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QST Compares: SSB Electronic UEK-2000S and Down East Microwave SHF-2400 2.4-GHz Satellite Downconverters

JPS Communications NRF-7 and NF-60 DSP Audio Filters

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Reviewed by Steve Ford, WB8IMY
Assistant Technical Editor

Ask any satellite-active ham to name the most popular communications mode on OSCAR 13. Most will tell you it's *Mode B*. By transmitting on the 70-centimeter (436-MHz) band and listening on 2 meters, OSCAR 13 enthusiasts have been working DX for years. At the highest point in its elliptical orbit, OSCAR 13 "sees" nearly half the globe. That presents a huge potential for plenty of international conversations!

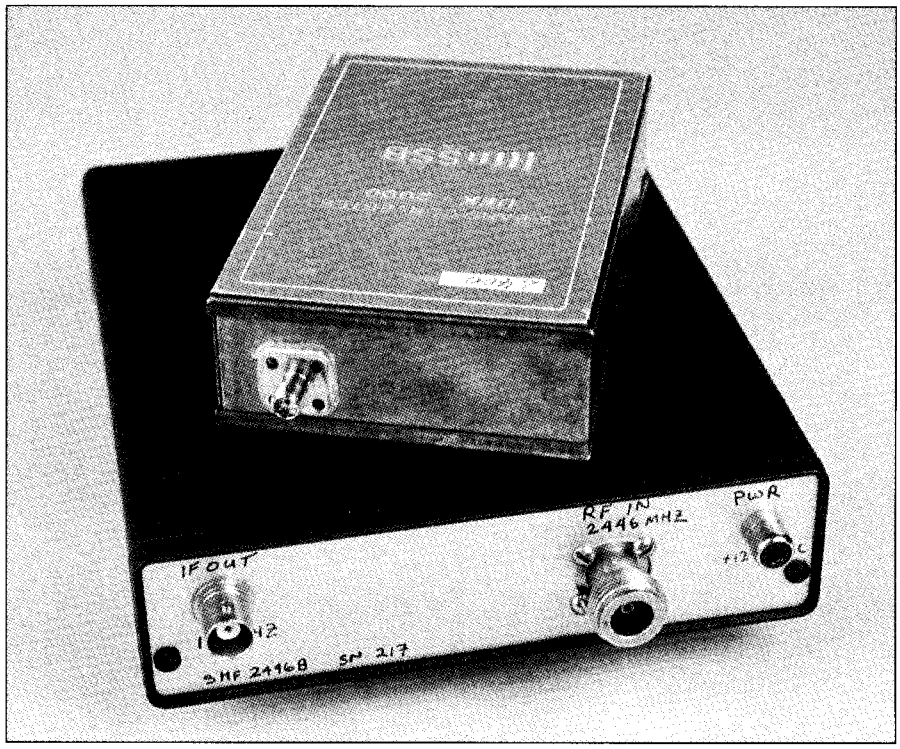
The rosy scenario for Mode B is changing, though. The 2-meter band is becoming crowded in many areas. Local signals easily overwhelm sensitive satellite stations. In addition, Mode B requires a fairly large antenna for 2 meters.

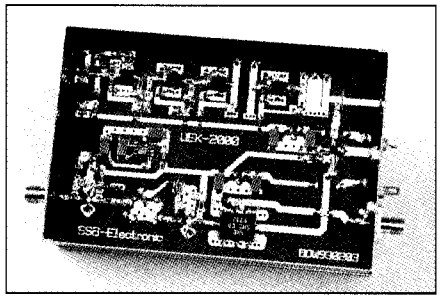
As a result, an increasing number of hams are "discovering" *Mode S* on OSCAR 13. To work stations via Mode S, you transmit on the 70-centimeter band and receive on 13 centimeters (2.4 GHz). As you can guess, Mode S offers the advantage of using small, unobtrusive antennas. In fact, some amateurs have worked Mode S successfully with *indoor* antennas.

