THE WEST RAND AMATEUR RADIO CLUB

July 2009
Volume 10, Issue 1

ANODE

Inside this issue:

Special points of interest:

- Contact details on back page (corrected & updated)
- Ham-Comp Latest on web site.

Editor's Comments

Volume 10, Issue 1
July 2009

Well we are now into Volume 10. This time next year it will be ten years!

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HANS Summers has updated his web site
http://www.hanssummers.com

73 Magazine
http://www.realtech.co.za/realwiki.php?title=73_(magazine)

{---}

Ham-Comp 25th July at 13:00

Ham-Comp - Backup, Restore and Why?
Electronic Enthusiasts - Multimeter and usage...

(continued on page 2)

Computer Control for Your Direct Digital Synthesis (DDS) VFO

Free yourself of the hassles of generating an accurate and stable sinusoidal signal and more!

by Victor Morin VE1ABC

"Wow!" I exclaimed as I began reading John Welch N9JZW's article "The Techno-Whizzy 1, Part 1 " (page 8 in the December 1992 issue of 73 Amateur Radio Today). N9JZW's article describes how to build a modular multiband CW low power (QRP) transmitter that uses a new Direct Digital Synthesis (DDS) chip. Why all the excitement? Read on!

Over the years I have constructed a number of home-built rigs (both receivers and transmitters) that have one thing in common: a variable frequency oscillator (VFO). Most receivers need VFO's to generate a local oscillator (L.O.) signal, and transmitters need them to be freed from crystal control of a single output frequency.

The VFO designs that I used in these projects were all tank-tuned with a combination of inductors (coils) and variable capacitors, either mechanical or varactor diodes. Those of you who have also gone this route know that there are certain inherent problems with this design: temperature drift, nonlinear tuning, difficulty in eliminating the mechanical backlash in the frequency-control element, frequency pulling when a load is placed on the VFO, and the list goes on ... For me, at least, this type of VFO design has been a royal pain!

I knew that there were alternatives, known as frequency synthesizers, to this traditional VFO construction and

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RSS FEEDS
The DXZone
http://www.dxzone.com/linktous/rss.shtml

http://www.southgatearc.org/ -->
http://www.southgatearc.org/sarc.rss

http://www.arrl.org/ -->
http://www.arrl.org/arrl.rss

http://www.indiana.edu/~k9iu/ -->
http://www.indiana.edu/~k9iu/?q=rss.xml

http://zs6erb.co.za/joomla15/ -->
http://zs6erb.co.za/joomla15/index.php?format=feed&type=rss

The SARL does not as yet have an RSS feed.

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The Missing Q signals
http://www.zerobeat.net/qrp/missingq.html

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Nice start to page…
Welcome to K9IU, the Indiana University amateur radio club. We invite everyone to participate in the club activities. If you are not a licensed amateur radio operator, we are more than happy to introduce you to this wonderful hobby and help you become a licensed operator. K9IU has a room full of radio resources at the Indiana Memorial Union that are available for members to use at any time. There are many club activities that members and non-members alike can participate in as well. Take a look through this site for more information, and keep an eye on our news section for updates on upcoming events.

We have RSS feeds available of the front page news and of all site content (which includes the news).

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You really should check your text before blogging it…

f* the kindle and the authors guild

new kindle

I'm sorry but I have to say this cause it angers me. Kindle is a great product. Hands down the best current e-book out on the market. The newest version came out with a built in feature to read the ebooks to you whenever you didn't feel like reading. So essentially your ebooks would become audiobooks. What amazing feature for the lazy, and most of all the sight impaired.

Because of dumb-bums like Authurs Guild whining about the copyright issues, the ebook reading out loud feature was crippled! What about the sight impaired people who want's to read the book and their is no audio version? ever thought about that? Paper is dying format, and it should just die. It's wasting trees, and creating trash which is further polluting the earth. Most of the books written today anyways is probably a shitty book anyways, so who gives a damn about your stupid copyright. Ok, I'm just ranting. Copyright is important but this audio feature thing on kindle is so stupid. What about computer? they can read any format you throw at it, even e-books… should we cripple our computers to? Should we rob the impaired of fairness and equality in life to enjoy already poorly written books?

