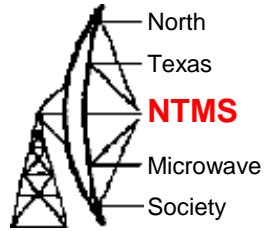


An Arduino Controlled 1 Hz to 60 MHz Signal Generator

Greg McIntire, AA5C

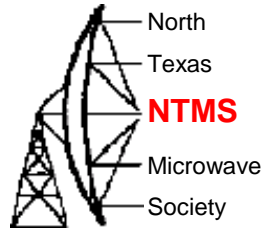
AA5C@arrl.net

Objectives



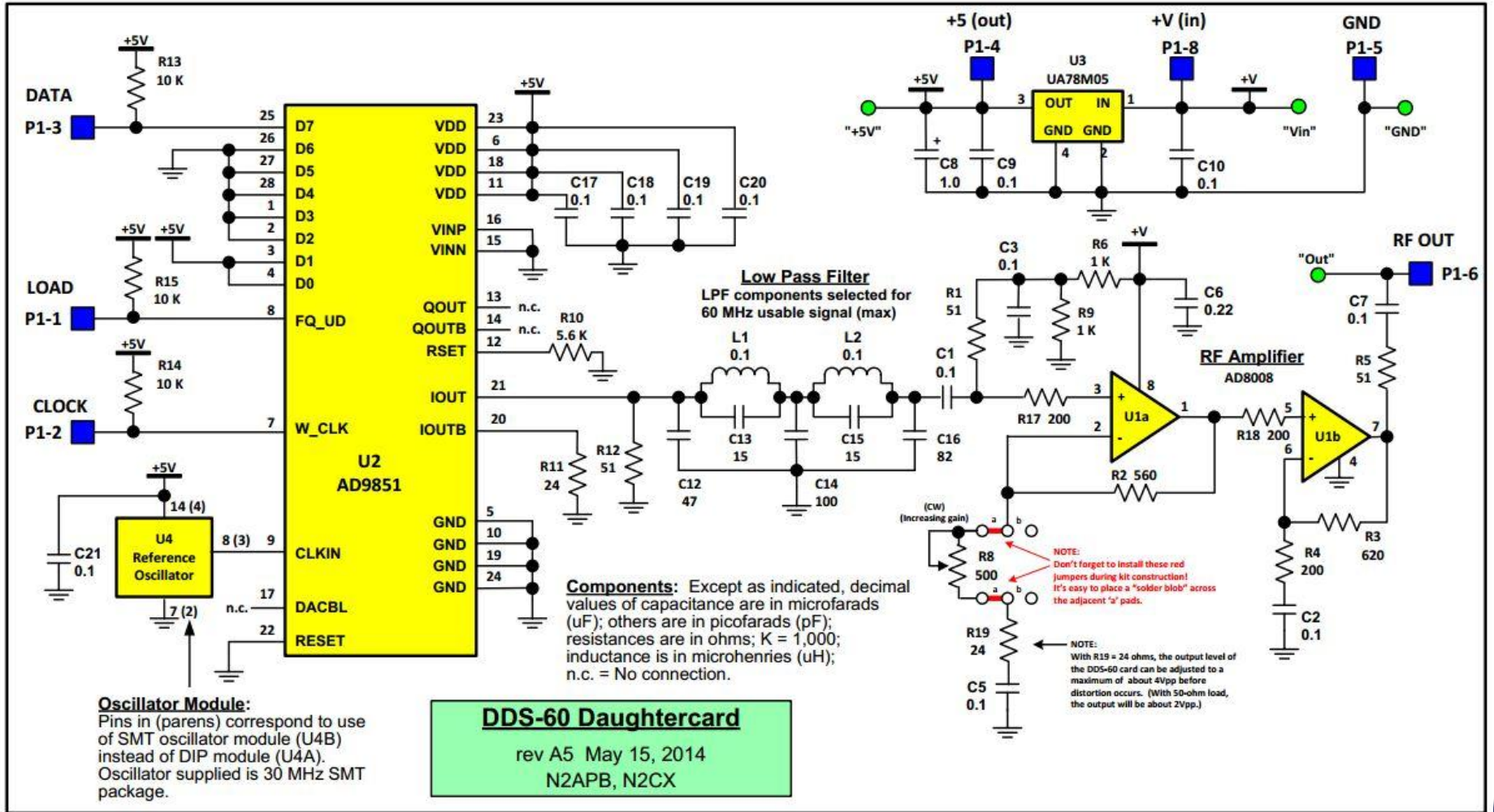
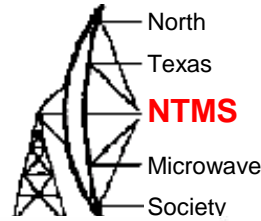
- Build a standalone 60 MHz signal generator based on the DDS-60 board.
- Originally controlled the DDS-60 via a PC parallel printer port
 - Not a standalone solution
 - Readily available software was written for XP and wouldn't run in compatibility mode on the newer operating systems