As an added bonus, noise levels at 2.4 GHz are low and interference is rare. A 2-foot parabolic dish is adequate to receive OSCAR 13's 2.4-GHz downlink. But is a dish really necessary? Not at all. James Miller, G3RUH, has designed and built a usable 2.4-GHz helical antenna that is less than 30 inches long! Other antenna designs can be used as well.

For acceptable receive performance at 2.4 GHz, you need more than a good antenna. You need a means to convert the signal to a lower band, usually 2 meters, where it can be received on an *IF* (intermediate frequency) receiver and easily demodulated. In other words, you need a *downconverter*.

For this review we evaluated off-the-shelf downconverters from SSB Electronic and Down East Microwave. I used a Kenwood TS-700S all-mode rig as my 2-meter IF receiver. The downconverters were mounted at the antennas and the 2-meter signals were fed to the TS-700S through a length of Belden 9913 coaxial cable.





UEK-2000S
(photos by Kirk Kleinschmidt, NTØZ)

SSB ELECTRONIC UEK-2000S

The SSB Electronic UEK-2000S is packaged in an enclosure somewhat larger than a pack of cigarettes. At one end of the case you find two feed-through connectors for the 12-V dc supply. A solder lug serves as the ground connection. More about the power connections later.

One reason the UEK-2000S is so small is that it uses the latest in professional microwave techniques. It has a low-noise HEMT front end, 2-pole helical filters, a second GaAsFET preamp stage, and many surface-mount devices (including a Schottky diode double-balanced mixer).

The unit I tested used SMA connectors (tiny) for the RF input/output jacks. My experience with SMAs was nil and finding them proved to be a frustrating experience. (They're not at your local Radio Shack!) Ultimately, I borrowed a couple of SMA-to-N adapters from the ARRL Lab. I've since discovered that SMA connectors and adapters are available at flea markets and from several *QST* advertisers, but you have to know what you're looking for.

While the UEK-2000S is small enough and light enough to mount at the antenna, the case is not watertight. Since my experiments were temporary, this wasn't a problem. If you intend to mount it permanently, I recommend the model UEK-2000SAT. It's the same downconverter packaged in a weatherproof, mast-mount enclosure. The UEK-2000SAT also features N connectors (an added bonus).

The UEK-2000S's claim to fame is high gain with a low noise figure (see Table 1). Its frequency range is 2.4 to 2.45 GHz. You'd need a wideband receiver to tune through the entire range, but for OSCAR 13 it's only necessary to tune over a 1-MHz range starting about 2.4 GHz. That's well within the coverage of any 2-meter all-mode radio.

The Bottom Line

Both of these Mode-S downconverters offer a low-hassle way to try a satellite mode of the future. You can't go wrong with either one.

Table 1

SSB Electronic UEK-2000S 2.4 GHz Downconverter

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Input frequency: 2.4 to 2.45 GHz	As specified.
IF: 144 to 194 MHz	As specified.
Conversion gain: >17 dB	22.5 dB
Noise figure: 0.8 dB	0.73 dB
Local oscillator frequency stability: Not specified.	The LO frequency drifted +31 kHz over a temperature excursion from 0 to 30°C.
Local oscillator warm-up drift: Not specified.	The LO frequency drifted +2 kHz within 5 minutes at an ambient temperature of 21°C.
Voltage requirement: 13.8 V dc	Converter draws 100 mA at 13.8 V dc. Little performance change from 9 to 14 V dc.

Size and weight: 1½ × 2¾ × 4¼ inches (HWD), 6 ounces.

My first test was with a 40-element loop-Yagi antenna. This did not work out as well as I expected, but the problem was with the Yagi, not the UEK-2000S. An antenna with circular polarization is recommended for satellite work to minimize fading and maximize signal strength. The loop Yagi isn't circularly polarized, and Mode S signals were weak. Despite this, I managed to eavesdrop on several SSB and CW conversations during a high-elevation OSCAR 13 pass.

For my next attempt I tried a 3-foot parabolic dish with a crude helical (circularly polarized) feed that I threw together on the spur of the moment. The feed is copied from a recent *AMSAT Journal* article by James Miller, G3RUH. The dish was something that had been lying unused in an HQ staffer's backyard, and I made no attempt to optimize the setup. Nevertheless, what a difference! I didn't have to strain to hear these signals. They were *loud*. I mounted the UEK-2000S directly at the dish feed with just a 3-inch piece of 9913 between the helical feed and the RF input.

