PRODUCT REVIEW

FlexRadio Systems FLEX-5000A HF/50 MHz Transceiver

Reviewed by Rick Lindquist, WW3DE
NCJ Managing Editor

As we said in May 1998 *QST* when reviewing the first commercially available strictly computer controlled Amateur Radio transceiver, the Kachina 505DSP: "The relegation of functionality from hardware to software and firmware opens broad vistas of future capability." *Are we there yet?* Or did our flight to nirvana get canceled? A decade down the road, Kachina is kaput in the amateur market, and the newer software defined radio (SDR) technology remains far from ubiquitous in the modern ham shack. FlexRadio Systems now represents the vanguard of equipment manufacturers prodding the Amateur Radio community into the SDR era.

Let's face it: Most equipment in today's ham stations reflects only incremental improvements in well-established wireless technology, form factor and human user interface. Additionally a "knob mentality" persists, despite Kachina's confidence, expressed 10 years ago, that owners of its milestone radio would embrace mouse-and-keyboard operating to the extent that knobs would become "superfluous." In 2005 FlexRadio Systems nudged things off the dime again with its SDR-1000. The FLEX-5000A raises the software-defined ham radio bar another notch.

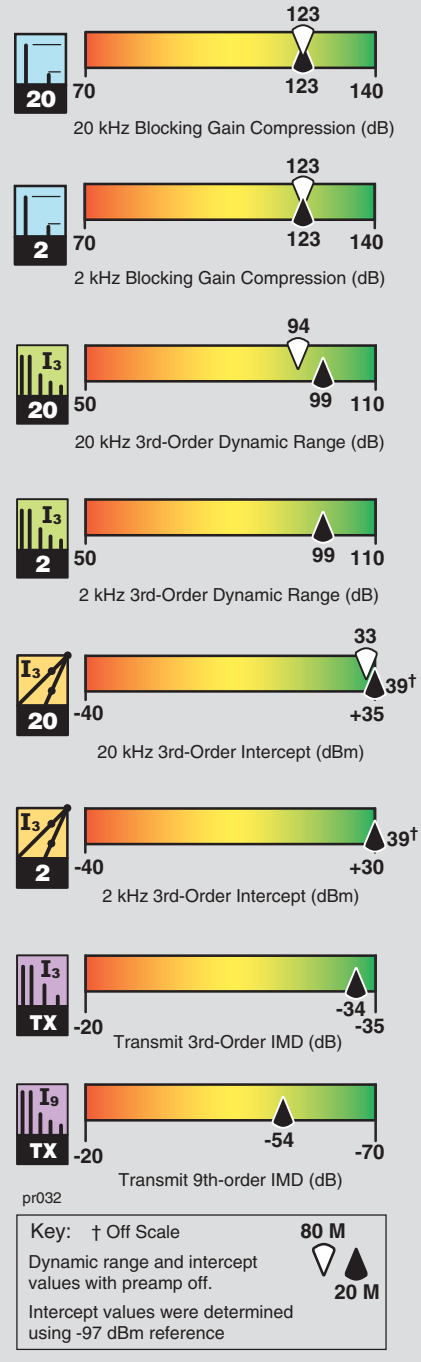
Expanding Your Vocabulary

Just as hams once fretted about grid drive, overmodulation and key clicks, the very nature of SDRs has given rise to a new crop of issues with names like "latency" and "sampling rate." This is *serious* technology, and it's not necessarily for the faint of heart.

In an SDR, analog RF signals are converted to a digital bit stream, and everything happens at that level using digital signal processing (DSP) techniques before conversion back to analog. As FlexRadio explains, its SDR is "essentially a direct-conversion receiver, but the mixing of the LO [local oscillator] to create a 9 kHz IF makes it appear a lot like a dual-conversion receiver." Something called a quadrature sampling detector (QSD) — 0°, 90°, 180° and 270° — is at the heart of all FLEX models. This generates the "I" in-phase composite and "Q" quadrature signals. Are your eyes glazing over yet?

FlexRadio points out that direct-conversion receivers like the SDR-1000 and FLEX-5000A don't require band-pass or roofing filters. Because the QSD doesn't respond to signals below its passband but is susceptible to odd harmonics above its LO

Key Measurements Summary



Bottom Line

The FLEX-5000A builds on the success of the SDR-1000, retaining the top-shelf radio performance and adding features. The package is far less complicated, shedding the many wires, cables, boxes and connectors that characterized the SDR-1000. Be prepared to experiment with the software and settings to get the most from this radio, however.

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frequency, FlexRadio uses a low-pass filter to block signals above its cutoff frequency. The rationale here, the company explains, is that low-pass filters have lower loss and wider component tolerance than band-pass filters.

While indisputably a direct descendant of the SDR-1000, the FLEX-5000A is a new and far slicker model that makes the earlier unit seem more of a beta test product than something ready for shrink wrap. A lot has changed in the intervening years; some has remained essentially the same.

PowerSDR — the Face of the Future?

