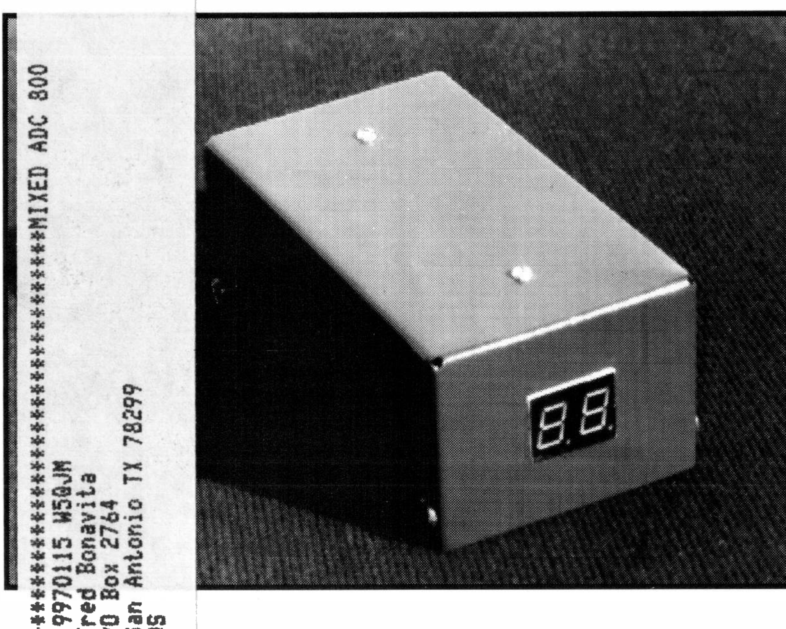
hambrew

FOR AMATEUR RADIO DESIGNERS AND BUILDERS

N7KSB: A Fifteen-Dollar Frequency Counter



WINTER 1997

SECOND CLASS POSTAGE PAID AT DENVER, COLORADO

• LETTERS •

From The Publisher

Christmas fast approaches, and as we finish up the details of this Winter, 96 issue of *hambrew*, no resolution for the continuation of this periodical has appeared to be viable. I have spoken to a few publishers who have indicated an interest, but none is a ham or has one on staff, much less one who builds his own equipment (have you noticed how few of us there are in the hobby?). Like many other endeavors, this situation has brought a number of well-meaning correspondences from readers and non-readers showering advice on how to improve the magazine. I guess they just have not been listening or reading what is really happening here. While I appreciate deeply the thoughts behind the advice rendered, the fact remains that advice is free and is well worth the price. What we do not need is plenty of free advice. We need individuals with the courage of their convictions who are ready to put their ideas into practice. Unfortunately, of all the contributors of ideas for improvements, not one has said "I want to put my ideas into a frame of reality...I'll take the magazine from here". Sound familiar?

Please understand that I report this without bitterness, although I wish only the best for the magazine, and therefore do confess to a certain disappointment for the sake of the readers and the future of this corner of the hobby. But I can get over it, since I will continue building, as will the movers and shakers in this realm. The losers will be the readers who get much from our forums.

In this issue, we get the pleasure of viewing a contribution from a great guy and radio designer in Russia, **Igor Kenik,UA6OCC**,who shows us a synthesized VFO schematic of great sophistication. Our thanks also to **Bill Currie, VK3AWC, Lew Smith, N7KSB, George Rosenburg, KC6WDK, Jim Lee, W6VAT, and Bill Copeland, WB6RVE**. These gentlemen are a great example of why and how we still exist to this day.

They give all of us who care about *hambrew* a reason for hope. 73, George

• Contents •

Photographic Credits:

Cover, pages 20, 22, 23: Lew Smith, N7KSB; Pages 5, 6: Marshall Emm, AAØXI, VK5FN;

All others: Hambrew

hambrew

FOR AMATEUR RADIO DESIGNERS AND BUILDERS

WINTER, 1997 • VOL. 5, NO. 1

Publisher................George De Grazio, WFØK

Writers, Editors and Contributors:
Igor A. Kenik, UA6OCC; Lew Smith, N7KSB;
Marshall Emm, AAOXI, VK5FN; George Rosenburg, KC6WDK;
James G. Lee, W6VAT; Bill Copeland, WB6RVE

Editorial Office, Ads & Subscriptions: (303) 989-5642 • hambrew@qadas.com

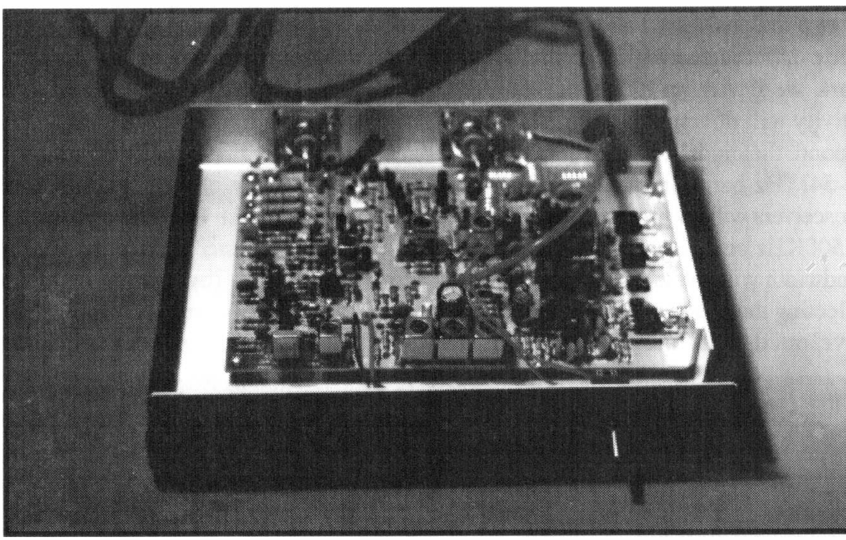
Hambrew (ISSN 10773894) is published quarterly by Smoking Pencil & Co., Publishers, Offices at 13562 West Dakota Ave., Lakewood, Colorado 80228.
Second-Class Postage paid at Denver, Colorado. POSTMASTER: Send address changes to *Hambrew*, P.O. Box 260083, Lakewood, CO 80226-0083.
Hambrew is sold by subscription only. Web page: http://www.qadas.com/hambrew
$10 per year (domestic), $21 US (foreign), $15 US (Canada and Mexico)
We welcome submission of articles, photos and manuscripts (S.A.S.E. for return)

KIT REVIEW

CQ 6... Calling CQ 6 Meters

Marshall Emm, AAØXI / VK5FN

2460 S. Moline Way, Aurora, CO 80014
MGEmm@intechnologies.com



Assembled transverter (photos, this article: Marshall Emm, AAØXI)

T-KIT (TEN-TEC) 2M-6M All-mode Transverter Cat. No. 1209 Kit $95.00, Assembled $159.00, +$6.00 s/h
T-KIT
1185 Dolly Parton Parkway Sevierville, TN 37862-3710
(423)453-7172
(800)833-7373 (Credit Card Orders)

Features:
144-148MHz input at 5W CW, SSB, FM, AM, Digital 50-54MHZ output at 8W
Automatic T/R switching with Semi-QSK
Receive Pre-amp Current Drain:
RX: Not stated. Measured 130mA no signal
TX: Not stated. Measured 2.3A

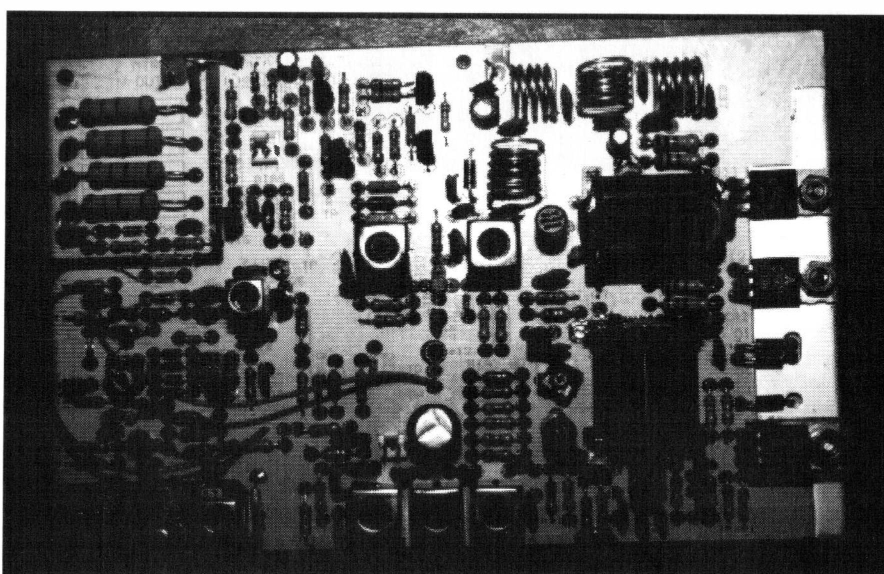
The popular wisdom is that six meters will be very active once the new solar cycle takes hold. That makes sense because 6 is is the one band with HF propagation characteristics that is accessible to the burgeoning crop of no-code tech licensees. But equipment for six poses something of a dilemma— there just isn't a lot out there. Single band 6M rigs are few and expensive. Rigs offering 6 in combination with either higher bands or HF (the new IC-706) are available, but also expensive. But for those considering an expansion of their band capabilities, there *is* an attractive and reasonably priced alternative— T-KIT, the kit division of TEN-TEC, Inc., offers a 6M transceiver kit and two trans*verter* kits, all of which are very reasonably priced.

The two transverter models are for use with a 2M (model 1209) or 20M (model 1208) transceiver. I chose the 2M model for two reasons. First, I already have an all mode 2M transceiver (note that it will work well with an H/T, but your 6M activity will of course be limited to FM). Second, the model 1209 covers the *entire* 50-54MHz band. In contrast, many HF transceivers will only transmit over a range of 500KHz or less on 20M— transverted bandwidth will be the same. And, possibly reflecting the nature of things when it was developed and despite the current prevalence of general coverage transmitters with FM, the 20M model 1208 is "not recommended" for use above 52MHz.

THE TRANSVERTER CIRCUIT

In its simplest form, a transverter requires only a local oscillator and a mixer. The 1209's crystal oscillator is at 94MHz, which is coupled to a double balanced diode mixer. Higher transmitted frequencies (e.g. 144MHz) mix with 94MHz to provide output on 6M; lower received frequencies (e.g. 52MHz) mix with 94MHz to provide output on 2M.

But a couple of circuits need to be added before a transverter is useful. First, transmit power in and out must be controlled (and of course unwanted frequencies must be filtered out). In practice it's far easier to drive the transmit converter with a low power level and amplify the down-converted signal with a standard RF power amplifier circuit than



Model 1209 board. Note that the heatsink is bent the wrong way (see text).

to design a mixer that will handle transmit power levels. In the 1209, input power is sunk into a 52 Ohm dummy load, with a small portion tapped off via a resistor as input for the mixer (the manual describes the arrangement as an "input attenuator"). The converted signal is amplified by a pair of 2SC1971 transistors driven by a 2SC1970, all mounted on a substantial heatsink about which more will be said later. Main output filtering is performed through a pair of binocular core RF transformers, which the user gets to wind and which are acknowledged in the manual as being the most difficult part of the whole kit.

There must also be some way to switch between transmitting and receiving modes, and the 1209 does this by switching control voltages via a pair of diodes and a capacitor that form an RF detection circuit. Detection is virtually instantaneous, and switching time is determined by the value of the capacitor— about which more will be said later!

Finally, the mixer and switching circuitry introduces some fairly substantial losses on receive, so the 1209 includes a receiving pre-amp based on a 3SK122 (MMIC), with a JFET buffer amp after signal conversion— the two provide more gain than required to account for the losses, but I had no way to measure it except by ear.

BUILDING THE 1209

For some reason I was expecting a TEN-TEC kit to be in the Rolls Royce category, and so I was surprised by a couple of things. The circuit board is double sided, and solder masked, with a neat parts overlay silk-screened on the component side. But oddly, the folks in Sevierville elected to avoid the expense of plated- through holes, so it is necessary for the builder to insert short pieces of wire to connect the ground plane on the two sides of the board. These connections are called "vias."

