A53-5-1

API-3: An Improved-Design Active Parallel L-C Tuner

Mark Connelly - WA1ION DX Labs - 23 JAN 1984

Recently, an article describing the step-by-step construction & use of the APT-2 (Active Parallel Tuner with Regeneration) appeared in DX Monitor & DX News.

Several design enhancements have occurred, giving rise to the subject of this article, the APT-3.

This article is meant to be a companion piece to that on the APT-2. One principal difference between the two tuners is that regeneration adjustment has been made simpler & less 'touchy' on the APT-3. A Q-pot is used instead of the former regen. vernier. A side benefit of the Q-pot is that use of the APT-3 as an input module in a phasing system has been improved. The recent MWDX-2 article discusses the merits of adjustable Q in phaser input-tuner modules.

Regeneration has also been improved by a modification to A1, the Front End Card subassembly. A buffer stage, using an MPS918 transistor, appears after the regen. feedback loop. Neil Kazaross had noted that the ease of obtaining regeneration on the APT-2 was somewhat influenced by the impedance characteristics of the receiver used. Different receivers load the APT-2 output differently causing variations in regeneration performance, chiefly in terms of control 'touchiness'. Performance with high-impedance receiver inputs (e. g. car RX) was generally superior to that obtained with low-impedance receiver inputs such as found on some communications receivers and on portable-radio coupling-coil inputs. The buffer stage in A1 of the APT-3 eliminates these performance variations. Of course, even the best buffer can be overloaded by an excessive signal (whether regenerated or not). The inclusion of an input attenuator pot [R1] as the level pot, instead of an output attenuation pot, helps one to apply accurately the most signal possible to the tuner, consistent with no spurs/no overloading.

An RF-source jack has been incorporated so that the output of a loop or the output of a phasing unit may be tuned, amplified, and (if desired) regenerated.

Shutting the APT-3 power off bypasses the input (antenna) to the output (receiver). This feature is necessary especially in mobile applications so FM & non-DX AM can be enjoyed without having to disconnect the tuner.

Construction steps are not included as they are very similar to those supplied with the APT-2 article. If you could build the APT-2, you shouldn't have any difficulty building the APT-3 by using the documentation in this article. An important difference between the two units is that a larger box (5 X 4 X 3 in.) is used for APT-3. This box permits C1 to be a more-durable air-variable capacitor of metal construction (GC/Calectro A1-227, Mouser 524-A1-227).

If compactness is necessary, stick with the APT-2 design, perhaps borrowing whatever APT-3 features can be accommodated in the small box. The APT-3 offers slight improvements over APT-2; these aren't enough to make existing APT-2's obsolete, however.

Documentation to follow includes: Figure 1 (Main Schematic), Figure 2 (Front End Card Schematic), Figure 3 (Front End Card Roadmap), Tables 1-A & 1-B (Approximate S3 Frequency Range Switch Settings), and Table 2 (Chassis Box Hole List). This documentation, along with the APT-2 article, should serve as guides to construction. Write to me if you need more construction details.

The usage notes are, of course, similar to those for the APT-2. Differences do occur, however, so it's necessary to read this new usage write-up.

Another use, beyond those in the main body of the article, to which the APT-2 & APT-3 may be put is that of spotting oscillator. In this role, the active tuner is set into intentional over-regeneration (oscillation). No antenna connection is made to the tuner's input jacks; rather, the output is connected to a T-adapter (Pomona 3285). One T adapter jack feeds a coaxial cable going to a digital frequency counter, the other jack couples the oscillation signal to the receiver. If the receiver is using a wire antenna, the oscillation signal may be coupled through a small (e. g. 10 pF) capacitor or large resistor (over 10K) from the wire antenna to the T-adapter jack noted above. If the receiver is getting its signals from a rod antenna or from a loop, connect a short piece of wire (e. g. 1 m) to the T-adapter, thereby coupling oscillation signal through the air. Such a setup will allow accurate frequency determination on receivers having dial calibration of insufficient accuracy.

