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Watkins-Johnson HF-1000 General-Coverage Receiver

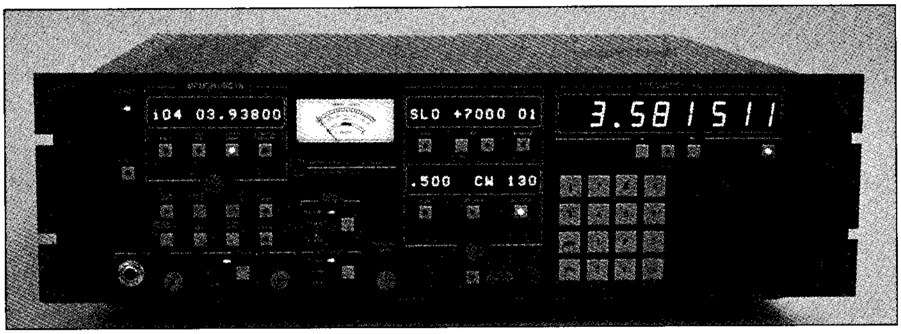
ASAPS and *CAPMAN*: HF Propagation-Prediction Software for the IBM PC

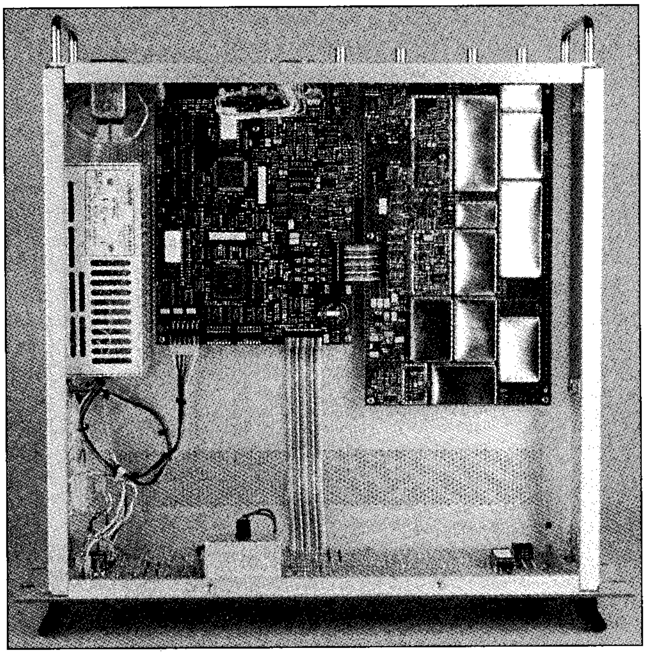
Watkins-Johnson HF-1000 General-Coverage Receiver

Reviewed by David Newkirk, WJ1Z

So rapidly has digital signal processing (DSP) worked its way into the hobby radio marketplace that now even Radio Shack carries a DSP audio filter. Although a select few Amateur Radio manufacturers have worked DSP into their product lines in one way or another, none have so far undertaken the formidable task of using DSP to replace the analog circuitry long used to handle IF filtering, AGC and demodulation. This month, we examine a general-coverage receiver that does exactly that: the Watkins-Johnson HF-1000.

Costing nearly $4000, the HF-1000 offers something for just about everyone interested in general-coverage-receiver technology. It covers 5 kHz to 30 MHz (tunable to 0 Hz) with 1-Hz tuning *and display* resolution, receiving AM, synchronous AM ("SAM"), narrowband FM, CW, USB, LSB and independent sideband (ISB). It includes a high-dynamic-range front end, a switchable RF preamp, a switchable RF attenuator, 58 IF bandwidth choices, a signal meter, a noise blanker, an IF notch filter, manual and automatic gain control, and squelch and scanning features. The HF-1000's outputs include audio (headphones, line [including simultaneous, separate USB and LSB outputs during ISB reception] and speaker), IF and signal monitor (both 455 kHz). Built-in test equipment (BITE) is included. The HF-1000 can be computer controlled by RS-232-C or a protocol "similar to several popular consumer receivers." A suboctave preselector, digital signal output unit and PC-based control software are available as options; the HF-1000 we tested did not include them.





Add three circuit boards and a power supply module to a rack-mountable box, and you have a Watkins-Johnson HF-1000 receiver. Handles mounted on the radio's front and rear panels let you set it down vertically without damaging its controls and connectors.

What About That DSP?

So relatively standard are the block diagrams of today's amateur MF/HF radios we rarely take Product Review space to talk much about their circuitry. The W-J HF-1000 is worth a closer look, however, since it's the first radio we've reviewed that does its detection and most of its IF filtering with DSP.

The short-form story of the HF-1000's critical RF path goes like this: A high-level DMOS-FET passive mixer (a Siliconix SD5400CY DMOS FET quad) upconverts incoming signals (which, without the optional preselector installed, are band-limited only by a 32-MHz low-pass filter) to 40.455 MHz, at which a 30-kHz-wide roofing filter provides more bandwidth limiting. After some amplification and PIN-diode variable attenuation, a diode double-balanced mixer converts the 40.455-MHz first IF signal to 455 kHz. After a bit more amplification, impedance shifting and band-limiting, a 74HC4053 analog multiplexer converts the 455-kHz signal to 25 kHz for analog-to-digital conversion and digital signal processing. A Motorola DSP56001FE33 chip does the DSP. As the HF-1000 manual puts it, this IC "digitally performs fine tuning to a 1 Hz resolution, IF bandwidth filtering, signal strength calculations, signal demodulation, noise blanking, and receiver gain control."

