CommRadio CR-1a Communications Receiver

A software defined receiver with no "computer" required.

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When we think of software defined radio (SDR), among the first images that appear in our imaginations are wide flat-screen monitors. If you go to a hamfest and visit an SDR exhibit, that's what you'll see: large computer monitors displaying SDR software. Signal waveforms pulse and dance; filter windows expand and contract. It is all quite impressive and very "21st century."

SDR performance is every bit as impressive as it looks, and its magic begins at (or near) the receiver's antenna terminals. A signal arriving at an SDR receiver is, by its very nature, analog, but it doesn't remain that way for long. Within microseconds it is "sampled" — chopped to bits at an extremely high rate by an analog-to-digital converter (ADC). The data from the ADC is processed into *in-phase* and *quadrature* components, or *I/Q* for short. Once you have rendered the signal to I/Q information, you can use software to demodulate whatever is contained within.

At the center of all this wondrous work is a computer. Without a computer and software, a software defined radio is useless; it is nothing more than a sophisticated piece of hardware spewing data that goes unprocessed and unheard. That's why images of monitors have become so iconic in the SDR universe. They represent the computer connection that is critical to software defined radio.

SDR computers don't have to be tablets, laptops, or desktops, though. They can also be arrays of microprocessors hidden away in nondescript enclosures. If you can communicate with those microprocessors through a set of buttons and a functional display of some sort, you can easily dispense with the bulky monitors and keyboards.

Which brings us to the CommRadio CR-1a receiver.

SDR Without a "Computer"

The CommRadio CR-1a is most definitely an SDR, and it incorporates the requisite computer, too. But instead of depending on extra pieces of hardware external to the radio itself — what we normally think of as a "computer" — the CR-1a combines everything, including powerful microprocessors, into a single metal enclosure that is just 5.6 inches wide, 2.4 inches high and 6.1 inches deep and weighs less than 2 pounds. Instead of a monitor and key-

board, you interact with this SDR through a collection of buttons, two knobs and a crisp organic LED (OLED) display.

The CR-1a is among the first SDRs designed to be completely portable. The radio features a bottom-firing speaker, which is the reason for its unusual elevated stance. The CR-1a includes a rechargeable lithium-ion battery, although it can also be powered from a USB port or an external 6 – 18 V dc source. The powder-coated steel case and machined aluminum knobs give the CR-1a a nice feel.

Since the CR-1a looks and acts like a conventional receiver, it's fair to ask why its SDR architecture deserves discussion. The answer is that one of the most attractive aspects of any SDR is the ability to make huge changes to the way the radio functions by simply installing new software. In the CR-1a, the software resides in nonvolatile memory and can be changed at any time. If CommRadio wants to add new features to the CR-1a, such as synchronous AM reception, for instance, they can do so by offering revised software that you download from their website and then upload to the radio. So, unlike conventional receivers, the CR-1a can "evolve" over time, at least within the limitations of its hardware.

In addition, if you want to use the CR-1a as a "typical" SDR with an external computer and software, you can do so. There is a USB port on the rear panel that is normally used to recharge the internal battery. The CR-1a makes I/Q data available at this port, which you can subsequently feed to a computer and software of your choosing.

Bottom Line

The CR-1a is a portable, battery operated, wideband receiver that uses software defined radio technology to receive a variety of modes on select frequency segments from 500 kHz through 512 MHz.

When this review was conducted, Comm Radio offered a free piece of software that allowed users to access the I/Q data and control the radio to a limited extent (see Figure 1). The software was in beta testing at the time, so improved and expanded versions will probably be showing up soon. As the CR-1a becomes more commonplace, I'd expect to see compatible third-party software as well.

Broad Coverage, Filters, and More

The CR-1a's coverage spans 500 kHz to 30 MHz; 64 to 260 MHz and 437 to 512 MHz in AM, SSB, CW, WBFM, NBFM. Wideband FM is the default when tuning through the FM broadcast band (monaural only — at least with the current software). The CR-1a will also receive long wave (LW) from 150 to 500 kHz, but with reduced performance due to the lack of a dedicated front-end preselector for those frequencies.

