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Author: Dave Newkirk, AK7M

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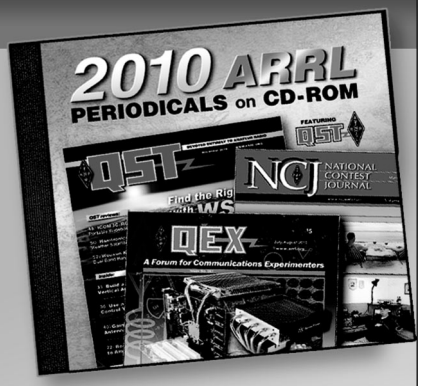

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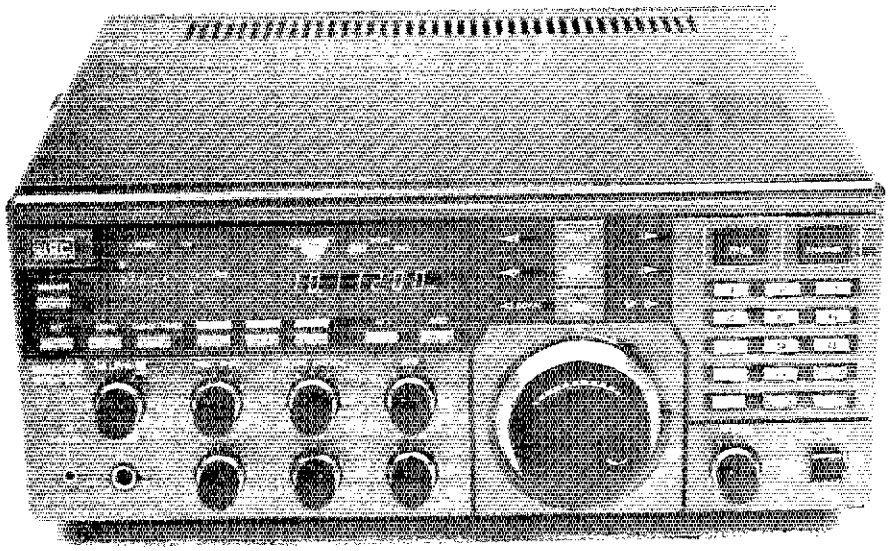
THE JAPAN RADIO COMPANY NRD-525 GENERAL-COVERAGE RECEIVER

Reviewed by David Newkirk, AK7M

The last Japan Radio Company (JRC) product reviewed in *QST* was the NRD-525's predecessor, the NRD-515.[1] What do *you* call a company that upgrades the lone consumer entry in its general-coverage-receiver line only once in seven years? I call it *careful*. The care paid off: The NRD-525 is far more than an upgraded '515. It's an entirely new receiver—and it's about as different from its competitive contemporaries as it is from the NRD-515.



Unusual Construction

The NRD-525 consists mainly of a motherboard and a vertical card cage (see Fig 4). To borrow further from computer terminology, the '525 has four expansion slots: Two allocated to the boards necessary for installation of an optional VHF/UHF converter (CMK-165), one for an optional RTTY demodulator (CMH-530), and one for an optional RS-232-C interface (CMH-532). (None of these options were tested for this review.) The motherboard completes most of the module interconnections you've probably seen made by means of wiring harness(es) in other ham gear.

The '525's front panel—plastic—is coated on the inside with sprayed-on conductive paint. All but a few of the '525's front-panel controls are mounted on the circuit board that backs the panel; umbilical cables connect the panel to the rest of the receiver. The top, bottom and back panels of the receiver are made of thin steel. The '525's tiny internal speaker is mounted in the right-front corner of the top panel; power-supply components are mounted on the rear panel (behind the card cage). The NRD-525 is well-ventilated and runs only warm.

Liberal use is made of surface-mount devices on the '525's circuit boards. Despite this, component density is relatively—and reassuringly—low. An optional extender board—the CMH-365—can be used to lift a given card clear of the cage for tests, adjustment or service work.

Conversion Scheme and Front-End Configuration

Electrically, the NRD-525 is a double-conversion superheterodyne receiver; its intermediate frequencies are 70.45399 to 70.45300 MHz and 455 kHz. All of the signals necessary for frequency conversion in the '525—including BFO and passband-tuning functions—are derived from a 12.8-MHz temperature-compensated crystal oscillator. The synthesizer is a two-loop design: loop 1 generates the first LO signal (1-kHz steps) and loop 2 generates the second LO (10-Hz steps) and BFO signals.

