Product Review Column from *QST* Magazine

August 1997

Cushcraft R7000 Multiband Vertical Antenna

A Portable Shortwave Receiver Roundup
(Grundig YB-400; Panasonic RF-B45; Sangean ATS-909; Sony ICF-2010)

Radio Shack Probe-Style Oscilloscope

Edited by **Rick Lindquist, N1RL**• Senior Assistant Technical Editor

Cushcraft R7000 Multiband Vertical Antenna

Reviewed by Rick Lindquist, N1RL
Senior Assistant Technical Editor

Even before unpacking the R7000 from its compact shipping carton, I began getting unsolicited "helpful advice" on the air about vertical antennas. Of course, someone just had to offer the cliché about how verticals "radiate equally poorly in all directions." Another orated at length about the necessity for a good radial system—even if the manufacturer says you don't need one. "Don't be sucked in by those ads showing that nice shiny antenna pointing up into a bright blue sky," he warned.

I've very successfully used a vertical on HF for many years—on my various mobile installations! So I was not about to be convinced that there was something inherently deficient about vertical antennas. But I'd never installed one for my home station, so this was going to be somewhat of a new experience for me.

The R7000 covers 40 through 10 meters (including 30, 17 and 12 meters) and replaces the R7 (see "Product Review," *QST*, Aug 1992) in Cushcraft's product lineup. (A kit is available to add 80-meter capability, but we did not test this.) The whole antenna comes in a box that's just about 5 1/2 feet long. The R7000 goes together and comes apart rather easily and quickly, making it worth considering for Field Day, a DXpedition, or portable operation. According to Cushcraft, the R7000 doesn't need those pesky radials my friend was talking about because it appears to your transmitter as an electrical half wavelength—even though it's physically *less* than a half wavelength on most of the bands it covers (it's nearly a half-wave on 17 meters). It does this by making double use of the three trap units, which also act as loading coils on some bands. The "no-radials" design and its small footprint are among the antenna's selling points. In fact, Cushcraft specifically says "The R7000 should not be attached to a ground radial system," although you are supposed to provide a safety ground (for static discharge) at the base of the antenna. The antenna is DC grounded through an RF choke.

BOTTOM LINE

The R7000 is a great complement to a dipole or low beam. If you need a decent HF antenna that does not take up much space or require an antenna tuner (provided you're willing to abide by the bandwidth restrictions), the R7000 is a suitable choice and a fine performer for its size.

Getting it together

With just a few tools and Cushcraft's directions, I had the R7000 together in around 90 minutes—being very deliberate about it to avoid dumb mistakes. I strongly recommend using nut drivers or small socket wrenches to secure the hardware and to tighten the stainless-steel clamps that hold the telescoping sections and traps. In all likelihood, you'll want to assemble the R7000 out-of-doors. I found it convenient to use a couple of sawhorses to support the R7000 once the 49-inch-long radial rods were attached and I'd begun to assemble the actual radiating portion of the antenna. This made it very easy to measure the individual sections for tuning and avoided possible damage to the radials. I also found it handy to sort the numerous small pieces of hardware into an old muffin tin. Be careful! There are pieces of slightly different sizes or lengths that *look* the same at a quick glance.

Cushcraft claims there are but five steps to assembling the R7000, but in all fairness, each of those "steps" comprises numerous sub-steps. I would have preferred that Cushcraft's eight-page *Assembly and Installation Instructions* booklet list each of these sub-steps individually (perhaps with a check-off box like the old Heathkit manuals). That way, you would not have to remember where you left off in the paragraph or two of sub-steps—or, worse yet, inadvertently skip something. Preceding the "five" steps is a page and a half of helpful advice and general instructions that are must reading. (My favorite piece of advice was this one: "Although the R7000 will operate in almost any location, it will perform best if it is mounted vertically…" Cushcraft says that it *needs* to be that specific, however—based on the inquiries it sometimes gets.)

All instructions are clear, and the illustrations are superb and reference accompanying parts tables, so you'll have no problems identifying individual pieces in each

Table 1 R7000 Manufacturer's Specifications

Bands covered	10, 12, 15, 17, 20, 30 and 40 meters
Typical SWR	1.2:1
2:1 SWR bandwidth	10 m, 1700 kHz; 12 m, 100 kHz; 15 m, 450 kHz; 20 m, 250 kHz; 30 m, 100 kHz; 40 m, 150 kHz.
Power rating	1500 W PEP (1000 W or less recommended for high-duty-cycle modes such as RTTY)
Height	24 feet
Weight	18 lb
Wind load	2 ft^2

of the major steps. The threaded hardware is all stainless and appears to be of excellent quality. I really liked the fact that Cushcraft supplied nut-washers instead of separate lock washers, which are so easily lost.

One step I did *not* do was to apply the supplied warning labels on each of the seven radial rods. The labels warn about avoiding overhead electrical wires, not avoiding the radials or the antenna itself. In other words, they're a warning to the *installer*, not passers-by. A similar warning label already was applied to the antenna mast, and the instructions are replete with warnings, so I considered myself duly warned. You install the "black box" MN7000 matching network after the radials are attached. The feed line attaches to an SO-239 on the MN7000.

There's probably no reason why you could not install the radial rods later in the process—say, after the radiator was assembled—since they do inhibit your ability to conveniently maneuver the antenna.

Assembling the radiator requires attention to detail and a good tape measure. This part of the job mostly involves fitting sections and traps together (in the proper direction and relationship) and measuring and tightening the spiral clamps (measure twice, tighten once). There's also a little capacitance hat made of aluminum tubing that goes about 11 feet up the pole. I assembled the radiator (which consists of three traps and the telescoping aluminum segments) according to the suggested dimensions in the manual. The only confusing part was when I came up with one piece of aluminum tubing that was 6 inches longer than the other ones of that same diameter. I guessed (correctly as it turned out—my hunches don't always pan out that well) that it went immediately before the very top section. The tubing section Cushcraft used to supply for that part of the radiator was a tad short for hitting the low end of 40 meters. That happens to be where I operate a lot, so I really lucked out! Cushcraft is updating the R7000 manual to reflect this and other changes.

