Product Review Column from *QST* Magazine

October 1991

Yaesu FT-650 6/10/12-Meter Transceiver

j-Com Magic Notch Automatic Audio Notch Filter

JPS Communications NIR-10 Noise/Interference-Reduction Filter

Modular Systems Corporation Smart Filter

Conducted By James W. Healy, NJ2L
Assistant Technical Editor

Yaesu FT-650 6/10/12-Meter Transceiver

Reviewed by Jon Bloom, KE3Z

Even though it covers only the amateur 12, 10 and 6-meter bands (plus continuous receive-only coverage from 24.5 to 56 MHz), the FT-650 has most of the features you'd expect to find in an all-band HF transceiver, including the benefits of digitally controlled frequency synthesis: memories, split-frequency operation and scanning. If you're in the market for a radio covering these bands, the FT-650 offers you quite a bit. And it's the only 100-watt 6-meter transceiver available to US hams.

Standard Features and Options

The FT-650 transceives in AM, CW, FM and SSB modes. Although it doesn't have separate RTTY or packet modes, it does have a connector for attaching 1200-baud AFSK packet modems. The '650 requires 13.8 V dc at 18 A on transmit and 2 A on receive; the FP-22 ac-operated switching power supply slips easily into a cavity in the rear of the transceiver. This design makes changing from home-station to mobile operation a snap.

The '650's receiver includes IF shift, a noise blanker and a notch filter. The notch filter can be operated manually or in an auto-tracking mode, in which it seeks, notches and tracks offending carriers. In place of a continuously variable IF-bandwidth control, the FT-650 allows selection from several IF bandwidths. The FT-650 manual states that, "In addition to standard IF bandwidths, fine tailoring of the IF passband is made possible by two of the DDSs [direct digital synthesizers], providing selectable IF bandwidths of 1.8, 2, 2.2 and 2.4 kHz in SSB modes, 300, 600, 1200 and 2400 Hz in CW mode, 2.4 and 6 kHz in AM and 8 and 15 kHz in FM modes (the two narrowest CW modes require an optional filter)." Of these, only the 600-Hz and 2.4, 6, 8 and 15-kHz choices reflect the actual bandwidths of single IF filters. The FT-650 uses two filters to implement the 300-Hz and 1.2, 1.8, and 2.2-kHz selectivities with a form of programmable, step-tuned variable bandwidth tuning (VBT).[1]

The FT-650's triple-conversion receiver has intermediate frequencies of 13.69 MHz, 455 kHz and 8.215 MHz. Its front-end sensitivity can be varied by selection of a 10-dB attenuator or a 10-dB-gain preamplifier. The radio's AGC circuit has fast- and slow-decay modes; it cannot be turned off.

The transmitter includes an RF speech processor. When you're transmitting, the built-in meter can indicate ALC voltage, SWR and output power (peak or average, selected by an internal switch). The FT-650's RF output is continuously variable from less than 5 watts to about 100 watts (50 watts in AM mode). VOX operation is *not* included, although semi-break-in CW is provided with an internally adjustable hang time.

FT-650 options include Yaesu's DVS-2 digital voice recording/playback unit and FTS-8 tone-squelch encoder/decoder. (The reviewed unit didn't include these options; see the FT-1000D review in March 1991 *QST* for a review of DVS-2 operation.)

The combination of direct digital synthesis and microprocessor control make for a good set of frequency control features, including RIT (or *clarifier*, as Yaesu calls it), 105 memories, split-frequency operation, repeater-offset selection and several scanning modes. Keypad frequency entry is not included. The FT-650 is also computer-controllable (frequency/memory/mode/PL-tone selection, TR switching) via Yaesu's CAT protocol.

The radio's fluorescent display brightness can be adjusted to one of eight levels. The brightest of these isn't adequate for operation in strong sunlight, but the control range is wide enough to handle most other lighting conditions.

Installing the optional 600-Hz IF filter in the FT-650's 455-kHz IF requires removing the radio's top cover and one of its plug-in circuit boards, and soldering the filter to the board. Once this is done, you flip a switch to enable the new filter and reinstall the board in the radio. The whole process takes only 15 minutes or so to complete.

The Manual

Yaesu continues to produce superior manuals. I especially appreciate the manual's photographs of each of the connectors that can be attached to the radio, with labeling to show the proper connection point for each signal on the connector. You need not squint to read the embossed black-on-black pin numbers on those tiny DIN connectors when making cables for the FT-650! And the FT-650 manual contains—surprise!—*examples* of how to perform the more complex memory and scanning operations. Having a lot of control operations is only useful when they're properly documented—and Yaesu addresses this need nicely in the FT-650 manual.

Operation

The FT-650 includes a host of well-thought-out control features. It's obvious that Yaesu designers actually *operate* ham radios! Two of the three bands covered by this radio allow FM operation (6 and 10 meters), and FM is well-integrated into the FT-650 design.

