RADIOS are awesome to build; hearing broadcast stations coming out of something you’ve created for the first time is a really awesome feeling. This is why I have presented this “weekend” construction project; an AM broadcast radio receiver utilising varicap tuning and an MK484 IC. Both the MVAM108 (BB-112) varicap diode and the MK484 IC may be hard to source locally, but these can be found on eBay rather cheaply. And, with the MK484, there would likely be a newer substitute version, so a little research would be prudent.

This circuit is not only just limited to AM broadcast radio (535 to 1605 kHz) and with a little modification to the inductor coils, could achieve tuning below 535 kHz or even higher for shortwave reception. However, with this project, it’s designed for standard AM broadcast radio. The over-all build cost shouldn’t break the bank and if built in to the plastic enclosure (or similar) I designed it for should only have a price tag of around 50 to 60 dollars; not too expensive.

Circuit Details

Referring to the circuit diagram of fig. 1, RV1 controls the tuning of the receiver. This is achieved by applying a small amount of voltage (isolated by R1) to D1, a varactor (varicap) BB-112 diode. The specs on this diode are it only requires 0 to 8V for a full capacitance range of 22 to 760 pF. The way a varactor diode works is the higher the voltage applied to it is in a reverse-biased configuration, the lower the capacitance will be. This is to do with how the reverse break-down voltage affects the silicon substrate within the diode causing a variation in capacitance and, in essence, we now have a variable capacitor. This new “capacitor” is isolated from the inductor, L2, via varicap D2 (connected in reverse bias with D1) which now, in turn, forms a “tank” or tuned circuit.

Next, L2 is fed in to pin 2 of U1, an MK484 Tuned Radio Frequency (TRF) IC which contains around ten transistors on board providing all the necessary RF and IF amplification and an AM detector. This IC requires only a maximum of 1.8V to operate, so this is biased at pin 3 via R3 to provide the necessary voltage drop. Pin 3 is also fed in to RV2, the “RF Gain” control and this provides feedback (via R2) to L2’s tank circuit.

Pin 3 is then blocked for DC via C3 and fed in to RV2, the “Tone” control which uses a basic hi/low pass filter configuration via C5 and C6. The center-tap of RV2 is fed to RV3, the “Volume” control where after passing via C5 (another DC blocking capacitor) is fed in to pin 3 of U1, which is which is an LM386N-1 amplifier IC. This IC is set to a gain of 200 times by capacitor C8, a 10uF 16V electrolytic.
MK484 AM Receiver With Varicap Tuning – TheAstro30

The output is fed to DC blocking capacitor C11 and also has R7 and C10 forming a Zobel network. This provides an output power of around 360mW which is sufficient enough to drive any small loud speaker (say 76 mm from a clock-radio, for instance) to pretty loud levels.

The power section is based around an LM317T adjustable voltage regulator (U101) so we can precisely adjust the voltage to a given “maximum” voltage. BR1 is a standard W-01 bridge rectifier package which rectifies the incoming 12VAC voltage from CN1 to DC. It is then filtered by C101, 102 and 103. RV101 adjusts the voltage of U101. This will be set later to around 9.6V at the output. The output is further filtered by C104 and also goes via R102, a dropper resistor to LED1 which is the power indicator.

Construction

The construction of the receiver is built on two PCB’s; one is for the power supply and the other is the main radio PCB. All you need do is copy the etching pattern of fig. 4 and either using photo etching or have someone make the PCB for you; you can then refer to fig. 2 for the component overlay.

Start with the wire links first (there’s only one on the main PCB) then the resistors and finally the capacitors taking care with their polarities.

For U2, I would install an 8 pin DIL IC socket and makes the job easier rather than soldering directly to the IC. This gives you the option of replacing the LM386N-1 in the case that something goes wrong and you damage the IC.
Next, D1/D2 and U1 can be installed taking care of their orientation. On U1, pin 1 is ground (or negative) and D1/D2, the anode is on the left of the TO-92(18) casing.

