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FlexRadio Systems FLEX-6300 Transceiver, FLEX-6700 Transceiver, and *SmartSDR for Windows* Software

The 6000-series transceivers from FlexRadio Systems offer a new level of performance and flexibility.

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This review looks at the FLEX-6300 and FLEX-6700 software defined transceivers. Along with the FLEX-6500 and the receive-only FLEX-6700R models (not reviewed here), they are the first products in the FlexRadio Systems 6000 Signature Series.

Unlike more traditional Amateur Radio gear, these software defined radio (SDR) products from FlexRadio are highly integrated with an advanced software product, *SmartSDR for Windows* (*SmartSDR*). *SmartSDR* needs to run on a *Windows*-based personal computer (PC) that must be supplied by the user. (See the section titled, "Choosing Your Computer" later in this review.) *SmartSDR* is under continuous development at FlexRadio, adding features and fixing bugs in software releases several times a year.

Because there always seem to be major improvements right around the corner, these products can be difficult to review. We are currently running version 1.3 of *SmartSDR*. This is the second release since we began the review, and version 1.4 may be available by the time you read this article.

We have run the FLEX-6300 and '6700 models through our regular battery of tests in the ARRL Lab, with generally excellent results, as you see in Tables 1 and 2 and Figures 1 through 6. Of particular note are the '6700's outstanding receiver dynamic ranges. Transmitted phase noise, CW keying sidebands, and transmitted SSB IMD levels are excellent for both radios as well. But much of the story these days is about the user interface — both for SDR and traditional radios. We don't have a "thermometer" scale for those questions. Many times it will come down to personal preference.

Signature Series Models

At the high end of the series is the FLEX-6700. At the mid level is the '6500, which is essentially a single Signal Capture Unit subset (see the section titled, "Dual Receiver Channels" later in this review), but at a performance level similar to the '6700. The junior member of the series is the '6300, a simpler and more economical design. All of these have 100 W transmit capability for the 160 through 6 meter bands. Although the hardware features of the 6000 series vary among models, the user interface is very similar, since all models share the *SmartSDR* software.

I will point out the most significant differ-

Bottom Line

The FlexRadio 6000 series of SDR radios with *SmartSDR* for *Windows* software provides a range of performance and price and promises a continuing stream of new features.

Units Tested

FLEX-6300, SN 2114-420A-6300-0260
FLEX-6700, SN 4213-3107-6700-9254
FlexControl USB Tuning Knob ("Rev D")
SmartSDR for Windows (v. 1.3.8)

Key Measurements Summary

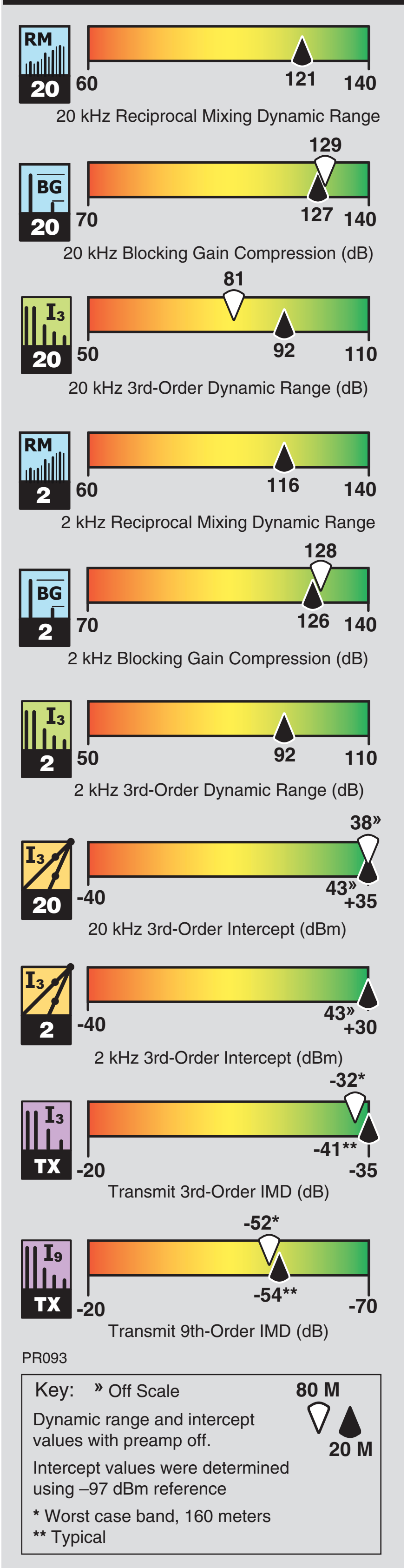

Table 1
FlexRadio FLEX-6300, serial number 2114-420A-6300-0260

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.03 – 54 MHz; transmit, 160, 80, 60, 40, 30, 20, 17, 15, 12, 10, and 6 meter amateur bands.	Receive, 0.100 – 54.1 MHz; transmit, as specified.
Power requirement: Receive, 1.7 A typical; transmit, 23 A maximum at 13.8 V dc ±15%.	At 13.8 V dc (typical): transmit, 16 A; receive, 1.6 A; off, 38 mA.
Modes of operation: SSB, CW, AM, synchronous AM, RTTY, FM.*	As specified.
Receiver	**Receiver Dynamic Testing**
Noise floor (MDS) in 500 Hz BW: –121/–125/–136 dBm (preamp off/ 10 dB, 20 dB).	Noise floor (MDS), 500 Hz bandwidth:
Noise figure: Not specified.	Preamp off/on: 14 MHz, 28/19 dB; 50 MHz, 29/12 dB.
Spectral sensitivity: Not specified.	–138 dBm (100 kHz screen bandwidth); –146 dBm (5 kHz screen bandwidth, maximum averaging).
AM sensitivity: Not specified.	10 dB (S+N)/N, 1-kHz, 30% modulation, 6 kHz bandwidth:
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz bandwidth:
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 121/117/116 dB.

Noise floor (MDS), 500 Hz bandwidth:

	Preamp off	*Preamp on*
0.137 MHz	–114 dBm	N/A**
0.475 MHz	–119 dBm	N/A**
1.0 MHz	–119 dBm	N/A**
3.5 MHz	–119 dBm	N/A**
14 MHz	–119 dBm	–128 dBm
29 MHz	–118 dBm	–136 dBm
50 MHz	–118 dBm	–135 dBm

AM sensitivity, 10 dB (S+N)/N, 1-kHz, 30% modulation, 6 kHz bandwidth:

	Preamp off	*Preamp on*
1.0 MHz	8.41 µV	N/A**
3.8 MHz	8.31 µV	N/A**
29 MHz	9.88 µV	1.08 µV
50 MHz	11.0 µV	1.24 µV

Blocking gain compression dynamic range, 500 Hz bandwidth:

	20 kHz offset Preamp off/on	*5/2 kHz offset Preamp off*
3.5 MHz	129 dB/**	128/128 dB
14 MHz	127/127 dB	127/126 dB
50 MHz	128/126 dB	127/127 dB