Because DSP performs so many of its functions, the HF-1000 is strikingly lightweight (15 pounds) and its cabinet is amazingly airy (see photo).

Frequency Agility

The HF-1000 gets around in the spectrum via a tuning knob, direct-entry keypad, ↑↓ buttons and 100 memories. In its normal tuning mode, the HF-1000 can tune in steps of 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz and 10 MHz. Its step tune mode allows the programming of any step size from 1 Hz to 25 kHz.

In the CW mode, the HF-1000's beat-frequency oscillator (BFO) is adjustable over a ±8 kHz range in 10, 100 or 1000-Hz steps. The BFO cannot be manually tuned in the HF-1000's other heterodyne-detection modes (USB, LSB, ISB and SAM).

The parameters storable in each of the HF-1000's memories include frequency, IF bandwidth, mode, BFO tuning, gain-control mode, manual gain value and squelch threshold.

Displays

The HF-1000's front panel includes four display elements:

- A green eight-digit display (**FREQUENCY MHz**);
- Three green, 12-character alphanumeric readouts (one for memory, scan and

Table 1
Watkins-Johnson HF-1000 General-Coverage Receiver, serial no. 1602, firmware version 4.01.01

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 5 kHz to 30 MHz (tunable to 0 Hz, degraded performance below 500 kHz).	As specified.
Modes of operation: AM, synchronous AM, LSB, USB, ISB, CW, FM.	As specified.
Power requirement: 90 to 264 V ac, 47 to 440 Hz, 35 W typ.	Tested at 120 V ac, 60 Hz only.
CW receiver sensitivity (bandwidth 0.3 kHz, 16 dB S+N/N): Minimum 0.35 µV (–116 dBm) with preamp off, 500 kHz to 30 MHz.	Minimum discernible signal (noise floor) with 0.3-kHz IF filter: 1 MHz: amp off, –135 dBm; amp on, –140 dBm 3.5 MHz: amp off, –134 dBm; amp on, –140 dBm 14 MHz: amp off, –133 dBm; amp on –140 dBm
AM receiver sensitivity (bandwidth 6 kHz, 10 dB S+N/N): Minimum 1.58 µV for 50% modulated signal at 400 Hz with preamp off, 500 kHz to 30 MHz.	10 dB S+N/N (signal 30% modulated with a 1-kHz tone, 6-kHz filter): 1 MHz: amp off, 1.44 µV; amp on, 0.82 µV 3.8 MHz: amp off, 1.58 µV; amp off, 0.83 µV
FM receiver sensitivity: Not specified.	12 dB SINAD with 8 kHz filter: 29 MHz: amp off, 0.95 µV; amp on, 0.44 µV
Blocking dynamic range: The manual gives this specification for blocking: An unwanted signal 1 mV separated 20 kHz from a desired signal of 1 µV will not cause the IF output to fall by more than 3 dB.	Blocking dynamic range with 0.3-kHz IF filter:* 1 MHz: amp off, 112 dB; amp on, 106 dB 3.5 MHz: amp off, 111 dB; amp on, 105 dB 14 MHz: amp off, 107 dB; amp on, 103 dB
Two-tone, third-order IMD dynamic range: Not specified.	Two-tone, third-order IMD dynamic range with 0.3 kHz filter:* 1 MHz: amp off, 100 dB; amp on, 95 dB 3.5 MHz: amp off, 99 dB; amp on, 98 dB 14 MHz: amp off, 97; amp on, 95 dB
Third-order input intercept: +30 dBm typical, +25 dBm minimum (for signals separated by 20 kHz minimum).	1 MHz: amp off, +27 dBm; amp on, +16.5 dBm† 3.5 MHz: amp off, +33 dBm; amp on, +21.5 dBm† 14 MHz: amp off, +30 dBm; amp on, +19.5 dBm†
Second-order intercept point: +60 dBm typical.	Amp off, +44 dBm; amp on, +46 dBm.‡
Signal meter sensitivity: Not specified.	Meter indicates –85 dBm for both amp on and off with a 50 µV (–73.0 dBm) 14-MHz input. (Note: The meter is calibrated in dBm, not S units.)
Squelch sensitivity: Not specified.	FM, 29 MHz: amp off, 0.5 µV; amp on, 0.4 µV USB, 14 MHz: amp off, 1.8 µV; amp on, 1.7 µV.
Receiver audio output: Up to 1 W into 8 Ω with less than 3% THD at 1 W.	1.7 W at 2.85% THD into 8 Ω measured at maximum audio output.
IF/audio response: Not specified.	At –6 dB: 500 Hz, CW mode: 742-1275 Hz (533 Hz); 1000 Hz, CW mode: 492-1533 Hz (1041 Hz); 2800 Hz, USB mode: 150-3075 Hz (2925 Hz); 2800 Hz, LSB mode: 142-3067 Hz (2925 Hz); 6 kHz, AM mode, 30-3200 Hz (3170 Hz).
Typical Shape factor (3/60 dB): 500 Hz: 1.40; 1000 Hz: 1.40, 2800 Hz: 1.35.	500 Hz, CW mode: 1.38; 1000 Hz, CW mode: 1.41; 2800 Hz, USB mode: 1.14; 2800 Hz, LSB mode: 1.16. Similar shape factors measured at 6/60 dB points.
Notch filter depth: Not specified.	Greater than 40 dB.
First image rejection: 90 dB minimum.	Amp off, 119 dB; amp on, 123 dB.
IF rejection: 85 dB minimum, greater than 90 dB typical.	As specified.
Size (height, width, depth): 5.25×19×20 inches; weight, 15 lbs.	