Figure 1 — APT-3 — Main Schematic

Active Parallel Tuner with Regeneration

WA1ION DX Labs : 23 JAN 1984

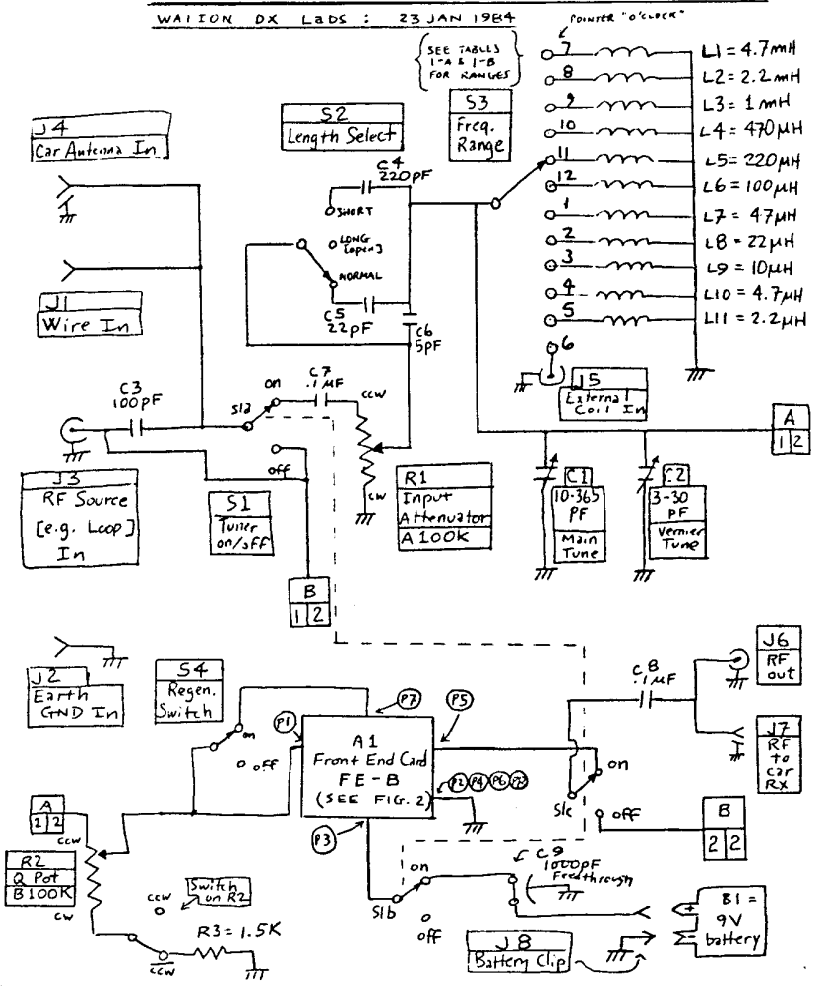
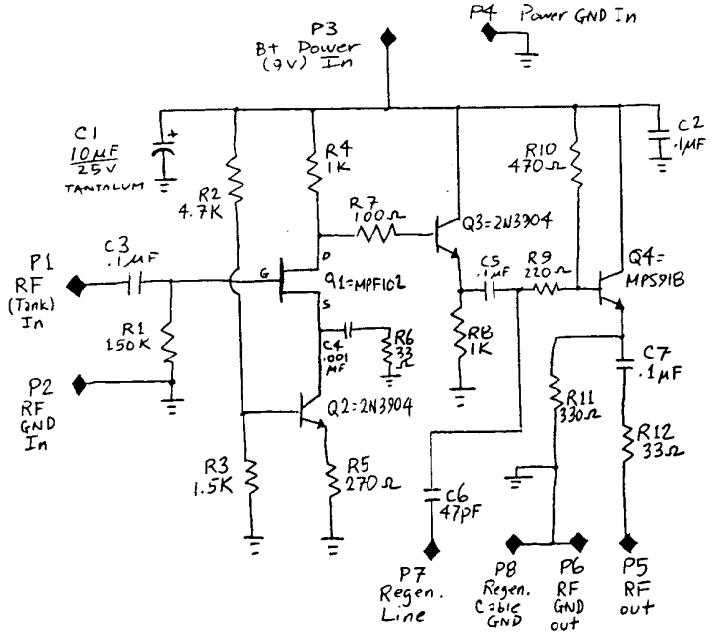


Figure 2

FE-B

A1 of APT-3

Schematic: Regenerative Front End Card



Front End Card component designations are a separate entity from main-assembly component designations.