Authors Guild, please… wake up and smell the technology. Move into the future and embrace the change and quit being greedy trying to squeeze every dime out of everyone.

I still love the kindle, but crippling this feature has now stopped me from purchasing one.

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Editor's Comments

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May 15th, 2009 in Tech News, WTF? | No Comments
[Who or What, is a "Authurs" Guild? Duh! You isn't one!
Come to think of it - What about "their is no audio"?]

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Computer Control for Your Direct Digital Synthesis (DDS) VFO

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my interest focused on two general types: phase-locked loop and direct digital synthesis. Looking over some phase-locked loop synthesizer designs convinced me that it would probably be more of the same: LC tank circuits are used at very high frequencies and are varactor-controlled. Frequencies are regulated using phase detectors, thus generating phase noise, etc. Please don't get me wrong-I'm not saying that phase-locked loop synthesizers should be avoided-I'm simply saying that for me they didn't seem to be the way to go.

That left the direct digital synthesis approach. I read all I could on the topic and probably the best article I found is "A Direct Frequency Synthesizer" by Fred Williams in the April 1984 issue of QST. Surprised? This concept has been around for a long time! If you're interested in the theory behind the direct digital synthesizer, I highly recommend Mr. Williams' article, in which he provides DDS theory and describes how to build a DDS using standard TTL IC chips, a read-only memory (ROM) and a digital-to-analogue converter (DAC).

This is the exciting part. When 1 read the "Techno-Whizzy 1" article, 1 knew it was the answer to my dreams! You see, 1 had actually begun building the Williams DDS and was contemplating building a ROM burner for it when Techno-Whizzy came on the scene-and there was a full kit available. No more chasing after parts; no more burning bits into a ROM. I could get right down to business! I ordered the DDS right away, explaining to my wife that "it would be my Christmas present from me to me."

What's So Great About a DDS?

A lot! Precise frequency control, frequency stability, no phase noise, the ability to change frequency very rapidly (frequency hop), etc. What's the price you have to pay for all this? In a nutshell, you have to be able to provide the DDS with a digital (binary) value that is proportional to the frequency of the sinusoidal signal you want your DDS to generate. To me this meant computer control, although there are other means, as demonstrated in the Techno-Whizzy 1 article where a diode matrix and switches are used.

I own an IBM-compatible AT clone computer. While waiting for my DDS kit to be delivered in the mail, I decided to design and build a hardware interface that would control the DDS from my computer and, just as important, the software driver routine that would make the DDS perform as I wanted.

The Design

I decided to use the printer interface port of my IBM-compatible to control the interface and I chose to use the simplest alternative in order to maximize my chances of success. That's why I elected to use what is in fact a parallel port as a serial port! Why?

Because 1 wanted to ensure that most of the computer output lines would not be used in solely controlling the interface (I may want to simultaneously control other devices with the computer in the future). 1 knew that the serial approach would slow down communications with the interface but 1 was willing to pay the price.

The software design was more complex than the hardware. Here is what I wanted to be able to do:

a) Enter a decimal frequency value in the computer keyboard and have the DDS generate that particular frequency (0 Hz to 22 MHz with 3 Hz resolution);

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Computer Control for Your Direct Digital Synthesis (DDS) VFO

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b) Have the frequency go up or down by a particular increment whenever the operator presses the up-arrow key or the down-arrow key;

c) Scan a particular range of frequencies with the frequency increment determined by the operator, and scan in either triangle mode (scan up to the highest specified frequency and then suddenly return to the lowest specified frequency for another scan) or saw-toothed mode (scan up to the highest specified frequency and then, at the same frequency interval, return to the lowest specified frequency for another scan);

d) Generate a trigger signal for an oscilloscope at the beginning of each triangle mode sweep.

Thus, 1 wanted it all-a VFO plus a sweep generator with trigger output. An instrument that is accurate and stable, with its output variable from DC to approximately 22 MHz. Yes, you can use the DDS to generate audio frequencies. It's like having a very expensive lab-quality instrument at a very inexpensive price!

