying a radio not only for your immediate need, but also for the future.

In my opinion, the Kenwood TM-255A goes a long way toward yielding the best bang for the buck. It's not often that I can say I've been unhappy to return a rig when the Product Review period has ended. When it comes to the TM-255A, I miss it every day!

Features

The TM-255A is styled as a mobile radio. It's compact enough to fit easily under most dashboards and it features a removable front panel. Presumably you can store the transceiver in your trunk and install only the front panel in the passenger compartment.

The only difficulty with the detachable front panel is that you must remove it to install the microphone. The mike connects to the radio with a modular telephone-type plug *behind the front panel*. Removing the panel is easy. That takes all of 10 seconds—once you figure out where to apply pressure. Putting it back on is more of a hassle because the wiring makes it difficult to snap the panel into place. Nevertheless, the detachable front panel makes it easy to install the radio under your car's dash or seat and get the controls to a spot where you can see them. If you're thinking of opting for a radio-in-the-trunk installation, though, you will find that you must run separate cables back to the rig for the microphone because it doesn't share the front panel wiring.

The front panel features a large amber LCD display that's easy to read in most lighting conditions. (The display's brightness is adjustable.) There are plenty of buttons and knobs to keep you busy, but not enough to bewilder most operators. For example, I was able to get the radio on the air on my local repeater *without* referring to the manual.

Through the front-panel controls, you adjust volume, squelch and frequency (the rig has dual VFOs). The TM-255A also provides RIT (receiver incremental tuning), IF shift, speech processing and an effective noise blanker. You toggle between high (40 W) and low (5 W) output power via a front-panel button, but there's no way to adjust to power levels in between. Repeater offset shift and transmit/receive frequency reverse are also operated from the front panel.

Two buttons drew my attention right away. The first was **AIP**—Advanced Intercept Point. Although an **AIP** button can be found on Kenwood's current MF/HF transceivers, I'd not seen one on a VHF rig before. From an operating standpoint, AIP is similar to adding an RF attenuator to the front end, or switching off a preamplifier. During contests and band openings on 2 meters, it's possible to have honest-to-goodness overcrowding on 2-meter SSB, resulting in interference from stations near your operating frequency. It's common to be listening for very weak signals in the presence of very strong local signals. As you can see from Table 1, switching the TM-255A's AIP on reduces the radio's sensitivity slightly but makes a noticeable improvement in dynamic range. The AIP feature does make a difference on the air.

The Bottom Line

Kenwood's TM-255A has all the features you'll need to explore the full range of modes and activities available on 2 meters.

The **PF** button is another interesting item. PF stands for "Programmable Function." By sorting through the TM-255A's firmware menu, you can assign specific functions that will occur whenever this button is pressed. The **PF** button also appears on the microphone, and that's where it sees the most use. For example, you can configure the PF to mute the audio when the button is pressed. This would be handy in mobile situations when you need a brief moment of silence without fumbling with the volume control.

FM

With the TM-255A you don't need to manually switch to the FM mode (or any other mode, for that matter). The radio will do it for you! The *automode* function places the rig in the appropriate mode according to the frequency. When you tune past 144.5 MHz, you're in the FM mode almost all the way to the top of the band. The exception is the segment from 145.8 to 146 MHz where CW or SSB are the desired modes for satellite operating. (You can reprogram the automode function, or disable it altogether and use the front-panel mode switches.)

I found the TM-255A's flexible memory functions of greatest use on FM. The TM-255A can store 50 simplex frequencies