Finally, I hauled the dish and the downconverter indoors and tried again from the confines of my second-floor shack. The signals were not as loud as before, but the strength and clarity were astonishing. If I had a 70-cm uplink antenna in my attic (and if I was using a reasonable amount of output power), I believe I could have worked OSCAR 13 that day with little difficulty.

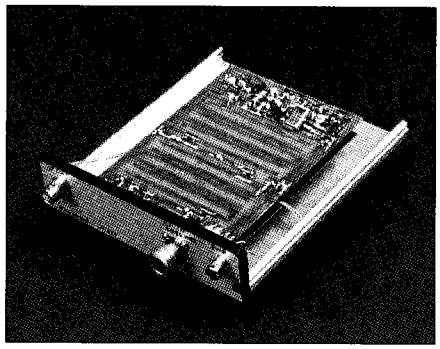
Aside from the SMA connectors, my only misgiving about the UEK-2000S is the documentation. It assumes that the user is experienced with microwave downconverters. In my case, this assumption caused some momentary confusion. When I attempted to connect the dc supply, I noticed that the connections were labeled **LO+** and **RX+**. Which one should I use? I consulted the documentation, but could not find a hook-up diagram. After some study, I learned that *both* connectors had to be wired to the positive side of my power supply. One routes power to the local oscillator (**LO**), the other to the downconverter (**RX**).

Despite these minor glitches, the UEK-2000S is an outstanding product. It packs a lot of performance in a very small box.

Manufacturer: SSB Electronic USA, 124 Cherrywood Dr, Mountaintop, PA 18707; tel 717-868-5643, fax 717-868-6917. Manufacturer's suggested retail price: UEK-2000S $369.95; UEK-2000SAT (mast-mount enclosure) $399.95; UEK-2000SAT option 01 (30 dB of conversion gain), $439.95.

DOWN EAST MICROWAVE SHF-2400

Down East Microwave takes an economical approach to S-band downconverters with the SHF-2400. You can buy the SHF-2400 preassembled or, for even greater savings, as a kit.



SHF-2400

The kit approach is not as difficult as you'd think. The downconverter design uses no-tune filters etched onto Teflon printed-circuit boards. There are two circuit boards: one for the local oscillator and another for the downconverter. The components consist of broadband, no-tune active devices and an assortment of resistors, diodes and chip capacitors. The kit can be assembled in a few hours and it's ready for use immediately—no test equipment or tune-up required.

For this review I opted for a preassembled unit. The preassembled SHF-2400 is packaged in a case about twice as large as the UEK-2000S. All the input, output and power supply connections are on one side of the case. The 2.4-GHz input uses an N connector. The IF output to the 2-meter radio is through a BNC connector. A phono connector serves as the 12-V dc input. The case is *not* watertight.

The first antenna I tried was the 40-element loop Yagi. I could hear signals on OSCAR 13's Mode S downlink, but they were weak. Again I brought out the 3-foot parabolic dish and attached the SHF-2400 to the feed point. As expected, there was a substantial increase in signal strength. I listened to several SSB conversations without difficulty, even though the satellite was nearly 20,000 km away. The indoor test was impressive. There seemed to be little additional attenuation of the downlink signals—as long as I was careful to aim my dish away from the aluminum siding.

As you can see in Table 2, the SHF-2400's conversion gain is lower than the UEK-2000S's, and the noise figure is somewhat higher. If you intend to use a small, lower-gain antenna, you may need to invest in an optional Down East Microwave 2.4-GHz preamplifier. Depending on how much gain your antenna has, the benefit you get from a preamp will vary. So try it without the preamp first. If the cable to your 2-meter receiver is longer than 100 feet, a 2-meter preamplifier on the IF line

Table 2

Down East Microwave SHF-2400 2.4 GHz Downconverter, serial no. 217

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Input frequency: 2.4 to 2.45 GHz	As specified.
IF: 144 to 194 MHz	As specified.
Conversion gain: 16 dB	16.3 dB
Noise figure: 5 dB	4.7 dB
Local oscillator frequency stability: Not specified.	The LO frequency drifted +13/–6 kHz over a temperature excursion from 0 to 30°C.
Local oscillator warm-up drift: Not specified.	The LO frequency drifted –6 kHz within 5 minutes at an ambient temperature of 23°C.
Voltage requirement: 13.8 V dc	Converter draws 330 mA at 13.8 V dc. Performance falls off below 12.5 V dc.

