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Heath HO-5404 Station Monitor

Conducted By Bruce O. Williams, WA6IVC
Assistant Technical Editor

Heath HO-5404 Station Monitor

Heath's latest offering in a line of station monitor scopes traces its ancestry over a period of about 23 years.[1] The first of the line was the venerable HO-10, still used in a number of shacks today. Next came the SB-610, much of it a carbon copy of the HO-10 internally, but in the then-new Heath two-tone green cabinet. The SB-614 was the successor to the SB-610, and in addition to again changing the external appearance of the unit, Heath made the transition from vacuum-tube circuits to a solid-state design. I've owned an HO-10 and an SB-610, but missed out on the '614, so I was anxious to get my hands on the '5404 when it was announced.

Why Use a Monitor Scope?

There probably is no better way than using a monitor scope to have a good idea of what outgoing, and to some extent, incoming signals are doing. When operating CW, for instance, you can adjust the monitor to display the output waveform and observe the keyed-wave shaping. No, you can't *see* key clicks (not on a monitor scope, you'd need a spectrum analyzer for that), but the shape of the wave can tell you if the *possibility* of generating clicks exists. On SSB, you'll easily be able to tell if you're "flat-topping" and making yourself unliked by your on-band neighbors. When operating RTTY, you can set up the monitor scope to view the incoming tones from your modem and tune for the well-known RTTY cross pattern. By tapping into your receiver audio output or IF strip, you can monitor (in different ways) incoming signals.

Description

The '5404 is housed in a steel, U-shaped cabinet with a matching top. The front-panel labels and the CRT graticule are all imprinted on a single, adhesive-backed sheet. A single transformer with multiple secondary windings provides the low, medium and high voltages that are required by the scope.

Comparing the SB-614 and HO-5404 schematic diagrams shows that the two scopes are almost identical electrically. The primary difference between the two is the addition of the panoramic adapter circuit to the '5404.

The optional pan adapter (HOA-5404-1) taps into your receiver IF strip. This unit allows you to monitor band activity within selectable ±20-kHz or ±100-kHz segments from the center frequency to which the receiver or transceiver is tuned. Some transceivers provide access to the IF strip for just such a purpose. Heath offers a choice of one of two IFs for use with the pan adapter: 3.395 or 8.830 MHz.

What's Inside

An inside view of the scope is shown in Fig 1. At the top is the 3RP1A CRT, immediately behind which is the shielded compartment that houses the demodulator board and antenna port ATTENUATOR switch. A shaft connects the front panel knob to the ATTENUATOR switch. Although this control is a rotary switch, it does not have a detent, and feels much like a potentiometer when rotated.

The small shielded compartment on the rear panel houses the horizontal and vertical input ATTENUATOR switch and the VERT and HORIZ input phono jacks. Next to that is the pan adapter board mounting location (the pan adapter board is the small board in the foreground). The pan adapter board is mounted on a steel plate that is secured to the rear panel with sheet-metal screws. The power transformer (to the top-right of the pan adapter board) is hidden beneath the pan adapter board when it is in place.

The main board occupies a large portion of the chassis floor. Low- and high-voltage power supply components take up a good portion of the board area.

A gang of seven push-button switches is mounted behind the front panel. The push-button switches are not mutually exclusive types. For some operations, you need to use two or more of the switches.

The seven potentiometers for the front-panel controls (not visible in this view) are beneath the switches. The black object to the top left of the power transformer is a cardboard shield that covers a terminal strip to which the transformer primary leads and fuse are attached.

Block Diagrams

A block diagram of the HO-5404 is shown in Fig 2. Fig 3 is a block diagram of the pan adapter board. There are basically five sections to the HO-5404: the outgoing-signal