DDS-60

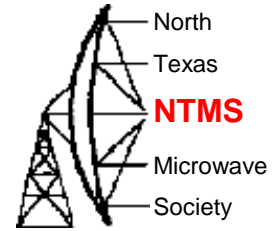


- Originally designed for the QRP community
- <http://midnightdesignsolutions.com/dds60/index.html>
- Based on the Analog Devices AD9851 DDS chip
- Current price is \$45 plus shipping

DDS-60 Schematic

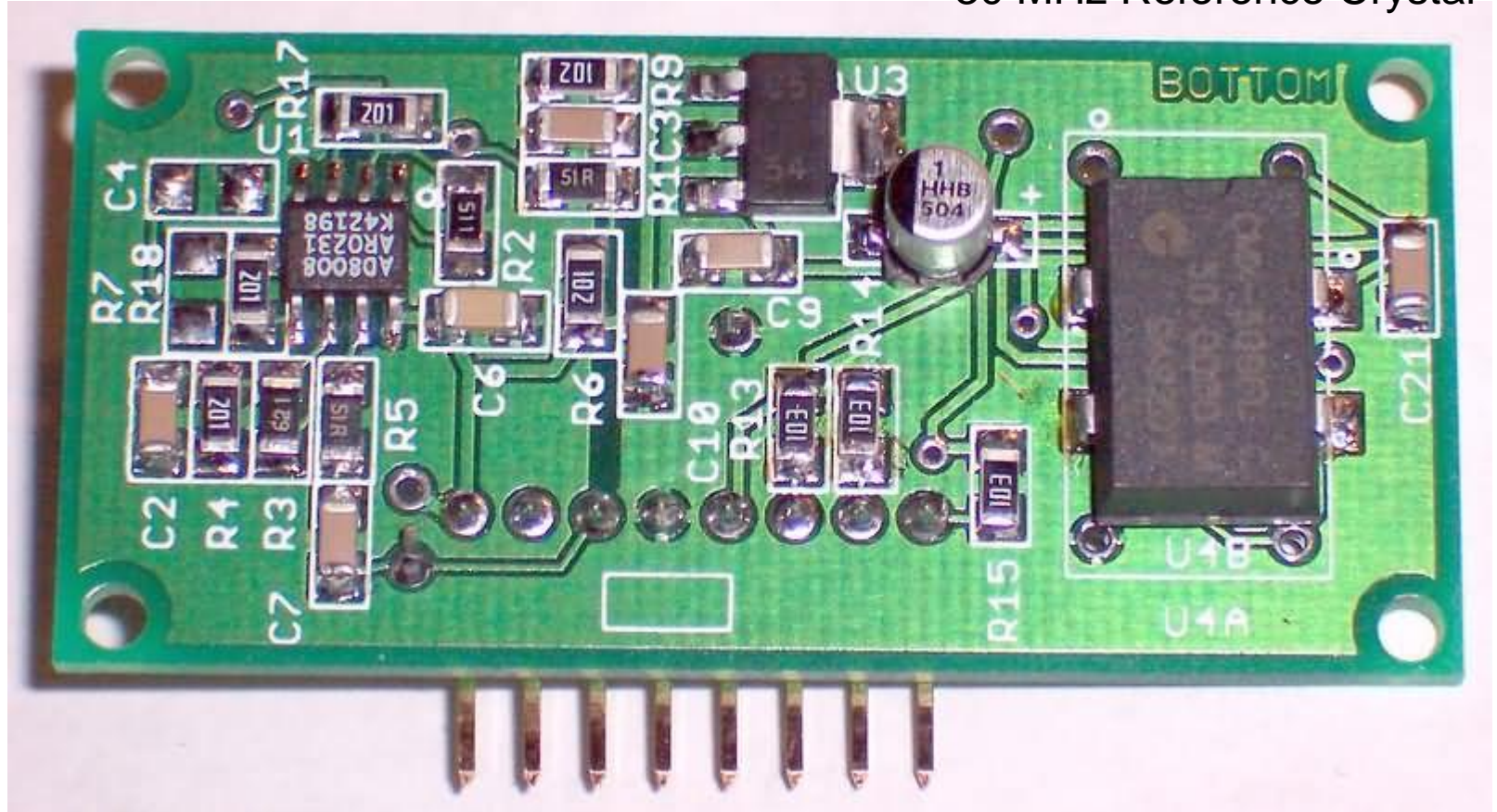


DDS-60 Back Side

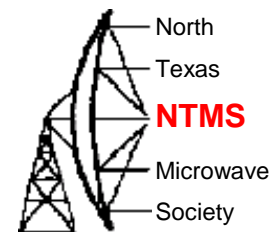


AD8008 Output Amp

30 MHz Reference Crystal

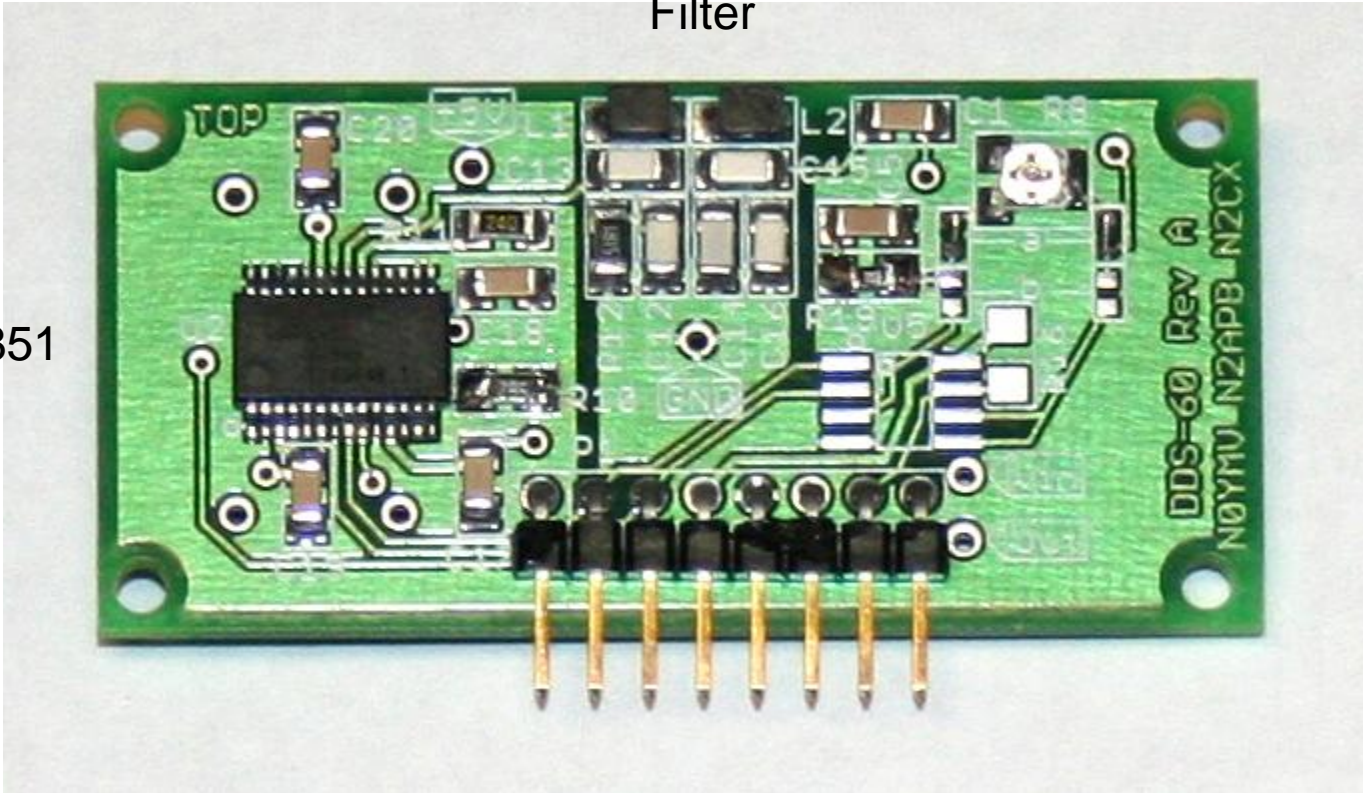


DDS-60 Top Side

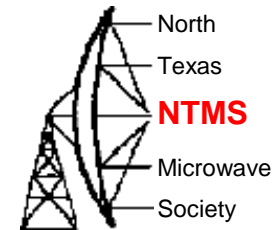


Filter

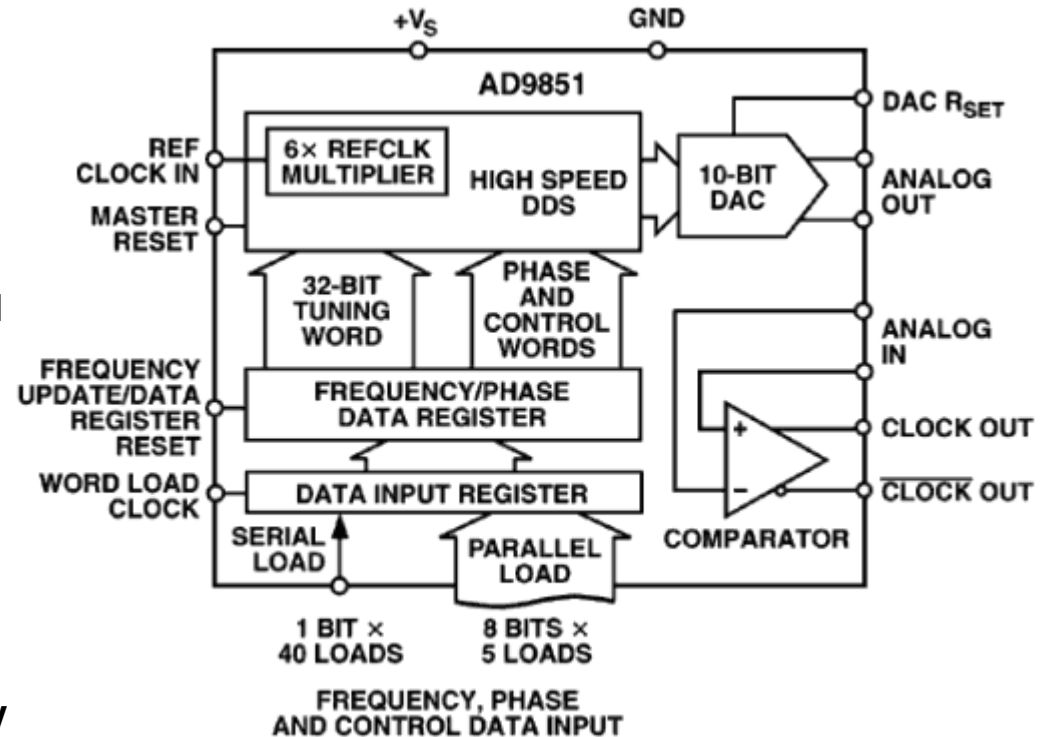
AD9851



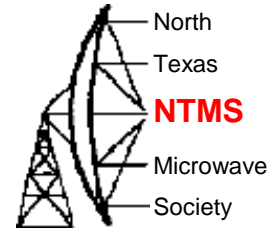
