IMPROVING KEYPAD CONTROL FOR MODERN RECEIVERS

An Approach for the NRD525

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Photos by Tom Zistatsis

The ergonomics or "human interfacing" of communication receivers is largely unexplored territory. Manufacturers of specialized, low production volume equipment such as Japan Radio Corporation's NRD525 receiver place low priority on making their equipment comfortable to use hour after hour.

The makers of mass-marketed products like automobiles have the budget to employ specialists in this field, and these professionals must apply their skills to every aspect of the product for acompetitive edge.

Any DXer who has used the NRD525 (or another receiver with a front panel keypad) for hours on end has found the vertical positioning of the keys to be a real pain. John Bryant in *Proceedings 1989* wrote that "It's simply unnatural for the human hand to punch something into a vertical surface. If this were not so, all typewriters and computer keyboards would have vertical rather than horizontal keyboards. Put the keypad on as a remote hooked by cable to the front face, or step into the mid-1980's and remote it with infra-red. Pulling the keypad off the front face would give the designers enough room to do some other things which badly need attention just as well."

John is an architect with industrial design experience. He understands ergonomics, and further criticizes the NRD525 keypad: "If JRC designers must put the bloody keypad on the front face, at least they should have had enough regard for their customers to provide either soft keys or rounded off hard ones. Instead JRC carefully selected hard, sharp-edged keys with front faces sloping about 15 degrees from vertical. If your hand happens to hit the key at the correct angle, it's fine. However, most of the time my fingers hit wrong and it's about like punching slightly dull knives. Is this a serious design flaw? Putting the keypad on the front face at all certainly is. The shape and hardness of the keys is merely a pain in an already sore posterior."

The keypad on the front face of the receiver is a problem that applies to other modern, digital receivers in general. Owners of the R71A and NRD515 receivers have ready solutions in the remote keypads that Icom and JRC make available, but what can be done to improve keypad operation on other radios?

DESCRIPTION

The remote keypad described in this article is designed for the JRC NRD525. However, a similar approach should work with other pushbutton controlled radios.

The concept is simple–the keypad is nothing more than a converted desktop calculator. The pushbuttons on the NRD525's front panel are connected in parallel to the pushbuttons on the gutted calculator. The press of a key on the remote keypad sends a electronic pulse to a corresponding key inside the receiver. A length of shielded computer cable connects the keypad to a plug on the back of the NRD525, while a computer ribbon cable routes the pulses from the back panel, underneath the Motherboard, and up to the appropriate circuit trace on the receiver's Display Board (behind the front panel).

This keypad permits the easy, swift entry of frequencies, memory channels, mode, bandwidth, and AGC

settings. It also gives control over the tuning rate and resolution ("RUN" button) and up/down frequency and channel slewing. The numeric keys are rearranged from the non-standard layout on the radio's front panel into the usual "10-key" configuration. The buttons on the remote keypad are twice the size of those on the NRD525, and have a softer touch. With a little practice it's possible to keep your eyes on the receiver while rapidly changing frequencies, memories, etc. by touch alone from the keypad. This ability REALLY speeds up bandscanning during a "hot" DX opening or changing grayline reception conditions.

The basic method of converting a calculator to a remote keypad for the NRD525 can apply to similar calculators. The calculator I used is a Sharp "Elsi-Mate" EL-334. It is solar-powered, measures 3-7/8" x 6" x 1/2", and comes with a useful "kickstand" on the back to tilt the unit toward the operator. Many drug and department store chains stock this model (about $14.00), or a virtually identical one marketed by Casio. The EL-334 has 24 keys, which can be used to control receiver functions most useful to you.

If the calculator you choose has more keys, and you want to control more receiver functions, you may need different shielded cable, ribbon cable, and connectors to handle more signal lines. Whatever brand and model you choose, I suggest you find one that has large, well-spaced keys. Also, if the overall size of the calculator is smaller than the EL-334, you may find it very difficult to install the necessary wiring.