*Dynamic-range measurements were made at the ARRL Lab standard signal spacing of 20 kHz. Blocking, two-tone dynamic range and third-order input intercept measurements were noise limited at the value shown. At 100-kHz signal spacing, the third-order IMD dynamic range measured 106.3 to 109.5 dB (preamp off), corresponding to third-order input intercepts of +26 to +30 dBm.

†Derived from measurements made at a signal spacing of 100 kHz. Measurements made at a signal spacing of 20 kHz were noise limited.

‡Based on test signals at 6.00 and 8.02 MHz. Spurious response was measured at 14.02 MHz.

step-tune operations, and two for general receiver parameters [passband, notch and BFO tuning, AGC, squelch, noise blanker and mode settings, etc]); and

- A backlit analog signal level meter.

Green LEDs act as button and panel annunciators for many of the receiver's control functions. The brightness of these and other HF-1000 light sources cannot be adjusted.

Signal Level Meter

The HF-1000's signal meter indicates *absolute* signal level from –120 to 0 decibels relative to a milliwatt (dBm)—even when the receiver is squelched or muted. As is appropriate, turning the radio's RF attenuator or preamp on and off changes its indication little, if at all.

Manual Gain Control

The HF-1000's **MANUAL GAIN** control differs from what we're used to in that an alphanumeric display indicates its setting in decibels, from 0 to 127—and in that adjusting it doesn't change the receiver's signal meter.

Automatic Gain Control

The HF-1000's AGC decay time can be set to fast, medium or slow, and you can turn it off. Each of the decay options is adjustable: fast, from 10 to 100 milliseconds in 10-millisecond steps; medium, from 100 to 1000 milliseconds in 100-millisecond steps; and slow, from 1 to 5 seconds, in 0.5-second steps.

That's the good news about the HF-1000's AGC. The bad news is that how the HF-1000's AGC actually *works* is arguably the radio's greatest performance flaw. The HF-1000's specified AGC attack time, 15 milliseconds, is *ten times longer than it should be* for popless reception of CW, SSB and "bursty" data signals like PacTOR, G-TOR and Mode B AMTOR. When a strong signal—a noise pulse, a syllable onset in SSB, a Morse dot or dash, or a data burst in AMTOR—appears, the HF-1000 simply can't turn its gain down fast enough to keep the radio from emitting a strong *pop* before the AGC takes hold. As a result, I find the HF-1000's fast and medium AGC-decay choices largely unusable for Amateur Radio communication at MF and HF. Selecting slow AGC decay makes the attack pops happen less often, but a long AGC decay is no substitute for well-designed AGC.

Judiciously adjusting the radio's AGC threshold feature, which determines how far the HF-1000 turns its gain up in the absence of signals, also helps, as a fax from J. Michael Cox, K3GEG, W-J Senior Applications Engineer, confirmed:

> ...For best results, it is recommended that the AGC is operated in the AGC Threshold Mode, with the manual gain control set between the 12:00 and 3:00 position.... Adjusting the AGC Threshold Control over this range will produce AGC action closely approximating an analog receiver.

It's evident that Watkins-Johnson is aware of the HF-1000's AGC limitations and is working to help HF-1000 users live with it, but make no mistake: A high-end communications receiver like this shouldn't require such pampering.

Those 58 IF Bandwidths

One of the oft-mentioned advantages of DSP IF filtering is that it can provide a multitude of IF bandwidth choices without requiring the installation of a wheelbarrowful of IF filters at 100-plus dollars a crack. The HF-1000 lets you choose among 58 3-dB IF bandwidths from 56 Hz to 8 kHz by pressing its **IF BW** button and turning a detented knob. (You can also cycle through the options by pressing **IF BW** repeatedly.) The dot-matrix subdisplay associated with the **IF BW, DET MODE** and **SQUELCH** buttons indicates the bandwidth selected. A nice touch in this arrangement is that you needn't click through all the choices unless you want to. Accessing the radio's IF BW Select function via the radio's **SPECIAL FUNCTION** button lets you mark each bandwidth to be included or skipped by the IF bandwidth switching.

Not all 58 bandwidths are available in all modes. Only those from 900 Hz to 4.0 kHz are available in USB and LSB, and only those from 1.8 to 3.2 kHz are available in the ISB mode. The HF-1000 doesn't remember the last bandwidth used for a given mode separately from all others. Rather, it remembers only three bandwidths: one for ISB; one for USB and LSB; and one for AM, SAM, FM and CW. Setting the IF bandwidth to 8 kHz for CW therefore does likewise for FM, SAM and AM; selecting 2.6 kHz for USB also selects 2.6 kHz for LSB.