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth)†

Band/Preamp	*Spacing*	*Input Level*	*Measured IMD Level*	*Measured IMD DR*	*Calculated IP3*
3.5 MHz/Off	20 kHz	–38 dBm	–119 dBm	81 dB	+3 dBm
		–7 dBm	–97 dBm		+38 dBm
14 MHz/Off	20 kHz	–27 dBm	–119 dBm	92 dB	+19 dBm
		–4 dBm	–97 dBm		+43 dBm
		0 dBm	–83 dBm		+42 dBm
14 MHz/On	20 kHz	–39 dBm	–128 dBm	89 dB	+6 dBm
		–28 dBm	–97 dBm		+7 dBm
14 MHz/Off	5 kHz	–27 dBm	–119 dBm	92 dB	+19 dBm
		–4 dBm	–97 dBm		+43 dBm
		0 dBm	–84 dBm		+42 dBm
14 MHz/Off	2 kHz	–27 dBm	–119 dBm	92 dB	+19 dBm
		–4 dBm	–97 dBm		+43 dBm
		0 dBm	–84 dBm		+42 dBm
50 MHz/Off	20 kHz	–24 dBm	–118 dBm	94 dB	+23 dBm
		–11 dBm	–97 dBm		+32 dBm
50 MHz/On	20 kHz	–43 dBm	–135 dBm	93 dB	+5 dBm
		–22 dBm	–97 dBm		+16 dBm

Manufacturer's Specifications	Measured in the ARRL Lab
Second-order intercept point: Not specified.	Preamp off/on, 14 MHz, +63/+57 dBm; 21 MHz, +67/+67 dBm; 50 MHz, +65/+57 dBm.
DSP noise reduction: Not specified.	Not tested. See text.
Notch filter depth: Not specified.	22 dB (normal), 44 dB (deep), 64 dB (very deep).
S-meter sensitivity: Not specified.	S-9 signal, preamp off/on 14 MHz, 60.9/55.5 µV; 50 MHz; 51.2/54.3 µV.
IF/audio response: Not specified.	Range at –6 dB points (bandwidth) †† CW (400 Hz): 399 – 800 Hz (401 Hz); Equivalent rectangular BW: 397 Hz; USB (2.4 kHz):94 – 2496 Hz (2402 Hz); LSB (2.4 kHz): 94 – 2496 Hz (2402 Hz). AM (6.0 kHz): 64 – 3009 Hz (5890 Hz).
Image rejection: >80 dB.	99 dB.
Transmitter	**Transmitter Dynamic Testing**
Power output: CW/SSB/FSK/FM, 100 W; AM, 25 W.	CW/SSB/FSK: HF, 1 W minimum, 84 – 99 W maximum depending on band. 50 MHz, 1 – 86 W. AM: HF typically 0.2 – 28 W; 50 MHz, 0.15 – 20 W. FM: N/A.* Power output typically 5 W lower at minimum operating voltage.
Spurious-signal and harmonic suppression: HF, 50 dB; 50 MHz, 70 dB.	HF, 60 dB worst case (1.8 MHz); 65 dB. typical. 50 MHz, 66 dB. Complies with FCC emission standards.
SSB carrier suppression: 80 dB.	>70 dB.
Undesired sideband suppression: 80 dB.	>70 dB.
Third-order intermodulation distortion (IMD): Not specified.	100 W PEP, 3rd/5th/7th/9th order: –32/–51/–52/–52 dBc (worst case, 160 m); –41/–42/–48/–54 dBc (HF, typical); –50/–38/–51/<–60 dBc (50 MHz).
CW keyer speed range: Not specified.	4.9 to 104 WPM, iambic mode A and B.
CW keying characteristics: Not specified.	See Figures 1 and 2.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S-9 signal, AGC fast, 184 ms.
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 138 ms.
Composite transmitted noise: Not specified.	See Figure 3.

Size (height, width, depth): 3.9 × 12.8 × 12.6 inches including protrusions; weight, 10 lb.

Price: FLEX-6300, $2499; 6300-ATU autotuner, $299; FlexControl, $99.95.

*FM operation was not available in the tested configuration but is scheduled for *SmartSDR* Version 1.4.
**Although the specifications indicate two levels of preamplification (10 dB or 20 dB) the review transceiver just offered Preamp Off or Preamp On. The preamp is not available for the 3.5 MHz band or lower frequencies to avoid interference from the AM Broadcast Band.
†ARRL Product Review testing includes Two-Tone IMD results at several signal levels. Two-Tone, Third-Order Dynamic Range figures comparable to previous reviews are shown on the first line in each group. The "IP3" column is the calculated Third-Order Intercept Point. Second-order intercept points were determined using –97 dBm reference.
††Default values; bandwidth is adjustable via DSP.

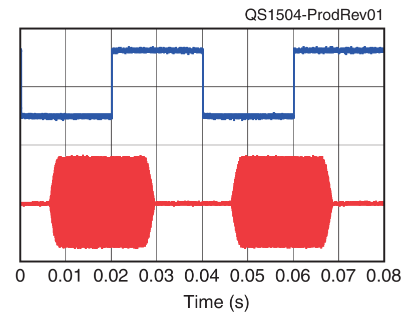

Figure 1 — CW keying waveform for the FLEX-6300 showing the first two dits in full-break-in (QSK) mode using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 94 W output on the 14 MHz band.

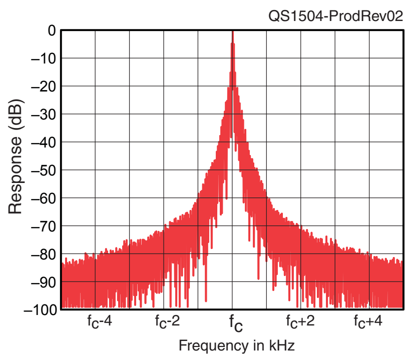

Figure 2 — Spectral display of the FLEX-6300 transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 94 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dB.

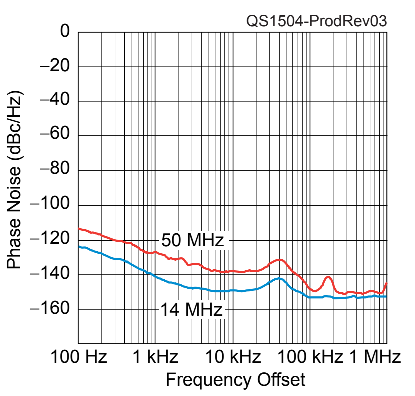

Figure 3 — Spectral display of the FLEX-6300 transmitter output during phase noise testing. Power output is 94 W on the 14 MHz band (blue trace), and 86 W on the 50 MHz band (red trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dB.

