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RT-1 REMOTELY-CONTROLLED ANTENNA TUNER

Article 2: Tuner Box Construction

Mark Connelly, WA1ION

26 DEC 1984

Article 1 of this series, dated 24 OCT 1984, described design features and operating concepts of the RT-1 remote tuner. Also presented was the schematic diagram of the unit.

This article (RT-1 Article 2) provides information required to build the active remote tuner box assembly of the RT-1 system. Instructions and tables should be sufficiently explicit to those who've done even just a modest amount of "homebrew" DX project construction.

To keep this article brief and unambiguous, I've decided to treat only the construction of the tuner box itself; cable and control box construction will be dealt with in Article 3 (to be released JAN 1985). Articles beyond #3 are anticipated to cover remote tuner applications, possibly including phasing of two remotely-tuned antennae.

I have about 10 MVAM115's available at present; auctions, flea markets, and commercial suppliers are always being checked for more. For those seriously interested in building the RT-1, I will sell MVAM115's at \$ 2.50 each (postpaid US & Canada) until my supply runs out.

Construction Outline

1. Read this article and RT-1 Article 1 thoroughly before starting the project. Keep both articles at the work area.
2. Obtain the parts specified in the Level 1 & Level 2 Parts List. Organize them in work area.
3. Ensure that customary electronics tools are available: screwdriver & nutdriver sets, drill & bits (per Hole List), soldering station & solder, accurate ruler, scriber, X-Acto knives, several styles of cutters & pliers, wire strippers, etc. (Other construction projects by me and by others will give the builder a good idea of which tools and shop supplies should always be accessible.)
4. Measure & mark chassis box hole locations; then drill holes (initially with a 0.113" bit, then with the final size bit if hole is to be larger). Consult Hole List.
5. Mount the following components (using hardware supplied with each component): J1, J2, J3, J4, J5, J6, M1, R1, S1, & S2. Install knob on S1 so that the pointer is at a 10:30 (clock)/NW (compass) position when S1 is set to its most-CCW/"1" position. Install knob on R1 so that the pointer is at an 8 o'clock position when R1 is set fully CCW.
6. Mount G1, G2, and G3 grounding hardware assemblies at the locations given by the Hole List. Each assembly consists of a 4-40 X .25 screw whose head rests against the outer chassis surface, a #4 solder lug on the screw against the inner chassis surface, and a 4-40 nut to hold the solder lug against the chassis.
7. Connect wires and "air-wired" components in accordance with the Wiring / Component Connections table. Use good soldering practice, including cleaning of flux from all joints. Leads of all "air-wired" components should be kept as short as possible without putting stress on the leads.
8. Finished unit may be inspected and tested (see Article 1 for expected performance characteristics).

Parts List for RT-1 Remote Tuner

NOTES: Prices (current DEC 1984) are subject to change.

Level 1 list = electrical & major mechanical components
 Level 2 list = small hardware (a total estimated price is given instead of item-by-item listings)

Stock #'s for mechanical (hardware) components and for fixed resistors represent packs having more than the needed number of components.

RS = Radio Shack - many locations
 MOU = Mouser Electronics - 11433 Woodside Ave. - Santee, CA 92071
 DK = Digi-Key Corp. - P. O. Box 677 - Thief River Falls, MN 56701
 me = Mark Connelly - 30 William Road - Billerica, MA 01866