Size and weight: 1½ × 5½ × 6½ inches (HWD), 1.2 pounds.

may also be worth consideration. The documentation includes a schematic for a simple 2-meter IF preamp.

Like the UEK-2000S, the SHF-2400 falls a bit short in the documentation department. The text instructions are detailed, but I found the hand-drawn illustrations a bit difficult to understand. Some CAD-produced diagrams would be an asset.

Down East Microwave offers an a la carte approach to Mode S reception. If you opt for the assembled unit with a companion assembled preamp, the price and performance are on par with the UEK-2000S. The SHF-2400 without an external preamp is much less expensive, and its performance may be adequate if your antenna is good enough. And if you assemble the unit from a kit, you can get on OSCAR 13 Mode S even less expensively, and with the satisfaction of knowing that you built a piece of your satellite station yourself.

Manufacturer: Down East Microwave, RR 1, Box 2310, Troy, ME 04987; tel 207-948-3741, fax 207-948-5157. Manufacturer's suggested retail price: $255 assembled; $155 kit (without enclosure or connectors). Optional 2.4-GHz preamplifier, $130 assembled.

JPS Communications NRF-7 and NF-60 DSP Audio Filters

Reviewed by Rus Healy, NJ2L, ARRL Technical Advisor

On the heels of its resoundingly successful NIR-10 DSP audio filter, JPS Communications has brought two more products in the same family to this rapidly expanding market. Using proven digital-signal-processing (DSP) technology and solid filtering algorithms, both versions have a place in today's hamshacks.

In the old days, an audio filter was the only way to augment less-than-optimum IF filtering. Unfortunately, it was also (usually) a poor solution: High-Q (narrow) passive filters rang significantly and had other objectionable effects. Then came switched-capacitor filters (SCFs), which raised audio filtering to new levels of ring-free, steep-skirted performance. But they lacked the flexibility to do much more than basic band-pass signal cleanup. Now that DSP-based filtering is in its second generation in the Amateur Radio market, audio filters have become truly valuable additions to most stations.

Both the NRF-7 and the NF-60 are based on the Texas Instruments TMS 320E15 chip. The NIR-10, however, is based on the more powerful TMS 320C25 chip, making it a vastly different product. Through software upgrades released since the NIR-10 was reviewed in *QST* (October 1991, pages 37-38), JPS has improved its main mode of operation—*denoising*, or removing unwanted, random noise from the passband—while passing desired signals. The NIR-10 also has more traditional band-pass modes. The NF-60 doesn't do denoising, while the NRF-7 does, as well as ably handling other everyday filtering needs.

All JPS filters are built of first-class material, in rock-solid cabinets. Taking audio from your receiver's speaker output, these filters supply both low-distortion speaker-level audio and headphone outputs. JPS includes an informative, clearly written instruction manual with each filter. Both units operate from 11 to 15 volts dc. JPS offers an optional power adapter for their filters, and includes connectors to match the NRF-7 and NF-60 connectors with every filter they ship.