COMPONENTS REQUIRED FOR FE-B (RS = Radio Shack)

C1	10µF/25v = Mouser 540-DTS25-10EM3	Q3	2N3904 = RS 276-1603
C2	.1µF = RS 272-111	Q4	MPS918 = Mouser 597-MPS 918
C3	.1µF RS 272-111	R1	150K = RS 271-047
C4	.001µF = RS 272-126	R2	4.7K = RS 271-1330
C5	.1µF = RS 272-111	R3	1.5K = RS 271-025
C6	47pF = RS 272-121	R4	1K = RS 271-1321
C7	.1µF = RS 272-111	R5	270Ω = RS 271-1314
P1, P2, P3, P4, P5, P6	pushpins = RS 270-1392	R6	33Ω = RS 271-007
Q1	MPF102 RS 276-2062	R7	100Ω = RS 271-1311
Q2	2N3904 RS 276-1603	R8	1K = RS 271-1321
		R9	220Ω = RS 271-1313
		R10	470Ω = RS 271-1317
		R11	330Ω = RS 271-1315
		R12	33Ω = RS 271-007

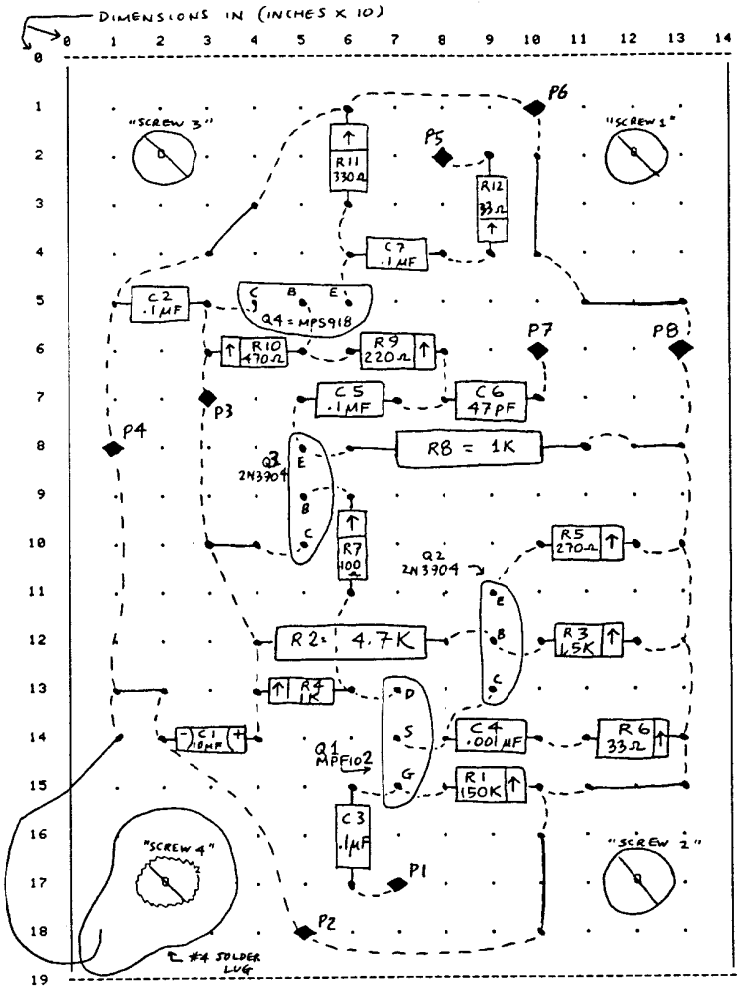
Miscellaneous (See APT-2 article)
perfboard [1.4 x 1.9 in.]
Buss wire
(4) 4-40 x ½" spacers
(7) #4 lockwashers
(8) 4-40 x ¼" screws
(1) #4 solder lug

