

# DDS Function Generator

Break-out Board  
Technical Manual Rev 1r0



e-Gizmo Direct Digital Synthesis DDS Function Generator is a bare bone sine, triangle, and rectangular wave generator based on Analog Devices AD9837 chip. AD9837 DDS implementation made possible precise and stable frequency generation in steps of 0.02Hz. Furthermore, frequency lock upon change is nearly instantaneous. Unlike older digital frequency synthesizer that employs Phase Lock Loop PLL method, the AD9837 DDS does not need any time to slew and lock whenever the frequency setting is changed. Features like these were once the exclusive domains of high end function generators, now, thanks to AD9837, even we hobbyists can easily build one at a much lower cost.

The Function Generator board can generate the three most useful functions in general electronics testing: Sine, Triangle, and Rectangular wave. Its 10-bit DAC allows it to generate low distortion sine (<0.05%THD @ 1KHz) and precise triangle wave. Rectangular wave frequency range is from DC to roughly the clock frequency (5MHz). Sine and triangle wave maximum usable frequency depends on the waveform quality that is still acceptable to the application, and is usually in the 100 kHz-1MHz range.

## Features

- Direct Digital Synthesis DDS frequency
- Crystal accurate frequency, 0.02Hz resolution
- 10 bit look up table, 28 bit freq control
- Sine, Square, and Triangle wave output
- 5MHz AD9837 Chip
- SPI interface

This breakout board contains only the components essential for the operation of chip itself. It does not contain an output level control circuitry (e.g. external potentiometer) and requires a host controller (e.g. gizDuino, Arduino board, AVR, Encore! PIC, etc.) as a minimum to operate.

## PIN DESCRIPTION

**OUT** - Function Generator Output

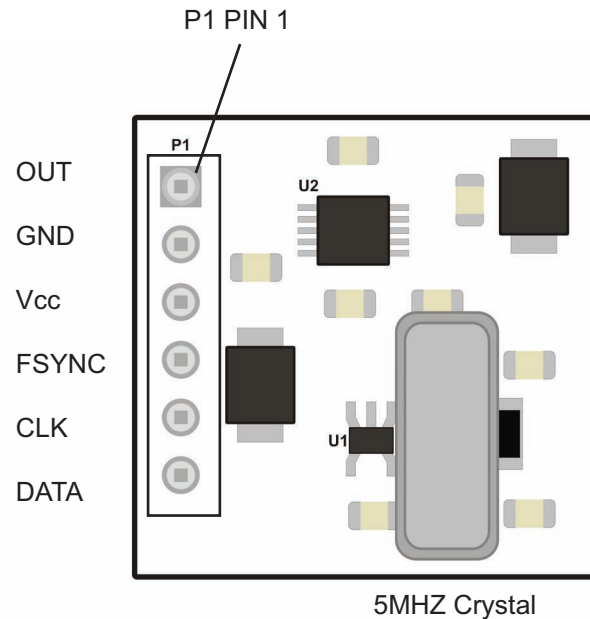
**GND** - Power input Ground

**Vcc** - Positive (+) Power Input, 3.0V to 5VDC

**FSYNC** - SPI SYNC (CS) Input

**CLK** - SPI Clock Input

**DATA** - SPI Data Input



For detailed explanations of AD9837 functions, interfacing, and programming, please download the corresponding device datasheet from Analog Devices:

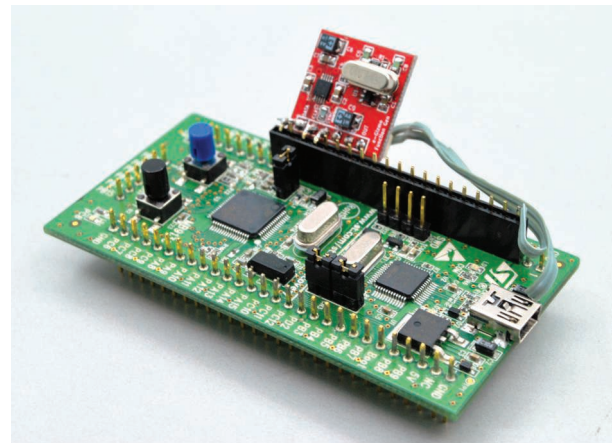
<http://www.analog.com/en/rfif-components/direct-digital-synthesis-dds/ad9837/products/product.html>