NF-60

The *NF* in NF-60 stands for *notch filter*. This filter does what you'd probably guess: notches unwanted carriers that fall in your receiver's audio passband. In principle and operation, it's a simple device: Connect it to your power supply, receiver, and headphones or speaker, and turn it on. It finds and notches carriers that appear anywhere in the passband—by as much as 60 dB, and nominally within 5 milliseconds. Multiple carriers? No problem. It's rated to notch up to four carriers by 50 dB or more each. If you're trying to listen to a signal among four or more carriers, you'll lose a bit of notch depth, but that's a rare situation in-

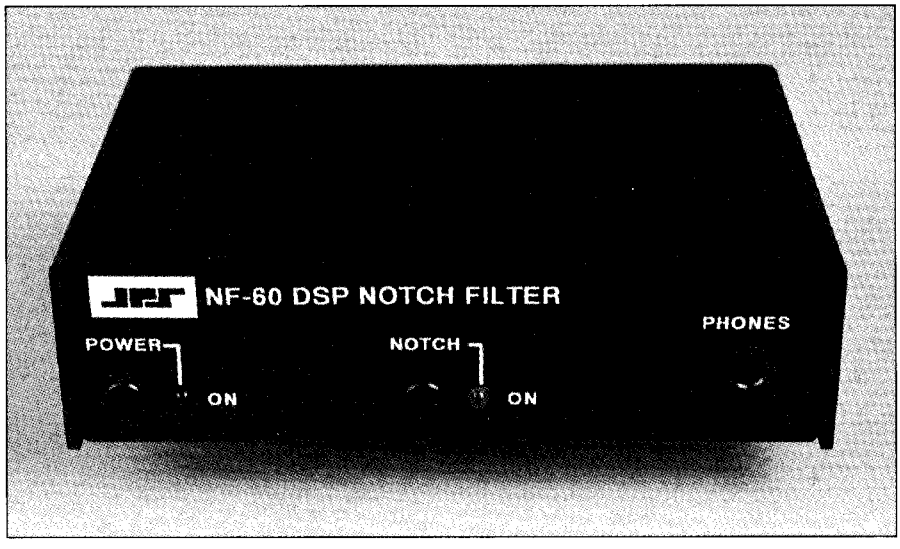
Table 3
JPS Communications NF-60 Automatic DSP Notch Filter

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Power requirement: 11 to 15 V dc at 0.5 A max.	As specified.
Frequency response: 300 Hz to 2.7 kHz.	100 Hz to 2.7 kHz.
Input level: 120 mV to 2.8 V rms.	Not measured.
Input-to-output delay: 0 ms.	1.2 ms from full input to full output.
Notch depth: >50 dB for one to four tones.	>60 dB with one 1-kHz tone at 0.5 V RMS input.
Time to notch suddenly appearing signal: <6 ms.	Signal notched >75% after 6 ms.
Headphone output impedance: 8 Ω.	Not measured.
Speaker output: 2 W at 10% distortion into a 3.2-Ω load.	As specified.
Audio output distortion: <0.5% at 1 kHz at 0.5 W output.	0.4% at 1 kHz at 0.5 W output.

Size and weight: 1.7 × 6 × 4.3 inches (HWD), 2 pounds.

The Bottom Line

Both of these solidly built filters bring modern DSP technology into play against an age-old problem: eliminating interference. The NF-60 does a fine job of notching unwanted carriers. The NRF-7 notches carriers and offers a variety of effective audio band-pass filters as well.



NF-60

deed. When the NF-60 notches a carrier, it does so by taking out only a small slice of the audio spectrum; it has no effect on intelligibility of SSB signals.

The NF-60's notching action occurs quickly, but not so quickly that you can't copy fast CW signals when the filter is in line. Anything under 30 WPM sounds like uniform-length tone bursts at the beginning of each character element. Of course, that's not what this filter is intended for. It's mainly for operating SSB in harsh environments, like 40 meters. And for that application, it works just great. The NF-60 doesn't do a great job of eliminating weak carriers (notch depth is proportional to signal strength, even within the filter's rated input range of 120 mV to 2.8 V rms).[1] But these aren't the most painful carriers in real operation. The bottom line is that the NF-60 knocks *every* carrier down to a sub-annoying level. That's what counts.

NRF-7

As someone who's generally skeptical about audio filters, I was truly impressed when I first heard the NRF-7 in action last spring. It worked wonders on tape-recorded signals. But how would it behave on the air?

