Product Reviews

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Product Reviews:

Icom IC-7851 HF and 6 Meter Transceiver

SPE Expert 1.3K-FA Solid-State Linear Amplifier

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Icom IC-7851 HF and 6 Meter Transceiver

Icom's flagship transceiver gets a makeover and a significant performance boost.

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It seems like only yesterday that we first reviewed the then-new, top-of-the-line Icom IC-7800 transceiver, but it actually has been more than 10 years, and a lot has happened to amateur transceiver performance since then.[1] In between, there were some other changes made to the '7800, as reported in a second review.[2] The IC-7851 is Icom's latest response to the gradual improvement in dynamic response that has happened in the industry, as well as providing other improvements to what was their top of the line when we first saw the '7800 at the 2003 Dayton Hamvention.

What it Does

The IC-7851 is a large transceiver that includes a lot of features in a correspondingly large and heavy box. This is a 200 W transceiver, and it includes the special 50 V dc internal power supply required by its final transistors. In addition, there is a built-in second receiver that matches the functionality and performance of its excellent primary receiver. While the second receiver is activated by the DUAL WATCH button, the IC-7851 works differently from other Icom transceivers. In other Icom radios, pressing DUAL WATCH allows reception on two frequencies that are in the same band and signals on the two frequencies are combined in a single audio stream. The '7851 has two completely independent receivers that can operate on different bands, with different antennas if desired, and provide output to stereo headphones or two speakers. Unlike the IC-7800, the IC-7851 does not swap receivers when operating split in the DUAL WATCH mode. Other features include a real-time dual spectrum scope (panadapter and/or waterfall display), a built-in antenna tuner, voice and CW memories, and digital-mode terminal functionality for RTTY and PSK with additional memories.

Connections are provided for up to four antennas via rear panel UHF sockets that can be selected from the front panel. Antenna selection is also remembered on a band-by-band basis. A row of six BNC connectors is provided, one for a 10 MHz external frequency reference (can also be used to supply the radio's internal reference to other equipment), one for transverter interfacing, and two pairs for a receive-only antenna connection for either receiver that can also be used to insert an additional preamp or filter in either receiver input line.

Bottom Line

The IC-7851 is an appropriate radio to sit at the top of the Icom transceiver lineup. Its quality is evident throughout its design, construction, and performance. While neither compact nor inexpensive, discriminating amateurs will likely be happy to find a place for it in their shack.

Many other connections are provided, including both USB Type-A and Type-B type connectors. The USB Type-A can be used for a computer keyboard, USB hub, or flash drive that can store the radio's configuration (an SD card slot is also available on the front panel). The USB Type-B supports a computer interconnection, but a connector for a classic Icom CI-V remote computer interface is available as well. There is even a pair of jacks for the Sony/Philips Digital Interconnect Format (S/P DIF), a digital input/output format that can interface to some sound cards via fiber-optic cables. An RJ-45 Ethernet jack is provided for remote operation via a LAN.

Four accessory sockets are provided, one pair dedicated to each receiver. Each pair has one 7-pin and one 8-pin to avoid confusion. The accessory sockets support operation of linear amplifiers or other equipment, including audio and control connections for use with a PC operating digital mode software. Thankfully, separate RCA jacks are also provided to control a non-Icom linear amplifier via a PTT (note voltage and current limits) and ALC interface. Separate sockets are provided for a straight key or external keyer and for paddles to be used with the internal keyer — perfect setup for my ancient Brown Brothers combination straight key and paddles. Jacks are provided for external speakers for each receive channel, the optional keypad, and 13.8 V dc at 1 A to supply accessory equipment. The rear panel is shown in Figure 1.

While dramatically different from the

Figure 1 — The rear-panel view of the IC-7851. While there are many connectors for various functions, normal operation can be conducted with just the 120 V ac power cable, one or more antenna connections, and a ground connection. When you want to do something requiring additional flexibility, the other options will likely be appreciated.

competition in 2003, the 7-inch TFT color display is still a head-turner in 2016. The display includes a separate S meter for each receiver, and the meters can measure from a choice of multiple parameters during transmit. There's also a frequency display for each VFO with resolution (depending on tuning step size) to 1 Hz. The pan-adapter can look at either or both receivers, and it offers a waterfall view as well as a traditional spectrum view. There are also indicators for menus and other controls and soft button tags.

The S meter still deserves special mention (see Figure 2). While there are a number of compact display choices (see Figure 3), the main S meters look just like traditional six-scale moving-coil D'Arsonval meter movements. Icom engineers studied the ballistics of meter pointer motion during the IC-7800 development and have captured it right on. Unless you peer in from the side and realize it is two-dimensional, you can't really tell. Of course, you won't be able to bend this needle around the pin. If the 7-inch display isn't large enough, a DVI-I (note, not VGA, as in the '7800) digital video jack is provided to allow use of a larger computer monitor. Another jack supports an external S meter for each receiver.

Between the IC-7851's mechanical controls — all very smooth and solid feeling, by the way — and the "soft" buttons that change function for different operating modes with indicators that appear on the left and bottom of the screen, the transceiver uses fewer menus than other software driven radios. The menus are all in plain English and easy to interpret and use. Most are of the "set and forget" type.

Included with the transceiver are all the connectors needed for interconnection, a special Allen wrench for tuning knob attachment (the radio ships with the knob removed), a comprehensive loose-leaf manual and CD-ROM that includes the full manual (also available on the Icom website), and a schematic package.

How it Plays

Receiver Performance

One big change to the IC-7851 from its predecessor is the use of narrower roofing filters to bring it up to current standards for top-performing rigs. In 2003, while VHF crystal filters were available, they weren't available in the narrow widths and with the steep skirts that enabled the high dynamic range of transceivers that used downconverting to an IF in the HF range. Fast-forward to 2016 and such filters are now available in the 64 MHz range to fit the upconverting architecture of the IC-7851. The '7851 includes selectable roofing filters at 15, 6, 3, and 1.2 kHz bandwidth in each receiver.