Operating Modes

The FT-650's CW operation is smooth, but its keying is hard, resulting in considerable key clicks. The CW offset and sidetone pitch are fixed. Also, the FT-650 suffers from the all-too-common problem of "dot swallowing"—that is, in semi-break-in mode, the first keyed element of each transmission is shortened—by about 14 milliseconds, according to our lab tests—and

[1]G. C. Collins and D. Newkirk, "Transceiver Features That Help You Beat Interference," *QST*, Mar 1991, pp 16-21.

Table 1

Yaesu FT-650 6/10/12-Meter Transceiver, Serial Number 0M050123

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 24.5-56 MHz; transmit, 24.5-25, 28-29.7 and 50-54 MHz.	As specified.
Modes of operation: AM, CW, FM, LSB, USB.	As specified.
Power requirement: 110-125 or 220-234 V ac or 13.8 V dc. Receive, 55 W max; transmit, 500 W max.	Not measured.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity (preamp on, bandwidth not specified): 0.125 μV (−125 dBm).	Minimum discernible signal (noise floor) with 300-Hz IF bandwidth: *Frequency* *Preamp off* *Preamp On* 24.9 MHz −132 dBm −138 dBm 28.0 MHz −135 dBm −139 dBm 50.0 MHz −133 dBm −139 dBm
AM (10 dB S/N, preamp on): 0.5 μV (−113 dBm).	10 dB S+N/N (6-kHz IF filter, signal 30% modulated with a 1-kHz tone, preamp off): 28 MHz, −119 dBm; 50 MHz, −120 dBm.
FM (12 dB SINAD, preamp on): 0.16 μV (−123 dBm).	12 dB SINAD, preamp off: 29 MHz, −111 dBm; 50 MHz, −112 dBm.
Receiver dynamic range: Not specified.	Blocking dynamic range (300-Hz IF bandwidth):† *Preamp off:* 28 MHz, 140 dB; 50 MHz, 109 dB. *Preamp on:* 28 MHz, 114 dB; 50 MHz, 104 dB. Two-tone, third-order intermodulation distortion dynamic range (300-Hz IF bandwidth):† *Preamp off:* 28 MHz, 84 dB; 50 MHz, 86 dB. *Preamp on:* 28 MHz, 82 dB; 50 MHz, 82 dB.
Third-order input intercept: Not specified.	*Preamp off:* 28 MHz, −9 dBm; 50 MHz, −4 dBm. *Preamp on:* 28 MHz, −16 dBm; 50 MHz, −16 dBm.
S-meter sensitivity (for S9 reading): Not specified.	At 28 MHz: preamp off, −88 dBm; preamp on, −98 dBm.
CW/SSB squelch sensitivity: Less than 0.2 μV.	As specified.
FM squelch sensitivity: Less than 0.125 μV.	As specified.
Notch-filter attenuation: More than 40 dB.	More than 30 dB.††
Receiver audio output: More than 1.5 W at 10% distortion with an 8-Ω load.	2.1 W at 5% total harmonic distortion with an 8-Ω load.
Receiver IF/audio response: At least 400-2600 Hz at −6 dB.	2.4-kHz IF bandwidth: 120-2532 Hz.
Transmitter	*Transmitter Dynamic Testing*
Transmitter power output: SSB/CW/FM, 10-100 W; AM, 50 W carrier.	Output power: 24 and 28 MHz, 95-115 W (CW, SSB, FM—output is typically more than 110 W and varies slightly by mode and band); 50-54 MHz, 88-93 W; AM, as specified. Minimum output: 3-4 W on each band.
Unwanted-signal suppression (below 30 MHz/above 50 MHz; Harmonic, >50 dB/70 dB below peak output; nonharmonic, >40 dB/60 dB below peak output.	As specified. See Fig 1.
Carrier and opposite sideband suppression: >40 dB below peak output.	>62 dB at 28.2 MHz.
Third-order intermodulation distortion products: Better than −31 dBc at 80 W PEP output at 51 MHz.	As specified. See Fig 2.
CW-keying waveform: Not specified.	See Fig 3.
Transmit-receive turnaround time (PTT release to 90% audio output): Not specified.	S1 signal, 34 ms; S9 signal, 28 ms.
Size (height, width, depth): 4.33 × 11.2 × 10.3 inches; weight, 18 lb with internal power supply, 15 lb without.	

†Unless noted otherwise, blocking dynamic range and third-order IMD dynamic range measurements were made at the ARRL Lab standard signal spacing of 20 kHz.

††Test-equipment limitations inhibit ARRL Lab measurement of notches deeper than about 30 dB.

hardened. This occurs because of the delay between the time the radio is keyed and when it first puts out RF. The FT-650's CW transmit performance leave considerable room for improvement.