All of the HF-1000's IF bandwidths exhibit excellent shape factors (1.2:1 to 1.45:1) and, per the HF-1000 documentation, outstandingly flat group-delay characteristics. The filter *blowby*—stopband leakage—we sometimes hear in analog-filtered radios just plain doesn't happen. Another great thing about the HF-1000's filtering is that its excellent passband symmetry makes USB and LSB audio sound *exactly the same*. Try *that* on your ham transceiver!

Passband Tuning

The HF-1000's passband tuning can be adjusted ±2 kHz in 10 or 100-Hz steps. Snag: Passband tuning is available only in the CW mode! If you want to use the HF-1000's passband tuning for SSB reception, you must select the CW mode, set the radio's BFO offset to a low value (0 Hz is suitable for bandwidths up to 3.2 kHz), and adjust the passband tuning for optimal opposite sideband rejection.

IF Notch Filter

The HF-1000's notch filter, manually tunable ±9999 Hz in 1, 10, 100 and 1000-Hz steps, works in all modes except CW. The same dot-matrix display doubles as an indicator of BFO offset and notch position. Conveniently, **>** and **<** signs indicate whether the notch is above or below IF center. And how effective is the notch? The best way to demonstrate it is to switch to SSB and tune in a local AM station to receive its carrier as a tone. Tune the notch to the carrier, and the carrier is *gone*! (But how about making this excellent notch filter *automatic*, W-J? And how about letting us use it in CW?)

AM Reception

The HF-1000's standard AM detection sounds fine, but I didn't spend much time listening to envelope AM detection when there's a *synchronous* AM detector as good as the HF-1000's on board.

The HF-1000's synchronous AM detector achieves and holds lock quite well, achieving lock within about ±700 Hz of a signal's carrier. Incredibly, however—for a radio that costs as much as this one does—the HF-1000 can't do *selectable-sideband* synchronous AM detection! It's possible to fudge the HF-1000's BFO-to-filter relationship by the value equivalent to the radio's lock-in range—thereby pulling the BFO away from filter center for a smidgen of passband tuning—but switching to another IF bandwidth during this procedure reveals another oddity: The detector unlocks—requiring the reestablishment of lock from scratch—with every IF-bandwidth change. All in all, however, the HF-1000 excels in synchronous reception of full-carrier AM.

Audio Quality

The HF-1000 outputs audio in three ways: via a $^1/_4$-inch "stereo" jack on the front panel (**PHONES**; impedance, 600 Ω); via line-output pins (two channels, both of which carry the same audio except in independent-sideband reception, when one channel carries USB audio and the other channel carries LSB) on the rear-panel DB15 connector; and via an internal speaker or external-speaker pins (4 to 16 Ω, and front-panel switchable between USB, both and LSB during ISB reception) on the rear-panel DB15 connector. Aside from the fact that it seems overly hissy, I can't say much about the **PHONES** audio because, not having 600-Ω headphones, I didn't use it much. I used a high-fidelity "line-to-grid" audio transformer and a homemade utility amplifier to verify that the radio's line outputs perform as advertised.

As for speaker audio, the HF-1000 can produce a healthy amount of it. But because an external speaker connects to the radio via two pins on the rear-panel DB15 **ACCESSORIES** connector, connecting an external speaker can't automatically disconnect the internal, top-firing speaker as we're accustomed to in Amateur Radio gear. The only way to disable the HF-1000's internal speaker while listening via an external speaker is to remove eight screws, take off the top cover and unplug the internal-speaker cable.

The HF-1000 includes no means of injecting a CW sidetone from a transmitter or keyer. Merely receiving the transmitted signal can suffice, of course, but then another artifact rears its head: The time delay associated with the HF-1000's narrower IF bandwidths (those narrower than 200 Hz or so) is so long that I just plain couldn't coordinate my hand with my ears while monitoring my sending with the HF-1000's IF bandwidth cranked way down.

So much for the good news about the HF-1000's audio. The bad news is that it's polluted by digital noise—a high-pitched whine in the **PHONES** and line outputs, and the high-pitched whine plus at least three distinct low-frequency signals in the speaker output. The **PHONES** audio spur is the least noticeable because the **PHONES** gain control must be turned up quite far before it's audible—and audio from the receiver's detector is usually too loud for comfort at that point. The speaker-output AF spurs are a different kettle of fish, however. I can hear *four*: two continuous drones an octave-plus-half-step apart, a continuous low *bum bum bum* an octave below one of the drones—like a robot cellist endlessly practicing tension music for *Jaws*—whenever one of the frequency-display digits flashes (that is, whenever **TUNE LOCK** isn't turned on), and the high-pitched whine I've already mentioned. The receiver's detector output usually just about masks the whine, but the dissonant drones and the *bum bum bum* are there even with the **SPEAKER** gain control turned all the way down. Such dirty audio is inexcusable in a radio of this price and pedigree.

Ergonomics

Considering that the HF-1000 was not designed for the Amateur Radio market, its control ergonomics are quite ham-acceptable. My limited experience with gear intended for military, governmental and commercial use confirms that the norm in nonamateur equipment is to use as few controls as possible to control as many functions (usually a subset of those functions radio amateurs take for granted) as possible. The HF-1000 strikes a reasonable compromise between this and hamdom's "a control for every feature" tradition. Often, you can change an HF-1000 operating parameter two related ways: By pushing a button to enable that parameter's adjustment and turning a detented rotary knob to step through the parameter's options, or by repeatedly pressing that parameter's enable button to step through its options directly.