The manual leaves a *lot* to be desired. It is poorly organized, and contains a number of errors beyond the *thirteen* described on a separate errata sheet. An example of factual error is the single trimmer capacitor, used in alignment. It is C43, but it is referred to in the instructions as C34 and C41. Prospective builders are invited to e-mail me for a list of corrections and hints.

In some places the manual goes into way too much detail (often about things only marginally related to what you are doing at the time) and in other places it doesn't give enough. I get really frustrated when I read a long paragraph telling me, step by step, how to install component x. I do it, tick it off, and go on to the next step which says, in effect "3.a.b.ii. Now install component x as per the instructions in step 3.a.b.1 above."

And it was also frustrating to discover that after mounting the circuit board in the chassis, with three screws and bolts in the heatsink, three screws through the board, and two SO-239's that have been hard-wired— it's necessary to undo all of the above to get at the solder side and connect power!

The moral of the story is that you would be well advised to read through the entire manual before starting, and build the kit "in your head" so you can make allowances and change the order of operations where necessary!

If I seem to be dwelling overmuch on the documentation problem, it is because the instructions can make the difference between a successful kit and a lot of frustration; the experience level of the builder is almost irrelevant. And this was in addition to three genuine problems, about which more will be said later!

Now that I've got that out of my system, progress is easily measured and the thing goes together quite nicely. You build it in stages, and generally test each stage before proceeding to the next. Apart from the single RF amplifier MMIC, there are no integrated circuits, few coils to wind (and they are easy) and little confusion in the values of capacitors— these being three common problem areas.

Alignment is very straightforward, provided you have some means of calibrating the crystal oscillator. If you know someone who has a 6M transceiver with digital readout, it's very easy to do by having them to listen and report as you adjust up or down a bit. As built, mine came up approximately 1Khz off.

The only other alignment steps are to peak the received signal strength and peak the output power, and in both cases what is called for is relative, not absolute measurement. So for example you can use an HF wattmeter to peak the transmitter without worrying about whether the indicated power is an accurate measurement.

THREE PROBLEMS I SHOULDN'T HAVE HAD

Remember I mentioned a big heatsink? It's a piece of right angle aluminum with six component holes in one side and three mounting holes in the other. There was only one way it could possibly be installed, and that's what's shown in the photo. Turns out that it could not then be installed in the chassis without leaving the board about an inch [above] the mounting posts. A call to TEN- TEC, and the tech asks 'Does it look like the heatsink is bent the wrong way?' When I replied that that was *exactly* what it looked like, he said "Well, we had a few of those but we thought we got them all out of stock." They sent me a new one, and three replacement diodes in case I had trouble removing them to replace the heatsink.

The second and third problems came to light after the new heatsink was installed, and fortunately both were addressed with a single phone call to TEN-TEC. First, when you set the final amplifier bias, the instructions tell you that with the trim pot fully clockwise the current drawn by the transceiver "should be about 600mA" and then you turn the trimmer to increase the current by 200mA. Initially I measured 400mA and didn't know whether that was close enough, and if so I didn't know whether to increase the current to 600 mA or to 800mA. The tech said it didn't matter— just adjust for .75V on the base of Q11 and Q12. So much simpler that I have to ask why it isn't in the manual! Indeed, the manual recognizes that many builders won't have multimters that can accurately measure current at that level, and instead of having you measure the voltage at the PA, they tell you how to cobble together an ammeter shunt!

Finally, while the transceiver performed perfectly on CW and FM modes, the output SSB signal was severely distorted. A friend said I sounded like one of the old Battle Star Galactica "Cylons." According to the TEN-TEC tech, there were three things to try. First confirm .75V on the base of Q11/12 which I did. Next, put a 4.7uF cap across C8 (on the theory that the TR switch is responding too quickly to voice peaks), which fixed about 90% of the problem and gave me an SSB signal that was at least intelligible if not clean. Finally, change R5 to reduce the amount of RF into the mixer. All done and all fixed. But once again I have to ask— 'Why isn't it in the %$@!* book?"

WRAPPING UP

A transverter is a pretty dumb piece of equipment— the only control is the on off switch— so there's not a lot to say about operation beyond confirming that it works as advertised. Whatever you put in at the 2M end comes out on 6.

TEN-TEC says there are technical reasons for not incorporating an antenna switch in the 6M version even though they've done that in the 20M (model 1208) version, so you'll need an extra coax switch or else have to plug and unplug cables every time you want to switch your 2M rig between 2 and 6.

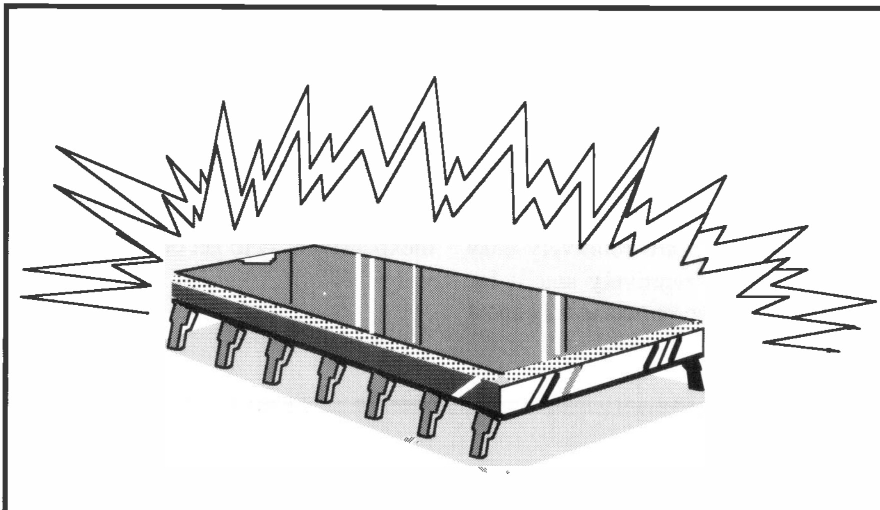
Antennas for 6 are relatively easy because they are relatively small; for example, a 1/4 wave vertical is only about 5 feet long. It's also an easy band to find an emergency substitute for by looking at harmonic relationships. I did the math and predicted that my 30M dipole should work on 6, and indeed it does. The 40M dipole is marginally better at the top of 6M. As with 2M there is a defacto standard that antenna polarization should be horizontal for CW and SSB, and vertical for FM, so you may want to equip yourself with two 6M antennas.

TEN-TEC has a nice kit here, and I have to say that when I needed support, I found their staff to be very knowledgeable and helpful. Apart from the documentation problems, I have no hesitation in recommending it as an easy and inexpensive way to get onto 6.

The One-Chip DC Receiver

Bill 'Scrooge' Currie, VK3AWC

PO Box 5197, Mordialloc, Victoria 3195, Australia



I have always been a bit of a "tightwad" and when I recently acquired some 74HCU04 chips at ten cents each, I couldn't resist the challenge of making a receiver using one, and one only, of these chips.

The 74HCU04 is really a digital chip containing six inverters, the HC denoting High speed CMOS, and the U denoting unbuffered. CMOS inverters can be biased into the linear mode by installing a feedback resistor from output to input and a series input resistor, similar to op-amp configuration.

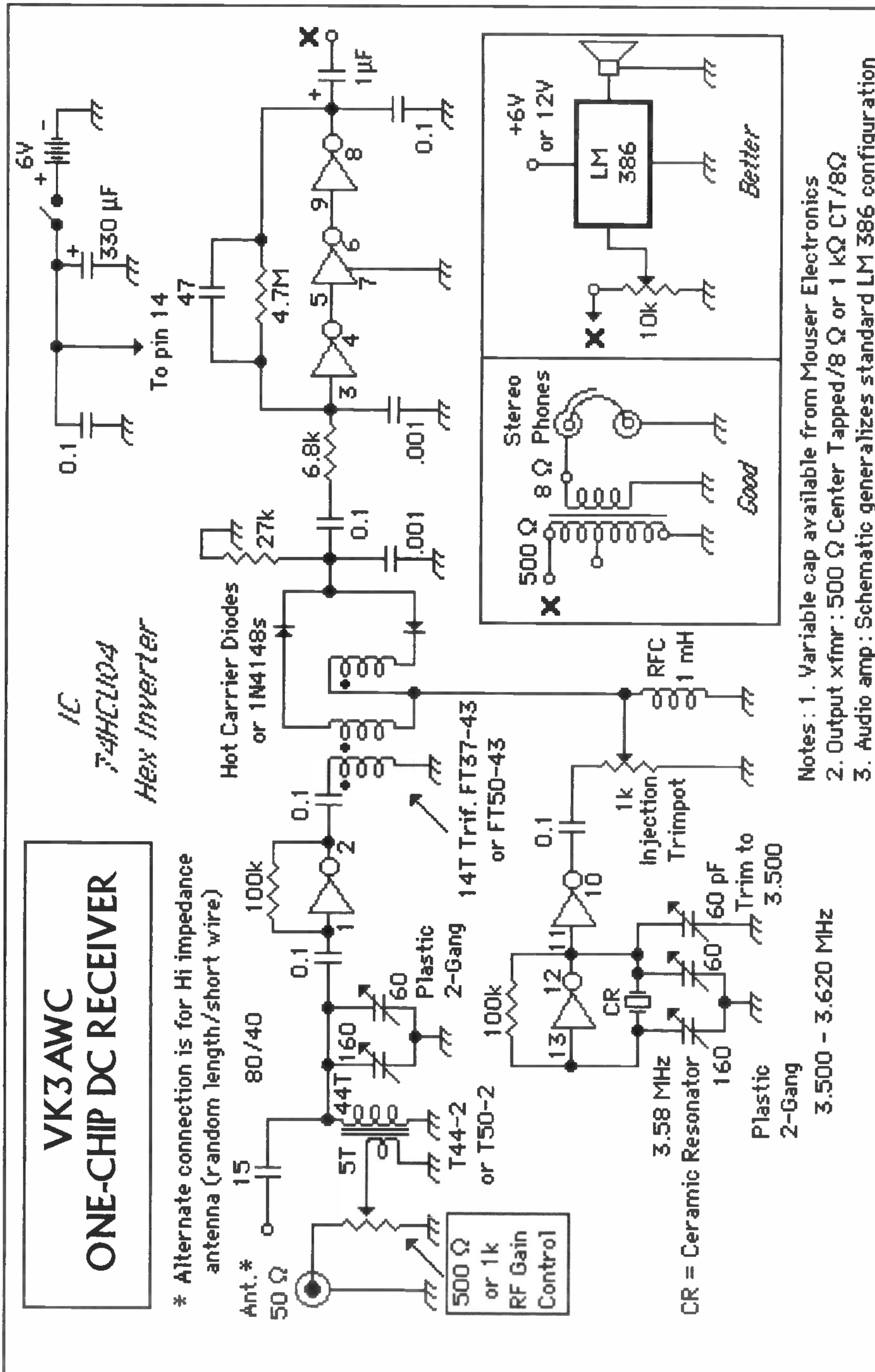
Some experiments proved that not only would the inverters amplify audio frequencies but they would also handle RF signals. A gain of about 10 is available up to 10 MHz or so.

DC Receiver

The resultant direct conversion receiver for 80 metres contains an RF stage, a VFO with a a buffer, a product detector and a high gain audio stage.

The product detector uses two diodes and is the only stage not contained on the chip.

The VFO uses a ceramic resonator and tunes from below 3.500 to about 3.620 MHz. This fairly large swing is obtained by using a two-gang capacitor, one section at each end of the resonator. Inciden-


VK3AWC
ONE-CHIP DC RECEIVER
* Alternate connection is for Hi impedance antenna (random length/short wire)
Ant. * 50 Ω
15
500 Ω or 1k RF Gain Control
5T
44T
T44-2 or T50-2
160
60
Plastic 2-Gang
80/40
0.1
100k
1
2
0.1
14T Trif. FT37-43 or FT50-43
IC 74HC04 Hex Inverter
Hot Carrier Diodes or 1N4148s
27k
.001
0.1
6.8k
.001
3
4
5
7
6
9
8
4.7M
47
To pin 14
0.1
330 µF
6V
0.1
1µF
X
RFC 1 mH
1k Injection Trimpot
0.1
10
11
12
13
100k
CR
60
160
60 pF Trim to 3.500
3.58 MHz Ceramic Resonator
Plastic 2-Gang
3.500 - 3.620 MHz
CR = Ceramic Resonator
X
500 Ω
8 Ω
Stereo Phones
Good
+6V or 12V
LM 386
X
10k
Better
Notes: 1. Variable cap available from Mouser Electronics
2. Output xfmr: 500 Ω Center Tapped/8 Ω or 1 kΩ CT/8Ω
3. Audio amp: Schematic generalizes standard LM 386 configuration

tally, I find that two-gang capacitors are easier to scrounge than single ones. I actually used a (shudder!) plastic capacitor, but you may not be as big a tight-wad as I am!

