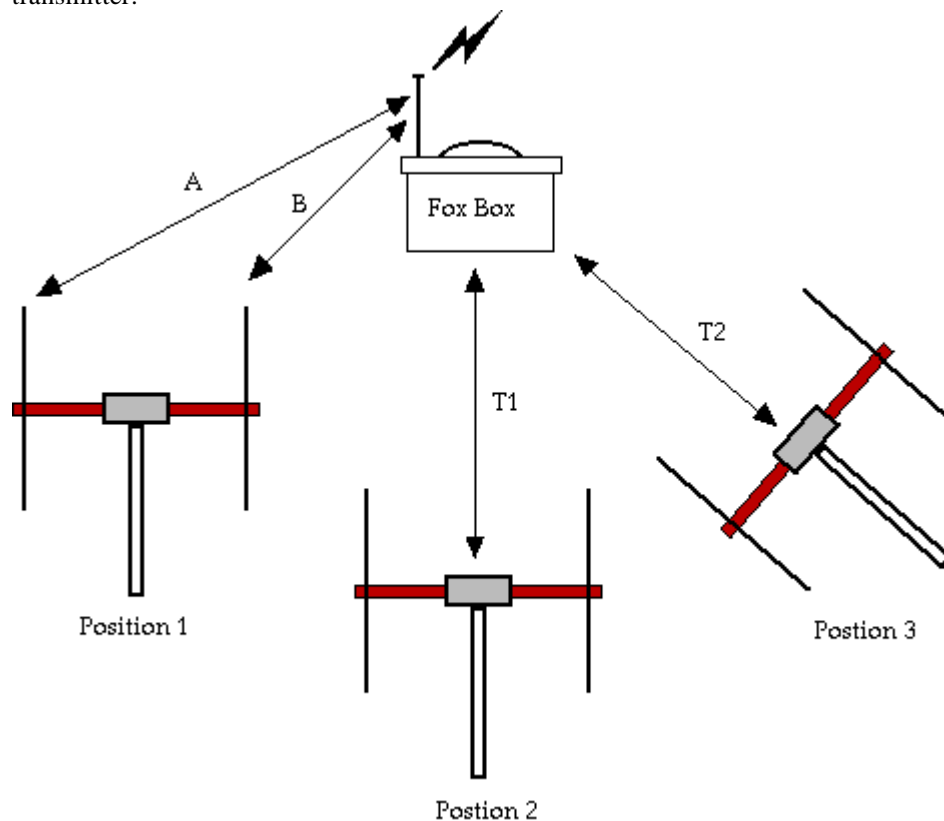


## Time of Arrival Radio Direction Finder.

Time of arrival (TOA) RDF units are simple and very useful. Various designs have been distributed over the years, and here is another one. This Kit Developed by James Lee N1DDK is an easy to build version of the design from our very own Rich Harrington, KN6FW. These units are so versatile and simple to make, and we are making the schematic available to the Ham community. They are so simple, you can build one for each of your vehicles, just to have in case of an emergency transmitter hunt.