SSB operation with the '650 is straightforward, requiring only microphone-gain adjustment, with the aid of the multimeter's ALC scale. RF speech processing is available at the touch of a push-button switch. On-the-air reports indicated that the processor provides a modest amount of compression with no noticeable distortion. Curiously, Yaesu rates the radio at 100 watts output, but specifies its transmitter IMD as −31 dBc (decibels relative to the carrier) *at 80 watts PEP output* at 51 MHz. This is acceptable IMD performance, but isn't particularly impressive for a 1990s transceiver. Our review FT-650 meets that specification at 51 MHz and does slightly better in the 24- and 28-MHz bands; at 100 watts PEP output, however, transmitted IMD products are typically 4-5 dB worse than they are at 80 watts, reaching a maximum of −26 dBc. In other words, operated at 100 watts PEP output, this radio produces objectionable distortion products (splatter) on adjacent frequencies. These IMD products can be especially bad if the FT-650 is used to drive an external power amplifier that requires more than 80 watts of drive. In sum: Keep the FT-650's SSB output at

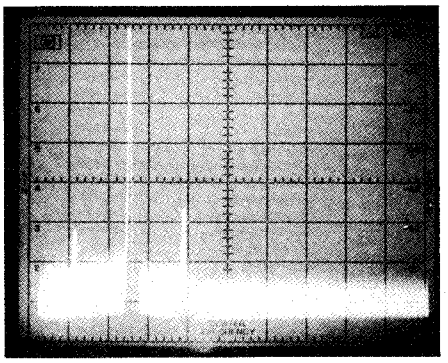


Fig 1—Yaesu FT-650 worst-case spectral display. Horizontal divisions are 10 MHz; vertical divisions are 10 dB. Output power is approximately 3 W at 24.5 MHz. All harmonics and spurious emissions are at least 46 dB below peak fundamental output. The FT-650 complies with current FCC specifications for spectral purity for equipment in this power-output class and frequency range.

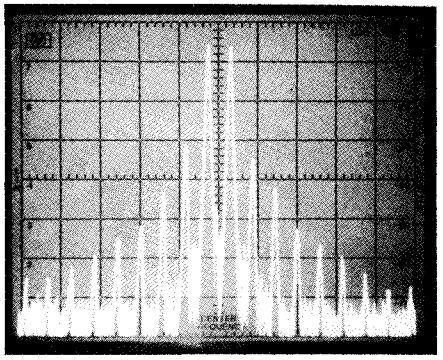


Fig 2—Worst-case spectral display of the FT-650 transmitter during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 31 dB below PEP output, and fifth-order products are approximately 42 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 80 W PEP output at 51 MHz. Transmitter IMD performance at 100 W PEP output is considerably worse than that at 80 W; see the text for details.

or below 80 watts PEP, whether you're operating with or without an external power amplifier.

The FT-650's lack of a separate RTTY mode makes it difficult to use the optional 600-Hz filter for RTTY or packet operation. This is a serious drawback for anyone considering use of the FT-650 for the digital modes on HF. For 1200-baud operation, though, the FT-650 should prove quite acceptable for FM-AFSK operation on 6 meters (such operation isn't legal on 10 meters in the US), 1200-bit/s PSK, and 2400-bit/s operation using the SSB mode.

FM operation is simple with the FT-650, and the 100-watt 6-meter output makes for a big signal among the FM crowd. The '650's selectable repeater offset allows use

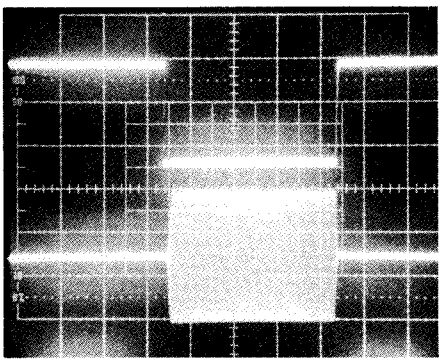


Fig 3—CW-keying waveforms for the Yaesu FT-650 in the semi-break-in mode. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 5 ms. The transceiver was being operated at 100 W output on 28.25 MHz. The FT-650's CW keying is hard; clicks are audible on the keyed signal. The first keyed element, not visible in this photograph, is shortened by approximately 14 ms.

of nonstandard-offset repeaters, and its memory system has all the control features you could want for FM. Access to most repeaters is possible with the optional CTCSS encoder. (The optional FTS-8 tone unit supports all but one [97.5 Hz] of the ARRL-recommended 10-meter access tones.)

Two "VFOs" (really tuned memories) are available in the FT-650. The primary use of the second VFO is for split-frequency operation. The FT-650 puts no limitation on the split: transmit and receive operation may be on different bands or even different modes. VFO contents can be stored in memory at any time. The memories store operating frequency, mode, IF-bandwidth selection, RIT setting and repeater offset. The main tuning knob selects memories during memory-storage and -recall operations. A recalled memory setting can be changed—you can tune around, for example—without affecting either the memory contents or the VFO settings. The modified memory information can, of course, be rewritten to memory (the same one or another) or to the selected VFO.