Getting it Vertical

Once I had the whole business together, I found it was surprisingly easy to handle. It looked much larger than I'd thought it would while it was lying prone across my sawhorses, and I considered enlisting help to get it onto the mast I'd installed in the middle of a briar patch (the better to deter the curious). Since Cushcraft's recommended dimensions were based on mounting the R7000 approximately 8 feet off the ground, I used a 10 foot piece of 2 inch diameter galvanized pipe as a support, with the lower 30 inches or so set into the ground and entombed in concrete. Putting the antenna up on the support mast was easier than I'd anticipated, and I was able to manage it single-handedly by securing the clamps around the mast somewhat loosely, then sliding the whole business up the pipe. This did require temporarily removing one of the radial rods, but I deemed it safer than trying to carry the whole antenna upright on a ladder and slipping it over the top of the mast. Once it was in place on the mast, I simply used a stepladder to re-install the radial rod, tighten up the very sturdy clamps, and install the feed line and ground connections. My feed line ended up being nearly 130 feet long.

On the Air

The $64,000 question with any antenna is: Does it work? In a word, yes. And it worked *much* better than I'd expected. The first thing I did, however, was check the SWR on all bands, and I ended up taking it down once to make some very slight adjustments to put the usable bandwidth in a more appropriate place for my operating habits or to make the unit resonate inside the particular band. For the most part, on 30 meters and on 17 meters and above, the R7000 can be adjusted to be flat or nearly flat across the entire band. On 20 meters, it showed approximately 250 kHz of 2:1 SWR bandwidth, and on 40 meters, I could cover 125 kHz or so before the SWR topped 2:1 (the *minimum* SWR I got there was 1.5:1). My bandwidth on 40 seemed a little shy of what Cushcraft specifies (see Table 1), but my measurements represented what I was seeing inside my shack on two different SWR meters.

I routinely work DX on 40 meter CW using 100 W and the "vertical" on my mobile setup, so I was not surprised to be able to work lots of DX on 40 running the same power into the much bigger R7000. What I was not necessarily prepared for was that occasionally—*just occasionally*—the R7000 would beat out my 260 foot "multiband" center fed! This typically (and understandably) happened on longer paths where the vertical's lower radiation angle might be a factor. One evening on 40 meters, stations in the UK and Slovenia detected little difference between the "big" antenna and the R7000—at 24 feet tall and approximately 10 times shorter than my center fed. On 30 meters, I got a similar report from a station in Budapest, Hungary, while a station I heard in Madrid, Spain, was generally an S unit stronger on the vertical. For the most part, however, reports were better by an S unit or two on the large dipole, but sometimes the vertical was quieter because it was further away from man-made noise sources (houses, our barn, power lines, etc). Late one evening while listening to 20 meters get longer and longer, I found I was able to copy a weak VK on the vertical but not on my center fed—in part due to a higher noise level on the horizontal antenna. For me, the real plus was being able to put a signal where my dipole had nulls.

In short (pun intended), I'm happy to have the additional capabilities the R7000 offers. It provides handy and useful variety to my admittedly limited antenna system. Among other possible applications, it's great for "roundtables" involving widely scattered stations (and it should make a good beacon antenna).

Manufacturer: Cushcraft Corp, 48 Perimeter Rd, Manchester, NH 03108; tel 603-627-7877; fax 603-627-1764. Manufacturer's suggested retail price: R7000 multiband vertical, $510; R80 80-meter add-on kit, $155.

A Portable Shortwave Receiver Roundup

By Steve Ford, WB8IMY
Managing Editor

When this issue of *QST* hits the newsstands and mailboxes, we'll be at the peak of the summer vacation season. Of course, radio junkies that we are, we *hate* being separated from life on the airwaves, even during pleasant afternoons on the beach or beside the pool. The cure is to *carry a radio along with you*! If you want to hear repeater chatter amidst the thundering surf, you can simply tote an H-T along. To keep your suntanned fingers on the pulse of HF activity, however, you'll need something different. That's when portable shortwave receivers become attractive options.

If you only care to listen to shortwave broadcast stations, just about any low-budget receiver will do. These radios are legion. But for the kind of performance and features that allow you to comfortably eavesdrop on ham activity, you'll need to step up to a somewhat higher category of receiver. We're talking about radios with SSB and CW receive capability, fine-tuning functions and so on.

We've selected four radios from among the units available in this category within a modest price range. They're small enough and light enough to travel anywhere, and they offer performance that's a cut above receivers intended strictly for broadcast reception. Curious ham that I am, I also conducted some tests to measure the abilities of these radios to function as honest-to-goodness ham rigs in portable station applications (see the sidebar, "Beyond Just *Listening*…").

All of these receivers exhibited adequate sensitivity and good audio characteristics. Selectivity was about what you would expect for receivers designed primarily for shortwave broadcast monitoring. In some

Table 2: Portable Receiver Features

	Grundig YB-400	Panasonic RF-B45	Sangean ATS-909	Sony ICF-2010
Tuning ranges	LW, MW, SW, FM	LW, MW, SW, FM	LW, MW, SW, FM	LW, MW, SW, FM, Air
FM stereo (with headphones)	Yes	No	Yes	No
Approx speaker size (inches)	3	3	$2^1/_2$	4
Total memories	40	27	306	32
Sleep timer	Yes	Yes	Yes	Yes
Standby timer	Yes	Yes	Yes	Yes
Display lamp	Yes	No	Yes	Yes
AM synchronous detection	No	No	No	Yes
Recorder output jack	No	No	Yes	Yes
Signal-strength indicator	Yes	Yes	Yes	Yes
AC adapter supplied	No	No	Yes	Yes
Suggested retail price	$270	$200	$389	$450
Typical "street" price (as of 6/97)*	$178	$170	$263	$355

*Typical "street" prices represent an average of prices provided by several *QST* advertisers, exclusive of sales, rebates and coupon specials.

cases, dynamic range was surprisingly good (see the tables). Which one is the best buy? The answer depends on which features are most important to you and on the flexibility of your budget.

