An Arduino Controlled
1 Hz to 60 MHz Signal Generator

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Objectives

• Build a standalone 60 MHz signal generator based on the DDS-60 board.

• Originally controlled the DDS-60 via a PC parallel printer port
  – Not a standalone solution
  – Readily available software was written for XP and wouldn’t run in compatibility mode on the newer operating systems
DDS-60

- Originally designed for the QRP community
- [http://midnightdesignsolutions.com/dds60/index.html](http://midnightdesignsolutions.com/dds60/index.html)
- Based on the Analog Devices AD9851 DDS chip
- Current price is $45 plus shipping
DDS-60 Schematic

Components: Except as indicated, decimal values of capacitance are in microfarads (μF); others are in picofarads (pF); resistances are in ohms; K = 1,000; inductance is in microhenries (μH); n.c. = No connection.

 DDS-60 Daughtercard
rev A5  May 15, 2014
N2APB, N2CX

Oscillator Module:
Pins in (parentheses) correspond to use of SMT oscillator module (U4B) instead of DIP module (U4A). Oscillator supplied is 30 MHz SMT package.

NOTE: Don’t forget to install these red jumpers during kit construction!
It’s easy to place a "wabber (rubber)" across the adjacent ‘a’ pads.

NOTE: With R10 ~ 24K ohms, the output level of the DDS-60 card can be adjusted to a maximum of about 4Vpp before distorting audio. (With 50 ohm load, the output will be about 100mVp.)
DDS-60 Back Side

AD8008 Output Amp

30 MHz Reference Crystal
DDS-60 Top Side

AD9851

Filter
Analog Devices AD9851 DDS

- 180 MHz Clock Rate with Selectable 6
  Reference Clock
- Multiplier
- On-Chip High Performance 10-Bit
  DAC and High Speed
- Comparator with Hysteresis
- SFDR >43 dB @ 70 MHz AOUT
- 32-Bit Frequency Tuning Word
- Simplified Control Interface: Parallel
  or Serial
- Asynchronous Loading Format
- 5-Bit Phase Modulation and Offset
  Capability
- Comparator Jitter <80 ps p-p @ 20
  MHz
- 2.7 V to 5.25 V Single-Supply
  Operation
- Low Power: 555 mW @ 180 MHz
- Power-Down Function, 4 mW @ 2.7 V
- Ultrasmall 28-Lead SSOP Packaging
Caution

- Older DDS-60 documentation noted using supply voltages up to 16 VDC.
  - AD8008 op amp is supplied directly from the +Vin line
  - AD8008 op amp maximum supply voltage is 12 VDC
  - They blow with 13.8 VDC
  - Recommend using a 9 VDC supply.
Arduino Uno Board

- 7 to 12VDC input
- 2.1mm x 5.5mm Male center positive
- Voltage regulator
- 16MHz crystal
- ATmega16U2 microcontroller IC/USB controller
- USB-B port to computer
- Reset button
- ICSP for USB interface
- (I2C) SCL – Serial clock
- (I2C) SDA – Serial data
- Pin-13 LED
- (SPI) SCK – Serial clock
- (SPI) MISO – Master-in, slave-out
- (SPI) MOSI – Master-out, slave-in
- (SPI) SS – Slave select

Note: Pins denoted with “~” are PWM supported
Atmel ATmega328P

- High Performance, Low Power Atmel® AVR® 8-Bit Microcontroller Family
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20MHz
  - On-chip 2-cycle Multiplier
ATMega328P Memory

- 32KBytes of In-System Self-Programmable Flash program memory
- 1KBytes EEPROM
- 2KBytes Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- Data retention: 20 years at 85C/100 years at 25 C
- Optional Boot Code Section with Independent Lock Bits
  - In-System Programming by On-chip Boot Program
  - True Read-While-Write Operation
- Programming Lock for Software Security
ATMega328P Peripheral Features

- Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
- One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
- Real Time Counter with Separate Oscillator
- Six PWM Channels
- 8-channel 10-bit ADC in TQFP and QFN/MLF package
- Temperature Measurement
- 6-channel 10-bit ADC in PDIP Package
- Temperature Measurement
- Programmable Serial USART
- Master/Slave SPI Serial Interface
- Byte-oriented 2-wire Serial Interface (Philips I2C compatible)
- Programmable Watchdog Timer with Separate On-chip Oscillator
- On-chip Analog Comparator
- Interrupt and Wake-up on Pin Change
Software Development for the Arduino

- Open source Integrated Development Environment (IDE)
  - [https://www.arduino.cc/en/Main/Software](https://www.arduino.cc/en/Main/Software)
- Many subroutines for hardware available
  - LCD Display, Keypad, ……
- Long list of examples included with IDE
- Lots of open source code
  - E.g., Arduino Uno makes a nice beacon keyer
Challenges and Solutions

• Setting 60,000,000 frequency settings
  – Keypad
  – Mechanical Encoder
    • 100 KHz, 10 KHz, 1 KHz, 100 Hz, 10 Hz, and 1 Hz step sizes selected with a push button switch

• Calibration

• Mode control
  – Push button switch
KT1F Software

• Ross Keatinge, KT1F wrote software for controlling the DDS-60 with an Arduino RBBB (really bare bones board).
• Code compiles and loads on the Arduino Uno and available at http://www.theladderline.com/node/10
• Latest Version on web is version 1.4
• 34 pages when printed out!
• Modes
  – Normal
  – TX
  – Memory
  – QRSS
  – Calibrate
  – Silent
Arduino Controls and Connections to the DDS-60 and LCD
Software Modifications

- LCD Display
- Frequency range
- Pull-ups on button ports
Front Side
Interior
Future Plans

• Signal Generator
  – Signal level to meter
  – Automatic Level Control (ALC)

• Broadband transmitter/RX LO
  – TX code not working right