It would be a good idea to verify this ahead of time before installing these components, especially the varicap diodes D1/D2 by doing a diode test on it first to determine where the anode and cathodes are. Installed in reverse direction to how it should be will result in the circuit failing to tune anything at all.

The loop stick coil (L1/L2), is made up on a 100mm long ferrite rod using 7 turns of 0.30mm ECW for the antenna coil and 60 turns of 0.30mm ECW for the main coil.

This is achieved by first wrapping a piece of paper around half the length of the rod just long enough to wrap around (loosely) no more than twice on itself. This is then cello taped to stop it from coming apart. You should be able to easily slide this up and down the length of the rod. If you can’t, un-tape it and re-tape it a little more loose.

Next, you can begin by taping a length of ECW to the paper around 5mm from its edge leaving yourself around 10cm of wire “hanging-off” the end of the rod. Begin winding 60 turns of ECW for the main coil first, periodically checking that the paper “tube” still slides freely up and down the rod. Try to keep your windings as neat and as close together as possible. Once winding of this coil is complete, place a piece of tape of the windings sticking it to the paper to stop them moving but still allowing the paper to slide on the rod.

Next, wind the 7 turns required for the antenna coil as close as practical to the main coil using the same method as above. The ends of the wires can now be scraped of their enamel, tinned and finally soldered in to the respective holes on the main board.

Finally, the three 16mm single-gang 10 k potentiometers can be installed and (except for the volume pot) it’s not overly critical as to whether they are of linear or logarithmic types.

If you have used an IC socket for U2, now would be a good time to insert the IC taking note of correct orientation. The notch faces towards the tuning pot.

Testing

Testing begins by adjusting the output voltage of the regulator IC101. Connect a suitable AC plug pack adapter to the AC input of the board, apply power and measure the output voltage with a voltmeter. Adjust RV101 until the meter reads around 9.6VDC. This should be more than adequate to power the main board and also allow the 0 – 8V across the varicap diodes (D1/D2) to give the desired frequency coverage. Once you are satisfied that the voltage output is correct, you can connect it the main board and also the speaker.
Start by rotating the RF set pot (RV4) to around half-mast and the volume pot (RV3) fully counter-clockwise. Connect power and listen for any unusual noises emanating from the speaker. If it starts squealing it’s indicative of the circuit oscillating. Disconnect the power and check for solder splashes across tracks or components not soldered in correctly.

Assuming no unusual noises are present, slowly rotate RV3 up and listen for “static”. You should be able to hear the normal AM noise of a radio not tuned to a station (or if you’re lucky, depending on the position of RV1, an actual station!). Next, rotate RV1 and see if you can tune anything in. If you hear nothing and after playing with RV2 for a while, switch off and check you have soldered everything in the correct place and the correct way around.

At this point, it may be necessary (if you haven’t already done so) to check that D1’s anode is definitely on the left of the device. This can be verified with a multi-meter set to the ohms or diode test scales and should only show a reading one way around. The pin that has the positive probe on it is the anode. If it is installed the incorrect way around in the circuit (i.e.: forward-biased), the variable capacitance effect of the diode will not be present.

Adjust the RF set pot until the sound is as loud and clear as possible; this is not overly critical and is purely up to how you want it to sound.

Next, you can now adjust the lower end of the tuning range which will require another AM receiver to verify what station is at the lowest end of the tuning range (531 kHz). Slide the paper “tube” slowly up and down the rod and you will notice that the tuning will “shift”. Re-adjust tuning pot RV1 to re-tune the station in. Repeat this until RV1 is tuning that station as far counter-clockwise as possible. Once satisfied, you can zip tie the rod to the circuit board via the four holes provided.

It’s now time to move on to the final hardware construction phase.