Receiver test results from the ARRL Lab are shown in Table 1. The close-in dynamic range measurements are among the best we've seen, particularly the third-order and reciprocal mixing dynamic range. Compared to our 2 kHz separation measurements of the '7800 in 2007, the third-order intermodulation dynamic range improved by 19 dB. The recently added 2 kHz spaced reciprocal mixing dynamic range test, which we didn't measure in 2007, was 114 dB at 14 MHz. That's close to the best we've measured, and a lot better than most radios, likely due to a new synthesizer design.

We did have a bit of a problem with the radio during our initial tests. The close-in third-order IMD dynamic range was actually better with the 3 kHz roofing filter than with the 1.2 kHz. We have seen this phenomenon before, attributed to intermod products actually generated within the filter itself, and Icom was able to resolve it by replacing the defective filter.

Transmitter Performance

In addition to improved receiver performance, the IC-7851 also offers improved transmit performance in a number of important respects. The keying sidebands are at a significantly lower level than observed in 2007 (see Figure 4), likely the result of a more rounded keying waveshape (see Figure 5) and the new, quieter synthesizer. For example, the response at ±1 kHz from the carrier has improved from about –70 dBc/Hz to almost –100 dBc/Hz. The transmit phase noise at 1 kHz has improved from about –102 dBc/Hz to –125 dBc/Hz, another benefit of the new synthesizer design (see Figure 6).

The full power transmit IMD has remained at about the same level as observed while testing the IC-7800 and remains better than many radios. That's likely in part due to the higher supply voltage used in the 200 W power amplifier. If run at the 100 W level or less, the typical drive level of most linear amplifiers, the transmit IMD is even better than shown in Table 1, but the transmitted phase noise increases slightly. Transmitter cleanliness is important because top-notch receiver dynamic range doesn't help when a nearby transmitter is generating strong IMD products, keying sidebands, key clicks, or phase noise that can cover up signals in adjacent channels.

A member alerted us to an out-of-band transmit spike that occurred 5 MHz higher than the transmit frequency after key up. The spike triggered his linear amplifier protection circuit, and we were able to reproduce the problem in the ARRL Lab. Icom made a design change that was incorporated in our transceiver and eliminated the problem. This change has been made in production radios starting with serial number 02001154. Owners of earlier

Figure 2 — A view of the front panel display of the IC-7851 during CW operation. Note that both receivers are active on different bands and the spectrum display is showing ±10 kHz around the operating frequency of the main receiver. Note particularly the S meters — they are digital images that look just like real moving-coil D'Arsonval meter movements.

Figure 3 — A view of the front panel display of the IC-7851 as in Figure 2, except we now have elected to show spectrum displays of both receivers and the meters are in a more compact format. Note that one receiver is set up for RTTY, one for CW, and the spectrum displays are set for different display widths — there's a lot of flexibility here. The spectrum displays can show panadapter views, as shown, or waterfall-type displays, or both. They can be set to show a fixed portion of the band, useful for monitoring, or can be centered around the tuned frequency.

radios who experience the problem should contact Icom.

The only other anomaly noted was slightly lower transmit output power than specified. As a practical matter, the measured output of 191 W is down only 0.2 dB from 200 W and within the measurement tolerance of most wattmeters. It's not likely to be noticed, except on a power meter. The 180 W output on 6 meters represents less than 0.5 dB below 200 W, possibly more significant on this band if you are operating barefoot and working signals at the noise level.

On the Air at W1ZR

I had the pleasure of using the IC-7851 for a number of weeks as my primary radio. In addition to my regular operating activity that includes a weekly CW sked (since 1974), checking into local and regional phone nets, chasing DX and other fairly typical operating, I had the opportunity to participate in both the CW and phone weekends of the ARRL International DX Contest with the '7851. This provided an opportunity to wring out this radio pretty well.

While the discussion below is separated by mode, there are some features that apply to all modes. I found the internal antenna tuner to be much more usable than the specifications promised. While it is specified to handle antenna loads with an SWR of "better than 3:1," I was pleasantly surprised to find that it could match all of my usual antennas, some with an SWR of almost 10:1. I'm sure you can't count on that in all cases, but it is certainly more flexible than its specifications imply.

All controls have a professional feel, with knobs large enough to grasp without running into neighbors. The main tuning control knob operates very smoothly and its flywheel, along with the tuning step (TS) button next door, make large frequency excursions happen with minimum effort. The second receiver tuning is with a somewhat smaller knob, but is also easy to use. The band stacking registers cycle through your last three frequencies on each band, along with other settings. A tap of the SPEECH button for either receiver will get you a pleasant feminine-sounding voice announcing the S-meter reading and frequency, to as many digits as on the display.

CW Operation

The IC-7851 is a good CW transceiver. The internal keyer operates smoothly from 6 to 48 words per minute and break-in operation is provided, either with an adjustable delay for semi break-in, or full break-in. The choice is made via the VOX/BK-IN button, which is next to the front panel KEY SPEED knob, surrounded by the DELAY ring — a very handy arrangement. I mention this because for a while I thought that selecting break-in with the DELAY knob at minimum would get me full break-in. Not quite so — an additional push of the VOX/BK-IN button yields real full break-in with an F-BKIN indicator showing on the display — yet another reason to carefully read the manual. The full break-in is very smooth and if there are any relays involved, I can't hear them.

Up to eight transmit-message memory channels can be employed to send contest or other transmissions that might be needed frequently. These work well and, once recorded, can be initiated from a portion of the screen using the function buttons, or via an optional key pad that we didn't have. (The manual provides simple instructions for making your own in both four-channel and eight-channel versions — allowing the function to be built into your console or elsewhere, if you wish.) One of the memories can include an auto-incrementing function for contests that require sequential contact numbers. A computer keyboard can also be used. If the keypad or keyboard is used, the bottom half of the display can be used for the spectrum scope, rather than being taken up by the memory menu.