Analog Devices AD9851 DDS



- 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

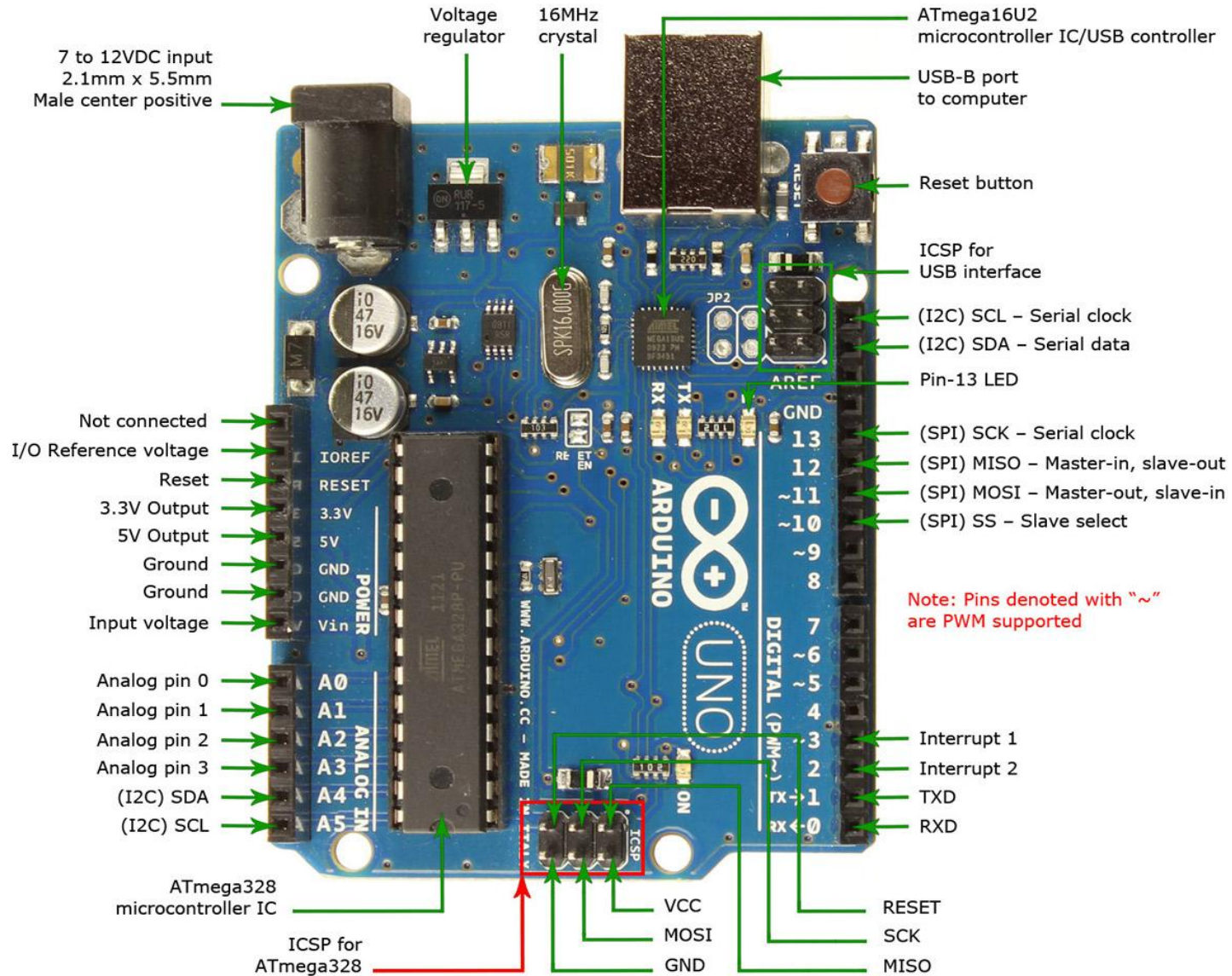
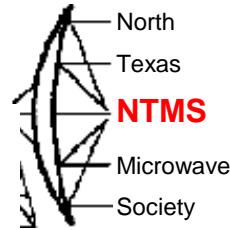


Caution



- 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



Atmel ATmega328P



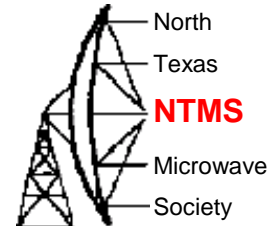
- High Performance, Low Power Atmel® AVR® 8-Bit Microcontroller Family
- Advanced RISC Architecture
 - 131 Powerful Instructions – Most Single Clock Cycle Execution
 - 32 x 8 General Purpose Working Registers
 - Fully Static Operation
 - Up to 20 MIPS Throughput at 20MHz