The audio output is sufficient to drive a pair of "el cheapo" stereo 'phones or an LM386 amplifier, such as Silicon Chip's "Champ" (Feb. '94 issue).

I built the receiver on a Tandy IC perfboard (Cat. No. 276-150). This board is 72mm x 45mm and is ideal for IC projects but requires that all components be very small. Drew Diamond (VK3XU)'s "paddy board" method of construction would probably be an easier way to go.

The receiver runs best on six volts but works OK on five. One disadvantage is the high current drain of 60 mA or so, which rules out dry batteries, unless your uncle owns Eveready.

A Brief Wander Across the Circuit Diagram:

The 50 ohm input is from a tuned antenna. I originally tried 4 turns on the primary of the T44-2 transformer, but found 5 works better on my set. The high input (option) was intended for a high impedance input (a short length of wire) for 80 and 40 metres. There tends to be more BC (SW) breakthrough from this input, but it is handy for those without resonant antennas.

The capacitor from pin 10 of the IC (the VFO buffer output) should be 0.1 μF mono, as are all the other 0.1's. The transformer feeding the 8 ohm phones should be the easily obtainable 500 Ω ct / 8 Ω. I've tried a 1k transformer here, but found it not as good as the 500 Ω. I really don't know what the output impedance of the buffers are, but guess the figure is less than 1k.

I did not include a Volume Control in the audio section as output is not very high. Of course with the "better" circuit and a gain of 10-100, then a V.C. is needed. A 1k or 500 ohm RF gain control could be included, but that's up to the individual homebrewer, I guess. Be careful to connect the positive side of the 1.0 μF capacitor at the output of the AF stages towards pin 8 of the IC.

Bonus Bits

The receiver will receive signals on 40 metres also. The square wave 3.5 MHz drive to the product detector probably accounts for this. the frequency coverage is 7 - 7.2 MHz or better, and all that is required is to re-tune the input circuit to 40 M. If you are troubled by Shortwave Broadcast Band breakthrough, you may need to install double-tuned circuits and/or band switching in the front end. As the VFO is buffered, you can feed a frequency counter and/or an 80 meter transmitter.

Afterthoughts

To prevent problems with the VFO output getting into the front end, it would probably be better to use a separate VFO and buffer, but the thought of squandering 10 cents for another chip was more than I could bear.

The values of components have not been optimized; feel free to fiddle with what you will. I used hot carrier diodes (H.C.D.'s) for the product detector, but 1N1448's work almost as well (and cost a lot less).

In the unlikely event that signals are too strong, cut your antenna in half (heh-

heh!) or install a 1k pot on the input as an RF gain control.

You may be able to use a standard CMOS chip such as the 4069 in this circuit, but for the sake of a few cents (it's your money, not mine), why bother?

It should be possible to use the 74HCU04 in at least some stages of superhet receivers, double and single sideband transmitters (e.g., as RF amps in a DSB transmitter to drive a MOSFET output stage) and various pieces of test equipment. The chip has six AF/RF amplifiers available, costs less than a dollar, and is easy to use.

It's over to you - and please don't reverse the charges!

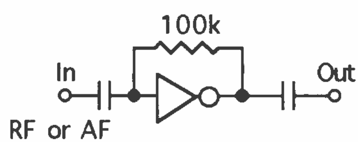
Postscript 1

My receiver is working well at the moment (and I hope to put it in a box one day), except that I recently discovered that is suffers from frequency hopping at one spot on the dial. This has been mentioned before about ceramic resonators by other ham homebrewers. At about 3.518 MHz, the frequency will "jump" to 3.523 and vice versa.

I haven't tried other resonators in this set yet, but I did have a similar problem with another resonator in a similar receiver. Has this happened to you, and do you have any ideas to overcome it?

The 74HCU04 CMOS Inverter Chip

"The 74HCU04 is a very useable chip when used for audio or RF amplifiers (below).



Gain of 10

The 74HC04 can also be used, but has higher gain and is hard to 'tame'."
...Bill, VK3AWC

Above article reprinted from
Lo-Key #47, (September, 1995) by permission of
CW Operators QRP Club (Australia) and the author.

Low-Cost PLL Frequency Synthesizer for QRP

Igor A. Kenik, UA9OCC

This experimental phase-locked loop frequency synthesizer is used in a 20-meter superhet with a single IF of 6 MHz. It covers 20-20.35 MHz.

The Circuit

The schematic diagram of the synthesizer is shown in Figure 1. The circuit can be broken into two basic sections: the controller and the synthesizer. Signals from the optical quadrature encoder (an old mouse from an IBM computer) are sent through U1B (Clock) and U1C (Data), and are fed to U2 - a programmed Zilog OTP microcontroller Z86E0812PSC. Via a three-wire serial interface, the microcontroller controls the PLL synthesizer: a Motorola MC145170P1. An Atmel serial EEPROM AT93C46 (U3) is used to store the IF value (6002.4 KHz), the last frequency entry and several other parameters. The VFO and PLL chip is built in a small shielded box.

The display (DS1, DS2) is made from two 4-digit, 7-segment common-cathode multiplexed DL34M indicators. The digit to the far left of the display indicates the current mode and the rest of the six digits show the operating frequency: X_14.XXX.X.

By pressing the MODE button, the synthesizer switches between the following modes of operation:

1. Fine tuning with a 93 Hz step at the lower band edge to 25 Hz at the higher edge. The frequency Fout is displayed and the IF is always shown in 100 Hz increments.
2. Same as mode 1, but the displayed frequency is Fout (for test purposes).
3. Speedy tune with 2 kHz step.

A complete listing of the microcontroller's code in Intel hex format is given in Appendix A.

The synthesizer draws about 20 mA from an 8 - 12V DC power supply.

Alignment

You'll need the following equipment: a frequency counter capable of measuring 30 MHz with a resolution of 10 Hz, a DC voltmeter, an oscilloscope with a bandwidth of at least 50 MHz and a 10X passive probe with input capacitance of no more than 12 pF. Attach a 50 Ohm, 1/4 W carbon or metal-oxide resistor to J2 and the probe to the oscilloscope.

U2, U3 and U7 must be out of their sockets. Connect the U7 socket's pin 13 to the U8 output (5V). Set C11 to a minimum capacitance. Turn the power on, and check the output voltages of the U6 and U8 regulators (5.0 +- 0.1 V).

Connect the probe to the source of Q3 to sense oscillation. If the VCO is not oscillating, slightly increase the C11 value. Attach a frequency counter to J2. Adjust C14 for a frequency of 21 MHz. Check the output amplitude (1-2 V peak-to-peak) at J2 and at the socket's pin 4 of U7. When you are satisfied that all is well, turn the power off. Disconnect the U7 socket's pin 13 out from 5V and insert the U2, U3 and U7 chips.

Turn the power on. DS1 and DS2 will Display: 1_13.997.6.

If you rotate the tuning knob, the frequency will change. Leave the tuning knob free for more than 15 seconds. The controller will go to the "sleep" mode and the display will turn off. Turn the power off. Turn the power on again. The DS1 and DS2 must display the previous value. Check the reference frequency at pin 3 of U7: 10240 KHz. Adjust C5 if needed. Change mode to "2" by pressing the S1 button. Check the output frequency.

Remarks to Figure 1

Unless otherwise noted, fixed-value capacitors are ceramic.
Resistors are 1/4 watt carbon composition, 5% tolerance.
C3: 10 to 33 μF, 16V tantalum or aluminum electrolytic
C4, C7, C18: 0.47 to 1.5 μF, 16V tantalum or aluminum electrolytic
C5, C11: 10 to 100 pF ceramic NP0 trimmer with shaft
C12: 0.5 μF, 160V Mylar
D3: Motorola MV104 Varicap
J1: Single-hole mount phono jack
J2: Female BNC connector
L1: 1.2 μH coil
RFC1, RFC2: 10-15 turns of #26 enameled wire on a ferrite toroid (850u)
The value of the choke is not critical.
S1: Normally open push-button switch.
Y1: AT-cut crystal with a marked frequency of 10235 kHz.

Appendix A.

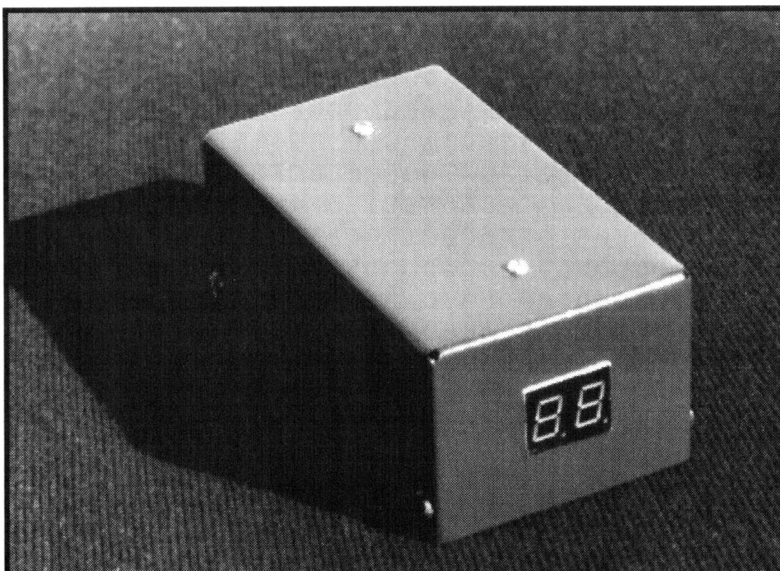
```
:10000000FFFFFFFF0022001200488FFFF8002FA8D64
:10001000000CA66F036B04206F8B03E66F01E46F87
:1000200029BFE6FB18BF70FD31507C11B0EAB0EB80
:10003000CFC0EAC0EBC0ECC0EDFB0402B912A87A55
:10004000F078EA427B50FDAF70FD3120A020E6023F
:1000500010FF45E302FF290267E380EB0346020835
:100060003E2EA6E208EB04B0E23C2850FDBF200132
:1000700004160018002007F70FD3110B00BB00C8A
:10008000B00DB00EB00F6C0B9C0522BD32AC7B04E2
:1000900021E68BF602BD12ACB058E6590AA95CB94C
:1000A0005DD60026A85CB85D6E9ADF50FDAF8F5616
:1000B00002BF5600FE70FD3140CF10E110E07B051D
:1000C000D600DD8B03D600D1BAEF46000150FD9F6C
:1000D000AF460280FF460240FF56023FAF56027F06
:1000E000FF460240FF5602BFAFD8F7C8E626ED0044
:1000F00036EC14FB0860ED06ED0146FC02E8ED026B
:10010000EFB058E959DC00CC2822D332C2C95CD900
:100110005DD60026E45C1AE45D1BE4461CE4471D42
:10012000D60076A60D042B04200CB00DA60B026B94
:1001300011E6170BE61663D601FAE46365B063B007
:1001400064AF7C006C1466FC016B0480F28B02A03F
:10015000E248E258E3B063B064B065AF70FD3110BF
:100160009C0370E970E6CFE38666FC026B0413879C
:100170008B02338740E8F36800E600E79AE950E62F
:1001800050E9CF17E60041E600E69AF750FDAF08C8
:10019000421843CF10E110E0B066B067B068B069B4
:1001A000B06AB06B26E11036E0277B0420668BF442
:1001B00006E11016E02726E1E836E0037B0420671D
:1001C0008BF406E1E816E00326E16436E0007B04E8
:1001D00020688BF406E16416E00026E10A36E000B0
:1001E0007B0420698BF406E10A16E00026E1013663
:1001F000E0007D01F9206A8BF3AF70FD31108C03B4
:10020000E3E7F0EE7EE3F742EFF36E7E6E8AF150A5
:10021000FDAF8F70FD31107C606C2A8C03E3E7F03A
:10022000EE56EE0FF36E6EE3E756EE0FF36E7E6E54
:100230008AEB462B80462E8050FD9FAF8F460002F2
:1002400070FD316070E970E8D600D1C8F8D8E85692
:10025000ECC06B09B8E9E0EB56EB30428BBC049084
```