Split frequency operation is possible in a number of ways. Separate RIT and XIT functionality is provided, each with a ±10 kHz range — enough for most split-frequency operations. If you're more serious about split operation, bringing in the second receiver by pushing the DUAL WATCH and

Key Measurements Summary

Icom IC-7851 HF and 6 Meter Transceiver

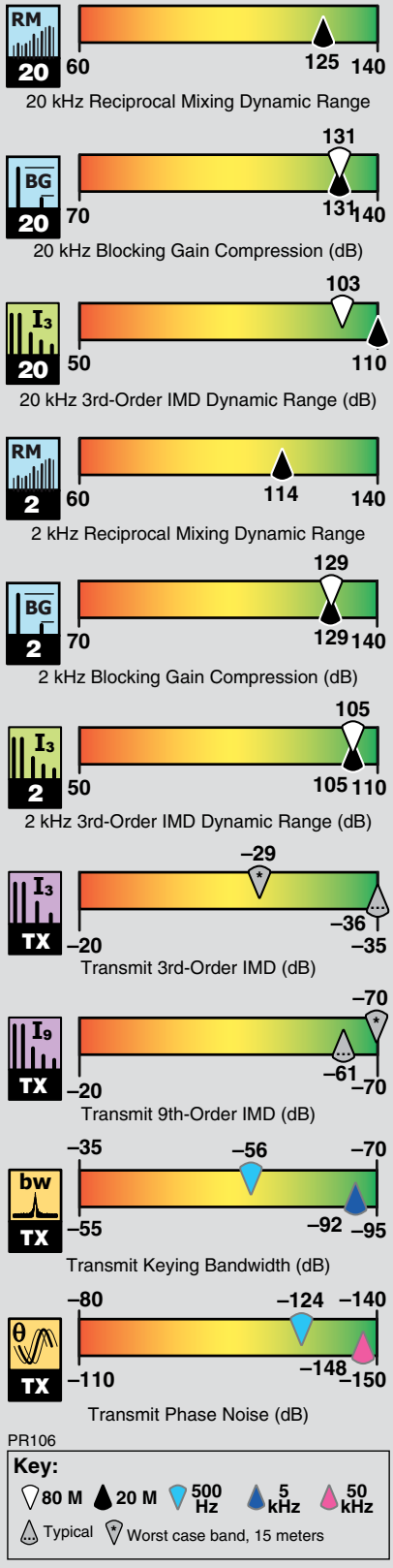

Table 1
Icom IC-7851, serial number 02001033

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.03 – 60 MHz; transmit, 160 – 6 meter amateur bands.	Receive and transmit, as specified; (5.255 – 5.405 MHz, 60 meters).
Power requirement: 15 W (power off), 150 W (standby, maximum audio), 800 W (transmit, 200 W power output).	At 120 V ac: transmit, 665 W (typical, maximum power output); receive, 95 W (max volume); power off, 9 W.
Modes of operation: SSB, CW, AM, FM, RTTY, PSK31, PSK63.	As specified.

Receiver	Receiver Dynamic Testing
CW sensitivity: 0.5 µV (0.1 – 1.799 MHz, preamp 1 on), 0.16 µV (1.8 – 29.900 MHz, preamp 1 on), 0.13 µV (50 – 54 MHz)	Noise floor (MDS), 500 Hz DSP BW, 1.2 kHz roofing filter: *Preamp* *Off* *1* *2* 0.137 MHz –121 –132 –136 dBm 0.475 MHz –121 –133 –136 dBm 1.0 MHz –120 –132 –137 dBm 3.5 MHz –121 –134 –139 dBm 14 MHz –121 –134 –139 dBm 28 MHz –126 –134 –142 dBm 50 MHz –126 –138 –142 dBm
Noise figure: Not specified.	Preamp off/1/2: 14 MHz, 26/13/8 dB; 50 MHz, 21/9/5 dB.
AM sensitivity: 10 dB S/N, 6 kHz BW, 6.3 µV (0.1 – 1.799 MHz, preamp 1 on), 2 µV (1.799 – 29-990 MHz, preamp 1 on), 1 µV (50 – 54 MHz, preamp 2 on).	10 dB (S+N)/N, 1-kHz, 30% modulation, 6 kHz DSP BW: 1.0 MHz 2.40 0.62 0.46 µV 3.8 MHz 1.68 0.52 0.39 µV 29 MHz 2.21 0.52 0.43 µV 50 MHz 1.48 0.52 0.44 µV
FM sensitivity: 12 dB SINAD, 15 kHz BW, 0.5 µV (28-29.990 MHz, preamp 1 on), 0.32 µV (50-54 MHz, preamp 2 on).	12 dB SINAD, 15 kHz DSP BW: *Preamp* *Off* *1* *2* 29 MHz 0.89 0.23 0.17 µV 52 MHz 0.64 0.22 0.18 µV
Spectral sensitivity: Not specified.	Preamp off/1/2: 14 MHz, –117/–130/–135 dBm; 50 MHz, –120/–134/–140 dBm.
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz DSP BW, 1.2 kHz roofing filter: *20 kHz offset* *5/2 kHz offset* *Preamp off/1/2* *Preamp off* 3.5 MHz >131/144/142 dB 131/129 dB 14 MHz >131/144/142 dB 131/129 dB 50 MHz >136/129/126 dB 136/131 dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 125/119/114 dB

ARRL Lab Two-Tone IMD Testing (500 Hz DSP bandwidth, 1.2 kHz roofing filter)

