Product Review Column from *QST* Magazine

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QST Compares: 1200/9600 bit/s Dual TNCs
(AEA PK-96; Kantronics KPC-9612; PacComm TNC/NB-96)

Kenwood TS-60S 6-Meter All-Mode Transceiver

Conducted by Mark Wilson, AA2Z
Editor, *QST*

QST Compares: 1200/9600 Bit/s Dual TNCs

Reviewed by Steve Ford, WB8IMY

1200/9600 Bit/s TNC Features

	PK-96	*TNC/NB-96*	*KPC-9612*
External level controls	Yes	No	No
Mailbox	Yes	Yes	Yes
Automatic mail handling	Yes	Yes	Yes
Radio cable provided	Yes	Yes	Yes
Serial cable provided	No	Yes	No
Software provided	No	No	Yes
Power supply provided	No	Yes	No
KISS mode	Yes	Yes	Yes
Host mode	Yes	Yes	Yes
Modem disconnect	Yes	Yes	No
Suggested List Price	**$229**	**$295**	**$219 (32 kbytes RAM)** **$249 (128 kbytes RAM)**

Except for some AX.25 backbone systems and TCP/IP, ROSE and TexNET networks, most packet activity still takes place at 1200 bits per second (bits/s). When packet exploded onto the amateur scene in the early 1980's, 1200 bits/s seemed adequate, even fast by the standards of the day. But now it's 1994 and amateur packet radio is still lumbering along at 1200 bits/s, long after most telephone modems have accelerated to 9600, 14400 and even 28800 bits/s.

Part of the reason so many hams remain at 1200 bits/s has to do with hardware. Twelve-hundred bits/s TNCs (terminal node controllers) are essentially plug-and-play devices. The TNC assembles and encodes the outgoing data, and it decodes incoming data. It's the link between you and your radio. You simply take the transmit audio and keying lines from the TNC and route them to the microphone jack of your FM transceiver. Receive audio is supplied by the transceiver's external speaker jack. Apply power, fire up your computer or data terminal and you're on the air.

Getting on the air at 9600 bits/s *isn't* plug and play. The TNCs are pretty much the same, but hooking up your radio often involves circuit surgery—an intimidating prospect for many hams these days. You must tap receive audio directly at the FM discriminator. Transmit audio must be injected in the modulator stage—preferably at or near the varactor. (And woe unto those whose rigs do not employ "true" FM. Sending a clean 9600 bit/s data signal with these radios can be a difficult prospect.)

After you've made the proper radio connections for 9600 bits/s, there is the matter of adjusting deviation. FM deviation at 9600 bits/s is *very* critical. It's not impossible to set by ear, but it's tough. (A 9600 bit/s data signal sounds like a burst of noise.)

There may be some light at the end of the proverbial tunnel, though. A number of major transceiver manufacturers are working toward a standard for implementing 9600 bit/s TNC ports. Rigs equipped with these ports are already on the market. Just glance at the transceiver ads in *QST* and look for "9600 Ready" in the list of features.

The new "data-ready" radios are not without their own problems. Some have IF filter and discriminator characteristics that leave little room for error. If you're off frequency by a small amount, you may not be able to pass data. In addition, the ceramic discriminator coils used in some transceivers have poor group delay, making it impossible to tune them for wider bandwidths. With this in mind, some amateurs prefer to make the leap to 9600 bits/s using *dedicated* data radios such as those manufactured by Tekk, Kantronics and others.

The Best of Both Worlds

Hams are a conservative bunch and getting them to move to 9600 bits/s isn't easy—even with 9600 bit/s-ready radios. Besides, the networks are still dominated by 1200 bit/s activity. The common lament among packeteers is, "Yes, I'd like to try 9600 bits/s, but all my buddies have 1200 bit/s TNCs. I don't want to own two TNCs, one for 1200 bits/s and another for 9600 bits/s."

Despite the clear advantages of 9600 bits/s on terrestrial packet networks, and the proliferation of 9600 bit/s packet satellites, hams are still holding back. What will it take to drag amateur packeteers into the 1990s? Perhaps the answer lies in the three TNCs presented here. Each product offers access to both packet worlds—1200 *and* 9600 bits/s—in compact, affordable packages. With these TNCs you can explore 9600 bits/s while still retaining the ability to communicate with your "slower" friends on the 1200 bit/s networks. Jumping from one data rate to another is often as simple as pushing a button or sending a software command.