The Hardware Interface

Figure 1 is a schematic of the hardware interface. It is straightforward and based on the Williams design. As expected, the computer software has to do all the work in driving the interface. Here is how it works: The computer generates a 23-bit binary number (representative of the frequency) that is to be presented to the DDS. This 23 bit number is sent to the DDS interface through the printer interface port and printer cable, bit by bit in serial fashion, beginning with the most-significant bit, on the serial data line. While the serial data bit is stable, the computer strobes the clock signal line, which accepts and shifts each data bit into three cascaded 74LS164 serial-in parallel-out shift registers. This is done 23 times, until all three shift registers have been loaded. The load line is then strobed, which presents the 23 bits, in parallel fashion, from the 74LS374 Tri-State Octal-D flip-flops to the DDS. The DDS then takes over and generates the required frequency. Piece of cake (sort of)! The trick is to generate the correct 23-bit binary number, and this is where the software provides all the functionality.

You will note that the load, serial data, and clock lines are "snapped up" through a 74LS14 Schmidt inverter to ensure that the leading and trailing edges of the pulses are sharply defined and jitter-free. Because the serial data pulses are inverted as a result. the software generates the l's complement of the required 23-bit data word (every bit is "flipped"-i.e. a 1 becomes a 0 and a 0 becomes a 1).

The Software Driver Routine

The only software-generating tool available to me was Microsoft QBASIC so I didn't have much choice! I've annotated almost every line of code in the DDS.BAS program to give you an idea of what is going on in case you'd like to change things and experiment.

The mainline section of the routine begins with the usual housekeeping chores, after which the instruction screen is drawn (Figure 2). An initial frequency is sent to the DDS (I chose 0 Hz but you can change this to any frequency you like). Figure 3 shows the layout of the control screen. Two subroutines are used to generate the required 23-bit data word that is sent to the DDS-ConvertToBinary and SerialToParallel.

ConvertToBinary accepts a decimal frequency value and converts it to binary in l's complement form (see above). It uses the age-old venerable "divide-by-two" algorithm that you may have learned in school to convert from the decimal

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system to binary notation.

```
TWl DDS Control
Key in frequency and press ENTER, or:
"+" To Change Frequency Increment
"↑" To Increase Frequency by Value of Frequency Increment
"↓" To Decrease Frequency by Value of Frequency Increment
"*" To Enter Scan Mode
Num Lock must always be ON, Caps Lock and Scroll Lock must always be OFF
otherwise the program does not run properly.
Press any key to continue...
```

Figure 2. The instruction screen.

```
TWl DDS Control
Enter Frequency in Hz:            ?
Current Frequency in Hz:  3,686,400
Frequency Increment in Hz:      200
```

Figure 3. The control screen.

SerialToParallel performs three chores: It scales the frequency value, calls ConvertToBinary, and pumps out the 23-bit data word to the DDS interface. Why scale the frequency value? Without going into a lot of technical details, the DDS will generate a frequency that depends not only on the 23 bit data word that is presented to it but also on its on-board clock frequency. The onboard clock chip that comes with the DDS kit has a frequency of 55 MHz, and what you have to do is scale the frequency value so that the DDS will generate the exact corresponding frequency.

```
TWl DDS Control
Enter Frequency in Hz:
Current Frequency in Hz:  6,240,000
Frequency Increment in Hz:    5,000

Scan Low Frequency in Hz:  5,000,000
Scan High Frequency in Hz: 6,500,000
Triangle (T) or Sawtooth (S):  T
Press Any Key to Start Scan Mode, "ENTER" to Exit Scan Mode
```

Figure 4. Scan mode for the DDS.

Back to the mainline section of the routine. The computer sits there and waits for you to do one of a number of things:

Press the "+" key. This selects the next frequency-increment value that is contained in the frequency increment table in round robin fashion (i.e. you return to the first frequency increment after having gone past the last). The frequency-increment value determines how much the frequency will jump when you press the up-arrow key, the down-arrow key, or while you are in scanning mode (see below).

Enter a frequency and press the enter key. The DDS generates the corresponding frequency.