Although it has a notch mode like the NF-60, the NRF-7 also features two bandwidths each for CW and SSB, plus a band-pass data filter and two additional modes that significantly increase its usefulness. The NRF-7's 10-position mode switch has these functions: 250-Hz CW filter (**CW NAR**); 500-Hz CW filter (**WIDE**); 1.5-kHz SSB filter (**SSB NAR**); 2.1-kHz SSB filter (**SSB WIDE**); 500-Hz filter centered at 2.2 kHz (**DATA**); **NOTCH**; **PEAK**; notch plus SSB narrow (**NT+SSB NAR**); notch plus SSB wide (**NT+SSB WIDE**); and, believe it or not, peak plus notch (**NT+PEAK**). To understand why the NRF-7 supports the last mode, an unlikely looking combination of notch and peak modes, you have to understand the peak mode itself—one of the filter's most clever ingredients.

The NRF-7's peaking mode is described as follows in JPS's NRF-7 documentation:

> The **PEAK** mode is useful for reducing white or pink (thermally generated) noise from received signals. It works by providing a dynamic peak around all coherent signals, voice or otherwise. This, in essence, provides noise reduction by reducing the effective audio bandwidth to the minimum required. The effective bandwidth constantly varies based on the audio signal present. With CW signals, the tones existing in the audio passband are peaked, so if a CW signal can be separated with the receiver filter, it can be further peaked and noise-reduced using the **PEAK** filter.

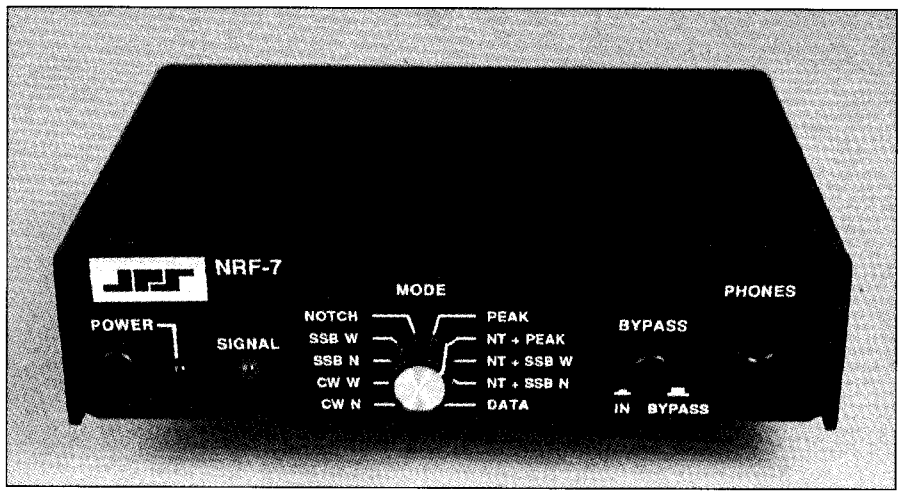
This, like the rest of the NRF-7 documentation, clearly states what the peak filter does. In operation, it provides a squelch-like quality to desired signals in the passband, reducing fatigue by significantly reducing band noise and receiver noise during pauses in speech or keying. The peak-and-notch mode does this at the same time as it notches unwanted carriers—a combination that's particularly useful when you're tuning through the 40-meter band in the evening, looking for SSB stations among the broadcast signals. When you find one, the NRF-7 tends to shut out the background noise and, of course, kills the carriers.

For serious contest and DX work, I find the NRF-7's band-pass modes most useful. They provide steep-skirted SSB and CW filters that augment the receiver's IF filtering. In demanding operation, many current radios that aren't near the top of the line suffer from wider-than-necessary SSB IF filtering, and in many cases no optional narrow filters. The NRF-7's 1.5-kHz and 2.1-kHz band-pass filters fill the gap nicely, reducing or eliminating off-channel chatter that can be quite annoying. And they're especially useful when combined with the notch mode.

Tuning with the NRF-7 in line is easy, since its front-panel **SIGNAL** indicator shows you when a signal is in the selected filter's passband. This works whether the filter is in line or bypassed, letting you tune a signal to the filter's center before switching it in line.

The CW modes improve most receivers' performance, but not quite as dramatically as the SSB modes do. One area in

[1]Lab tests showed that the NF-60 notches a single 1-kHz carrier by only 36 dB when the input signal level (tone only) is 450 mV rms.



