Low cost AM SWBC Radio

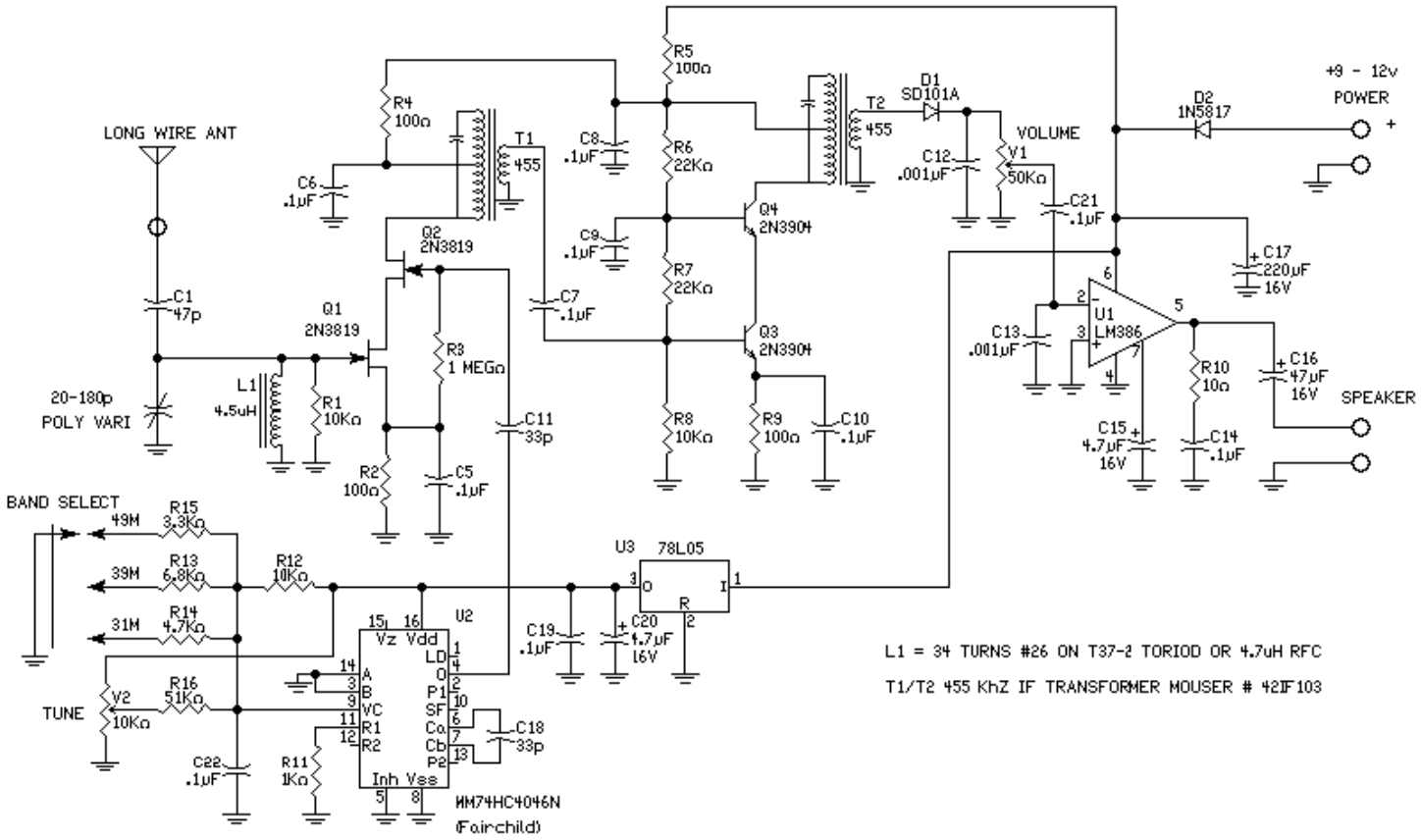
This AM Short Wave Broadcast Receiver is of reasonably simple, but effective design and can be built at low cost. It requires no adjustments to get to work and is more or less fool proof. This makes it a great beginners project, with little or no test equipment. The radio can be built for about $15.00, even if all new parts need to be bought.

The trickiest part of any radio is the Local Oscillator. It is difficult to make a traditional L/C oscillator which will tune a wide range of frequencies at low cost, due to the need for now scarce air variable capacitors. L/C oscillators also need to be adjusted to tune the proper range, generally requiring a frequency counter.

These problems are eliminated by using a voltage tuned R/C oscillator, which is part of a 74HC4046 Phase Lock Loop chip. The down side of using this type of oscillator is that it is not very stable. This is a minor annoyance and not of great consequence, especially if the radio is intended for kids. It not likely they will sit and listen to any one station for long, but rather be nearly constantly tuning around.

The radio will easily drive a small speaker to room filling volume. It will work with a fairly short 6 foot antenna wire, but longer is better. Tuning is divided into three ranges, covering the 49 meter band (around 6 MHz), the 39 meter band (around 7.5 MHz) and the 31 meter band (around 9 MHz) Tuning range is about 500 kHz in each of these segments.