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Level 1

Component Designation	Description	Vendor	Stock #	(US \$) Est. Price
C1	15 pF mica capacitor	MOU	586-DM015	0.40
C2	.001 uF disc capacitor	RS	272-126	0.39
C3	.1 uF monolithic cap.	DK	P4525	0.18
C4	.1 uF monolithic cap.	DK	P4525	0.18
C5	.1 uF monolithic cap.	DK	P4525	0.18
C6	.47 uF monolithic cap.	DK	P4533	0.41
D1	MVAM115 varactor diode	me	(LIMITED QUANTITY)	2.50
J1	stereo headphone jack	RS	274-277	1.39
J2	banana jack (red)	RS	274-662	1.39
J3	banana jack (red)	RS	274-662	1.39
J4	banana jack (black)	RS	274-662	1.39
J5	BNC jack	RS	278-105	1.69
J6	BNC jack	RS	278-105	1.69
L1	3300 uH molded inductor	MOU	43LH233	0.75
L2	150 uH molded inductor	MOU	43LS154	0.39
L3	8.2 uH molded inductor	MOU	43LQ826	0.38
L4	390 uH molded inductor	MOU	43LR394	0.46
L5	18 uH molded inductor	MOU	43LS185	0.39
L6	1 uH molded inductor	MOU	43LS186	0.39
M1	FE-A Front End Card	me	FE-A	15.00
R1	500 ohm linear pot w/swt.	MOU	31CT205	0.99
R2	4.7K resistor	RS	271-1330	0.39
R3	15K resistor	RS	271-1337	0.39
R4	68 ohm resistor	RS	271-010	0.19
S1	3-pole, 4-pos. switch	MOU	10W034	1.08
S2	SPDT on/on toggle switch	RS	275-326	1.99
--	knob for R1	MOU	45KN013	0.42
--	knob for S1	MOU	45KN013	0.42
--	chassis box (5.25"x3"x2.125")	RS	270-238	2.49

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(RT-1 Parts List - continued)

Level 2

NOTE: Mounting hardware is supplied with the following Level 1 components: J1, J2, J3, J4, J5, J6, M1, R1, S1, & S2.

The builder must provide hardware as follows:

Components (Qty.) where used	Total Qty.	Description	Vendor	Stock #
G1(1), G2(1), G3(1)	3	4-40X.25" screw	MOU	572-01880
G1(1), G2(1), G3(1)	3	#4 solder lug	MOU	565-1416-4
G1(1), G2(1), G3(1)	3	4-40 nut	MOU	572-00484

Estimated total cost of hardware actually used to construct the RT-1 is \$ 1. Approximate total cost of all RT-1 parts is \$40. (THIS DOES NOT INCLUDE CABLES OR CONTROL UNIT.)

Hole List for RT-1 Remote Tuner

BOX USED = (approx.) 5.25" X 3" X 2.125" aluminium (Radio Shack 270-238, or equivalent)

X = horizontal distance, in inches, from the vertical centreline (VCL) on the side observed. Negative values of X are left of VCL; positive values of X are right of VCL.

Y = vertical distance, in inches, from the bottom horizontal edge of the side observed.

D = hole diameter in inches.

LEFT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	G1	GND hardware (int. lug)	-0.75	1.25	0.113
2	J5	External Coil In, BNC	0.0	1.25	0.375
3	J3	Shortwire In, banana jack	-0.75	0.5	0.3125
4	J4	Earth GND In, banana jack	0.0	0.5	0.3125
5	J2	Longwire In, banana jack	0.75	0.5	0.3125

TOP SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	S1	Freq. Range switch, tab	-1.25	2.0	0.14
2	S1	Freq. Range switch, shaft	-1.25	2.5	0.375
3	R1	Attenuator Pot, shaft	-1.25	0.625	0.3125
4	R1	Attenuator Pot, tab	-0.9375	0.625	0.14
5	M1	FE-A card - hardware 2	0.0	2.375	0.113

TOP SIDE (RT-1 Hole List - continued)

Hole #	Comp. Desig.	Description	X	Y	D
6	M1	FE-A card - hardware 1	1.0	2.375	0.113
7	M1	FE-A card - hardware 4	0.0	1.375	0.113
8	M1	FE-A card - hardware 3	1.0	1.375	0.113
9	S2	Q switch, shaft	0.0	0.5	0.25
10	S2	Q switch, tab	0.0	0.25	0.113
11	G2	GND hardware (int. lug)	1.5	0.5	0.113

RIGHT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	J1	Control/Power In, shaft	0.0	1.25	0.375
2	J1	Control/Power In, tab	0.0	0.96875	0.14
3	J6	RF Out, BNC	0.0	0.5	0.375
4	G3	GND hardware (int. lug)	0.625	0.5	0.113

Wiring / Component Connections for RT-1 Remote Tuner

NOTES: W = insulated wire (approx. #22 AWG)
 BW = bare (solid) buss wire
 TPN = twisted-pair of insulated wires (where n = the designation number of that pair)

Use "spaghetti" (plastic insulation) on all component leads longer than 0.5".