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz (off)	20 kHz	–121 dBm –97 dBm –76 dBm	–18 dBm –7 dBm 0 dBm	103 dB
14 MHz (off)	20 kHz	–121 dBm –97 dBm –85 dBm	–11 dBm –4 dBm 0 dBm	110 dB
14 MHz (one)	20 kHz	–134 dBm –97 dBm	–24 dBm –12 dBm	110 dB
14 MHz (two)	20 kHz	–139 dBm –97 dBm	–35 dBm –20 dBm	104 dB
14 MHz (off)	5 kHz	–121 dBm –97 dBm –83 dBm	–12 dBm –4 dBm 0 dBm	109 dB

Manufacturer's Specifications			Measured in the ARRL Lab	
Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
14 MHz (off)	2 kHz	–121 dBm –97 dBm –51 dBm	–16 dBm –8 dBm 0 dBm	105 dB
50 MHz (off)	20 kHz	–126 dBm –97 dBm –60 dBm	–26 dBm –16 dBm 0 dBm	100 dB

Second-order intercept point: Not specified.	Preamp off/1/2: 14 MHz, +73/+73/+73 dBm; 50 MHz, +72/+72/+72 dBm.
IF and image rejection: >70 dB.	IF rejection: 14 MHz, 111 dB; 28 MHz, 109 dB; 50 MHz, 87 dB. Image rejection: 14 and 28 MHz, >131 dB; 50 MHz, >136 dB.
DSP noise reduction: Not specified.	18 dB (maximum).
Audio output: >2.6 W into 8 Ω at 10% THD.	At 10% THD, 2.87 W into 8 Ω. THD at 1 V_{RMS}, 0.175%.
FM adjacent channel rejection: Not specified	29 MHz, 92 dB; 52 MHz, 92 dB.
Two-tone third-order dynamic range: Not specified.	For 20 kHz spacing: 29 MHz, 92 dB*; 52 MHz, 92 dB*. For 10 MHz spacing: 29 MHz, 116 dB; 52 MHz, 115 dB.
Squelch sensitivity: SSB, 5.6 µV, FM, <1 µV.	At threshold, 14 MHz (SSB, preamp off): 6.09 µV; 29 and 52 MHz, 0.09 µV (preamp 2 on).
Notch filter depth: Not specified.	Manual notch, 55 dB. Auto-notch, 55 dB; 33 dB (two tones). Attack time: 60 ms (single tone), 500 ms (two tones).
S-meter sensitivity: Not specified.	S9 signal (preamp off/1/2): 14 MHz, 57.5/ /16.8/7.9 µV; 50 MHz, 70.4/23.2/13.3 µV.
IF/audio response: Not specified.	Range at –6 dB points** CW (500 Hz): 345 – 850 Hz (495 Hz); Equivalent rectangular BW: 501 Hz; USB (2.7 kHz) 52 – 2783 Hz (2731 Hz); LSB (2.7 kHz): 52 – 2784 Hz (2732 Hz); AM (6 kHz): 124 – 3015 Hz (5782 Hz).

Transmitter	**Transmitter Dynamic Testing**
Power output: <5 – 200 W, <5 – 50 W (AM).	HF, 0.6 – 191 W typical; 50 MHz, 0.5 – 180 W.
Transverter output level: Not specified.	–19 dBm.
Spurious-signal and harmonic suppression: >60 dB (HF); >70 dB (50 MHz).	As specified. Complies with FCC emission standards.
SSB carrier suppression: >63 dB.	>70 dB.
Undesired sideband suppression: >70 dB.	As specified.
Third-order intermodulation distortion (IMD): Not specified.	3rd/5th/7th/9th order, 200 W PEP HF: –36/–52/–49/–61 dB (typical) –29/–40/–48/<–70 dB (worst case, 160 m) 50 MHz: –39/–52/–60/–69 dB
CW keyer speed range: Not specified.	6.2 to 48 WPM, iambic Mode B.
CW keying characteristics: Not specified.	See Figures 4 and 5.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, AGC fast, 8 ms.
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 16 ms; FM, 17 ms (29 MHz), 20 ms (52 MHz).
Transmitted phase noise: Not specified.	See Figure 6.

Size (height, width, depth, including protrusions: 6.7 × 16.7 × 19.0 inches. Weight: 52 pounds).
Price: $13,000.

Both receivers measured identically.
Second-order intercept points were determined using S-5 reference.
*Measurement was noise limited at the value indicated.
**Default values, sharp setting (smooth setting is available). Bandwidth and cutoff frequency are adjustable via DSP. CW bandwidth varies with PBT and pitch control settings.

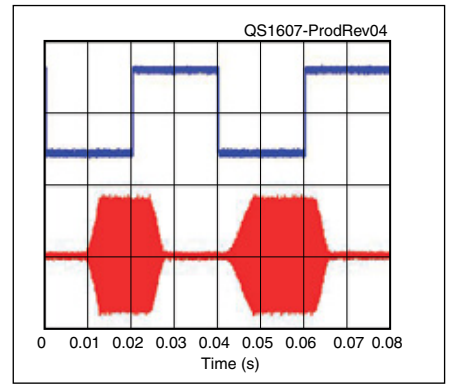

Figure 4 — CW keying waveform for the Icom IC-7851 showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 190 W output on the 14 MHz band.

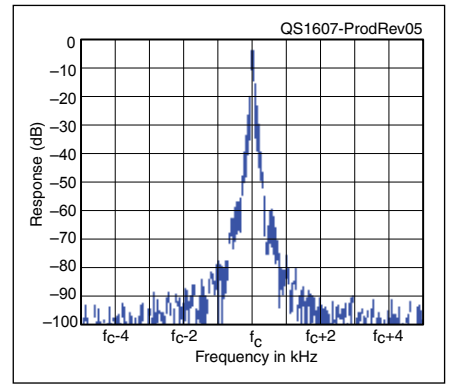

Figure 5 — Spectral display of the Icom IC-7851 transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 190 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is 10 dB/division.