Table 1
Kenwood TM-255A 2-Meter Multimode Transceiver, serial no. 60200031

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 144-148 MHz.	As specified.
Modes of operation: LSB, USB, CW, FM.	As specified.
Power requirement: 13.8-V dc, ±15%; 0.9 A max on receive, 13 A max on transmit.	At 13.8-V dc: 0.9 A on receive (no signal, max volume); 11 A max on transmit.
Receiver	*Receiver Dynamic Testing*
SSB/CW receiver sensitivity (bandwidth not specified): 0.13 μV for 10 dB (S+N)/N (–125 dBm).	Minimum discernible signal (noise floor) with 2.4-kHz IF filter: AIP off, –139 dBm; AIP on, –135 dBm.
FM receiver sensitivity: 0.2 μV for 12 dB SINAD.	AIP off, 0.14 μV for 12 dB SINAD; AIP on, 0.25 μV for 12 dB SINAD.
Blocking dynamic range: Not specified.	Blocking dynamic range with 2.4-kHz IF filter:* AIP off, 111 dB; AIP on, 121 dB.
Two-tone, third-order IMD dynamic range: Not specified.	Two-tone, third-order IMD dynamic range with 2.4-kHz IF filter:** AIP off, 81 dB; AIP on, 86 dB.
Third-order input intercept: Not specified.	AIP off, –18 dBm; AIP on, –6 dBm.
FM adjacent channel rejection: Not specified.	At 20-kHz channel spacing: AIP off, 79 dB; AIP on, 80 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz offset from 146 MHz: AIP off, 70 dB; AIP on, 73 dB. 10 MHz offset from 146 MHz: AIP off, 98 dB; AIP on, 99 dB.
S-meter sensitivity: Not specified.	S9 signal at 146 MHz, USB mode: AIP off, 5 μV; AIP on, 24 μV.
Squelch sensitivity: SSB/CW, ≤0.13V; FM, ≤0.09 μV.	At threshold: FM, ≤0.07 μV; SSB, ≤0.14 μV.
Receiver audio output: 2 W or more into 8 Ω at 5% distortion.	2.4 W into 8 Ω at 5% THD.
IF/audio response: Not specified.	At –6 dB: CW 295-1925 Hz (1630 Hz); USB, 300-1937 Hz (1637 Hz); LSB, 262-2053 Hz (1791 Hz).
Image rejection: Not specified.	≥89 dB.
IF rejection: Not specified.	≥130 dB.
Transmitter	***Transmitter Dynamic Testing***
Power output: High, ≈40 W; low, ≈5 W.	High, 47 W; low, 5 W.
Spurious-signal and harmonic suppression: Better than –60 dB.	As specified. Meets FCC specifications for equipment in its power output class and frequency range.
SSB carrier suppression: 40 dB or more.	>55 dB.
Undesired sideband suppression: 40 dB or more.	>55 dB.
Third-order intermodulation distortion products: Not specified.	See Figure 1.
CW keying characteristics: Not specified.	See Figure 2.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S9 signal, 29 ms.
Composite transmitted noise: Not specified	See Figure 3.
Bit-error rate (BER), 9600 baud: Not specified.	Receiver: BER @ 12-dB SINAD, 9.8×10^{-4}; BER @ 16-dB SINAD, 5.5×10^{-5}; BER @ –50 dBm, $<1\times10^{-5}$; Transmitter: BER @ 12-dB SINAD, 5.7×10^{-4}; BER @ 12-dB SINAD +30 dB, $<1.5\times10^{-5}$.

Size (height, width, depth): 2.4×7.1×8.5 inches; weight, 6 pounds.

*Blocking dynamic range measurements made at 100 kHz because measurements at the ARRL Lab standard signal spacing of 20 kHz were affected by the AGC loop. The AGC could not be disabled.

**IMD dynamic range measurements were made at the ARRL Lab standard signal spacing of 20 kHz.

and up to 49 repeater pairs. There are also two memory slots for scan limits and a call channel. You jump from the VFO to the memory mode by simply by pressing the **MR** button. Rotating the **ALTERNATE TUNING** knob steps you through the various memory channels.

Scanning is a breeze with the TM-255A. You can scan through the memory channels, or do a programmed scan on the frequency segment of your choice. You can even set up a scan that sweeps the memory channels, the call (priority) channel *and* the current frequency selected by your VFO—in rotation! Although the utility of scanning is not limited to FM operating, I found it most useful when I was hunting for active repeaters.

You may never "time out" a repeater again with the TM-255A. If you have a tendency to babble beyond the maximum time your repeater allows, you can program the TM-255A to stop you before the repeater does. It's much better to be cut off in midprofundity by your own radio than suffer the embarrassment of taking the repeater with you!

The TM-255A can even be programmed to turn itself off if you haven't used it in more than three hours. This is a great energy saver—and potentially a car-battery saver—for forgetful operators.