## TEST RESULTS

A final production sample of the module is tested using a STM32VL Discovery board as a host controller (figure 3). The STM32 board is programmed so that the Function Generator will generate sine, triangle, and rectangular wave function in every two seconds interval. A Tektronix TDS784D DSO is used to measure and record the waveforms. The output waveforms are measured without an output load.

Waveforms were taken on two generator test frequencies, 1000Hz and 500kHz. As shown in the oscilloscope traces in figure 4, at 1000Hz, the Function Generator produces a clean low distortion sine, triangle and rectangular waveform. Sine THD+N is a low 0.055% when measured with a Panasonic VP-7720A (30kHz Filter ON). At 500kHz, the quantized portions of the waveforms becomes evident (figure 5). Still, the sine and triangle wave functions are still usable as test sources at these frequencies.

Output amplitude for both sine and triangle wave is around 600mVp-p. Rectangular wave is internally taken off from the chip logic circuit, hence swings at 3Vp-p.



*Figure 3. An AD9837 DDS Function Generator tested using a STM32VL Discovery Board as host controller to produce the test waveforms shown in figure 4 and 5.*

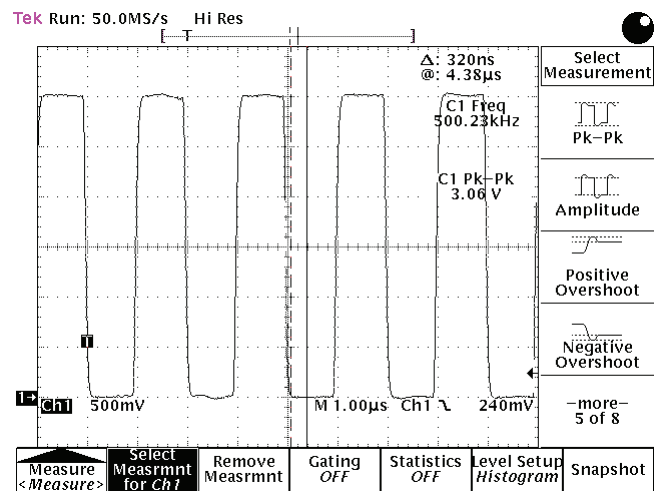
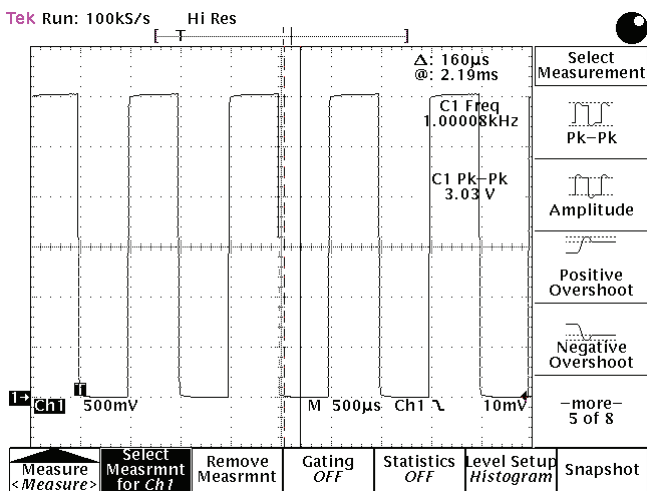
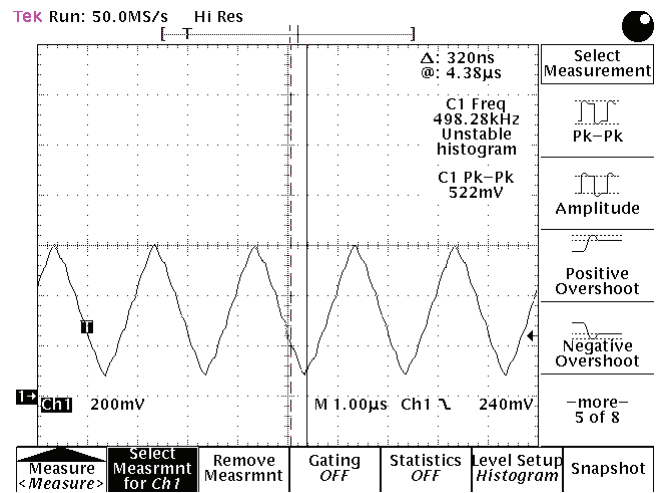
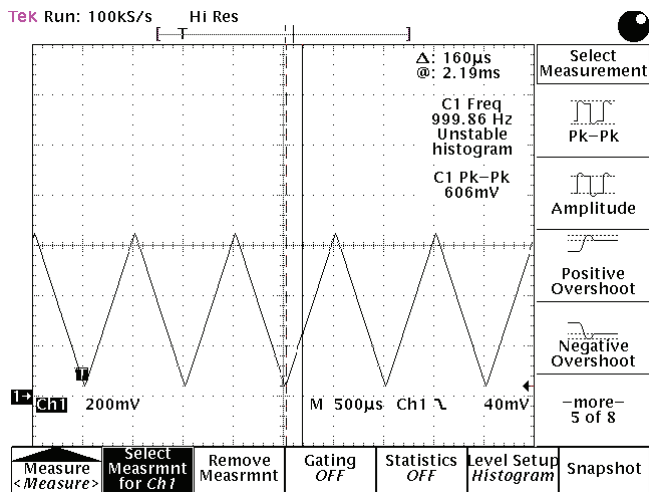
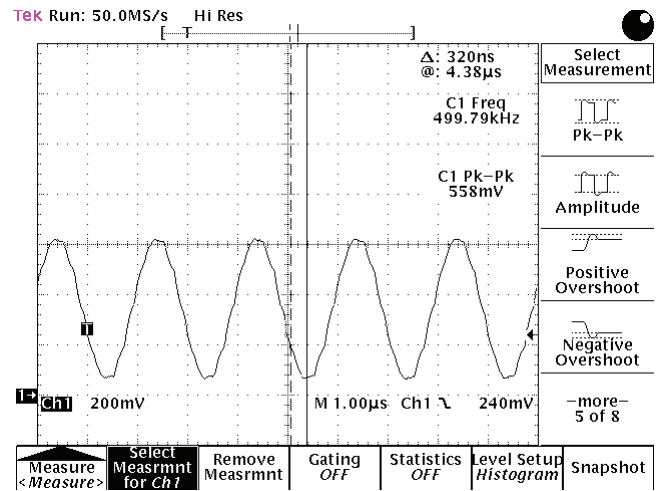
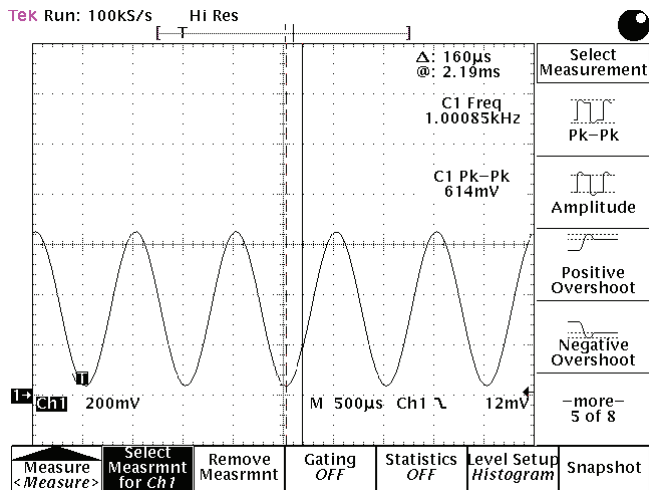