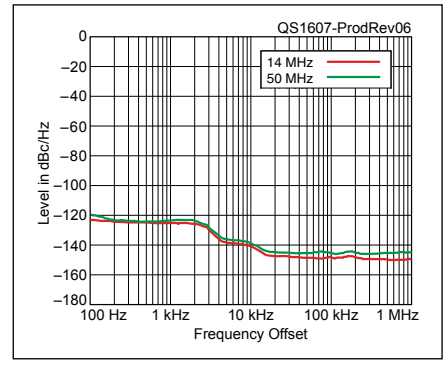

Figure 6 — Spectral display of the Icom IC-7851 transmitter output during phase noise testing. Power output is 190 W on the 14 MHz band (red trace) and 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dBc/Hz.

Figure 7 — The display during RTTY operation. Note the window on the lower right that provides tuning information by comparing the received spectrum to the RTTY mark and space frequencies. On the lower left is a screen portion with up to eight lines of decoded receive text. Below that is a space for a type-ahead buffer ready to send upon shift to transmit mode. Below the mini spectrum and waterfall displays are summaries of the first four transmit memories to allow sending via a keypad or connected keyboard. The transmit memories in detail can also be displayed on the lower portion of the screen to allow transmission via soft buttons, if the keypad or keyboard is not available.

Figure 8 — Similar to Figure 7, but in PSK mode. The main differences are the additional PSK phase-indicating circle and the single center frequency. Each mode has its own set of recorded transmit messages.

SPLIT buttons allows you to listen to the DX station in one ear and the calling frequency in the other, with transmission on the sub-receiver's frequency. The spectrum scope has cursors for both channels, so you can watch as well as hear what is going on. I found that the spectrum scope allowed me to slide my transmit frequency into a notch between two clumps of callers, which got me a contact on more than one occasion.

The receivers' DSP selectivity provides for the presetting of three bandwidths per mode, which are then cycled through using the FILTER button. With any of the selections, it is possible to adjust the upper and lower limits separately via the TWIN-PBT (passband tuning) knobs, effectively shifting the passband. This can also be used to narrow the passband from either or both sides. The three filter bandwidths can each be adjusted from 50 Hz to 3600 Hz wide, through a process initiated by a long push of the FILTER button.

I settled on bandwidths of 900, 500, and 150 Hz for CW mode, which worked well in most conditions. While the selection of three bandwidths is workable, it seems to me that it is an unnecessary emulation of earlier technology in which a limited number of discrete filters were selected. I'm not sure why Icom didn't allow for the almost continuous selection of any bandwidth during normal operation, perhaps in 50 Hz steps, as do many other modern radios. Perhaps they will consider that change for a future software release.

In addition to the regular filtering, a very sharp audio peaking filter is provided, as is a manually adjustable notch filter that provides a sharp and deep rejection notch that can eliminate an interfering signal within the passband.

Phone Operation

At its heart the IC-7851 is, after all, an SSB transceiver. In addition, it supports AM and FM operation. The receivers are top notch and use the same selectivity arrangements as described for CW, but the three virtual filters are set independently for each mode. I had them set up for 2.8, 2.0, and 1.5 kHz width for SSB. The mode choice is made via buttons below the display, with an extra push of the SSB button used to switch between USB and LSB, but it remembers which you use for each band. The adjustable noise reduction, noise blanking, and notch filter all work well.

On transmit, the audio response can be adjusted for cut or boost at either end of the range. While not as flexible as some radios with multi-range equalizers, I was able to get good-sounding audio for both an Icom hand mic that I had as well as my usual contest headset that includes an electret mic. Upon looking at the mic connector pin-out diagram, I saw that the mic connector provided a bias voltage for an electret mic on a separate pin from the audio connection and was prepared to fabricate an adapter to support that connectivity. I was pleasantly surprised to find that by a menu selection, I could provide the bias directly on the audio lead, making my adapter much simpler to fabricate.

I had an opportunity to check in with my usual AM test bed, the Antique Wireless Association (AWA) Sunday afternoon AM net.[3] Reports were good, and I even got to listen to a recording of my voice made by W3GMS, the net control station. It sounded like me. The receiver also works very well on AM. I set my three selectivity choices for AM to 9, 6, and 3 kHz — ready for anything from a wide open channel to challenging interference or the need to reduce the noise bandwidth to copy weak signals.

Digital Mode Operation

The IC-7851 has digital features similar to its predecessor, and I recommend a look at Steve Ford's, WB8IMY, comprehensive review of digital operation that's part of the 2004 review of the IC-7800. I used the '7851 on RTTY and PSK using the internal terminal with a USB keyboard attached directly to the radio. I found this a useful arrangement for casual use, and think it could also work in a contest with the usual short exchanges that could fit into the eight transmit memories, each of which can contain up to 70 characters. A bit of practice is needed to toggle smoothly between transmitting with the stored message screen

back to receiving with the decoding screen. A log is generated that can be saved onto an SD card or USB drive.

For RTTY reception, a window shows the peaks of the twin peak filter (TPF) at 2175 and 2295 Hz (170 Hz shift) overlaid on a slice of spectrum scope, above a mini-waterfall display that makes it possible to precisely line up the receive signal (see Figure 7). The left side of the window provides up to eight lines of the received text that scroll down the page. An adjustable threshold can minimize the usual decoded noise garble that would appear between signals.

PSK operation using the internal terminal function is similar, except the right hand window now has a single line at 1500 Hz over the mini spectrum scope (see Figure 8), along with the usual circular phase indicator. A soft button enables an automatic frequency control (AFC) function that keeps the phase locked on.