Figure 3

FE-B

A1 of APT-3

Roadmap: Regenerative Front-End Card



↑ = LONG LEAD OF VERTICALLY-MOUNTED COMPONENT

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Using the APT-3

1.0 NORMAL TUNING (wire or car whip operation)

1.0.0 Initialisation

1.0.1 [Note - S2 positions: normal=up, long=middle, short=down]
Set S2 to 'long' if wire length exceeds 300 ft. in an area with no strong local stations [hereafter defined as 'rural' area] or if antenna is longer than 75 ft. in an area with strong local signals [hereafter defined as an 'urban' area].
Set S2 to 'normal' if the antenna is shorter than the 'long' specifications, but longer than 15 ft. Set S2 to 'short' if antenna is 15 ft. or shorter. Double all length specs. if operating frequency is lower than 400 kHz.
1.0.2 Connect the appropriate antenna to J1 or J4.
1.0.3 Set S4 to down (regeneration off).
1.0.4 Set C1 & C2 to centre (variable capacitors half-meshed).
1.0.5 R1 to fully counterclockwise (CCW)i
(maximum signal level).
1.0.6 Set R2 to fully CCW (maximum Q).
1.0.7 Connect receiver, with coaxial cable, to J6 or J7.
The receiver should be of a shielded (metal case) variety. A transistor portable radio can be used if its rod antenna is kept far enough from the wire aerial to prevent unwanted feedback & instability.
1.0.8 S1 (power) to ON (right).
1.0.9 S3, the frequency range switch, can be preset by referring to Table 1-A; this, however, is optional: S3 will be accurately set in steps 1.1.1 to 1.1.3.

1.1.0 Tuning

1.1.1 Run S3 through all of its positions: find the position which yields the maximum DESIRED FREQUENCY signal. (Don't peak on a spur.)
1.1.2 Adjust C1 for peak signal. If C1 yields maximum signal at fully open [fully CW], move S3 one step clockwise (CW) (= next lowest value inductor) and then repeak C1. If C1 had yielded maximum signal at fully-meshed [fully CCW], move S3 one step CCW (= next highest inductor) and repeak C1.
1.1.3 If, in step 1.1.2, a good peak couldn't be found, or, as the desired signal peaked, an off-channel station's audio simultaneously became clear (e. g. spur or cross-modulation overloading), set S2 to next longer-antenna position (e. g. to long if it had been on normal) & re-iterate steps 1.1.1 & 1.1.2.
1.1.4 If spurs/overloading still occur when the desired frequency is peaked and S2 is on long, use R1 to reduce the input level to the point that the desired frequency signals are 'in the clear'.

2.0 REGENERATIVE TUNING for higher gain & selectivity

NOTES: (1) With APT-3 design, regeneration is only used between 320 kHz and 1900 kHz. (2) The battery must be 'fresh' (7 volts minimum, loaded) for regeneration to work properly, even though 'normal' tuning can be achieved with batteries running as low as 5v.

2.0.0 Initialisation

2.0.1 Tune the antenna 'normally' by performing all Part 1 steps.
2.0.2 Set R2 to midrange (= partially reduced Q).
2.0.3 Set S4 to up (regeneration on).
2.0.4 Observe Table 1-B. Change position of S3, if indicated, so that frequency range inductor selected is optimised for regeneration.

Using the APT-3 (continued)

2.1.0 Tune/Regenerate

2.1.1 Perform step 1.1.2 (C1 peaking).
If, at any time, regeneration (squealing) breaks out, move R2 slightly CW until it stops.
2.1.2 After C1 has been peaked, gradually turn R2 slightly CCW in SMALL INCREMENTS, while simultaneously repeaking C1 after each incremental R2 adjustment.
2.1.3 When regeneration breaks out, or when selectivity is so tight that received audio becomes 'mushy', carefully play C1 & R2 so that, to the best of your ability, you have a C1-peaked-signal condition at the 'borderline of regeneration', as set by R2.
When C1 peaking gets too touchy, use C2 instead.
2.1.4 If satisfactory regeneration occurs, there's no need to do subsequent part 2 steps.
2.1.5 If regeneration/oscillation only occurs with R2 fully CCW or if adjusting regeneration with R2 becomes too touchy, step 2.1.7 should help.
2.1.6 If, even with both R1 & R2 fully CCW and C1 peaked, regeneration cannot be established, set S2 to next longer antenna position, set R2 to midrange, & re-iterate procedure from step 2.1.1 onward.
2.1.7 With R2 set at the most-CW position producing oscillation, use R1 & C1 to set peaked maximum useful selectivity condition. Use C2 when C1 adjustment becomes excessively touchy. C1 (or C2) must be retweaked anytime R1 is adjusted.