Below 400 kHz, the '525 uses a low-pass network for front-end filtering. From 400 kHz to 34 MHz, the front-end filtering is unusual: Instead of the fixed band-pass filters common in most modern MF/HF gear, the '525 uses top-coupled circuits tuned by voltage-variable-capacitor diodes. The filters are diode switched. Relays are used to switch components *within* several of these filters; this occurs at 400 kHz, and at 1.6, 2.65, 4.4, 7.4 and 12.3 MHz. A relay-switched 20-dB RF attenuator can be selected by means of a front-panel button. The NRD-525's two antenna inputs (50 Ω and 600 Ω) are selectable by means of a rear-panel slide switch.

Technology-watchers, take note: As is reflected in Table 4, the NRD-525's front end is "strong" (resistant to overload). JRC achieves this performance without

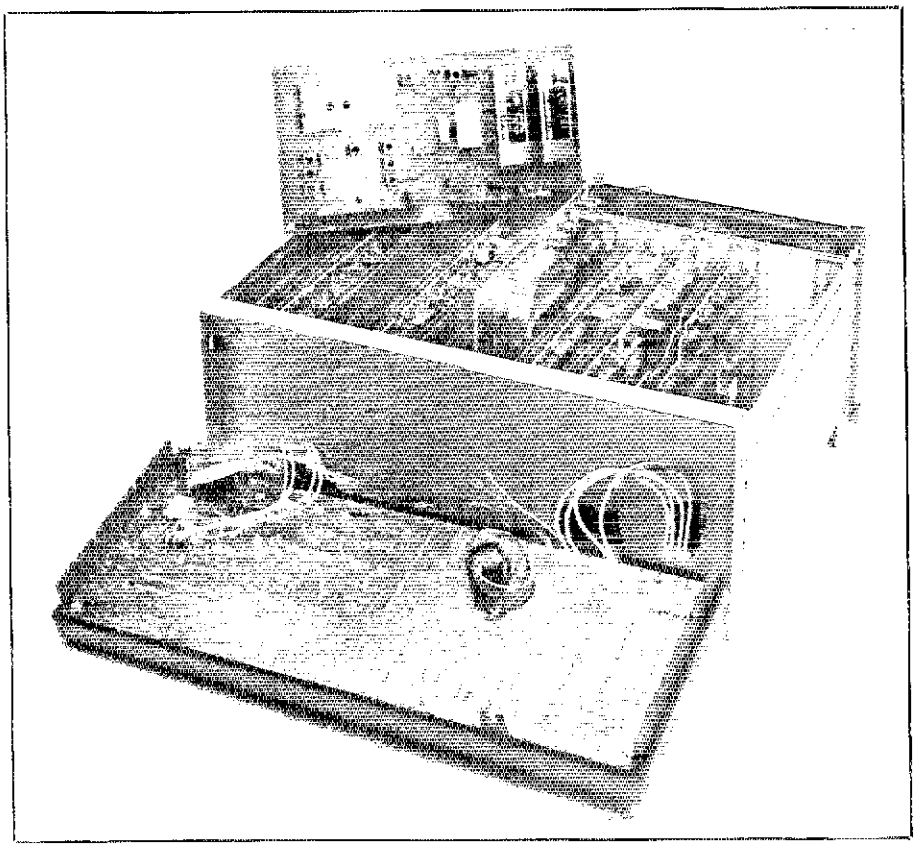


Fig 4—Construction of the NRD-525 receiver. Most of its circuitry is contained on boards mounted in a card cage; here, the IF-filter board has been removed for your inspection. The assembly in the foreground is the '525's plastic front panel—face down.

[1]Notes appear on page 43.

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resorting to esoteric techniques: Each of the receiver's two mixers consists of a balanced pair of 2SK125 JFETs operating at a drain supply voltage of 10.8. The first mixer uses a grounded-gate configuration; the second mixer, grounded-source. The first mixer is preceded by an RF amplifier: two *paralleled* 2SK125s, in a grounded-gate configuration, operating at that 10.8-V drain supply.