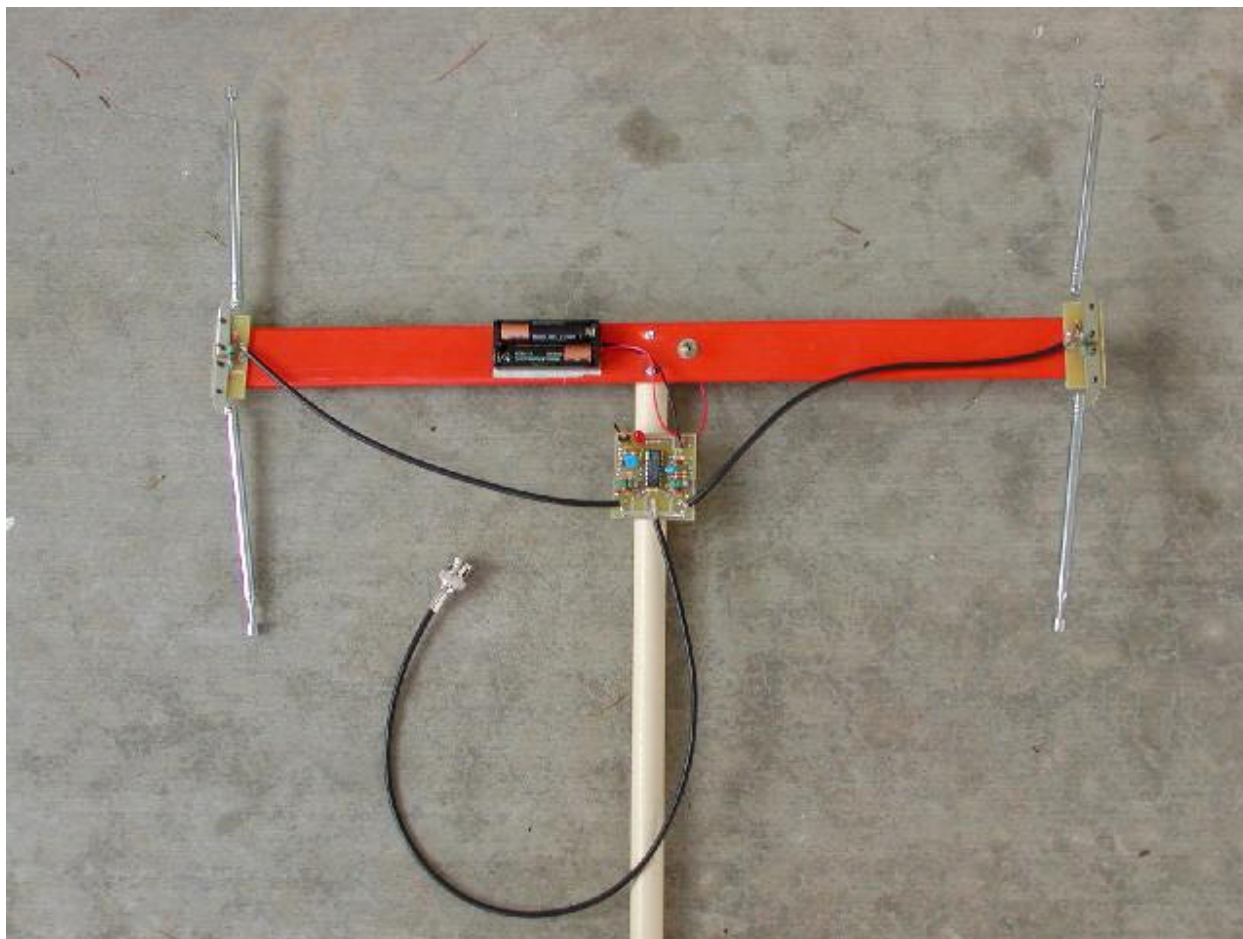
TOA units work by exploiting the phase shift that occurs when the path length from the transmitter to the TOA unit elements is unequal. This phase shift produces an audio tone in the radio. When you minimize the audio tone, by rotating the TOA unit, you can determine what line the transmitter is on (in front of you, or behind you). Moving will allow you to triangulate on the transmitter.

The following figure illustrates what happens. The TOA in position 1 is not rotated to "face" the transmitter. As a result, the path lengths from the transmitter to each antenna (A and B) are unequal. This results in an audio tone being heard from the radio. Position 2 and 3 both are rotated until the audio tone minimized. In position 1, the transmitter is then known to be on line T1. Because the transmitter could be in front of the TOA or behind it, another position is used to get a second bearing. Position 3 gets the bearing T2. Where T1 and T2 cross is the transmitter.