In Zen terms, the radio is one with its GPL open-source *PowerSDR* software. Well, not *quite*. As FlexRadio Support Staffer Dudley Hurry, WA5QPZ, told me, "80% of the radio is in the computer." Not only does *PowerSDR* serve as the radio's virtual front panel, or *console*, it handles all DSP functions, including modulation, demodulation, metering (digital and analog) and filtering. The black box with its hypnotic bright blue pilot light provides the physical portals — and *many* of them — into and out of the virtual world where the *real* radio resides.

For the benefit of Flex cognoscenti, our unit ran *PowerSDR* version 1.10.4, at the time the latest Official Release, throughout the review process. It is important to keep in mind that any review of a software defined product is a snapshot in time. FlexRadio and their user community are constantly working on enhancements and upgrades to this product. As time marches on, the FLEX-5000A with a later version of the software *will* be different from the radio reviewed here. Many of the concerns and observations we make might be resolved by the time you read this, or at some time in the future. The operation, performance and feature set change regularly in both obvious and subtle ways.

For those who enjoy adventures in software, new *PowerSDR* test versions are available for download on a regular (sometimes daily) basis. To take advantage of the latest version under development you must install and set up *TortoiseSVN*, a program that manages the various files and versions (SVN stands for Subversion). The SVN releases may have solved some of the issues described in this review and can be evaluated by the user community as development progresses. Eventually, after extensive testing, the changes find their way into the next Official Release.

According to FlexRadio, the majority of owners use three versions of *PowerSDR*. They have the current Official Release for backup and benchmarking, their favorite stable SVN release for most operating, and the latest SVN release to play with. More information and a setup guide are available from the FlexRadio Web site.

FlexRadio says *PowerSDR* will continue to be open source, although certain control functions are defined in closed-source firmware in order to meet FCC requirements to restrict transmissions on unauthorized frequencies (the radio provides for MARS and non US band operation).

Ugly Betty

The FLEX-5000A offers more features and flexibility than virtually any other transceiver I've ever seen and possibly any other radio on the market. I was disappointed in *PowerSDR*'s look and feel, however. The latest version of *PowerSDR* is a *Windows 98* implementation in a *Vista* world. Although more feature laden, cosmetically it's very similar to the SDR-1000's "front panel" of an earlier PC epoch.

But even TV's "Ugly Betty" has a boyfriend. It's what lies behind *PowerSDR*'s stodgy, less-than-stylish appearance that

Table 1
FlexRadio FLEX-5000A, serial number 5107-5268

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.01-65 MHz; transmit, 1.8-2, 3.5-4, 5.3305, 5.3465, 5.3665, 5.3715, 5.4035, 7-7.3, 10.1-10.15, 14-14.35, 18.068-18.168, 21-21.45, 24.89-24.99, 28-29.7, 50-54 MHz.	Receive, as specified (sensitivity degrades below 0.2 MHz). Transmit, as specified.
Power requirement: 12.4-15.2 V dc; receive, 1.5 A (typical); transmit, 25 A (max).	Receive, 1.6 A; transmit, 17 A; tested at 13.8 V dc.
Modes of operation: SSB, CW, AM, FM, FSK, AFSK.	As specified.
Receiver	**Receiver Dynamic Testing**
CW sensitivity, 500 Hz bandwidth, preamp off/on: –123/–133 dBm.	Noise Floor (MDS), 500 Hz bandwidth: *Preamp* *Off* *On* 1.0 MHz –122 dBm n/a 3.5 MHz –119 dBm –129 dBm 14 MHz –119 dBm –132 dBm 50 MHz n/a –128 dBm
Noise figure: Not specified.	14 MHz, preamp off/on: 28/15 dB.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1 kHz, 30% modulation: *Preamp* *Off* *On* 1.0 MHz 4.4 μV n/a 3.9 MHz 6.3 μV 1.6 μV 50 MHz n/a 3.7 μV
FM sensitivity: Not specified.	For 12 dB SINAD: *Preamp* *Off* *On* 29 MHz n/a 0.64 μV 52 MHz n/a 1.4 μV
Blocking gain compression: Not specified.	Gain compression, 500 Hz bandwidth:[1] *20 kHz offset Preamp off/on* *5/2 kHz offset Preamp off* 3.5 MHz 123/120 dB 123/123 dB 14 MHz 123/122 dB 123/123 dB 50 MHz n/a/118 dB n/a
Reciprocal Mixing (500 Hz BW): Not specified	20/5/2 kHz offset: –99/–99/–99 dBc.
Third-Order Intercept, 2 kHz offset: +30 dBm	39 dBM.