3.0 REGENERATING THE OUTPUT OF AN AMPLIFIED LOOP OR THE OUTPUT OF A PHASING UNIT (ACTIVE OR PASSIVE)

3.0.0 Active (= built in amp.) Loop

3.0.1 Set S1 to off. Connect the loop output to APT-3 J3 (RF Source In).
3.0.2 Set S2 to normal length position.
3.0.3 Do steps 1.0.3 through 1.0.7.
3.0.4 Peak desired frequency in normal manner with loop tuning capacitor.
3.0.5 Treat the loop's output as if it were the signal from a wire. Perform steps 1.0.8 through 1.1.4.
3.0.6 Once the loop signal has been peaked through the APT-3, the loop position may be adjusted to obtain a 'pest-null' (if desired).
3.0.7 Regenerate by executing part 2 procedures, starting at step 2.0.2.

3.1.0 Passive Phasing Unit with Pre-Tune Function

3.1.1 Make usual antenna & ground connections to phasing unit. Connect the phasing unit's output to J3.
3.1.2 Set phasing unit function switch to Pre-Tune.
Set APT-3 S2 to short.
3.1.3 Perform steps 1.0.3 through 1.1.4.
3.1.4 Execute customary phasing unit pest-nulling procedures.
3.1.5 Regenerate by performing part 2, starting at step 2.0.2.

3.2.0 Phasing Unit without Pre-Tune Function

3.2.1 Set S1 to off. Do step 3.1.1.
3.2.2 Do steps 1.0.3 through 1.0.7.
3.2.3 Execute customary phasing unit pest-nulling procedures.
3.2.4 If the phaser is passive, set S2 to short. If the phaser has active Line 1 & 2 tuners, set S2 to normal.
3.2.5 Perform steps 1.0.8 through 1.1.4.
3.2.6 Regenerate by performing part 2, starting at step 2.0.2.

4.0 USE OF APT-3 AS LOOPHEAD TUNER/AMPLIFIER

NOTES: (1) The term 'loophead', for the purposes of this discussion, refers to the actual pickup coil part of a loop antenna system. (2) Two loopheads will probably be required for complete coverage of the 500-1700 kHz MW band. Other heads may be fabricated for LWBC, 160m, etc.

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4.0 LOOPHEAD TUNER/AMPLIFIER (continued)

4.0.0 Preliminary Setup

4.0.1 Fabricate air-core or ferrite loophead(s) to be used. These should be of a single-winding type with connections to be made at each end of the winding.

4.0.2 For each head, prepare a piece of RG174 cable of 2 ft. maximum length. One end of the cable should be fitted with a BNC plug; the other end should have bared leads (shield and centre conductor).

4.0.3 On each head, solder the bared centre conductor of a prepared cable to one lead of the loophead winding.

4.0.4 Solder a short insulated hookup wire jumper from the prepared-cable bared shield to the other lead of the loophead winding.

4.0.5 Connect the BNC plug of the cable (whose other end goes to the loophead) to J5, the external coil input jack of the APT-3.

4.1.0 Normal Tuning of Loophead

NOTE: Receiver should preferably be of a shielded type so that unwanted feedback / undesired oscillation may be avoided.

4.1.1 Do not connect anything to J1, J3, or J4 of APT-3.

4.1.2 If the receiver is being operated on batteries or if a cable greater than 3 ft. is to connect J6 or J7 to the receiver, a ground connection to J2 is desirable. The ground chosen may be an earth ground rod or pipe, a mains ground, or a vehicle chassis ground.