Scan mode (Figure 4). Enter a scan-low frequency, a scan-high frequency and determine whether you want a saw-toothed scan or a triangle scan. The DDS generates frequencies beginning at the scan-low frequency, jumping by the frequency- increment value (see above). When the scan-high frequency is reached, the DDS either jump's back to the scan-low frequency (triangle mode) or proceeds downward, at the same rate, toward the scan-low frequency (saw toothed mode). At the beginning of each triangle-mode cycle, a scope trigger signal is generated in case you'd like to trigger the sweep of your scope externally. The whole thing happens over and over until you decide to exit scan mode.

Press either the up-arrow key or the down-arrow key and the frequency will change upward or downward, depending on the key you pressed, by a value corresponding to frequency-increment. Hold your finger down on either key and the DDS will scan up or down as long as the key is pressed.

Construction

I decided to build the prototype interface on a printed circuit board that is exactly the same size as the TWI DDS. This would afford a couple

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of advantages: The DDS board could be mounted on top of the interface board or vice versa, and the 25 X 2 headers could be made to line up exactly one on top of the other. I would simply wire one header to the other, ladder fashion and each wire perpendicular to the boards.

Because my skills at designing and building, two-sided printed circuit board are limited (non-existent would be a better choice of words), I built a one-sided board where most of the signal lines would be interconnected using, 30-gauge insulated wire. If you choose to go this route, be prepared for a lot of drilling and a lot of precise soldering! Perhaps a better way to go would be to use a drilled and etched PC board available for $6.50 plus $1.50 S&H from FAR Circuits, 18N640 Field Ct., Dundee IL 60118.

If you decide to make your own board, first etch the printed circuit and drill all the required holes. Install IC sockets! This will help you immensely if you have problems and have to troubleshoot in the future. Interconnect all the signal lines using Figure 1 as a guide. Install the 0.01 bypass capacitors as well as the 10 uF electrolytic capacitor.

Don't put in the IC chips in their sockets yet! Check each and every interconnection with an ohmmeter looking for "opens" and pin-to-pin shorts. Only proceed to the next step once you are satisfied that the assembled printed circuit board checks out perfectly!

Check-Out

Temporarily connect the clock, serial data, and load signal lines to pins 1, 2, and 3 of the, 36-pin Centronics-style printer cable panel receptacle. Temporarily connect a wire from pin 18 of the printer cable receptacle to a suitable grounding point on the interface board. Plug the printer end of your printer cable (36-pin) into the receptacle leaving, the other end (25-pin) unconnected from the parallel port of your computer. Check for the following continuity: pin 1 of the printer cable (25-pin end) with pin 3 of the 74LS 14 chip, pin 2 of the printer cable (25-pin end) with pin 1 of the 74LS14 chip. pin 3 of the printer cable (25-pin end) with pin 5 of the 74LS14 chip, pin 18 of the printer cable (25-pin end) with ground on the interface board.

Don't proceed any further unless you are convinced that the above checks out.

Next, load the DDS.BAS program into your computer. Access the SerialToParallel subroutine and disable the HoldFreq& = CLNG(CDBL (Freq&) * .3050398#) line by commenting it out with a single apostrophe at the beginning of the line. This disables scaling, for the time being. Enable the statement immediately after the line that you have just disabled (HoldFreq& = Freq&). To provide display of the 23-bit data word on your monitor screen, access the ConvertToBinary subroutine and enable the following line:

LOCATE 23, 1: FOR i % = 22 to 0 STEP 1: PRINT Bi naryValue(i %);:NEXT i%.

This causes the 23-bit word to be displayed in binary at the bottom of the screen.

Remember that this is the l's complement of the number entered, however.

You are now going to check out your unit by using eight LEDs to ensure the correct bit pattern is being generated by the interface. (You could use 23 LEDs at once, if you like). Build a test jig based on Figure 5. I used an IC proto board because the test jig, is only used once for check-out purposes. Temporarily connect the eight test jig inputs to the eight least- sig-

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nificant bit outputs of the interface (outputs 32 to 46 to inputs d7 to d0.

Populate your printed circuit board with its ICs. Connect the computer printer cable to the parallel port on the printer. Provide 5 volts to the interface board and the test jig. Run the DDS.BAS routine and key in a frequency of zero Hz. All eight LEDs on the test jig should be out. All the bits at the bottom of the screen should be 1's. Now key in a frequency of 255 Hz. The inverse should happen and all eight LEDs should be lit, the eight least significant bits on the screen should all be 0's.