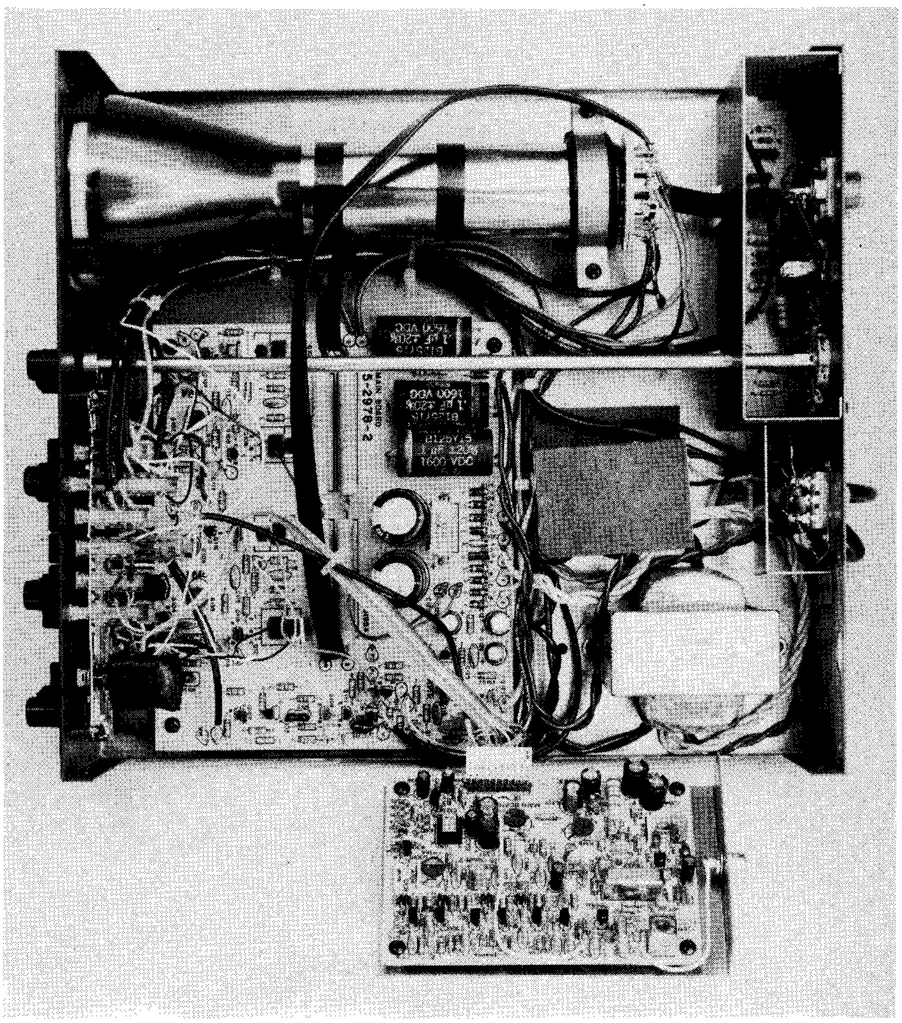


Fig 1—An inside view of the HO-5404. Refer to the text for a "tour" of the scope.

[1]Notes appear on page 33.