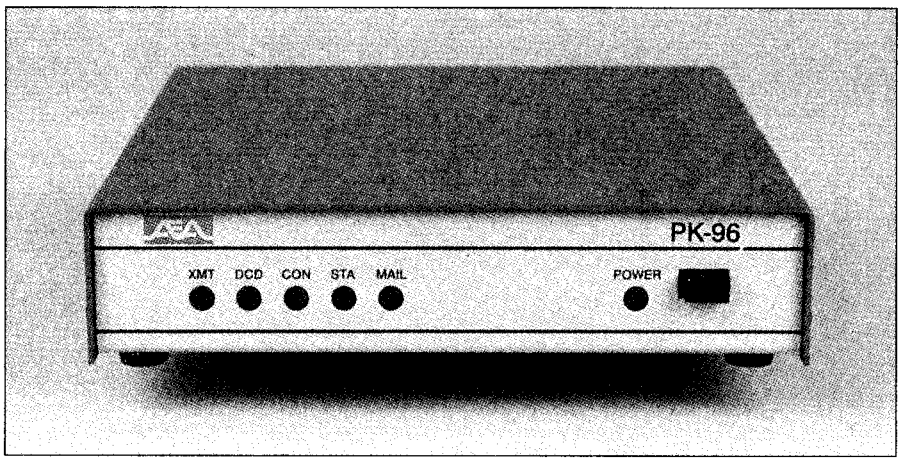
For this review I put each TNC to the test using 9600 bit/s packet satellites (KITSAT-OSCAR 23 in particular). Satellite packet signals at my station are subject to constant drifting and occasionally fading. I hoped that the demanding conditions of a PACSAT link would expose any weakness in these TNCs. To be thorough, I also tested the TNCs on a local 9600 bit/s TCP/IP network. That's where these TNCs will probably find their greatest use.

My 2-meter satellite transceiver was a Kenwood TS-700S modified to transmit 9600 bit/s data (it also served as my 1200 bit/s terrestrial packet rig). The receive setup consisted of an ICOM IC-745 HF transceiver with the optional FM board installed. I converted the 70-cm satellite downlink signals to 10 meters and used the IC-745 as my receiver, tapping the 9600 bit/s audio from the discriminator output. For terrestrial packet, I borrowed a modified Motorola Mitrek 70-cm transceiver from a friend.

AEA PK-96

The PK-96 TNC is about as straightforward as you can imagine. The TNC is built into a slender, lightweight enclosure. The front panel features the usual LED indicators for DCD, STA, power and so on. A 25-pin socket is provided on the back panel for the serial cable to your computer.

The connections to your transceiver are made through a 5-pin DIN socket. Although you can pass receive audio through this connection, the AEA engineers thoughtfully added a $^1/_8$-inch miniature jack for auxiliary audio. They recognized that there might be configurations that require you to receive with one radio and transmit with another. Two potentiometers are included on the rear panel: one for 1200 bit/s output level adjustment and the other for 9600 bits/s. These proved to be very convenient!



AEA PK-96

Switching from 1200 to 9600 bits/s is performed through the **HBAUD** command. **HBAUD 1200** places the PK-96 in the 1200 bit/s mode. **HBAUD 9600** places the unit in the 9600 bit/s mode. I used the Microsoft *Windows* 3.1 terminal program to communicate with the PK-96. Operation may be easier with one of AEA's software products, such as *PC Pakratt*. The PK-96 will also function in the host or KISS modes for particular applications such as TCP/IP.

The manual provided with the PK-96 is a real winner—one of the best I've ever seen. It spends a great deal of time taking you through the steps necessary to interface common FM transceivers for 9600 bit/s operation. There are several pages of modification information for a variety of radios. The author doesn't sugarcoat the difficulties involved. You're warned, for example, about the critical nature of 9600 bit/s deviation settings.

The Importance of Deviation

When I fired up the PK-96 for the first time, I took the impatient approach and tried to set the 9600 bit/s deviation by ear. This gave me an immediate appreciation for deviation meters! I used an H-T to monitor my transmit signal. With some careful tweaking of the pot on the back of the PK-96, I adjusted the output to a level that I *thought* sounded correct. Of course, you're listening to little more than a rushing noise, so it's difficult to be certain.

KITSAT-OSCAR 23 passed over my area an hour later and I made my first attempt to get its attention. No luck! After several transmissions it was clear that something was wrong. The downlink was working perfectly. The PK-96's DCD indicator glowed brightly and all sorts of data went flying across my screen. But when I tried to request a file or a directory listing, the satellite was deaf to my pleas.

Before the bird was out of range, I grabbed my trusty alignment tool and reduced the transmit audio level a bit further. Now the 9600 bits/s signal sounded like a hiss just above the background noise. I gave OSCAR 23 another blast and it heard me! I must have stumbled onto the right level setting, or something close to it. It was impressive to watch the PK-96 and the satellite communicate. Within a minute I had the file I wanted.

A few days later I asked Mike Stemmler, N1LMP, to take a look at my signal from his station. Mike owns a service monitor that can measure the characteristics of a received signal. He watched my signal on the monitor, gauging the shape of the eye pattern and measuring my deviation. My data signal looked good, but my deviation was set a tad too low at 2.5 kHz. (Not bad, however, when you consider my adjustment method!) With his help I set it to 3 kHz exactly.

The next test took place a week later on the local 70-cm TCP/IP network. With the PK-96 recalibrated to match the Motorola transceiver, its operation was flawless. I transferred a number of files with ease.

Two-meter Operation and More

I disconnected the cables to the Mitrek and wired up my 2-meter rig. Checking into my home PBBS at 1200 bits/s was a painful experience after screaming along at 9600 bits/s. The PK-96 worked fine, but it was difficult to tolerate the slowness of the connection itself. You could compare it to the sensation you get when you exit a freeway and find yourself in stop-and-go traffic. As you're plodding along at 5 or 10 mph, you really miss 55 mph!