Next, unsolder the eight test jig inputs and temporarily solder them to outputs 16 to 30 of the interface (30 to d0, 28 to d1, etc.). Key in a frequency of 65,536 Hz. All eight LEDs should be lit. Key in a frequency of zero Hz. All eight LEDs should be out. Enter other values to see the generated bit patterns.

Finally, disconnect the input leads to the test jig and re-connect the seven least significant test-jig, inputs to the seven most-significant-bit outputs of the interface (2 to ^ 4 to d5, etc.) Leave d7 unconnected and ignore the left-most LED. Key in a frequency of zero Hz. All seven LEDs should be out. Key in a frequency of 8,388,607 Hz. All seven LEDs should be lit. You will notice that the bits displayed at the bottom of the screen always show the inverse of the bits represented by the LEDs.

If things don't check out, the particular bit(s) that is (are) not functioning properly will give you a hint as to where the trouble might be on the interface. Use your analytical skills to zero in and determine where the problem lies. Once everything is OK, disconnect the test jig.

Final Assembly

I assume that you've constructed and checked out your TW 1 DDS board before proceeding to this point. Mount the DDS board on top of the interface board using half-inch threaded spacers. Solder the 23 signal lines (outputs 2 to 46) from the interface board to the DDS board and check the continuity of the 23 lines from one board to the other. Use 22 gauge hook-up wire to provide Vcc and ground to the DDS board. Next, attach the combined units, using two small-angle brackets, to a front panel. My front panel holds a seven-pin DIN round receptacle, a 36-pin Centronics-type printer cable receptacle, and a BNC single hole-mount chassis jack. Solder the three signal wires leading, from the printer cable receptacle to the interface board. I use the seven-pin DIN receptacle to provide power to the unit and to provide the scope trigger signal to the outside world. Solder the scope trigger line from pin 4 of the printer cable receptacle to an unused pin on the DIN receptacle. Connect the BNC jack to the DDS output with a short length of miniature 50 ohm cable. You may wish to build an enclosure for the unit in order to provide shielding. I built mine using double-sided printed-circuit board.

Calibration

Calibration? But there aren't any trimmer capacitors! Do you remember the scaling factor in the software routine that I mentioned earlier? Well, it's now time to '*tweak" the scaling factor to your on-board DDS clock. Go back to the DDS.BAS program and disable the program lines that you used for checkout purposes. Also remove the single apostrophe in front of the following line: HoldFreq& = CLNG(CDBL (Freq&) * .3050398#). Now connect a fre-

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quency counter to the output of the DDS. connect the unit to a 5 Volt power supply. connect the printer cable between your computer and the DDS, and fire everything up. Begin by keying frequencies that are multiples of 1 MHz and observe the values on the frequency counter. If you have an oscilloscope, you may also want to view the purity of your sinusoidal signal. Assuming, there are no problems in your soldering and wiring job, you should act frequencies that are close to those being keyed in and that have a very high degree of purity. Once you've gone up to 22 MHz and everything looks OK, play with the unit by entering oddball frequencies. The DDS should react accordingly and this should be reflected on your frequency counter.

The adjustment of the scaling factor should now be obvious. If your input frequency is consistently high compared to the frequency counter, reduce the scaling factor. and vice versa. B how much?

I don't know. I just did mine by trial and error until the frequency counter read dead-on and then I built a direct conversion receiver using the DDS as the LO to zero-beat it against WWV I think the accuracy of my unit is within 50 Hz, if not better.

Operation

I tried to make operation of the unit as -intuitive as possible and 1 hope that the instruction screen is self-explanatory. Those of you who are accustomed to Windows-based applications won't find this very fancy but, in my defence, all I can say is that 'the proof is in the pudding'. Speaking of Windows, you will find that the scanning process is slowed it' the software is run in a Windows environment. If you want maximum scanning speed from your computer, run DDS.BAS in an MS-DOS environment.

What Next?

1 encourage those of you who are interested in software design to combine forces with the hardware types, and vice versa. The software that I have developed is first generation and 1 have placed it in the public domain. Play with it. Change it for the better! A machine-language routine to speed up the scanning process might be interesting. The hardware interface is nothing fancy. How about someone developing a true parallel interface, or using adder chips on the interface board again to speed up the scanning process? How about frequency hopping or spread-spectrum applications? The sky's the limit!