The FT-650's scanning function can be programmed to continuously step through the transceiver's memories or to stop when a signal is detected. During its mode-specific scanning, the radio scans only the memories set to a selected mode—handy for scanning only stored FM channels, for instance. You can program the '650 to skip individual channels; this programming can be overridden with the microphone PTT switch.

Of the FT-650's 105 memories, 99 are general-purpose, and the remaining six are devoted to specialized scanning modes. Two band segments can be selected for use in the programmed-scan mode. This mode scans the selected segments in selectable frequency steps, stopping when signals are detected. During scan pauses in this mode, you can manually tune the radio's frequency within the programmed limits.

The FT-650 can also perform priority-channel monitoring, in which up to two stored channels can be checked for activity once every 5 seconds.

A Novel Notch

The FT-650's tracking notch filter uses a phase-locked loop to lock onto a single steady signal such as a heterodyne or carrier, and adjusts itself to minimize that signal. This filter is similar in action to the j-Com Magic Notch reviewed elsewhere in this column, except that the j-Com version works at audio and Yaesu's works at IF. The FT-650's notch filter works well, too, although it has trouble eliminating weak carriers. (Weak signals aren't as much of an interference problem as strong signals, anyway.) In the US, heterodyne interference isn't often encountered on the bands covered by this transceiver—but we understand that higher band occupancy makes the FT-650's automatic notch filter potentially very useful in Japan. (Yaesu, how about working this feature into US-bound radios that cover 20 and 75 meters?) You can also switch the notch to manual control and adjust it the old-fashioned way.

Noise Blanker

The FT-650's noise blanker works well. A neighbor's old rattletrap car provided me with an excellent source of test signals, which the FT-650 noise blanker all but eliminated. (The noise, that is, not the source!) The FT-650 is a natural for mobile operation, and an effective noise blanker is essential for that application.

Pros and Cons

In spite of the many control features built into the FT-650, its uncluttered front panel makes the radio easy to use—and to learn to use. A few rough edges exist, though.

The **F** key selects the transceiver's fastest tuning rate and selects a second set of commands on the control keypad. Because the **F** key is right next to the tuning knob, it's all too easy to brush the tuning knob and experience a large jump in frequency when all you want to do is select a keypad function. A bit more physical separation would have been nice—or how about an **UNDO** key? Another complaint: The FT-650 *displays* its operating frequency in *100-Hz* steps, even though it tunes in *10-Hz* steps. Although you may not often need to know your exact frequency for casual QSOs, setting up frequencies for skeds, channelized operation and digital modes would be much easier with 10-Hz display resolution.

Senior Assistant Technical Editor Dave Newkirk, WJ1Z, considers the FT-650's dynamic receiver performance to be out of keeping with the radio's pedigree and expense. With a third-order-IMD dynamic range (DR) measured as 82 to 86 dB (depending on the frequency and whether its preamp is on or off), the FT-650's ability to handle strong signals without gener-

ating spurious signals of its own is about 10 dB (and thus about 10 years) behind the times below 30 MHz, and on the low edge of okay at 50 MHz. (More WJ1Z opinion: Third-order-IMD-DR figures in the 90s—at *least*—are appropriate below 30 MHz for radios *of* the 90s that cost this much. At 50 MHz, 1990s radios of this pedigree and expense should exhibit third-order DRs no lower than the high 80s.) The FT-650's strong preamp-off blocking-DR performance at 28 MHz (140 dB) is marred by much worse performance with the preamp on (114 dB); at 50 MHz, its blocking-DR performance is just okay. On the other hand, the FT-650's composite-noise performance is good enough to allow us to measure its 28-MHz, preamp-off blocking DR as 140 dB—a very respectable number.

The FT-650's frequency synthesizer—and the realities of amateur operation between 24.89 and 54 MHz—merit a stronger receiver front end.

Along slightly different lines, NJ2L notes that the FT-650 has no provisions for use with transverters as an IF transceiver (no low-level transmitted signal is available at the rear panel, and the only place to connect a receive-converter output is the FT-650's antenna jack).

Overall, the FT-650 provides good performance. Its control features are well designed for operator convenience and flexibility. Its 100-watt 6-meter output is attractive, too. If your interest lies in the upper-HF and lower-VHF spectrum, consider the FT-650 a contender, especially if FM operation is in your plans.