Key Measurements Summary

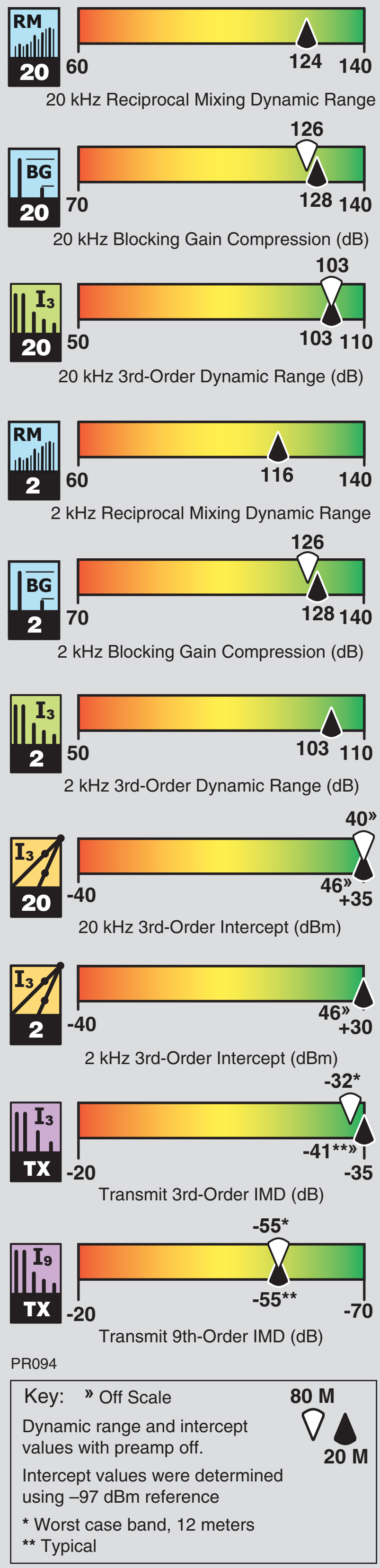

Table 2
FlexRadio FLEX-6700, serial number 4213-3107-6700-9254

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.03 – 77, 135 – 175 MHz; transmit, 160, 80, 60, 40, 30, 20, 17, 15, 12, 10, and 6 meter amateur bands.	Receive, 0.100 – 74, 136 – 165 MHz; transmit, as specified.
Power requirement: Receive, 2 A typical; transmit, 23 A maximum at 13.8 V dc ±15%.	At 13.8 V dc (typical): transmit, 16 A; receive, 1.75 A.
Modes of operation: SSB, CW, AM, synchronous AM, RTTY, FM.*	As specified.
Receiver	**Receiver Dynamic Testing**
Noise floor (MDS) in 500 Hz BW: –121/–125/–136/–141 dBm (preamp off/ 10 dB, 20 dB, 30).	Noise floor (MDS), 500 Hz bandwidth: *Preamp Off/1/2/3* 0.137 MHz –115 /–116 /–123 /–80 dBm; 0.475 MHz –119 /–123 /–132 /–116 dBm; 1.0 MHz –119 /–123 /–132 /–127 dBm; 3.5 MHz –119 /–125 /–135 /–140 dBm; 14 MHz –119 /–125 /–135 /–140 dBm; 50 MHz –118 /–124 /–135 /–140 dBm; 70 MHz –116 /–123 /–133 /–139 dBm; 144 MHz –116 /–123 /–133 /–138 dBm
Noise figure: Not specified.	Preamp off/1/2/3: 14 MHz 28/22/12/7 dB; 50 MHz 29/23/12/7 dB; 70 MHz 31/24/14/8 dB; 144 MHz 32/24/14/9 dB
Spectral sensitivity: Not specified.	–144 dBm (100 kHz screen bandwidth); –157 dBm (1.2 kHz screen bandwidth, maximum averaging).
AM sensitivity: Not specified.	10 dB (S+N)/N, 1-kHz, 30% modulation, 6 kHz bandwidth: *Preamp Off/1/2/3* 1.0 MHz 7.24/3.80/1.26/2.82 µV; 3.8 MHz 8.12/3.23/1.15/0.80 µV; 29.0 MHz 8.03/3.89/0.90/0.80 µV; 50.4 MHz 9.65/5.01/1.26/0.81 µV; 70.4 MHz 12.20/5.43/1.51/0.95 µV; 144.4 MHz 17.20/6.68/1.97/1.13 µV
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz bandwidth: (see below)

	20 kHz offset Preamp off/1/2/3	*5/2 kHz offset Preamp off*
3.5 MHz	126/126/126/122 dB	126/126 dB
14 MHz	128/129/130/125 dB	128/128 dB
50 MHz	>128/131/132/127 dB	>128/>128 dB
70 MHz	126/129/130/126 dB	126/126 dB
144 MHz	126/129/131/128 dB	126/126 dB

Reciprocal mixing dynamic range: Not specified. — 14 MHz, 20/5/2 kHz offset: 124/117/116 dB.

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth)**

Band/Preamp	*Spacing*	*Input Level*	*Measured IMD Level*	*Measured IMD DR*†	*Calculated IP3*
3.5 MHz/Off	20 kHz	–16 dBm	–119 dBm	103 dB	+36 dBm
		–6 dBm	–97 dBm		+40 dBm
14 MHz/Off	20 kHz	–16 dBm	–119 dBm	103 dB	+36 dBm
		–2 dBm	–97 dBm		+46 dBm
		0 dBm	–88 dBm		+44 dBm
14 MHz/1	20 kHz	–25 dBm	–125 dBm	100 dB	+25 dBm
		–11 dBm	–97 dBm		+32 dBm
14 MHz/2	20 kHz	–28 dBm	–135 dBm	107 dB	+26 dBm
		–17 dBm	–97 dBm		+23 dBm
14 MHz/3	20 kHz	–42 dBm	–140 dBm	94 dB	+1 dBm
		–28 dBm	–97 dBm		+7 dBm
14 MHz/Off	5 kHz	–16 dBm	–119 dBm	103 dB	+36 dBm
		–2 dBm	–97 dBm		+46 dBm
		0 dBm	–90 dBm		+45 dBm
14 MHz/Off	2 kHz	–16 dBm	–119 dBm	103 dB	+36 dBm
		–2 dBm	–97 dBm		+46 dBm
		0 dBm	–90 dBm		+45 dBm

Manufacturer's Specifications	Measured in the ARRL Lab

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth)** [continued]

Band/Preamp	*Spacing*	*Input Level*	*Measured IMD Level*	*Measured IMD DR*†	*Calculated IP3*
50 MHz/Off	20 kHz	–18 dBm	–118 dBm	100 dB	+32 dBm
		–1 dBm	–97 dBm		+47 dBm
50 MHz/3	20 kHz	–40 dBm	–140 dBm	100 dB	+10 dBm
		–28 dBm	–97 dBm		+7 dBm
70 MHz/Off	20 kHz	–48 dBm	–116 dBm	68 dB	–14 dBm
		–9 dBm	–97 dBm		+35 dBm
70 MHz/3	20 kHz	–41 dBm	–139 dBm	98 dB	+8 dBm
		–24 dBm	–97 dBm		+13 dBm
144 MHz/Off	20 kHz	–34 dBm	–116 dBm	82 dB	+7 dBm
		–7 dBm	–97 dBm		+38 dBm
144 MHz/3	20 kHz	–43 dBm	–138 dBm	95 dB	+5 dBm
		–22 dBm	–97 dBm		+16 dBm

Second-order intercept point: Not specified.	Preamp off/1/2/3: 14 MHz, +87/+87/+87/+87 dBm; 50 MHz, +85/+85/+85/+85 dBm; 70 MHz, +25/+67/+63/+39 dBm; 144 MHz, +89/+87/+87/+79 dBm.
DSP noise reduction: Not specified.	Not tested. See text.
Notch filter depth: Not specified.	19 dB (normal), 39 dB (deep), >70 dB (very deep).
S-meter sensitivity: Not specified.	S-9 signal, 14 MHz, 50.1 µV; 50 MHz, 46.7 µV; 144 MHz, 33.1 µV.
IF/audio response: Not specified.	Range at –6 dB points (bandwidth) ††: CW (400 Hz): 399 – 800 Hz (401 Hz); Equivalent rectangular BW: 399 Hz; USB (2.4 kHz):98 – 2496 Hz (2402 Hz); LSB (2.4 kHz): 98 – 2502 Hz (2403 Hz). AM (6.0 kHz): 65 – 3008 Hz (5886 Hz).
Image rejection: >100 dB.	107 dB.

Transmitter	Transmitter Dynamic Testing
Power output: CW/SSB/FSK/FM, 100 W; AM, 25 W.	CW/SSB/FSK: HF, 1 W minimum, 87 – 99 W maximum depending on band. 50 MHz, 1 – 82 W. AM: HF typically 0.2 – 27 W; 50 MHz, 0.3 – 19 W. FM: N/A.* Power output typically 5 W lower at minimum operating voltage.
Spurious-signal and harmonic suppression: HF, 60 dB; 50 MHz, 70 dB.	HF, 59 dB worst case (24 MHz); 65 dB. typical. 50 MHz, 68 dB. Complies with FCC emission standards.
SSB carrier suppression: 80 dB.	>70 dB.
Undesired sideband suppression: 80 dB.	>70 dB.
Third-order intermodulation distortion (IMD): Not specified.	100 W PEP, 3rd/5th/7th/9th order: –32/–40/–44/–55 dBc (worst case, 12 m); –41/–44/–48/–55 dBc (HF, typical); –41/–38/–50/<–60 dBc (50 MHz).
CW keyer speed range: Not specified.	5 to 50 WPM, iambic modes A and B.
CW keying characteristics: Not specified.	See Figures 4 and 5.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S-9 signal, AGC fast, 198 ms.
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 140 ms.
Composite transmitted noise: Not specified.	See Figure 6.

