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QST Compares: Dual-Band FM Mobile Transceivers
ICOM IC-207H; Kenwood TM-V7A; Kenwood TM-G707A; Standard C510A/CPB510DA; Yaesu FT-8100R

The MFJ-224 2-Meter FM Analyzer

Product Review

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QST Compares: Dual-Band FM Mobile Transceivers

Reviewed by Steve Ford, WB8IMY
QST *Managing Editor*

This is the era of the FM dual-band transceiver. That's not to say that single-band rigs have entirely lost their luster, but the FM world isn't confined to one band in most areas. In many parts of the country, the 2-meter repeater subbands were filled to capacity long ago. The overflow jumped to 70 cm (440 MHz), particularly in metropolitan areas. This pattern is so well established that it is generally assumed that when people speak of FM operating, they mean activity on both 2 meters and 70 cm.

The industry has responded with a flood of dual-band FM transceivers. During the last several years costs have fallen substantially, placing dual-band rigs within reach of most amateurs. The physical dimensions of the radios have decreased as well. No longer do hams have to wrestle imposing boxes into today's smaller cars.

Although this is a "comparison" review, the contrast from one rig to another really involves the application and target market intended. For example, if you're looking for every feature under the sun and price is no object, one radio may stand out from the others. But a need for convenience at an affordable price may draw you to another transceiver. Or, you may be shopping strictly on the basis of price alone.

In other words, there is no "best" radio in this lineup. It all depends on what you are looking for. Our product review team consisted of Martin Cook, N1FOC; Dan Miller, K3UFG; Peter Budnik, KB1HY, and Joe Bottiglieri, AA1GW.

ICOM IC-207H

The rugged ICOM IC-207H transceiver appears to be mostly heat sink when you take it out of the box. Not only are the heat-sink fins present on the rear of the unit, they cover the top as well. (The internal speaker is mounted on the bottom panel.) Like many mobile rigs these days, the IC-207H features a detachable front panel.

Speaking of the front panel, the controls and buttons are few. The large **BAND**

Feature	ICOM IC-207H	Kenwood TM-V7A	Kenwood TM-G707A	Standard C510A/CPB510DA[1]	Yaesu FT-8100R
Simultaneous Dual-band receive	No	Yes	No	No	Yes
Total memories	182	280[2]	180	200	310
Alphanumeric memory naming (characters)	No	Yes (7)	Yes (7)	No	No
Crossband repeat	No	Yes	No	No	Yes
CTCSS tone scan	Yes	Yes	Yes	Yes	Yes
AM aircraft receive	Yes	Yes	Yes	Yes	Yes
DTMF autodialer (memories)	Yes (14)	Yes (10)	Yes (10)	Yes (10)	Yes (6)
DTMF paging	No	Yes	No	Yes	Yes
CTCSS decode (paging or tone squelch)	Yes	Yes	Yes	Yes	No[3]
Detachable front panel	Yes	Yes	Yes	N/A[4]	Yes
RF Output-VHF	5/10/20/50 W	5/10/50 W	5/10/50 W	5/50 W	5/20/50 W
RF Output-UHF	5/10/20/35 W	5/10/35 W	5/10/35 W	5/35 W	5/20/35 W
Packet ready	1200/9600 baud	1200/9600 baud	1200/9600 baud	1200 baud	1200/9600 baud
Typical selling price (as of 9/98)[5]	$375	$500	$350	$650	$500

[1]Hand-held transceiver with CPB510DA "docking adapter."
[2]180 when using memory-naming feature.
[3]Optional.
[4]C510A H-T detaches from CPB510DA.
[5]Typical selling prices represent an average of prices quoted by three retailers and do not include rebates, coupons, or other sales incentives.

button allows you to quickly jump from VHF to UHF, or vice versa. Just below, the tuning dial steps through individual frequencies or memory channels. There is one set of separate **VOLUME** and **SQUELCH** controls with the **POWER** button between. This is a tight fit; some reviewers had difficulty getting their fingers between the knobs to push the button, especially when using the IC-207H in their cars. Only one set of **VOLUME/SQUELCH** controls is necessary because, in the interest of economy, the IC-207H does *not* support simultaneous VHF/UHF receive (or crossband repeat).

Other front-panel buttons include **SET/LOCK, MONITOR/DTMF, TONE/TONE SCAN, MEMORY/CALL CHANNEL** and **OUTPUT POWER/DUPLEX**. The button labels appear at the bottom of the amber LCD display. The display itself is bright and easy to read, with a stylish "curved" S meter. Display brightness is adjustable through several levels. Power output is also adjustable through four levels from low to high (5 to 50 W VHF, 5 to 35 W UHF). The multifunction programmable microphone plugs into a recessed section to the right of the panel. This goes a long way toward helping protect the telephone-style mike plug. However, it is important to note that the mike jack is *not* part of the front panel itself. If you mount the main body of the IC-207H in a location separate from the front panel, you may have to purchase the ICOM mike extension cable.

The included HM-98 microphone offers a wide variety of radio control operations right at your fingertips. The face of the mike has 25 well-labeled backlit buttons. Besides providing the usual DTMF and frequency changing capabilities, many of these buttons duplicate the functions of the radio's front panel controls. Volume and squelch, output power level, VFO, memory, band change, tone, direct frequency entry, offset—just to name a few—can all be controlled using the microphone's buttons. If you find it inconvenient to operate these functions using keypad control, no problem, just snap on the included cover plate and forget about them. Those who find these capabilities interesting may also want to consider the optional HM-90 infrared wireless microphone. This mike will provide similar microphone and control operation without that pesky cord!

The rear panel of the IC-207H sports a chassis mounted antenna jack, cooling fan, dc power pigtail and external speaker jack. There is also a DIN jack for 1200 or 9600 baud packet. The manual describes how to use the IC-207H in either packet mode.