Interestingly, the CR-1a has what you might call a "split" receiver architecture, which you notice right away when you examine the rear panel shown in Figure 2. There are two BNC jacks: one for LW through 30 MHz and the other for 64 MHz and above. The review radio also has a separate 3.5 mm jack for a long wave or AM antenna, but this was eliminated in later production runs (s/n 750 and higher). For reception below 30 MHz, the CR-1a uses a dual conversion approach to providing a lower-frequency IF signal for the ADC. For 64 MHz and up, however, it makes the jump to the IF frequency in a single step.

Tuning is not continuous from long wave to VHF or UHF. To switch from HF to VHF or UHF you must enter the menu system and select the frequency group. Once you've made your selection, you punch the user configurable BAND key to step from one band to another, or simply select the tuning step you desire and spin the tuning knob. A nice touch: you can configure the BAND key to limit choices to the 160 – 10 meter amateur bands or the 120 – 11 meter shortwave broadcast bands.

While in the menu, you'll also find a squelch adjustment. Actually, there are two separate squelches: one for HF and the other for VHF/UHF.

If you have the CR-1a in AUTOMATIC mode, the radio will automatically select the proper mode and filter as you tune. When you tune into the 40 meter Amateur

Table 1
CommRadio CR-1a, serial number 0629

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive only, 0.5 – 30, 64 – 260, 437 – 512 MHz.	As specified; 150 – 500 kHz also provided for experimental purposes.
Power requirement: 5 V dc via USB jack, or 6 – 18 V dc to charge 3.7 V dc internal Li-ion battery.	3 W maximum at 120 V ac for wall charger.
Modes of operation: SSB, CW, AM, wideband FM (FM Broadcast band only).	As specified.

Receiver	Receiver Dynamic Testing
Sensitivity: –130 dBm (71 nV) nominal at 500 Hz bandwidth (0.5-30) MHz.	Noise floor (MDS), 3 kHz filter: 3.5 MHz –125 dBm 14 MHz –122 dBm 70 MHz –130 dBm 144 MHz –126 dBm 440 MHz –113 dBm
AM sensitivity: Not specified.	10 dB (S+N)/N, 1 kHz, 30% modulation, 6 kHz BW: 1.020 MHz 3.23 µV 3.8 MHz 2.04 µV 29 MHz 3.16 µV 120 MHz 1.12 µV 144 MHz 1.30 µV 440 MHz 9.43 µV
FM sensitivity: For 12 SINAD, –98 dBm (2.9 µV) VHF, –86 to –98 dBm (11.5-2.9 µV), UHF.	For 12 dB SINAD, 15 kHz BW: 29.6 MHz 1.29 µV 70 MHz 2.09 µV 146 MHz 0.83 µV 162 MHz 1.05 µV 223 MHz 0.76 µV 440 MHz 3.75 µV
IF and image rejection: Not specified.	IF rejection, 115 dB; image rejection, >132 dB.
Receiver audio output: Not specified.	0.3 W at 10% THD into 8 Ω. THD at 0.85 V RMS, 6.3%.
IF/audio response: Not specified.	Range at –6 dB points, (bandwidth) CW (500 Hz): 350-1135 Hz (785 Hz) SSB (2.6 kHz): 140-3000 Hz (2860 Hz) AM (7.5 kHz): 2 Hz-3830 Hz (7660 Hz)

Size (height, width, depth): 2.4 × 5.6 × 6.1 inches (including protrusions); weight, 1.5 lb.

Price: $599.99.

Note: The AGC could not be defeated, so blocking gain compression, reciprocal mixing and IMD dynamic range tests could not be performed.
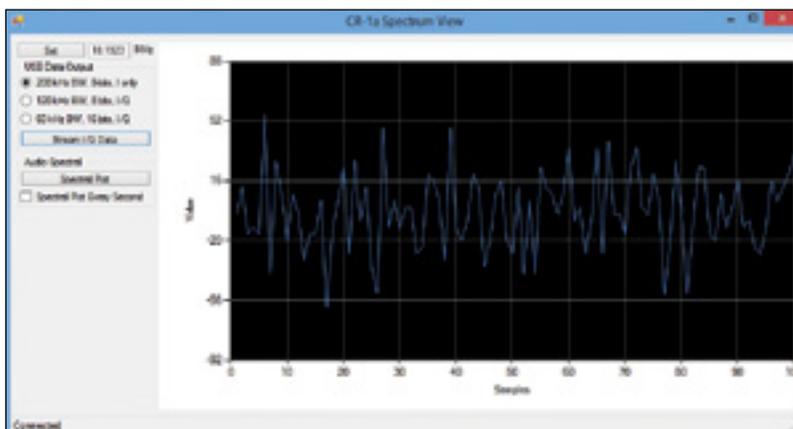