:10026000E87B05D600DD8B03D600D1BAF256E91F34
:10027000BC0390E9BAFCBC0590E97B05D600DD8B95
:100280003D600D1BAF2A6ED806B4AA6ED206B2111
:10029000A6ED406B0CA6ED306B52A6ED006B4D8BBE
:1002A0004BBC0890EA7B05D600DD8B03D600D1BAA3
:1002B000F25600FDFFE6F6A0FFFFFF460002BCDCA1
:1002C00070EBBC16BAFE50EB6602806B05BAF1DF2C
:1002D0008B01CF8B17D600DDE6F6A0B0EAB0ECBC00
:1002E0008C80290EC10EAD600DDBAF55600FDE62B
:1002F000F62050E850E950FD9FAF8F31F0B0F1FC8F
:1003000055EC7FF3EF00EEA6EE036B0460EF8BF38A
:10031000EC7F60EFA3FEED000F00EEA6EE03EBF224
:10032000A6EFAAEB038D0301EC04B1EEEEA6EE7F7F
:10033000EBF831204C005C6E6CF62C0AC3642AFC8F
:10034000B0E23C28E6F5C1E6F45AE6F305E6F20A27
:10035000E6F10FE60001B025600FDD600DDD60042
:10036000DDD600DDD600DD5600FED600DDD600DD90
:10037000D600DDD600D1D600DE46000131400C4468
:10038000B0E1BC08D600AEE66F01E6287FE46F2935
:10039000E6697EE66880D6023CA66A566D040E631
:1003A000697FD6023CA66A57EB19E66E42E669001
:1003B000D6023CF56A6E206E2069A66909EBF19FB2
:1003C0008D04602C273C1048E258E360147C00E656
:1003D0004806E64900E64A249F8D0460B0FCB02040
:1003E000B02166FA206B46A62010EBF6E66830D600
:1003F00023CE66E42E66900E66840E56E6AD602B7
:100400003C206E2069A66906EBF1E66800D6023C46
:100410008FE6287FE62A7FE62B7FE62C7FE62D7F7E
:10042000E62E7FE62F7FE6FB049F7F8BB556FADF33
:10043000A66F03EB156C147C007602206B0480E23F
:100440008B02A0E248E258E38B197602206B089009
:10045000E680E480E48B09A0E6A0E4A0E4E6FC01E9
:10046000D600E9D6018FE61766E61660D601FAE6F1
:100470001765E61662D6015CA66F026B15E448634 9
:10048000E44964E44A65E61765E61662E6FC02D6CE
:10049000015CD6021218E708E6CF10E110E0BC0FAD
:0F04A000D600AE18F508E4BC10D600AE5D03DC24
:0307FD008D000C60
:00000003FD
:00000001FF

A Fifteen Dollar Frequency Counter

Lew Smith, N7KSB

4176 N. Soldier Trail, Tucson, AZ 85749



This counter was built on two sawed-off Radio Shack 270-170 PC boards.
(All photos, this article: N7KSB)

Adding digital frequency readout to most homebrew transmitters or receivers is easy with this counter. The basic circuit displays the KHz and tens of kHz digits of any frequency up to 30 MHz. Modular construction allows additional digits to be added as needed. Parts (including PC boards, but excluding an enclosure) can be obtained for approximately $15.

Circuit

The circuit uses a low cost 4,096 kHz microprocessor crystal and one of U1's NAND gates to make a stable time base oscillator. Half of dual decade counter U2 divides the oscillator frequency down to 409.6 kHz. Binary ripple divider U3 further divides the time base down to 50 Hz at pin 2 and 25 Hz at pin 3. The positive half of the 50 Hz square wave is used by pins 1,2, and 3 of U1 to allow 10 milliseconds of the input signal to be counted.

The 10 millisecond sample of the input is first sent to the bottom half of U2 which functions as a divide by ten prescaler. The prescaler minimizes jitter. Without it, readings often flicker between two numbers.

Output from the prescaler is fed into dual decade counter U4. The 4 bit binary output of each decade counter is sent to display decoders U5 and U6. Diodes Dl, D2, and D3 plus the output resistance of U5 and U6 limit the current supplied to the display to about 10 milliamps per segment.

Figure 2 shows the timing of the count, counter reset, latch, and time base reset signals. Between 0 and 10 milliseconds the positive crests of the input signal are counted. At 10 milliseconds the input is gated off and a latch spike is generated. This spike allows the count to be latched into U5 and U6. At the same time C5 and R4 generate a 300 millisecond long spike. This latter spike resets and stops the time base long enough for the human brain to make sense out of a changing count.

At 310 milliseconds, the time base starts up again. Between 320 and 330 milliseconds an extraneous count is taken but not used. At 330 milliseconds the counter is reset to zero. The cycle begins again at 340 milliseconds as a new count is taken.

Construction

This project will be easy to debug and modify if it is built on several separate PC boards. The photos show a construction method using Radio Shack 276-150 multipurpose PC boards. The counter can be built and tested with the boards laid out side by side. Once it has been tested, the counter can be folded up into a compact 1.8 X 2.8 X 2 inch (HWD) assembly.

The 74HCxx chips and the crystal can be obtained from most mail order houses. 74HCTxx, 74ACxx, or 74ACTxx ICs may be substituted for the 74HCxx parts.

The voltage regulator needs a modest heat sink. A 2 by 3 inch metal plate (or double sided PC board) will suffice. Alternatively, the regulator can be bolted to the metal enclosure.

It is a good idea to house the counter in a metal box. Otherwise harmonics from the crystal oscillator and other EMI nay interfere with reception. Brass sheets sold in hobby stores can be used to fashion a shield if the counter is built into a receiver.

Variations

The basic counter has a —,-99 kHz full scale readout. The circuit can be easily modified to read other digits.

A pushbutton switch can be added to temporarily disconnect pin 1 of U4 from pin 7 of U2 and reconnect it to pin 3 of U1. This gives 100 Hz resolution with a —,— 9.9 kHz full scale readout whenever the switch is depressed.

A —,99- kHz full scale readout is possible if the top half of U2 is bypassed. A switch can be used to connect pin 10 of U3 to either pin 9 of U2 or pin 6 of Ul for this purpose.

More digits can be added by cascading one (or more) 74HC390 decade counters, 4511 display decoders, and 7 segment displays. Modular construction makes it easy to add digits at any time.

The entire counter draws about 150 milliamps. At this current level the display is bright enough to be read in direct

UA9(
PLL FREQUENCY

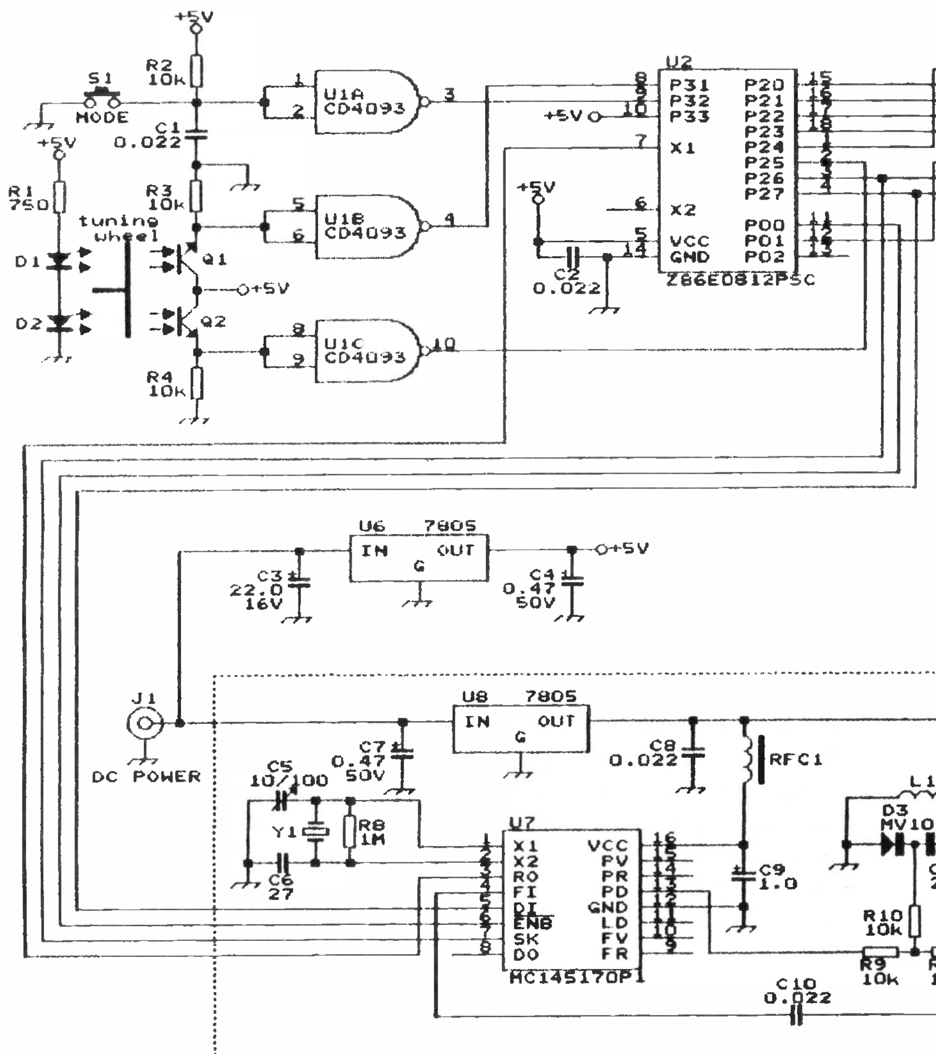
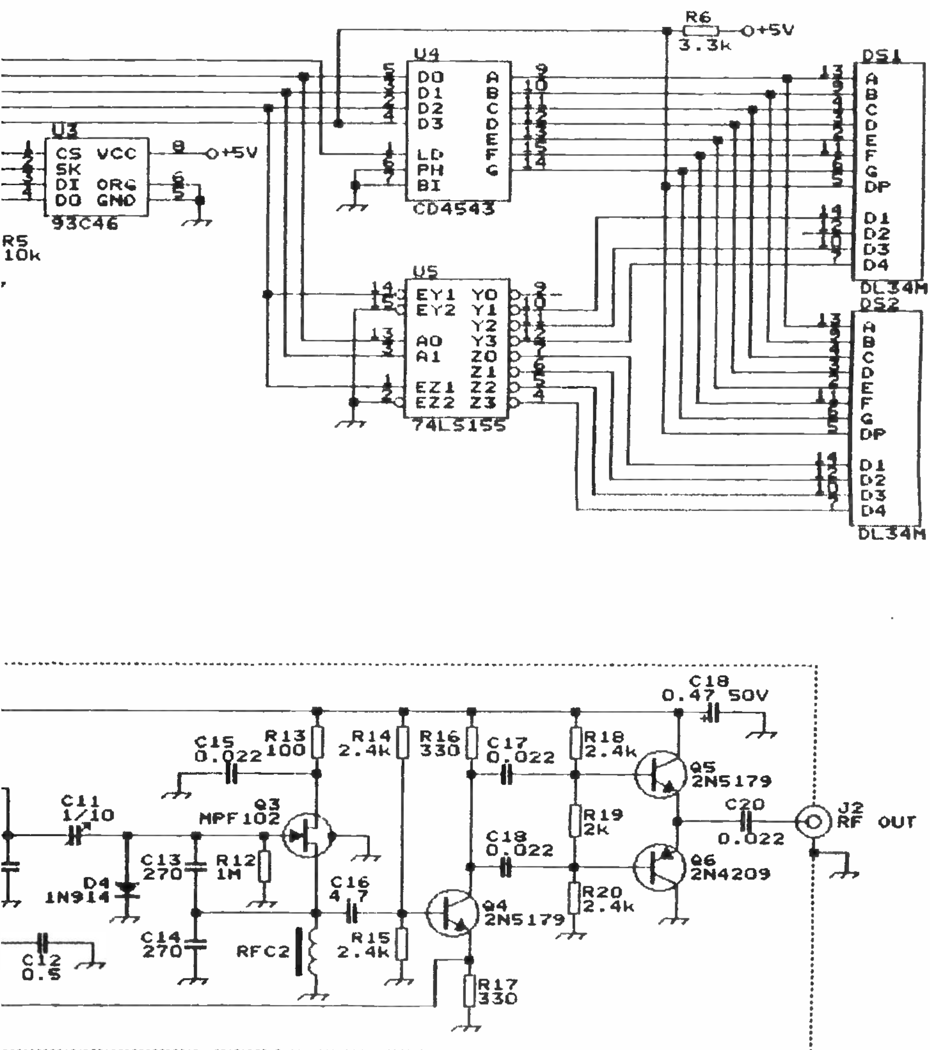