The cooling fan is a bit noisy. An initial set mode menu allows you to toggle between continuous fan operation and an "automatic" mode that turns on the fan during transmitting and shuts it off automatically after two minutes.

Receive coverage on 2 meters extends from 118 to 174 MHz, but 70-cm coverage is confined to 440 to 450 MHz. Sensitivity seems adequate and there is plenty of full-bodied audio. The only exception appeared while listening to the AM aeronautical band. While the receiver remained sufficiently sensitive, the audio level was noticeably low.

The IC-207H offers CTCSS encode and decode (decode is often an option with some other radios.) If you find yourself inadvertently locked out of a repeater because you don't know the proper CTCSS tone, you could activate the IC-207H tone scan function to determine the tone frequency. For those who enjoy autopatch operation, there is a DTMF autodialer with 14 memories.

Our reviewers appreciated the IC-207H's ease of operation and overall durability. The manual is clear and concise. Even the descriptions of the IC-207H's multiple scanning functions were easily understood (we wish we could say this for all transceivers!). Our reviewers also enjoyed some of the more advanced features, especially the squelch delay. Setting up the IC-207H with a long squelch delay prevents the annoying open/close squelch action with rapidly fluctuating signals.

Manufacturer: ICOM America, Inc, 2830 116th Ave NE, Bellevue, WA 98004, tel

Table 1
ICOM IC-207, serial number 02227

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 118-174 MHz, 440-450 MHz; transmit, 144-148 MHz, 440-450 MHz.	Receive, as specified; transmit, 140-150 MHz, 440-450 MHz.
Power requirement: Receive, 1 A; transmit, 12 A (high power).	Receive, 0.7 A; transmit, 8.6 A. Tested at 13.8 V.
Size (height, width, depth): 1.6×5.5×7.3 inches; weight, 2.6 pounds.	
Modes of operation: FM, AM (receive only).	As specified.
Receiver	*Receiver Dynamic Testing*
FM sensitivity, 12 dB SINAD: <0.18 μV.	For 12 dB SINAD, VHF, 0.14 μV; UHF, 0.18 μV.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1-kHz tone, 30% modulation: 0.4 μV.
FM adjacent channel rejection: Not specified.	20 kHz channel spacing, preamp on: VHF, 66 dB; UHF, 67 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz channel spacing, preamp on: VHF, 66 dB*; UHF, 67 dB*; 10 MHz channel spacing, preamp on: VHF, 83 dB; UHF, 78 dB.
S-meter sensitivity: Not specified.	S9 signal: VHF, 2.2 μV; UHF, 1.9 μV.
Squelch sensitivity: <0.13 μV.	At threshold: VHF, 0.07 μV; UHF, 0.16 μV.
Receiver audio output: 2.0 W at 10% THD into 8 Ω.	2.5-W at 10% THD into 8 Ω.
Spurious and image rejection: 60 dB.	First IF rejection, VHF, 104 dB; UHF, 86 dB; image rejection, VHF, >147 dB; UHF, >142 dB.
Transmitter	*Transmitter Dynamic Testing*
Power output: VHF, 50 W / 20 W / 10 W / 5 W; UHF, 35 W / 20 W / 10 W / 5W.	VHF, 49 W / 17 W / 8.5 W / 4.3 W; UHF, 34 W / 18 W / 9.4 W / 4.6 W.
Spurious-signal and harmonic suppression: ≥60 dB	VHF, 70 dB; UHF, 68 dB. Meets FCC requirements for spectral purity for equipment in its power output class and frequency range.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, VHF, 200 ms; UHF, 200 ms.
Receive-transmit turn-around time (tx delay): Not specified.	VHF, 150 ms; UHF, 164 ms.

Note: Unless otherwise noted, all dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.
*Measurement was noise-limited at the value indicated.

425-454-8155; fax 425-454-1509; **http://www.icomamerica.com**. Manufacturer's suggested retail price, $453; HM-90A infrared wireless microphone, $209.

Kenwood TM-V7A

The TM-V7A grabs your attention from the moment you power it up. The dazzling "cool blue" display is captivating. The blue-on-white characters are extremely easy to read; they seem to almost shimmer against the background. The color scheme is also reversible, and you can adjust brightness and contrast.

But the *size* of the TM-V7A makes an impression even before you toggle the **POWER** switch. Not only is the rig itself quite small, the detachable front panel is *tiny*—about the size of a deck of cards. When you leave your car, you can remove the panel and slip it into your pocket!

Despite the small dimensions of the panel, all buttons and controls are positioned for easy access. There is a main tuning knob, as well as separate **VOLUME/SQUELCH** concentric knob sets for each band. A row of four buttons beneath the sizable LCD section do double duty as selected by the **FUNCTION** button.

On the front of the main chassis there is a DIN jack for 1200 and 9600-baud packet and a telephone-style microphone connector. As with other rigs of similar design, this means that you may need to extend the mike cord if you decide to mount the chassis and front panel separately.

Several optional remote faceplate kits, some including mike extension cables, are available. The front panel pops off the chassis easily—perhaps a little too easily. When you operate the release you must have the TM-V7A resting on a desk or other surface, or be ready to catch the panel with your other hand. The panel falls away instantly and can be damaged if it strikes the ground.

Our review team commented on several interesting features of the TM-V7A. The automatic simplex checker (ASC) continually checks the input frequency of the repeater you are using. If the signal strength of the person you're talking to is sufficient to permit direct (simplex) operation, an icon flashes on the display to alert you. (Too bad this can't be a mandatory requirement for all FM transceivers!) Another very handy item is the Automatic Band Change (ABC). Let's say that you have designated 2 meters as your transmit/receive (main) band and 70 cm as receive only, and you've activated the ABC function. If someone suddenly pops onto 70 cm, the TM-V7A will flip-flop the status automatically. You can answer the call on 70 cm without touching the radio! (The TM-V7A switches back to the original configuration two seconds after the signal on the receive-only band drops out.)