Selectivity

The NRD-525's adjacent-channel selectivity is provided by one of up to four 455-kHz filters. These choices are indicated on the '525 fluorescent display as NARrow, INTERmediate, WIDE and AUXiliary, in that order. The filters can be selected independently of mode by means of < and > BANDWIDTH buttons; the buttons allow stepping through the filter choices bidirectionally. Unfortunately, there's no provision for default or "auto" filter selection with mode. Thus, changing modes with the '525 often means pressing *two* buttons, one to select the mode of choice and the other to select an IF filter.

Out of the box, the NRD-525 comes equipped with three stock filters: the first is approximately 3 kHz wide at −6 dB (INTER); the second, WIDE, is about 6 kHz wide; the third, used for FM reception and the AUX default, is 12 kHz wide. JRC offers four optional filters, any two of which can be installed in the NRD-525's NAR and AUX filter positions. These are the CFL-231 (approx 250 Hz wide), the CFL-232 (approx 500 Hz), the CFL-233 (approx 1.2 kHz) and the CFL-218A (approx 1.8 kHz). In the test receiver, the CFL-232 is installed at NAR and the CFL-233 is installed at AUX.

Tuning Range and Tuning Methods

The NRD-525 is specified as tuning from 90 kHz to 34 MHz. In fact, it can be tuned down to 0.00 kHz, although its sensitivity drops off below 90 kHz.[2] The '525's tuning knob tunes in 10- or 100-Hz steps (2 or 10 kHz per revolution, respectively); the < DOWN and UP > buttons shift the receiver tuning in 1- or 10-kHz steps. (Pressing the 525's front-panel RUN button toggles the 525's tuning control and < DOWN/UP > buttons between these step sizes. If this seems like an afterthought, it is: Soon after the '525's release, user feedback persuaded JRC that a tuning rate faster than 2 kHz/r was a necessity. Subsequent production included the RUN-button rate shift; owners of earlier units were offered the option of upgrading their receivers to the newer control program.)

The '525's frequency display can be toggled between 0.1- and 0.01-kHz resolution by a keypad command. The display indicates the suppressed-carrier frequency for a correctly tuned SSB signal; in the RTTY, CW, AM, and FAX modes, the display indicates correctly when the incoming signal (as converted to the 2nd IF) is centered on 455 kHz. The NRD-525's frequency display is not counter-based; it indicates what it is commanded to indicate by the microprocessor.

Modes and Detectors

Mode selection in the '525 is accomplished bidirectionally by means of < and > MODE buttons. Product detection is used in the RTTY, CW, LSB, USB and FAX modes. Receiver operation during these modes differs only in how the '525's BFO is configured. During CW reception, the '525's BFO is tunable (in 10-Hz steps) about ±2 kHz relative to IF center by means of the front-panel BFO control. Because adjustment of the BFO control does not alter the displayed frequency, this arrangement allows the operator to choose the pitch of properly tuned CW signals: You're not locked into the ear-splitting 800-Hz CW pitch so unfortunately