Like most FM-only rigs, the TM-255A offers CTCSS subaudible tone encoding for repeater access. The radio can also decode received CTCSS signals, but only when the optional TSU-8 is installed. The TM-255A also generates and decodes DTMF (touchtone) signals. You can set up an elaborate paging system for single station or group calling. When you receive a DTMF tone page, your squelch opens and an alert tone sounds.

Packet

Kenwood thoughtfully provided a rear-panel data port on the TM-255A. The 6-pin miniature DIN jack is configured according to a standard set by several radio manufacturers by mutual agreement. This was a pleasant discovery because it meant that I could use the same TNC/radio plug that I made for the Azden PCS-9600D review (May 1995 *QST*).

The TM-255A performed quite well at 1200-bit/s packet, but this wasn't a surprise. Most modern FM transceivers can

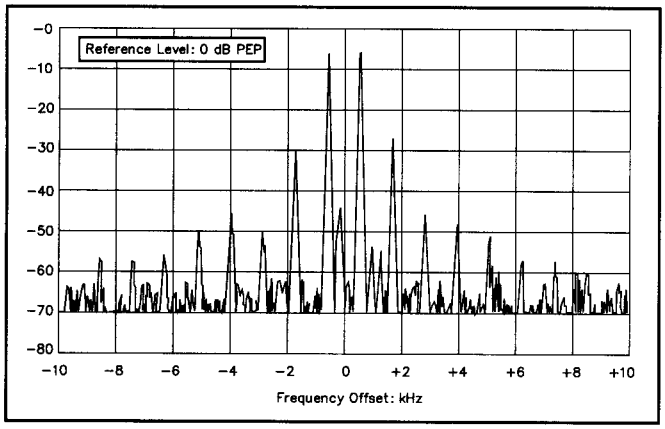

Figure 1—Worst-case spectral display of the Kenwood TM-255A transmitter during two-tone intermodulation distortion (IMD) testing. Worst-case third-order product is approximately 28 dB below PEP output, and the fifth-order product is approximately 48 dB down. The transceiver was being operated at 42 W PEP output at 146 MHz.

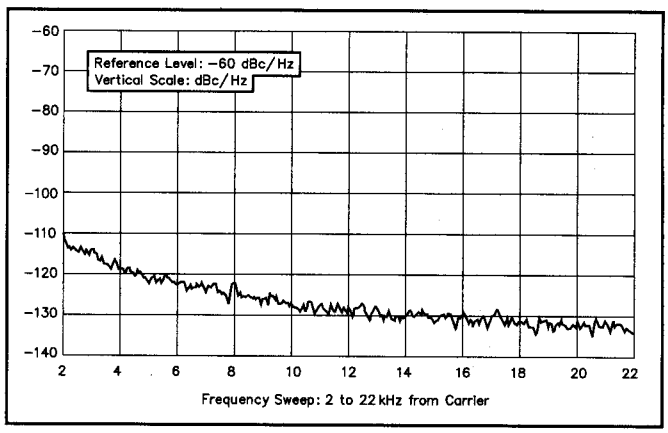

Figure 3—Spectral display of the Kenwood TM-255A transmitter output during composite-noise testing. Power output is 47 W at 146 MHz. The carrier, off the left edge of the plot, is not shown. The plot shows composite transmitted noise 2 to 22 kHz from the carrier.

handle 1200-bit/s data signals without much difficulty. The real test would be at 9600 bits/s.

In my area of New England there is little 9600-bit/s packet on 2 meters. So, I had to rely on the OSCAR 23 packet satellite as my test bed. During one pass I used a receive converter to monitor the satellite's 435-MHz data downlink. The information seemed to flow well enough. On another pass I attempted to grab a file from the bird. This requires a 9600-bit/s transmit signal on the 2-meter FM uplink frequency. After several attempts, OSCAR 23 heard my plea and began sending the file.

The bit-error-rate (BER) measurements conducted by the ARRL Lab are more meaningful than my nonscientific test. The results are listed in the specification table. As you can see, the TM-255A performs very well at 9600 bits/s, and its transmitter is outstanding. (For more information on the ARRL Lab's BER testing, see "'9600-Ready' Radios: Ready or Not?" by Jon Bloom, KE3Z, in May 1995 *QST*.)