The "cool blue" display received mixed reviews. Some found it difficult to read under certain viewing conditions, especially in bright sunlight. All reported readability for desktop operation was excellent. If you are mounting this unit in a vehicle, you'll want to choose the location and viewing angle of the display carefully before permanent installation.

Our reviewers reported excellent receive audio from the internal upward-firing speaker. There are also separate speaker jacks on the rear panel so that you can dedicate one speaker to UHF and another to VHF. Transmit audio reports were also quite good when using the multifunction backlit microphone. The TM-V7A supports simultaneous dual-band receive and cross-band repeat. The unit is also capable of simultaneous voice and data operation. Most of the radio's features can be controlled by DTMF tones from the microphone or over the air.

CTCSS and DTMF paging functions are standard equipment in the TM-V7A. The TM-V7A also features an "answer-back" function that will reply to a page if you are away from your radio temporarily. CTCSS tone scan is available to help you decipher which CTCSS tone a particular repeater

Table 2
Kenwood TM-V7A, serial number 90200212

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 118-174 MHz, 410-470 MHz; transmit, 144-148 MHz, 430-450 MHz.	As specified.
Power requirement: Receive, 1 A; transmit, 10 A (high power).	Receive, 0.9 A; transmit, 8.6 A. Tested at 13.8 V.
Size (height, width, depth): 2.2×5.5×8.1 inches; weight, 2.6 pounds.	
Modes of operation: FM.	FM, AM (receive only).
Receiver	*Receiver Dynamic Testing*
FM sensitivity, 12 dB SINAD: <0.16 μV;	For 12 dB SINAD, VHF, 0.14 μV; UHF, 0.14 μV. Sub-band (in VHF/VHF or UHF/UHF mode), <0.25μV.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1-kHz tone, 30% modulation: 0.5 μV.
FM adjacent channel rejection: Not specified.	20 kHz channel spacing, preamp on: VHF, 71 dB; UHF, 72 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz channel spacing, preamp on: VHF, 68 dB; UHF, 69 dB; 10 MHz channel spacing, preamp on: VHF, 81 dB; UHF, 73 dB.
S-meter sensitivity: Not specified.	S9 signal: VHF, 5.0 μV; UHF, 5.5 μV.
Squelch sensitivity: <0.1 μV.	At threshold: VHF, 0.1 μV; UHF, 0.08 μV.
Receiver audio output: 2.0 W at 5% THD into 8 Ω.	2.9-W at 6% THD into 8 Ω.
Spurious and image rejection: 60 dB.	First IF rejection, VHF, 134 dB; UHF, 147 dB; image rejection, VHF, 126 dB; UHF, >147 dB.
Transmitter	*Transmitter Dynamic Testing*
Power output (H/M/L): VHF, 50 W / 10 W / 5 W; UHF, 35 W / 10 W / 5 W.	VHF, 54 W / 12 W / 4.3 W; UHF, 37 W / 13 W / 5.3 W.
Spurious-signal and harmonic suppression: ≥60 dB	VHF, 70 dB; UHF, 64 dB. Meets FCC requirements for spectral purity for equipment in its power output class and frequency range.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, VHF, 64 ms; UHF, 64 ms.
Receive-transmit turn-around time (tx delay): Not specified.	VHF, 50 ms; UHF 55 ms.

Note: Unless otherwise noted, all dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.

system is using.

There are a host of scanning functions in this dual-band radio—everything from programmed scans to memory scanning. The visual scan mode is exactly what the name implies. In this mode you are presented with a graphical display of all signals the TM-V7A discovers within the selected range. The height of the vertical bars indicates relative signal strength. By using the **TUNE** knob or the microphone **UP/DOWN** buttons, you can move the cursor to the desired frequency and hear the result. Obviously, this function is best used at home or as a passenger, and definitely *not* while you're driving!

For situations where several different operators may use the radio, there are four "five-in-one" programmable memories that store individual operating profiles. You simply push a single button and the radio will configure itself according to you preset preferences, including such things as the brightness of the display, frequency range and so on. This is analogous to the memory function found in some luxury automobiles where a single button automatically adjusts the car to the preferences of a particular driver.

With all of these functions and standard features, including automatic power-off, S-meter squelch, selectable power levels (5 to 50 W VHF; 5 to 35 W UHF) and many others, the TM-V7A can be a complicated radio to use. Fortunately, the manual is very well composed and easy to understand. In addition, the TM-V7A includes a "guide" feature that can provide on-screen text instructions for programming many common operations.

Manufacturer: Kenwood Communications Corp, 2201 E Dominguez St, Box 22745, Long Beach, CA 90801; tel 310-639-5300; fax 310-537-8235; **http://www.kenwood.net**. Manufacturer's suggested retail price, $720.