Grundig YB-400

The Grundig YB-400—better known as the "Yacht Boy 400"—has been a favorite among shortwave listeners for a few years. It offers AM, SSB/CW and FM stereo in a package that's easy to use and relatively easy on your bank account.

As with many radios of this type, you can choose between direct frequency entry and scan-type tuning. With the YB-400, however, you have the ability to step through memory channels, forward or backward, with the push of a single button (the direction is set by how long you hold in the button). On the side of the case there is a **FINE TUNING** wheel with a center detent for frequency tweaking (±1 kHz) during SSB or CW reception. In our tests it did a decent job of receiving SSB and CW signals on the ham bands. One neat touch was the band

Grundig Yacht Boy 400, serial number 285114

Manufacturer's Specifications	*Measured in ARRL Lab*
Frequency coverage: AM, SSB, 144-353 kHz; 0.52-30 MHz. FM, 87.5-108 MHz.	As specified.
Modes of operation: AM, FM, SSB (CW).	As specified.
Power requirements: 9 V. Current consumption not specified.	9 V at 110 mA.
Size (HWD): $4^3/_4 \times 7^3/_4 \times 1^3/_8$ in; weight, 1 lb, 12 oz (with batteries and carrying case).	
SSB sensitivity: Not specified.	Minimum discernible signal: 180 kHz, 7.24 µV; 1 MHz, 0.80 µV; 14 MHz, 0.08 µV.
AM sensitivity: Not specified.	AM, test signal modulated 30% with a 1 kHz tone, 10 dB (S+N)/N: 1 MHz, 6.02 µV; 14 MHz, 1.44 µV.
FM BC sensitivity (12 dB SINAD): Not specified.	FM, 12 dB SINAD: 100 MHz, 1.64 µV.
Blocking dynamic range: Not specified.	SSB mode, 14 MHz: 78 dB.
Two-tone, third-order IMD dynamic range: Not specified.	SSB mode, 14 MHz: 76 dB.

NOTE: Except as noted, all dynamic-range measurements were taken using the ARRL Lab standard spacing of 20 kHz. All measurements were made with the **DX/LOCAL** switch set to **DX**, the **NARR/WIDE** switch set to **NARR**, and the **TONE** switch set to "high."

buttons. Push 40 plus the **FREQU./METER** button, for example, and you're on the 40 meter band!

The YB-400 offers two independent clocks. That's a handy feature when you want to have one set to local time and the other to UTC. There is also a sleep timer and standby timer (a clock-radio emulation). It's noteworthy that the YB-400 includes a large **SNOOZE** button on the top of the radio. This is exactly what you need when the radio wakes you up a bit too early (doesn't it always?). Figuring out how to use the clock required a trip to the manual for some users. Speaking of the manual, it was judged adequate but not terrific. Some users found it difficult to follow. It includes instructions in English, French and Spanish.

You can attach an outside antenna (a convenient spool-type antenna is provided) and there is a **LOCAL/DX** switch (an attenuator) to reduce the front-end overload when you have a little *too much* gain. You may be surprised to see a **WIDE/NARROW** filter switch, but don't get your hopes up. These are AM filters for shortwave broadcast listening. The **WIDE/NARROW** switch doubles as a **STEREO/MONO** switch on FM reception.

The YB-400's LCD display—which can be lighted—is very informative and easy to read. It includes a bargraph S meter along the lower left edge. Frequency digits dominate the display with the time digits occupying the upper left corner. The 3 inch speaker provides a full-bodied sound in spite of its size.

Manufacturer: Grundig AG, D-90762 Fürth, Germany. *Supplied accessories:* Stereo headphones with 33 inch cord; external antenna on a reel with 21 feet of wire; soft carrying case; *Shortwave Listening Guide*. *Battery requirements:* six AA cells, alkalines recommended.

Panasonic RF-B45

The RF-B45 is on the low-priced end of our selection of sets, but it offers plenty of features to make it a good value, although the radio might be difficult to find. After we'd purchased our RF-B45, we learned that Panasonic had pulled out of the shortwave receiver market and discontinued this model. However, new units were still available at press time from Amateur Electronic Supply (800-558-0411).

You can tune the RFB-45 two ways. There is a 12-button keypad with 10 of the buttons corresponding with digits 0 to 9 for direct frequency entry. So if you want to go to 8080 kHz, you'd press the button marked **FREQ**, then tap 8-0-8-0 on the keypad and press **ENTER**. Ten of the 12 push bottons on the keypad are also labeled to corespond to 10 different broadcast bands between 2 and 30 MHz. Press the **METER** button (it does double duty with the **ENTER** button), then the meter-band button you desire, and the RFB-45 puts you on that band.

If you prefer manual tuning to direct frequency entry, you can surf the bands using the large tuning buttons or the "autotune" mode (which only scans higher in frequency). There is a thumbwheel **FINE TUNE** control, and it works well enough to make SSB and CW tuning a breeze. Unfortunately, however, the RF-B45 **FINE TUNE** control lacks a center detent. So, once you begin fiddling with the **FINE TUNE** wheel, you never know when it is centered again—in part because the display only reads out in 5-kHz steps. This problem falls more into the "minor annoyance" category. The LCD display is easy to read in most lighting conditions and all controls are well placed and simple to use.