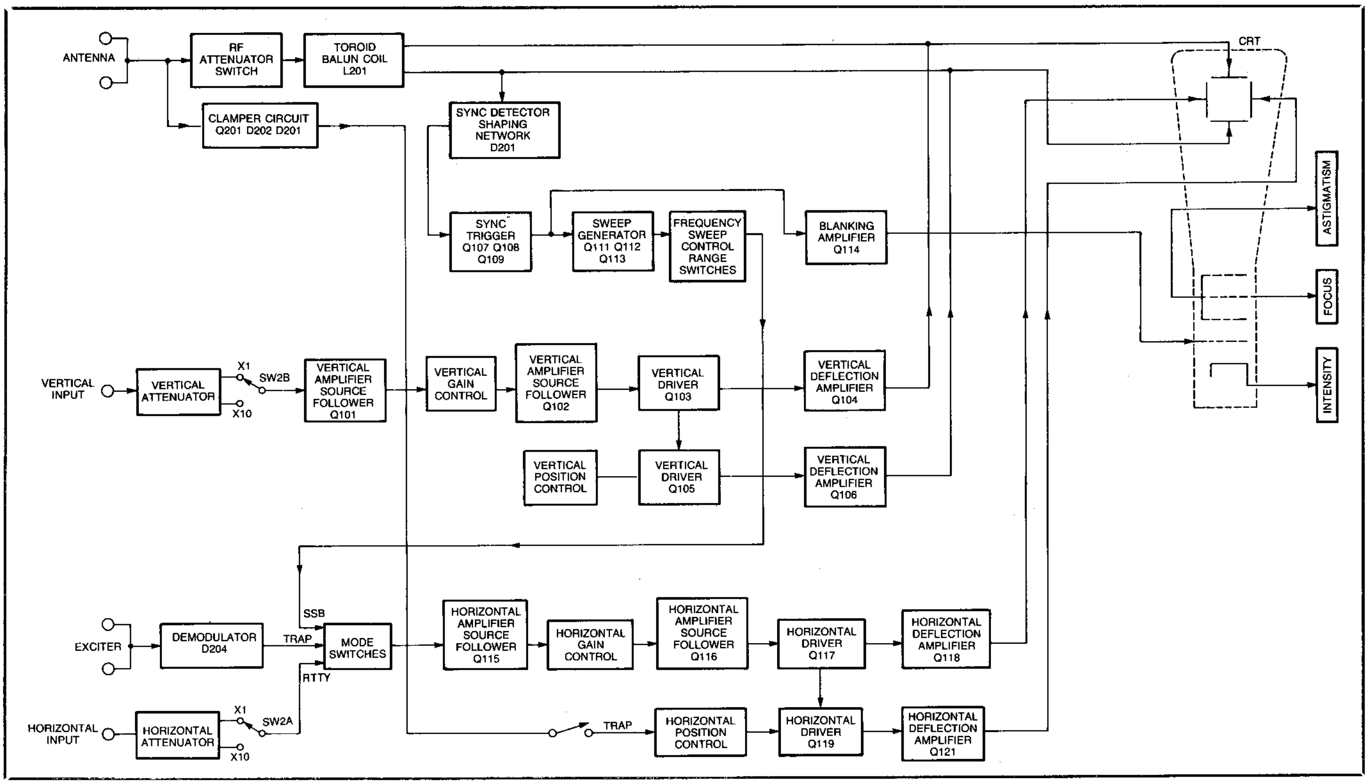


Fig 2—Block diagram of the HO-5404. A brief description is given in the text.

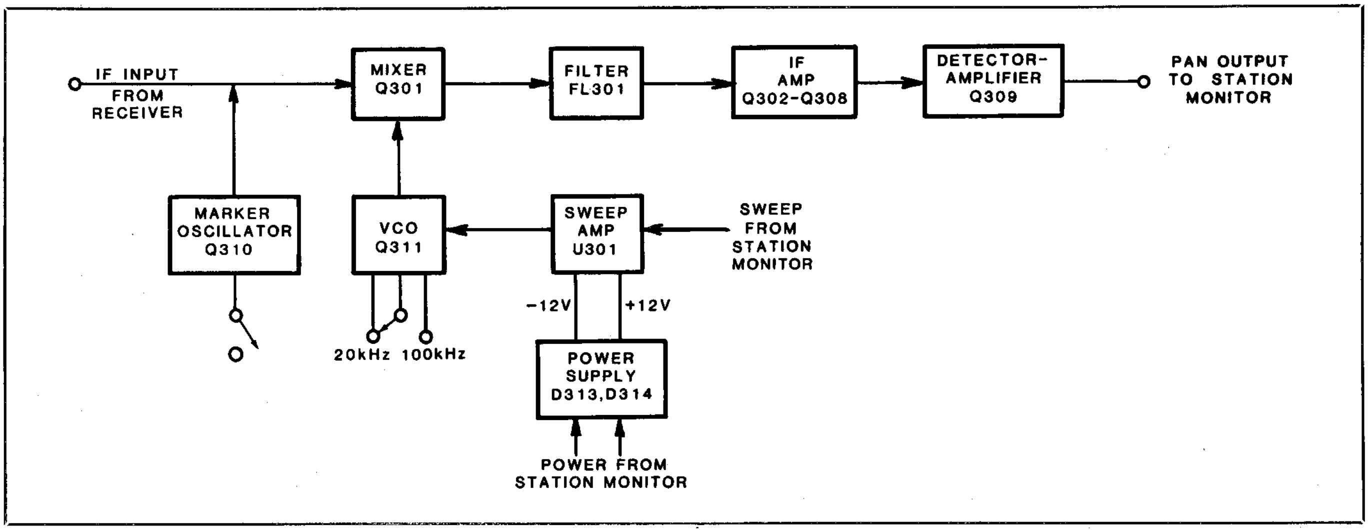


Fig 3—Block diagram of the pan adapter board. A 455-kHz crystal filter is used in the IF strip. One of two IFs (3.395 or 8.830 MHz) can be accommodated during construction by appropriate choice of components.