INSIDE BOX:	From	To	Description
	R1 CCW pin	J2	2" W
	R1 arm	S1B arm	1.5" W
	R1 CW pin	R1 switch side nr CW pin	1" W
	M1 card GND lug	R1 switch side nr CCW pin	1.5" BW
	J4	G1 internal lug	1.5" BW
	M1 card GND lug	jct. L4/L5/L6	1.5" W
	S1A pin 1 (CCW)	jct. L4/L5/L6	L4
	S1A pin 2	jct. L4/L5/L6	L5
	S1A pin 3	jct. L4/L5/L6	L6
	S1A arm	S1B arm	0.5" BW
	J3	jct. L1/L2/L3/C1	C5
	S1B pin 1 (CCW)	jct. L1/L2/L3/C1	L1
	S1B pin 2	jct. L1/L2/L3/C1	L2
	S1B pin 3	jct. L1/L2/L3/C1	L3
	S1B pin 4 (CW)	jct. L1/L2/L3/C1	C1
	S1C arm	J5	1" W
	M1 pin P1	jct. L1/L2/L3/C1	1.5" W
	S2 arm	jct. L1/L2/L3/C1	1.5" W
	S2 Low Q position	M1 card GND lug	R3
	S2 arm (anode)	jct. C2/D1 cathode	D1
	M1 card GND lug	jct. C2/D1 cathode	C2
	jct. R2/C6	jct. C2/D1 cathode	3" W
	M1 pin P3	J1 pin B	2" W
	G2 internal lug	J1 pin B	C4
	J1 pin A	jct. R2/C6	R2
	G3 internal lug	jct. R2/C6	C6
	G3 internal lug	J6	R4
	M1 pin P5	J6	2" TPI
	M1 pin P6	G3 internal lug	2" TPI

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RT-1 REMOTELY-CONTROLLED ANTENNA TUNER

Article 3: Control Box and Cable Construction

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27 DEC 1984

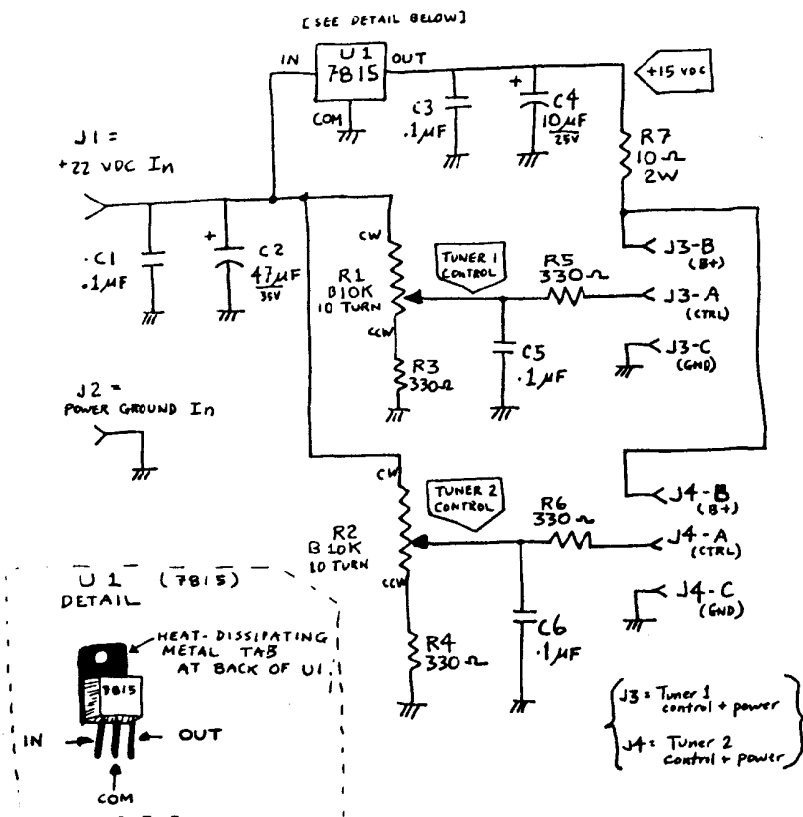
Article 1 of this series, dated 24 OCT 1984 introduced the RT-1 remote antenna tuning system. Article 2 (26 DEC 1984) gave details necessary to build the remote tuner box part of the RT-1 system.