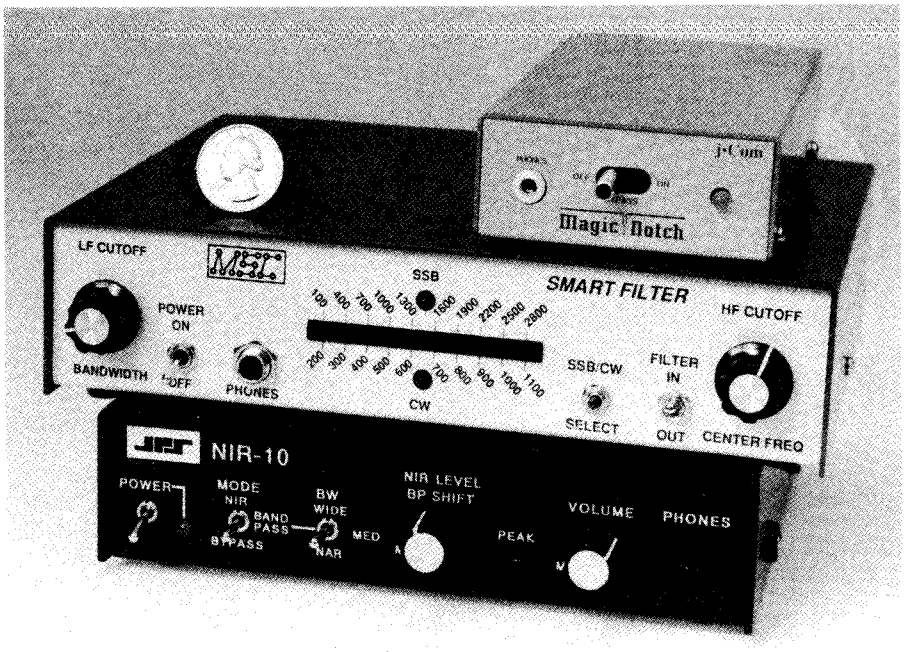
Thanks to Dave Newkirk, WJ1Z, for contributing to this review.

Manufacturer: Yaesu USA, Inc, 17210 Edwards Rd, Cerritos, CA 90701, tel 213-404-2700. Manufacturer's suggested retail prices: FT-650 with internal power supply, $1599; XF-455M601-01 600-Hz CW IF filter, $159; DVS-2 digital voice recorder/player, $289.95; FTS-8 CTCSS encoder/decoder, $55.

Audio-Filter Roundup

Audio filters have long been popular accessories in the ham shack. The following reviews take a look at three relatively new and unique audio filters for Amateur Radio use. Although this is not a comprehensive overview of currently available audio filters, it spotlights some interesting and promising developments.

As you read these reviews, keep in mind that audio filters have one major performance handicap (when compared to IF filters): They do their work outside the receiver AGC loop. Therefore, any audio filter, no matter how effective, can't keep strong signals in or adjacent to the receiver passband from actuating the receiver AGC. At best, this effect can be annoying; at worst, it pushes desired signals below the AGC threshold, where no audio filter can revive them.—Ed.



THE j-COM MAGIC NOTCH AUTOMATIC AUDIO NOTCH FILTER

Reviewed by Jim Kearman, KR1S

Readers of *QST*, *The National Contest Journal* and other ham magazines have probably noticed j-Com's Magic Notch advertisement. The ad features a cartoon of a hapless ham bemoaning the fact that all the DX nets are on the national tune-up frequency. Hearing stations tuning up all over the HF bands shows that j-Com has stepped in to fill a real, if aggravating, need.

The Magic Notch is small (3 × 1.25 × 5.5 inches HWD), and requires 10-14 V dc at a maximum of 200 mA. The Magic Notch's single control, a front-panel switch, is labeled **OFF**, **BYPASS**, and **ON**. You connect the Magic Notch between your headphone or speaker jack and your headphones or speaker via 1/8-inch jacks. The headphone jack is wired for stereo headphones; you'll need an adapter to use headphones with a ¼-inch, two-conductor plug. (Such adapters are available from many sources, including Radio Shack [p/n 274-047].) You set the front-panel switch to **ON**, and forget about single-heterodyne interference. Period.

A device this clever deserves a few more words, though. The little blue-and-gray box contains a switched-capacitor audio filter (SCAF), which constantly scans through the its speech-audio passband (the manual defines its "active range" as 200-4000 Hz). Speech signals vary in frequency and amplitude and are ignored by the filter. It notices continuous tones, however. Frequency information from the scanning circuit is passed to the notch filter, which slices out a sliver of the passband, attenuating the interfering signal.

So, you ask, suppose the interfering signal starts to wobble in frequency? Well, once the filter detects a carrier, it phase locks to it, so the "swishers" are also sliced out (figuratively, that is).

Best of all, if you leave the filter turned on, you might never know it's operating. Yes, it responds *that* quickly. Having sold you a neat gadget, the manufacturer would, of course, like you to know how much your life has been improved by purchasing it. So, the green LED on the Magic Notch's front panel turns red to tell you when the Magic Notch is doing its job. I didn't notice any effect on received-signal intelligibility; the notch is narrow.

When operating CW, you'll probably have to place the filter in bypass mode. Otherwise, you'll find that it seeks out and attenuates signals you're trying to copy. Effectiveness against CW signals is necessary for the SSB operator, and not always to prevent careless or malicious interference. For example, on the 40-meter band, most SSB DX stations transmit on frequencies used for CW in the US.