I strongly recommend you have the NRD525 Service Manual available when constructing this project. You should possess excellent soldering skills. The circuit traces you will be making are delicate, and the circuitry you will be working on inside the NRD525 can be damaged by excess heat, static electricity, or sloppy soldering. Of course, your receiver's warranty will be invalidated by this surgery. Though not for the faint of heart, this project will substantially improve your radio's flexibility and speed of operation.

MATERIALS NEEDED (* = optional):

Sharp Elsi-Mate EL-334 (or similar) desktop calculator

1 sq. ft. clear self-adhesive vinyl ("contact" paper)

1 roll 1/16" wide adhesive copper tape (Active #76083, $2.47)

30 ga. wire-wrap wire ("Kynar") (Active #86349, $4.95)

5 ft. of 15 conductor, 24 ga. round shielded computer cable (Active #84023, $0.65/ft)

*1 qty. 15-pin, sub-D male connector w/solder pot contacts (Active #85079, $1.79)

*1 qty. hood (boot) for 15-pin, sub-D connector (Active #81211, $4.22)

*1 qty. panel-mount 15-pin, sub-D female connector, terminating in 15-pin flat cable connector, IDC-type (Active #58006, $4.08)

*2 ft. 15 conductor ribbon cable (Active #58101, $0.47/ft.)

*1 qty. 16-pin, dual row IDC female socket (Active #58173, $3.30)

*1 qty. 16-pin, dual row, IDC low-profile male header (Active #58146, $1.71)

OTHER SUPPLIES/MISC. TOOLS:

Small diameter heat shrink tubing, to fit 24 ga. computer cable wires

Fine or Extra Fine grade steel wool

rub-down lettering, white & black letters & symbols as needed (Mecanorma #2196600 wht., #2196100 blk., 2mm. high letters.

Triangle or arrow symbols: Letratype #68920)

protective clear plastic spray (Illinois Bronze "Crystal Clear Glaze" or equiv. from craft supply)

jeweler's screwdriver set

elec. drill & small diameter drill bits

You can save about $17 or $18 by eliminating all the parts listed above as optional, if you don't mind the remote keypad "hardwired" into the receiver via the rear panel. I chose to make the keypad so I could unplug it from the rear of the receiver, as well as making the NRD525's front panel/Display Board easily detachable from the remote keypad wiring (in keeping with the receiver's modular, plug-in approach). This involves considerable work, but results in a professional looking job.

If you hardwire the unit to the NRD525, the round cable could be routed through one of the unused VHF or UHF antenna input holes (remove plug) on the rear panel. You may need to drill a couple holes in the interior chassis to get the wires to the back side of the Display Board.

PREPARING THE CALCULATOR CASE

Current calculators such as the EL-334 utilize a sheet of rubber "bubbles" or domes that pop up and down when a key is depressed. Inside each dome is a small conductive pad that shorts out a trace on a circuit board, sending an electric pulse to the calculator IC chip and numeric display. By applying new circuit traces to the PCB, current flow can be redirected to control the NRD525.

Modifying the existing calculator PCB is simpler and quicker than making a totally new printed circuit board for our purposes. The original board is irregularly shaped, with numerous, tiny drill holes for small screws to hold the board to the calculator case. Completely recreating this specific board shape would be very time consuming.

To begin, disassemble the case halves. The EL-334 is held together by two small screws and six internal tabs. After removing the screws, a table knife or similar straight edge can be used to pop the case apart. Be careful not to break any of the small plastic tabs.

Remove all the screws holding the calculator's printed circuit board in place. Clip off wires going to the solar cell, and discard the small battery. Cut off and discard the flexible wiring board that runs from the PC board to the LCD panel. Remove and separate the rubber dome sheet and the plastic keys. Watch out for a small "U" shaped metal rod that may fall out from behind the EQUALS key. Notice how the wire rod is used, because it will be needed at reassembly.

Set aside the numeral keys 0 to 9 and the decimal point key. Using the fine steel wool, gently buff off the printing on the other keys. With care, you should end up with smooth, blank keytops. You'll need to decide on the functions of your receiver that you wish to control remotely, keeping in mind the number of keys on your particular model of calculator.