ARRL Lab Two-Tone IMD Testing

Band/Preamp	*Spacing*	*Input level*	*Measured IMD level*	*Measured IMD DR*	*Calculated IP3*
3.5 MHz/Off	20 kHz	–25 dBm	–119 dBm	94 dB	+22 dBm
		–10 dBm	–97 dBm		+33 dBm
14 MHz/Off	20 kHz	–20 dBm	–119 dBm	99 dB	+30 dBm
		–6 dBm	–97 dBm		+39 dBm
		0 dBm	n/a[2]		
14 MHz/On	20 kHz	–33 dBm	–132 dBm	99 dB	+17 dBm
		–18 dBm	–97 dBm		+21 dBm
14 MHz/Off	5 kHz	–20 dBm	–119 dBm	99 dB	+30 dBm
		–6 dBm	–97 dBm		+39 dBm
14 MHz/Off	2 kHz	–20 dBm	–119 dBm	99 dB	+30 dBm
		–6 dBm	–97 dBm		+39 dBm
50 MHz/On	20 kHz	–33 dBm	–128 dBm	95 dB	+15 dBm
		–22 dBm	–97 dBm		+16 dBm

Second-order intercept: Not specified.	Preamp off/on: +63/+59 dBm.

Manufacturer's Specifications	Measured in the ARRL Lab
FM adjacent channel rejection: Not specified.	20 kHz offset, preamp on: 29 MHz, 59 dB; 52 MHz, 44 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz offset, preamp on: 29 MHz, 59 dB*; 52 MHz, 44 dB*; 10 MHz offset: 52 MHz, n/a.[3]
S-meter sensitivity: Not specified.	S9 signal at 14.2 MHz: preamp off, 50 μV; preamp on, 50 μV.
Squelch sensitivity: Not specified.	At threshold, preamp on: SSB, 14 MHz, 0.28 μV; FM, 29 MHz, 0.22 μV; 52 MHz, 0.6 μV.
Audio output power: 10 dBV at 600 Ω.	As specified.[4]
IF/audio response: Not specified.	Range at –6 dB points, (bandwidth): CW (500 Hz): 345-856 Hz (511 Hz),** Equivalent Rectangular BW: 499 Hz; USB: 141-2851 Hz (2710 Hz); LSB: 140-2850 Hz (2710 Hz); AM: 71-3293 Hz (3222 Hz).
Image rejection: 70 dB.	First IF rejection, 43 dB[5]; image rejection, 88 dB.
Transmitter	**Transmitter Dynamic Testing**
Power output: HF and 50 MHz: SSB, CW, FM, 100 W (high); AM, 25 W (carrier)	HF: CW, SSB, FM, typically 100 W high, <1 W low; AM, typ. 25 W high, <1 W low; 50 MHz: CW, SSB, FM, typ 99 W high, <1 W low; AM, typ. 25 W high, <1 W low.
Spurious and harmonic suppression: HF, >55 dB; VHF, >65 dB	HF, 51 dB; VHF, 61 dB. Meets FCC requirements.
SSB carrier suppression: >55 dB.	HF, 51 dB; VHF, 54 dB.
Undesired sideband suppression: >55 dB.	HF, 61 dB; VHF, 60 dB.
Third-order intermodulation distortion (IMD) products: –33 dB PEP at 100 W on 14 MHz.	3rd/5th/7th/9th order (worst case band): HF, –34/–40/–48/–54 dB PEP; VHF, –21/–32/–39/–40 dB PEP.
CW keyer speed range: Not specified.	1 to 60 WPM.
CW keying characteristics: Not specified.	See Figures 1 and 2.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	29 ms.[6]
Receive-transmit turn-around time (tx delay): Not specified.	25 ms.[6]
Composite transmitted noise: Not specified.	See Figure 3.

Size (height, width, depth): 9 × 9.3 × 12.4 inches; weight, 13 pounds.

Price: FLEX-5000A, $2799; antenna tuner option, $299; RX2 second receiver, $649.

*Measurement was noise-limited at the value indicated.
**Varies with CW pitch setting.
[1]The level indicated is where the sound card's ADC went into overload. Gain compression could not be measured because of this behavior.
[2]An input level of 0 dBm was higher than the ADC overload level, so the test was not performed.
[3]No IMD product could be detected.
[4]Audio output is dependent on external amplified speakers.
[5]Spur near the IF frequency. Note: The IF is in the audio range, so IF rejection will not affect RF performance.
[6]Measurements made with 1.6 GHz dual-core processor. Turnaround time may be faster with higher speed CPU.

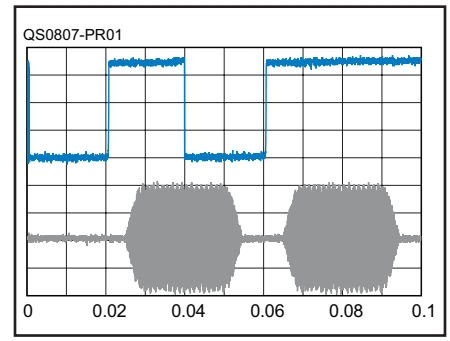

Figure 1 — CW keying waveform for the FLEX-5000A showing the first two dits in full-break-in (QSK) mode using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output on the 14 MHz band.

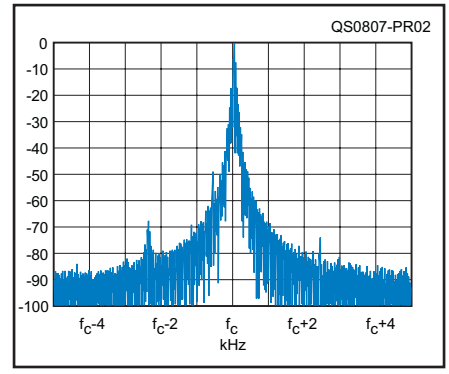

Figure 2 — Spectral display of the FLEX-5000A transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 100 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier.