This article (RT-1 Article 3) provides information required to build an operating-position control box (DTC-1) capable of controlling one or two RT-1 remote tuner heads.

Construction details will follow the same paradigm used in Article 2: outline, parts list, hole list, and wiring & component-connection list.

Part I: DTC-1 Dual Tuner Controller Box

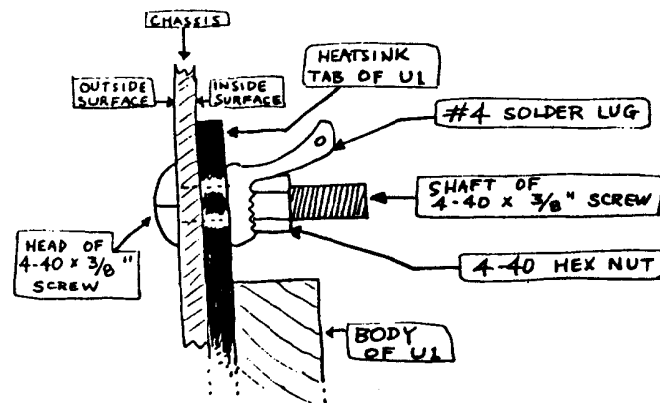
Figure 1: DTC-1 Schematic Diagram



Construction Outline

1. Read this article thoroughly before starting the project. Keep a copy of the article in the work area.
2. Obtain the parts specified in the Level 1 & Level 2 Parts List. Organize them in work area.
3. Ensure that customary electronics tools are available; Refer to construction outline given in RT-1 Article 2.
4. Measure & mark chassis box hole locations; then drill holes (initially with a $\emptyset.113"$ bit, then with the final size bit if hole is to be larger). Consult Hole List.
5. Mount U1 to the chassis using G1 mounting / grounding hardware in accordance with Figure 2.

Figure 2: +15 V Regulator Mounting



6. Mount G2 & G3 hardware at the locations specified by the Hole List: assembly is the same as that used in Figure 2 except that there is no regulator IC at the G2 & G3 locations.
7. Mount the following components (using hardware supplied with each component): J1, J2, J3, J4, R1, & R2. "Loctite", or a similar substance, should be painted onto the mounting threads of each jack and pot during mounting to prevent later loosening and slippage.
8. Install knobs on R1 & R2 so that the pointers are at the 6 o'clock position when each pot is set fully CCW.
9. Connect wires and "air-wired" components in accordance with the Wiring / Component Connections table. Use good soldering practice, including cleaning of flux from all joints. Leads of all "air-wired" components should be kept as short as possible without putting stress on the leads.
10. Inspect finished DTC-1; set it aside and proceed to Part II (Cable Construction).

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Parts List for DTC-1 Dual Tuner Control Box

NOTES: Prices (current DEC 1984) are subject to change.

Level 1 list = electrical & major mechanical components
 Level 2 list = small hardware (a total estimated price is given instead of item-by-item listings)

Stock #'s for mechanical (hardware) components and for fixed resistors represent packs having more than the needed number of components.