The blank keys are labeled using the rub-down lettering, and protected from wear with a few thin coats of clear plastic protective spray. The brand of spray I used (listed above) gave excellent results, and is described as "flexible" and "non-yellowing". The keys for MODE, BANDWIDTH, DOWN, and UP need arrow or directional triangles, with the appropriate wording just above the keys on the calculator case itself.

Use your imagination when camouflaging the upper portion of the top case. Thanks to the ingenuity of *Proceedings* Senior Editor John Bryant, my remote keypad is covered with custom graphics. He had a trophy shop imprint a thin, brushed aluminum panel with a map of the world and appropriate lettering. I covered the aluminum panel with clear 1/16" thick Lexan plastic for protection.

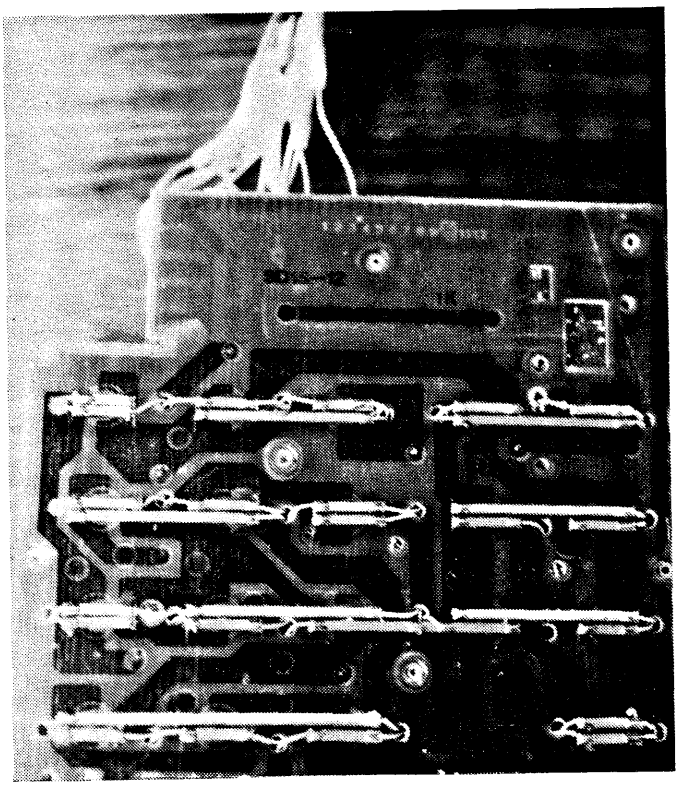
KEYPAD WIRING

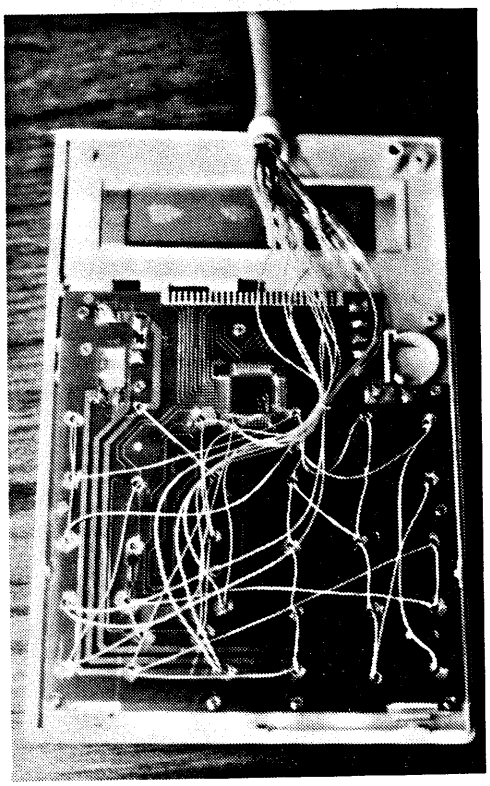
Refer to Figure 1 which is reproduced from the NRD525 Display Board schematic. This matrix diagram is the key (no pun intended) to the design of your remote controller. The matrix allows 32 different switches (keys) to reside on only 12 signal lines. These lines are attached to pins 11, 13, 15, and 17 on IC7 and the anode side of diodes CD9 through CD16. The MEMO switch is attached directly to pins 1 and 7 of IC1. By paralleling the appropriate signal lines we can remotely control any of these switches.

