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Pacific Research RI-300/Ri310 Controller Application Note #9

A Method of using the RBI-3 to control a Kenwood 541

Executive Summary:
A Kenwood 541 transceiver will be used as a remote base without the use of an additional RI-300. The RBI-3 (Remote Base Interface) option is installed in the RI-300. Other similar Kenwoods such as those for 2M, 220 and 440 could also be used with this approach. Simple cable connections, an interface board and some inventive programming make this project interesting.

The Connections:
A cable was constructed to connect the Kenwood 541 8-pin "Microphone" connector to the DB9 connector on the interface board. The other end of the interface board connects to the male DB25 on the RBI-3.
Pin-outs with numbers and labels are listed here:

Kenwood 541 ↓	DB9 pins	Label	Interface board: ↓	RBI-3 DB25
Pin # 1	5	Audio In to Kenwood Microphone	|	3
Pin # 2	4	PTT to Kenwood	|	4
Pin # 4	8	Step UP (DO 11)	|	8
Pin # 6	1	Kenwood Discriminator out- Audio in to controller	|	2
Pin # 7	3	Audio Ground	|	15
Pin # 8	3	Digital Ground	|	21
Radio	2	COS (Wire from radio- Location listed below)	|	6
		Interface board internal DO 15	|	12
		Interface board internal DO 14	|	11

The Interface board:
The circuitry on the interface board consists of a 74LS02 four-element NOR gate, and a 4053 audio multiplexer device. This board interfaces the DB25 on the RBI-3 to the Kenwood 541 via a DB9.

The Interface board was constructed from a piece of double sided perforated board with plated through holes. One side of the board has a ground plane that covers the board, with clearances for each of the plated through holes on the ground-plane side. The board was cut to match the size of the pins on the DB25 connector. See Photos below.

I installed a DB9 connector on the 541-interface side, so as to make this board a modular one. The wiring, schematics, and connections are listed below. A matching DB9 connector was attached to the cable coming from the 541.

You will notice on the top side photo that the ground plane has been carefully cut out around each of the pins on the DB9. These "lands" allow mechanical connection to the DB9 pins without shorting any of them together, or to ground. A long notch was cut in the DB25 side, with pins attaching the connector to the board only at the 25-13 end and the 1-14 end. The remaining DB25 pins are hanging free within the notch.

DESIGN AND TESTING COMPLETED BY CARMEN D'AGOSTINO, N6AKK

Under side photo   Top Side photo
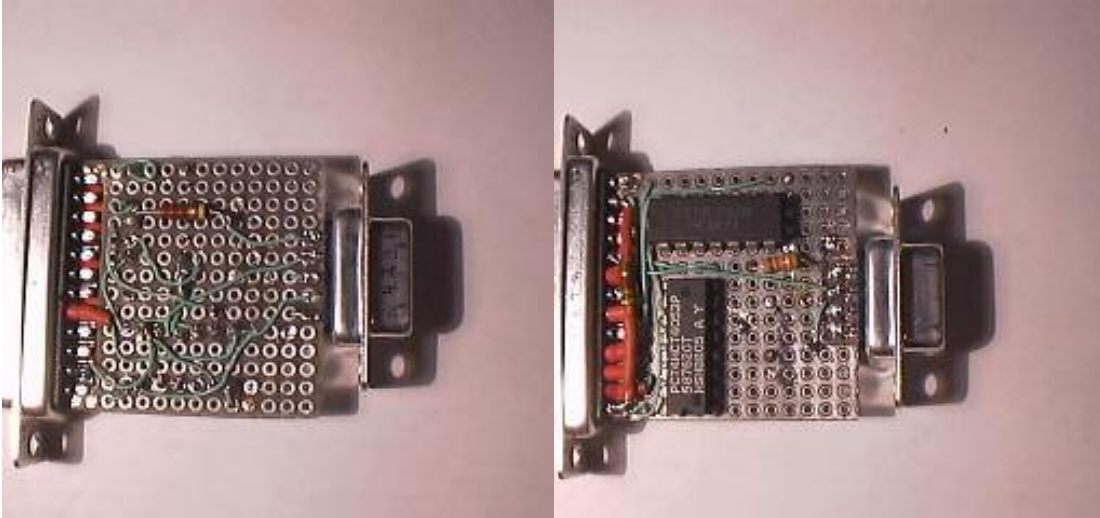
As you can see, there are not many connections, nor are there difficulties in construction. A Dremel tool with a very fine cutter is required to remove the ground plane connections around the DB9 pins. There are only two chips, four resistors, one 0.1mfd capacitor, and two connectors.