Documentation

The HF-1000 documentation consists of a test report, a technical data flyer, and a comb-bound, inch-thick book entitled *Intermediate Level Maintenance Manual for the HF-1000 Digital HF Receiver.* Although its title seems to portend industrial-strength technospeak straight from a repair depot, the book devotes nearly half of its pages to quite readable detail on how to *use* the HF-1000. The manual also includes schematics; testing, alignment and remote control details; and 14 pages of circuit description. Like many manuals for complex equipment, it lacks, and sorely needs, an index.

Energetic Support

Control and DSP programming largely determine the sound and feel of a DSP-based receiver, so just as we completed this review for publication, we called Watkins-Johnson to be sure our radio had the latest firmware. It didn't, so W-J shipped us new firmware ICs by overnight express, free of charge. This level of response taken together with the positive presence of W-J staff in the Usenet *rec.radio.shortwave* newsgroup, indicates a strong commitment to customer support and satisfaction.

The HF-1000 Overall

Communications receivers are my thing. I can't wait until DSP-based IF filtering and demodulation make ham-affordable transceivers and communications receivers better. So how come I'm not tickled pink about the HF-1000?

For starters, the HF-1000's poor AGC response, a serious flaw in any communications receiver worthy of the name, is an inexcusable flaw in a receiver costing close to $4000. Really fixing it—as opposed to applying band-aids like the AGC Threshold mode—will likely require considerable reengineering.

The HF-1000's spur-ridden audio is an outrage. CD players, even portable ones, contain all sorts of digital circuitry on cramped circuit boards, and *they* don't assault their listeners with audio whines and buzzes. Why not work that quiet, clean, *cheap* audio technology into an expensive communications receiver like this? (The argument that communication-quality audio doesn't demand such post-processing cleanliness doesn't wash. Serious shortwave listeners and Amateur Radio communicators do much of their listening with music-quality headphones because of their high fidelity and high dynamic range.)

On the plus side, the HF-1000 uses a DMOS FET switching mixer. It's about time we saw this high-dynamic-range technique in a receiver that's within reach of consumers—although Table 1's noise-limited test measurements indicate that the HF-1000's frequency synthesizer is somewhat noisier than its mixer is strong. I also applaud the HF-1000's combination of 1-Hz tuning steps with 1-Hz display resolution, and its absolutely calibrated signal meter—features long overdue in high-end Amateur Radio gear.

In its current form, however, the HF-1000 is better suited to high-quality broadcast reception than demanding all-mode communication. A data modem might be able to ignore its poppy AGC and spur-ridden audio, but serious SSB and CW listeners won't be satisfied with just "closely approximating an analog receiver" after so much has been said about what's achievable with IF filtering and demodulation done with DSP.

Manufacturer's suggested retail price: $3995. Manufacturer: Watkins-Johnson Company, Electronic Equipment Division, 700 Quince Orchard Rd, Gaithersburg, MD 20878-1794, tel 1-800-954-3577.

ASAPS and *CAPMAN*: HF Propagation-Prediction Software for the IBM PC

Reviewed by R. Dean Straw, N6BV

It's been 12 years since Bob Rose, K6GKU, published his *MINIMUF* propagation-prediction program in December 1982 *QST*. *MINIMUF* was pretty limited in accuracy (and very limited in flexibility)—but then again, it had to work with the tiny memory resources available to the microcomputer of 1982. (Remember when 64 kBytes of RAM was considered a *lot* of memory?) On balance, *MINIMUF* was an elegant piece of code and it tantalizingly showed the possibilities for computer modeling of the ionosphere.

It's now almost the end of 1994. A sophisticated computer program called *ASAPS*, Version 2.2 ("Advanced Stand Alone Prediction Program," from Australia) showed up at HQ and I volunteered to run it through its paces, comparing it directly with its nearest commercial competition, *CAPMAN* ("Computer Assisted Propagation Manager for IonCAP"). First, let me try to explain where I think *ASAPS* and *CAPMAN* fall in the ever-expanding spectrum of propagation programs available for today's radio amateur. Propagation programs can be placed in two categories:

- Low-cost programs for "Let's see what the bands are doing"
- Heavy-duty programs for long-term station and antenna planning.

A simple program like *MINIMUF* clearly falls into the first category. It gives a quick idea of what the MUF (Maximum Usable Frequency) should be for a particular propagation path and solar sunspot level. It makes no predictions about signal strength, nor does it give any indication of what elevation angles to expect. No indication is given about unlikely, but statistically possible, modes or frequencies of propagation.

By their very nature, radio amateurs love to push the edge of the envelope, and nowhere is this more true than in the area of propagation. Over the years, amateurs have been directly responsible for discovering many propagation modes, some of them pretty exotic. Many hams, particularly HF DXers, want to know if there is even a remote possibility a band might open up. Hams delight in prowling the bands, exploiting statistically unlikely openings.