demodulator, the pan adapter, vertical and horizontal low-frequency input circuits, the main signal-processing circuits and the high- and low-voltage power supplies. The EXCITER and ANTENNA jacks are through connections and are used as tap points to sample the signals applied at those ports. Attenuators for the VERT and HORIZ inputs are switched simultaneously by a DPDT slide switch. A clamper circuit (sampling at the ANTENNA jacks) keeps the CRT from being burned when using the RF trapezoid method of checking amplifier linearity. The clamper does this by moving the trace off the screen when no signal is present.

Kit Assembly

Three errata sheets and two additional components were supplied for correction and addition to the basic kits. Additionally, I found one incorrect item supplied: a 1-kΩ resistor in place of the required 10-kΩ resistor. Since you construct the pan adapter for use at only one IF (3.395 or 8.830 MHz), you'll have some parts left over.

Two circuit boards—the demodulator and main boards—hold most of the components in the '5404. The optional pan adapter adds a third board that sits above the power transformer. The 3RP1A CRT is equipped with a mu-metal shield that is wrapped around the neck of the tube. Shield partitions are provided between the demodulator board and the rest of the circuitry, and another shield covers the ATTENUATOR switch and VERTical and HORIZontal input-jack section.

It took me a total of 12 hours to assemble the basic '5404 and another 3 hours to complete the pan adapter board. Overall alignment and testing consumed another five hours. I ran into some difficulty during initial testing of the main unit: The dot on the screen kept dancing around and varying in size. I realized this to be a high-voltage problem and, after a couple of checks, suspected the power transformer as being the culprit. I made a tube from a sheet of paper and placed one end to my ear and the other end near the transformer. Sure enough, an intermittent "bzz-bzz" could be heard, indicating all was not right. I called Heath Technical Service, described the symptoms and requested a new power transformer. The new transformer cured the problem. The rest of the main-unit alignment proceeded without difficulty.

I recommend allowing the scope to warm up for a few minutes before attempting any alignment procedures as there is a noticeable amount of drift during the first 15 minutes or so. When aligning the pan adapter board, one of the procedures calls for centering 100- and 20-kHz marker pips at the center of the screen. The 100-kHz marker pip was relatively easy to locate, but the 20-kHz marker continued to evade me. It took several attempts at the adjustments before I got the 20-kHz marker on the screen. Checking this adjustment over a period of days, I found the centering of the 20-kHz marker to be unreliable: Sometimes it was "on the money," at other times it might be off screen. Using a discarded hair dryer as a heat source and some cooling spray, I learned that the small inductor in the VCO (L303) was quite temperature sensitive. Another call to Heath's Technical Service brought a replacement inductor. The replacement is approximately twice the physical size of the original. After installing the new inductor, I had to go through the alignment procedure once again. Initially, the marker seemed to be more stable, but over a period of days, even with the new inductor, the marker centering was still unreliable. During transport to the ARRL Lab, the markers once again were lost and the set-up procedure had to be repeated.

The VCO components are sensitive to hand capacitance, which is not surprising since everything is out in the open. Also, the position of the VCO components relative to each other can affect adjustment. I found that by varying the position of a capacitor (C336) relative to a diode (D312), for instance, I had a vernier control of the pip position.

You must install the enclosure cover so that the perforated portion is above the pan adapter board. Doing so allows you to reach the pan adapter board variable controls with an adjusting tool that you assemble from parts supplied. More than likely it will be necessary to readjust the controls once the cover is in place.

Hookups

Four large pictorial diagrams show you how to hook up the HO-5404 to the rest of your station equipment. The simplest of these hookups is that used for monitoring incoming signals using the audio output of your receiver. You merely connect a pair of wires between the receiver speaker terminals and the VERT jack on the '5404. This shows you what demodulated audio looks like. So many variables can affect what you see (as Heath quite clearly points out), that I'd be quite reluctant to make any sort of judgment regarding signal quality using this procedure.