Table 3
Kenwood TM-G707, serial number 91100171

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 118-174 MHz, 410-524 MHz; transmit, 144-148 MHz, 430-450 MHz.	As specified.
Power requirement: Receive, 1 A; transmit, 11 A (high power).	Receive, 0.8 A; transmit, 7.8 A. Tested at 13.8 V.
Size (height, width, depth): 2.2×5.5×8.1 inches; weight, 2.6 pounds.	
Modes of operation: FM.	FM, AM (receive only)
Receiver	*Receiver Dynamic Testing*
FM sensitivity, 12 dB SINAD: VHF, <0.22 µV; UHF, <0.16µV.	For 12 dB SINAD, VHF, 0.20 µV; UHF, 0.18 µV.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1-kHz tone, 30% modulation: 0.5 µV.
FM adjacent channel rejection: Not specified.	20 kHz channel spacing, preamp on: VHF, 69 dB; UHF, 73 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz channel spacing, preamp on: VHF, 69 dB*; UHF, 66 dB. 10 MHz channel spacing, preamp on: VHF MHz, 81 dB; UHF, 67 dB.
S-meter sensitivity: Not specified.	S9 signal: VHF, 1.6 µV; UHF, 1.9 µV.
Squelch sensitivity: VHF, <0.11 µV; UHF, <0.10µV.	At threshold: VHF, 0.09 µV; UHF, 0.07 µV.
Receiver audio output: 2.0 W at 5% THD into 8 Ω.	2.1W at 2% THD into 8 Ω.
Spurious and image rejection: 60 dB.	First IF rejection, VHF, 92 dB; UHF, 139 dB; image rejection, VHF, 78 dB; UHF, >133 dB.
Transmitter	*Transmitter Dynamic Testing*
Power output: VHF, 50 W / 10 W / 5 W; UHF, 35 W / 10 W / 5 W.	VHF, 52 W / 11 W / 4.2 W; UHF, 40 W / 13 W / 5.1 W.
Spurious-signal and harmonic suppression: ≥60 dB	VHF, 70 dB; UHF, 72 dB. Meets FCC requirements for spectral purity for equipment in its power output class and frequency range.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, VHF, 72 ms; UHF, 68 ms.
Receive-transmit turn-around time (tx delay): Not specified.	VHF, 56 ms; UHF 60 ms.

Note: Unless otherwise noted, all dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.
*Measurement was noise-limited at the value indicated.

Kenwood TM-G707A

At first glance the TM-G707A looks identical to the TM-V7A transceiver. It has essentially the same size and styling—including the ultra-tiny detachable front panel. Power output is also the same: 5/10/50 W VHF and 5/10/35 W on UHF. Like the TM-V7A, the TM-G707A offers a front-chassis connector for 1200 and 9600-baud packet, a small array of front-panel buttons, a single antenna port and a heat-sink cooling fan.

So how do these transceivers differ?

Start with the display. The TM-G707A lacks the unusual "cool blue" LCD found on the TM-V7A. Even so, our reviewers found the large amber screen easy to read in all lighting conditions. A **BAND** button is located at the bottom-right portion of the panel near a single set of concentric **VOLUME/SQUELCH** controls (the TM-V7A had two sets of **VOLUME/SQUELCH** knobs).

The TM-G707A does not have several of the special features found in the TM-V7A. Items missing include dual external speaker jacks (the 'G707A has one), DTMF paging and answer back, visual scan mode, automatic band changing and automatic simplex checking. Although the TM-G707A is capable of transmitting and receiving on separate bands, it cannot do so simultaneously (as the TM-V7A does). In this regard the TM-G707A is also incapable of simultaneous dual-band receive.

But our reviewers didn't seem to miss these features. As one fellow put it, "Listening on two bands at once is convenient, but it can drive you nuts. I didn't mind pressing a button to manually switch bands on the TM-G707A." Another described the G707A as, "A rig with the basics, the stuff you really want and need. No frills of questionable utility."

The TM-G707A is not a "stripped down" radio by any means. It offers more programmable memories than you're ever likely to need, alphanumeric memory channel labeling, CTCSS encoding and decoding, a DTMF autodialer, versatile scanning modes, an S-meter squelch, the "five-in-one" programmable memories to store your operating preferences and much more.

An optional voice synthesizer, the VS-3,

can be installed in either the TM-G707A or the TM-V7A. Its vocabulary extends beyond just the usual operating frequency identification. Pressing the **VFO**, **MR**, **CALL**, **PM**, **MENU** or **BAND SEL** buttons will result in a voice verification of the new operating mode. The VFO, memory recall, call and band select message will automatically be proceeded by an announcement of the resulting operating frequency. A button on the microphone will announce "enter" when the direct keypad frequency entry feature is activated, and will speak each digit as you enter it. The VS-3 option should make these Kenwood radios especially popular with mobile operators and the vision impaired.

Manufacturer: Kenwood Communications Corp, 2201 E Dominguez St, Box 22745, Long Beach, CA 90801; tel 310-639-5300; fax 310-537-8235; **http://www.kenwood.net**. Manufacturer's suggested retail price, $520; VS-3 voice sythesizer, $40.

Standard C510A with CPB510DA Docking Adapter

Not all mobile installations rely on a dedicated dual-band under-the-dash radio. In other reviews we've noted that some detachable front panels are so small that you can easily slip them into your pocket when you leave your car. But what if you could take the *entire radio* with you? That's the approach offered by the combination of the Standard C510A H-T and the CPB510DA docking adapter.

The Standard C510A is a full-featured VHF/UHF H-T that almost disappears in the palm of your hand. It was reviewed in the April 1998 *QST*. The C510A offers a wide receive range from 100 to 950 MHz (cellular blocked) in three band segments (including AM receive in the aeronautical band). The C510A is powered by three AA alkaline batteries and includes a battery saving feature so you can stretch the operational lifetime to the limit. With a 1-W maximum power output, the C510A by itself is fine when you're working within the coverage area of a sensitive repeater, or for close-range simplex. But when you're using the C510A mobile, or in a fringe coverage area, the limitations of a single watt and a rubber-duck antenna become apparent.

Enter the CPB510DA docking adapter. Installed under your dash or seat, the CPB510DA boosts the output of your C510A to 50 W on VHF and 35 W on UHF. The adapter is more than simply an external amplifier. It connects to the C510A H-T through a 7-foot umbilical cable (the cable pops on and off in seconds) and powers the hand-held, thereby saving your batteries for "barefoot" work. Connecting this cable automatically disables the C510A's top-mounted SMA antenna connector. The back of the docking adapter has a short pigtail with an SO-239 antenna connector for your mobile antenna. On receive, the adapter provides sharp passband filtering to reduce interference. Receive preamps, one for each band, automatically switch in and out as you transmit. The C510A's dual receive capability is not available when the unit is connected to the docking adapter.