SSB

I really enjoyed using the TM-255A on SSB. The receive audio was clean and crystal clear. I obtained similar reports on my transmit audio. With only a horizontally polarized omnidirectional antenna I was able to work stations as far as 300 miles away. With a beam antenna and an outboard power amplifier, I could have easily worked more distant stations. Meteor scatter would have also been a possibility. (I heard several "pings" while monitoring the calling frequency of 144.200 MHz.) Another ARRL staffer tried the TM-255A during the ARRL 2-Meter Spring Sprint contest and used it to work stations 100 miles away with a small indoor beam antenna.

The TM-255A's squelch deserves special mention. It's one of the most flexible—and sensitive—squelch circuits I've ever used. I could park the receiver on 144.200 MHz, turn up the squelch to just past the point where the noise stopped, crank up the volume and walk away. The squelch was sufficiently sensitive that even relatively weak signals would open it. I'd hear any 2-meter action no matter where I was in the house (much to my wife's consternation!).

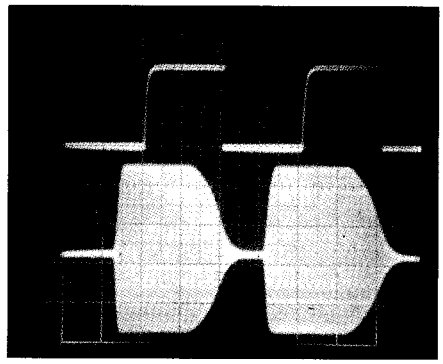

Figure 2—CW keying waveform for the Kenwood TM-255A in the semi-break-in mode. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 47 W output at 146 MHz.

And if you don't care for the traditional approach, you can activate the TM-255A's programmable "S-meter squelch." In this mode, the squelch will open only when the receive signal strength exceeds the S-meter setting of your choice. You say you only want to listen to signals that are S5 or better? No problem. Simply program the S-meter squelch and that's exactly what you'll get. You can even adjust the squelch *hang time*—the amount of time the squelch remains open after the signal drops. And by activating the S meter "peak hold" function, you'll have nearly three seconds to glance at the display and see how strong the signal really is.

Satellite operating was very enjoyable with the TM-255A. The 40-W output was more than enough power to make CW and SSB contacts through the RS-10 and RS-15 satellites. I was also able to monitor the 2-meter downlink from OSCAR 13.

With the proper transverter, the TM-255A could become a platform for even more satellite exploration—particularly with the launch of Phase 3D next year. The Kenwood engineers may have had this application in mind when they designed the radio. It's evident by the thoughtful addition of a clever "transverter frequency display" mode. If you're using the TM-255A with a 1240 or 2400-MHz transverter, you can program the radio to display the actual transceive frequency rather than the 2-meter equivalent. Let's say you're using a 2400-MHz receive converter with a 2-meter output to listen to the Mode S downlink from OSCAR 13. With most rigs, you'll see 145.720 MHz displayed when you're receiving 2400.720 MHz. Not so with the TM-255A. By switching to the transverter display mode, you'll see 2400.720 MHz on the LCD! This is a major convenience for transverter-based operating.

The only catch is that the TM-255A doesn't seem to offer the means to crank down the output power to anything less than 5 W. Some transverters are designed to work with multimode 2-meter rigs and have built-in switching and attenuators to knock the power down to the required level. Other transverters are set up to work with 2-meter signals at the milliwatt level, though, so be sure to check the transverter's instructions before hooking up the TM-255A. Of course, if you're using the TM-255A only with a receive converter, you don't need to worry. Just don't forget to lock the transmit function so you don't fry the converter!

Conclusion

The TM-255A is an excellent all-mode radio. It gives you almost everything you could possibly want for 2-meter operating, and it's just the ticket to the huge variety of fun, interesting and exciting activities that await beyond the local repeater. Yes, the rig is considerably more expensive than an FM-only box, but this is one of those radios you'll buy and use for most of your amateur career. In other words, it's a one-time investment that will pay for itself over the years. And it's good enough that its resale value should stay high for a long time.