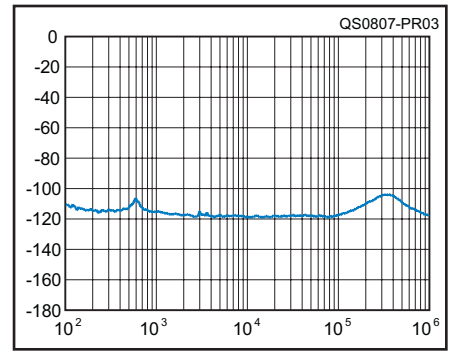

Figure 3 — Spectral display of the FLEX-5000A transmitter output during composite-noise testing. Power output is 100 W on the 14 MHz band. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier.

really counts. The current maximum sampling rate (more on this topic later) permits viewing 192 kHz of band spectrum, with immediate access to both VFOs as well as to the panoply of major functions, most common, some less so. You access most functions via buttons, sliders, menus and sub-menus or tabs.

"Light Years Ahead"

What the FLEX-5000A brings to the table now is a far less complicated Amateur Radio package that's free of the surfeit of wires, cables, boxes and connectors that characterized the SDR-1000. (Further eliminating the need for wires is *VAC* [virtual audio cable], third-party software that routes signals for digital programs to and from the FLEX-5000A.) As one "Flexer" remarked on the FLEX-5000A Web site, "fit and finish are light years ahead of the SDR-1000" and "it looks like a professional radio."

This ham radio *system* essentially consists

of the FLEX-5000A box and the PC. It offers 100 W (PEP) on all bands 160 through 6 meters, general-coverage receive (0.01-65 MHz, same as the SDR-1000) and lots and lots of features, including several that weren't available on the SDR-1000. For example, the newer model offers substantial improvement in CW operation, VOX capability and other novel and useful amenities, plus some impressive performance statistics (see Table 1).

The close-in two-tone third-order IMD dynamic range of the FLEX-5000A remains comparable with that of the SDR-1000 and of some of the best transceivers on the market. On the SDR-1000, the best IMD DR on 14 MHz at 2 kHz spacing was 99 dB at the medium preamp setting, but as much as 10 dB worse at other preamp settings. On the FLEX-5000A we measured 99 dB on 14 MHz at *all* spacings, with or without the preamp. The FLEX-5000A includes some features that became viable simply because today's average PC is a lot more powerful than the ones common in 2005. By the same token, continued upward mobility of PC technology is bound to further improve the FLEX-5000A down the road, so enhanced performance and additional features remain moving targets. In addition, faster video cards can improve radio performance by offloading of the CPU.

FlexRadio got rid of the gaggle of wires that shackled the SDR-1000 and its associated high-end sound card by using a FireWire (IEEE-1394) interface to handle signals between the black box and the PC. Hurry explained that several essential "threads" travel up and down the FireWire cable, including receive and transmit I and Q signals (essentially the radio's IF) and receive and transmit audio. The FireWire cable may be up to 10 feet long.

The "functional equivalent" of the SDR-1000's sound card and USB control now resides in the FLEX-5000's hardware. These include low-level control and communication functions needed to run the specific hardware. The FLEX-5000A has a device driver just like any other PC peripheral. The user must enter both the desired sampling rate and buffer size into the driver dialog box — which sets up the FireWire connection parameters and something called "operating mode" — as well as in the *PowerSDR* Setup menu (or "form," as FlexRadio calls them).

Our unit had the optional automatic antenna tuner (ATU) installed. It can produce a rather disconcerting symphony of grinding and whirring as it tries to come to terms with whatever load you have attached to one of the three SO-239 connectors on the box's rear apron (Figure 4). The ATU has semi-automatic and automatic settings as well as memory capability. You can set the maximum SWR threshold (up to 3:1). Unless you have the ATU tab open on your screen, however, you may not know right away if the tuner couldn't find a match. Although a tuner fault will not necessarily switch the ATU to bypass mode, a red HIGH SWR warning will flash when you transmit.

The FLEX-5000A's transmit and receive signal paths are completely independent, opening new horizons of opportunity. For example, at press time an optional full-featured second receiver, known as RX2, was poised to provide the potential for SO2R — single-operator, two radio capability — in a single box.

Figure 4 — Rear view of the Flex-5000A. Note the real analog connectors here.

Knobs? We Don't Need No Stinkin' *Knobs*!

Anyone who's ever used a Kachina, Ten-Tec Pegasus or SDR-1000 — or, for that matter, ever controlled a conventional transceiver via computer or Internet — appreciates that the most significant part of the learning curve is getting used to mousing rather than tried-and-true dial twisting and button pushing. FlexRadio's slogan is "Real radios don't *need* knobs!"

Mouse control is an acquired taste. Think of it this way: The front panel of the FLEX-5000A is the graphical user interface of a computer program, and, for better or worse, the mouse has become the *de facto* controller for programs ranging from accounting to word processing. Last time I was in a Best Buy store, the array of computer mice and adjunct control devices was astonishing.