The CPB510DA is $1\frac{1}{4}$ inches high by $5\frac{3}{4}$ inches wide by $6\frac{1}{2}$ inches deep—about the size of a large paperback book. In fact, it is about the same size as many of the mobile transceivers included in this review. A sizable heat sink dominates the adapter and there is a cooling fan as well. An external speaker jack (with a 2 W amplifier) is available on the front panel. There is a single **POWER** switch on the front panel and several LEDs to indicate operational status.

Our reviewers were impressed by the convenience of the CPB510DA. As one individual commented, "It was a blast to be able to jump in the car, plug in the cable and instantly transform the H-T into a mobile rig. When you reach your destination, you pop the cable and you're on a hand-held again!" Of course, H-Ts can be much more difficult to program while in motion, but

Table 4
Standard CPB510DA (with C510A), serial number 78U200021 (with 73U120119)

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive and transmit, 144-148 MHz, 438-450 MHz.	Receive, 100-192 MHz, 700-955 MHz; transmit, 144-148 MHz, 438-450 MHz.
Power requirement: Receive, 0.15 A; transmit, 10 A (high power)	Receive, 0.5 A; transmit, 9.6 A. Tested 13.8 V.
Size (height, width, depth): 1.25×5.75×6.5; weight, 3 pounds.	
Modes of operation: FM.	FM, AM (receive only).
Receiver	*Receiver Dynamic Testing*
FM sensitivity, 12 dB SINAD: C-510A, VHF, <0.2 μV; UHF, <0.22 μV; CPB510DA preamp gain, ≈2 dB.	For 12 dB SINAD, VHF, 0.16 μV; UHF, 0.21 μV.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1-kHz tone, 30% modulation: 0.38 μV.
FM adjacent channel rejection: Not specified.	20 kHz channel spacing, preamp on: VHF, 61 dB; UHF, 56 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz channel spacing, preamp on: VHF, 57 dB; UHF, 54* dB; 10 MHz channel spacing, preamp on: VHF, 87 dB; UHF, 69 dB.
S-meter sensitivity: Not specified.	S9 signal: VHF, 2.2 μV; UHF, 2.6 μV.
Squelch sensitivity: Not specified.	At threshold: VHF, 0.13 μV; UHF, 0.16 μV.
Receiver audio output: 2.0 W at 10% THD into 8 Ω.	2.3 W at 6% THD into 8 Ω.
Spurious and image rejection: 60 dB.	First IF rejection, VHF, 113 dB; UHF, >143 dB; image rejection, VHF, 145 dB; UHF, 140 dB.
Transmitter	*Transmitter Dynamic Testing*
Power output: VHF, 50 W / 5 W; UHF, 35 W / 5 W.	VHF, 51 W / 4.1 W; UHF, 29 W / 4.1 W.
Spurious-signal and harmonic suppression: ≥60 dB	VHF, 68 dB; UHF, 63 dB. Meets FCC requirements for spectral purity for equipment in its power output class and frequency range.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, VHF, 135 ms; UHF, 135 ms
Receive-transmit turn-around time (tx delay): Not specified.	VHF, 92 ms; UHF 93 ms.

Note: Unless otherwise noted, all dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.
*Measurement was noise limited at the value indicated.

you're not likely to be doing that much programming on the road anyway. The CPB510DA not only gives you a hefty power boost, it offers maximum operational flexibility. This aspect would be particularly attractive to hams who are active in public-service work.

Manufacturer: Standard Amateur Radio Products, Box 48480, Niles, IL 60714; tel 773-763-0081; fax 773-763-3377; **http://www.stdradio.com**. Manufacturer's suggested retail price, $788.

Yaesu FT-8100R

Although the Yaesu FT-8100R is compact enough to fit in almost any vehicle imaginable, the '8100R features a removable front panel so you can install the body of the radio in the trunk (or under a seat).

Separate volume and squelch controls are a blessing in any dual-band radio. The FT-8100R uses separate concentric volume/squelch controls for each band positioned at either side of the bright amber LCD display. In most cases, VHF uses the left-hand set of controls while UHF utilizes the right-hand set. Directly beneath the left volume control is the main tuning dial (a 20-position detented rotary switch).

Under the bottom edge of the LCD display are eight tiny function buttons. The function of each button is indicated in the display itself. Among the functions you'll find repeater shift (plus, minus or simplex), tone (to activate CTCSS), power output (low, medium, high), audio muting and scan. There are also four "command" keys (including the **POWER** switch) along the right-hand side of the display.

The microphone plugs directly into the front panel using a telephone-style plug. On the rear panel you find a single coaxial pigtail, a power connector, separate speaker jacks for VHF and UHF audio and the **DATA** jack for packet use (1200 or 9600 baud). The '8100R has an internal speaker, but we found it difficult to hear in most mobile installations. An external speaker or two is a worthwhile investment.

Receive flexibility is outstanding, with coverage from 110 to 550 MHz and 750 to 1300 MHz (cellular frequencies are blocked, of course). Unfortunately, receiver sensitivity on frequencies outside 2 meters and 70 cm is lacking. ARRL Lab measurements found sensitivity between 0.71 to 2.2 μV for frequencies between 160 and 190 MHz. Performance just above and below 70 cm is a bit better, averaging about 0.45 μV. Sensitivity at 750 MHz measures a mediocre 0.71 μV and drops off considerably with increasing frequency.