AEA has added some notable goodies to the PK-96. There is a personal mailbox with 18 kbytes of battery-backed memory capacity, upgradable to 100 kbytes. The PK-96 mailbox supports automatic reception of mail as well as reverse forwarding.

The PK-96 also includes a gateway function that's similar to the Kantronics KA-Node. Unlike a simple digipeater, the PK-96 gateway supports node-type operation without the need for end-to-end acknowledgments of every packet. The gateway operates simultaneously with other PK-96 functions. A friend could use your gateway to reach a distant PBBS, for example, while you communicate with another station.

If you want to add an external modem—to jump up to 19,200 bits/s, for example—the PK-96 provides a *modem disconnect header*. This connection point allows you to disable the PK-96 modem and substitute another. The header is internal, however, which makes it a little difficult to access. Still, it's a great feature for hams who wish to push the envelope a bit further.

The PK-96 is a solid little TNC with a lot to offer the 9600 bit/s packeteer. It's easy to set up (as easy as any 1200/9600 bit/s system could be) and simple to operate.

Manufacturer: Advanced Electronic Applications (AEA), PO Box C2160, 2006 196th St SW, Lynnwood, WA, 98036, tel 206-774-5554. Suggested list price: $229. 100 kbyte mailbox memory upgrade: $50.

KANTRONICS KPC-9612

Of the three TNCs tested for this review, the Kantronics KPC-9612 has one of the most interesting features: the ability to operate at 1200 and 9600 bits/s *simultaneously*. By using the proper software, you can do some remarkable things with the KPC-9612, as we'll discuss in a moment.

If you think the KPC-9612 bears a strong resemblance to the popular KPC-3 TNC, you're right. The KPC-9612 is based on the KPC-3 architecture and includes all of its features. For example, the KPC-9612 provides a personal packet *mailbox* with various enhancements for compatibility with existing packet bulletin board systems (PBBSs). If you buy the KPC-9612 with the 32 kbyte RAM option, you'll get a 20 kbyte mailbox. Spring for the 128 kbyte option and you'll enjoy nearly 100 kbytes of storage space. By making arrangements with your local PBBS SysOp, you can use the KPC-9612 to interact with the bulletin board automatically. It will forward messages to the PBBS and download any waiting mail.

Like the KPC-3, you can access your KPC-9612 from different locations. All you need is another packet system. With remote access, you can check mail and even modify your KPC-9612 parameters.

The KPC-9612 offers very low power consumption, allowing it to be powered from a 9-V battery. (You can use the **LEDS OFF** command to reduce the power drain even further.) This has great benefits for portable/mobile packet, high-altitude ballooning, remote site control, etc.

KA-Node, Gateway and WEFAX

Like all the Kantronics TNCs, the KPC-9612 includes the Kantronics *KA-Node*. When the KA-Node is active, the KPC-3 behaves like a *NET/ROM*-style node. Anyone can connect to the KA-Node and use it as a relay. Like a NET/ROM node, a KA-Node forwards packets without requiring end-to-end acknowledgments. Once a packet has been received by the KA-Node, it takes "responsibility" for passing it along to the next station. If the packet must be re-

peated, the KA-Node does so automatically without involving the originating station. Unlike NET/ROM nodes, however, KA-Nodes do not maintain node lists for automatic routing. To reach a destination, you must use KA-Nodes like traditional digipeaters, hopping from one to the other until you establish your desired connection.

Part of the KA-Node is the *gateway* function. The gateway allows cross-port digipeating, which has fascinating potential in the KPC-9612. With the proper software you could set up a system that would enable 1200 bits/s users to connect to your 9600 bit/s port. How about a satellite gateway that lets 1200 bit/s packeteers access OSCARs 22, 23 or 25 in real time? Or a gateway from a 1200 bit/s AX.25 network to 9600 bit/s TCP/IP?

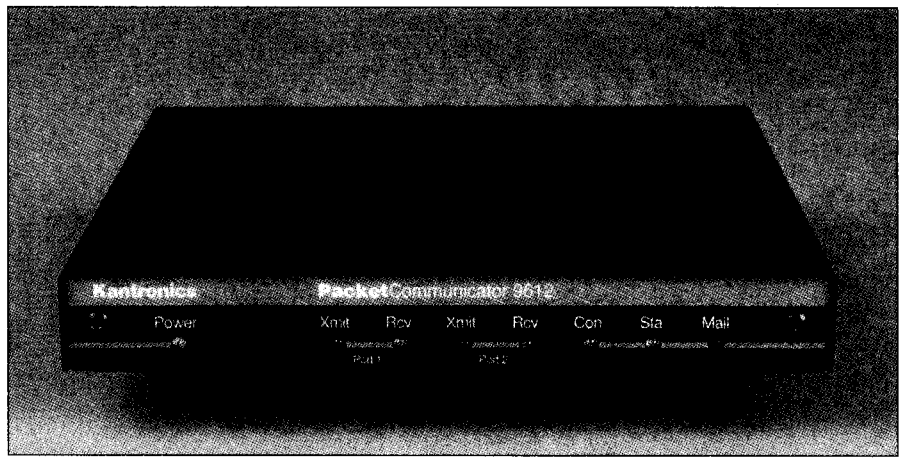
The KPC-9612 has another neat trick up its sleeve. If you have only one data-ready transceiver, the KPC-9612 can use it to operate at 1200 *or* 9600 bit/s. How is this accomplished? The cables from the 9600 bit/s port attach to the data connector on the transceiver. The cables from the 1200 bit/s port attach to the microphone and external speaker jacks on the same radio. With the **ONERADIO** command **ON**, the KPC-9612 will inhibit transmission whenever 1200 or 9600 bit/s signals are detected. In this fashion the TNC avoids transmitting at 9600 bits/s while a 1200 bit/s signal is being received, and vice versa. This allows one radio to serve as both a 1200 *and* 9600 bit/s transceiver, depending on the data rates of the signals received. This feature is especially interesting for those who own dual-band (2 meter/70 cm) data-ready transceivers.