The printed circuit board of the calculator is used only as a platform for the construction of electrical contacts for the keypad controller. Firmly apply a layer of clear, self-adhesive plastic to the side of the PCB that faces the rubber contact sheet, and trim off the excess. This electrically isolates the PCB from the new circuit traces.

Notice the small circular areas or interlocking "fingers" on the PCB located beneath each rubber dome/pushbutton location. Construct a pattern of short, parallel lengths of 1/16" copper tape on the clear plastic, centered over each circular area. The parallel copper strips should be no more than 1/32" apart, and should extend about 1/8" left and right beyond the circular area (original PCB contact fingers). Be certain that each pair of copper strips is positioned exactly; the small conductive pads inside the rubber domes need to complete the circuit when a key is pressed.

Drill a small (1/32") hole at the end of each pair of copper strips. Pre-tin with solder the very ends of each copper strip. Using the NRD525s switch matrix diagram Figure 1 and Figure 2 if you have the EL-334 calculator, solder together the copper strips with wire-wrap wire. Route the wires through the 1/32" holes, across the back of the PCB, and back through a hole to the next copper strip. Link all copper strips together in this fashion, and leave about 6" extra wire connected at the end of each matrix line for attaching to the





shielded cable. It helps to visualize the wiring pattern if you attach the bottom copper strip from each pair to only horizontal matrix lines, and upper copper strips to only vertical matrix lines. Make all connections quickly, with a minimum of solder, so the plastic sheet will not melt. The final product will be a spiderweb of wires on the back of the PCB, with a clean pattern of copper contact strips on the front. Photo at above left shows front side, and photo at above right shows back side of PCB.

Drill a hole at the top (side) of the case half to accept the round, shielded computer cable. Insert the cable into the hole, and make small, neat connections between one end of each matrix line and a conductor of the shielded cable. (Make a note of which matrix line you attach to which conductor.) Insulate each joint with a small piece of heat shrink tubing. A cable-tie around the shielded cable can serve as a strain relief inside the case. Reassemble the entire calculator case with all components, being careful not to pinch any wires.

Leave about three feet of cable between the keypad controller and the sub-D male connector. Assemble the connector and its boot to the shielded cable, soldering matrix line (cable conductor) #1 to pin #1 on the sub-D connector, matrix line #2 to pin #2, and so on. Solder the cable's ground (shield) wire to a pin by itself, adjacent to the last matrix line connection.

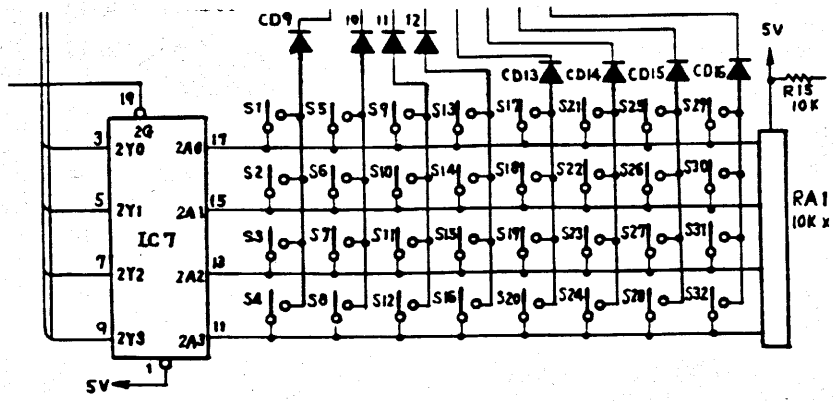
WIRING INSIDE THE RECEIVER

Remove the NRD525's top and bottom covers. Remove the side screws that hold the rear panel to the chassis, and also remove the screws that attach the Ground and Hi-Z antenna terminals. Pivot rear panel toward you and disconnect wiring harnesses from rear panel. Desolder coax from SO239 (panel mount) antenna connector. This frees the rear panel for installation of the keypad's sub-D connector.