Table 5
Yaesu FT-8100, serial number 7K070372

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 110-550 MHz, 750-1300 MHz (cell blocked); transmit, 144-148 MHz, 430-450 MHz.	Receive, see text; transmit, as specified.
Power requirement: Receive, 1 A; transmit, 10 A (high power).	Receive, 1.1 A; transmit, 7.6 A. Tested at 13.8 V.
Size (height, width, depth): 1.6×5.5×6.5 inches; weight, 2.2 pounds.	
Modes of operation: FM, AM (receive only).	As specified.
Receiver	*Receiver Dynamic Testing*
FM sensitivity, 12 dB SINAD: <0.18 μV; <0.25 μV (sub receiver).	For 12 dB SINAD, VHF, 0.18 μV; UHF, 0.15 μV; sub receiver, as specified.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1-kHz tone, 30% modulation: 0.65 μV.
FM adjacent channel rejection: Not specified.	20 kHz channel spacing, preamp on: VHF, 69 dB; UHF, 68 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz channel spacing, preamp on: VHF, 70 dB*; UHF, 68 dB*; 10 MHz channel spacing, preamp on: VHF MHz, 89 dB; UHF, 81 dB.
S-meter sensitivity: Not specified.	S9 signal: VHF, 4.2 μV; UHF, 4.7 μV.
Squelch sensitivity: <0.13 μV.	At threshold: VHF, 0.07 μV; UHF, 0.05 μV.
Receiver audio output: 2.0 W at 5% THD into 8 Ω.	2.3 W at 5% THD into 8 Ω.
Spurious and image rejection: 70 dB.	First IF rejection, VHF, 100 dB; UHF, 132 dB; image rejection, VHF, 77 dB; UHF, >146 dB.
Transmitter	*Transmitter Dynamic Testing*
Power output: VHF, 50 W / 20 W / 5 W; UHF, 35 W / 20 W / 5 W.	VHF, 50 W / 18 W / 4.7 W; UHF, 34 W / 21 W / 4.9 W.
Spurious-signal and harmonic suppression: ≥60 dB	VHF, 65 dB; UHF, 68 dB. Meets FCC requirements for spectral purity for equipment in its power output class and frequency range.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, VHF, 27 ms; UHF, 45 ms.
Receive-transmit turn-around time (tx delay): Not specified.	VHF, 60 ms; UHF 40 ms.
Bit-error rate (BER), 9600-baud: Not specified.	146 MHz: Receiver: BER at 12 dB

Note: Unless otherwise noted, all dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.
*Measurement was noise-limited at the value indicated.

On the positive side, lab tests also revealed some very good two-tone, third order-IMD dynamic range performance, typically a good indicator of a receiver's ability to reject interference from paging and commercial radio services. This enhanced performance may have come at the expense of reduced out-of-band receive sensitivity. Those who experience interference from these sources may very well consider this a reasonable tradeoff.

The FT-8100R has dual-receive capability. That is, you can *listen* simultaneously to VHF and UHF, or to two separate frequencies within *either* VHF or UHF bands. Naturally, it has crossband repeat, but the manual is quick to caution against abusing this feature.

Yaesu's "Smart Search" will help you quickly find popular frequencies. It sweeps the band and automatically loads active frequencies into one of 102 dedicated memories (51 per band). In addition to the "Smart Search" memories, each band also has 99 regular memory channels, four "band limit" memories and one call channel. Scanning functions include memory, selected memory, VFO and sub-band limit scans.

There are other FT-8100R features worth mentioning. The S-meter squelch reduces some of the guesswork that comes

with setting a squelch threshold. The time-out timer is programmable for 1 to 60 minutes with three minutes being the default setting. Automatic power off is handy if you have the rig connected directly to the vehicle battery. If you forget to turn off the '8100R when you leave the car, it will switch itself off after the programmed time has expired (1 to 12 hours). CTCSS *encoding* is a standard feature in the FT-8100R, but you must install the optional FTS-22 module if you want CTCSS *decoding*, too. The microphone offers a complete backlit DTMF keypad and four programmable keys that can be assigned to perform the function of almost any of the unit's front panel buttons. Direct frequency entry from the microphone keypad is not available.

Manufacturer: Yaesu USA, 17210 Edwards Rd, Cerritos, CA 90703, tel 562-404-2700; fax: 562-404-1210; **http://www.yaesu.com**. Manufacturer's suggested retail price, $699; FTS-22 tone squelch unit, $68.

The MFJ-224 2-Meter FM Analyzer

Reviewed by: Mike Gruber, W1MG
ARRL Technical Advisor

Topics involving modulation and measurement technique used to be quite common in amateur literature. As many "old timers" remember, no treatment of this topic was complete without at least one or two oscilloscope patterns. Typically these discussions concerned AM and SSB signals, and a 'scope was often the instrument of choice to evaluate transmit audio quality. Today this once familiar topic receives only minimal coverage, even in the FCC amateur exams.

While the importance of a properly adjusted AM and SSB transmitter may be obvious (most of us have heard the distortion and excessive QRM that results from an overdriven SSB transmitter), FM transmitter audio, usually called deviation, commands its own set of considerations.

Deviation and Bandwidth

Like AM, the intelligence of an FM signal is contained in the sidebands. Theoretically, FM sidebands extend out indefinitely above and below the carrier frequency. Practical amateur FM operation requires the sidebands outside a specified bandwidth be removed. The maximum deviation level of either sideband for 2-meter amateur FM voice operation, set by agreement and protocol, is 5 kHz. The audio modulating frequency and the deviation both contribute to the actual channel bandwidth requirement for an FM signal. The important point here is that the maximum bandwidth of an FM signal is not simply twice its deviation, it is greater than twice its deviation.