NRF-7

Table 4
JPS Communications NRF-7 Multimode DSP Audio Filter

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Power requirement: 11 to 16 V dc at 1 A max.	As specified. Typical current drain during headphone operation is less than 0.2 A.
Frequency response: 200 Hz to 3.4 kHz.	100 Hz to 2.7 kHz.
Input level: 100 mV to 2 V rms.	Not measured.
Input-to-output delay: 0 ms.	1.2 ms from full input to full output.
SSB filter bandwidths: 300-1800 Hz and 300-2400 Hz.	100-1700 Hz and 100-2200 Hz.
SSB filter shape factor: 1.15:1.	As specified.
Data filter bandwidth: 500 Hz.	As specified.
Data filter center frequency: 2.2 kHz.	As specified.
Data filter shape factor: 1.4:1.	As specified.
CW filter bandwidth: 250 and 500 Hz.	As specified.
Notch depth: >50 dB for one to four tones.	62 dB with one 1-kHz tone at 0.5 V RMS input.
Time to notch suddenly appearing signal: <5 ms.	Undesired signal notched by approximately 75% after 5 ms.
Headphone output impedance: 8 Ω .	Not measured.
Speaker output: 2 W at 10% distortion into a 8-Ω load.	2.37 W.
Audio output distortion: <0.5% at 1 kHz at 0.5 W output.	1.76% at 1 kHz at 0.5 W output; 0.5% at 1 kHz at 0.1 W output.

Size and weight: 1.7 × 6.5 × 5.1 inches (HWD), 2 pounds.

which they're particularly useful, however, is weak-signal VHF-and-up work where many commercial radios don't offer adequate IF filtering for this mode. The 250-Hz filter is especially useful for moonbounce operation, where it further reduces the noise power that slides through along with the desired signal, improving signal-to-noise ratio on very weak signals.

To account for differences in the CW center frequencies used by radios (and operators), JPS provides a set of internal jumpers by which you select a center frequency of 400, 800 or 1000 Hz. I prefer 400 Hz, but I pointed out to JPS Communications that many radios on the market don't work well with these standard center frequencies because they don't allow changing the center frequency of a properly tuned CW signal. I suggested that 400, 600 and 800 Hz would make better choices. They agreed, and make this combination available on request in the NRF-7.

The NRF-7's data filter provides a significant advantage to HF data-mode operators who use radios that aren't flexible enough to allow the use of narrow IF filters in data-mode reception. Its 500-Hz-wide passband is centered at 2200 Hz—the appropriate part of the audio passband to pass only the tones used for many of these modes. This filter has low passband ripple (less than 0.7 dB) and a very good shape factor. Although the NRF-7's passband ripple is a bit higher (a little more than 1 dB) in its other modes, lab tests with an HP 3562A dynamic signal analyzer show that its other key characteristics in these modes—shape factor, in particular—are outstandingly good, as its specs indicate.

The NRF-7 doesn't quite meet JPS's specs in its SSB modes: The low-frequency cutoff is about 100 Hz, not the specified 300 Hz. (None of the other modes are affected.) The upper cutoff frequencies (1800 Hz in SSB narrow and 2400 Hz in SSB wide) are as specified, however. A call to JPS revealed that this resulted from an IC that was changed late in the design stages, broadening the NRF-7's low-end response to 100 Hz. (The NF-60's low-end response also measured 100 Hz, rather than the specified 300 Hz.) Updated firmware is available to move the passbands up to where the spec sheet says they should be, and JPS offers it to any NRF-7 owner at no charge. It's important to note here that I would never have known about this situation without performing lab tests, because the narrowness of these filters is much more important on the air than the difference in their low-cutoff frequencies.

In addition to its more obvious advantages, the NRF-7 fixes one problem that's unfortunately common in many modern radios: hissy audio. You shouldn't need to add an external audio filter to get rid of high-frequency noise generated in your transceiver's audio-amplifier stages, but the NRF-7 will kill it for you if it's there.