Table 4

Japan Radio Co NRD-525 Receiver, Serial No. BR 41235

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency range: 90 kHz to 34 MHz.	0 kHz to 34 MHz, with reduced sensitivity below 90 kHz.
Modes of operation: RTTY, CW, SSB (LSB, USB), AM, FM, FAX.	As specified.
Receiver Sensitivity	
RTTY/CW/SSB/FAX (for a 10-dB [signal + noise]/noise ratio, 3-kHz filter): 90 kHz-1.6 MHz: 5.0 μV (−93 dBm). 1.6-34 MHz: 0.5 μV (−113 dBm).	Minimum discernible signal (noise floor), with 500-Hz filter: 1 MHz: −140 dBm 3.5 MHz: −137.5 dBm 14 MHz: −137 dBm 29 MHz: −134 dBm
AM (for a 10-dB [signal + noise]/noise ratio, test signal modulated 30% with a 400-Hz tone, 90 kHz-1.6 MHz: 15 μV 1.6-34 MHz: 2 μV	Test signal modulated 30% with a 1-kHz tone, 3-kHz filter: 1 MHz: 0.72 μV 3.5 MHz: 1.0 μV 14 MHz: 0.63 μV 29 MHz: 1.0 μV
FM (for 20-dB quieting): 0.7 μV from 1.6-34 MHz.	0.38 μV for 20 dB quieting; 0.4 μV for 12-dB SINAD at 29 MHz.
Receiver dynamic range: 100 dB or more (with 500-Hz IF filter).	Blocking dynamic range (dB)†: 1 MHz: 135 3.5 MHz: phase-noise limited 14 MHz: 140 29 MHz: 133.5
	Two-tone, third-order intermodulation distortion dynamic range (dB)†: 1 MHz: 95 3.5 MHz: 93.5 14 MHz: 95 29 MHz: 93
	Third-order input intercept (dBm): 1 MHz: +2.50 3.5 MHz: +2.75 14 MHz: +5.50 29 MHz: +5.50
Image rejection: 70 dB or more.	Not measured.
IF rejection: 70 dB or more.	1st-IF (70 MHz) rejection: 103 dB.
Pass-band shift range: ±1 kHz or more.	Not measured.
Notch filter attenuation: 30 dB or more.	37 dB at 750 Hz.
Squelch sensitivity: Not specified.	29 MHz, FM mode: 0.13 μV min.
S-meter calibration (μV for S9 reading): Not specified.	44 at 1.02 MHz; 55 at 3.52 MHz; 62 at 14.02 MHz; 84 at 29.02 MHz.
BFO tuning range: 455 kHz ±2 kHz or more.	+2.286/−2.193 kHz.
RIT range: ±5 kHz max.	As specified.
Receiver audio output: 0.5 W or more at 10% distortion with 4-Ω load.	2.9 W at 5% total harmonic distortion with 4-Ω load.
AGC characteristic: Audio output varies 10 dB or less with RF input variation from 3 μV to 100 mV.	Varies 0.5 dB from 3 μV to 100 mV.
Color: Black and dark gray.	
Size (height, width, depth): 5.1 × 13 × 11 inches (excludes projections).	
Weight: 18.7 lbs.	

†Tone spacing was the ARRL Lab standard of 20 kHz for blocking dynamic range test and two-tone, third-order IMD dynamic range test.

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routine in modern factory-made ham gear. Further, the '525's tunable BFO allows the operator to choose the "sideband" in which CW signals will be received—in other words, how the pitch of received signals varies as the receiver is tuned in a given direction. In the RTTY, USB, LSB and FAX modes, the BFO control is inoperative and the BFO-to-IF relationship is fixed. The BFO offset is 2.21 kHz for RTTY; 1.5 kHz for USB and LSB; and 1.9 kHz for FAX.

The NRD-525's AM detector is unusual. The '525's SN16913P product-detector IC operates in all modes except FM. During RTTY, CW, LSB, USB and FAX reception, the '16913P's BFO port is driven by the NRD-525's BFO. During AM detection, the BFO is switched off, and the incoming signal—at IF—is fed to a limiter strip in addition to the normal IF amplifier. The limiter removes the AM sidebands and recovers the signal carrier. The recovered carrier is fed to the BFO port of the product-detector IC to demodulate the carrier-plus-sidebands signal at the product detector's IF port. Although some publications refer to this as "synchrophase" detection—after the term used several years ago by the R. L. Drake company for a similar circuit—it is none other than true *exalted-carrier* detection. My subjective impression is that the NRD-525's exalted-carrier AM detection sounds equal to or worse than rectification detection achieved by means of a lowly point-contact diode! The NRD-525's narrow-band FM reception is adequate.

AGC

The NRD-525's automatic-gain-control button steps *unidirectionally* through OFF, FAST and SLOW choices. Moving from SLOW to FAST, therefore, requires that you move through OFF. If you want to save your ears, this makes every SLOW-to-FAST AGC adjustment a two-control operation: You must reduce the AF or RF gain first—or risk being blasted.

S Meter

The NRD-525's S meter consists of a 40-segment horizontal "moving dot" display. The display scale is calibrated in half-S-unit increments from S1 to S9 (bluish white), and in 2.5-dB steps from S9 to S9 +65 dB (red). Signal strengths are indicated by the apparent motion of a green "vertical hyphen" beneath the scale.