Software

To get the most out of the KPC-9612, you need the right software. Kantronics provides *PacTerm* terminal software on a 3½-inch diskette with the KPC-9612. This program will get you started, but you'll probably want to graduate to a more sophisticated package.

To switch ports on the KPC-9612, you use a method that may be familiar to experienced packeteers: *stream switching*. Think of the 1200 and 9600 bit/s ports as two streams flowing side by side. If you want to sail down the 1200 bit/s stream, you have to let the TNC know your intentions. In the KPC-9612 you do this by entering **|A** at the **cmd:** prompt. From that point onward, you're paddling down the 1200 bit/s stream. Everything you send—including commands to connect, disconnect and so on—will be sent through the 1200 bit/s port. To jump to the 9600 bit/s stream, you must enter **~A** at the **cmd:** prompt. If you have connections on both ports at the same time, this could get very confusing very quickly.

My solution was to use the *HostMaster* software that I purchased with my KAM Plus. Through the *HostMaster's* HOSTSET program, I reconfigured the software for use with a dual-port VHF TNC. The KPC-9612 has a host mode that's compatible with *HostMaster*, so the rest was easy. *HostMaster* made it simple to flip from one stream to another. All I had to do was hit the **PAGE UP** or **PAGE DOWN** keys.



Kantronics KPC-9612

I didn't attempt to use my PACSAT software in a dual-port configuration, but I couldn't resist trying TCP/IP. One of the benefits of TCP/IP is that it supports connections to and from AX.25 users. By operating TCP/IP with the KPC-9612, I hoped to connect to my local PBBS on the 1200 bit/s port and the regional TCP/IP network on the 9600 bit/s port.

My first task was to reconfigure the AUTOEXEC.NET file in my TCP/IP (NOS) software to recognize two ports. By adding another **attach** command to the file, I configured AX1 as my 1200 bit/s port, effectively a *subport* of AX0 on COM 1. When I wanted to connect to my home PBBS (W1NRG) at 1200 bits/s, all I'd need to do is communicate through AX1. Anything sent to AX0—such as a TCP/IP command to transfer a file—would wind up on the KPC-9612's 9600 bit/s port.

Unfortunately, you won't learn how to modify your AUTOEXEC.NET file by reading the KPC-9612 manual. You might expect to see this information in the KISS section (you must use the KISS mode with TCP/IP software), but the manual only mentions how to take the TNC in and out of KISS. I had to tap some of my more knowledgeable TCP/IP buddies to learn the secret. A call to Kantronics put the rest of the puzzle pieces together.

Installation

The KPC-9612 is compact enough to fit almost anywhere. The TNC measures only 0.8×6.2×6.1 inches and weighs just 13 ounces. In addition to the **CONNECT**, **STATUS** and **MAIL** indicators on the front panel, there are separate **TRANSMIT** and **RECEIVE** LEDs for each port. These LEDs are very convenient when you need to spot the active port at a glance.

The 1200 and 9600 bit/s audio levels are adjusted through *internal* potentiometers. I had to remove the cover (two screws hold it in place) and tweak the PC board pots while monitoring my deviation. This approach is a bit of a headache, but you shouldn't need to do it very often.

The serial cable from the computer or data terminal connects to a 25-pin socket on the rear of the KPC-9612. Nine- and 15-pin sockets connect to the radios. In my case, I connected the 1200 bit/s port to my 2-meter transceiver. The 9600 bit/s port was patched to the Mitrek rig on 70 cm.

On the Air

Using my modified NOS, I connected to W1NRG on 144.97 MHz. Bingo! The connection was established!

Now the moment of truth. While still connected to W1NRG on the 1200 bit/s port, I linked with a station two states away on the TCP/IP network (on 70 cm) and started transferring a large image file.

With the file transfer under way, I turned my attention back to W1NRG. I requested a list of bulletins and sat back to watch the fun. The KPC-9612 seemed to jump from one port to another as data flowed in and out. If throughput suffered in the ensuing traffic jam, I wasn't aware of it. The bulletin list appeared on my screen in due time while the file transfer continued on the other channel. Within about 10 minutes I had surveyed the latest messages on my PBBS *and* transferred a file to another station!