Those who spend more of their time operating digital modes will likely use PC software for the encoding and decoding functionality. The '7851 can support that as well, either through connectivity via one of the ACCESSORY connectors or through the fiber based S/P DIF ports designed for sound card adapters that support them. See Steve's report for details of the use of that connectivity.

Documentation

Icom provides a comprehensive looseleaf 279-page instruction manual with the IC-7851. It is also available as a PDF file on the Icom website for a preview, which I recommend. The electronic version also allows use of the Adobe *Acrobat* software search function to find topics quickly. The manual is well organized and doesn't miss much. The full schematic package and a copy of the manual are available on a provided CD-ROM.

The manual provides instructions for updating the firmware, including the URL on the **www.icom.co.jp** website that lists the available firmware updates. The current version of firmware is indicated on the lower right corner of the turn-on screen — in our case, it was 1.01, while the website showed version 1.11 available. In order to perform the update, you need to format a USB drive or SD card by plugging it into the appropriate jack on the IC-7851 and selecting FORMAT on the SD/USB MEMORY MENU screen. This will remove all other data from the device. The software is then downloaded from the website and unzipped into the folder that the radio puts on the portable drive. It is then moved to the radio and the update process is executed from the same menu. This process is not without risk.

The warnings indicate that if power is lost during the process, the update may fail and then the radio requires a trip to the factory in Japan to restore operation. We kept our fingers away from the radio during the process, and had it powered by the office computer uninterruptable power system. We had version 1.11 up in about 1 minute. They suggest that your settings be saved to a different device, because most memorized functions and settings revert to default values during the process.

Summing It Up

With the IC-7851, Icom has made a number of improvements to its top-end transceiver. Most notable are the narrower receiver roofing filter and new synthesizer, which make noticeable and measureable improvements to receiver dynamic range and transmitter cleanliness. The new dual spectrum scope offers fast response, and the waterfall view presents another view of band activity. Overall, the radio is a pleasure to use.

Manufacturer: Icom America, 12421 Willows Road NE, Kirkland, WA 98034; tel 800-872-4266; **www.icomamerica.com**.

Notes

[1]J. Hallas, W1ZR, "Icom IC-7800 HF and 6 Meter Transceiver," Product Review, *QST*, Aug 2004, pp 64 – 70.

[2]D. Patton, NN1N, "Icom IC-7800 HF and 6 Meter Transceiver Revisited," Product Review, *QST*, Mar 2007, pp 60 – 65.

[3]The net has coverage over the Northeast US and Mid-Atlantic states. The time changes with the advent of Daylight Saving Time, 3840 kHz, AM, 7 PM during EDT, 3837 kHz, AM, 4 PM during EST. See **www.antiquewireless.org/awa-on-the-air.html** for any late changes or more information.

See the Digital Edition of *QST* for a video overview of the Icom IC-7851 HF and 6 meter transceiver.

SPE Expert 1.3K-FA Solid-State Linear Amplifier

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In 2009 we reviewed a new solid-state power amplifier from Italy, the SPE 1K-FA.[1] That amplifier covered 160 through 6 meters with output power typically 1 kW PEP for SSB and 900 W for CW on the HF bands, 700 W at 6 meters, and 500 W (HALF POWER setting) for extended operation using digital or other high duty cycle modes. That compact amplifier weighs 44 pounds. In 2013, we reviewed the SPE 2K-FA. That amplifier had no problem delivering legal-limit output from 160 through 6 meters, and it dropped back to the MID power setting for 1000 – 1100 W output during extended digital operation. It is larger than the 1K-FA but still smaller than typical legal-limit tube-type amplifiers and weighs 55 pounds. Both of these amplifiers are still available.

The subject of this review, SPE's 1.3K-FA, fits between the two older models in power output and price, but brings some new technology to the table. The 1.3K-FA covers 160 through 6 meters and operates at reduced power on the 4 meter (70 MHz) band available in other parts of the world. In the MAX power setting, the review unit delivers 1300 to 1500 W on all bands except 6 meters, where output is 1100 W. With the MID setting it delivers 1000 – 1100 W, and 500 – 600 W in LOW. The amplifier automatically switches to a lower power during extended high duty cycle operation (RTTY, for example) or for amplifier protection (high antenna SWR, for example).

The 1.3K-FA uses just one LDMOSFET power transistor rather than the six earlier generation MOSFETs used in the other models. The LDMOSFET offers quite a bit of gain, so amplifiers for the US market include attenuation at the input to comply with the 15 dB gain maximum required by FCC regulations. The review unit typically requires 30 – 35 W for full output and exhibits higher gain at lower drive levels.

Our amplifier includes a built-in automatic antenna tuner (ATU) that will match SWR of up to 3:1 on HF and 2.5:1 on 6 meters. The 1.3K-FA is also available without the antenna tuner. The amplifier has four antenna connectors, as well as RF input, ALC, transmit-receive relay, and band data connections for two transceivers. A built-in switchmode power supply supplies 50 V for the LDMOSFET. That's reduced to about 40 V for the MID power setting and about 33 V for LOW. The supply works from 100 to 255 V ac, but operation from a standard 15 or 20 A household 120 V line will likely result in reduced output.

The front panel LCD is 5 × 1.5 inches and displays the amplifier's settings, operating conditions, and menus. Backlight brightness and contrast are adjustable. Indicators along the bottom show radio, band, and antenna selected, CAT (transceiver interface) setting, output level (MAX, MID, LOW), SWR on the amplifier side of the ATU, and temperature. The upper portion of the display shows RF output (both bar graph and numerical display) and PA current when the amplifier is ready to operate. A front panel switch changes the upper display to PA voltage, indicators showing that the fans are running, and SWR on the antenna side of the tuner. In standby the LCD shows exciter power (up to 200 W) and SWR on the antenna side of the ATU.