Keypad, "VFOs" and Memories

In effect, the NRD-525 has two frequency-control modes, FREQuency and CHANNEL. Movement between these modes is toggled by buttons marked accordingly. In the frequency mode, the '525's tuning knob and < DOWN/UP > buttons adjust only the receiver tuning; the keypad enters frequencies directly. In this mode, the NRD-525 has one "VFO." Keypad frequency entry can be in kilohertz or megahertz. Leading and trailing zeros need not be entered, and the keypad allows frequency entry down to the 10-Hz resolution of the synthesizer. Although the feel of the keys belies the expense of the receiver, they work well, are clearly labeled, and are laid out in the format common to calculator and telephone keypads.

Pressing CHANNEL puts the '525 into its memory mode. In this mode, the tuning knob adjusts frequencies, the < DOWN/UP > buttons step down or up through the '525's 200 memories, and the keypad allows direct entry of memory channels by channel number. Each memory stores frequency, mode, bandwidth, AGC and attenuator settings; a lithium cell backs up this information. Any of the data in a given memory channel can be altered at will, including frequency. In popular terminology, this gives the NRD-525 "200 VFOs." (Not *201* VFOs, I add. Switching from FREQ to CHANNEL and selecting a memory channel obliterates the frequency/mode/bandwidth/AGC/attenuator settings present in the FREQ mode. Such information must be written to memory if it will be needed again; returning to the FREQ mode does not restore it.)

What I miss in the 525's frequency-control scheme is a VFO A/B switch. Under some circumstances, the ability to toggle rapidly between two frequencies is useful. With the NRD-525, this can be achieved only by storing the desired two frequencies in adjacent memory channels and toggling between them with the < DOWN and UP > buttons.

Scanning, Sweeping, Shifting, Notching

Each equipment manufacturer has its own idea of how these equipment-control frills should perform; JRC presents yet another approach in the NRD-525. The '525 can scan its memory channels and sweep frequencies between two preset limits. Three buttons (SCAN, SWEEP and RUN) and two dual-function controls (PBS/SPEED and P LEVEL/NOTCH) control these features. (For the remainder of this discussion, I'll refer to scan and sweep reception as *automatic reception.*)

During normal reception, the PBS/SPEED and P LEVEL/NOTCH controls adjust the passband-shift and IF-notch circuits, respectively. The '525's notch filter does a really—dare I say?—topnotch job in the receiver's product-detection *and* AM modes. The IF shift circuit works as expected; it functions in product-detection *and* AM modes.

During automatic reception, the PBS/SPEED control sets scanning/sweeping speed and P LEVEL/NOTCH sets the signal level at which automatic reception is interrupted. (On some receivers, the latter function is handled by a squelch-threshold control; the NRD-525's SQUELCH and P LEVEL controls operate *independently.*) During automatic reception, the notch circuit is inoperative and the IF-shift circuit is set to the center of its tuning range. The front-panel SCAN, SWEEP and RUN buttons are used to select automatic reception, to set memory and frequency limits, and to start and stop automatic reception. (Pressing the FREQ or CHANNEL buttons also returns the '525 to normal reception.)

I don't like two things about the '525's automatic-reception features. First, no means are provided of locking a channel out during scanning—a major flaw in any scanning scheme. Second, the NRD-525's sweep function operates only in steps of 1 kHz. In my opinion, 1-kHz steps are too coarse for sweep operation during heterodyne detection: The tuning steps chop up signals too much for recognition unless the sweep rate is very slow. I can't get too excited about these "flaws," though: They're far removed from basic radio performance and do not seriously detract from the utility of the NRD-525.

More Features

The DIMMER button steps the fluorescent display and front-panel indicator LEDs through four levels of brightness from off ("nearly off" for LEDs in the FREQ, CHANNEL and LOCK buttons) to sunlit-room level. The receiver defaults to the brightest dimmer setting when first turned on.

Pressing RIT turns the tuning knob into a fine-tuning control capable of tuning 5 kHz above and below the nominal tuned frequency. During RIT operation, the frequency display indicates only the RIT offset. The RIT circuit retains the last-tuned offset even when RIT operation is turned off or the receiver is powered down.

Several of the NRD-525's secondary features indicate that the Japan Radio Company has the radio amateur in mind, particularly the CW operator. The '525 can be muted for use with a transmitter, and sidetone can be injected into the receiver audio chain via a rear-panel connector. The sidetone level is adjustable by means of a trimmer potentiometer accessible through a hole in the receiver's bottom cover. Also accessible through a bottom-panel hole is the MONITOR LEVEL potentiometer—an auxiliary RF-gain control that comes into play only when the receiver is muted *and* the front-panel MONI button has been pressed. Result: Thanks to JRC, you can monitor your transmitted signal off-air with the NRD-525!