Now let's consider the available 2-meter channel bandwidth. While initial channel spacings were 30 kHz apart, introduction of the so-called "splits" later reduced that spacing to 15 or 20 kHz. (On the plus side, the additional split frequencies doubled the number of available channels.) The importance of proper deviation becomes readily apparent when two transmitters are in close geographic proximity and operating only 15 kHz apart! You can find more information on FM in the 1999 edition of the *ARRL Handbook*. Look for it in the *Modulation Sources* chapter.

Devices like H-Ts and similar FM equipment seldom have external transmit audio level controls. Factors such as the microphone, transceiver circuitry and operator speech level all contribute to variations in modulation characteristics. Nearly all FM transceivers contain internal deviation level controls. Details on the location of the deviation controls and adjustment procedures appear in the equipment's service manuals.

Unlike AM and SSB modulation waveforms, FM waveforms cannot be directly displayed on an oscilloscope. Consequently, I've often lamented the lack of a convenient and affordable deviation measurement instrument. A laboratory-grade product is typically way beyond the budget of most amateurs, and a "ham grade" instrument didn't seem to exist—at least until the MFJ-224 2-Meter FM Signal Analyzer. It not only gives a meter indication of the deviation of a continuously modulated 2-meter FM signal, but it can also work as an oscilloscope adapter. This will allow you to view FM waveforms on your 'scope. It has some other neat features as well. Let's take a closer look.

The Bottom Line

The MFJ-224 2-Meter FM Analyzer provides an economical means for directly measuring the field strength of a 2-meter FM signal, and the deviation level of almost any continuously modulated FM signal. Connect it to an oscilloscope and you've got a powerful tool for the measurement of the peak deviation level and the evaluation of the overall audio quality of CTCSS, DTMF and speech-modulated FM.

Under the Hood

If you're like me, the first thing you want to know when encountering a new piece of test equipment is what's inside. At the heart of the '224 is a Motorola dual conversion "receiver on a chip" IC. Additional circuitry provides a deviation detector, headphone monitor and discriminator meter. There is also circuitry for such things as tuning and voltage regulation. Most of the unit's components are contained on a single printed circuit board.

So what does it do? As I reviewed the manual and schematic, I began to think of the MFJ-224 as essentially a 2-meter receiver with some specialized features:

- A deviation meter.
- A signal strength meter.
- An oscilloscope adapter for viewing FM waveforms.

Although the signal strength meter somewhat corresponds to a conventional S-meter, it has the added capability of measuring absolute signal power levels. The resulting measurements in dBm allow for easy comparison in dB or dBm between signal levels. (Note: dBm indicates dB relative to 1 mW. Details on dBm also appear in the *ARRL Handbook.* Look for them in *Mathematics for Amateur Radio* chapter.)

Applications for this unit include the measurement of continuously modulated 2-meter FM transmitter deviation, evaluating 2-meter antenna performance, checking coax cable loss, repeater field strength mapping, measuring 2-meter preamplifier gain and fox hunting. Interconnection with an oscilloscope will allow you to analyze FM audio quality and determine the peak deviation of speech-modulated FM signals.

The manual consists of nine stapled sheets with sections on specifications and applications, hookup and operating instructions for making field strength and deviation measurements and a *Field Service Guide* describing calibration procedures. A schematic is also included. Overall, I would rate the manual as adequate. The step-by-step instructions for making various measurements are easy to follow, and additional information helps you interpret the results.

Product Profile

The clean logical layout of the MFJ-224 helps make it intuitive and simple to operate. The uncluttered $3\frac{1}{2}\times7\frac{1}{2}$-inch front panel has only four controls, one meter and a pilot light. Its outward appearance and black crinkle finish also remind me somewhat of other MFJ products. On the minus side, the $1\frac{7}{8}$- inch deep box is held together by eight Phillips head screws, which must be removed to replace the 9-volt alkaline battery. No provisions are included for powering the unit from an external power source.

The upper part of front panel features the surprisingly large $1\frac{1}{2}\times2\frac{1}{2}$-inch analog meter. Near the bottom, a corresponding **METER** switch selects one of the four meter-display options. These provide the four basic functions of the MFJ-224:

SIGNAL corresponds to the upper **RSSI-dBm** meter scale. The RSSI (Recovered Signal Strength Indicator) shows the level of the incoming signal power. The meter range extends from –100 to –40 dBm.

DISCRIMINATOR corresponds to the lowest scale on the meter. It provides a center line indication when the MFJ-224 is properly tuned to the frequency of interest.

DEVIATION corresponds to the **Dev-KHz** meter scale. With the switch in this position the meter displays the carrier swing of an FM signal during modulation, or the actual deviation of a continuously modulated FM signal. The scale range extends from 0 to 7 kHz.

BATTERY corresponds to a **Bat. OK** zone on the meter display. A green area is clearly marked on the meter display between the upper and center scales providing a quick and easy way to check battery status.

The most prominent control on the MFJ-224 is the large protruding $1\frac{1}{4}$-inch diameter **FREQUENCY** knob located below the meter and on the right side of the front panel. A reduction drive mechanism requires almost four turns to move the plastic pointer through 180°, resulting in frequency coverage from 144 to 148 MHz with some overlap at each end.

On the top panel of the case is an SO-239 antenna jack. The remaining controls and jacks include:

A red **POWER** push-button switch located in the lower left corner of the front panel. Just to its right is a red LED that illuminates when power is on.

A **MONITOR** button in the lower right corner of the front panel. This is an on/off switch for the headphone audio monitor.

A 3.5 mm **PHONO** jack for the audio monitor is located on the bottom panel. This output allows you to connect headphones for monitoring received signals.

A **SCOPE OUTPUT** RCA phono jack is also located on the bottom panel just to the left of the **PHONO** jack. This connector provides an easy and convenient connection point for an oscilloscope. With the 'scope connected, you can observe incoming signal waveforms. This feature is essential for measuring peak deviation of speech and other complex waveforms. More about this later as well.