Fig 1 - Schematic Diagram of

CC
SYNTHESIZER

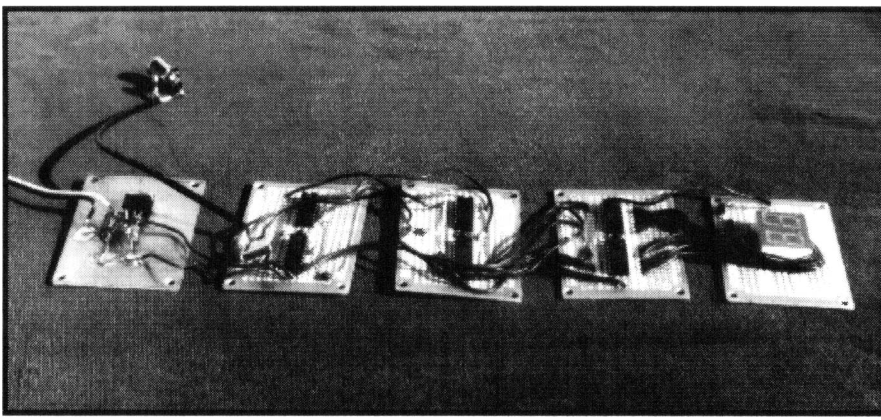


the Synthesizer

sunlight. The display can be dimmed and the supply current reduced to approximately 30 milliamps by adding a fourth diode to the Dl, D2, D3 string.

The input sensitivity is approximately 4 volts peak-to-peak. A threefold improvement in sensitivity can be obtained by adding a 6.8 megohm resistor between pin 2 of Ul and +5 volts.

the test oscillator's frequency is changed. Most problems can be diagnosed by analyzing numbers that are displayed. Strange characters can be caused by a miswired display or by "illegal" codes. Illegal codes can be caused by incorrect U4 to U5, U6 wiring. If the counter displays a string of apparently random numbers, the counter reset (the circuitry feeding pins 2 and 14 of U4) is likely to be at fault.



Counter unfolded for initial testing. PC boards (left to right): 7805 voltage regulator, U1 and U3 time base, U2 and U4 prescaler and counter, U5 and U6 decoders, and display.

Checkout

Before applying power, double check the wiring and orientation of the components. Use a magnifying glass to check for shorts between solder pads.

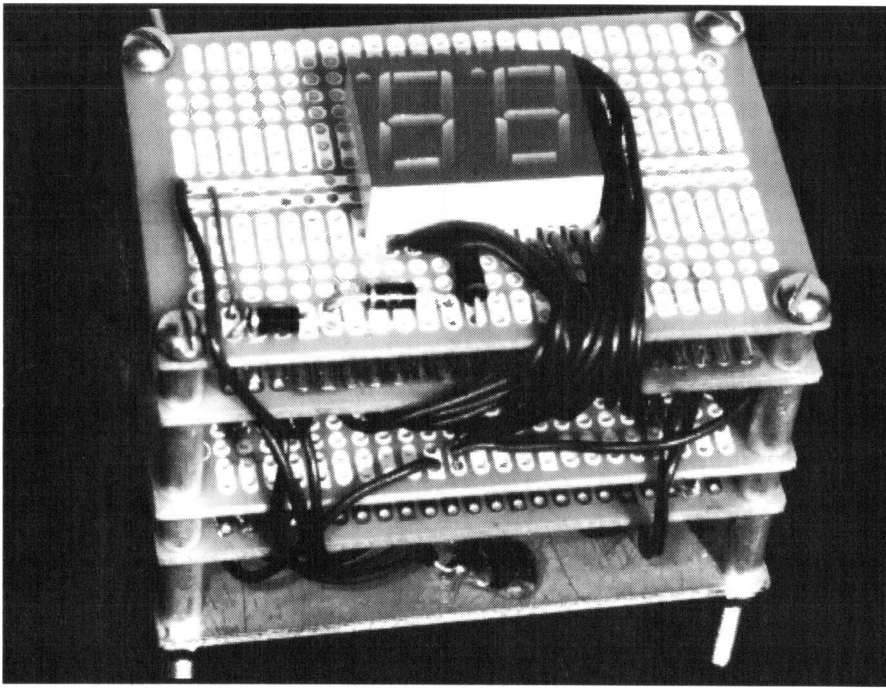
Apply power and check the supply current. Excess current usually indicates shorted or miswired supply and ground leads. Check for +5 volts at the voltage regulator output.

The display should read 00. Connect the input to the 4,096 kHz oscillator (pin 6 of U1). The display should now read 96. Next connect the counter to a VFO or test oscillator. The readout should move up or down between consecutive numbers as

If the counter is stuck at one number, either the latch circuitry (the circuitry feeding pin 5 of both U5 and U6) or the time base is at fault.

If the time base is suspected of being faulty, check the 4,096 kHz oscillator. As long as the counter is unshielded, it should be possible to pick up the oscillator or one of its harmonics on a nearby receiver.

Once the counter is working, zero beat the test oscillator with WWV, W1AW, or some signal whose frequency is known. The counter will typically be within +/- 1 kHz of the correct frequency. If desired, the counter can be fine tuned by adding or subtracting a few pf from C2. A Radio



Counter built with stacked Radio Shack 276-150 Multipurpose PC Boards. The bottom board is a double-sided, unetched board used as a heat sink for the 7805 regulator.

Shack "Pico-Pack" assortment of small value capacitors is ideal for this purpose.

<u>Application</u>

It is easy to add a counter to a non-heterodyne type transmitter that has a continuously running oscillator. Connect an 18 inch or less coax cable from the counter to the collector of any low power unkeyed stage. (Connect to the emitter if an emitter follower stage is selected.) If the oscillator is an LC type VFO, tap into one of

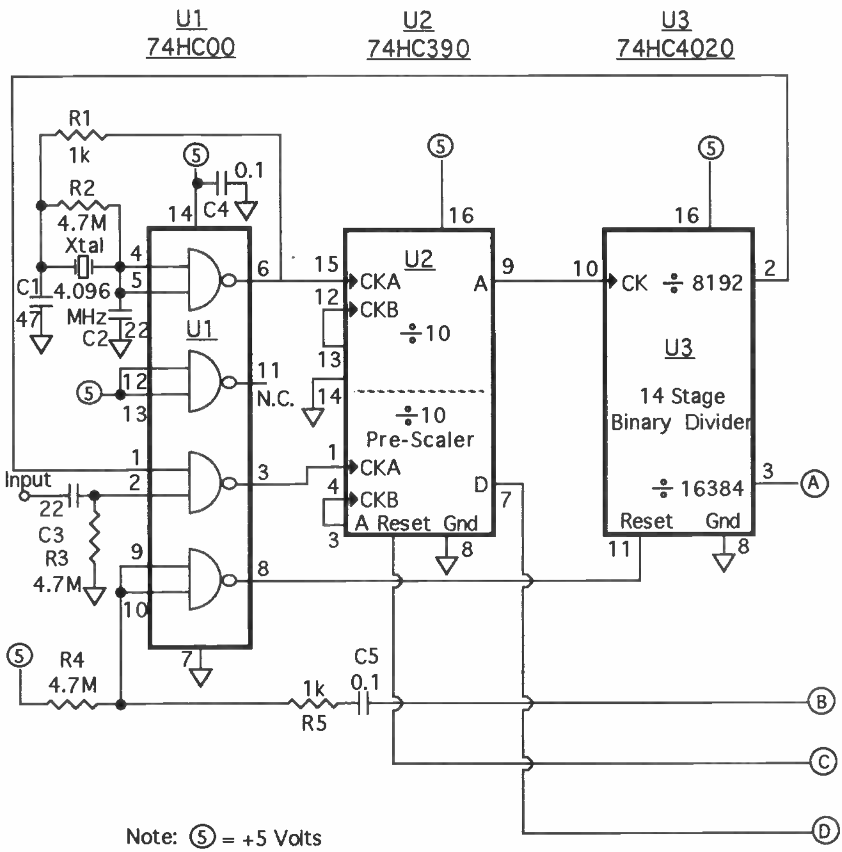
the buffer stages following the oscillator. Many homebrew transmitters key the crystal oscillator. These rigs have (or should have) a spotting switch to activate the oscillator without turning on the final amplifier. This allows the frequency to be checked or adjusted without causing QRM. The counter can be powered up by another section of the spotting switch. Running the counter only when the spotting switch is pressed prevents it from displaying erratic numbers as the transmitter is keyed.

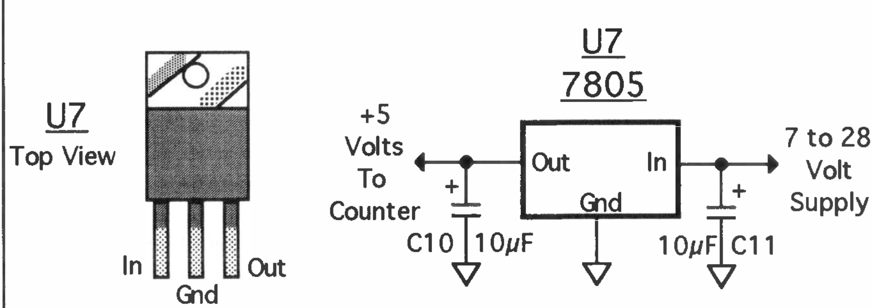
Although adding a counter to a direct conversion receiver is normally straightforward, watch out for a clicking signal radiating from pin 3 of U1. A metal shield will normally fix the problem, but stubborn cases may require using shielded wire for the Ul, pin 3 to U2, pin 1 connection.

Heterodyne type transmitters and superhet receivers have one variable and one (or more) fixed oscillators. Digital readout is

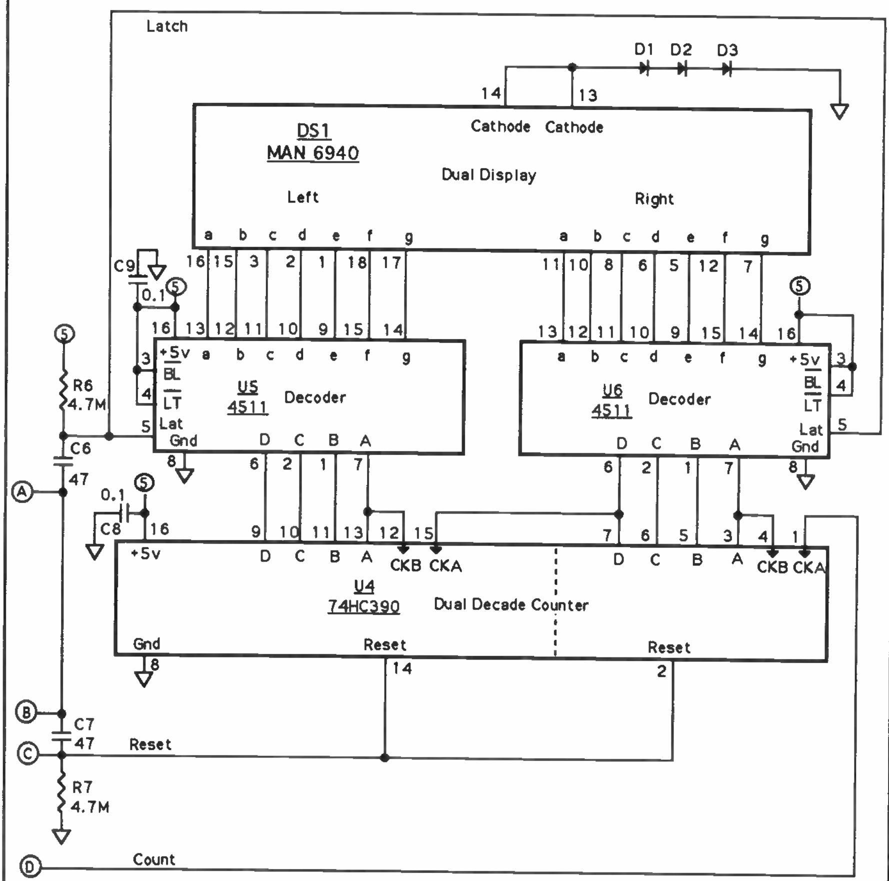
(Article concludes on inside back cover)