4.1.3 Set APT-3 controls initially as follows:

S2 to 'long'
S3 to EXT. L (6 o'clock pointer position)
C2 to centre (12 o'clock or 6 o'clock)
R1 to fully CW
R2 to fully CCW (= maximum Q)
S4 to down (regeneration off)
S1 to Power ON (up)
C1 is to be adjusted in next step.

4.1.4 Connect receiver to J6 or J7 of APT-3. Tweak C1 to obtain maximum signal at frequency of interest.

4.1.5 Position loophead for null of 'pest' and/or peaking of a desired station.

4.2.0 Regenerative Tuning of Loophead

4.2.1 Perform steps 4.0.1 through 4.1.5 as a prerequisite.

4.2.2 Perform these steps in the order indicated: 2.0.2, 2.0.3, 2.1.1, and 2.1.3.

NOTE: Frequency coverage range with a given loophead may differ in the 'normal-tune' mode from that noted in the 'regenerative-tune' mode. Normal-mode range is generally greater as the parallel capacitance of the regeneration circuit is not switched in.

5.0 LOOPHEAD INDIRECT COUPLER

5.0.1 The loophead may be placed close to a wire, pipe, or electrical conduit to which a direct connection cannot (and/or should not) be made. One example is the the conduit going to the electric meter on the outside of a house. Of course, the loophead, in this application, will not have nulling capability.

5.0.2 Position loophead near coupling source.

5.0.3 Perform 'normal tuning' steps 4.1.1 through 4.1.4.

5.0.4 Move loophead through various placements near the coupling source to maximise signal; then repeak C1.

5.0.5 To regenerate after having peaked C1, perform steps 4.2.1 & 4.2.2.

Table 1-A

Approximate Frequency Ranges

C2 at centre. Regen. (S4) off
S2 to 'normal' length setting
Aerial = 100 ft. / 30 m. wire

S3 Switch Pointer (o'clock)	L uH	fmin kHz	fmax kHz
7	4700	130	250
8	2200	170	330
9	1000	240	490
10	470	360	700
11	220	510	1030
12	100	740	1450
1	47	1130	2200
2	22	1680	3400
3	10	2450	4900
4	4.7	3500	7000
5	2.2	5100	10000
6	EXTERNAL	*	*

* = range depends on ext. L value

Table 1-B

Approximate Frequency Ranges: REGEN mode

C2 at centre. Regen. (S4) on.
S2 to 'normal' length setting
Aerial = 100 ft. / 30 m. wire

S3 Switch Pointer (o'clock)	L uH	fmin kHz	fmax kHz
10	470	320	450
11	220	440	640
12	100	630	930
1	47	920	1390
2	22	1390	1900
6	EXTERNAL	*	*

* = range depends on ext. L value

TABLE 2

Hole list for APT-3 regeneration-capable tuner
(X=horiz.distance from vert. centreline:- = left of CL,+ = right)
(Y=vertical distance from lower horizontal edge of side observed)

LEFT SIDE

Hole	Comp.	Description	X(in.)	Y(in.)	DIA(in.)
1	J2	GND in	-1.5	0.5	0.3125
2	J1	Wire in	-0.75	0.5	0.3125
3	J3	RF source in (BNC)	0.0	0.5	0.375
4	G1	GND screw, int.lug	0.0	1.125	0.113
5	J4	Car Ant. In, screw 1	1.0	0.5	0.14
6	J4	Car Ant. In, body	1.0	0.894	0.5
7	J4	Car Ant. In, screw 2	1.0	1.288	0.14

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TABLE 2 [continued]