The NRD-525's CLOCK/TIMER button switches the receiver's display from frequency to time (HH:MM) and steps unidirectionally through four time-display options (clock 1, clock 2, timer on and timer off). Once CLOCK/TIMER has been pressed, the keypad can be used to set the clock and timer times. Like some other receivers billed as having two clocks, the NRD-525 seems to have *one* clock with two programmable displays: Clock 2 "rolls over" in synchronism with clock 1 no matter when clock 2 is reset. The timer can

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be used to control an external device by means of normally-open and -closed relay contacts; these contacts, none of which is common to chassis, are accessible via a rear-panel barrier strip. Although the NRD-525's memory information is backed up by a lithium cell, the clocks *aren't*: If you unplug the receiver—or if ac power fails—you'll have to reset the clocks.

The NRD-525's noise blanker works *sometimes*—just like every noise blanker I've ever used. Its threshold can be adjusted by means of the NB LEVEL control; pulling this control out lengthens ("widens") the blanking interval to combat the Soviet over-the-horizon radar and similar noises.

The NRD-525 provides fixed-level audio output at its front-panel RECORD and rear-panel LINE OUT jacks. The output level is adjustable.

The NRD-525's keypad has a few special functions in addition to allowing direct entry of frequencies and memory channels. These are: (1) selection of whether or not the receiver tuning and displayed frequency shift when moving between LSB and USB, and from these modes to RTTY, CW, AM and FAX; (2) selection of 0.1- or 0.01-kHz frequency-display resolution; (3) selection of blinking or static colon during time display; (4) whether or not pressing any (except DIMMER) of the set's push buttons results in the emission of a beep (mercifully, the factory default for this is *off!*); and (5) whether or not the front-end filters are used. (Yes! The front-end filters can be switched entirely out of the circuit to remove filter loss [during weak-signal reception, the instruction manual suggests]. ARRL lab tests reveal, however, that this feature gives mixed results. Switching out the filters *degrades* the noise floor by 33.5 dB at 1.02 MHz, and *improves* the noise floor at 3.52 MHz [5 dB], 14.02 MHz [0.5 dB] and 29.02 MHz [1.5 dB]. These figures were derived with the 3-kHz IF filter in use.)

Power Supply and Rear-Panel Connections

The NRD-525 can be powered from dc at 12 to 16 (nominally 13.8) V (power consumption, 25 W max) or ac at 100, 120, 220 or 240 V (35 VA maximum, frequency range not stated). A fuse holder is integral with the ac voltage selector. Ac connection is made by means of a chassis-mounted CEE-22 connector; a two-terminal connector is included for dc operation. Other rear-panel connectors include: high-Z (spring-operated, wire) and low-Z (SO-239, coaxial) antenna terminals for 90 kHz to 34 MHz; LINE OUT, EXTernal SPeaker, SIDE TONE, MUTE and DC OUT (10.8 V, 30 mA maximum)—all phono; TIMER OUT (24 V, 3 A maximum); PRINTER (Centronics; present only when the optional RTTY demodulator is installed); OSCILLO MARK and SPACE (phono; these allow connection of an oscilloscope for tuning indication when the optional RTTY demodulator is installed); VHF ANT and UHF ANT (present only when the optional VHF/UHF converter is installed) and RS-232-C (present only when this optional interface is installed).

The NRD-525 comes with an instruction manual, a spare 1-A fuse, a three-wire ac cord, a dc power cord and a plug for every jack not associated with an option.

Documentation

The 35-page *Instruction Manual for Model NRD-525* is succinct and complete. Although its English is occasionally substandard, it covers operation of the NRD-525 well. Good news, technology-watchers: Schematics and a block diagram *are included* in the instruction manual, as well as instructions on how to install optional IF filters and replace the lithium backup cell.

The typewritten appearance of the optional, 154-page *NRD-525 General Coverage Receiver Service Manual* belies the expense and quality of the '525, but it's safe to assume that everything necessary for service and alignment is there. Neither manual contains detail on the control features afforded by the '525's RS-232-C option.