This time of arrival RDF unit sees lots of use in San Francisco Bay Area transmitter hunts. Early editions of the time of arrival unit were built with welding rod antenna elements, various structural elements, and more complicated circuitry. This current design has improved because of continuous improvements. The features of this design are:

- Adjustable tone. This allows you to get the tone you need to clearly hear the null.
- Low current consumption. The circuit is built with 74HC logic parts.
- Runs from two AAA cells.
- Telescopic antenna elements for easy storage.



### Parts Inventory

Item	Qty	References	Description
1	1	BT1	Battery Holder
2	2	C1,C3	0.01 uf capacitor Blue Labeled 103.
3	1	C2	0.022 uf capacitor Yellow Radial leads labeled 223
4	2	C4,C5	680 pf capacitor Yellow, Axial Leads
5	1	D7	LED
6	3ft	J1,J2,J3,J4,J5	RG-174 coax
7	4	L1,L2,L3,L4	12uh inductor Silver-Brown-Red-Black-Gold
8	1	R8	100K trim pot
9	6	D1,D2,D3,D4,D5,D6	1N4148 diodes
10	4	R1,R2,R7,R9	220 ohm resistors Red-Red-Brown-Gold
11	1	R10	680 ohm resistor Blue-Gray-Brown-Gold
12	1	R3	10k ohm resistor Brown-Black-Orange-Gold
13	1	R4	100K ohm resistor Brown-Black-Yellow-Gold
14	2	R5,R6	47K ohm resistors Yellow-Violet-Orange-Gold
15	1	S1	SPST switch
16	1	U1	74HC04 IC
17	1	J3	BNC connector (SMA optional)
18	1		Printed Circuit Board

## ***Tools and additional parts required***

In addition to the parts required for this kit you will also need:

Solder and soldering tools.

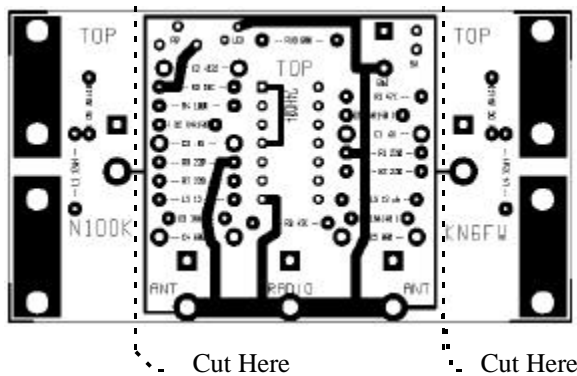
- 1) Fine tipped soldering iron.
- 2) Solder.
- 3) Wire cutters.
- 4) Wire strippers or sharp knife.
- 5) Crimp tool.

Additional parts

- 1) Antennas. Either four of the Radio Shack 270-1409A or four 18 inch pieces of aluminum or brass welding rod or copper wire.
- 2) Something to mount the antennas and board. A piece of plastic, wood or Fiberglass approximately 18 long by 1.5 inches wide.
- 3) 2 AAA batteries.
- 4) A radio receiver.

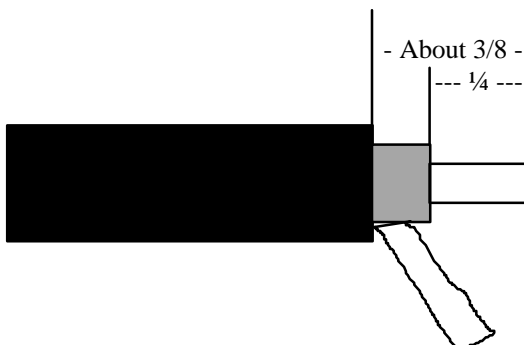
## ***Electrical Assembly instructions***

- 1) Read all instructions before beginning. These instructions are the electrical assembly instructions You will need to proceed with the mechanical assembly after you complete the electrical assembly.
- 2) Verify each part against the parts list. It may be helpful to place each group of parts near its line on the inventory list for easy identification.
- 3) Carefully cut apart the board into the central control board and the two antenna boards. As shown below.