Size (height, width, depth): 4.0 × 13.0 × 12.6 inches including protrusions; weight, 13 lb.
Price: FLEX-6700, $7499; GPSDO GPS disciplined oscillator, $699; FlexControl, $99.95.

*FM operation was not available in the tested configuration but is scheduled for *SmartSDR* Version 1.4.
**ARRL Product Review testing includes Two-Tone IMD results at several signal levels. Two-Tone, Third-Order Dynamic Range figures comparable to previous reviews are shown on the first line in each group. The "IP3" column is the calculated Third-Order Intercept Point. Second-order intercept points were determined using –97 dBm reference.
†Two-Tone, Third-Order IMD dynamic range figures are "up to" the value indicated. See *QST*, Feb 2010, page 52. Note that the IMD DR increases with Preamp 2 on, which is the opposite of typical traditional superhet receivers. (Engaging Preamp 2 puts the sensitivity more in line with that of other radios.) An important characteristic of direct sampling radios is that dynamic range increases with the signal strength of the interfering signals. IMD DR increases with Preamp 2 (20 dB gain) engaged because the noise floor goes down by 16 dB and the drive to the ADC goes up by 20 dB. The increased drive to the ADC improves IMD DR performance.
††Default values; bandwidth is adjustable via DSP.

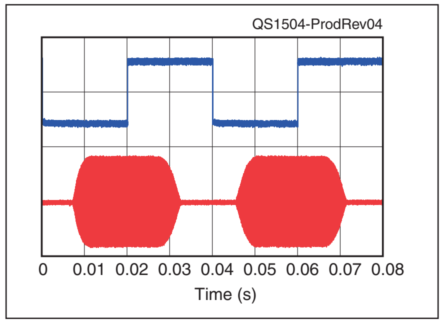

Figure 4 — CW keying waveform for the FLEX-6700 showing the first two dits in full-break-in (QSK) mode using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 87 W output on the 14 MHz band.

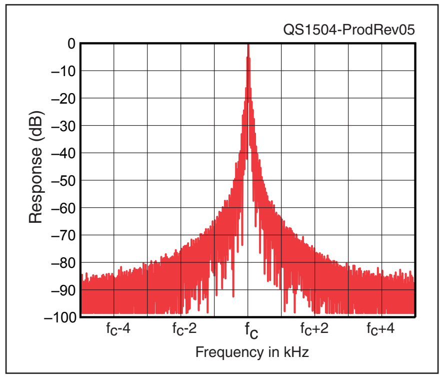

Figure 5 — Spectral display of the FLEX-6700 transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 87 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dB.

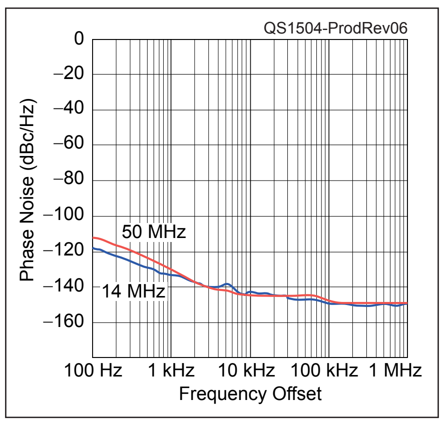

Figure 6 — Spectral display of the FLEX-6700 transmitter output during phase noise testing. Power output is 87 W on the 14 MHz band (blue trace), and 82 W on the 50 MHz band (red trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dB.

In this view of the FlexRadio *SmartSDR* software, a total of eight separate receivers are open and running simultaneously.

ences between the FLEX-6300, ’6500, and ’6700 as we go. More information about the differences among the models is available from the FlexRadio website.

A Software Defined Radio

FlexRadio Systems has pioneered software defined radios (SDR) for the general Amateur Radio market. In earlier models, the sampling occurred at a low IF frequency, in the kilohertz range. This permitted sampling up to about 100 kHz at one time, which could be shown as an instantaneous panadapter power spectrum and over time as a waterfall plot. This is a key feature of most SDR radios, by the way, being able to visualize a large swath of spectrum showing all the activity on an amateur band — or even the entire HF spectrum — so you can see where the action is at a glance. You can click on a point on the display, and a small slice of the spectrum will be demodulated as an SSB, CW, AM, or FM signal.

The “ideal” SDR is one where the conversion from analog to digital occurs as early — as close to the antenna — as possible. This will eliminate most of the “messy” (drifting, noisy, expensive) analog components in favor of digital processing.

FlexRadio has taken on that challenge and produced the FLEX-6300 that samples the RF spectrum up to 54 MHz. The ’6500 samples up to 77 MHz. The ’6700 also samples to 77 MHz, but adds another 30 MHz segment, 135 – 165 MHz. Analog circuitry rejects out-of-band signals and provides switching and preamplification before analog-to-digital conversion. The overall scheme is shown in Figure 7.

The switching, filtering, and preamplification are traditional, but after that we’re in SDR territory. The FLEX-6300 analog-to-digital converter (ADC) produces 122 million 16-bit samples per second (Msps). In the ’6500 and ’6700, the ADC runs at 245 Msps.

In terms of computing power, the major block in Figure 7 is the field programmable gate array (FPGA), a Xilinx Virtex-6 chip.[1] This is a specialized computing engine well suited for DSP operations, such as the fast Fourier transform (FFT). Up to eight parallel programs in the FLEX-6700 (four in the ’6500 or two in the ’6300) run in the FPGA, each one computing the data necessary for a single panadapter/waterfall display. The FPGA reduces the torrent of input data by a large factor so that further processing can be done in general purpose computing environments.

The block labeled “DaVinci Processor” refers to an embedded ARM Cortex-A8 chip from Texas Instruments supporting the Linux operating system.[2] It does not have a direct user interface. The DaVinci processor accepts data from the FPGA and provides further filtering and signal demodulation. Audio inputs and outputs are provided directly on the Flex box or remotely through your PC and LAN (local area network). Remote LAN operation will require *SmartSDR* Version 1.4 or later.

One of the most important elements of any of the 6000 series radios is “customer supplied equipment,” namely your *Windows* personal computer. (There is no native support for Macintosh or Linux computers at this time.) The FlexRadio hardware communicates with your PC through an Ethernet connection (at least 100 Mb/s). Two-way digital audio transmissions are provided through custom DAX drivers installed in *Windows*.