On the other hand, someone at a shortwave broadcasting giant like the VOA or the BBC is interested in seeing that they have 90% to 100% coverage in their broadcasts, and they design their stations accordingly. For this application, they need heavy-duty software that can generate reams of data, with all the statistical under-

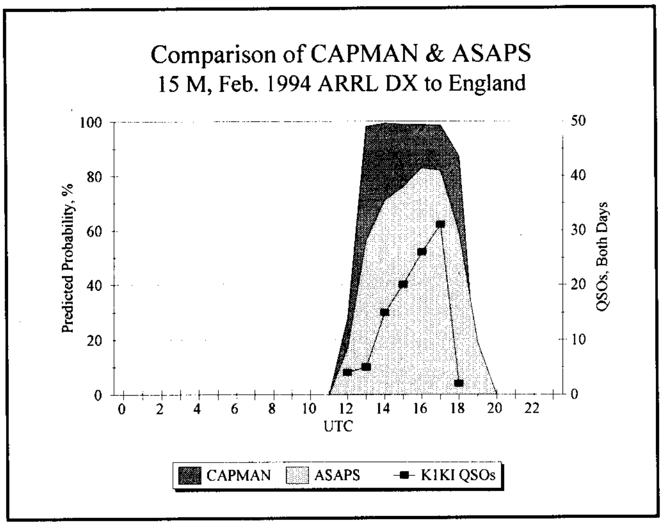


Figure 1—Graph showing K1KI's 15-meter QSOs to England versus time, along with the predicted probabilities produced by *ASAPS* and *CAPMAN*. Computations were made for a smoothed sunspot level of 45, the value at the time of the ARRL DX Contest in February 1994. The correspondence between prediction and actuality is close, particularly for *CAPMAN*.

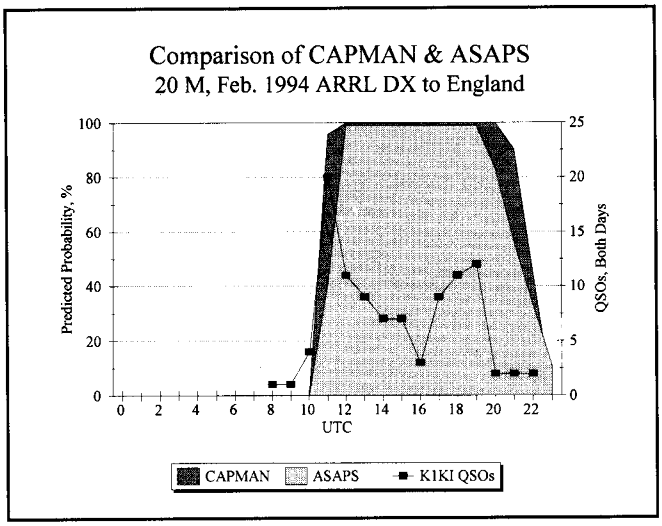


Figure 2—Graph showing K1KI log results plus computer predictions for the 20 meter band to England in February 1994. Again, *CAPMAN* is slightly more believable than *ASAPS* on 20 meters, although neither program predicts the 4 QSOs made before 1000 UTC.

pinnings necessary to convince a Congress or a Parliament to spend millions of dollars on an installation!

Common Points

Both *ASAPS* and *CAPMAN* fall into the second category of programs. They are indeed heavy-duty programs. Neither is inexpensive, so far as amateurs are concerned, although at $275, *ASAPS* is far more costly than *CAPMAN*, at $89. (If you're more interested in "let's see what the bands are doing," other propagation-prediction software packages advertised in *QST* sell for roughly half what *CAPMAN* commands.)

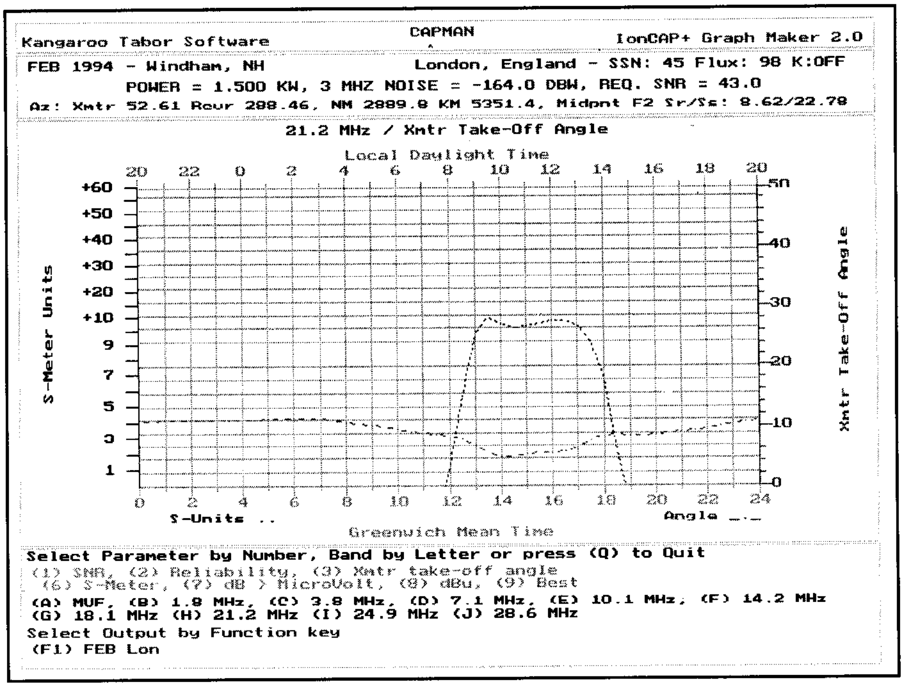
Both require more computing horsepower than simpler software. Although *ASAPS* will work on 8088-based machines, it works far better with a more modern PC, especially one equipped with a numeric coprocessor. *CAPMAN* is compiled only for 32-bit or more computers, and thus requires a minimum of an 80386 PC with a numeric coprocessor. The software does run up to three times faster than does standard *IONCAP* on a similar machine. Both programs compute a host of parameters, including predicted signal strength and elevation angles, quantities of considerable interest to hams.