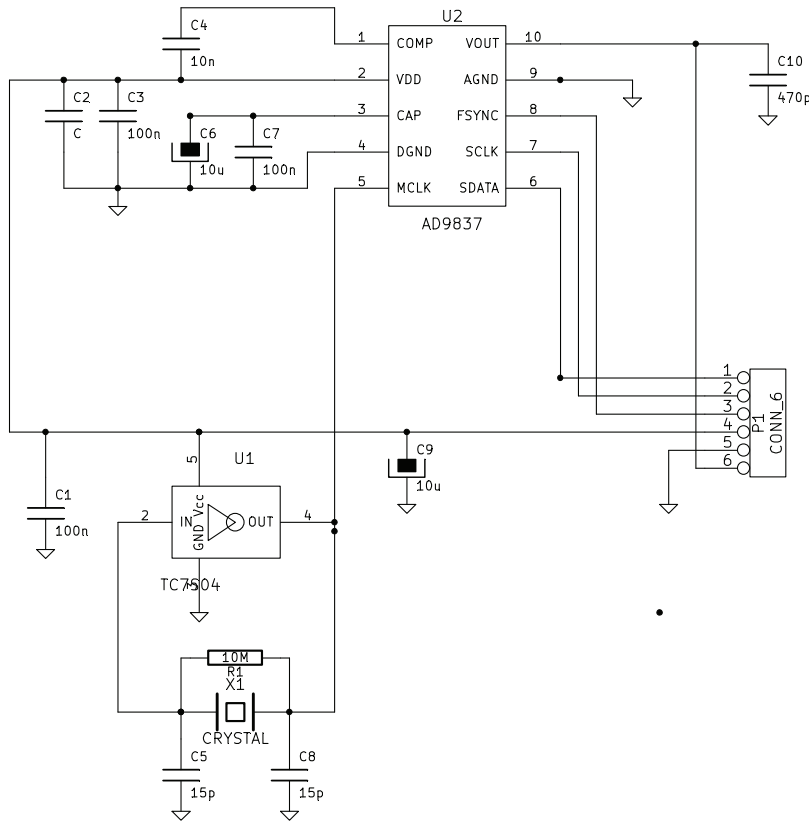
Figure 4. DDS Function Generator output waveforms at 1KHz. Full 10 bit resolution waveform generation can be realized at low frequency region, giving rise to a clean and low distortion waveforms.

Figure 5. DDS Function Generator output waveforms at 500kHz. Quantized waveforms become evident. Above 700kHz, the sine and triangular waveforms look almost identical, this places the upper frequency limit where the triangle wave can be generated. The rectangular wave output frequency can be set close to the crystal frequency limit of 5MHz.

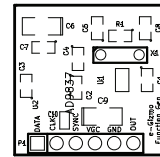
## APPLICATION IDEAS

The most obvious application of course, is to use the DDS Function Generator board to build your own Function Generator. Does a PC controlled Function Generator sounds good? PC control is advantageous since it will allow you to take a step further like using the setup as an automatic testing equipment ATE, for example, to measure the frequency response of an audio or speaker assembly. An intervening controller is probably needed, but advance users can do this by hacking the PC serial or parallel port (bit bang SPI emulation).

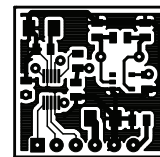
To prevent electrical noise from the PC from coupling into the Function Generator circuitry, it is best to avoid making any electrical connection at all with the PC. You can use wireless links, such as Bluetooth, Zigbee or IR Links.



Component Layout



Component Side



Bottom Side

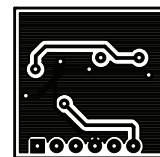


Figure 6. Schematic Diagram and PCB Layout of the AD9837 DDS Function Generator break-out board.