As for me, I'm going to continue my quest for the Holy Grail: building an upconverting general -coverage HF receiver (with FM, of course) using the TWI DDS as one of the fundamental building blocks. Hmm ... 1 wonder if cheap HF crystals can be used at their third overtone to build a ladder filter at approximately 45 MHz? The TW1 DDS in scanning mode, heterodyned to VHF, will help me find out. I hope 1 have as much success with that project as 1 did with this one.

Parts Information

A copy of the DDS.BAS driver routine software written in OBASIC can be downloaded free from the 73 BBS at (603) 924-9343. [Sorry guys, I cannot find this file anywhere.]

The DDS VFO module kit is available from Elktronics, 12536 T.R. 77, Findlay OH 45840; (419) 422-8206.

The receptacles, capacitors,]C chips and sock-
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ets for the computer interface are all available from Digi-Key at (800) 344-4539, or from other major distributors.

The eight LEDs used in the test jig can be any LEDs that you have in your junk box.

The use of a manufactured computer cable is not mandatory-you can build your own cable using receptacles of your choice. [How about an old printer cable?]

Drilled and etched PC boards are available for $6.50 plus $1.50 S&H from FAR Circuits, 18N640 Field Ct., Dundee 1L 60118.
[Far Circuits still exist and are on the net as farcircuits.com.]

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Bench notes from John N9JZW, designer of the TW-1 DDS rig.

Since 1 built the TW-1, people have been asking me why I didn't make it computer controllable. Frankly. I didn't want to-given my other plans for expansion. However, there is a need, and this board fills it well.

I built the project on a PC board, which is shown in the adjacent photo. It went together smoothly, taking about an evening's work to assemble. There are a lot of jumpers, but they are plainly marked and should cause you little trouble. Do socket all the chips, as 1 had one bad chip which kept mine from working the first time. A quick change took care of that, though, and it has worked since then.

Be careful about soldering. and make sure you have the chips inserted the right way. The parallel port on an IBM PC isn't protected. and it is possible to blow up a chip if you get some wires crossed. Just be sure to double-check your wiring, as the article

The program will only work if you use a parallel port at address 3F8 (hex). The port on an old monochrome video board is not at this address, but for most computers this is LPT1 and should cause no problem.

There is an easier and faster way to calibrate the frequency. You'll need a calculator and a frequency counter that can handle 55 MHz signals. Measure the frequency of your TW-1's oscillator (it's available on the jumper on the DDS V.F.O. board). The "fudge factor" should be 16777216 / (your oscillator frequency in hertz).

My oscillator runs at 55000230 Hz so my value is :-
16777216 / 55000230 = 0.3050390153. This should put you dead on frequency the first time you run the program.

If you don't have a frequency counter, don't worry-the 55 MHz oscillators are very accurate and stable, and you'll be no more than about 50 Hz away from where you think you are over almost all bands.

There is an enhancement I'm working on for the TW-1 that will increase your upper range from 21,5 MHz to slightly over 30 MHz. This will require a small change to the program, and another jumper to be added to this board. FAR Circuits is adding a pad on pin 48 of the header for this.

When 1 get this board functional, I'll also let you know what to jumper and what to change in the program. Till then, hope you have fun with your TW-1 Direct Digital Synthesized rig. 73 de N9JZW.

Taken from 73 Magazine February 1994.