The FLEX-5000A's tuning controls enable all the usual capabilities you'd expect on a conventional Amateur Radio transceiver and more. You can set (or reset) the tuning step anywhere from 1 Hz to 10 MHz with a mouse click, lock the VFO, operate "split," dump the contents of one VFO into the other, equalize VFOs and listen to two frequencies at the same time with the click of a button.

One disappointment was the minimal "scratch memory," a feature I've always found extremely handy in contests. Clicking SAVE retains a frequency, mode and filter, but *only* for a single frequency. Some adept programming that already may be on the drawing board very likely could overcome this minor deficiency.

The FLEX-5000A gives you a number of ways to tune. On the panadapter display — the one you're likely to use the most — the radio lets you put a signal in its crosshairs. Then *click*, you're there, aside from a little fine tuning (FlexRadio calls this "ClickTune"). You can do the same thing with the waterfall display. It's possible to choose a split panadapter/waterfall or any combination of the two, as shown in Figure 5. At the *PowerSDR* window's normal size, the menu to access this feature may not be visible. It's below the main console win-

Switching Computers Midstream

The "right" computer is key to satisfactory operation of the FLEX-5000A. We started out with a high-end HP/Compaq dc7700p, which has an Intel E6300 Core 2 Duo processor (2 MB of L2 cache, 1066 MHz bus) running at 1.8 GHz. It was equipped with 2 GB of memory, a RAID hard drive system and *Windows XP Pro*. After we noted performance that was at odds with FlexRadio's experience, the manufacturer suggested that we try a Compaq Presario SR5310F with an Intel Pentium E2140 Dual-Core processor (1 MB of L2 cache, 800 MHz bus) running at 1.6 GHz. This inexpensive machine came with 1 GB of memory and the *Vista Home Premium* operating system. ARRL installed a FireWire card and removed the fancy video card and all unnecessary applications that might bog down the processor.

Switching to the SR5310F demonstrated that you don't need a blazing-hot, high-end computer to run a FLEX-5000A. On the other hand, there were occasions when it seemed that more computer muscle would have resolved some of the issues we encountered. The FLEX-5000C model has a built-in Intel Core 2 Duo processor computer with 1 GB of RAM and *XP Pro*. — *Rick Lindquist, N1RL*

Figure 5 — You can split the *PowerSDR* screen to show any combination of the panadapter and waterfall displays.

Figure 6 — *PowerSDR* offers 3 or 10 band graphic equalizers for both receive and transmit.

dow and seemed tacked on as an afterthought (or maybe they just ran out of space). I liked the combination panadapter/waterfall display, since the waterfall sometimes shows signals not readily visible on the spectrum scope.

Manually tuning with the cursor works like this: Hold down the left button and the cursor becomes a little hand. Then swipe the "hand" across the display horizontally in the desired direction. But there's the rub. I had to swipe in the opposite direction, or sense, from what my aging brain expected. To move up the band, you swipe from right to left, whereas on a conventional transceiver you'd turn the knob from left to right (clockwise). It's logical when you think about it (moving from a lower frequency to the left to a higher one to the right), and I eventually got the hang of it.

If you don't like swiping/sliding to tune, the little mouse scroll wheel does the job quite nicely. This made better sense to my brain too. You scroll up to move up in frequency, down to move down.

You can use the cursor not only to tune but to shift the receive passband and change its bandwidth. FlexRadio calls this feature "FilterSlide." It works very well for custom filtering on the fly, although the preset filters suffice under most circumstances. Filters are not mode-specific and you can winnow the passband down to a lean 25 Hz assuming adequate sampling rate and buffers. You can click and drag the VFO B passband anywhere on the visible display — above or below your operating frequency.

PowerSDR also lets you control various radio functions, including tuning, band switching, mode, filter and RIT/XIT via the keyboard. This includes the ability to directly enter a frequency.

For less pointing and clicking, an optional ShuttlePRO controller is available through FlexRadio. This mouse-like device has 15 programmable buttons and two concentric tuning/control knobs that you can set up for VFO tuning, RIT, filter width, mode and other often-used functions. The optional Griffin Power Mate VFO control knob is also available if you find you can't live without a knob.

Of Buffers and Sampling Rates

The various buffer and sampling rate settings significantly affect how — and how *well* — the FLEX-5000A functions. Reaching equilibrium can be a chore. First you need to set the sampling rate and buffer size for the FLEX-5000A driver, which determines the data rate and buffer size for the FlexWire interface. Once inside *PowerSDR*, you enter the same sampling rate and buffer size under the Setup menu AUDIO tab and set buffers for transmit (TX) and receive (RX) under the DSP tab. These DSP buffer settings significantly impact filter shaping and latency.