RS = Radio Shack - many locations
 MOU = Mouser Electronics - 11433 Woodside Ave. - Santee, CA 92071
 DK = Digi-Key Corp. - P. O. Box 677 - Thief River Falls, MN 56701
 me = Mark Connelly - 30 William Road - Billerica, MA 01866

Level 1

Component Designation	Description	Vendor	Stock #	(US \$) Est. Price
C1	.1 uF monolithic cap.	DK	P4525	0.18
C2	47 uF/35V electrolytic cap.	RS	272-1015	0.69
C3	.1 uF monolithic cap.	DK	P4525	0.18
C4	10 uF/25V tantalum cap.	DK	P2049	0.82
C5	.1 uF monolithic cap.	DK	P4525	0.18
C6	.1 uF monolithic cap.	DK	P4525	0.18
J1	banana jack (red)	RS	274-662	1.39
J2	banana jack (black)	RS	274-662	1.39
J3	stereo headphone jack	RS	274-277	1.39
J4	stereo headphone jack	RS	274-277	1.39
R1	10K, 10-turn pot	me	B10K-10T	3.50
R2	10K, 10-turn pot	me	B10K-10T	3.50
R3	330 ohm resistor	RS	271-1315	0.39
R4	330 ohm resistor	RS	271-1315	0.39
R5	330 ohm resistor	RS	271-1315	0.39
R6	330 ohm resistor	RS	271-1315	0.39
R7	10 ohm / 2 W resistor	RS	271-000	0.69
U1	7815 regulator IC (+15V)	RS	276-1772	1.59
--	knob for R1	MOU	45KN017	0.54
--	knob for R2	MOU	45KN017	0.54
--	chassis box (5.25"x3"x2.125")	RS	270-238	2.49

Level 2

NOTE: Mounting hardware is supplied with the following Level 1 components: J1, J2, J3, J4, R1, & R2.

The builder must provide hardware as follows:

Components (Qty.) where used	Total Qty.	Description	Vendor	Stock #
G1(1), G2(1), G3(1)	3	4-40 X .375" screw	MOU	572-01881
G1(1), G2(1), G3(1)	3	#4 solder lug	MOU	565-1416-4
G1(1), G2(1), G3(1)	3	4-40 nut	MOU	572-00484

Estimated total cost of hardware actually used to construct the DTC-1 is \$1. Approximate total cost of all DTC-1 parts is \$25.

Hole List for DTC-1 Dual Tuner Control Box

BOX USED = (approx.) 5.25" X 3" X 2.125" aluminium
 (Radio Shack 270-238, or equivalent)

See RT-1 Article 2 for definitions of parameters X, Y, & D.

LEFT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	J2	GND In, banana jack	-0.375	0.5	0.3125
2	J1	+22 VDC In, banana jack	0.375	0.5	0.3125
3	G1	U1 mounting/GND hardware	0.0	1.25	0.113

TOP SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	R1	Tuner 1 Control Pot	-0.875	1.375	0.375
2	G2	GND hardware (int. lug)	0.0	2.0	0.113
3	R2	Tuner 2 Control Pot	0.875	1.375	0.375

RIGHT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	J3	Tuner 1 CTRL/PWR Out, shaft	-0.625	0.625	0.375
2	J3	Tuner 1 CTRL/PWR Out, tab	-0.625	0.34375	0.14
3	G3	GND hardware (int. lug)	0.0	0.375	0.113
4	J4	Tuner 2 CTRL/PWR Out, shaft	0.625	0.625	0.375
5	J4	Tuner 2 CTRL/PWR Out, tab	0.625	0.34375	0.14

Wiring / Component Connections for DTC-1 Dual Tuner Control Box

NOTES: W = insulated wire (approx. #22 AWG)
 BW = bare (solid) buss wire

Use "spaghetti" (plastic insulation) on all component leads longer than 0.5".

On J3 & J4 the A pin is that which mates to the tip end of the plug inserted; the B pin is that which mates to the plug's centre section (neither the A nor the B pin mates to the outer shell (ground)).