Shack and Test Bench Operation

I found operation of the MFJ-224 to be very simple and easy. First, connect an antenna to the **ANTENNA** SO-239, then depress the **POWER** button and verify that the pilot light illuminates. Since I find the monitor function to be pretty much essential, I recommend that you connect a set of headphones (not included) to the **PHONO** jack. Next, you can perform an optional battery check. Set the meter control to **BATTERY** and verify the meter indicates in the green **Bat. OK** zone. You are now ready to tune and listen across the 2-meter band or to measure signal power levels.

I decided to start out by listening on 2 meters just to see what I could hear. I borrowed my wife's Walkman headphones and connected the MFJ-224 to a 2-meter ground-plane. Numerous local repeaters popped out of the noise as I slowly turned the **FREQUENCY** knob.

The monitor audio is a bit loud so I readjusted the headphones away from my ears. The MFJ-224 is not primarily intended to be an amateur receiver, so it does not have an audio level control or squelch. Unlike most modern 2-meter amateur transceivers, the MFJ-224 does not use a synthesized VFO. Tuning is therefore a bit "touchy" and the frequency tends to drift slightly. The analog frequency dial is also less precise than the tuning arrangement on radios with which you may be familiar. I find this limitation to be minimal since the typical signal of interest is usually quite strong. Although I discovered making measurements is easy, it does require a certain degree of finesse.

Both signal power and deviation measurements require tuning the MFJ-224 to the desired signal, just as you would with an ordinary receiver. First, set the **METER** switch to **DISCRIMINATOR** and tune in the signal using the **FREQUENCY** control. I find the monitor very helpful as a tuning aid, as hearing the audio not only helps find a signal, it also helps verify that you are tuning to the *correct* signal. Just fine-tune the **FREQUENCY** control to set the needle to the centerline of the discriminator scale. You are now ready to measure either signal power or deviation.

To measure signal power, set the meter function switch to the **SIGNAL** position and read power on the RSSI-dBm meter scale. While tuning across the band, I heard several repeaters in the –90 dBm range. The local machine on a nearby hill measured –55.5 dBm with my $\frac{1}{4}$-wave mobile antenna. The same machine on my wife's mobile $\frac{5}{8}$-wave antenna was –50.5 dBm. This simple antenna comparison was easy to perform and one I found most revealing.

To measure deviation, set the meter switch to **DEVIATION**. The MFJ-224 now will indicate the deviation of any continuously modulated FM signal deviated from 2 to 7 kHz. Measurements of the maximum deviation of speech and accurate measurements of deviation below 2 kHz (such as CTCSS tone levels) require that an oscilloscope be connected to the **SCOPE OUTPUT** jack.

The manual recommends signal levels be from –70 to –50 dBm for "clean noise-free audio" for deviation measurements. Off-air signals should exhibit a minimum of 20 dB of quieting before attempting to measure deviation, and obviously, you must never connect a transmitter directly to the '224.

It's unfortunate that the MFJ-224 can not directly measure the actual value of the peak deviation of non-continuously modulated signals. Adding this capability would enable you to measure the peak deviation of FM signals modulated by normal speech without connecting the unit to an oscilloscope. The difference is similar in concept to a peak vs average reading wattmeter when measuring SSB signal power. While it is possible to carefully observe the meter motion and get an estimate of the deviation level or compare different levels, actual peak deviation measurements require the 'scope.

Connecting the 'scope to the MFJ-224 is easy. Complete instructions on hookup and recommended settings are given in the manual. Tuning across the band, I could view the actual waveforms of the received signals on the oscilloscope. I found peak deviation is now easily measured. Just use the peak-to-peak voltage observed on the 'scope and a chart provided in the manual to convert this to the actual deviation level.

Fox Hunting and More

Those active in fox hunting will quickly recognize the value of the MFJ-224's easy to read analog signal power meter. When used in conjunction with a step attenuator and a directional antenna the '224 can be a powerful fox-locating aid. Simply tune to the fox's frequency, switch in enough attenuation to keep the RSSI reading near mid-scale, and determine a heading by rotating the antenna for peak signal strength. Minor variations in signal are readily apparent on the large analog meter.

While the receiver in the MFJ-224 is sufficiently sensitive for most other measurement purposes, fox hunters may want to consider adding a receive preamplifier for weak signal locating.

The manual also includes sections on measurement techniques for 2-meter antenna performance and field strength evaluations. Methods and tips for determining the important characteristics of directional antenna patterns, such as forward gain, beamwidth, front-to-back ratio and sidelobe suppression are included.

Here, the importance of a calibrated signal strength meter that gives signal levels in dBm becomes more apparent. Conventional S-meters are useful for relative type measurements only. There really is no "standard" S-unit. This makes S-meters unsuitable for antenna performance and field strength evaluations.

The specifications given in most antenna literature and the values that result from antenna modeling programs are most commonly expressed in units of dB. These values can be measured or verified directly by using data collected with the '224.

Overall Impressions

The MFJ-224 sure fills a needed niche. It's not only a deviation and signal strength meter, but a great fox hunting tool as well. Antenna performance and field strength measurements are surprisingly easy.

First and foremost on my wish list for the MFJ-224 would be a peak-reading deviation meter. Less touchy tuning would be second, and an audio level control for the headphones trails as a distant third.

Overall I feel the MFJ-224 merits consideration by anyone seeking an economical approach to 2-meter deviation and/or signal strength measurements.

Manufacturer: MFJ Enterprises, Inc, Box 494, Mississippi State, MS 39762; tel 800-647-1800; fax 601-323-6551; **http://www.mfjenterprises.com**. Manufacturer's suggested retail price, $160.

SOLICITATION FOR PRODUCT REVIEW EQUIPMENT BIDS

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