FlexRadio suggests setting the driver and the audio buffers as low as the associated computer's processor can handle (lower buffer settings shift the workload to the processor with less latency or delay but broader filter skirts). The "Buffers and Sample Rate" appendix of the *Owner's Manual* advises avoiding a buffer size of 512 for SSB operation "except for casual QSOs and then only at sample rates of 48 kHz and 96 kHz." For those situations where you need steep filters, however, the manual suggests buffer sizes of 2048 or 4096. It's a bit different for CW and digital operation. For these FlexRadio recommends steering clear of buffers of 512 and 1024 and using "only the sample rate of 48 kHz." FlexRadio says that some of these suggested settings are in error and has revised the instructions for proper selection of buffer size.

Operating with our second computer (see sidebar, "Switching Computers Midstream") and using a 192 kHz sampling rate, the FLEX-5000A was more prone to audio dropout — essentially "holes" in the audio — especially when you're working in one of the menus, enabling other radio features such as MULTIRX or using (not just running) another program on the same PC. Lowering the RX buffer seemed to cure this. I went through 2048 to 1024, experiencing far less dropout at the latter and even lower settings.

There's a tradeoff, however. Reducing the size of the RX buffer alters the filters' skirt shape and makes them less effective — "roll-off" filters as opposed to "brick-wall" filters. With a too small buffer you'll find essentially no change in the actual passband below a certain filter selection, depending on mode. On the other hand, latency — a minute but finite lag between the time you key the PTT and the RF signal appears — gets closer to real time with smaller driver and audio tab buffer sizes; the DSP TX buffer also has an effect, however. In short, getting it just right for a particular mode can be a juggling act.

Big and Beautiful SSB

Simply put, this radio can generate a remarkable SSB signal. Within legal limitations your ability to tailor the radio's audio characteristics is extensive. The panadapter displays your SSB/phone waveform, so you can see what's going on. The compander — something not found on most transceivers — yields bigger, louder audio while not being obnoxious. It is possible to engage both the compressor and the compander, but you'll want to avoid extreme settings. Less is more in this case. Stations I worked told me the DX button, which is new with *PowerSDR* v 1.10.4, added another S unit or so to my signal. *How cool is that?* Switching in my headset's DX mic element augmented the effect.

The radio also has a "leveler" — a sort of AGC to compensate for times when the operator changes position with respect to the microphone. A NOISE GATE is available to handle high background noise situations; it operates independently of VOX.

The dual equalizers, one for transmit and one for receive, go far above and beyond the "tone controls" of many hardware transceivers. Both offer a choice of 3 or 10 bands (see Figure 6). The 3 band EQ unit is great for quickly compensating either transmit or receive audio; the 10 band unit allows you to apply additional nuance. You click the MON button to listen to your own audio. Some sampling rates and buffer settings we tried imparted varying degrees of latency, lending an "echo" effect to what you're hearing.

One station judged the FLEX-5000A's SSB audio quality "orders of magnitude better" after I spent a few minutes setting up the 10 band equalizer on transmit. Another fellow said I had "a perfect signal." (When was the last time *you* heard that?) I used the 10 band receive equalizer to compensate for low-end emphasis resulting from the effects of noise reduction, which is excellent by the way.

I assumed (silly me) that the record feature was essentially a digital voice keyer. Not really. It's actually designed to record snippets of off-the-air audio. It does let you record your own messages — lots of 'em — in very high-quality audio. The only way you can transmit them, however, is by manually keying the PTT line and clicking on the message file; initiating the message alone does *not* trip the VOX! I also didn't see any way that you could rename the file (the radio applies a date/time/frequency stamp) to, say, "CQ contest." A little digital rejiggering could make this feature more useful.

To retain various audio-related settings such as transmit or receive equalization you must save the "transmit profile." FlexRadio includes several stock choices or you can create your own. In addition to EQ settings, the transmit profile saves the TX filter high and low, compander and mic gain settings, leveler parameters, RF output power and ALC values. *Very handy!* I only wish the radio had some way of saving various sampling and buffer setting profiles that the operator could access them with the click of the mouse.

CW Choices

New with the FLEX-5000A is a *real* keyer plus provisions for CW keyboarding, CW memories, dot-to-dash ratio and waveform shaping. Even so, CW operation was a somewhat less enjoyable experience than SSB. While the manufacturer claims the FLEX-5000A is capable of full-break-in (QSK) CW, most CW aficionados would call it "near QSK." If another station can't break you with a single *dit* while you're sending, it's not true QSK.

With the first computer, we experienced CW latency — that pesky time lag. With the delay set at 10 ms, the lowest it goes, sending was choppy at a 192 kHz sampling rate and a 2048 RX buffer. Operation with the second computer was much improved. The optimum CW setting seemed to be a buffer setting of 512 at a 48 kHz sampling rate, although filters are less sharp with a buffer that small. The latency problems that plagued us on CW with the SDR-1000 are pretty much gone with the FLEX-5000A, however.

The CWX (keyboard/CW memory) menu accesses nine easily programmable CW memories (just type and play!) and keyboard capability with a substantial type-ahead buffer. I found these especially convenient when using the FLEX-5000A as part of the W1MGY *Titanic* anniversary special event. Opening the CWX menu immediately switches the transceiver to CW mode (and to the last-known CW filter setting).