The radio can be powered by a 9 volt battery and draws a modest 21 ma of current.



How it works:

The antenna is coupled into the mixer through C1, 47 pfd. The input to the mixer is tuned to about the receive frequency of interest by L1 and a poly-variable cap. These are a little hard to find as a new part, but can be salvaged from a dead or cheap AM/FM radio.

The mixer is a active stage using two JFETs in a cascode configuration. 2N3819's are shown, but just about any N channel JFET will work. The circuit was shamelessly borrowed from experimental Methods of RF Design" by W7OZI and co-anthers. This mixer exhibits about 13 dB of conversion gain. It requires a large amplitude Local Oscillator drive, which makes directly coupling to the square wave output of the 74HC4046 VCO quite acceptable.

The output of the mixer is tuned to the IF frequency of 455 kHz by the IF transformer T1. This is coupled into a cascode amplifier consisting of Q2 and Q3. This amplifier basically combines a common emitter amplifier to which the input signal is coupled to, with a common base amplifier which adds additional gain, but keeps the amplifier quite stable. The output of this stage is again tuned with a 455 kHz IF transformer. The combination of the two IF transformers gives the radio a reasonable amount of selectivity.

The AM signal is detected by a Shottky diode on the output of T2. A Shottky is used due to its low forward drop voltage, which reduces the level needed to detect a signal by at least 3 times over a silicon diode. The diode is connected to the volume control, which in turn goes to a common LM386 audio amp.

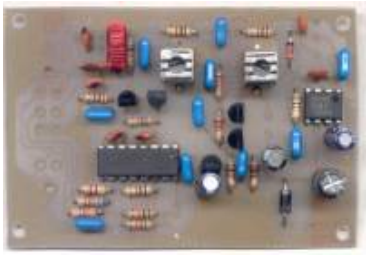
The Local Oscillator uses the Voltage tuned R/C oscillator section of a 74HC4046 PLL. This

part is capable of generating a signal up to about 20 MHz. C18 and R11 comprise the R/C part of the oscillator. A voltage divider consisting of R12 and R13, R14 or R15 sets the voltage for the operating frequency of the desired tuning band. V2 is used to adjust the frequency and R16 limits the range of the tuning. The Oscillator is set provide high side LO injection.

WARNING: Not all 74HC4046s are created equal. The values shown are for 74HC4046s made by Fairchild Semiconductor. Parts made by a different manufacturer will require different values. Probably radically different values.

Construction:

If you can make your own circuit boards, the layout and component location screen is avaiable as a bit map file in this zipped file: SWBC_PCB_BITMAP.zip The bit mapped files can be opened with MS Paint and if printed from there, will be at proper scale. Track layout is through board view, so it can be printed to toner transfer film with out reversing first. Of course, you can also build the radio dead bug or ugly style.



An early version of the board, which used a slide switch for band changing.

Parts list

Designator	Value	Mouser part number	Price as of 11/04	
C1	47 pFd	140-50S2-470J	$0.07 each	
C	poly-variable 20-180p	salvage from AM/FM radio		
C5 - 10,14,19,21,22	.1 uFd (10 TOTAL)	80-C317C104M5U	$0.12 each	
C11, C18	33 pFd	140-50N5-330J	$0.06 each	
C12,C13	.001 uFd	140-50P2-102K	$0.08 each	
C15,C20	4.7 uFd /16V	140-XRL16V4.7	$0.06 each	
C16	47 uFd / 16V	140-XRL16V47	$0.06	
C17	220 uFd / 16V	140-XRL16V220	$0.11	
L1	4.7 uHy	434-22-4R7	$0.20	or 34T on T37-2
R1/8/12	10K 5% 1/4W	291-10K	$0.07 10 min	($1.98 / 200!)

			order	
R2/4/5/9	100 ohm 5% 1/4W	291-100		
R3	1 Meg 5% 1/4W	291-1MEG		
R6/7	22K 5% 1/4W	291-22K		
R10	10 ohm 5% 1/4W	291-10		
R11	1K 5% 1/4W	291-1K		
R13	6.8K 5% 1/4W	291-6.8K		
R14	4.7K 5% 1/4W	291-4.7K		
R15	3.3K 5% 1/4W	291-3.3K		
R16	51K 5% 1/4W	291-51K		
T1/T2	mini 455 kHz	42IF103	$0.79 each	
V1	10Klinear pot	31VA401	$1.25	
V2	100K audio pot	31C501	$1.13	17mm with on/off sw
U1	74HC4046	512-MM74HC4046N	$0.52	DIP-16
U2	LM386N	513-LM386BD	$0.28	DIP-8
U3	78L05	512-LM78L05ACZX	$0.27	TO-92
Q1/2	2N3819	512-2N3819	$0.12 each	TO-92
Q2/3	2N3904	511-2N3904	$0.06 each	TO-92
D1	SD101A	625-SD101A	$0.17	
D2	1N5817	615-1N5817	$0.14	
speaker	3" 8 ohm	253-4130	$1.91	

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