This transceiver offers all the conveniences and capabilities you're likely to need for FM, plus 9600-baud packet performance the FM-only radios can't touch. On top of that, it has all the features you'll want for SSB/CW work. Regardless of which modes you prefer, the TM-255A is sure to please.

Manufacturer's suggested retail price: $1110. Manufacturer: Kenwood USA, PO Box 22745, Long Beach, CA 90810-5745; tel 310-639-5300.

Force 12 C-3 "Classic" Triband Yagi Antenna

Reviewed by Mike Tracy, KC1SX
ARRL Technical Information Specialist

When assembling a modest HF station with decent antenna directionality and gain, many hams consider buying a three-band beam to improve their chances of working DX, and perhaps also as a good way to start building a contest station. Tribanders are quite common these days and the basic 10, 15 and 20 meter design is considered a "classic." There are quite a few commercial manufacturers and models to consider. In addition to the practicalities of cost and antenna performance, you also have to take into account such factors as weight, turning radius, and wind survival rating when making your decision.

Force 12 co-founder/chief engineer Tom Schiller, N6BT, is no stranger to competitive HF antennas and the hams who use them. He has used modern computer tools to bring a huge line of single- and multiband antennas to market. Although Force 12 is a newcomer to the tribander market, the C-3 model is a competitive antenna with some unique design features that are worth a closer look.

Construction

It is certainly true that first impressions are lasting ones, and I admit that I was very pleased with this antenna from the moment I opened the box. The manual for the C-3 comes bound in a report presentation folder, and the assembly instructions are presented in a comprehensive, step-by-step fashion reminiscent of a Heathkit manual. The element subassemblies are clearly marked at the factory and are bundled together by element-half. Additionally, each of the three boom segments and all of the elements are permanently engraved for easy identification if the antenna is disassembled at a later date.

Also included with the antenna is a small package of Noalox, an antioxidant grease used to prevent corrosion in the joints of the subassemblies. The only things needed

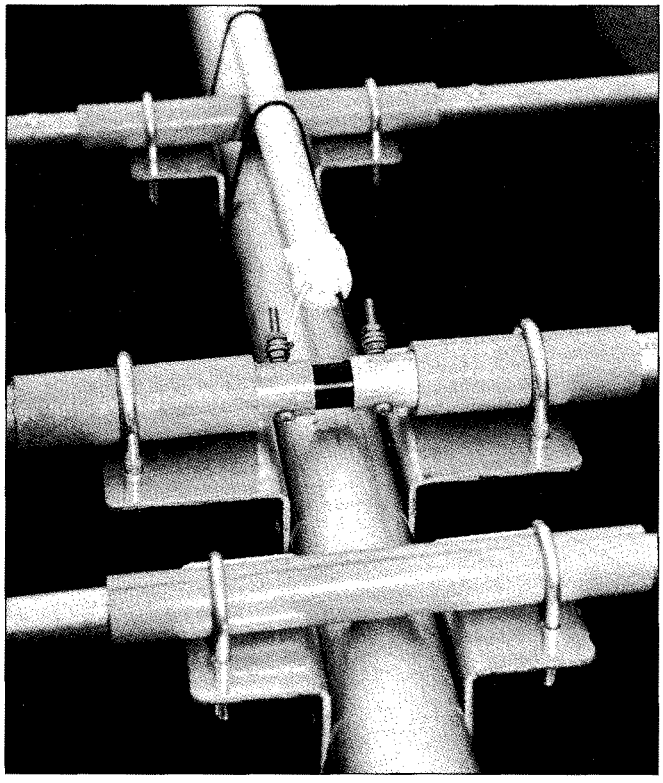

Figure 4—The C-3's 20-meter driven element is split in the center and insulated from the boom. RF power is applied through a Force 12 B-1 current balun (ferrite beads over coaxial cable, encased in PVC for weatherproofing). The nearby 10 and 15-meter driven elements are parasitically excited; they have no direct connection to the feed line.