N7KSB FREQUENCY COUNTER





N7KSB FREQUENCY COUNTER



Note: (5) = +5 Volts

N7KSB FREQUENCY COUNTER

Parts List

C1, C6, C7	47 pF ceramic capacitor
C2, C3	22 pF ceramic capacitor
C4, C5, C8, C9	0.1 μF monolithic ceramic capacitor
D1, D2, D3	1N4001 rectifier diodes
DS1	MAN 6940 common cathode dual LED display
R1, R5	1k resistor (1/8 watt)
R2, R3, R4, R6, R7	4.7 megOhm resistor
U1	74HC00 quad NAND gate
U2, U4	74HC390 dual decade counter
U3	74HC4020 14-stage binary divider
U5, U6	4511 display decoder
U7	7805 5 volt regulator
Misc.	four Radio Shack 276-150 multipurpose PC boards

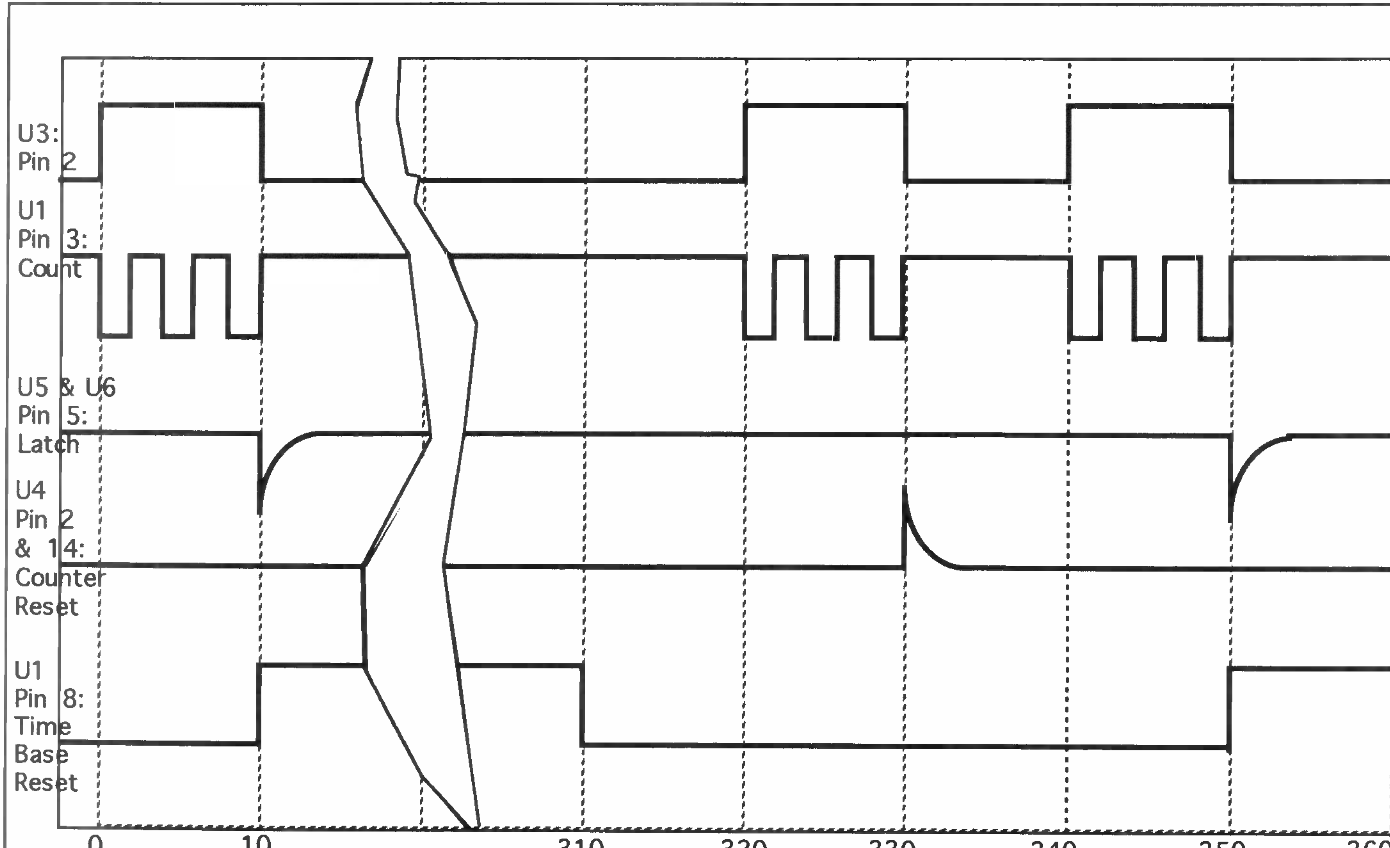
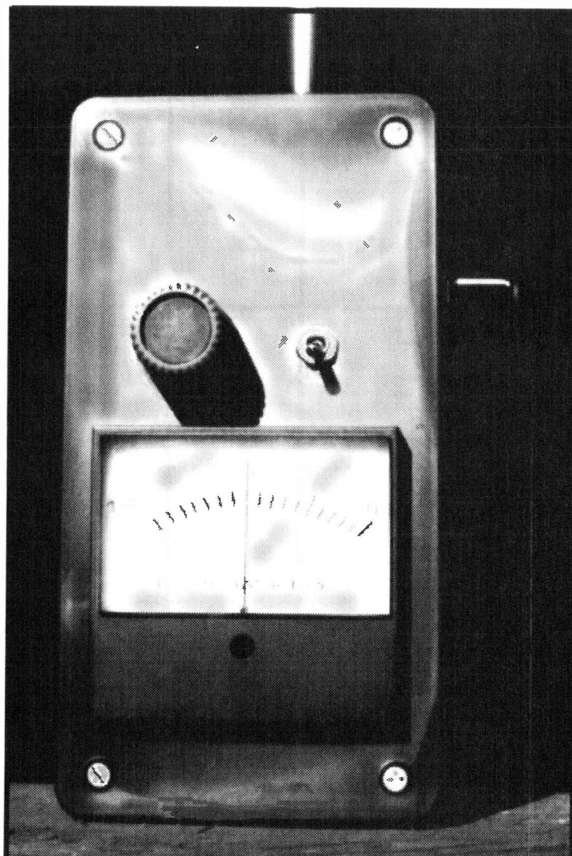


Figure 2: Timing Diagram

Field Strength Meter

George Rosenberg, KC6WDK

123 E. 24th. St., Tucson, AZ 85713



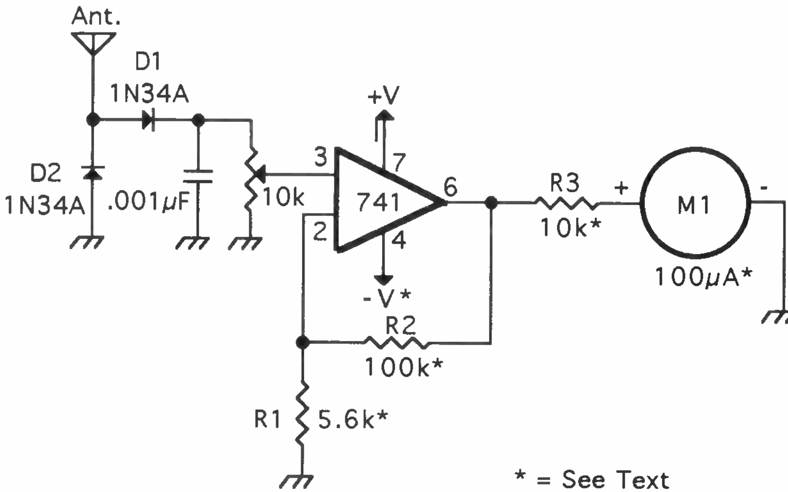
hambrew-built KC6WDK Field Strength Meter.
Pot on front is zero-adjust; pot on side is intensity-adjust.

FIELD STRENGTH METER

Cost estimate: $12

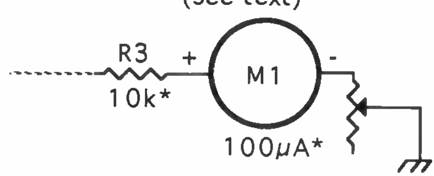
If you have a ham radio license and a transmitter, it really helps to check if your signal is coming out of the antenna! This extremely sensitive field strength meter will show whether or not something is being transmitted and indicates any changes in power output or antenna design. It does NOT indicate whether the signal is free of spurious (unwanted and illegal) emissions - for that a tunable field strength meter (wavemeter) is needed. Nonetheless I find that this unit comes in very handy for checking a transmitting system. A big advantage is the wide range of meters that

K06WDK
Field Strength Meter

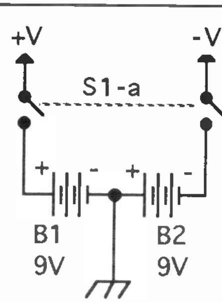


* = See Text

Optional Meter-Zero
Potentiometer
(see text)



Battery Configuration

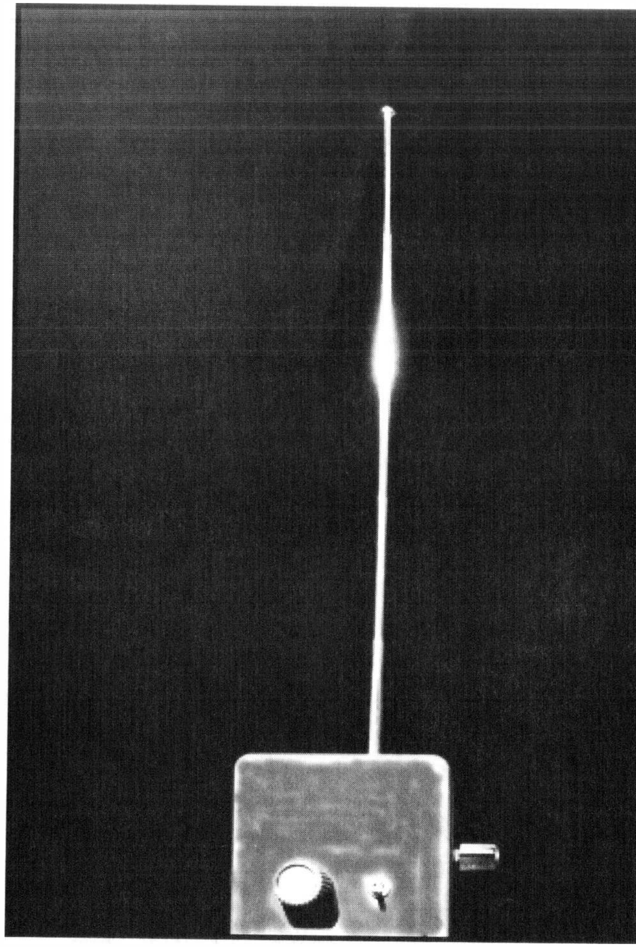


can be used for this project; almost anything that can be found will work. I threw this design together myself with what I had on-hand at the time and use it frequently.

How it works: RF signals entering through the antenna are detected by voltage-doubler diodes D1/D2. A 741 IC op-amp configured as a non-inverting amplifier increases the signal by a factor determined by R1 and R2 according to the formula

GAIN = 1 + (R2 / R1)

and finally a micro- or milli- ammmeter, shunted by resistor R3 to read 1-volt full-scale, displays the amplified signal strength.



Construction: Build on a prototyping board first and start with R1 and R2 values shown, with appropriate R3 value for the meter you have (see M1 in parts list below). Apply power. The circuit will probably need adjusting to zero the meter: add resistance in increments of about 10% of R3 in series with M1 to bring the meter needle to zero - this will take some trial-and-error. Alternatively, a zero-adjust potentiometer can be inserted between M1 and ground. For more gain, increase the ratio of R2 to R1 and re-zero the meter. Use a walkie-talkie, remote or cellular phone, toy car remote control - anything that emits an RF signal - to confirm that it's working. Solder and assemble the unit. An IC socket for the 741 is always a good idea.