- 4) Refer to the top layout drawing and insert the 4 inductors at L1, L2 L3, and L4. Unfortunately the holes are a bit snug. Take your time and carefully install these parts.
- 5) Insert R5 Upper right and R6 lower center.
- 6) Next insert 4 of the 6 diodes All of the banded edges away from the center. D3, with the banded end to the left, away from the center. D4, with the banded end to the right, D5, D6 on the antenna boards with the bands down toward the inductors. Do not insert D1 and D2 at this time. Read the notes at the end.
- 7) Insert R1,R2,R7,R9 the 220 ohm resistors.
- 8) Insert C1 and C3 The Blue 0.01 capacitors.
- 9) Insert R4 the 100K Brown-Black-Yellow resistor just above D2. Double Check you have Yellow not Orange.
- 10) Insert R3 the 10K Brown-Black-Orange resistor Just above R4. Double Check you have Orange not Yellow.
- 11) Insert C2 0.022 uF capacitor.
- 12) Install R10 the 680 ohm Blue-Gray-Brown Resistor at the top of the board.

- 13) Recheck that you have R3 Brown-Black-Orange near the top of the board and R4 Brown-Black-Yellow below it.
- 14) Solder in and clip all the leads.
- 15) Install C4 and C5, the remaining yellow capacitors towards the bottom of the board. Solder in place.
- 16) Install R8, Solder in place.
- 17) Install the IC Verify that the notch is to the top. Solder in place.
- 18) Cut two 9-inch pieces from the RG174 coax.
- 19) Strip about 3/8 at each end. Separate the Center and strip about 1/4 inch at each end. Separate the braid as shown. Be careful not to damage the center insulator or pull too hard when you strip the cable. You may pull out the center insulator if you pull too hard. It is best to use a razor blade knife to strip the coax. It is critical that your two coax cables end up with identical lengths.