ASAPS and *CAPMAN* are both designed for DOS, and both have reasonably elegant menu-driven operator interfaces, in full color. Each program has its own little quirks, but one learns quickly how to navigate through each program. *CAPMAN* must be set up for the operator's transmitter location, using the *CAPCFG32* setup program that comes with the package. *CAPCFG32* is somewhat clunky and nonintuitive to use, but thankfully needs to be run only once.

Both *ASAPS* and *CAPMAN* include a database of worldwide locations, but only *CAPMAN* allows you to select a location either by name or by ham call sign. Both programs quickly compute and display great-looking on-screen graphics. Neither program exploits the power and uniform user interface of *Windows*.

Differences

A number of Amateur Radio publications throughout the world include *ASAPS*-generated charts in their propagation columns, while *QST* for years has used the mainframe-based program *IONCAP* to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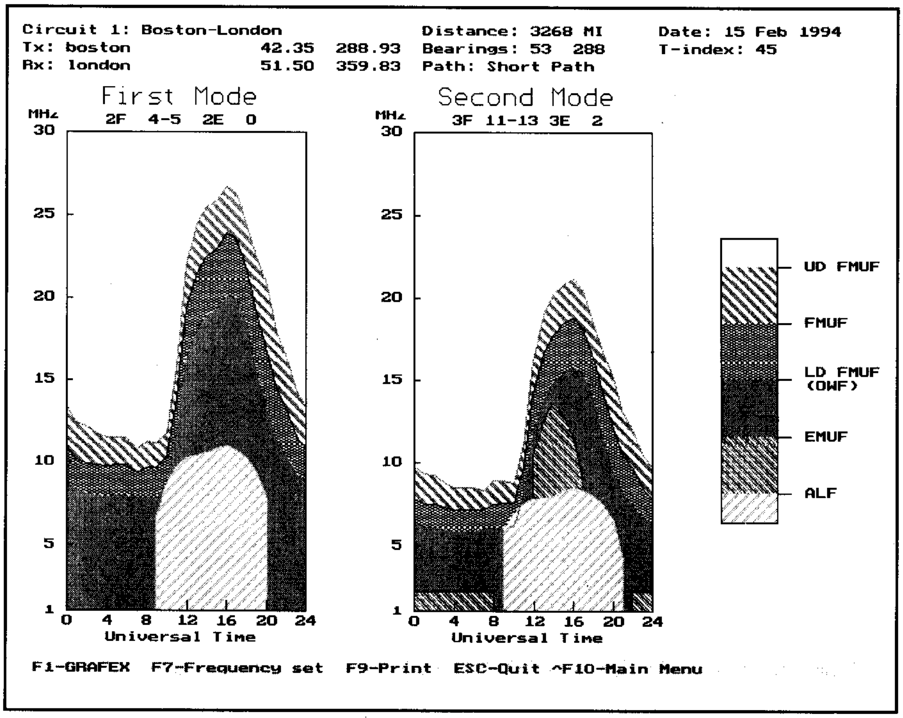
Kangaroo Tabor Software              CAPMAN             IonCAP+ Graph Maker 2.0
FEB 1994 - Windham, NH               London, England - SSN: 45 Flux: 98 K:OFF
        POWER = 1.500 KW, 3 MHZ NOISE = -164.0 DBW, REQ. SNR = 43.0
Az: Xmtr 52.61 Rcvr 288.46, NM 2889.8 KM 5351.4, Midpnt F2 Sr/Ss: 8.62/22.78
                    21.2 MHz / Xmtr Take-Off Angle
```

```
Select Parameter by Number, Band by Letter or press (Q) to Quit
(1) SNR, (2) Reliability, (3) Xmtr take-off angle
 (6) S-Meter, (7) dB > MicroVolt, (8) dBu, (9) Best
(A) MUF, (B) 1.8 MHz, (C) 3.8 MHz, (D) 7.1 MHz, (E) 10.1 MHz, (F) 14.2 MHz
(G) 18.1 MHz (H) 21.2 MHz (I) 24.9 MHz (J) 28.6 MHz
Select Output by Function key
 (F1) FEB Lon
```

Figure 3—*CAPMAN*-generated graph of predicted S-meter readings for 21.2 MHz, with overlay of predicted elevation angles. At this point in the solar cycle, the elevation angle varies between 4° and 9° over the predicted band opening from 1200 to almost 1900 UTC.