Take a deep breath, and drill & file a rectangular hole in the back panel of the NRD525 sufficient to hold the panel-mount female sub-D/IDC ribbon cable connector. A good spot for this connector is just to the left of the Model Number and Serial Number block. Drill two holes for the nuts and bolts to fasten the connector to the rear panel.

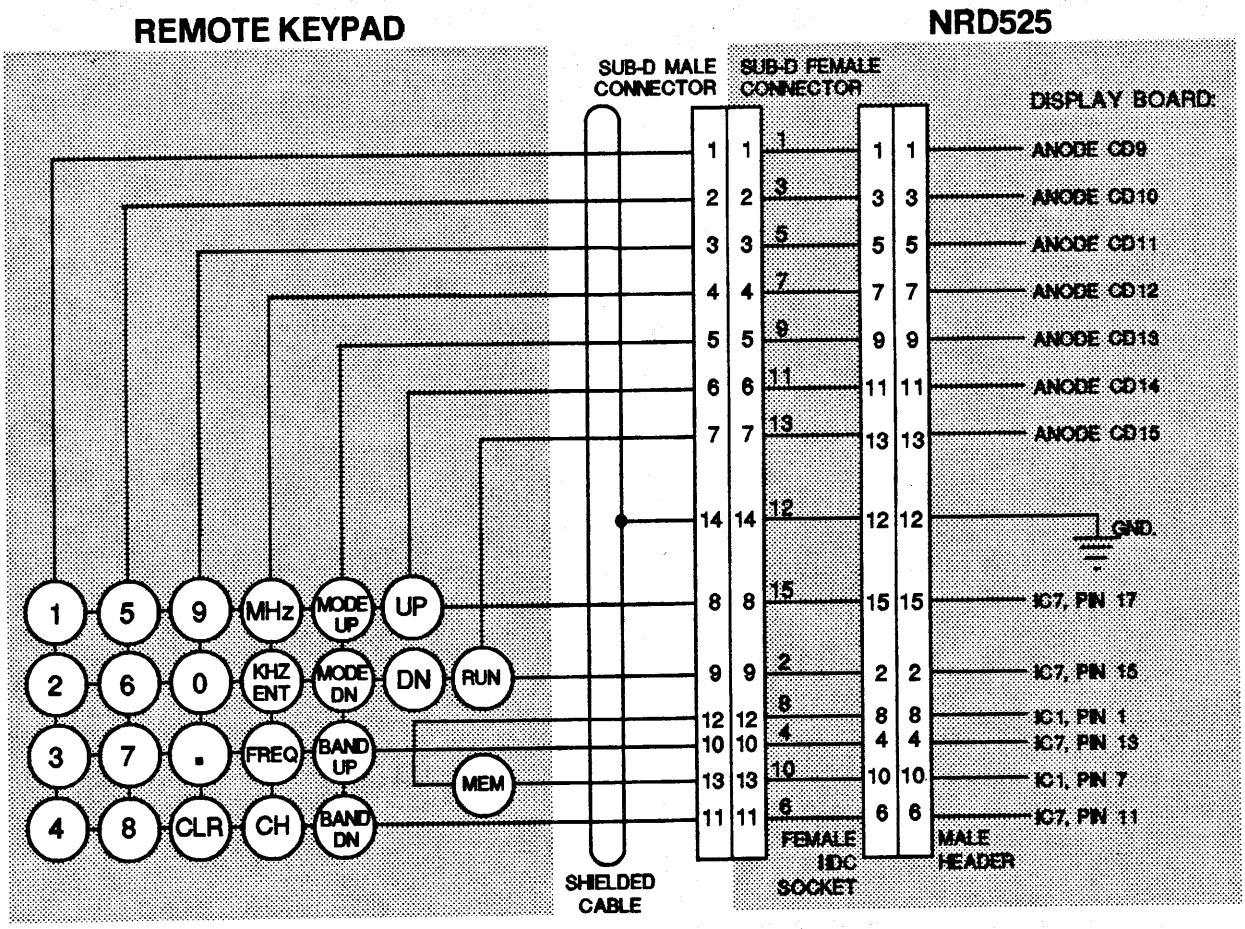
Attach a two foot length of ribbon cable to the connector, with the striped (or otherwise marked) #1 conductor going to the connector's pin #1. Carefully route the ribbon cable between the Ground/Hi-Z Ant. block and the antenna SPDT slide switch, and underneath the receiver's Motherboard forward to the Display Board. Resolder the SO239 connector on the rear panel and reassemble rear panel.