The *Magic Notch* works extremely well against one undesired continuous tone in the passband. *Two* tones? That's a different story. I guess if you're really dedicated, you can connect two Magic Notch filters in series. Leave one on and the other in bypass mode. When you hear a carrier, you know there are two; the first one's been attenuated in the first filter, letting the second one sneak through. Just turn on the second filter and the carriers are neutralized. Of course, if you're dealing with more than two carriers

you'll have to find another way to deal with them. The Magic Notch is not designed to reduce other types of interference, such as power-line noise or renegade vacuum cleaners.

All the same, the Magic Notch is an impressive, affordable package. It's even small enough to fit in a Christmas stocking! I can think of no more useful accessory for the HF SSB operator.

Manufacturer's price: $114.95. Manufactured by j-Com, PO Box 194, Ben Lomond, CA 95005, tel 408-336-3503.

MODULAR SYSTEMS CORPORATION SMART FILTER

Reviewed by Jim Kearman, KR1S

The Modular Systems Corporation (MSC) *Smart Filter* is a versatile switched-capacitor filter suitable for use on SSB, CW and digital modes. Switched-capacitor-filter theory was described in *QST* by Shellenbach and Noble,[2] and by Arndt and Fikes,[3] who presented filters they designated the SuperSCAF and JuniorSCAF. You should review these articles for details of SCAF theory and operation. The Smart Filter's performance is similar to the filters described in note 3, but its operation is *much* simpler.

Like the SuperSCAF described by Arndt and Fikes, the Smart Filter has two independent audio filters: high pass and low pass. (In fact, the Smart Filter uses the same switched-capacitor filter ICs as SuperSCAF and JuniorSCAF.) Manipulating the cutoff frequencies of these filters allows you to adjust the filter's center frequency and bandwidth at will. Where the Smart Filter principally differs from the referenced SCAF is in the method used to set the filter cutoff frequencies. Instead of thumbwheel switches, the Smart Filter uses potentiometers. An internal microprocessor senses the potentiometer settings several times per second and provides adjustment signals to the high- and low-pass filters.

Operating the Filter

The Smart Filter has two operating modes: SSB and CW. When you first turn on the filter, it defaults to SSB mode, which is indicated by the **SSB** LED indicator above the 10-segment bar-graph display, which I'll describe shortly. In this mode, the two potentiometers directly adjust the cutoff frequencies of the low- and high-pass filters. This mode is similar in operation to the SCAF described by Arndt and Fikes in *QST*.

Although the two filters can be adjusted to provide a narrow bandwidth for CW reception, having to constantly adjust two controls would be tedious. Pressing the front-panel **SSB/CW SELECT** button switches the Smart Filter into its **CW** mode, which is indicated by an LED below the display. In CW mode, the two filters are linked. One pot adjusts filter bandwidth and the other controls its center frequency. Adjustment is smooth, and intuitive control settings are aided by the display.

So far, the Smart Filter sounds like any of several active audio filters available to radio amateurs. Active audio filters feature adjustable bandwidth and center frequency and usually contain notch filters as well. The Smart Filter does not include a notch filter, but that isn't the only way it differs from typical active filters. Active filters are based on traditional filter models, but use op amps to get high filter Q. Unfortunately, with most active filters, narrow bandwidths are accompanied by unacceptable *ringing*, a result of insufficient damping of the filtered waveform. Listening to a ringing signal is annoying and fatiguing. Switched-capacitor filters like the Smart Filter simply do not ring, even at very narrow bandwidths. I consider this their greatest advantage.

I used the Smart Filter with a variety of transceivers. Listening to CW signals on an uncrowded band, it was difficult to tell the difference between the Smart Filter and cascaded 500-Hz IF filters. This filter's ultimate rejection and skirt selectivity are excellent. On a crowded band, with the IF filters switched out, strong adjacent signals pumped the receiver's AGC, but the Smart Filter still rendered them inaudible.

I also found I could use the Smart Filter to effectively tailor received SSB audio, reducing high frequencies, low frequencies, or both, with ease. Despite the lack of a notch filter, I was able to use one of the filters to reduce most heterodynes to a level that made the desired signal copiable.

I used the SCAF in the Spring 1991 QRP ARCI CW QSO Party. My rig for this contest had a single 500-Hz IF filter and a built-in audio filter. With the Smart Filter in line, signals well down in the noise were copiable. For normal operation, I set the bandwidth to about 1 kHz, so the filter was effectively out of the circuit. When I had to copy a weak signal, I simply reduced the bandwidth as necessary.

Received audio is applied to the filter through a rear-panel phono jack. An audio-amplifier IC drives a low-level phono-jack output and a ¼-inch, three-conductor headphone jack on the front panel. Inserting a plug into the headphone jack disconnects the low-level output from the rear panel. You can use monaural or stereo headphones with the Smart Filter.