Schematic:
The DO 15 line and the DO 14 line each have a 4.7k resistor to (+5v) to pull up the line. The internal pull-up is insufficient to drive the logic. The .1mfd capacitor provides de-emphasis for the 541 audio sourced from the "discriminator" pin of the 541 microphone connector.

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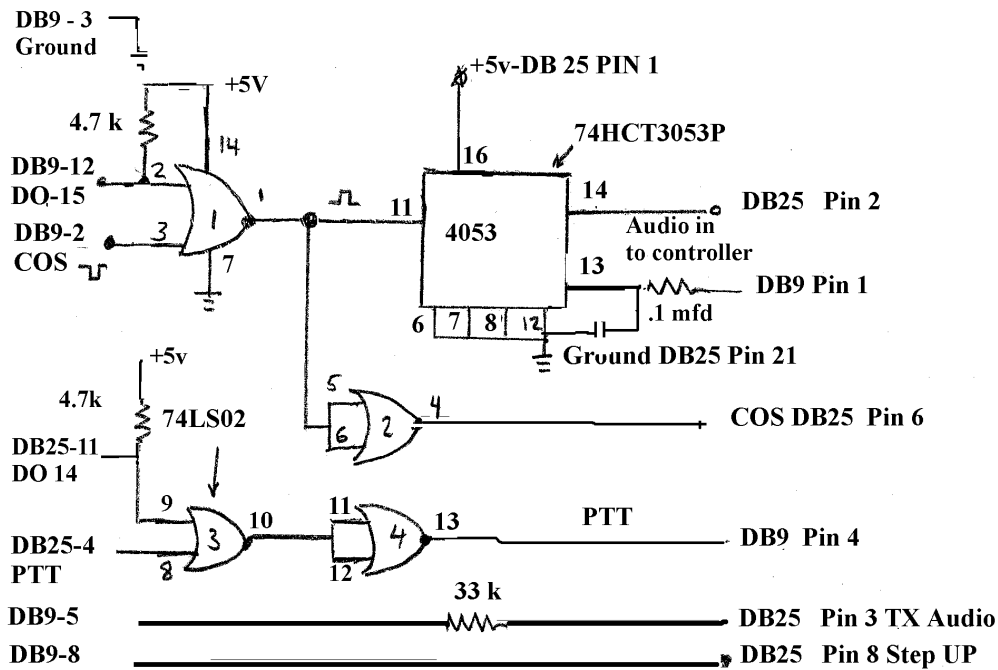
The Control Line:
DO line #15 is used to gate the COS from the 541, and the 541 discriminator audio to the controller inputs. DO 14 gates the PTT from the controller to the Kenwood 541. In this configuration, DO15 and DO14 together either completely connect or sever communication between the RBI-3 and the Kenwood 541.

The COS Source:
Of particular note is the COS line. Since we are unable to use the Smartsquelch of the controller in which the RBI-1 module is installed, a digital COS must be created. A fancy way, and somewhat expensive, would be to use a separate squelch device like the MOT unit from LinkCom to create a negative going COS from the microphone audio. If one used the MOT unit, the COS output could be used with the interface board without getting it from the Kenwood as described below. The following explanation shows how to obtain a negative going signal from an internal point in the 541 radio that can be used for a COS.

A COS from the 541
Remove the bottom cover on the 541 radio. With the front panel and knobs toward you, locate a connector pin arrangement very close to the front panel at the lower edge of the pc board. There are two of these pin arrangements, one to your middle left, and one on the middle right. Let's look at the one on the left. There are 13 pins arranged as six away from you, and seven towards you and the front panel. The second solder pad from the left on the row of six is the COS take off. Check this pin with power on and a scope or high impedance multi-meter to make sure the correct pin has been chosen. The correct point goes from about 5 volts towards ground when the receiver senses a signal.

Solder a small (#22 or so) wire to this pad, and thread it through the space available in the front center of the board, near the middle casting bump. Remove the upper cover (the one with the speaker) and route the wire to the power feed-through. Lift the red and black power wires with plastic feed-through strain relief, and route the COS wire to the outside. Clip a small plastic cable clamp through a loop in the COS wire inside the radio for a strain relief, then pass the wire through the groove in the casting made for the power wires.

Replace the power wires with their strain relief over the COS wire. Replace top and bottom covers. Done. This wire will be sent to Pin #2 of the DB9 connector on the interface board, as per the chart above.

Programming.