Figure 1



S	NAME	S	NAME	S	NAME	S	NAME
1	TEN KEY 1	9	TEN KEY 9	17	MODE ▶	25	ATT
2	• 2	10	• 0	18	MODE ◀	26	RUN
3	• 3	11	PERIOD •	19	BAND ▶	27	SCAN
4	• 4	12	CLR	20	BAND ◀	28	SWEEP
5	• 5	13	MHz	21	UP	29	CLOCK/TIMER
6	• 6	14	KHz/ENT	22	DOWN	30	MONI
7	• 7	15	FREQ	23	LOCK	31	RIT
8	• 8	16	CH	24	AGC	32	DIMM

Figure 2



Loosen the two screws at the top of the front panel, unsnap the side tabs from the chassis and tilt the front panel/Display Board assembly forward. You will be making solder connections to this, the non-component (reverse) side of the Display Board.

Solder 10" lengths of wire-wrap wire to the short pins of the 16-pin, low-profile male header. Using epoxy, attach the header near the edge of the Display Board, positioned so that the 16-pin IDC female socket can plug into it. Attach the female socket to the ribbon cable, allowing enough slack for the socket to reach the header.

Carefully note the orientation of the integrated circuits on the Display Board. Solder each wire-wrap wire from the header to the appropriate pins of IC7 and the anodes of CD9 through CD15. Route the leads neatly, and bundle them together where necessary. Attach the two leads for the MEMO key to pins #1 and #7 on IC1. Connect the IDC female socket to the header.

CHECKOUT

Attach the keypad controller's sub-D connector to the receiver, turn on the radio, and try out all functions. A single, light press of each key should be sufficient to register with the NRD525, with no false or extraneous entries. If the unit does not operate properly, trace the signal path from the controller to the solder connections on the Display Board using a multimeter or continuity tester. Make repairs if necessary.

When all appears to be operating correctly, reassemble the receivers case and enjoy your NRD525 remote keypad controller! I've found that I enjoy using my keypad controller by operating it with my left hand, which leaves the right hand free to adjust the NRD525s main tuning knob and other controls or to make entries in a logbook. I estimate I can change frequencies, memory channels, etc. with the remote controller in one half the time it would take to accomplish on the receivers front panel keypad.

FINAL NOTES

If you find that the keypad causes some digital circuit noise in the receiver, the internal ribbon cable may be picking up interference from the fluorescent display. My unit does not suffer from this, but an identical installation in another NRD525 produced some digital noise on the higher frequencies. The installation of .1 uf (50vdc) capacitors between each signal line connection and chassis ground eliminated the noise. Keep all capacitor leads short, and make connections as close as possible to the joint. Fabricate a short, grounded buss wire and route all capacitor ground leads to it.

You will occasionally need to remove oxidation from the copper strips inside the keypad case to ensure positive action of the keys. A light rubbing with a pencil eraser is sufficient.

ACTIVE ELECTRONICS: order line 1-800-ACTIVE-4 (outside New England), or 1-800-ACTIVE-6 (New England) M-F 8am-6pm EST. By mail: P.O. Box 9100, Westborough, MA 01581