The KPC-9612's performance on OSCAR 23 seemed almost anticlimactic after my dual-port test. Still, it's worth noting that its 9600 bit/s modem functioned well, considering the fluctuating signal from the satellite. I copied an average of 300 kbytes of data during each pass. Without a modem disconnect header in the KPC-9612, you're confined to working only the 9600 bit/s birds. (Through the **HBAUD** command, however, you can accelerate the KPC-9612 up to 19200 bits/s.) You can't add an external PSK modem for OSCARs 16, 19, 20 and 26.

Manufacturer: Kantronics, 1202 East 23rd St, Lawrence, KS 66046, tel 913-842-7745, fax 913-842-2021. Suggested list price: $219 (32 kbyte RAM); $249 (128 kbyte RAM).

PACCOMM TNC/NB-96

The TNC/NB-96 is a hybrid product. PacComm has taken its popular TINY-2 Mk 2 TNC and combined it with its NB-96 *DFM* 9600 bit/s modem. (*DFM* stands for *D*irect *FM*, a reference to the G3RUH direct FM modem design.) The result is a switchable 1200/9600 bit/s TNC with excellent versatility.

There are two rows of LEDs on the front panel. The top row indicate the status of the TINY-2 TNC (STA, DCD, PTT and so on). The bottom row indicates which modem is functioning and, if the NB-96 or another modem is selected, the status of the modem.

Choosing Modems

Selecting modems is simple. If you want to operate 1200 bit/s packet, press the front-panel button until the **AFSK** LED glows. To switch to 9600 bit/s packet, press the button again until the **DFM** LED lights up. One of the versatile aspects of the TNC/NB-96 is that you can use the same switch to select an *auxiliary* modem. In other words, the TNC/NB-96 can be your springboard to digital experimentation at speeds beyond 9600 bits/s. All you have to do is plug in the new modem and you're on your way!

You can interface a PSK modem to the TNC/NB-96 and select it from the front panel as well. Simply plug it into the DIN socket on the rear panel. You'll be ready to communicate with the 1200 bit/s PACSATs (OSCARs 16, 19, 20 and 26). You can even try your hand at terrestrial PSK work.

EPROM Switch

The TNC/NB-96 includes an EPROM-switching feature on the rear panel. There is a push-button switch labeled **OPTIONAL EPROM** and **NORMAL EPROM**. The TNC is shipped with the TINY-2 Mk 2 firmware in the "lower half" of the 64 kbyte 27C512 EPROM chip. The upper half is occupied by WA8DED version 2.6 code. Most users will leave the switch in the **NORMAL** position.

This EPROM switching feature is ideal for network nodes. You can load your desired network software in the upper half of an EPROM and standard TNC code in the lower half.

Mailbox

The TNC/NB-96 includes a mailbox known as a Personal Message System, or *PMS*. The PMS supports standard packet mailbox functions as well as forwarding to and from a full-fledged packet bulletin board. Automatic forwarding (initiated by the TNC itself) is *not* supported. Incoming messages are stored in 15 kbytes of RAM. When you have mail waiting, the **STA** LED on the front panel blinks on and off.

KISS, Host and GPS Modes

KISS is included among the list of operating modes. This is essential for TCP/IP and as well as the PB/PG packet-satellite software. The TINY-2 also supports a Host mode (Host software not provided) as well as an innovative *GPS* mode.

The GPS mode configures the TNC to interface with an NMEA 183-compatible Global Positioning System (GPS) receiver. Location data from the receiver is automatically incorporated into the TNC's beacon and connect-message fields. You can do many intriguing things with this capability. Automatic Packet Reporting (APR) systems come to mind. (See "Interfacing GPS or LORAN Devices to Packet Radio" by Bob Bruninga, WB4APR, in February 1994 *QEX*.)

The Manual

The only nagging problem with the TNC/NB-96 is the manual. Like the product itself, the manual is a hybrid. The first section is a TINY-2 manual. It's informative, providing a beginner-level discussion of the TINY-2 itself. The second section is a manual for the NB-96 modem and it is *not* a beginner-level discussion. Unless you have some familiarity with digital communication, the text may be bewildering.

The manual refers to the TINY-2 in several places, but you'll be hard pressed to find a detailed discussion of both units as they operate *together* in the TNC/NB-96. For example, I had to search for an explanation of the front-panel modem-select switch. What I finally found was a brief mention (a couple of sentences) of its existence and function.

To its credit, the manual includes a copy of the *9600 Baud Packet Handbook* by Mike Curtis, WD6EHR. This text is almost legendary in the high-speed packet world. It's an easy-to-understand explanation of the joys and pitfalls of 9600 bit/s packet. The *Handbook* also includes modification instructions for several radios.

Installing the TNC/NB-96

The TNC/NB-96 comes complete with a serial computer cable as well as cables for your transceiver. A dc power block is included, too. This greatly streamlines installation. The only hassle is the lack of external level controls for the 1200 and 9600 bit/s signals. You must disassemble the case and remove the circuit boards to reach the potentiometers.