JAMES D. CAIN, K1TN

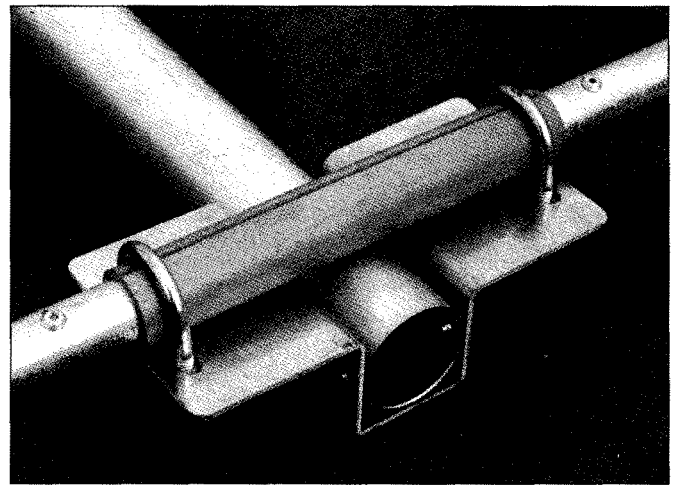

Figure 5—Force 12's boom-to-element clamp is simple but effective. The clamp is riveted to the boom, and the element is secured with U-bolts. All elements are insulated from the boom by PVC sleeves. The brackets are attached to the boom at the factory, and all holes are predrilled, so it's impossible to attach an element in the wrong spot or misalign elements. An added advantage is that the elements won't twist on the boom in a windstorm. When installed, the elements hang underneath the boom. This provides mechanical stability and helps protect the feedpoint and insulators from the weather.

The Bottom Line

Force 12's C-3 uses several interesting electrical and mechanical design techniques to create a small, lightweight triband beam with good performance.

to complete this antenna are a few common hand tools, a 1:1 balun or RF choke (8 turns of coax) and a standard Pop Rivet tool. These last two items may be purchased from Force 12. We used a Force 12 model B-1 current balun.

The assembly is straightforward—a couple of bolts complete the assembly of the three pieces of the boom, and the element-mounting brackets are already attached to the boom sections. Each element piece is prefitted at the factory and predrilled for the rivets, so there is no need to measure and adjust as you go along.

There are a few extra holes in each element for fine-tuning the SWR, but in this installation I used the center holes (the "default" position). No changes were required for a quite acceptable SWR.

Because the antenna is partially assembled at the factory, a minimum of work is needed to complete the job. This work consists of mating only a few dozen subassemblies, each of which uses different-sized tubing. The antenna can not be assembled incorrectly, even if the step-by-step instructions are not followed closely! Clearly, the Force 12 human engineers know the intricate workings of the ham mind!

Design Features

What sets this antenna apart from the typical triband Yagi is the lack of traps. Although having no traps means that there are more elements on the 18-foot boom (*seven*, in the case of the C-3), it also means more usable bandwidth on each band. The C-3 is essentially three separate two-element beams on a common boom. Fifteen and 20 meters each have a driven element and reflector. Ten meters has two driven elements (to provide wider frequency coverage) and a director.

With more elements than normal, you might think that the C-3 would weigh more than trap designs; surprisingly, that is not the case. At a little more than 32 pounds, this antenna is easy for one person to handle during assembly and installation. Force 12's unique mounting system helps as well—their Easy-On mount makes it simple to get the antenna oriented properly at the time it is raised into position. The C-3's turning radius is about 20 feet.

The feed system is also simplified, with the feed line connected via your balun to only the 20-meter driven element. The other bands are coupled to the 20-meter driven element parasitically. The result is that there are fewer electrical connections, lessening the opportunity for corrosion to set in once the antenna is installed and put into use. In case you are scratching your head at the idea that "the other bands are coupled to the 20-meter driven element parasitically," that is truly the way the antenna operates. It may seem like smoke and mirrors, but the basis for this sort of performance is described in the 17th edition of *The ARRL Antenna Book* under the heading "The Open-Sleeve Antenna" (pages 7-4 to 7-8).

Operation

After the antenna was completed and raised into position, the moment of truth arrived. A quick check of the meter revealed that the SWR of this antenna is quite low across the band on both 20 and 10 meters. On 15 meters, however, the situation was slightly different.