The RF-B45's memories are not backed up by a separate battery. When the time comes to put in a fresh set of cells, you have to complete the job within 60 seconds or you'll lose your memory settings. The radio flashes a convenient "E" (for "empty") warning when the batteries are low.

Although the RF-B45 receives FM, it isn't stereo. If you're listening to its 3-inch speaker, you won't care; when you plug headphones into the RF-B45, you *will* care. FM stereo is standard equipment on much less expensive radios and its absence here is perplexing. Another curious contradiction: the **POWER** button stays lighted whenever the radio is on, but you cannot illuminate the display.

Other features include a sleep timer to shut off the radio after you've drifted into slumberland. There is also a standby timer that enables the RF-B45 to function like a clock radio, waking you up to the sound of your favorite station.

Like all radios in this review, the RF-B45 includes a built-in telescoping antenna. This is entirely adequate for casual listening. There is an external antenna jack, but you'll probably have to use the **DX/LOCAL** switch in the "local" mode to prevent front-end overload.

The *Operating Instructions* booklet was complete and very easy to follow. It's in three languages (English, French and Spanish) and includes information on propagation and what to look for on each band. But—a minor point—it omits the 30, 17 and 12 meter ham bands in its discussion of amateur allocations.

Manufacturer: Matsushita Consumer Electronics Co, One Panasonic Way, Secaucus, NJ 07094. *Supplied accessories:* Monophonic earpiece with 42-inch cord; soft carrying case; approximately 30 feet of very flexible antenna wire with jack; *Frequency and Language Schedule of the Major SW Stations*. *Battery requirements:* four AA cells.

Sangean ATS-909

With the Sangean ATS-909 you step into a different class of portable shortwave receivers. At first glance the ATS-909 looks quite similar, albeit slightly larger, than

Panasonic RF-B45, serial number XE4LA18684

Manufacturer's Specifications	*Measured in ARRL Lab*
Frequency coverage: AM, SSB, 144-288 and 520-1611 kHz; 1.62-30 MHz. FM, 87.5-108 MHz.	As specified.
Modes of operation: AM, FM, SSB (CW).	As specified.
Power requirements: 6 V dc, current consumption not specified.	6 V at 100 mA.
Size (HWD): $4^1/_2 \times 7^7/_8 \times 1^3/_8$ in; weight, 1 lb, 12 oz (with batteries and carrying case).	
SSB sensitivity: Not specified.	Minimum discernible signal: 180 kHz, 7.24 μV; 1 MHz, 0.92 μV; 14 MHz, 0.13 μV.
AM sensitivity: Not specified.	AM, test signal modulated 30% with a 1 kHz tone, 10 dB (S+N)/N: 1 MHz, 16.60 μV; 14 MHz, 1.74 μV.
FM BC sensitivity (12 dB SINAD): Not specified.	FM, 12 dB SINAD: 100 MHz, 1.44 μV.
Blocking dynamic range: Not specified.	SSB mode, 14 MHz: 95 dB.
Two-tone, third-order IMD dynamic range: Not specified.	SSB mode, 14 MHz: 81 dB.

NOTE: Except as noted, all dynamic-range measurements were taken using the ARRL Lab standard spacing of 20 kHz. All measurements were made with the **DX/LOCAL** switch set to **DX** and the **TONE** switch set to "high."

Sangean ATS-909, serial number 40640653

Manufacturer's Specifications	*Measured in ARRL Lab*
Frequency coverage: AM, SSB, 153-1710 kHz; 1.7-30 MHz. FM, 87.5-108 MHz. .	As specified.
Modes of operation: AM, FM, SSB (CW).	As specified.
Power requirements: 6 V at 300 mA.	6 V at 78 mA.
Size (HWD): $5^1/_2 \times 8^1/_2 \times 1^1/_2$ in; weight, 2 lb, 2 oz (with batteries and carrying case).	
SSB sensitivity: Not specified.	Minimum discernible signal: 180 kHz, 0.14 μV; 1 MHz, 0.06 μV; 14 MHz, 0.06 μV.
AM sensitivity (10 dB [S+N]/N): Not specified.	AM, test signal modulated 30% with a 1-kHz tone,10 dB (S+N)/N: 1 MHz, 0.67 μV; 14 MHz, 0.71 μV.
FM BC sensitivity (12 dB SINAD): Not specified.	FM, 12 dB SINAD: 100 MHz, 1.8 μV.
Blocking dynamic range: Not specified.	SSB mode, 14 MHz: 85 dB.
Two-tone, third-order IMD dynamic range: Not specified.	SSB mode, 14 MHz: 80 dB, noise-limited.

NOTE: Except as noted, all dynamic-range measurements were taken using the ARRL Lab standard spacing of 20 kHz. All measurements were made with the **AM RF GAIN** control set to maximum, the **NARR/WIDE** switch set to NARR, and the **TONE** switch set to "music."

the Panasonic RF-B45 and the Grundig YB-400. The *big* differences become apparent when you take a close look at the ATS-909's array of features.

The "gee whiz" goodies begin with the *ATS—Automatic Tuning System*. This feature operates in similar fashion to the automatic channel setup that many TVs include these days. Let's say you're vacationing in a distant town and you want to quickly program the ATS-909 for all the strongest FM stations in the area. Just press the FM band button for a couple of seconds and the radio scans the dial for signals and stores the 18 strongest stations in memory. You can quickly zip through the lineup using the keypad. ATS does the same for the AM broadcast band, storing the nine strongest stations it can find. This function does not work on shortwave, however.