I removed the boards and gingerly connected the cables to the radio, computer and power supply. While monitoring my transmissions I adjusted each potentiometer for the proper level. Most hams will perform this adjustment once and won't need to repeat it unless they connect a new transceiver. If you're going to be using the TNC/NB-96 with several rigs, however, the lack of external controls is a drawback.

While setting up the TNC I noticed that the 1200 bit/s audio was somewhat low. It would be sufficient to feed the microphone amplifier stages, but I was injecting the 1200 bit/s audio at the varactor. A quick call to PacComm solved the problem. The technician advised me to replace R11, a 22 kΩ resistor, with a 2.2 kΩ resistor. Sure enough, that provided enough audio drive to do the job.

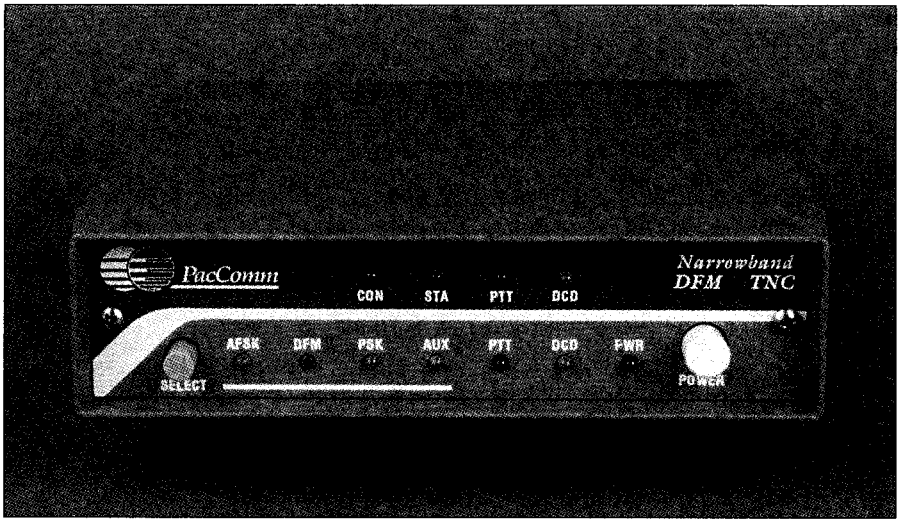
On the Air

The TNC/NB-96 performed very well during my terrestrial and satellite tests. The NB-96 modem appeared to be quite sensitive. On several KITSAT-OSCAR 23 passes, it managed to decode packets during slight signal fades. Its performance on the local 9600 bit/s TCP/IP network was as good as other TNCs I tested.

It was a pleasure to switch from 9600 to 1200 bits/s at the push of a button. When I finished one of my OSCAR 23 sessions, all I had to do was switch frequencies on my 2-meter transceiver and select the 1200 bit/s AFSK modem. Within 15 seconds I was connected to my home BBS on 144.97 MHz. Nice!

Other than the confusing manual, the TNC/NB-96 is a fine product. Not only do you gain access to 1200 and 9600 bit/s packet in the same box, you have the opportunity to go even farther!

Manufacturer: PacComm Packet Radio Systems, 4413 N Hesperides St, Tampa, FL 33614-7618, tel: 813-874-2980, fax: 813-872-8696. Suggested list price: $295.



PacComm TNC/NB-96

Kenwood TS-60S 6-Meter All-Mode Transceiver

Reviewed by Mark Wilson, AA2Z

Last year, Kenwood introduced the TS-50S, a tiny, full-featured MF/HF transceiver that gained instant popularity. As an encore, Kenwood offers the TS-60S, a 6-meter multimode radio that looks virtually identical to the TS-50S and shares many of its features (see the TS-50S review in September 1993 *QST* for a detailed description). Although Kenwood and other manufacturers offer transceivers with 160 through 6 meter coverage, it's been a long time since anyone introduced a full-featured 6-meter-only box. Six meters is an exciting band that combines reliable local communication with exciting DX opportunities (see this month's The World Above 50 MHz for a sample). It's encouraging to see Kenwood take the plunge and bring us a new radio for this underappreciated band.

Features

The TS-60S offers SSB, CW, AM and FM operation from 50 to 54 MHz. The receiver covers 40 to 60 MHz, letting you spot band openings before they happen by monitoring out-of-band signals. Transmitter power is selectable in three fixed steps: 10, 50 and 90 W. The TS-60S's impressive list of features reads like that of a modern MF/HF transceiver: dual-VFO and split-frequency operation, QSK and semi-break-in CW, IF shift, multiple scanning modes, 100 memories, CTCSS, a 20-dB attenuator and AIP (Advanced Intercept Point), automatic power shutoff (if none of its key controls have been used for 3 hours). The rig also offers CW normal and reverse (that is, CW reception on your choice of upper or lower sideband), adjustable CW offset (from 400 Hz to 1 kHz in 50-Hz steps), various tuning-step sizes, display-backlight intensity, and a selectable RIT range (±1.1 or ±2.2 kHz). The rig's memories (and VFOs) store transmit and receive frequencies, mode, filter bandwidth, AIP, attenuator and AGC selections, and tone-encoder frequency (for FM CTCSS operation). The TS-60S is rugged and features a thermostatically controlled fan for cooling. Surprisingly, there's no provision for VOX operation.