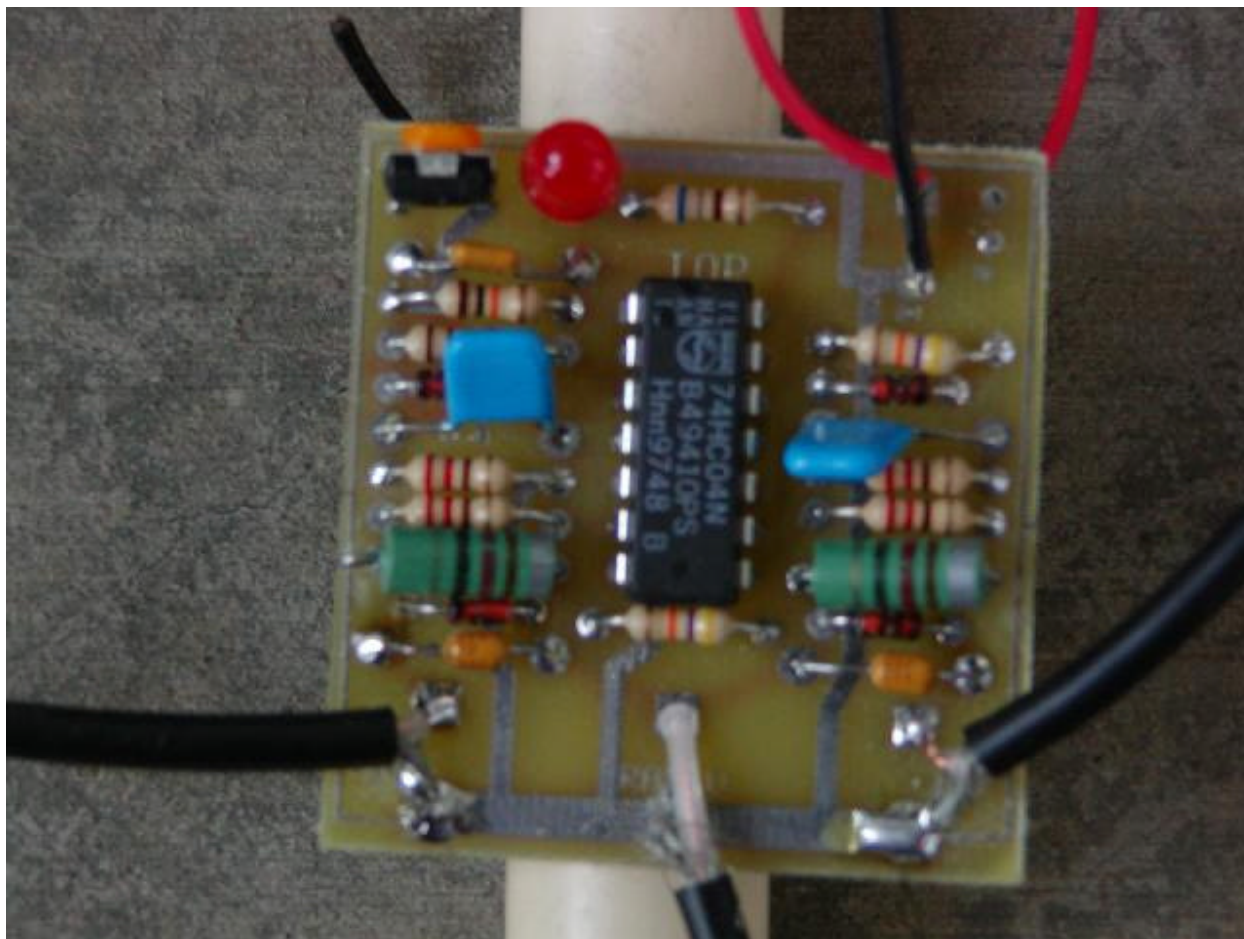


- 19) Solder one end of each of the cables to one of the antenna boards. The center conductor goes to the square hole, and the shield goes to the large round hole.
- 20) Solder the other end of each cable to the corresponding ANT holes on the main board.
- 21) Prepare the final length of cable. One end gets the radio connector BNC or SMA. This may be pre-installed. Strip the other end as in step 18, and solder to the radio set of holes on the main board.
- 22) Once you have determined how you will mount your board, battery holder, switch and LED, you can install the LED to the desired height. The flat side goes toward the top edge of the board.
- 23) Cut off some of the battery holder lead if needed to shorten it and to use to hook up the switch. Solder in the battery leads The Red lead goes to the square hole near the top of the board. The black lead to the round hole just below it near the label **Bat**.
- 24) Use the cut off Battery leads to make leads for the switch and solder to the switch and the two holes labeled **SW**.
- 25) Proceed to mechanical Assemble.

### **Notes about D1 and D2.**

D1 and D2 control the overlap between the antennas. The Sensitivity and width of the null is controlled by these diodes. There are 4 possible settings. Do not Solder in these diodes until you decide which setting you would prefer.

<b>D1 and D2</b>	<b>Setting</b>
Facing Outward D1, just below R5 with the banded end to the right, away from the center. D2, with the banded end to the left, away from the center.	Most sensitivity tightest null.
Shorted	Broadest Null, easiest to find null.
Open	No null.
Facing Inward	You tell me



### ***Mechanical Assembly.***

You will need to provide your own materials for mounting the board and antennas. The picture at the beginning shows a possible mechanical assembly.

- 1) Mount the Board and antenna assemblies.
- 2) Attach you antennas.
- 3) Attach the battery holder and switch as appropriate.
- 4) Proceed to testing.

### ***Testing.***

- 1) Install the batteries, turn on the switch, the LED should light.
- 2) Insure that your antennas are extended to form two parallel dipoles at each end of your unit.
- 3) Connect your radio and turn to an active transmitter.
- 4) Hold the antennas so they are not equidistant to transmitter.
- 5) Adjust R8 to an audible tone.

### ***Usage in direction finding.***

You should hear the tone null or decrease when the antennas are equidistant to the transmitter. The transmitter is either directly in front or directly behind you. You can adjust R8 as needed to change the tone.