Limitations and Summary

Like any audio filter, the NF-60 and NRF-7 work outside your receiver's AGC loop. As a result, they don't do as much good as they would if they were inside the AGC loop. For example, if you're tuning a busy band listening to CW signals with a wide filter in line, you'll hear many signals. If one of them is particularly strong, you may not be able to hear the weaker ones you're interested in copying, because the strong signal "grabs" the receiver's AGC and reduces your radio's IF gain, putting the weaker signals below the audible threshold. An AF filter like the NRF-7 may let you select only the signal you want to hear under these circumstances, but it doesn't keep those strong, undesired signals from affecting the receiver's AGC; narrower IF filtering is the only way to do that.

The result is this: Audio filtering is a great *supplement* to good IF filtering—especially when it can perform adaptive tasks like notching carriers and peaking desired signals as they move through your receiver's passband. The NF-60 handles notching, and the NRF-7 does that plus a lot more. Both filters also share the advantage of being upgradable by merely replacing their preprogrammed chips with improved versions as JPS releases them, such as they've done with the NIR-10.

The quality of the NF-60, NRF-7 and NIR-10 packaging mirrors JPS's commitment to customer service. If you have a problem or a question, a call to JPS will quickly get you an answer from a friendly and knowledgeable person.

Thanks to Chris Piggott, WZ2B, and Don Russ, N2CZL, for their assistance with this review.

Manufacturer: JPS Communications, Inc, PO Box 97757, Raleigh, NC 27624-7757, tel 919-790-1048, fax 919-790-1456. Manufacturer's suggested retail price: NF-60, $150; NRF-7, $250

SOLICITATION FOR PRODUCT REVIEW EQUIPMENT BIDS

[In order to present the most objective reviews, ARRL purchases equipment off the shelf from dealers. ARRL receives no remuneration from anyone involved with the sale or manufacture of items presented in the Product Review or New Products columns.—*Ed.*]

The ARRL-purchased Product Review equipment listed below is for sale to the highest bidder. Prices quoted are minimum acceptable bids, and are discounted from the purchase prices. All equipment is sold without warranty.

AEA PK-88 TNC with PC-Pakratt-88 software and AC-1 power cube (sold as a package only; see Product Review, December 1993 *QST*). Minimum bid: $135.

DRSI DPK-2 TNC (see Product Review, December 1993 *QST*). Minimum bid: $76.

Kantronics KPC-3 TNC with Host-master II software (sold as a package only; see Product Review, December 1993 *QST*). Minimum bid: $122.

MFJ-1270B TNC (see Product Review, December 1993 *QST*). Minimum bid: $73.

MFJ-8100 regenerative shortwave receiver (see Product Review, January 1994 *QST*). Minimum bid: $40.

PacComm TINY-2 MK-2 TNC (see Product Review, December 1993 *QST*). Minimum bid: $99.

Ten-Tec Model 555 Scout with 160, 80, 40, 30, 20, 17, 15, 12 and 10-meter band modules and Model 700C hand mike (sold as a package only; see Product Review, December 1993 *QST*). Minimum bid: $469.

Yaesu FRG-100 general-coverage receiver with YF-110C 500-Hz CW filter (sold as a package only; see Product Review, January 1994 *QST*). Minimum bid: $429.

Sealed bids must be submitted by mail and must be postmarked on or before February 27, 1994. Bids postmarked after the closing date will not be considered. Bids will be opened seven days after the closing postmark date. In the case of equal high bids, the high bid bearing the earliest postmark will be declared the successful bidder.

In your bid, clearly identify the item you are bidding on, using the manufacturer's name and model number, or other identification number, if specified. Each item requires a separate bid and envelope. Shipping charges will be paid by ARRL. Please include a daytime telephone number. The successful bidder will be advised by telephone with a confirmation by mail. No other notifications will be made, and no information will be given to anyone other than successful bidders regarding final price or identity of the successful bidder. If you include a self-addressed, stamped postcard with your bid and you are not the high bidder on that item, we will return the postcard to you when the unit has been shipped to the successful bidder.

Please send bids to Bob Boucher, Product Review Bids, ARRL, 225 Main St, Newington, CT 06111-1494.