The TS-60S's front panel shares the simple elegance of the TS-50S. This is possible because some 40 functions — including RF output power, AGC constants, CW offset, IF filter selection, CTCSS tones, and tuning steps — are software-controlled by menus that allow you to customize the radio to your operating style. You access these functions by pressing the **MENU** button, then making selections with the main tuning knob and **UP/DOWN** buttons. You'll need to use the instruction manual for reference. To make it easier to access the features you use most often, you can program the four switches on the standard MC-47S microphone to operate any of the front-panel or menu-controlled functions. The TS-60S includes provisions for connection to an external amplifier (rear-panel phono jacks for ALC input and amplifier-control line), and for computer control with the optional IF-10D interface.

Where many small radios fall short is the main tuning knob. The tuning on the TS-60S is smooth, like a quality MF/HF rig. The smallest tuning step is 5 Hz, but the step increases to as much as 200 Hz when you spin the knob faster. A comfortable tuning speed yields about 2 kHz per knob revolution. In FM, the tuning-step range is 50 Hz to 2 kHz. Tuning over a wide range (say to tune across the beacons in the lower part of the band) is a bit slow. If you're a rabid 6-meter DXer, you'll probably want to use the scanning features (memory scan or continuous scan) to look for openings and activity in key parts of the band.

The versatile memories make FM and repeater operation easy. You can store the input and output frequencies of your favorite repeaters, along with any of the standard CTCSS tone frequencies.

Kenwood's instruction manual is clear and well illustrated. This is especially important for a radio like the TS-60S where many of the functions are not accessed by conventional front-panel controls. Extensive cross references help, too. Interspersed with the operating instructions are a number of helpful hints for successful on-the-air operation.

Performance

In the past, multimode VHF transceivers have fallen short on receiver performance. This is a shame, because strong-signal-handling capability is particularly important on 6 meters and the other VHF bands — you're often listening for very weak signals in the presence of very strong local signals. The TS-60S's receiver sensitivity and dynamic range compare favorably with MF/HF radios in the $1000 to $1500 price class, and its dynamic range is noticeably better than previous-generation 6-meter single-band radios. Even so, loud local stations can be annoying. The AIP feature helps you deal with very strong local signals, but it does reduce the sensitivity (which may hurt when you're listening for weak DX signals in the noise).

The optional CW filter is evidence that the TS-60S is intended for more demanding applications. Installation is identical to the TS-50S, requiring a bit of transceiver disassembly and soldering. It's not difficult to do, and the instructions are quite clear.

The peak-reading S meter deserves mention because it's particularly useful on 6 meters where rapid fading is common. The noise blanker is effective on power-line noise that plagues many operators. And, typical of Kenwood radios, the receiver audio sounds great.

At 90 W maximum, the TS-60S has sufficient power to work any propagation mode on 6 meters. Most of the time, when starting a QSO you'll probably run the TS-60S in the 50-W position. The difference between that power level and the full 90-W output can't be noticed under most conditions. When signals are good, you'll want to drop down to 10 W.

In Short

The TS-60S squeezes big-rig features into a tiny package that's easy to use. The radio is based on an MF/HF radio that's intended to see a lot of mobile use, and for serious home-station use, some 6-meter operators may wish for more convenient access to features like IF filter, AGC constant and power selection. But for most users, the TS-60S offers all the 6-meter radio you'll ever need in a box so small that you may have to keep reminding yourself that it's a real radio. But that won't be hard. All you'll have to do is turn it on!

Thanks to Emil Pocock, W3EP, and Dave Sumner, K1ZZ, for their contributions to this review.

Manufacturer's suggested retail prices: TS-60S, $1210; YK-107C 500-Hz CW filter, $110; PS-33 dc power supply, $240. Manufacturer: Kenwood Communications Corporation, Amateur Radio Products Group, PO Box 22745, Long Beach, CA 90801-5745, tel 310-639-5300.

