A Useful DDS VFO Circuit and Board

Jon Titus - May 24, 2010

If you have thought about experimenting with a direct digital-synthesis (DDS) circuit but put it off, here's a nice surprise. You can get a capable DDS variable-frequency oscillator (VFO) board and parts for $US 145--that includes an 2-line 16-character liquid-crystal display and incremental shaft encoder.

I had hoped to buy a DDS development board, but found them either expensive or not versatile enough to build into something practical like a programmable lab signal source. Analog Devices sells an eval board for its popular AD9851 DDS IC for about $250. That IC operates up to 180 MHz; sufficient for many designs. But good luck finding the board on the ADI Web site. Digi-Key lists the board (AD9851/CGPCB), but as a non-stock item.

The VFO board I mentioned and showed above comes from James Hagerty of Hagerty Radio Co., who described his circuit in the May/June issue of QEX magazine, a publication for hard-core experimenters in the amateur-radio community. You can download the 6-page article and schematic from Hagerty's Web site at www.wa1ffl.com. This design uses an ADI AD9951 DDS IC that includes a 14-bit DAC and can generate sine-wave signals at frequencies as high as 160 MHz. Hagerty's Web site includes spectral plots of the circuit's output with resolutions of 10 kHz and 1 kHz at several frequencies. If you want a useful DDS circuit that includes a display and tuning control, this is it.

The board uses an Atmel AT89S8253 microcontroller--an 8051 derivative--to program registers in the DDS chip, manage external controls, and update the LCD. Hagerty's software resides in about 2 kbytes of flash-memory space in the MCU, so engineers have plenty of room to experiment with their own code in the remaining 10 Kbytes of flash. The circuit uses a standard 2-wire interface between the MCU and the AD9951 chips. Jim and I exchanged several email messages and he told me his source code is proprietary.

But, fear not. Analog Devices lets anyone use the online ADIsimDDS tool that accepts a DDS IC part number, reference clock frequency, and desired output frequency. You get back the actual output frequency for the AD9951 along with the digital tuning word needed to create that frequency. The tool also plots frequency- and time-domain signals. You can run the tool as often as you please. Here's the link to the ADIsimDDS Web-based tool:
ADI also has some Windows-based tools for its DDS chips that appear to use a Visual Basic runtime. But I could not find an AD9951 programming flow chart, sample C code, or other types of information that showed some real register programming examples. That's unfortunate but sadly true of many complex ICs from a variety of vendors--great hardware, not much tutorial-level software support.

The data sheet for the AD9951 explains the various registers and bits you need to control, although if you use Hagerty's software, you don't have to think about these aspects and can simply use the DDS chip and MCU as a programmable oscillator.

Hagety explained he continues to experiment with the basic circuit and has some enhancements underway, including electrical isolation of the MCU from the DDS to improve spectral purity. Check the Hagerty Web site for updates.

By the way, Analog Devices has a nice primer on DDS operations and techniques, although it's about 10 years old. Visit: www.analog.com/static/imported-files/tutorials/450968421DDS_Tutorial_rev12-2-99.pdf.

Perhaps some code for use with this kit could turn into a neat open-source project. If you have some DDS resources, code, or related application information, please post a comment for the dev-monkey community.