Of course, you can still punch in frequencies (or bands) directly from the keypad, or sweep through the bands with the tuning buttons or the **MANUAL TUNING** knob. Hams will definitely appreciate the manual tuning knob; it even has "fast" (1 kHz) and "slow" (40 Hz) step settings. Thanks to its adjustable "resolution," there is no need for a separate **FINE TUNING** knob when you're listening to CW or SSB. By the way, the ATS-909 doesn't make you squint to see the dial. It's nice and large.

The ATS-909 sports an elaborate memory system involving the concept of "pages." Not only can you store frequencies, you can store *modes*. The ATS-909 remembers if the station was in AM, lower sideband or upper sideband. You can even store short "labels" for each memory channel—the station call sign, for example. Memory names can be up to eight alphanumeric characters long. The radio comes complete with 30 preprogrammed stations. The list includes Deutsche Welle, BBC, Radio Netherlands, Voice of America, Radio Vlaanderen International, Radio Japan, and the Christian Science Monitor.

The ATS-909 is the only radio in this review—and one of the few in this category—to offer the *Radio Data System* on FM (the radio provides stereo FM listening via the supplied headset). An increasing number of FM stations are sending data subcarriers containing information such as the station's call sign and format. When you tune the ATS-909 to an RDS station, the call sign of the station will appear in the LCD display within a few seconds. You need to have a fairly strong signal for this to work, though. You'll also discover that some stations are now using RDS to send weather information, commercial messages and so on.

A few RDS subcarriers contain time codes. If you're fortunate enough to find one of these, the ATS-909 will automatically update its internal clock every 60 seconds! You can also recall the time in 42 cities worldwide.

Many portables offer a **Local/DX** attenuator switch, but the ATS-909 takes the concept to the next logical step. It offers a *variable* RF attenuator, so that you can choose the exact level of attenuation you desire. There are wide and narrow AM audio filters and push-button selection for LSB and USB. By the way, the accessories include a little "antenna on a reel" for portable use.

You have your choice of three separate standby timers and a sleep timer. In addition to a fixed-level audio-output jack for recording, there is a switched "standby" line to start your recorder automatically. That's a super feature for recording a program while you are away or asleep. The ATS-909 has two intriguing **DATA IN** connections on the bottom of the set (next to the **RESET** button) but the *Operating Instructions* booklet does not mention these.

Considering that the radio was a real crowd-pleaser, the *Operating Instructions* booklet was a bit of a disappointment, mainly because it lacked detail and the kind of step-by-step approach many users appreciate. Instructions were in four languages, English, Spanish, German and French.

Manufacturer: Sangean Electronics Inc. *Supplied accessories:* AC adapter cube; external antenna on a reel with 24 feet of wire; stereo headphones with 32 inch cord; soft carrying case; *Quick-Start* guide, *Guide to World Radio. Battery requirements:* four AA cells.

Sony ICF-2010

This receiver is the largest and most complex of the group. It's still a portable radio, but its size almost puts it in the tabletop class. The ICF-2010 has been on the market for about a dozen years now, and some would consider it a "classic" of this genre (Sony offers a line of smaller sets, including the ICF-SW7600G).

The ICF-2010 can seem a bit intimidating at first sight. There are buttons everywhere; a total of 68 in all. Despite appearances, the radio is relatively easy to operate. Direct frequency entry is a matter of punching the necessary digits, followed by a tap on the **EXECUTE** button.

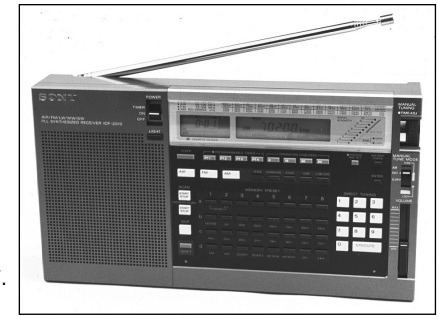
Accessing memory channels is not as straightforward. The 32 available channels are represented by four rows of eight buttons each. These aren't marked 1 through 32, as you might expect. It's a bit more like using a jukebox (remember those?). The buttons are laid out in matrix fashion, with the rows marked A to D and the columns, 1 through 8. So it takes a two-finger operation to store a frequency in memory slot "B4" or "D6."

The ICF-2010 has the widest frequency coverage of any radio in this review. It begins at 150 kHz and extends to the top of the aeronautical band at 136 MHz, with breaks at 30 to 76 MHz and 108 to 116 MHz.

You can scan between two chosen frequencies, stopping when a signal is picked

Sony ICF-2010, serial number 359167

Manufacturer's Specifications	*Measured in ARRL Lab*
Frequency coverage: AM, SSB, 0.15-30 MHz. FM, 76-108 MHz. Aircraft AM, 116-136 MHz.	As specified.
Modes of operation: AM, FM, SSB (CW).	As specified.
Power requirements: 4.5 V (radio), current consumption not specified; 3 V (computer).	4.5 V at 150 mA.
Size (HWD): $6^1/_2 \times 11^1/_4 \times 1^3/_4$; weight, 3 lb, 8 oz (with batteries).	
SSB sensitivity: Not specified.	Minimum discernible signal: 180 kHz, 1.64 μV; 1 MHz, 0.58 μV; 14 MHz, 0.04 μV.
AM sensitivity: Not specified.	AM, test signal modulated 30% with a 1-kHz tone, 10 dB (S+N)/N: 1 MHz, 9.99 μV; 14 MHz, 0.78 μV; 120 MHz, 1.55 μV.
FM BC sensitivity (12 dB SINAD): Not specified.	FM, 12 dB SINAD: 100 MHz, 1.15 μV.
Blocking dynamic range: Not specified.	SSB mode, 14 MHz: 112 dB.
Two-tone, third-order IMD dynamic range: Not specified.	SSB mode, 14 MHz: 82 dB.