Using the type-ahead buffer involves first putting the keyboard output on "pause," then activating the keyboard keys to type. To send what you've typed, simply "un-pause" the output stream. It's possible to continue typing at that point, assuming you've still got the keyboard activated. My CW preference was a combination of the CW memories and the keyboard.

A separate "Morse Definition Editor" lets users define or redefine nearly each element in the 64-character set. Send CW in German a lot and want to sound like a native? Program in those inflected letters (ü, for example), *und Du bist ein Berliner*!

The speed setting on the CWX tab is independent of the CW SPEED setting on the main *PowerSDR* console. So are the various timing/delay settings, which, depending on your computer, may need a little diddling to get just right. You may be able to achieve near-QSK on the paddle, but you still have to adjust the keyboard settings to get the same effect. Very tight TR delay settings — near QSK — introduce annoying pops and clicks in the sidetone. In addition, if you're listening on the speakers you'll also hear lots of relay chatter from the FLEX-5000A box.

A Semi-Automatic AGC?

Without judicious use of the AGC-T (AGC threshold) and AF controls, signals can and will block or overload the FLEX-5000A and possibly blow your eardrums. FlexRadio concedes that users have posed "numerous questions" related to the AGC-T control, which essentially acts like an RF gain control. The fact that the AGC-T and AF settings somewhat interact has given rise to considerable explanation in the *Owner's Manual* and the online knowledge base.

Here's the thing: The FLEX-5000A's AGC, which operates at audio frequencies, seems to be something *less* than automatic. The AGC-T control adjusts the AGC gain and, as the *Owner's Manual* explains, "is used to maximize the signal-to-noise ratio based on band conditions (QRN)." FlexRadio recommends reducing the AGC gain until you reach "a sweet spot at which weak signals will appear to 'jump out' of the noise," enhancing weak-signal reception. Dropping the AGC gain also means less AF output, hence the interaction. On the other hand, audio dynamic range improves.

Making volume levels more uniform requires tinkering with the AGC-T and AF controls. The manual advises setting the AGC-T control "as low as possible to comfortably hear the signal of interest" (the default setting is 90) while setting the AF gain to a slightly louder-than-comfortable level. I'm not sure I ever really found that "sweet spot," however.

The separate AGC control lets you set the AGC action to slow, medium, fast, long or custom. You also can turn the AGC off altogether. It's possible to customize the AGC action via the SETUP menu.

Gremlins?

We encountered a few transient gremlins. With the *Vista* computer, the display driver would quit momentarily from time to time — at one point twice in the course of an hour-long QSO. This typically occurred only while using high sampling rates. On numerous occasions I found it necessary to stop and restart *PowerSDR* after it froze up on the first try. Less frequently the radio would not receive after the VOX dropped out. Briefly tripping the PTT got it going again.

Other times I'd see this announcement: "Error communicating with the FLEX-5000. Please reload *PowerSDR* to try again." Starting *PowerSDR* too soon after energizing the radio box can cause this, although that was rarely the case. A further complication: After clicking "OK" on the error dialog box, the program continues to load, then gives you a *second* error message informing you that it could not open the driver.

While the ATU worked well most of the time, sometimes it simply balked, and I had to try again, usually getting a match on a subsequent attempt. Sometimes I'd get an error message saying no RF was detected. Other times I got nothing, although the ATU remained in line, rather than switching to bypass as it's supposed to. Early on, I "lost" the ATU function altogether and had to restart everything from scratch a couple of times to get it back.

A few times the panadapter disappeared or failed to show the spectrum trace. Sampling rate and buffer settings that *seemed* to work okay initially later didn't. Then too, sometimes the driver buffer setting would change mysteriously and without warning. At least once, the FLEX-5000A quit receiving after I'd entered some buffer and sampling rate settings the manufacturer had suggested. FlexRadio attributes gremlins like these to *Vista* and recommends using *Windows XP* unless there is a strong reason to go with *Vista*.

Jots and Tittles (in No Particular Order)

■ The nearly 200 page *Owner's Manual* (updates available online) is comprehensive, but the manual and its several supplements can get highly technical. The book includes some guidelines to set up the radio for that first QSO. In addition, FlexRadio's support staff and the fraternity of Flexers are willing to provide ample wise counsel to help you and your FLEX become fast friends.

■ If you like using memories, you'll love the FLEX-5000A, since you can essentially store as many as you'd like, limited only by the available space on your computer's hard drive. Under a "GRP" choice of AM, FM, SSB or SSTV (there's no CW group), you can store mode, filter, step size, AGC, call sign, frequency and comments. You can input 95 characters to the comments buffer, but only about 50 of them show up upon recall.

■ The ANTENNA SELECTION tab — as do some other menus and tabs — offers "Simple" and "Expert" user levels. At the higher end, you can define not only which antenna to connect but on which band, at what transmitter power level and even at what AGC-T setting.

■ The FLEX-5000A includes built-in test equipment. With the exception of the power/SWR circuitry, the radio can test and calibrate itself. As Youngblood explained, "You can push a button and walk away for 20 minutes. When you come back, the radio will have gone through the full factory test/alignment procedure."