Without an input signal, the Smart Filter's audio output is very quiet, with a few spurious responses, but no detectable hiss. The spurs are barely perceptible when the filter is in use. No output-level control is included; you adjust audio gain at the receiver. Output level doesn't change noticeably as the filter is switched in and out, so not having a level control on the filter was not a disadvantage for me.

The Smart Filter is housed in a two-piece, 2 × 8.25 × 6-inch metal cabinet. Power is supplied by an external 12-V ac wall transformer, which is supplied with the filter. Internally, the ac is rectified, regulated and filtered to provide the three dc voltages the filter requires (+12, +5 and −5 V). Thus, it isn't possible to operate this filter from a single 12-V dc supply.

Opening the cabinet reveals a single glass-epoxy circuit board. The heart of the Smart Filter, and the component that seems to have inspired its name, is an 8749H microprocessor chip with built-in UV-erasable EPROM. The quartz window through which the PROM can be erased was not covered, but it takes at least several minutes' exposure to UV light (or prolonged exposure to room lighting) to erase the PROM. I put a piece of electrical tape over the window, but this precaution is unnecessary if you don't remove the cover.

Although no audio filter can make up for shortcomings in a receiver, the Smart Filter is much more pleasant to use than any active audio filter I've tried. Active filters, however, use inexpensive op amps, and are priced accordingly. As much as I like the Smart Filter, I would find it difficult to justify its cost if my transceiver could accommodate more IF filters for about the same amount of money. If copying weak signals is important to you and your receiver is as good as you can make it, a SCAF such as the Smart Filter would be a smart investment.

Manufacturer's price: $195. Manufactured by Modular Systems Corp, 1304 Toney Dr, Huntsville, AL 35802.

THE JPS COMMUNICATIONS NIR-10 NOISE/INTERFERENCE-REDUCTION FILTER

Reviewed by Jim Kearman, KR1S

Hams like gadgets, but a good audio filter is a *useful* gadget. The NIR-10 Noise/Interference Reduction filter is a particularly useful one. And you won't find many more-sophisticated gadgets than this one!

Audio filters have traditionally performed two functions: band-pass and notch filtering. If you're trying to copy a weak voice or CW signal, you use the band-pass function to narrow the bandwidth, hoping to remove hiss, atmospheric noise and other signals, without reducing the intelligibility of the desired signal. In many cases, an otherwise unreadable signal becomes copiable when the audio bandwidth is decreased.

The second useful function of an audio filter is the notch. You use the notch when someone starts tuning up on top of the station you're trying to copy, and the screeching tone makes copy difficult or impossible.

Enter DSP

The NIR-10 is not a traditional audio filter, and its manufacturer doesn't bill it as

[2]R. Shellenbach and F. Noble, "Switched Capacitor Filters—An Emerging Technology for Amateur Radio Use," *QST*, Mar 1984, pp 19-25.
[3]R. Arndt and J. Fikes, "SuperSCAF and Son—A Pair of Switched Capacitor Audio Filters," *QST*, Apr 1986, pp 13-19.

one. It uses digital signal processing (DSP)[4] and has two operating modes, called Noise/Interference Reduction (NIR) and Bandpass. The Bandpass mode offers three switch-selectable bandwidths and a continuously adjustable center frequency. Like the MSC filter reviewed elsewhere in this issue, the NIR-10 exhibits none of the narrow-bandwidth ringing associated with bandpass filters based on fed-back op amps.

JPS Communications' well-written instruction manual recommends using the band-pass mode for CW reception. I found the **NARROW** position was too narrow, resulting in unacceptable distortion, though not ringing. The **MEDIUM** and **WIDE** positions didn't distort desired signals, but also didn't provide the filtering I expect from an accessory in this price range.

Voice Reception

The NIR-10's other mode, NIR, is where the filter really shines. A DSP filter is programmed to respond to the amplitude and frequency variations associated with voice signals. With the NIR-10 in its NIR mode, all types of noise and continuous-tone interference are greatly attenuated. The filtering level is continuously adjustable. A signal completely obliterated by noise is not salvageable by any filter, of course, but the NIR-10 makes it possible to easily copy voice signals that are simply unreadable without it. In fact, I know of no other device that allows you to copy a voice signal when someone on frequency has left the VOX on while vacuuming the shack—but the NIR-10 does!

I should mention here that the NIR-10 works with any voice signal: AM, SSB or FM. I also used it to enhance reception of weak AM medium- and short-wave broadcast stations. In addition to reducing the effects of broadband noise, the NIR program includes an automatic notch filter. Continuous tones don't look like voice signals to the digital filter, so the filter doesn't pass them.