The entire package is compact and weighs just 21 pounds (16.5 pounds without the automatic antenna tuner) — less than half the weight of the 1K-FA and roughly the same size. All that power from such a tiny box is amazing to someone who grew up in the days of tube-type amplifiers that were hard to move around the shack.

Bottom Line

The SPE Expert 1.3K-FA supplies near-legal-limit power from 160 through 6 meters and includes sophisticated transceiver interfaces and antenna switching. The built-in antenna tuner makes it tolerant of less-than-perfect antennas. For those with well matched antenna systems, the amplifier is available without the tuner at significant cost savings.

Setup

The first step after unpacking the amplifier is reading through the manual, which is supplied in PDF format on a CD-ROM or downloadable from the Expert Linears website. While you could likely get the amplifier set up and running for basic operation without reading the manual, there are quite a few features to learn about.

As with most power amplifiers, the user supplies and installs the ac line plug. In my case I needed a 240 V, 20 A connector to match the outlet in my station. The power supply senses the input voltage automatically, so there are no jumpers or menu settings involved.

Figure 9 shows the (many) rear panel connections. There are separate sets of RF input (SO-239), TR relay (phono), ALC (phono), and transceiver interface/band data (DB-15) connectors for two radios. The 1.3K-FA is capable of interfacing with transceivers from all major brands, including Elecraft, FlexRadio, Icom, Kenwood, TEN-TEC, and Yaesu. Only the RF input and TR relay connections are absolutely required because the amplifier uses a

Table 2
SPE Expert 1.3K-FA, serial number 153700175
FCC ID number 2ADK5GC324809

Manufacturer's Specifications	Measured in ARRL Lab
Frequency range: All amateur frequencies in the range of 1.8 to 29.7 MHz, 50 to 54 MHz and 70 to 70.5 MHz.	160, 80, 60, 40, 30, 20, 17, 15, 12, 10, 6 meters.*
Power output: Up to 1500 W, 1300 W typical (Max); 800 W (Mid); 450 W (Low); 600 W (typical) at 70 MHz.	As specified, except 1100 W on 6 meters.*
Driving power required: Not specified.	25 – 35 W typical for 1300 – 1500 W PEP output (1100 W at 6 meters).
Spurious and harmonic suppression: HF, >60 dB; 6 meters, 65 dB.	HF: 57 dB (typical), 49 dB worst case (40 meters); 6 meters, 64 dB. Meets FCC requirements.
Third-order intermodulation distortion (IMD): 30 to 35 dB below PEP typical.	3rd/5th/7th/9th (14 MHz, 1300 W PEP): –31/–39/–57/–55 dB.
TR relay switching time: Not specified.	Unkey to key, 13 ms; key to unkey, 5 ms.
Primary power requirements: 100 – 255 V ac, 47 – 63 Hz.	Tested at 240 V ac. Operation from 120 V may result in reduced output power.
Size (height, width, depth): 4.7 × 11 × 15 inches; weight, 21 lbs.	
Price: $4995 with automatic antenna tuner; $3795 without automatic antenna tuner.	

*In the US, the legal power limit on 30 meters is 200 W PEP output, and on 60 meters it is an ERP of 100 W PEP relative to a half-wave dipole. A 4 meter exciter was not available at the time of testing.

Figure 9 — Rear-panel view of the SPE Expert 1.3K-FA amplifier. The four antenna connectors are at the upper left, while the RF input for two radios and the SO2R connector are at the upper right. Along the bottom are connectors for interfacing two transceivers and USB and serial ports for computer connectivity/remote control.

frequency counter that can sense the RF input when you transmit and adjust accordingly. You can change bands by speaking a syllable or two, or sending a dit or two on CW. Use of the band data cable is "highly recommended," however, so that the amplifier follows transceiver frequency changes without transmitting.

When we ordered the amplifier, we also ordered transceiver interface cables from Dan Tassel, KC5PCB, who is associated with the US distributor. One set was for an Icom IC-7100 in the Lab and the other for a Kenwood TS-590S in my station. In my case, one end connected to the CAT1 jack on the back of the amplifier and the other end had connectors for the COM (RS-232) and REMOTE jacks on my transceiver. No other cables were required because TR relay and ALC connections are also available on the amplifier's CAT connectors. To complete this step, I next went to CAT menu, selected KENWOOD and 9600 BAUD, and the radio was talking to the amplifier. The instruction manual provides quite a bit of information and helpful diagrams for those who want to make their own cables.

Next I used the menu to set up the amplifier for my antennas. There are four antenna connectors on the rear panel. The ANTENNA menu lists all bands from 160 through 4 meters. You select the proper antenna connector (1 – 4) for each band, or NO if you don't have an antenna for that band. You can set two antennas for each band and select between them with the front panel ANT switch. When assigning antenna connectors by band, you can also chose whether or not to use the automatic antenna tuner for that band. Note that you can set up two "banks" of antenna settings — A and B — which would come in handy if you use the amplifier in multiple locations.

Antenna Tuner

The internal automatic antenna tuner (ATU) is specified to match loads with an SWR of up to 3:1 (2.5:1 on 6 meters). The manual warns to use antennas having SWR less than 1.5:1 without the ATU. When SWR exceeds 1.7:1, the amplifier protection circuitry gives a HIGH SWR warning and drops the power back to MID. Above 2:1 the amplifier switches to standby.

My antenna system is pretty well matched, but I did need to use the tuner on 160, 40, and 17 meters. Setup is easy. Each band is divided into segments shown in a chart in the manual. For example, 160 meters is divided into 10 kHz segments, 20 meters uses 50 kHz segments, and 10 meters uses 100 kHz segments. Tune the transceiver to the center of the first segment. With the amplifier in standby and the transceiver set to 30 W output or less, press TUNE and transmit briefly. The tuner relays click and typically find a match within a few seconds. Tune to the center of the next segment and repeat the process. Do this for each band and antenna where the SWR is higher than 1.5:1. The display shows SWR on the amplifier and antenna sides of the tuner simultaneously.