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Dual Control Box Wiring / Component Connections

INSIDE BOX:

From	To	Description
J1	J2	C1
J1 (+ of C2)	J2 (- of C2)	C2
J1	U1 In pin	1" W
G1 lug	U1 GND pin	2" W
G1 lug	J2	1" BW
U1 Out pin	jct. C3/C4/R7	4" W
G2 lug	jct. C3/C4/R7	C3
G2 lug (- of C4)	jct. C3/C4/R7 (+ of C4)	C4
J4 pin B	jct. C3/C4/R7	R7
U1 In pin	R1 CW pin	2" W
R1 CW pin	R2 CW pin	3" W
R1 CCW pin	jct. R3/R4	R3
R2 CCW pin	jct. R3/R4	R4
jct. R3/R4	G2 lug	3" W
R1 arm	jct. C5/R5	2.5" W
R2 arm	jct. C6/R6	1.5" W
jct. C5/R5	J3 pin A	R5
jct. C5/R5	G3 lug	C5
jct. C6/R6	J4 pin A	R6
jct. C6/R6	G3 lug	C6
J4 pin B	J3 pin B	2" W

Part II: RTC-50 Control, Power, & RF Cable Assembly
(Length = 50 feet / 15 metres)

The control, power, & RF cable assembly, designated RTC-50 (Remote Tuner Cable - 50'), provides transfer of +15 VDC power, +0.7 to +22 VDC varactor control, and power ground between one of the DTC-1 control box output ports and the input port of an RT-1 tuner box. Furthermore, a coaxial section of the RTC-50 sends RF from the RT-1 tuner back to the receiver (or the input of an amplifier or phaser) at the operating position. Audio-type cable is used for DC transfer. The two 50' cables are tie-wrapped together to form a single assembly.

Construction Outline

1. Read this article thoroughly before starting the project. Keep a copy of the article in the work area.
2. Obtain the parts specified in the Parts List. Organize them in work area.
3. Ensure that customary electronics tools are available; Refer to construction outline given in RT-1 Article 2.
4. Prepare the RF cable by screwing an F-to-BNC adaptor onto each end. Then set the RF cable aside until step 8.
5. Strip about 2" of outer insulation from each end of the 50' Control / Power Cable (Radio Shack 278-1275). Then, at each end, remove about 0.5" of red-wire and clear-wire insulation.

6. Assemble a stereo phone plug to each end by soldering control cable wires to plug connection pins as follows (use ohmmeter to verify wire-connection-pin -(to)- plug-section correspondence):

Designation	Cable Wire	Solder to plug pin that corresponds to:
A (Control)	red	tip of plug
B (B+) (+15V)	clear	central section of plug
C (GND)	shield	large ground section of plug (closest to cable)

7. Wrap waterproof tape over areas at which each plug's solder-connection-zone-cover meets an insulated control cable end.
8. Tie-wrap (at intervals of approximately 2') the RF cable to the control cable to permit about 1' of separated cables at the tuner end and about 5' of separated cables at the operator "shack" (receiver) end.
9. Test finished RTC-50 with an ohmmeter for proper C & I (Continuity and Isolation). If two RT-1 tuner heads are to be controlled, a second RTC-50 should be fabricated.

Parts List for RTC-50 (50'/15 m.) Cable Assembly

NOTES: Prices (current DEC 1984) are subject to change.

There is only a Level 1 parts list for the RTC-50 cable assembly.

RS = Radio Shack

Level 1

Description	Vendor	Stock #	(US \$) Est. Price
50' coaxial cable w/F plugs	RS	15-1526	7.99
50' control cable (2cond.+shld.)	RS	278-1275	5.19
F female to BNC male adapter	RS	278-251	2.39
F female to BNC male adapter	RS	278-251	2.39
stereo phone plug	RS	274-285	1.49
stereo phone plug	RS	274-285	1.49
tie-wraps (package of 30)	RS	278-1632	1.59
electrical tape (roll)	RS	64-2348	0.49

(+ solder, as required)

Estimated cost of parts to construct the RTC-50 cable ass'y: \$24