CW and Digital-Mode Reception

The NIR function is somewhat useful when copying CW signals if you experiment with the level setting. Too high a setting makes the signal disappear altogether! The transceiver with which I used the NIR-10 has two cascaded 500-Hz IF filters. Overall, the NIR-10 didn't provide a substantial improvement in CW reception in either of its modes; for copying SSB signals under less-than-optimum conditions however, it's hard to beat. As the level control is advanced, noise just drops away, leaving nothing but the signal you want to hear. I don't operate the digital modes on HF, but I experimented to see how packet and RTTY signals sounded when passed through it in the NIR mode. Above some setting of the level control, the signals disappear (the NIR-10 thinks they're interference and processes them out), but a lower setting allows reception with reduced noise.

Connection to a Rig

You can connect the NIR-10 directly to a headphone or speaker jack, or to a low-level output jack if one is available. The NIR-10 has a very robust output amplifier, which easily drives a speaker or headphones. The NIR-10 can be left permanently in the line, so its amplifier can be used when the filter functions are disabled. A separate volume control is provided.

In line, the NIR-10 operates almost in real time, but not quite. Its signal-processing time is an easily perceptible fraction of a second. This delay causes no problems in reception (although it does take the S-meter response out of sync with received-signal audio), but it makes monitoring your transmitted signals through the filter impossible. I know: I tried to monitor my transceiver's sidetone through it. If I had continued, I'd have been guilty of transmitting codes and ciphers! Fortunately, the cure is simple, if your transmitter or transceiver has an output to control an amplifier or other external device. You'd connect that line to the NIR-10 so that when you transmit, the processing stages are bypassed. There is no audible popping or clicking, even when using full-break-in CW.

There are two complementary switching lines on the NIR-10. If the amplifier-control line on your rig is shorted on transmit, you use the inverted input on the NIR-10 (J5). This input presents a 10-kΩ impedance and can handle ±50 volts. The noninverting input (J4) accepts a positive signal instead of a short to ground. A positive signal greater than 1 V should do the trick.

Although the instruction manual covers what to do if your transmitter doesn't have such an output, I imagine most purchasers of this accessory have a rig or rigs that offer this output as standard. Should this situation develop (on Field Day, perhaps), it may be possible to borrow a signal from the microphone push-to-talk switch for phone use, or from a keyer for CW use. Speaking of Field Day, the NIR-10 operates from a 12-V dc supply (negative ground), a desirable feature in any amateur accessory. Maximum current consumption is specified as 500 mA.

What's That Sound?

I noticed a couple of interesting effects while using the NIR-10. In the NIR mode, setting the level control too high causes strange noises to appear in the output. Anyone who saw the movie *The Conversation* has heard similar sounds. They are caused by the filter trying to process noise as a signal, and can only be described as sounding like "bloops."

Other Applications

The instruction manual states that the NIR-10 can also be used for transmitted voice audio processing, but I did not try to do so. It's hard to imagine an operating situation where the background noise is so loud as to require this filter. Mind you, I've heard SSB stations with *incredible* fan and background noise, but they could correct these problems by simply reducing their microphone gain. (You could use the NIR-10 to make such a signal less annoying to copy, or you could ask the other operator to adjust his or her mike gain. I'd just go find someone else to work.) The NIR-10 cannot function as a speech compressor; as its name states, it is a noise-reduction unit.

I also used the NIR-10 on the output of a stereo cassette recorder. You can use it to clean up noisy recordings made off the air, or in other less-than-optimum conditions, although you'll need two units for stereo processing.

Conclusions

I enjoyed using the NIR-10. Setup and operation is simple and intuitive. The improvement in readability of voice signals is remarkable. I sometimes run a kilowatt output into open-wire feeders on HF. Doing so produces enough RF in the shack to "crash" my packet-radio TNC and sometimes my computer, but I never got the NIR-10 to misbehave under the same conditions. Its internal construction is very professional. The NIR-10 has a no-nonsense appearance and is built to last. JPS Communications also sends service and upgrade information to registered owners. Upgrading the filter is a simple matter of removing the top cover and swapping chips.

In spite of my favorable impressions, I can only recommend this device under certain circumstances. DSP integrated circuits are expensive. I don't fault JPS Communications for setting the price where they did, as this well-built accessory performs well. The price looms, however, and prospective purchasers should consider where else in their stations this much money could be more effectively invested. If you've installed the best antenna system you can, *and* you're happy with the rest of your station, the NIR-10 is a good Amateur Radio investment—especially for SSB devotees.

If you live in an area where antennas are restricted and your ability to receive is otherwise optimized, the NIR-10 will certainly improve your ability to hear other stations, even those that may not hear you. Otherwise, improving your antenna system or upgrading your rig may be better investments. If DSP follows other recent trends in technology, it should become more affordable in the future, making an accessory like the NIR-10 an even better buy.

Manufacturer's suggested retail prices: NIR-10, $395; ac adapter, $12. Manufactured by JPS Communications, Inc, 5516 Old Wake Forest Rd, PO Box 97757, Raleigh, NC 27609, tel 800-533-3819. QST

[4]For an overview of DSP that'll help you understand how the NIR-10 works, see B. Hale, "An Introduction to Digital Signal Processing," *QST*, Jul 1991, pp 35-37.