NOTE: Except as noted, all dynamic-range measurements were taken using the ARRL Lab standard spacing of 20 kHz. All measurements were made with the **DX/LOCAL** switch set to **DX**, the **AM RF GAIN** control set to max, the **NARROW** switch enabled, and the **TONE** switch set to "high."

up, or scan through the 32-channel memory. In that case, the 2010 stops at each "occupied" memory channel for 5 seconds, then moves to the next. You can also opt for manual tuning, using the convenient knob or push buttons. The tuning increments in 50 kHz steps on FM, 25 kHz on the aeronautical band, and either 1 kHz or 100 Hz on shortwave. There is no fine tuning control. (This made clear SSB reception difficult at times.)

The ICF-2010 is the only radio in the group to offer AM synchronous detection. This feature can greatly improve shortwave broadcast reception. You simply press the **SYNC** button and the 2010 switches to SSB (either upper or lower sideband) and locks onto the station's carrier, generating an internal carrier of its own to match it. The result is a signal that's less prone to a type of annoying distortion caused by signal fading. In our tests the ICF-2010 was able to maintain carrier lock on all but the weakest stations.

This is a very sensitive radio. You'll find yourself using the variable RF attenuator often if you hook the ICF-2010 to an outside antenna. There are selectable wide and narrow audio filters, but their effects are minimal. Signal strength is displayed on a scale using 10 bright red LEDs. This "meter" also doubles as a battery indicator.

Other features include an array of sleep and standby timers, as well as a line-level audio output jack for recording. Unfortunately, the audio level at the jack is low, so you'll probably have to use the microphone input on your recorder instead of the line input. A three-position tone control is available, but the middle setting seems sufficient for most types of listening.

Manufacturer: Sony Corporation. *Supplied accessories:* AC adapter; monophonic earpiece with 42 inch cord; external reel antenna with 21 feet of wire; two antenna connection adapters; shoulder strap; *Wave Handbook—Short Wave Stations of the World*; *Aviation Guide*. *Battery requirements:* 3 D cells for the radio and two AA cells for the CPU and the clock.

Beyond Just *Listening* ...

These portable shortwave receivers were never intended to function as components of an Amateur Radio station. But you *know* some screwy ham is going to try to use them in that fashion. A ham like me, for instance.

I spent a weekend putting all four radios to the test in three applications: RTTY, QRP CW and satellite (using RS-12, which has downlink on 10 meters). The results were surprising!

RTTY: I used the *RITTY* software package by Brian Beezley, K6STI, for this test. It was a simple matter to feed the audio from the receivers to my PC sound card. The difficult part was switching between my IC-706 transceiver for transmitting and the portable receiver for listening. With some delicate legerdemain, however, I managed to pull it off—most of the time. The only receiver that I couldn't adapt to this application was the Sony ICF-2010. Without a fine tuning control or very small tuning steps, it was often impossible to properly tune RTTY signals.

QRP CW: Every receiver did remarkably well in these tests. It was as easy as using my IC-706 (set to low power) on 20 meters. With the receiver's telescoping whip antennas I was able to work the stronger stations and enjoy a crude form of "diversity reception." With a simple antenna switch, a little QRP transmitter and one of these receivers, you could put together a "vacation" QRP station!

Satellite: Every receiver was able to pick up RS-12's downlink signal to some extent, but the Sony ICF-2010 was especially sensitive in this application. In each case I used the built-in antennas to receive the bird, but an external antenna would offer a significant improvement. By keying my IC-706 within RS-12's 15 meter uplink passband, I was able to hear myself through the satellite and contact a few stations. The performance wasn't terrific, but it *worked*. Sometimes, that's all that matters. —*WB8IMY*

Summary

We've looked at just four of the many similar portable shortwave receivers out on the market today. The vast selection includes other models by these same manufacturers as well as several other makers. Happy listening!

A special thanks to Al Brogdon, W1AB, and Rick Lindquist, N1RL, for their assistance in the preparation of this review.

Radio Shack Probe-Style Oscilloscope

By Larry Wolfgang, WR1B
Senior Assistant Technical Editor

What is a probe-style oscilloscope, and how can it fit in such a small box? Those were just a couple of my questions when Rick Lindquist, N1RL, first asked me if I'd be interested in reviewing this little device. The pictures on the box looked interesting, and the description certainly was intriguing: "Ideal for on-the-spot testing of electronic circuits; freeze-and-hold function allows comparison of waveforms; 20-MHz maximum sampling rate provides 5-MHz effective bandwidth; view waveforms or voltage readout on a 16×32-pixel LCD; displays time or Hertz between defined points; 10 pushbutton-selectable sampling rates from 50 nanoseconds to 1 millisecond." Yes, this certainly sounds interesting. The box also says it operates alone or with your computer, and DOS and *Windows* software is included!

I don't own an oscilloscope, but I know there are many useful tests and measurements I could perform if I had one. There are even a few projects lying around that have puzzled me for some time now, and I'll bet I could get them working with the help of a 'scope. "Sure, I'll review this gadget, Rick."

It looks simple enough. The probe is about the size of a simple logic probe, and looks a lot like one, too, with a body that fits comfortably in my hand and with a metal tip that is about 3/4-inch long sticking out the front. The power cord has a pair of alligator clips on one end for connection to a source of dc between 9 and 13 V dc. You could connect this to a bench-top 12-V power supply, but I opted for connecting the alligator clips to the terminals on a 9-V battery. An ac adapter is optional, if you'd prefer that.