Operation: Extend antenna, power up, and approach RF source. Adjust sensitivity control (10K pot) for desired reading. My version, built with the values given in the schematic, pins the needle when brought to within 6 feet of my dipole antenna fed with the Mighty Mite transmitter powered at 14 volts.

KO6WDK
Field Strength Meter

PARTS LIST

R1 - 5.6K-ohm resistor (see text)
R2 - 100K-ohm resistor (see text)
R3 - resistor appropriate for meter used (see M1 description below)

M1 - any meter from 100uA to 100mA fullscale. Use Ohm's Law to determine R3 shunt resistor's value with meter used: for:

100uA meter use: 10K resistor

200uA	5K
500uA	2K
1mA	1K
5mA	200-ohm
10mA	100-ohm
25mA	40-ohm
50mA	20-ohm
100mA	10-ohm

(Ohm's Law: R=E/I; in this application: Resistance in ohms = volts desired fullscale / meter current in amps fullscale)

(If you have a 50uA (or less) meter, SAVE IT for a different project!)

(1) 10K-ohm potentiometer
(1) 741 op-amp integrated circuit
(1) 8-pin IC socket for above
(2) 1N34A germanium diodes, or equivalent.
(1) 0.001-uF ceramic disc capacitor
B1,B2 - 9-volt transistor-radio batteries
S1 - Double-Pole, Single-Throw Switch (or use 1/2 of DPDT switch...)
Collapsible portable-radio replacement antenna (or use about an 18" of wire as an antenna), box, knob, etc.

DESIGN BASICS SERIES

Thoughts On Theory

Leakage Current

James G. Lee, W6VAT

1060 Big Oak Court, San Jose, CA 95129

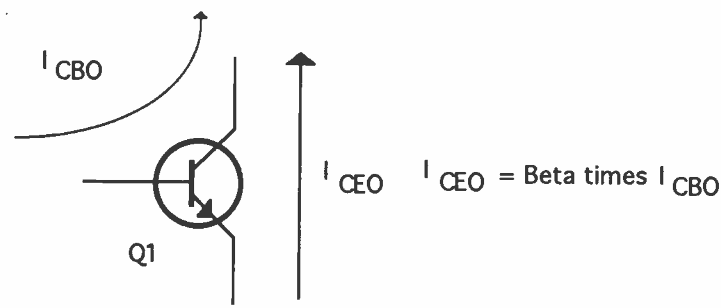


Figure 1:

Leakage Currents for NPN Transistor

One subject I have not discussed up to now is semiconductor leakage current. As the name implies, semiconductors are not perfect - they are neither pure conductors nor pure insulators -but somewhere in between. As a result, when a semiconductor junction is reverse-biased, a current - called leakage current-flows. This current is directly affected by temperature and can cause problems.

There is a leakage current flowing between the collector and the base called I_{CBO}. Note that the capitalized letters mean it is a DC component. The sequencing of the letters "CBO" refers to the three elements of the transistor - the Collector (C) , the Base (B), and the Emitter (E). The letter "O" stands for Open, and so the leakage current I_{CBO} means the leakage current flowing between the collector (C) and base (B) with the emitter Open (O).

FIGURE 1 shows the two leakage currents that can affect transistor operation. There is also a collector-to-emitter leakage

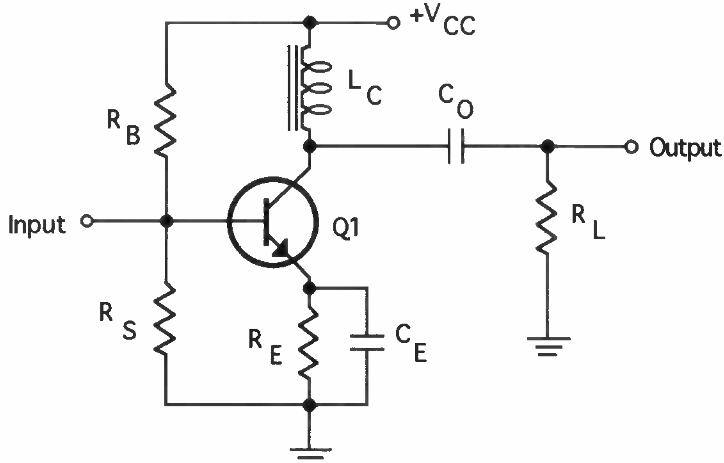


Figure 2:
Choke-Coupled Output

current I_{CO}, which flows between the collector and emitter with the base open. As with normal transistor currents, there is a definite relationship between the two, and, as you can guess :

$$I_{CEO} = \beta (I_{CBO}) + I_{CBO}, \text{ or}$$

$$I_{CEO} = (\beta + 1) I_{CBO}$$

Yes, our old friend β is back in the act, but if it is large enough (β greater than 10) the formula can be reduced to just :

$$I_{CEO} = \beta(I_{CBO}) .$$

If the leakage current is 3 uA, and β = 100 , then I_{CEO} = 300 uA. These numbers are typical of what germanium transistors show. Germanium transistors are more sensitive to temperature than are silicon transistors. Today silicon transistors are very competitive in price and have much lower leakage currents. This is the reason they are found much more often in circuitry than the germanium type.

THERMAL RUNAWAY

One condition leakage currents can start when the temperature increases is called "thermal runaway", Since the leakage current is part of the collector current, it adds to the collector current. This causes a slight increase in the collector-base junction power dissipation, which causes a slight increase in junction temperature. This temperature increase causes a further increase in leakage current, which increases the collector current again causing a further increase in junction temperature and so on. If not stopped or held in check this will eventually destroy the transistor.

regulator to supply the necessary voltages. During testing, the regulator would overheat and shut down if I didn't have a small radiative-fin type heat sink on it. With the heat sink in place, the standard runs 24 hours a day with no problems, while without the heat sink it only runs about 1 minute before shutting down.

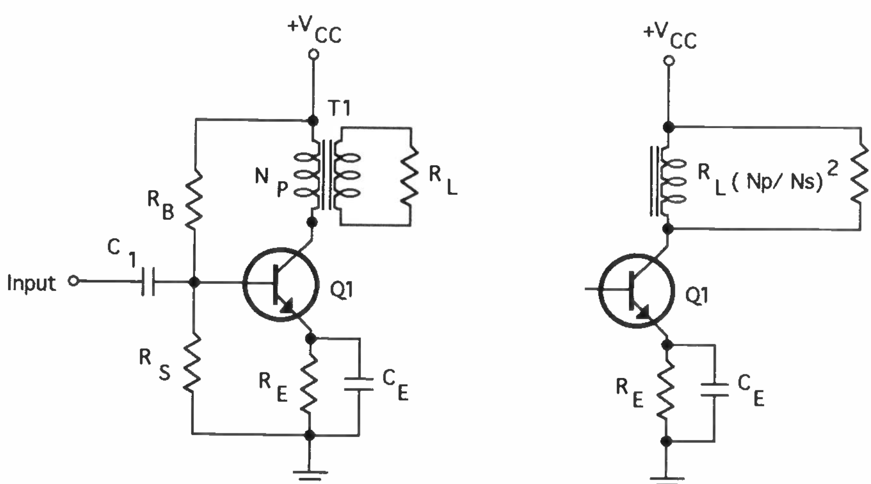


Figure 3:

Transformer Coupling Showing Reflected Impedance

The H-biasing method is one effective way to keep thermal runaway from happening. Other methods which can be applied are the use of heat sinks. fans, or other cooling techniques which put a limit on any temperature increase. Some years ago I designed and built a secondary frequency standard using the Neophyte receiver on 10 MHz driving a digital divider string. I used a small IC voltage

Since leakage current I_{CEO} adds to the collector current, it can cause a shift in the DC operating point on the DC load line. If the temperature changes - both internally and externally - it can cause enough shift in the operating point for clipping to occur on the AC signal which is undesirable. Unless you have some specific reason for using a germanium transistor, the use of silicon transistors usually prevents problems.

Manufacturers usually specify the leakage current on their data sheets. It often is called I_{CO} rather than I_{CEO}, and stands for collector cutoff (CO) current. Silicon transistors have leakage currents measured in nanoamperes (10^{-9}A) while germanium transistors have leakage currents in microamperes (10^{-6}A) .

INTERSTAGE COUPLING

Up to now the amplifiers I 've discussed have all been RC-coupled amplifiers. In small signal stages a resistive collector load does not dissipate much power and is relatively insensitive to frequency. Resistors are inexpensive and don't take up much space. But a problem occurs when you get into large signal amplifiers. At powers above 0.5 watts, a collector resistor will dissipate excessive power under no-signal conditions and this is both undesirable and unnecessary .

There are two other types of coupling which avoid this waste of power by using inductive means for coupling. FIGURE 2 shows a choke-coupled amplifier which replaces the collector load resistor with an inductance, LC. Since the choke has inductive reactance, it isolates the collector from the power supply at the signal frequency. At DC however, the collector voltage is equal to the supply voltage V_{CC}, for all practical purposes, since the choke has very low resistance.

Thus, the DC load line is a near-vertical line drawn through the operating point, Q, which itself is determined by R_B, R_S, and R_E. The AC (or signal) load line is determined not by the parallel combination of a collector load resistor and the input impedance of the next stage, but by the input impedance (R_L) of the next stage alone. Ideally, the AC load line should ve positioned so that there are equal swings up and down centered on the operating point Q. Maximum output will occur when $I_Q = V_{CC}/R_L$.

Inductive coupling of any kind has some drawbacks: since the inductive reactance is proportional to frequency, the choke can begin to look like a long piece of wire at very low frequencies. This affects the low frequency response of the stage. High frequencies are limited by the stray capacity between the winding turns, which tend to short the signal to ground. Even though the choke saves DC power - it may be large and heavy to handle large AC signal powers. Finally, the "kickback" voltage can be quite high due to large current changes through the choke.

Kickback voltage occurs when the magnetic field - which is caused by the flow of current in the inductor - changes rapidly with AC current variations. These voltage spikes can be quite high - more than twice the supply voltage - and may exceed the transistor's ratings. Some of you may remember back in the days of vacuum tube "hi-fi" amplifiers when you were cautioned not to operate the amplifier without the speakers connected to the outputs. The speaker load helps damp out the spikes and so protects the amplifier.

The second form of inductively coupled stages is called transformer coupling. FIGURE 3 shows a typical schematic of this type of coupling. Here a secondary winding is used to transform the collector output impedance down - or up as the case may be - to the required load impedance. The DC load line is still a vertical line through the operating point, but now it's necessary to see what the transformer's effect on the load resistance is.

Recall that the voltage step-up (or step-down) ratio of a transformer is proportional to the turns ratio of the primary winding (N_P) to the secondary winding (N_S). Here N is the number of turns on each winding. If N_P is larger than N_S, then the transformer is a step-down type and the secondary voltage is less than the primary voltage. By the law of conservation of energy, the *current* in the secondary is *larger* than the current in the primary.

Conversely, if the number of secondary turns is greater than the number of primary turns, the transformer is a step-up transformer, and the secondary voltage is greater than the primary voltage. The secondary current is *smaller* than the primary current. Put another way, the number of volt-amperes (VA) in the primary must equal the number of VA in the secondary, assuming there are no losses in the transformer itself. Generally, most transformers are 85 to 90 percent efficient using today's metallurgical and manufacturing techniques.

What does this mean when you consider impedances? The VA is called "reactive" power, and may or may not be equal to any "real" power in a circuit. I won't get involved in the differences between reactive power and real power here. Just think of VA as real power for right now. In order to have usable power developed across an impedance means that impedance must have a resistive part to dissipate the power. So how is impedance related to the step-up or step-down transformer?

Since power is proportional to the voltage (or current) squared, this means that the turns ratio squared equals the impedance ratio, or

$$(N_P / N_S)^2 = (Z_P / Z_S) .$$

So if the transformer is a step-down transformer, the primary impedance will be higher than the secondary impedance. The converse is true of step-up transformers - the secondary impedance will be higher than the primary impedance.