Computer Control for Your Direct Digital Synthesis (DDS) VFO

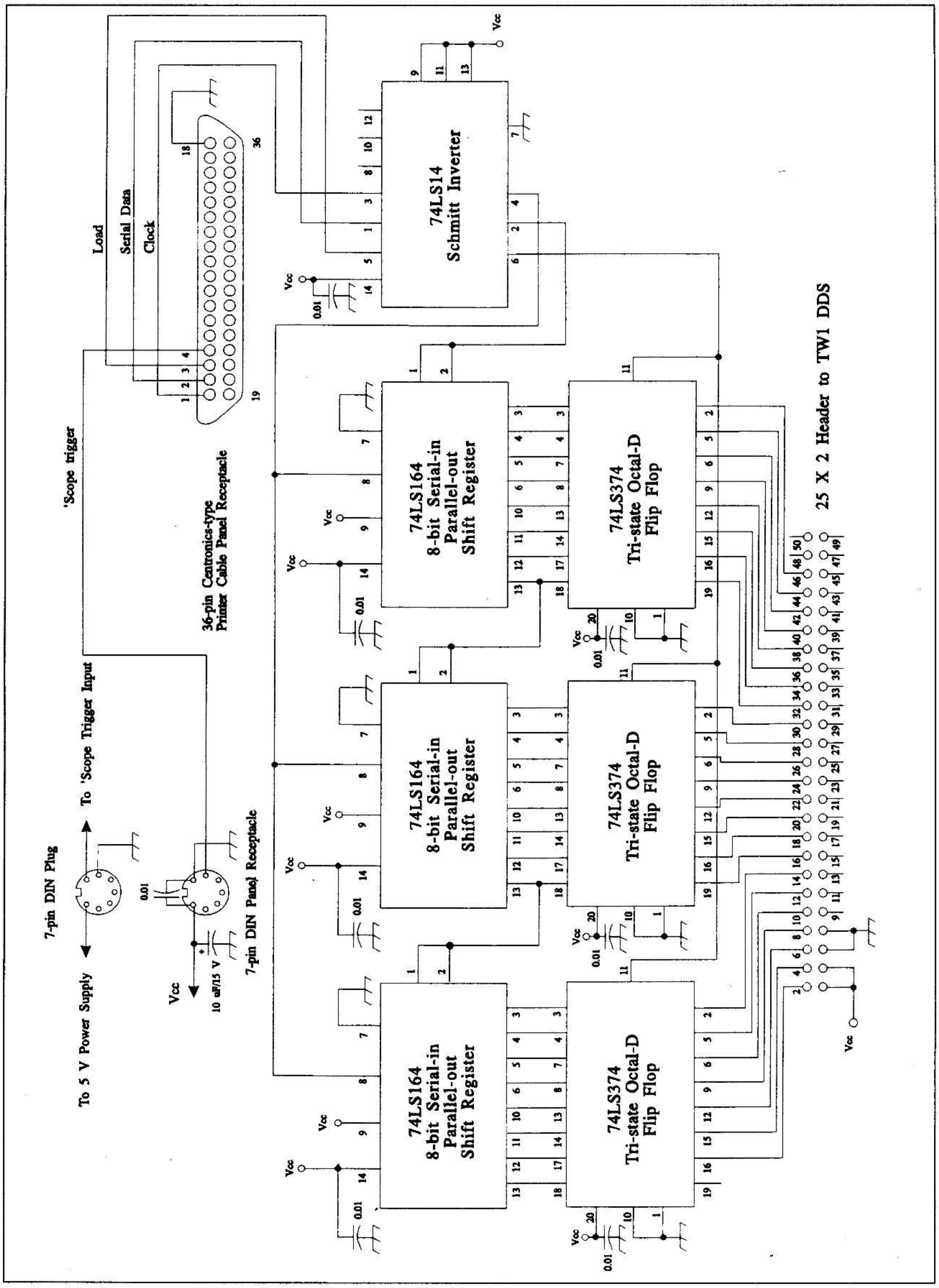

Figure 1. Schematic for the TW1 DDS computer interface.

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KG33XU 26.14122 South - 27.91870 East

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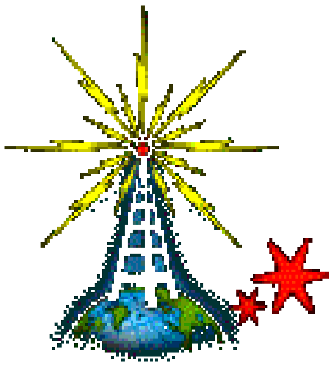
West Rand members - we need your input!

To make this the best ham radio magazine in South Africa we need your input. Please submit articles, comments, suggestions etc.

Please send plain text with no formatting to the email address below.

In July 2003, we re-published an Anode Compendium on CD. It has the issues from July 2000 until June 2005. This included the new Adobe reader. It has been updated, check with the chairman for details.



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