If you're not happy with the match, the 1.3K-FA comes up with, you can adjust the inductance and capacitance manually while watching indicators that appear on the display. I didn't find that necessary.

The only place I could not find a match was the very high end of 160 meters, where my antenna SWR approaches 4:1 and the amplifier flashed a warning that the SWR was too high. I use 450 Ω balanced line and an external tuner for my 80 meter dipole, and in that case turn off the internal tuner. I wasn't able to try this, but the manual indicates that the 1.3K-FA can be connected to the control box of a SteppIR or Ultrabeam antenna to manage tuning of those antennas.

It's a bit tedious, but once the ATU setup is complete, you don't have to worry about it again until something changes.

Other Features

Like the other SPE amplifiers, the 1.3K-FA uses a microprocessor-based protection system that monitors heatsink temperature, input power, PA voltage and current, reflected power and SWR, and RF voltage on the tuner. Problems are classified as simple, serious, or fatal, and the amplifier handles them in different ways. For simple problems such as excessive input power, the amplifier sounds a warning beep and resets itself. For serious problems, such as excessive heatsink temperature or high SWR, the amplifier switches to standby and an error message with the reason for the fault flashes on the display and is stored in memory so that the operator can find and fix the problem. I tested this protection a few times by inadvertently transmitting on the wrong antenna. For a fatal fault, such as a power supply or microprocessor problem, the amplifier power switches off and might be restarted by cycling the power switch on the rear panel. The manual recommends contacting the distributor if a fatal fault occurs.

The 1.3K-FA rear panel has four small fans that come on when the amplifier is turned on and run at low speed. Fan speed increases noticeably when you close the TR switch to transmit and returns to low speed when you switch back to receive. Fan speed in receive automatically increases with heat sink temperature and slows down as the heat sink temperature drops. Some people may find the fan noise at higher speeds bothersome. I wear headphones for nearly all operation, so it wasn't an issue for me.

The LCD includes a temperature display that's always visible. According to the manual, if the temperature reaches 75°C, the power will drop back to MID or even LOW until the temperature reaches safe levels. During routine operation in my basement location, the temperature tended to stay between around 40° C. During extended CW and RTTY contest operating periods, it would reach the 60 – 65° C range. At that point, the fans were running pretty fast on receive as well as transmit.

Full break-in (QSK) is available for CW operation. The amplifier uses mechanical relays, rather than vacuum relays or PIN diodes, and some operators might find the clicking bothersome without the use of headphones.

As with the other models, SPE advertises the 1.3K-FA as being capable of SO2R (single operator, two radio) operation. This technique is used by contest operators to transmit on one band while listening on another, and quickly transmitting on the second band when a needed contact is found. Normally this is accomplished with two transceivers, two amplifiers, bandpass filters, and appropriate switching.

As described previously, the 1.3K-FA has connections for two radios with independent settings for each. There's an SO2R jack on the back of the amplifier for an antenna separate from the main antennas, and this antenna is used only for receiving. The transceiver connected to the active input uses the main antennas and antenna tuner. The other transceiver is connected to the SO2R antenna and can use that antenna for receiving while the active radio is transmitting. The idea is to use the second transceiver and receive-only antenna to find a station on another band that you want to work and then to switch that transceiver to the main transmitting antenna for that band in order to make the call.

As noted in the 2K-FA review, this capability is somewhat useful but it is not as versatile as how SO2R is typically implemented with a switching system that allows one transceiver to use any of the main antennas not being used by the other. My system is quite simple and uses an Array Solutions Six Pak antenna switch (two radios, six antennas) that is operated manually. The 1.3K-FA manual describes SO2R station configurations using the amplifier to control an optional SPE SO2R1 switching unit and BPF1 bandpass filters, but these units were not available during the review period.

Note that the manual recommends high isolation (physical separation) between the SO2R antenna and main antennas and the use of bandpass filters for receiver protection. It goes on to say, "In this case, SPE is not responsible for any damage caused to equipment."

The 1.3K-FA has USB and RS-232 ports on the rear panel that can be used to connect the amplifier to a *Windows* PC to upgrade the firmware or for controlling the amplifier. Terminal and control software is supplied on the CD shipped with the amplifier or available for download from the SPE website. The remote control software displays a replica of the amplifier's front panel LCD and switches for monitoring and control.

Final Thoughts

I enjoyed using the SPE Expert 1.3K-FA at my station for several months, including extended contest operation in the ARRL RTTY Roundup and ARRL International DX Contest. Once I had the amplifier installed and programmed for my station, it performed flawlessly. There is not much to say about using it — band changes instantly follow the transceiver, and the amplifier makes power on the selected band. Temperature stayed within the safe range, even during extended RTTY contest operation. Its low drive requirement allowed my transceiver to run cooler.

SPE calls the 1.3K-FA a "1.3 kW solid state fully automatic amplifier" and it certainly lives up to that billing. Its light weight, built-in antenna tuner, and wide-range power supply make it attractive for DXpeditions. Those setting up remote stations will want to explore its remote control and monitoring capabilities.

Manufacturer: SPE (Societa Per L'Elettronica), Via di Monteverde, 33, 00152 Rome, Italy; **www.linear-amplifier.com**. *US distributor*: Expert Linears America, PO Box 1224, Magnolia, TX 77355; tel 281-259-7877; **www.expertlinears.com**.

Notes

[1]M. Wilson, K1RO, "SPE Expert 1K-FA Linear Amplifier," Product Review, *QST*, Sep 2009, pp 44 – 47.

[2]D. Sumner, K1ZZ, "SPE Expert 2K-FA Solid State Linear Amplifier," Product Review, *QST*, Nov 2013, pp 54 – 56.