FIGURE 3 shows a typical low frequency transformer coupled stage which matches the output of Q1 to a load resistor RL. Knowing the value of R_L, you buy (or build) a transformer with the proper turns ratio to match the impedances. The load impedance R_L is reflected back to the primary side of the transformer as the product of the turns ratio squared times R_L. This is shown in the right hand part of FIGURE 3.

You generally don't need to know the turns ratio since most transformers have the impedances marked on them - such as 500: 3.2, which means a 500 ohm primary and a 3.2 ohm secondary. Often a small schematic and some resistance data is supplied with the transformer. If not, and you have a need to know what the turns ratio is, it is simply calculated by taking the square root of the impedance ratio. So 500 / 3.2 = 156.25, and the square root of 156.25 = 12.5, which is the turns ratio of the transformer.

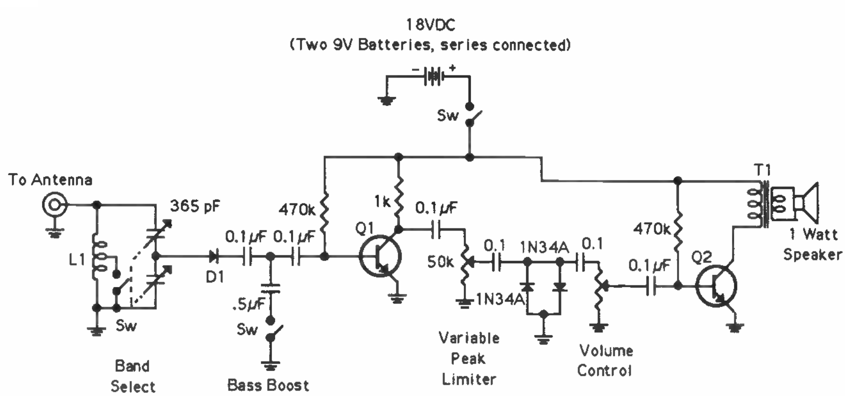
If you know, or calculate, the turns ratio, it allows you to use other impedances simply by applying the formula for turns ratio versus impedance. For example, if you want to use an 8 ohm load across the 3.2 ohm secondary winding, the reflected impedance in the primary will be 8 times 156.25 = 1250 ohms. There are limits as to how far you can carry this procedure, since other factors enter the scene. Power and voltage (or current) limitations also must be taken into account for the circuit you want.

These two types of coupling are not limited to low frequencies. they are also common from HF well up into the VHF/UHF region, and we'll see them in future columns. Their sizes and shapes vary considerably, but their major functions are the same. This looks like a good place to stop, and so I will. If you've been with me from the beginning of this series, I think you see that a lot of electronic design is the logical application so some relatively simple mathematics of physics. So don't let the mathematics hold you back - homebrewing is fun.

20/20 Hindsight

Looking Back Into Past Issues • Updates & Elaborations

Fall, 1997: H.C.D. Receiver Update
Thanks to Bill Copeland, WB6RVE, 3406 Baldwin Park Blvd., Baldwin Park, CA 91706 for the below mods to his receiver. Note that now the receiver will listen in on the short wave bands to 15 MHz!



D1: Hot Carrier Diode (Motorola HPA-2800 or equiv.)
L1: 50 T #22 wire over 10mm coil form with center tap
Q1, Q2: 2N2222
T1: 1k to 8Ω Audio Transformer

Tuning Range = 500KHz - 15MHz
Sensitivity = 5 µV (+/-)
Selectivity = 4 KHz (+/-)

With the exception of the hot carrier diode, all parts should be available from Radio Shack.

CLASSIFIED ADS

A Reader Service of **Hambrew - No charge to subscribers** to place one ham-related ad per issue, limit 15 words, 25 cents per word thereafter. Commercial or non-commercial subscribers, no minimum. All ads must be related to amateur radio. **Hambrew** does not vouch for nor guarantee the reliability nor legitimacy of any item or company represented herein. Deadlines: Sept.1 (Autumn), Dec.1 (Winter), March 1 (Spring) June 1 (Summer). We reserve the right to deny publication of any ad. Copy To: PO Box 260083, Lakewood, CO 80226-0083. Sorry, no phone orders on classified ads. Prepay only.

CHASSIS AND CABINET KITS: #10 SASE 5120-H HARMONY GROVE RD., DOVER, PA 17315. 717-292-4901 EVENINGS

2N4416A FETs for sale. Prime/JAN devices in ESD pack 10/$6.00 PPD to KC5RT, 701 Oakridge, Liberty, MO 64068

The History of QRP in the U.S. 1924-60 by Ade Weiss K8EFG/WØRSP. 208 pages, 56 photos/16 illustrations-W1FB: "I recommend this book for your Amateur Radio library, even if you never become a member of the fast-growing QRP fraternity..." WB8UUJ:"something to warm the cold winter nights with good memories.." $12/1st Class ($10 Sen. Cits.) AdeWeiss, 526 N. Dakota St., Vermillion, SD 57069

Builders! Hard-to-find ceramic rotary switches. Ideal for bandswitching, antenna tuners, etc. Four wafers with single pole, five positions on each. Limited supply. $5 post-paid. Limit one per person. Unfilled orders returned. Fred Bonavita, W5QJM, Box 2764, San Antonio, TX 78299-2764

ELECTRONICS GRAB BAG! 500 PIECES OF NEW COMPONENTS: INDUCTORS, CAPACITORS, DIODES, RESISTORS. $5 POSTPAID. ALLTRONICS, 2300 ZANKER RD., SAN JOSE, CA 95131

WANTED: SERVICE MANUAL/SCHEMATIC FOR JFD MODEL 7200 FIELD STRENGTH METER. MARVIN MOSS, BOX 28601, ATLANTA, GA 30358

FOR SALE: TEN-TEC Argonaut II QRP XCVR, XLNT, $950/OBO. Call Bill, KJ6GR, (310) 542-9899

K6LMN Simple Superhet Monoband Receivers: 80-10m. 6m converter. S.A.S.E. Roger Wagner, 2022 Thayer Ave., Los Angeles, CA 90025

Measure RF dBm Directly with dBm Meter. Complete kit, Unicorn Electronics, Valley Plaza Drive, Johnson City, NY 13790. (607) 798-0260. See Electronics Now, November, 1995, page 112.

1 Tube 80-40 breadboard transmitter kit. Not a toy! Complete kit for both 80 and 40 meter amateur bands. To order send $39 to N2EDF, PO Box 185, Ogdensburg, NJ 07439. Or write for more information.

WANTED: To borrow servicemanual/schematics for Singer/Gertsch FM10CS Station Monitor. Marvin Moss, Box 28601, Atlanta, GA 30358

Wanted: Cover for Precision 10-12 Tube Tester. Schematic: 1924 Splitdorf model 500 Receiver. Wm. G. Mitch, 668 W. 725 So., Hebron, IN 46341

6 Meter Project Articles Wanted! Help us give 50 MHz a shot in the arm! Send to Hambrew- we're raising the fallen 6m banner!

INVENTORY REDUCTION SALE- Prices slashed on kits and all parts. Bill Hickox, Tejas Kits, 9215 Rowan, Houston, TX 77036

WANTED: HAMBREW (WINTER, 1995) IN GOOD CONDITION. SASE for list of back issues of CQ, 73, Popular Electronics. All magazines in mint condition and in plastic covers. $1.00 each plus shipping. Bob Olson (WD4OHD), 6838 Hampton Wood Circle, Hixson, TN 37343

CLASSIFIED ADS

(Continued from page 23)

easily added to heterodyne circuits provided that the kHz and tens of kHz digits of the variable oscillator track the same digits of the signal frequency. If this is the case, connect the counter to the buffer amplifier following the variable oscillator. If the circuit does not have a buffer, it may be a good idea to add one. Some heterodyne circuits use a variable oscillator that tunes down as the signal frequency is increased. Other heterodyne circuits have an oscillator that is offset by a non-multiple of 100 kHz. The kHz and tens of kHz digits in these variable oscillators will not track the signal frequency. The counter described in this article will not work with a non-tracking oscillator. However there are presetable, up/down counters (for example, the 4 digit S & S counter kit) that will work with non-tracking oscillators.

Results

Two of these counters have been built. The first used two sawed-off Radio Shack 270-170 PC boards and was housed in a 5 1/4 by 3 by 2 1/8 inch aluminum box. The second was built on stacked Radio Shack 270-150 PC boards and will be used as part of a future project. Each counter had two easily diagnosed wiring errors. After fixing these errors, both worked perfectly.

UA9OCC
PLL FREQUENCY SYNTHESIZER

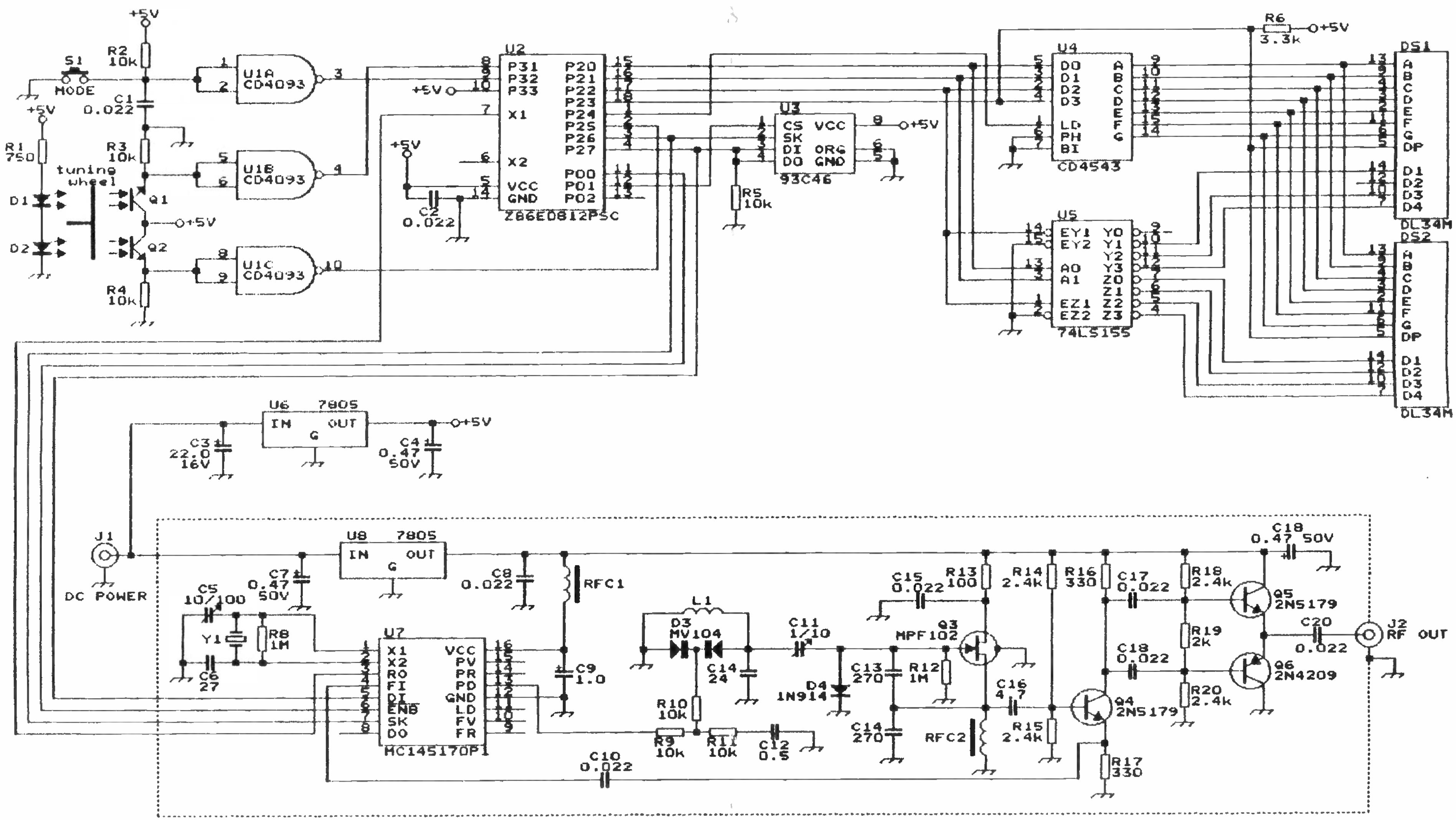


Fig 1 - Schematic Diagram of the Synthesizer