**Final assembly**

Final assembly begins by fitting out the plastic housing by drilling its front and rear panels and the necessary holes on the lid for the speaker. The enclosure (Jaycar catalogue number HB5970) measures 140 mm wide by 110 mm deep and 35 mm high and each panel measures 134 mm wide by 30 mm high. Fig. 5 shows the artwork for both the front and rear panels which can be printed on to A4 sticker paper (purchasable at most office supply stores), cutting them out with a pair of scissors and sticking them carefully to each panel.

You could do one of two things; use the original plastic panels that come with the enclosure, or you could cut them out of a sheet of 1 mm thick (18 gauge) aluminium. The latter would probably be the better choice (even if it involves more effort) for two reasons. One, the metal will give the pots something to earth to acting as a ground plane and two, its less messy to drill. Plastic has the tendency, together with the paper sticker, to melt and burr.
After deciding what type of material to make the panels out of, you can use the stickers that you have affixed to each to assist in drilling. Start with the smallest drill bit first (and if using aluminium, centre-punch each hole) and then step it up to the final size. The LED hole on the front panel should be drilled out to 4 mm and you can use an LED clip to mount the LED to the panel. The pots are drilled out to around 7 mm and take note that there are no pilot holes drilled to accept the dowels on the pots. These will have to be broken off the pots prior to marrying the PCB to the panel.

The power switch is of a miniature panel mounted toggle variety and the hole can be drilled out to around 7 mm. The antenna hole on the rear panel is of an RCA type connector and these usually have a 7 mm mounting hole.

The DC socket is drilled out to around 8 mm and is of the lock-nut bulkhead (5.5 mm barrel with a 2.1 mm centre) with a switched negative variety. Basically, everything is drilled out in steps until they fit snugly in their respective holes but don’t need any extra force to insert them.

On the front of the bottom panel of the case, there are four circuit board mounting stand-offs (and the two in the middle at the rear) which will have to be removed otherwise it will interfere with the PCBs. These can be nicked of with a sharp Stanley knife, miniature hacksaw or a pair of side-cutters and sanded down flush, taking care not to damage to front tongue that accepts the front panel.

Next, you can move on to the drilling of the speaker holes and I have provided a rough sketch of the drilling plan in fig. 6. Use this as a guide and this is solely dependent on what size speaker you’re using. In my case, I’m using a 76 mm 1W 8 ohm speaker which just fits inside the case (Jaycar catalogue number AS3006). Again, start with the smallest drill bit first which will assist in drilling roughly central in the plastic and move up to the final size. A size of around 4 mm should be adequate for this purpose. Once cleaned up and de-burred, the speaker can be glued in to its new home on the inside of the lid using some Quik-grip or contact adhesive cement and left to dry.

Keep all wires short as possible to prevent binding inside the case and also from picking up stray noise. The AC connector socket has the “negative” or barrel portion of it wired directly to the power supply board’s AC in and the tip is wired to the power switch. The power switch is then wired back to the power supply board’s AC in. The LED is wired to its respective location on the PCB via two lengths of wire and with heatshrink around the anode and cathode leads of the LED to keep them from touching and also to keep them neat.

The DC output should be wired to the main board (if not all ready) with short wires as well. It’s a good idea to twist the negative and positive wires around each other to prevent noise pickup/injection.
Wire a very short, as possible, wire between the antenna connection and the associated banana socket connector. Finally, you can wire the speaker with reasonably short wiring to keep things neat to its respective location on the main board. Now would be a good time for a final power-up test to make sure the device still works.

**Conclusion**

In conclusion, this project should only take around four to five hours to complete which includes all of the drilling of the hardware. I hope you enjoy building this project as much as I have presenting it here and I also hope that the construction details presented here are detailed enough. Enjoy! – TheAstro30

*Figure 6 – The drilling pattern for the speaker grill produced here at 1:1 scale which can be printed on paper and sticky-taped to the top cover as a template prior to drilling.*