Figure 1 — The beta version of CommRadio's *Spectrum View* software.

Radio phone band, for example, the CR-1a automatically selects lower sideband. The CR-1a offers a variety of filter bandwidths — 500 Hz, 1.0, 1.8, 2.2, and 2.6 kHz on CW; 1.8, 2.2, and 2.6 kHz on SSB; 2.6, 5, 7.5, and 15 kHz on AM; and 15 and 25 kHz on NBFM. Unlike SDR receivers controlled by external software, you don't have the ability to create continuously variable filters on the fly. That said, with compatible software and an external computer you could connect the CR-1a and have the full SDR flexibility.

Like a conventional receiver, the CR-1a provides 64 memory slots to store your favorite frequencies for easy access. Scanning functions are available, but on HF only.

The CR-1a display includes a numeric S meter in the lower left corner. The S meter functions for all modes when you select the HF frequency range, but only operates while in the AM mode on VHF or UHF.

Last, but hardly least, the CR-1a can decode CW! Watch the video to see it in action.

Hands On with the CR-1a

I found the CR-1a easy to navigate once I became used to its menu system. The manual includes clear instructions and many illustrations to help with the learning curve. As I mentioned earlier, you must access the menus to switch from VHF to HF coverage, and to change filter bandwidths (if necessary).

The radio turns on with a momentary push on the VOLUME control and the amber display springs to life after a brief sign-on message. The 2.5-inch bottom-mounted speaker has plenty of power, so much that I rarely needed to advance the VOLUME knob past 11 o'clock in any listening environment. There is also a ⅛-inch jack on the front panel for headphones.

Bob Allison, WB1GCM, our ARRL Laboratory Test Engineer, measured substantial audio distortion during his tests with the VOLUME control set at low levels. Not that I doubt Bob's instruments, but I could not hear the distortion when using the external speaker. With headphones it was audible, but I didn't find it at all objectionable. Oddly enough, both Bob and I noticed

Figure 2 — The CR-1a has separate jacks for MF/HF and VHF/UHF operation The AM/HF antenna jack is eliminated on current production units. The USB jack can be use to power the receiver and charge the internal Li-ion battery or for connection to an external computer.

that the distortion *decreased* with increasing audio volume. Speaking of unusual sounds, it is also worth mentioning that the CR-1a made a slight ticking or popping noise when stepping from one frequency to another.

The CR-1a's AGC performance is selectable — FAST, MEDIUM, and SLOW — but cannot be turned off, and so the Lab could not perform the usual dynamic range tests (which require AGC be turned off). The AGC is sensitive and starts to reduce the audio output levels when encountering signals as weak as –68 dBm at 20 kHz from the selected frequency. This would occasionally manifest as significant "pumping" when a strong signal was within range. This AGC behavior may also have something to do with the popping sound heard when changing frequencies.

Other than the difficulty of working the buttons with my oversized fingers, the CR-1a was a pleasure to operate. I had no difficulty

listening to everything from CW, to single sideband, to FM. The CR-1a was more than sensitive enough for casual listening, including eavesdropping on Amateur Radio activity. It did double duty as a convenient test receiver and I even put it to work as a JT65 monitor by feeding the audio from the headphone jack to my station computer, which was running *JT65-HF* software.

When it comes to ham uses, the only notable limitation of the CR-1a is its inability to tune at VHF or UHF in less than 5 kHz steps. This presents issues when trying to monitor SSB or CW on these bands, although channelized FM operation is no problem. SDR being what it is, however, it is always possible that this may change with a new software release.

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