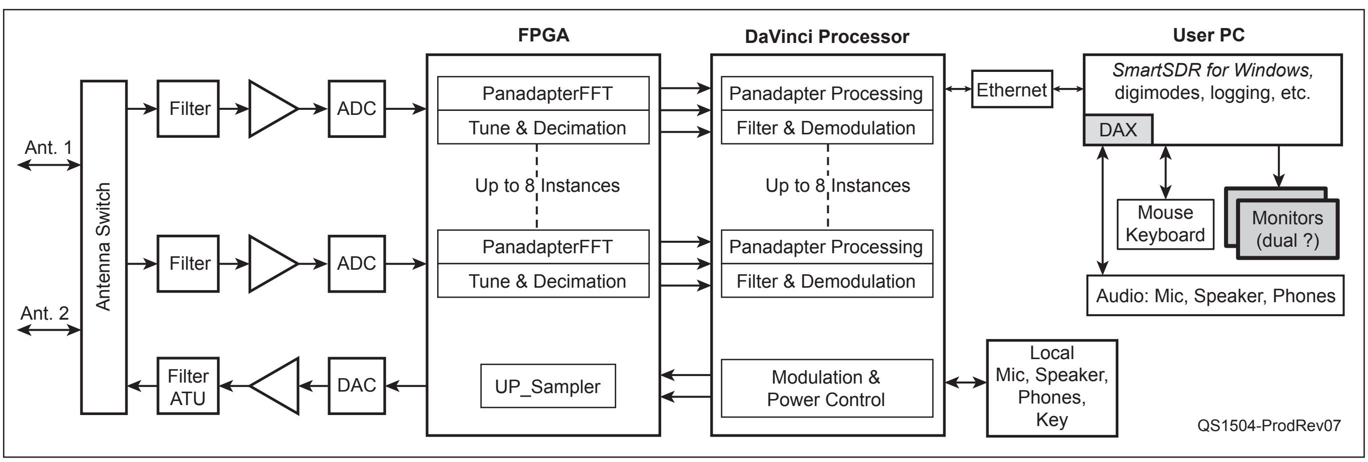

Figure 7 — FLEX-6000 signal flow diagram (adapted from FlexRadio Systems)

The block diagram also indicates the transmitter signal flow, which is more-or-less like the receiver's, but in reverse. More filtering, power amplification, and an automatic antenna tuner complete the transceiver. (For the FLEX-6300, the antenna tuner is an optional extra.)

Dual Receiver Channels

The FLEX-6700 has two identical major receiver channels called *Signal Capture Units* — SCUs . (The '6500 and '6300 have only one SCU.) Why would you want two SCUs when each one can take in the entire HF spectrum? It is true that with a single SCU, you can create up to eight panadapters in the '6700 (four in the '6500, and two in the '6300), and you can demodulate up to eight signals (using *Slice Receivers* — in FlexRadio lingo) anywhere in the panadapter bands. (Up to four Slice Receivers are allowed in the '6500 and two in the '6300.) There is no problem when operating "split" in a single band, or monitoring phone and CW subbands at the same time. But if you use a single SCU across multiple bands, you can't use the ham band preselector filters. You will be switched into "wide" mode, where the receiver is wide open across the spectrum and potentially more susceptible to out-of-band interference. (The '6300 has no preselectors, so it is always in wide mode.)

With two independent SCU samplers and switchable preselectors, the FLEX-6700 is super versatile. You can have optimum reception on two different bands with separate antennas, or you can have one receiver on HF and the other on VHF+ with a transverter. You can set up diversity reception, fast QSK, and probably other creative configurations.

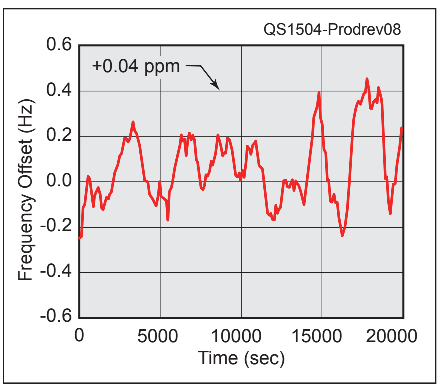

Figure 8 — Apparent frequency of WWV, showing FLEX-6700 stability.

FlexControl USB Tuning Knob

Many users will say that a "real radio" needs a tuning knob, that tuning by mouse pointing and clicking is not the whole story. The FlexRadio Systems FlexControl USB Tuning Knob is an optional addition to a 6000-series SDR radio that takes care of that little issue.

Installation of the FlexControl should have been a snap, but it was not. A number of reboots and software settings were required to get *SmartSDR* talking to the FlexControl. The problem apparently was that the FlexControl was initially installed on a COM port that interfered with *SmartCAT*'s assignments. Once I reset the FlexControl's COM port to 4 before assigning *SmartCAT* ports, everything began working reliably.

The big rotary knob has a great feel, and it spins nicely. Don't spin too fast though, because *SmartSDR*'s internal retuning rate is limited. There are three additional buttons, which can be programmed to set the knob's current action: controlling a slice receiver tuning, RIT, audio volume, and so on. An LED indicator tells you which button is active. Unfortunately, the FlexControl's physical labeling has no relationship to any *SmartSDR* function!

I did some work that allows the FlexControl to be used with Linux software projects. See **blog.aa6e.net/2015/01/flexcontrol-for-linux-hamr.html**.

Frequency References

I am one of those who worry about the accuracy and stability of a transceiver's frequency reference. If the dial indicates "Hz," the frequency accuracy should be better than 1 Hz! Modern radios typically offer stability in the 1 part per million (ppm) range. Often, the reference oscillator is a temperature compensated crystal oscillator (TCXO). The FLEX-6500 and '6300 use a TCXO quoting 0.5 ppm stability. This is adequate for most amateur operation, but it could be a problem for critical HF and VHF work. (A 1 ppm offset is 50 Hz on 6 meters!) The '6700 provides much better performance with an oven-controlled crystal oscillator (OCXO) and quoted stability of 0.02 ppm.

Stability is mostly about frequency changes over a period of minutes or hours. It does not guarantee accuracy. An oscillator is accurate if it operates very close to its rated frequency. Out of the box, at about 70 °F ambient temperature and without correction, I found our FLEX-6700 reference was about 0.08 ppm high, while our '6300 was about 0.5 ppm low. (The exact numbers will vary among production radios.) These errors are not serious, because you can correct for them by entering a frequency offset in *SmartSDR*. Under steady ambient conditions, I found that both radios were quite stable over a period of hours at the ±0.04 ppm level or better. Looking at this in more detail, I recorded WWV's apparent frequency at 10 MHz using the '6700 and *Fldigi* software for frequency measurement as shown in Figure 8.[3] Most of the fluctuations are probably propagation effects. This radio will be an excellent, albeit expensive, tool to ace the ARRL Frequency Measurement Tests!

If you are seeking ultimate frequency control, both the FLEX-6700 and '6500 provide for an optional GPS Disciplined Oscillator (GPSDO), which locks your radio to the atomic frequency standards behind the Global Positioning Satellite system. FlexRadio quotes stability of 5×10^{-12} over 24 hours for this $699 option. While this is far beyond normal amateur requirements, it will appeal to the Time-Nuts crowd.[4] If you sync all your oscillators to the 10 MHz GPS stabilized output, you might have fun operating JT65 at 100 GHz!

The GPSDO does not support GPS timekeeping, but adding a network time server function to *SmartSDR* seems feasible. This would give your station precise time synchronization independent of the Internet — useful for portable or emergency situations. Flex can add that to their to-do list!

Transverter Operation

The FLEX-6700 should be popular among VHF+ folks who need a high-quality base system to operate with transverters for the higher bands. The '6700 and '6500 offer a lot of flexibility for this application, supporting transverters with split IF connections or common IF (send and receive on a single cable). (The '6300 requires the common IF setup.) Figures 9 and 10 show the rear panels of both transceivers.

I connected my Elecraft XV144 transverter with a split 28 MHz IF setup to the FLEX-

6700. It went on the air with no special problems. *SmartSDR* helpfully allows you to enter the frequency conversion scheme, along with any local oscillator (LO) offset, so that *SmartSDR* displays the correct RF frequency scale. Up to 17 different transverter schemes are allowed, which should satisfy most of us!