For transmitter/transceiver connections, two different sets of input/output jacks can be used. If you're running "barefoot" (using just a transmitter or transceiver, no amplifier), you connect the output of the transceiver to one of the ANTENNA jacks and connect the second ANTENNA jack to the antenna circuit. If you want to hook an amplifier into the line and be able to check for linearity using a trapezoid pattern, a different arrangement is used. In this case, the transceiver is connected to one of the EXCITER jacks and the other EXCITER jack is hooked to the amplifier input. The output of the amplifier is connected to one of the ANTENNA jacks and, as before, the other ANTENNA jack is cabled to the antenna circuit.

Because there are specific power limitations for the EXCITER and ANTENNA jack circuits (see the specifications table), be sure to use the correct cabling procedure. If you don't, you're liable to damage the scope and possibly something else.

To display the RTTY cross pattern, the VERT and HORIZ jacks are used. The SPACE channel scope output of your modem connects to the HORIZ jack, and the MARK channel is wired to the VERT jack. Using the '5404 as a crossed-ellipse tuning indicator for RTTY is a better alternative than most LED displays I've seen. But the display is small —¾ × ¾ inch. Whether you see nice, sharp ellipses or "bananas" will depend on the demodulator you're using and the amount of shift: 170-Hz shift will probably look more "bananaish" than 850-Hz shift.

Heath says you can use the '5404 to some extent as a bench oscilloscope. The manual mentions that such applications must not require high sweep frequencies or high vertical amplifier gain. Signal frequencies from 10 Hz to 40 kHz can be displayed. The 10:1 vertical and horizontal input attenuator (controlled by the rear-panel ATTENUATOR switch) is designed to maintain a constant input impedance regardless of the switch position. To use the '5404 as a test scope, you attach a scope probe (not supplied) to the VERT input jack on the rear panel. But don't expect too much from the '5404 in this application—it's not designed to be a workbench troubleshooter.

Comments

I noticed that the trace on the '5404 is much sharper than that of an HO-10 and SB-610. You'll find that the HORIZONTAL and VERTICAL position controls move the spot rapidly across the screen, so work them slowly. If you can't find the spot by rotating the controls during initial adjustment, turn the scope off and watch for the spot to move onto the screen as the power supply dies. (In my case, it invariably came in from the top-right of the CRT.) That will give you a clue as to how to adjust the controls to center the spot.

The combination of the FOCUS and ASTIGMATISM controls allows for fine adjustment of the trace thickness.

I'm not a fan of internally mounted fuses. Sure, you shouldn't have to replace a fuse often, but when you do, it's nice to be able to get at it quickly. With the terminal-strip-mounted fuse, it's a bit of a bother to replace. At least it's not a pigtail fuse, and can be snapped in and out of the holder clips easily.

Because of the way the front-panel ATTENUATOR control is arranged—an undetented switch selection of one of nine capacitors—the attenuation of the signal applied to the ANTENNA jacks is stepped rather than smooth. The control action feels like that of a potentiometer, but it doesn't act like one. Also, you must pay attention to the setting of this ATTENUATOR control during transmit: Heath warns of this. If there is too little attenuation in the line (the waveform amplitude should be within the graticule area), a toroid and a resistor on the demodulator board (L201 and R201) can overheat and may be damaged. With only a bit of experience, however, maintaining a proper setting of the control should be no problem.

Input Power Limitations

According to the manual, care must be taken to minimize the key-down time of 1-kW level transmitted signals passed through the scope. Unfortunately, no specific time limit is given, so you're left to your own guesstimates. Though the manual mentions that 1-kW keyed CW and voice-modulated SSB signals should not present a problem, no reference is made to RTTY signals. RTTY in all its forms has become a popular mode of communication. RTTY operation is a key-down mode with a single average transmission lasting anywhere from 10 minutes to a half hour or more, depending on how talkative the operator happens to be or the traffic being handled. Also, the 1-kW power-*input* limitation of the Amateur Radio service has been surpassed by the 1500-W power-*output* ruling. Again, I called Heath's Technical Service to inquire about the ambiguous key-down time limit. Regrettably, the technician could provide me only with a guess: "about two minutes."