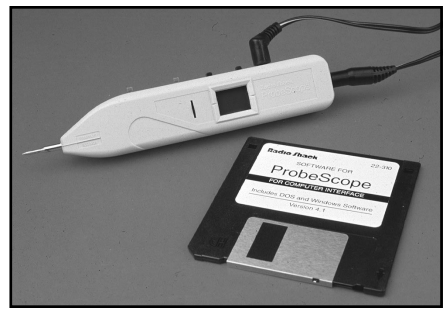
That's it. The display says "Probe Scope," and it's ready to go as soon as you plug in the power. One tiny blue button steps through a menu of choices and a second button selects choices for each option. For example, the display says "TIMEBASE" and displays the current value. Press the second button to step through the choices until you select the desired sampling rate. (This is a digital device, and you are selecting the sampling rate for the analog to digital converter here.) You also select *Auto Trigger*, *Internal +*, *Internal –*, *External +* or *External –* triggering—and the triggering level if you select anything but *Auto*. The last menu choice allows you to set the probe to function as an oscilloscope or a digital voltmeter. Just to the left of the display is the edge of a small wheel that controls a potentiometer to set the zero level, or axis on the scope.

Before you connect the probe to your test circuit be sure to set the input voltage selector to the expected range of maximum signal level (100 V, 10 V or 1 V). If you aren't sure, always select a higher voltage level.

Table 3

HP Signal Generator and HP Power Meter			*Radio Shack Probe Scope*		
Frequency	*dBm*	*V RMS*	*Frequency*	*V P-P*	*V RMS*
5.0000 MHz	0.4	0.234	5.00000 MHz	0.62	0.22
4.0000 MHz	0.4	0.234	4.00000 MHz	0.65	0.22
3.0000 MHz	0.4	0.234	3.33333 MHz*	0.65	0.22
3.3333 MHz	0.4	0.234	3.33333 MHz	0.65	0.22
2.5000 MHz	0.4	0.234	2.50000 MHz	0.65	0.22
2.5000 MHz	–0.53	0.210	2.50000 MHz	0.60	0.20
2.5000 MHz	–2.52	0.167	2.50000 MHz	0.48	0.17
2.0000 MHz	0.5	0.237	2.00000 MHz	0.65	0.22
1.5000 MHz	0.4	0.234	1.53846 MHz	0.65	0.22
1.0000 MHz	0.4	0.234	1.00000 MHz	0.68	0.22
0.5000 MHz	0.6	0.240	0.50000 MHz	0.68	0.22
0.5000 MHz	–5.35	0.121	0.50000 MHz	0.37	0.12
0.5000 MHz	2.7	0.305	0.50000 MHz	0.86	0.30
0.5000 MHz	3.61	0.339	0.50000 MHz	0.97	0.33

*Marking 2 cycles on the scope display and multiplying by 2 gave f = 3.07692 MHz.



Also set the input coupling for ac or dc, according to the expected signal you are about to measure. Now plug one of the supplied clip leads in to the GND terminal and attach the small push-clip to an appropriate ground point. Touch the probe tip to the test point in your circuit and you are making measurements.

The built-in LCD display is quite limited, and it is difficult to make much sense out of the waveform display. You may have to try a variety of sampling rates to get much of a pattern. Even at its best, this display isn't going to show you much detail. It may be enough to give you an indication of what is going on, though. In DVM mode, the display clearly shows the voltage.

Enter the Computer

Okay, the truth is, you can make some simple measurements with the Probe Scope as just described. It is really convenient to carry into "the field" for some help with your troubleshooting. If that's all it did, though, you would be left feeling kind of empty. This is where the computer interface comes into play. Install the software, which is supplied on a 3 1/2 inch 1.44 MB disk. To use the *Windows* version, you'll need at least a '386 computer with 400 kB of available hard disk space and *Windows* 3.1 or later—it ran with no problems under *Windows 95* on my computer. Alternatively, to run the DOS version of the software you'll need 800 kB of hard disk space and DOS 3.3 or later. (There is no mention of the required processor to run it under DOS, and I didn't have access to anything less than a '386 to try it on.) Connect the supplied interface cable to a serial port, plug it into the serial jack on your Probe Scope, and you are ready for some real work! (The cable has a 9-pin serial plug. If your computer has a 25-pin serial port, you will need an adapter.)

The computer screen provides an enlarged horizontal and vertical display area as well as other handy information—such as the time base, trigger mode, type of coupling and voltage per division. The *Windows* version also includes a handy toolbar that allows you to quickly freeze the display, select the DVM readout and show or hide other display features.

The DOS software produces a similar display, but you must use pull-down menus and keyboard commands rather than simply clicking on a tool button. I recommend the *Windows* version, if you can use it.

A Useful Troubleshooting Tool

One of the first tasks I tackled with the Probe Scope was the fine adjustment of an electronic keyer I had built. The weighting adjustment was not *quite* right, but with the scope I was able to display a dot, a dash and the space between them with relative ease. Then it was a simple matter to tweak the weighting adjustment. This keyer also in-

BOTTOM LINE

The Radio Shack Probe-Style Oscilloscope is a good value. It won't take the place of a dual-trace 50 MHz Tektronix or similar scope. But if you want a piece of test equipment that won't fill your workbench (or collapse it!) and won't break your bank account, this is worth a careful look.

cludes a "speed meter" feature, so you can read the approximate keying speed on a 50 µA meter. I could adjust the speed trim potentiometer by ear so the readout was close to the correct speed, but again the scope made it easy to obtain a more accurate adjustment by measuring a single dot time (Figure 1 shows the display I obtained for the weighting adjustment).

Some months ago I installed a CTCSS tone encoder board in my old Santec ST-142 2 meter hand-held radio. The tone encoder would not work, and I had not yet figured out why. The Probe Scope quickly helped me determine that the encoder was, in fact, producing a nice clean sine-wave signal with approximately the correct frequency when I connected it directly to the H-T battery.

Using the Probe Scope in DVM mode, I then determined that the "ground" connection the instructions had suggested was, in fact, *not* a ground connection! My analog multimeter had given me a false indication, but the DVM quickly identified the problem. In short order, I had the encoder working as originally expected!