Table 1

Kenwood TS-60S 6-Meter Multimode Transceiver, serial no. 50800781

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Transmitter: 50-54 MHz. Receiver: 40-60 MHz.	As specified.
Modes of operation: CW, LSB, USB, AM, FM.	As specified.
Power requirement: 13.5-V dc, ±15%; 2 A or less on receive, 20.5 A or less on transmit.	At 13.8-V dc: 0.9 A on receive (no signal); 16.3 A max on transmit.
Receiver	*Receiver Dynamic Testing*
SSB/CW receiver sensitivity (bandwidth not specified, 10 dB S+N/N): 0.16 μV (–123 dBm) or less.	Minimum discernible signal (noise floor) with 500-Hz IF filter: AIP on, –130 dBm; AIP off, –139 dBm
AM receiver sensitivity (bandwidth not specified, 10 dB S+N/N): 2 μV or less.	10 dB S+N/N (signal 30% modulated with a 1-kHz tone, 5-kHz filter): AIP on, 1.8 μV; AIP off, 0.6 μV
FM receiver sensitivity (bandwidth not specified, 12 dB SINAD): 0.25 μV or less.	12 dB SINAD with 12-kHz filter: AIP on, 0.7 μV; AIP off, 0.2 μV
Blocking dynamic range: Not specified.	Blocking dynamic range with 500-Hz IF filter:* AIP on, 115 dB; AIP off, 110 dB
Two-tone, third-order IMD dynamic range: Not specified.	Two-tone, third-order IMD dynamic range with 500-Hz IF filter:* AIP on, 94 dB; AIP off, 87 dB
Third-order input intercept: Not specified.	AIP on, +2 dBm; AIP off, +0.7 dBm
FM adjacent channel rejection: Not specified.	FM adjacent channel rejection at 20-kHz offset: AIP on, 68 dB; AIP off, 67 dB
FM two-tone, third-order IMD dynamic range: Not specified.	FM two-tone, third-order IMD dynamic range at 20-kHz offset: AIP on, 72 dB; AIP off, 68 dB
S-meter sensitivity: Not specified.	S9 signal at 50 MHz: AIP on, 123 μV; AIP off, 21 μV.
Squelch sensitivity: SSB/CW/AM, <2 μV; FM, <0.25 μV.	SSB: AIP on, 3.7 μV; AIP off, 0.7 μV. FM: AIP on, 0.18 μV; AIP off, 0.05 μV.
Receiver audio output: 2 W into 8 Ω with 10% THD.	2.6 W at 10% THD into 8 Ω.
IF/audio response: Not specified.	At –6 dB: CW-N, 621-1222 Hz (601 Hz); USB, 226-1832 Hz (1606 Hz); LSB, 242-2269 Hz (2027 Hz); AM, 120-1700 Hz (1580 Hz).
Image rejection: More than 80 dB.	SSB/CW: AIP on, 65 dB; AIP off, 93 dB; FM, 100 dB (AIP on and off).
Transmitter	*Transmitter Dynamic Testing*
Power output: SSB/CW/FM, adjustable in 3 steps: 10, 50 and 90 W; AM, 4-7, 10-20 and 15-30 W.	Maximum power output typically 98 W SSB/CW/FM and 23 W AM. Minimum power output typically 8 W SSB/CW/FM and 5 W AM.
Spurious-signal and harmonic suppression: >60 dB.	As specified. Meets FCC specifications for equipment in its power output class and frequency range.
Third-order intermodulation distortion products: Not specified.	See Figure 1.
CW keying characteristics: Not specified.	See Figure 2.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S9 signal, 24 ms.
Composite transmitted noise: Not specified	See Figure 3.
Size (height, width, depth): 2.4×7×9.2 inches; weight, 6.4 lbs.	

*Dynamic-range measurements were made at the ARRL Lab standard signal spacing of 20 kHz. Blocking dynamic range measurements with AIP on were noise-limited at the value shown. AGC could not be disabled.

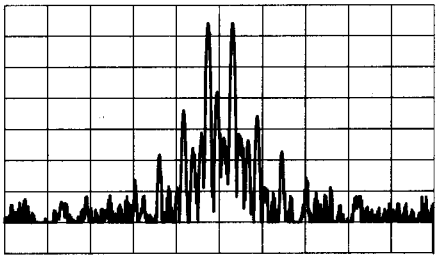


Figure 1—Worst-case spectral display of the Kenwood TS-60S transmitter during two-tone intermodulation distortion (IMD) testing. Worst-case third-order product is approximately 34 dB below PEP output, and the fifth-order product is approximately 47 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 90 W PEP output at 50 MHz.

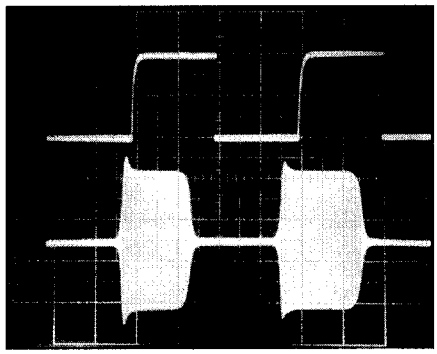


Figure 2—CW-keying waveform for the Kenwood TS-60S in the semi-break-in mode. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 90 W output at 50 MHz. There is only a slight shortening of the first dit.

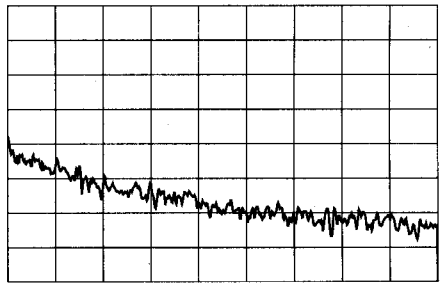


Figure 3—Spectral display of the Kenwood TS-60S transmitter output during composite-noise testing. Power output is 90 W at 50 MHz. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The log reference level (the top horizontal line on the scale) represents –60 dBc/Hz and the baseline is 140 dBc/Hz. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 20 kHz from the carrier. QST