In the ARRL Lab, the HO-5404 survived a 15-minute key-down test with 1-kW of transmitter output power being fed through it. On 15 meters, however, the insulating material in the upper SO-239 ANTENNA coaxial connector started to bubble. It turned out that I'd not securely fastened the connector to the chassis. Once the screws were tightened, the bubbling process stopped, but the two ANTENNA connectors were warm to the touch. The bubbling process reminded me of another situation I'd encountered—with the SA-2040 Antenna Tuner.[2] In the course of testing that piece of equipment, one of the coaxial output connectors melted and burned briefly with a visible flame. Heath replaced the connectors in the '2040 with ones having Teflon® insulation.

There are two ways of monitoring received signals with the HO-5404: Using the audio output of your receiver or connecting to the receiver IF strip. To effectively use the IF strip and obtain believable results, the bandwidth of the IF strip should be about 10 times the modulating (in this case, received) frequency. For a 3-kHz-wide signal, that amounts to a 30-kHz IF bandwidth. If you attempt to monitor incoming signals from a point in the IF strip after the 3-kHz filter, for instance, you can't expect to faithfully reproduce a signal frequency greater than 300 Hz. You must tap off the IF signal at a point between the receiver mixer and the IF filters, where the passband is wider. To take advantage of the ±20-kHz and ±100-kHz viewing windows theoretically possible with the HO-5404, your receiver passband at the tap point has to be 40 to 200 kHz wide. The IF output of the Lab's TS-820 was found to be about 3 kHz wide; a TS-930's IF output is at 100 kHz.

In the pan adapter package, Heath provides a list of IFs for 25 receivers and transceivers. Two on the list (the HW-9 and HW-99) are deleted in an errata sheet. A few of the rigs on the list have a factory-installed IF connection point. But for many of the rigs, you'll have to make a modification (consisting of a capacitive tap—a small-value capacitor, a length of shielded wire) to bring the IF signal out to a conveniently accessible point; a phono jack on the rear panel, for instance. So, before you purchase this option, think about whether you want to make the modification—on some rigs it's easier to do than on others. Adding the tap may cause some receiver desensitization and require some circuit adjustment. Also, if the tap point is one that is common to transmit as well as receive, transmitter output may be affected. So, you should check receive and transmit operation on all bands before and after the modification is made. In ARRL Lab tests, the pan adapter couldn't cleanly display a two-tone signal fed into it.

The audio-channel method of monitoring received signals merely displays detected audio waveforms. When examining received waveforms, don't be too quick to accuse the received station of having a problem if things don't look "textbook" to you. Your receiver AGC (and the bandwidth of the IF pick-off, for instance) can affect the displayed waveform and present you with an incorrect picture of what the waveform really looks like. Take the time to learn the idiosyncracies of your particular set-up before you criticize anyone's signal. Many factors can affect the presentation you see on the scope, and it takes some practice to really know what you're doing. (Heath provides a series of 44 drawings of scope patterns representative of received and transmitted signals under different modes of operation.)

Heath HO-5404 Station Monitor

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 160-10 m.	As specified.
Worst case SWR: Not specified.	2.3:1 at 54 MHz.
Sensitivity: 80-6 m, ¼-in vertical deflection at 10 W; 80-6 m, ¾-in vertical deflection for 100 W; 160 m, ¼-in vertical deflection at 100 W.	As specified.
RF power limitations:	
Exciter input (50-75 ohms), 10 to 300 W. Antenna input (50-75 ohms), 1000 W.	As specified.
Insertion loss: Negligible.	1 dB at 54 MHz.
Color: Brown	
Dimensions (height-width-depth): 4-3/8 × 11-1/4 × 12-1/8 in.	
Weight: 10.6 lb.	

When connected to a Kenwood TS-820 transceiver in the ARRL Lab, Lab Engineer Zack Lau, KH6CP, noticed that the HO-5404 produced broadband noise in the receiver. The noise is at its lowest level on 160 meters, worst at 80 meters and decreases in amplitude from 40 meters on up, although it is still quite noticeable. The noise is produced by the sweep circuit in the '5404. Another call to Heath's Technical Service revealed that they are aware of the problem. The technician reported that the problem hadn't been pinpointed, nor is it common to all transceivers and receivers. He said that some HO-5404 owners have been able to reduce or eliminate the noise by better grounding.