The objective is to create three main macros, along with some support and indexing macros. One main macro would turn ON the interface from the 541 to the controller, the other would turn the 541 interface OFF, and the third would step "UP" the channel selection. The 541 radio will have just four channels programmed into its memory available for selection.

Two RI-300 commands must be set to provide the correct default interface to the 541. The command "35 8"is the command for interfacing the RX audio from the 541 to the repeater controller, and the "92" command sets the appropriate configuration of RBI-3 DB25 pins as a remote base. See Command #92 for details. Please see the Programming panel note that labels the 92 6 choice as the #5 position.

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Linking is accomplished using DO15 and DO14. The purpose of separating the linking controls into two DO lines is to provide the option to selectively disable the PTT line while retaining the ability to listen to the 541 receiver input. .

Note that the command 35 8 configures "Controller #8" as always on, using the programming panel. You will see a note on the panel that says that turning ANY of the link addresses ON will enable the RBI-3 inputs, but AT LEAST ONE must be on to allow audio from the RBI-3 to be recognized by the controller. With complete and crisp control of the interface using DO14 & DO15, there is no downside to leaving # 8 on at all times.

This system has a "legitimate" 2 Meter link at Aux address #2 using another RI-300 controller attached to a Yaesu FTL 2 Meter transceiver. The configuration described here is compatible with that 2 Meter remote, and works without logical interference. All combinations of 2 Meters on/off, or 1.2 on/off can be chosen.

When the 541 remote is on, the remote follows the repeater PTT exactly. There is no carrier delay. When the 2M remote is on, the 541 remote may be on or off, depending on the DO 15/14 status.

Let's look at the INTERFACE ON macro: Line 159

06 1	Suppress FC (Function Complete) once
46150	DO 15 OFF (Negative output)
46140	DO 14 OFF (Negative output)
40 31618000	Delay Timer 3, line 161, 8000 seconds.
30 001	Start of Msg
30 008	Delay 1 Second
30 033	ONE
30 432	POINT
30 034	TWO
30 405	ON
30 002	End voice
64	

This is the OFF macro: Line 161

06 1	Suppress FC once
46 141	DO 14 ON
46 151	DO 15 ON
30 001	Start voice
30 008	Delay 1 Second
30 033	ONE
30 432	POINT
30 034	TWO
30 402	OFF
30 002	End of voice
64	End

This is the "STEP UP" macro: Line 171

40 4 163 1	Delay timer 4, 1 Sec. Go to line 163 1.2 Remote off
40 5 166 2	Delay timer 5, 2 Sec. Go to line 166 Negative Pulse
40 6 159 2	Delay timer 6, 2 Sec. Go to line 159 1.2 Remote on
40 7 179 2	Delay timer 7, 2 Sec. Go to line 179 Increment & Report.

On Line 163: Remote PTT OFF Macro.

06 1	Suppress FC once.
65491400	If DO 14 =0 Then
46 141	DO 14 ON
30 001	Start Voice
30 008	Delay 1 Second
30 008	Delay 1 Second
30 402	OFF
30 002	End Voice
64	Else
64	End

Line 166: The First part of Step UP command: (Starts the Negative Pulse). This two-part macro actually increments the 541 memory:

06 1	Suppress FC
30 001	Start Voice
30 008	Wait 1 Second
30 570	UP
30 002	End voice
46 110	DO # 11 off (DO 11 goes negative)
40 4 169 001	Delay #4 for one second, jump to 169
64 End	

On line 169: Second part of UP command, (Finishes negative pulse)

06 1	Suppress FC
46 111	DO #11 ON (DO 11 goes Positive)
64	End

You will notice the use of the "40" command in all these macros. These delays allow smooth channel changing of the 541 radio after the repeater PTT is released. Remember, the Kenwood 541 cannot have its status changed while it is transmitting. Additionally, the multi-tasking nature of the processor demands that serial activities be separated by delay.

It is possible to use the pulse feature of command 47 for this "UP" operation. The operational state of the pulse, however, is that the pulse goes Positive. We need a negative pulse. To use the positive pulse feature of command 47, one would have to invert the signal with an inverter, or use an NPN transistor to invert the signal. These macros eliminate the need for additional hardware, although an additional inverter could be located on the interface board described above, and command 47 could be used.

The challenge in creating the "UP" macro was that the 541 radio will not change channel while it is transmitting, and it WOULD be transmitting if it is interfaced while the repeater is active. To change the channel from the repeater input, the remote must first be de-interfaced to put the 541 in "receive" mode. Once de-interfaced, the 541 radio will respond to the DO11 pulse to change channels.
 The Change UP macro also increments User Variable #3 to a numeral within the range of 1 and 4. A user variable larger than four resets UV #3 to a value of 1.