Two Meters

The FLEX-6700 will support the 2 meter band directly, with +8 dBm output power at the transverter jack. This capability can be used to work with a higher frequency transverter that may require an IF in the 135 – 165 MHz range. While you can operate directly on 2 meters, most amateurs would want to use external transmit and receive amplification. At least one 2 meter linear amp and receive preamp is being marketed specifically for the ’6700.[5]

You might prefer to use the FLEX-6700’s 2 meter capability rather than a transverter because you get a simpler hook-up and full coverage of the band, which is not available with many transverters. You also get the benefit of the ’6700’s precise frequency control.

Choosing Your Computer

Smooth operation of the Flex 6000 radios depends on your *Windows* PC, which must be powerful enough to support computation, communications, and display of large amounts of data. You don’t want to skimp on the PC, but how much is enough?

It is hard to define a minimum *required* system, because computer performance has so many dimensions: CPU speed, RAM, graphics capability, and other factors. FlexRadio recommends that your computer should have *Windows Vista* SP2 or later as its operating system. (*Windows* XP is not recommended because Microsoft has withdrawn support.) FlexRadio’s minimum *suggested* CPU is an Intel Core 2 Duo or AMD Athlon 64 X2, but more is better — a more powerful CPU would give more headroom for non-Flex applications.

Graphics performance is important. Flex Radio suggests a graphics card with hardware graphics acceleration that supports *DirectX* 9 or greater.[6] Many computer chips now come with built-in graphics processors, but they may not be ideal for *SmartSDR*’s graphics workloads, especially with more than two or four panadapters. An additional graphics card may be helpful, especially for the FLEX-6700.

Figure 9 — The FLEX-6300 rear panel. The transceiver has two antenna ports, a transverter jack, amplifier key and ALC jacks, and an Ethernet jack for connection to the PC.

Figure 10 — The FLEX-6700 rear panel. Some of the available connections include two antenna ports, separate receive antenna connections for each SCU, four transmit relay outputs, amplifier ALC, line/mic inputs, connections for an external reference oscillator, and an Ethernet jack for connection to the PC.

I had only a few problems using my 4-year-old home-built Intel Core i7-920 computer (quad core) with 12 GB of RAM, an EVGA GeForce GT 640 graphics card, and *Windows* 7 driving dual 1920 × 1080 displays. With up to five panadapters**,** the ’6700 and *SmartSDR* behaved well on my computer. Above five, there were noticeable dropouts in the audio output and also in the waterfall display. Operating with “excessive” active panadapters can also lead to delays (up to a few seconds) between receiver audio output and the panadapter display.

Under these conditions, my PC CPU is only utilized about 50%. The GPU is running about 40%, and there is plenty of RAM available. There may be some other bottleneck in my computer system, but it’s not obvious where. It is also possible there is a bottleneck in the *SmartSDR* software, since it is not able to use all the available hardware resources. It would be helpful if FlexRadio provided diagnostics to evaluate your particular computer setup. According to FlexRadio, *SmartSDR* version 1.4 includes significant software performance and stability enhancements that will address these issues. They have moved significant portions of the spectral and waterfall processing to FPGA hardware to offload CPU operations and address bottlenecks affecting performance.

A typical current mid-level desktop computer with an Intel Core i3 or i5 processor and 4 GB RAM will probably do the job well, but you may need to add a graphics card, such as the GT 640 with at least 1024 MB and dual DVI support. If you want totally solid performance with FLEX-6700 and many fast scrolling panadapters, you might need a higher performance graphics card.[7] You might not need that capability. (How often are you likely to operate with eight blazing panadapters?) Various monitor sizes are usable, but the graphical layout works best with 1920 × 1080 resolution or greater. Dual monitors are a convenience if you like to run a logger, web browser, digimode software, or other programs alongside the big SDR display — and if you have the desk space!

As a low-end test, I was able to run *SmartSDR* on a Toshiba L645D laptop (AMD Phenom II P820 triple core processor, internal ATI graphics, 4 GB RAM). That worked and might be usable for the 6000 radios using lower refresh rates, fewer panadapters, and smaller window sizes.

If you're a Linux fan like me, you might want to know that *SmartSDR* will run with *Windows* 7 as a virtual machine under Oracle *VirtualBox*. The results were only fair on the Core i7 hardware. The radio was fair to moderate with one or two panadapters and modestly sized windows. As a critic once said, it's not that it's done well, but that it is done at all!

High Frequency Resolution Receiving

Theory says that the high resolution (narrowest frequency bin) offered by the FLEX-6700 (1.5 Hz) should provide about 6 dB better signal to noise than the '6500 (4.5 Hz) for very narrowband signals. I tested that on my favorite weak signal 2 meter beacon, WA1ZMS — a 482-mile path for me. I usually receive this high power beacon at about S-1. Figure A compares the full resolution FLEX-6700 data against the lower resolution available with the '6500 and '6300. The higher resolution shows better signal to noise ratio. Here's even some "radio science" — the pure beacon carrier breaks up into three or four components that vary over time, presumably due to time-varying reflections along the signal path.

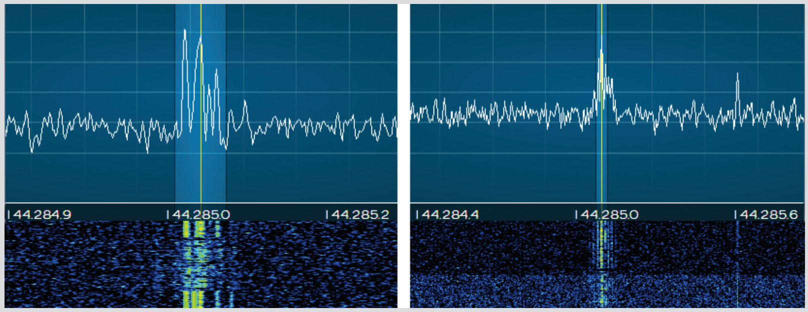

Figure A — WA1ZMS beacon received at AA6E with the FLEX-6700. On the left, full resolution, bin size 1.5 Hz. On the right, quarter resolution, bin size 5.9 Hz, comparable to FLEX-6500. Vertical divisions are 10 dB. See text.

Operating Modes

SSB

Phone operation using the supplied FHM-1 hand microphone had good results. The FLEX-6700 provides eight-octave graphic equalizers for both the transmit and receive audio. Predefined transmitter profiles include suggested equalization settings for the FHM-1 and the Heil PR-781 microphones. You can modify these or define your own transmitter profiles.

There are four audio processor settings: off, normal, DX, and DX+ that give you increasing amounts of "talk power" (and distortion) according to your needs. The 6000 series uses an advanced "Controlled Envelope" compression method, recently described by Dave Hershberger, W9GR.[8] Transmit low and high cut frequencies can be set as desired, up to 10 kHz. A "downward compression" feature allows you to suppress background noises during speech pauses. (But beware, the downward compression can cut you off if you speak too softly!)

I wish that a rig with so much computing horsepower would offer more help with diagnostics for voice and other modulation setup. For example, there are some 11 settings that will affect audio quality (including the equalizer). The panadapter does show a version of the transmitted signal, but Flex warns it may not be completely accurate. You could hope for some advanced analysis — perhaps peak-to-average audio, a distortion measure, a time averaged spectrum, or some help evaluating the downward compression feature. The monitor output does not seem to sample actual RF output, so it does not fully verify on-air quality. To gain confidence about my audio, I had to rig up an external receiver to record and play back my signal. (That's a good check for any transmitter.)

FM

Frequency modulation (FM) is slated for release in version 1.4 of *SmartSDR*. It is said to provide both standard and narrow deviation modes, along frequency memories and automatic support for repeater offsets.