As the C-3 manual states, "If the VSWR is measured directly at the feed point, the 2:1 points on 15 and 10 meters will not span the entire band; however, making use of a particular phenomenon with coax cable, the VSWR response is flattened out slightly and the C-3 covers all the bands with 2:1 or less across the entire band." According to the manual, the design assumes that the C-3 will be fed with at least 100 feet of coax. In our installation, the SWR at the 15-meter band edges was about 2.5:1 and the 2:1 bandwidth was roughly 300 kHz. In practical operation, this is usually not worth worrying about.

In addition, the SWR levels on 12 and 17 meters are less than 3:1, so this antenna could easily be used on these bands as well, with a little help from a tuner. Because the antenna was not designed with these bands in mind, however, it will be outperformed by a dedicated 12 or 17-meter beam.

We installed the C3 on a 30-foot tower atop the ARRL HQ building for use with W1INF, the Headquarters Operators Club/ARRL Lab station. The C-3 has performed very well on the air during the several months of use it has seen to date. Both the front-to-back and front-to-side ratios are quite satisfying, and excellent signal reports are commonplace with 100 W output from the rig.

Some hams have expressed skepticism about the relatively small diameter, tapered elements common to Force 12 antennas. On the C-3, the 20-meter elements start at 1 inch OD and taper to $^3/_8$ inch. The 10 and 15-meter elements start at $^3/_4$ inch OD and taper to 3/8 inch. This design choice helps keep the the C-3's windload rating to only 5.6 square feet, making the antenna very friendly to small towers and small rotators. Our C-3 has weathered the worst months of New England winter, as well as an early spring thunderstorm that included wind gusts in excess of 70 mph, all without mishap.

I recommend the C-3 without hesitation to someone looking for a durable tribander with good performance. If you're interested in more elements or other bands, Force 12 offers a *very* broad range of products.

Manufacturer's suggested retail price: C-3, $450; B-1 balun, $30. Manufacturer: Buy USA Inc [Force 12's parent company], 3015-B Copper Road, Santa Clara, CA 95051; tel 408-720-9073, 800-248-1985; fax 408-720-9055. QST

New Books

HOW TO BUILD EARTHQUAKE, WEATHER AND SOLAR FLARE MONITORS

By Gary G. Giusti, KA6OLO

Published By TAB Books, Division of McGraw-Hill, Blue Ridge Summit, PA 17294-0850. First edition, 1995, 290 pp including glossary and index, illustrated with B&W photographs and diagrams. 7⅜x9¼ inches, paperback. Retail price $19.95. ISBN 0-07-025209-2

Reviewed By Paul Danzer, N1II
Assistant Technical Editor

If you have ever wondered how earthquakes are monitored or how to watch for solar flares, this book could be a lot of fun. Don't let its title fool you. Although it does give instructions that will guide you step by step, a number of the projects are probably more fun to speculate upon than to build.

The "'generic' seismic sensor" undoubtedly could be built, but the idea of wrapping 3000 to 4000 feet of no. 30 to no. 36 magnet wire on a form doesn't sound like a project most people would ever complete. Once completed, however, the simple circuit given as the sensor's amplifier could really allow you to monitor earth movements.

The book includes an interesting summary of the underlying causes of earthquakes. It provides theories and data that seem to show a link between solar events, weather and other occurrences. A host of interesting related definitions liven up the material.

The book starts with a safety chapter, necessary because a number of the circuits are based on vacuum tube designs. One chapter includes several circuits that date from the 1930s to the '50s, with pentaflex regenerative circuits and grid leak detectors. The "Geo-monitor" in this chapter uses a 1T4 pentode followed by a 3Q4 audio amplifier. If you're a fan of old-time radio lore, the photos of a two-tube regenerative detector are classics and should be preserved to explain the definition of *haywire*.

Although this chapter is fun to read, it could be a challenge to locate 1N5G and 1G4G tubes, not to mention the coil, listed as taken from a 1925 *Atwater Kent* Model 20 radio.

The chapters that include solid-state devices were designed to allow relatively inexperienced hobbyists to build the circuits. The figures contain schematic and mechanical views so that the correct connections could be made to transistors and integrated circuits. Some of the solid-state components appear obsolescent, however, and may be a problem to purchase.

The discussions of weather, solar events and other natural phenomenon scattered about the book are similar to the high school freshman science course that used to be given under the name "Earth Science." A little bit of information here, a little bit of information there, and a few quick looks make an interesting book to browse. QST