■ The FLEX-5000A's MOSFET output stage is rated at 100 W continuous duty on all modes. This is a recent change that reflects the results of additional testing, as the manual warns against operating continuous carrier modes above 40 W output for longer than 15 seconds. The radio box appears to have adequate cooling, although it did get warm and the fan came on continuously following moderate exercise during a special event operation on CW.

■ The software version we used (v 1.10.4) included some noise reduction (NR) "enhancements." A few Flexers consider these a step backward or, as one said, "a work in progress." FlexRadio support offered some basic numbers to stick into the NR menu (for example, how many "filter taps" are optimal?).

■ The FLEX-5000A offers a huge variety of audio and RF connections and a substantial switching matrix for accommodating outboard transverters. This makes it possible to enjoy the SDR advantage on VHF and UHF.

■ The 0 BEAT button works fine on CW.

■ The FLEX-5000A receiver sounds excellent on the AM broadcast band. You can set up an 8 to 10 kHz passband for great audio fidelity. The automatic notch filter readily dispatched a slight heterodyne I was hearing on one signal.

■ The two adjustable noise blankers are exceptionally effective, and you can enable NB(1), NB2 or both. NB(1) is the more aggressive of the two

■ Clicking the BIN (binaural) button adds an entirely new dimension to SSB audio.

■ The MULTIRX is great! It's sort of a dual-watch feature. Just for starters, while operating split you can keep inserting as much audio from your transmit frequency as you prefer to help stay ahead of the competition.

■ For those contemplating remote operation, say from a deed-restricted home location, the FLEX-5000A may be an ideal solution. It's eminently remotable via the Internet.

■ A rear-apron stereo jack is designed to drive powered computer type speakers, not included. I'm pretty much a headphones guy, but occasionally I'll switch to the speaker. Do this with the FLEX-5000A while operating phone, and you'll also quickly discover there's no anti-VOX.

■ Three band-stacking registers retain frequency, mode, filter, preamp and other important settings.

■ The display ZOOM and PAN controls let you zero in on the particular part of the band you want to see in the display window, and they permit some compensation for the smaller chunk of spectrum visible at lower sampling rates.

■ The preamp is terrific. It neither raises the noise level nor affects the receiver's dynamic range. I wondered, however, why it couldn't just be a button that illuminates when enabled, like the ones on many "hardware" transceivers. What's there now requires selecting "On" or "Off" from a tiny pull-down menu. There is no attenuator.

■ Very handy is the ability to establish a separate low-power output level for the transmitter while the ATU is doing its thing. Once the tuner successfully matched an antenna I expected to see 1:1, but it read 0.0:1.

■ For digital modes, the radio employs AFSK using upper and lower-sideband modes, DIG-U and DIG-L.

Summer Reading List

Check out the April and October 2005 *QST* "Product Review" columns covering the FLEX-SDR-1000 transceiver, available online at **www.arrl.org/members-only/prodrev/**. Those inclined to delve more deeply into this subject should also visit the award-winning series, "A Software Defined Radio for the Masses," by Gerald Youngblood, K5SDR, who's FlexRadio's president. These appear in the July/August and September/October 2002 issues of *QEX* and are available on FlexRadio's Web site. Also, don't miss "The FLEX-5000A as a Contest Radio — A First Look," by Bill Heinzinger Jr, W9OL, in the May/June 2008 issue of *NCJ*. — *Rick Lindquist, N1RL*

So, *Are* We There Yet?

This latest FLEX has come a long, *long* way from what we looked at in 2005. But, is this the radio for which you would forsake all others? In a word, *maybe*. Here's why: The FLEX-5000A requires its owner to engage in what some might consider an excessive amount of tweaking and experimenting to get it working properly with a given PC (think, "high maintenance partner/spouse").

A decision to buy really hinges on whether you're up for the challenge of the FLEX-5000A. Using and, especially, fine tuning the FLEX-5000A for routine or specialized multimode operating can demand a level of technical knowledge and acumen that's a step above that of the average radio amateur, even in 2008 — and that's even excepting the "Expert Level" settings on the transceiver's menu. Perhaps "Flexer" Steve, K5FR, put it best in his posting to the Flex-Radio Web site. "The Flex family of radios has brought a new 'Event Horizon' to Amateur Radio," he said. "These are exciting times to be a ham."

For the most part, I was able to get our FLEX-5000A working to my satisfaction on CW; the narrow, brick-wall filtering is breathtaking, the keyboard and memory implementation is superb and latency issues were very nearly non-existent. To achieve the same level of satisfaction on SSB did require reconfiguring the radio with new sampling rate and buffer settings.

Many happy Flex campers are enjoying their SDR-1000s and FLEX-5000As, and I had a great deal of fun using this radio myself, despite — and possibly because of — the challenge. With an expanding user base and the efforts of the fine folks at FlexRadio, I'm confident it will *get there* in the relatively near future. Better yet, it will *keep on going!*

Manufacturer: FlexRadio Systems, 13091 Pond Springs Rd, Suite 250, Austin, TX 78729; tel 512-535-5266; **www.flex-radio.com**. QST