I think a monitor scope is a useful adjunct to an amateur station. To me, its greatest utility is allowing the station operator a means of checking the transmitted signal. Having the option to monitor incoming signals could be a useful adjunct to station operation.

The HO-5404 is available from the Heath Co, Benton Harbor, MI 49022, tel 800-253-0570. Price class: HO-5404 Station Monitor, $250; HOA-5404-1 Pan Adapter, $100.—*Paul K. Pagel, N1FB*

Notes

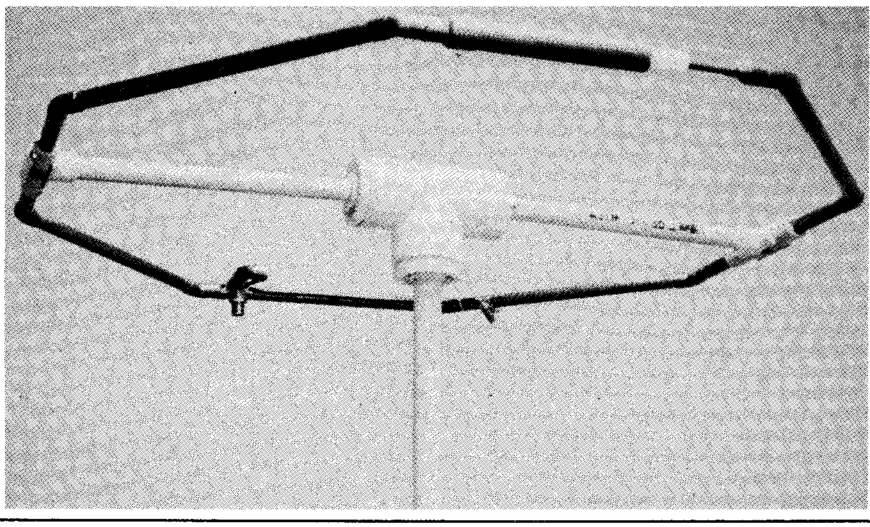
[1]"Heathkit HO-10 Monitor Scope," Recent Equipment, *QST*, Dec 1963, p 58; "Heathkit SB-620 "Scanalyzer," Recent Equipment, *QST*, Apr 1968, p 50; "The Heath SB-610 Monitorscope," Recent Equipment, *QST*, Apr 1972, p 49; "Heathkit SB-614 Monitor Scope," Product Review, *QST*, Jun 1976, p 37.

[2]"Heath SA-2040 Antenna Tuner," Product Review, *QST*, Nov 1980, pp 49-50.

New Products

ADVANCED DESIGN NETWORKS MICROLOOP ANTENNAS

☐ Advanced Design Networks offers small, rugged loop antennas for the 10- through 40-meter amateur bands. Sizes range from 27-in diam for the 10-m version to 108-in diam for the 40-m version. Construction elements are of stainless steel and copper. The insulator in the coaxial capacitor is a special material with a high breakdown voltage and very low losses. The antennas can be mounted vertically or horizontally.



The manufacturer claims omnidirectional coverage with these antennas mounted horizontally, with maximum radiation in the plane of the loop, not through the center. In the vertical mountain position, performance approaches that of a full-size dipole. The manufacturer also points out that this antenna, like any small size antenna, is narrow-banded.

Loop Dimensions

Band (meters)	10	20	15	20	30	40
Diam (inches)	27	30	41	54	81	108

Measured Bandwidth of ADN Microloops

Band (meters)	10	12	15	20	30	40
Center Freq. (MHz)	28.2	24.9	21.2	14.2	10.13	7.2
BW at 1.5:1 SWR (kHz)	46	31	22	13	11	14

Available from Advanced Design Networks, Inc, 8601 66th St North, Pinellas Park, FL 33565, tel 813-544-2596. Price class: 10,12, 15 or 20 m, $83.50; 30 or 40 m, $93.50. —*Bruce O. Williams, WA1VC*