APT-3 Hole List

TOP

Hole	Comp.	Description	X(in.)	Y(in.)	DIA(in.)
1	C1	Main Tuning Cap., screw 1	-1.625	3.125	0.14
2	C1	Main Tuning Cap., shaft	-1.625	2.5625	0.5
3	C1	Main Tuning Cap., screw 2	-1.625	2.0	0.14
4	R1	Input Atten. pot, shaft	-1.875	0.625	0.3125
5	R1	Input Atten. pot, tab	-1.5625	0.625	0.14
6	G2	GND screw, int.lug	-1.25	1.125	0.113
7	S1	On/Off switch, tab	-0.625	0.625	0.113
8	S1	On/Off switch, shaft	-0.875	0.625	0.25
9	S2	Length switch, tab	0.0	0.375	0.113
10	S2	Length switch, shaft	0.0	0.625	0.25
11	G3	GND screw, int.lug	0.0	1.5	0.113
12	R2	Q pot, shaft	0.75	0.625	0.3125
13	R2	Q pot, tab	1.0625	0.625	0.14
14	G4	GND screw, int.lug	1.4375	0.625	0.113
15	S4	Regen. switch, tab	1.875	0.375	0.113
16	S4	Regen. switch, shaft	1.875	0.625	0.25
17	S3	Freq.Range switch, shaft	1.125	1.75	0.375
18	S3	Freq.Range switch, tab	1.625	1.75	0.14
19	C2	Fine Tune cap., screw 1	0.125	3.568	0.113
20	C2	Fine Tune cap., screw 2	0.568	3.125	0.113
21	C2	Fine Tune cap., screw 3	0.125	2.682	0.113
22	C2	Fine Tune cap., shaft	0.125	3.125	0.5
23	J5	Ext. Coil in (BNC)	1.5	3.375	0.375
24	G5	GND screw, int.lug	1.5	2.75	0.113

RIGHT SIDE

Hole	Comp.	Description	X(in.)	Y(in.)	DIA(in.)
1	J8	Battery Holder, screw 1	0.2813	2.5	0.113
2	J8	Battery Holder, screw 2	1.25	1.625	0.113
3	A1	FrontEndCard, screw 1	1.625	0.5	0.113
4	A1	FrontEndCard, screw 2	1.625	2.0	0.113
5	A1	FrontEndCard, screw 3	0.625	0.5	0.113
6	A1	FrontEndCard, screw 4	0.625	2.0	0.113
7	C9	B+ in feedthrough cap.	-1.375	0.5	0.188
8	G6	GND screw, int.& ext.lugs	-0.75	0.5	0.113
9	J6	RF out (BNC)	0.0	0.5	0.375
10	J7	RF to car RX, screw 1	-1.375	1.894	0.14
11	J7	RF to car RX, shaft	-1.375	1.5	0.5
12	J7	RF to car RX, screw 2	-1.375	1.106	0.14

NOTES: C1 is GC/Calectro # A1-227. J8 is Acme type. C2 is Etco # SV408

Box = Mouser # 537-TF-779 (5" x 4" x 3")

TOP END

February 1984

A monthly column of loggings, discussions & information for the 1600 - 1800 kHz range. Deadline: The last Saturday of the month All times are GMT

Craig Healy.....66 Cove St ..... Pawtucket, RI ..... 02861.....

First off, it looks like KPE-643 (WATD) will be delayed more due to tower construction hangups. More as it happens.

I was asked what reference books I use to ID beacons. Two are available:

1. The Beacon Guide by the late John Clements and Ken Stryker. I don't know if it's still around in any quantity. Try Century Print Shop, 6059 Essex, Riverside, CA, 92504-1599
2. Handbuch der Funknavigationshilfen by Dr. Jurgen Trochimczyk. It's available in the States from: Sol C. Quintos, 2055 E.Hampton 202, Mesa, AZ 85204. It's an alphabetical list, seems accurate, and easy to use.

Loggings:

1613 GUATEMALA Rabinal 0820 1/16 RAB good. (Neal)
1615 NEW ZEALAND Ohura 1615+ 1/11 OR fair. IDS every six sec. (Arthur)
1615 ??? 1525 1/22 Another CW beacon, very weak under OR. (Arthur)
1620 ??? 0504-0507 1/5 SDT good. Keying inaccurate, last dit in "S" is slightly prolonged. Letter spacing is short. Weak 0630 1/18 (Healy)
1621.2 ??? 0818 1/16 UDT fair. (Neal) see above? ed.
1622 ??? 0819 1/16 KA83736 fair. (Neal)
1637 ??? 0657 1/17 KA80084 fair-poor. (Neal)