AM

On-air tests of the AM mode received good reports. *SmartSDR* gives you the ability to set your audio bandwidth up to 10 kHz (20 kHz RF bandwidth on AM), which would be excessive for crowded band conditions, but it permits broadcast-level fidelity. The graphic equalizers for receive and transmit offer a lot of options for tailoring your results, although the on-air conclusion is that for best results you want something more than the supplied FHM-1 microphone. All 6000 series models support an eight-pin front-panel mic connector. The FLEX-6700 and '6500 also allow back-panel mic inputs at low level or line level, on a balanced XLR or ¼-inch jack.

The synchronous AM (SAM) mode for reception was very effective for reducing noise and the effect of selective fading.

CW

The FLEX-6300 and '6700 performed well on CW. You can readily select iambic paddle or straight-key operation, selecting automatic break-in or manual transmit/receive switching, keyer speed, and sidetone level and pitch. QSK is supported by fast reed relay switching up to about 60 WPM. The '6700 will support very high speed "QRQ" CW (to 100 WPM or more) by operating with separate receive and transmit antennas, avoiding receive/transmit switching delays that would otherwise be a problem above 60 WPM.

SmartSDR provides a CW memory keying system called CWX. In its "live" mode, the keyer will send whatever message you type in your keyboard at any rate from 5 to 100 WPM. The most recently sent messages show up in smartphone-like text bubbles. (You can easily imagine *SmartSDR decoding* Morse or digital modes some day.) An alternate CWX mode allows you to predefine up to 12 CW messages that can be invoked with your keyboard's function keys.

Digital Modes

The 6000-series radios provide two ways to connect to digimode software. You can use the analog audio inputs and outputs to connect to your computer's sound card, where the computer can be the same one running *SmartSDR* or any device that has digimode software. The other way, however, is an all-digital channel between the radio and your computer that uses the Ethernet link. Special DAX drivers for *Windows* are provided that allow you to receive and transmit digital audio without any sound card. The DAX connection is usually preferable because there is no wiring or interface box required, and there are no extra steps of digital-to-analog and analog-to-digital conversion to introduce distortion.

I tried hooking up *Fldigi, WSJT-X,* and *WSPR* software using both techniques, and all of them worked well.

Other Operating Features

Cooling

Digital modes such as JT65 or RTTY can involve high duty cycle transmissions. If you run full power, a high speed cooling fan will eventually switch on. On 40 meter CW, I tested full power into a dummy load. Starting at ambient 70 °F, the FLEX-6700 fan switched on after about 8 minutes of key down. My smartphone's sound meter app, at about 6 inches from the radio, jumped from about 35 dB (from the rig's normal low speed fans) to about 48 dB when the high speed fan kicked in. That's unpleasantly loud in my shack environment, but it's probably no worse than many linear amplifiers. In typical operation, you're unlikely to encounter the fan noise very often.

QRO and QRP

Connecting a linear amplifier to either the FLEX-6700 or '6300 is straightforward. The '6700 (and '6500) have four transmit/receive relay outputs with independently adjustable switching delays, allowing very flexible control of amplifiers, transverters, and other gear. (The '6300 has one output.) Any model will accept an ALC input from the linear, if required.

Some amplifiers and other equipment such as antenna switches may require a band selection signal. *SmartSDR* currently has no provision to switch external equipment or to provide a band select signal. You can use the *DDUtil* software from Steve Nance, K5FR, to support this external control, but I would prefer a solution that was integrated into *SmartSDR*.[9] I find it can be confusing to have to deal with multiple auxiliary programs such as *SmartCAT* and *DDUtil*, each of which has its own interface style and setup procedure.

SmartSDR provides a 0 – 100 power slider control. The setting is a rough estimate of output power in watts. Zero is zero power (transmit inhibited). A setting of 1 delivered about 0.8 W on 40 meter CW with my station power meter. It's easy to operate in the QRP range, 5 W and below.

Diversity and Binaural Operation

The FLEX-6700, with its dual sampling units, supports independent receivers that can be directed to left and right headphone channels. For any slice receiver on a particular frequency on one antenna, you can enter "DIV" mode, which creates an identical slice receiver (same frequency) on the other antenna. The two antennas should be different, maybe one vertical and one horizontal or maybe separated by several wavelengths. With diversity reception, the hope is that a fade in one channel (or interference) will not happen on the other, so you can get better copy overall. In a few tests, I found that diversity produced interesting stereo effects, but intelligibility was not greatly increased. Your mileage may vary depending on spatial, pattern, or polarization diversity between available antennas.

Even in the single-SCU radios (the '6500 and '6300), you can "pan" the audio output of each Slice Receiver, directing the audio left, center, or right as desired. This allows you to place a DX station's receiving frequency on your left, and the split calling frequency on your right, for example.

The 6000 series does not (yet) provide binaural separation of CW tones, as some other radios do. This could help separate your operating frequency (in the center) from slightly lower or higher notes to the left or right. We can hope this will be a future enhancement.

Notch and Noise Reduction Filters

The 6000 series provides two ways to zap undesired narrowband signals (carriers). The ANF (automatic notch filter) operates on the demodulated output of a slice receiver, at the same stage as the NB and NR functions (noise blanking and noise reduction). An algorithm looks for high correlation typical of an interfering tone and tries to cancel it out. There is an ANF setting for each slice receiver, operating independently of any other slice.

A completely separate capability is provided by the TNF (tracking notch filter). This filter operation occurs near the beginning of the DSP process. You can insert a filter manually at any RF frequency with selectable depth and width. A TNF filter notches out a particular small frequency band across all slice receivers that may include that frequency. In fact, in the FLEX-6700, a TNF filter applies to both SCU receivers — which may not be what you want if the interfering signal is only present on one antenna! TNF filters are visible on panadapter displays, but they do not notch the visible spectrum — you can still view the interfering carriers. A TNF can be "remembered" so that it will be a permanent block, even if you power down the radio. This would be convenient if you need to block fixed birdies or other interference sources at your station.

I found the ANF to be effective in some situations and not in others. Sometimes there was excessive distortion. ANF is naturally problematic when you are receiving CW or digimodes — the "good" signals look too much like the "bad." FlexRadio says the ANF algorithms are still under development. On the other hand, the TNF feature worked quite well. As a manual stop-band filter, a TNF stops a fixed band of frequencies and does not have to make choices between good and bad signals.

I'd like to have a "TNF editor" that would allow you to see all the TNFs that are in effect and to modify them as needed. *Smart-*

See the Digital Edition of *QST* for a video overview of the FlexRadio Systems FLEX-6300.

SDR offers the ability to inhibit or enable all TNFs, but you can't tell where the TNFs are (or delete any TNF) without tediously searching for them on the panadapter.

SmartSDR provides a noise reduction (NR) option that is meant to increase signal to noise ratio. I found it can help with marginal SSB signals. (We find it difficult to measure some NR filters in the lab.) When you have stronger SSB signals, there may also be an improvement, but you may or may not prefer the effect. To be useful on CW, NR needs a relatively wide bandwidth (~1000 Hz). I find that choosing a 100 or 200 Hz CW bandpass helps intelligibility more than a wider channel with NR.

SmartSDR provides slider controls for NR, ANF, and noise blanking, but these seem to have no effect. FlexRadio has said that these filtering functions should be improved in upcoming software versions.

Configurations and Profiles

The 6000 series radios have a lot of configuration options: panadapter settings, slice receiver parameters, RF setup, audio setup, and other parameters. Even the antenna switching configurations are quite complicated. The manual provides a helpful list of 19 rules describing all your antenna switching options. I keep saying it — this is a very flexible radio!

Most of this information can be stored in a "profile." The user can set up any number of profiles and give them names. For example, you might have "40M CW," "20M PSK31," or "15M SSB" profiles, that would set up the radio the way you like it for those particular bands or modes. A larger set of data, including profiles, TNF information, transverter settings, and so on can be exported as a "configuration" to your PC. This serves as a backup and also as a way to transport your favorite setup to a different Flex radio.