Measuring the frequency and voltage of a signal couldn't be much easier. Measure the voltage by dragging the horizontal display bars to the center and top of the waveform to indicate peak voltage or set them along the top and bottom of the waveform for peak to peak values. Likewise, you simply drag the vertical display bars to mark off a single cycle and click the **HZ/SEC** button to display the frequency of your signal (Figure 2 shows the display for such measurements on a 200 Hz tone from my CTCSS board). Notice that the signal is slightly less than 10 V peak-to-peak, which is just under 5 V peak. That corresponds to 3.3 V RMS, which is what the DVM readout on the screen displays.

Caution is in Order

The Probe Scope samples the signal at a rate determined by the selected time base. If the signal you are measuring has a frequency that is too *high* for the selected time base, you will see *aliasing* of the displayed signal. Selecting a faster time base restores the proper display. Basically, you have to sample a signal waveform more than twice during each cycle. If you sample the signal less than twice during each cycle, then the samples will create a waveform with a frequency that is less than that of the actual sampled waveform.

For example, I was displaying the sine-wave output of a signal generator, and as I adjusted the frequency I noticed what appeared to be a low-frequency modulation on a higher-frequency signal. As I tuned to a lower signal frequency, however, the display came back to a nice sine wave. After tuning back to the distorted waveform, I changed to a faster time base on the Probe Scope. The display quickly jumped to a perfect sine-wave picture again.

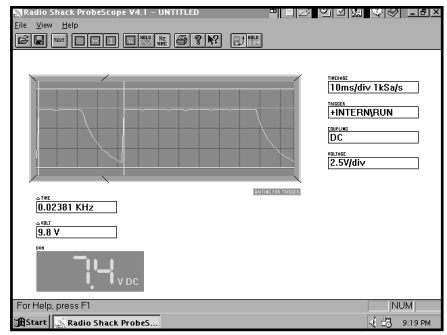


Figure 1—The waveform display of a dot and dash from a keyer made weighting adjustment easy.

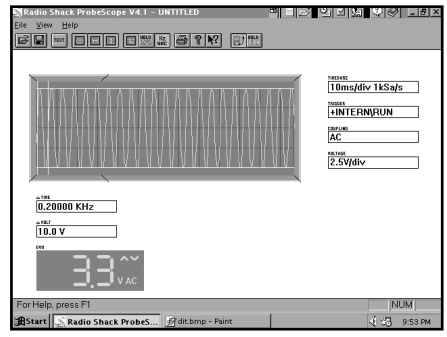


Figure 2—Measuring the frequency and amplitude of this 200 Hz signal from a CTCSS board is simple. Notice the vertical bars aligned with the crest of successive cycles near the left edge. They measure frequency, and the readout is below the display.

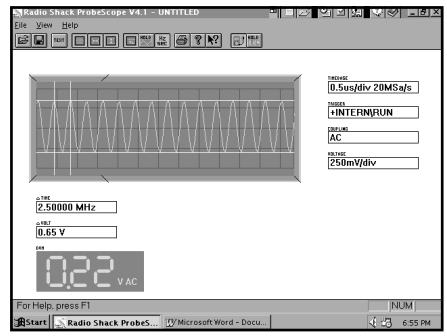


Figure 3—This screen shows a 2.5 MHz signal displayed by the Radio Shack Probe-Style Oscilloscope.

You can also experience this problem when you are using the Probe Scope in DVM mode to measure an ac voltage. If the sampling rate is too low, the display will appear to jump between several voltages. By selecting a faster sampling rate, you will see the correct number appear.

A distorted waveform isn't the only problem aliasing can produce. At one point, I measured a 2.5 MHz signal but with an incorrect sampling rate selected. The display was fine—a nice sine wave—but the readout indicated the frequency was 5.0 kHz, not 2.5 MHz!

Comparison Measurements

So, how accurate is this thing, anyway? Can I trust the measurements? I used a Hewlett-Packard 8640B signal generator from the ARRL lab to produce some signals with known frequency and amplitude. I used a 50 Ω resistor as a constant termination for the signal generator, and took readings across the resistor with the Probe Scope. (Mike Gruber, W1DG, measured the signal generator output values using an accurate Hewlett-Packard 435B power meter.) Table 3 shows the comparison between the readings I obtained with the Probe Scope and the Lab-measured signal generator output values. I was amazed when I started looking at the numbers. The Probe Scope was measuring frequency as accurately as the HP signal generator, and it was measuring peak-to-peak and RMS voltages to within the calibration accuracy of the lab instrument!

I was picking nice round frequency values, and using a nearly constant amplitude signal. Things may not have looked so rosy had I picked other values. For example, look at the 3.0 MHz measurement. The Probe Scope measured that signal at 3.33333 MHz. This is another way the digital limitations of the scope show up. The frequency measurement is limited by the sampling values. By sliding the measuring bars back and forth across the sine wave peak, I could get values above and below 3.0 MHz, but not exactly 3.0. By selecting two cycles of the waveform, the display showed a frequency of 1.53846 MHz. Multiply that value by 2, and the result is 3.07692 MHz, much closer to the expected value. I changed the signal generator output frequency to 3.3333 MHz and the Probe Scope continued to read 3.33333 MHz. This problem showed up again when I selected a signal at 1.5000 MHz.

The Probe Scope is capable of making measurements that are quite accurate. The results are limited by the digital sampling rate, however, and that can create some misleading results. It was easy for me to see these problems while I was measuring sine waves with known frequency. It may not be as obvious when you are measuring a complex waveform with unknown frequency components. But remember: Caution is in order.

Made in Germany and distributed by: Radio Shack, a Division of Tandy Corp, Fort Worth, TX 76102. Probe-style oscilloscope, model 22-310, $100; AC adapter, Catalog No. 273-1651, $12. QST