```
Circuit 1: Boston-London                 Distance: 3268 MI      Date: 15 Feb 1994
Tx: boston          42.35  288.93        Bearings: 53  288      T-index: 45
Rx: london          51.50  359.83        Path: Short Path
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Figure 4—GRAFEX output from *ASAPS* program for path from Boston to London in mid February, with *ASAPS*'s solar "T-Index" of 45, corresponding to a smoothed sunspot number of 45. The terminology used in the Australian program is somewhat different from US terminology. UD FMUF is the upper decile (10%) of the time. The term LD FMUF is the lower decile MUF, and ALF (absorption limited frequency) is commonly called the LUF, or Lowest Usable Frequency. The graph on the left is for the dominant first mode, with two F2 hops, with a launch angle from 4° to 5°. The graph on the right shows the second mode, with three F2 hops, with a launch angle from 11° to 13°.

generate graphs in the How's DX? column. For about twenty years, *IONCAP* has been the standard of comparison for propagation prediction and *CAPMAN* uses the *IONCAP* "engine" to do its work, surrounding it with a user-friendly shell to shelter the user from the messy details of *IONCAP* itself.

Don Lucas, WØOMI, one of the principals behind *CAPMAN*, was one of the scientists working on *IONCAP* from the very beginning. *ASAPS* uses its own prediction algorithm. Do the two different algorithms make a difference in the predictions? I must invoke the old saw: "A man who has two watches never knows what time it is." Both *ASAPS* and *CAPMAN* give just about the same numbers, but not quite *exactly* the same numbers.

Readers have reported in the past that the *QST* graphs were overly conservative predicting openings, especially on the highest HF bands. Jerry Hall, K1TD, in October 1994 *QST* described several important changes in the graphs, especially the addition of the LUF (Lowest Usable Frequency) curve. He also changed to a lower minimum-elevation angle and to a less-conservative local noise factor in the computations. These changes make the *QST* graphs much more useful to ferret out marginal openings—and they also require a very well-equipped station to exploit these marginal openings. (But we can all dream of pushing that envelope, can't we?)

I decided to use a recent contest log to compare the predictions from both *ASAPS* and *CAPMAN*, using the same assumptions used in the latest *QST* computations. In the February 1994 ARRL DX CW Contest, Tom Frenaye, K1KI, ran a full-blown multi-operator, multi-transmitter operation. The station was active on 160 through 10 meters for the full 48-hour contest period, with competitive equipment, antennas and operators. Figure 1 shows the 15-meter QSOs to England (for both days) versus time, along with the predicted probabilities produced by *ASAPS* and *CAPMAN* for a sunspot level of 45.

Both programs predict that the 15-meter band opens up before 1200 UTC, just as it did during the contest. *ASAPS* predicts that the 15-meter band closes somewhat after 2000 UTC, while *CAPMAN* predicts that the band will close by 1900 UTC. The log shows that through the 1800 to 1900 UTC hour, only three QSOs with England were made. *CAPMAN* thus models the path just a little bit better than *ASAPS* on 15 meters in this comparison, but the difference is not large.

Figure 2 shows the log results plus computer predictions for 20 meters to England. Again, *CAPMAN* is just a tiny bit more believable than *ASAPS* on 20 meters, although neither program predicts the four QSOs made before 1000 UTC. Examination of the log reveals that these QSOs were made with stations using with huge antennas, who could, and did, open the band up earlier than garden-variety stations.

When it comes to output, my opinion is that *CAPMAN* has a slight edge, since it generates graphs tailored for the amateur operator rather than for professional broadcast station planners. *CAPMAN* can also create reams and reams of statistics if you want it to, but normally it will produce summaries useful for radio amateurs. Figure 3 shows a *CAPMAN* graph of predicted S-meter readings for 21.2 MHz, with elevation angles overlaid on the same graph. At this point in the solar cycle, the elevation angle varies between 4° to 9° over the predicted band opening from 1200 to almost 1900 UTC. This is precisely the sort of information a ham delights in!

Figure 4 was created by *ASAPS*, and shows the so-called Grafex output, where the traditional propagation terms UD FMUF (Upper decile, F-layer MUF = Highest Possible Frequency), FMUF (F-layer MUF), LD FMUF (lower decile, F-layer MUF), E MUF (E-layer MUF) and ALF (Absorption Limited Frequency = Lowest Usable Frequency) are plotted versus time for the first mode (lowest elevation angle) and for the second mode (next higher elevation angle). In color on the computer display the graph is even more striking visually. While the data is certainly useful, it is not tailored specifically for the amateur.

Summary

Either *ASAPS* or *CAPMAN* represents software that is remarkably easier to use than *IONCAP*, the standard of reference among professionals for many years. On a state-of-the-art microcomputer, either program will generate accurate propagation predictions, providing that the Sun cooperates by not blitzing the ionosphere with protons or X-rays from solar flares. However, because it is customized for amateur use, and because it carries a list price about a third of *ASAP*'s, *CAPMAN* looks like more of a bargain for hams.

Manufacturer: *CAPMAN* (Computer Assisted Prediction Manager), from Lucas Radio/Kangaroo Tabor Software, 2900 Valmont Road, Suite H, Boulder, CO 80301; tel 303-494-4646, fax 303-494-0937. Price class: $89. *ASAPS* (Advanced Stand Alone Prediction System), IPS Radio and Space Services, PO Box 5606, West Chatswood NSW 2057, Australia. US and Canada distribution: Jacques d'Avignon, 965 Lincoln Dr, Kingston, Ontario K7M 4Z3, Canada. Price class: $275 (US funds).