The 6000 series allows you to record and play back audio signals. This can be useful, but the audio files are stored internally in the radio and are not available to your PC. FlexRadio has said they intend to eventually provide audio export and import. It would also be handy if panadapter and waterfall data could be captured for offline analysis.

Fortunately, these configuration and data management issues are problems that can readily be addressed in future software releases.

Auxiliary Software

SmartSDR is delivered with two important auxiliary software programs, *SmartSDR CAT* and *DAX*. *SmartSDR CAT* is an interface program that allows a 6000 series radio to accept standard CAT commands from your other software, such as digimode or logging programs, to control the radio. Two command sets are recognized: the "ZZ" commands defined by FlexRadio and the Kenwood TS-2000 commands. These will cover the majority of software control requirements, including dual VFO and split operation. However, because the 6000 series radios have more configuration options than traditional radios, many features will not be accessible through traditional CAT commands. A more powerful "FlexLib" interface is provided via the Ethernet connection, which an advanced user can access.

A second feature of *SmartSDR CAT* is to manage virtual COM ports so that your digimode software, say, can issue Kenwood-style commands on one port while addressing a second port for transmit/receive control. I found the *Windows* COM port management was sometimes a bit tricky, especially if you also have a FlexControl or other devices that need to set up virtual COM ports. The *SmartSDR CAT* documentation is detailed, but it can still be confusing for neophytes (and product reviewers!).

SmartSDR's *DAX* software is a control panel for the DAX drivers that are installed in your *Windows* computer when you install *SmartSDR*. The DAX drivers communicate over the Ethernet with your radio's internal computer for digital audio transmission. Eight audio streams for transmit and receive (in the '6700) allow you to operate up to eight Slice Receivers simultaneously. On transmit, eight inputs are supported, although only one Slice Receiver can be selected for transmit at a time.

DAX also supports up to four panadapters outputting IQ streams, centered on a panadapter display. Essentially, this exports a segment of the panadapter IF data, up to 192 kHz wide, to any *Windows* software that may be able to process it, perhaps to support new digital modulation modes.

General Comments

Software Stability

The Flex 6000 series products depend on very complex operating software. *SmartSDR* is still developing rapidly. The good news is that a new release is always just around the corner. The bad news is that there are inevitably some bugs, and even occasional system crashes. While the system has impressive capabilities, it is evolving and not fully mature. In months of sometimes "aggressive" testing, I experienced a couple of crashes or hangups. These seemed more likely after adding, manipulating, and deleting a number of panadapters. All in all, while *SmartSDR* isn't perfect, I consider it quite acceptable for amateur use. As noted previously, FlexRadio expects that version 1.4 will offer improved stability.

Software Support

Unlike other Amateur Radio vendors, FlexRadio has announced a policy of charging for major software updates. Buyers get current software along with the radio, and updates within the current version (for example, version 1.x) are provided at no cost. However, when a new major version is released (such as version 2, slated for delivery in 2015), users will have the choice to stay with the old version, or to upgrade to the new version, which will carry a license fee of $199. This scheme is meant to assure continued active software development.

Community Support

FlexRadio provides an unusually good web-based set of informal community forums and a formal help desk. Users contribute their operating problems, suggestions for development, and so on, and FlexRadio staff and other community members answer them. The web system is very user-friendly compared with the typical e-mail lists that have grown up around other vendors' products. Having a close relationship between users and the vendor is especially important for an SDR radio and its ongoing software development.

Software Issues

The *SmartSDR for Windows* software is powerful and usable at version 1.3, but there are still a few rough edges. In my review process, I accumulated a lot of notes about various features or problems, but I only have space to mention a few that seemed particularly notable.

First, tuning can be a challenge. With your mouse or FlexControl, you adjust frequency in a user-selectable step size. For fine CW or SSB adjustments, you might choose a 10 or 50 Hz step size. With such a small step, it takes a long time to sweep across a band using the mouse wheel or

FlexControl. You are forced to switch to the mouse click/drag method, which can be too coarse if your panadapter covers a wide band. (For my taste, it's awkward to switch very often between mouse movements and wheel/knob operation.) We need a variable or coarse/fine tuning rate. On CW, it would also be handy to have a signal tuning indicator or an auto-tune function to let you easily zero-beat another station.

It would be very handy if *SmartSDR* supported a set of "live" keyboard commands for tuning (up and down arrows?) and other common functions. Currently, the keyboard is completely unused, except for CWX. Keyboard tuning control would be especially welcome when you don't have a mouse wheel or FlexControl knob to tune with.

One particular nuisance I noted was that at lower frequencies, where there may be a lot of lightning crash QRN, the broadband noise will cause the panadapter trace to bounce around and the waterfall to be full of "hash" lines. I suggest that *SmartSDR* could provide optional baseline stabilization to eliminate the problem.

The software could also do a better job of automatically scaling the panadapter and waterfall displays. Perhaps a "trace finder" button would help to set the scales when switching to a different band or antenna.

The 6000 series radios have a large array of setup options, especially the '6700. Profiles let you switch among your pre-stored favorites, but it would be handy if the profiles could be managed offline, perhaps as text files, perhaps with a scripting language. You might want to change panadapters and slice receivers in groups, for example, to change the slice band pass on all receivers to some new value. As it is now, you have to load a profile and manually change each parameter before saving a new profile.

It would be useful to provide more annotation of panadapter windows. If you have eight panadapters, you probably need some visual grouping to help identify which is in use for which purpose — text titles, color coding, and so on. I would like to see band and subband edges marked, along with allowed modes for my license class. I would add special frequencies for nets, calling, and maybe DX spots from the Internet — why not? (I note that Ray Andrews, K9DUR, offers a free frequency/mode memory utility.[10])

Longer term, FlexRadio (and the user/developer community) will need to work on integration of the *SmartSDR* system with major functions that are now mostly independent, such as logging, contest operation, digimodes, and other applications. It is inconvenient to switch attention between multiple screens. On the other hand, it may be unrealistic for developers of backend software, such as *Fldigi* and logging systems, to spend too much time adapting to one particular radio system. It will be interesting to see how this market develops.

Summing Up

The FlexRadio 6000 series with *SmartSDR* for *Windows* is really a "platform" for communications development. The FLEX-6300, '6500, and '6700 are the first hardware implementations. Over time, we can expect new hardware to come along, but before that happens there is a lot of room for adding and improving features through software. It's not called software defined for nothing!

As our Lab tests show, the FLEX-6700 is at or near the top of the heap among current Amateur Radio gear. The latest release of *SmartSDR for Windows* is good for a wide range of amateur operation, and it is getting better month by month. Already, the 6000 series, especially the FLEX-6700, provides unprecedented flexibility for receiver configurations.

The FLEX-6300 is the economical transceiver that will provide for the needs of many amateurs who are looking for an SDR experience with dual receive panadapters. The '6500 supports four panadapters and offers options for an advanced station and has better receive performance, while the '6700 offers dual-antenna reception, eight panadapters, 2 meter support, and ultimate flexibility.

The Flex 6000 direct sampling radios will appeal to those who are seeking the maximum in performance and versatility — and who enjoy a technical adventure!

Manufacturer: FlexRadio Systems, 4616 W Howard Ln Suite 1-150, Austin, TX 78728; tel 512-535-4713, fax 512-233-5143, **www.flexradio.com**.

Notes

[1]**en.wikipedia.org/wiki/Field-programmable_gate_array**
[2]**www.ti.com/lsds/ti/dsp/video_processors/overview.page**
[3]**www.w1hkj.com/Fldigi.html**
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See the Digital Edition of *QST* for a video overview of the FlexRadio Systems FLEX-6700.