Performance Notes

This is one modern radio that has knobs you can *grab*. The tuning knob is free-wheeling and sufficiently heavy; the rest of the knobs are of uniform size (½ inch in diameter) and well spaced. There are *no* concentric controls! The push buttons are large and spaced for operation by real people! Wake me up—I must be dreaming.

Aside from a bit of IF-filter blowby, the NRD-525's basic radio performance is excellent, and this is reflected in the ARRL Lab test results in Table 4. In particular, the set's blocking dynamic range is outstanding, indicating (1) a strong front end and (2) a relatively phase-noise-quiet frequency synthesizer. (One exception to this: Mysteriously, the 3.52-MHz blocking-dynamic-range measurement was phase-noise limited.) As is *not* the case with some other "communications" receivers and general-coverage transceiver receivers, the '525's designers have chosen *not* to reduce intentionally the '525's medium-wave sensitivity. Because of this, the NRD-525 is a superb medium-wave DX receiver.

The '525's tuning range is practically free of internally-generated spurious signals. By *practically* I mean that most spurs disappear into the noise when an antenna is connected—and that what few remain are hardly a problem. The strongest spur appears at 12.8 MHz; that's the '525's microprocessor-clock frequency. Weak harmonics of signals associated with the '525's fluorescent display are evident below 400 kHz; these sound somewhat like TV-oscillator harmonics and can be identified by the fact that they shift frequency as the DIMMER button is pressed.

I'm a bit put off by the low-level 13-kHz whine apparent in the '525's audio output during headphone operation. I suspect that this has to do with the dc-to-dc converter used with the fluorescent display. This whine is not present in the '525's RECORD and LINE audio outputs. If your hearing doesn't stretch to 13 kHz, you'll never know the whine is there!

The '525's synthesizer generates slight clicks every kilohertz at 0.1 kHz points, and overshoot (my term: fishtailing) because of long settling time is noticeable as CW signals and carriers are tuned. This is okay with me, because I know that this generally means a phase-noise-quieter synthesizer—and because the NRD-525's on-the-air performance indicates that its phase-noise characteristics are excellent.

The '525's slow AGC decay is overly long, and its fast AGC might be considered "medium" by hard-nosed CW addicts. The AGC seems a bit clicky on attack; this is especially noticeable with the AGC set to FAST, of course.

Although the NRD-525 does a fine job on AM and SSB, it isn't the smoothest-sounding receiver I've used for strong-signal reception on these modes: I can occasionally hear what sounds like detector overdrive on signal peaks during reception of *very strong* AM and SSB signals. It's possible that this is an AGC-overshoot effect. The NRD-525 *really* shines during weak-signal CW reception. Distortion in the audio chain is minimal, the TONE control is effective in cutting wide-band IF hiss, the BFO control allows me to set the receiving pitch (and "sideband") of my choice, and the '525's 2 kHz/r slow tuning rate is smooth as velvet. Ahhh!

Conclusion

The NRD-525 doesn't feel like *Amateur* Radio gear. That's not surprising: The Japan Radio Company has been manufacturing radio gear since 1915, and its principal business is satellite, marine and other professional communications equipment. If you're looking for a receiver capable of excellent SWL *and* two-way-communication performance, there may be an NRD-525 in your future!

Manufacturer: Japan Radio Co, Ltd, Akasaka Twin Tower, 17-22, Akasaka 2-chome, Minato-ku, Tokyo 107, Japan. Available from several US distributors. Price class: NRD-525, $1365; CFL-232 500-Hz filter, $150; CFL-233 1 kHz filter, $150; NVA-88 external speaker, $60.

Notes

[1]Gerry Hull, "Japan Radio Company Model NRD-515 All-Wave Receiver," Product Review, *QST*, Nov 1981, pp 42-43.

[2]The '525's ability to tune to 0.00 kHz—that is, to listen to its own LO—results in a hidden feature: The receiver can be used as an accurate source of audio test tones! The '525 must be in the CW mode, BFO tuning set at center, for correct display of the tone frequency. Example: For a 440-Hz tone, key in 0.44 kHz. This works from about 3.5 kHz (above which spurs and hiss spoil the purity of the tone) down to at least 200 Hz. This discovery was made by ARRL Lab Engineer Ed Hare, KA1CV.