A message macro tests for the value of User Variable #3, and will speak the name of one of the four channels programmed in the Kenwood 541 memory.

Since this scheme is "Open Loop"- that is, there is no way for the controller to know which of the four channels is REALLY selected, there has to be a way to "index" the spoken readout to agree with the actual channel that is selected. The determination of the actual channel is done empirically, by listening to the link signal. Once the actual channel and the readout messages are in synch, there should be no de-synching unless a power failure or program upload occurs.

The Message Macros:
Messages have been constructed to speak the name of the repeater or link that exists in each of the Kenwood 541 memories, based on the value of a user variable.(UV)

Start line 173: This is a message macro only, it does not increment the UV 3.

65 77 03 0 1	If UV 3 = 1, Then
67 181	Call Macro line 181
64	Else
65 77 03 0 2	If UV 3 = 2, Then
67 182	Call Macro line 182
64	Else
65 77 03 0 3	If UV 3 = 3, Then
67 183	Call Macro line 183
64	Else
65 77 03 0 4	If UV 3 = 4, Then
67 184	Call Macro line 184
64	Else
65 77 03 0 5 * 77 03 3 5	If UV 3 = 5or > 5, Then
99 03 1	Make UV 3 = 1
67 181	Call Macro line 181
64	Else
64	End Macro

Start line 181: One of the voice macros that show the status of the UV.

30 001	Start Voice
30 076	N
30 038	SIX
30 063	A
30 073	K
30 073	K
30 002	End Voice
64	End

Lines 182, 183, 184 are similar to line 181 , with different call signs installed.

The Indexing Macros:
The "Index" macro will increment the user variable WITHOUT incrementing the 541 memory. This action shifts the index relationship with the actual 541 memory value. At each index operation, the voice readout of the value of the channel associated with that user variable will be announced to tell the user the synch status.

Line 179 The Indexing macro, called by User command, and by the "UP' command, Line 171.

99 03 *	Increment UV 3 by one.
67 173	Call Macro Line 173 – Say Channel Status name.

Adjustments:
Two potentiometers exist on the RBI-3 board to control audio levels to and from the 541 remote. See the RI300 manual for placement. Counterclockwise adjustment of these pots gives more gain to the respective signal.

Automatic Interference reduction:
When keying control commands over a linked system, the tones heard over the link are a constant source of annoyance to users of the linked-to systems. A scheme has been developed to minimize this interference. The target system of a remote base frequency selection doesn't hear you coming, but once linked, even if you <u>don't</u> want to talk on the target system, they WILL hear you when you want to de-interface your remote from them. Here's how I deal with that.

Line 146, the remote PTT disable macro:

06 01	Suppress FC once
65 25 0 028	If PL decode =13 then
67 163	Call line 163, The PTT OFF Macro
64	Else
64	End

This macro is called by the Lo-Hi trigger, and is executed every time a key-up occurs. When a PL of 100 Hz exists, the Line 163 Macro is executed. The Hi-LO trigger command is 45 23 1 146. In operation, a transmission using 100 Hz PL turns off the PTT to the remote and allows you to change channels, or operate your repeater in "Monitor-Mute/Mix" mode, while using a PL of 100 Hz.
You can hear, and command, but no tones are sent to the Linked-To system. Neat.

Channel changing Summary:
Demonstrated here is a way to change the channel by integrating elements of the OFF macro, the UP macro and the ON macro into one macro with appropriate delays, so as to allow the 541 to come to a receive state, and accept the channel UP pulse. Because an interfaced remote can only be in receive mode after the end of the PTT from the repeater, delay was added to allow the remote to move to receive mode before the UP command activates. The Idea was to UP the channel, <u>without the need for the user to execute multiple commands</u>. Additionally, the use of a different PL code allows courteous control by not having control tones sent to the Linked-To system.

Final Summary:
An RI-300 user can implement an interface to a dedicated remote using simple connections, an interface device and programming, with the Remote Base option (RBI-3) from Pacific Research.

Channel changing is provided, and although there is some open-loop feedback to the user indicating the channel selected, an index macro must be used in case the actual Channel and the Readout channel get out of synch.

Choosing the frequency to be memorized in each of the Kenwood 541 channels is critical when using an in-band remote. Antenna design and directional properties are important to minimize desensitization.

The above method is working at this time, but subject to improvement without notice.

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