 - On-chip 2-cycle Multiplier

ATMega328P Memory



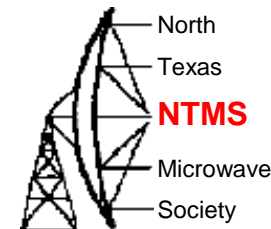
- 32KBytes of In-System Self-Programmable Flash program memory
- 1KBytes EEPROM
- 2KBytes Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- Data retention: 20 years at 85C/100 years at 25 C
- Optional Boot Code Section with Independent Lock Bits
 - In-System Programming by On-chip Boot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

ATMega328P Peripheral Features



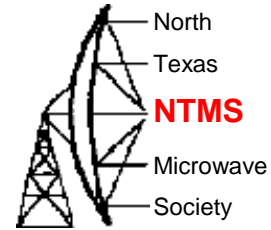
- Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
- One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
- Real Time Counter with Separate Oscillator
- Six PWM Channels
- 8-channel 10-bit ADC in TQFP and QFN/MLF package
- Temperature Measurement
- 6-channel 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



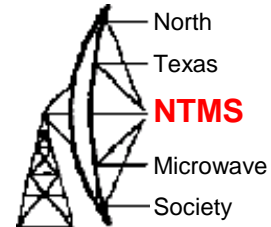
- Open source Integrated Development Environment (IDE)
 - <https://www.arduino.cc/en/Main/Software>
- Many subroutines for hardware available
 - LCD Display, Keypad,
- Long list of examples included with IDE
- Lots of open source code
 - E.g., Arduino Uno makes a nice beacon keyer

Challenges and Solutions



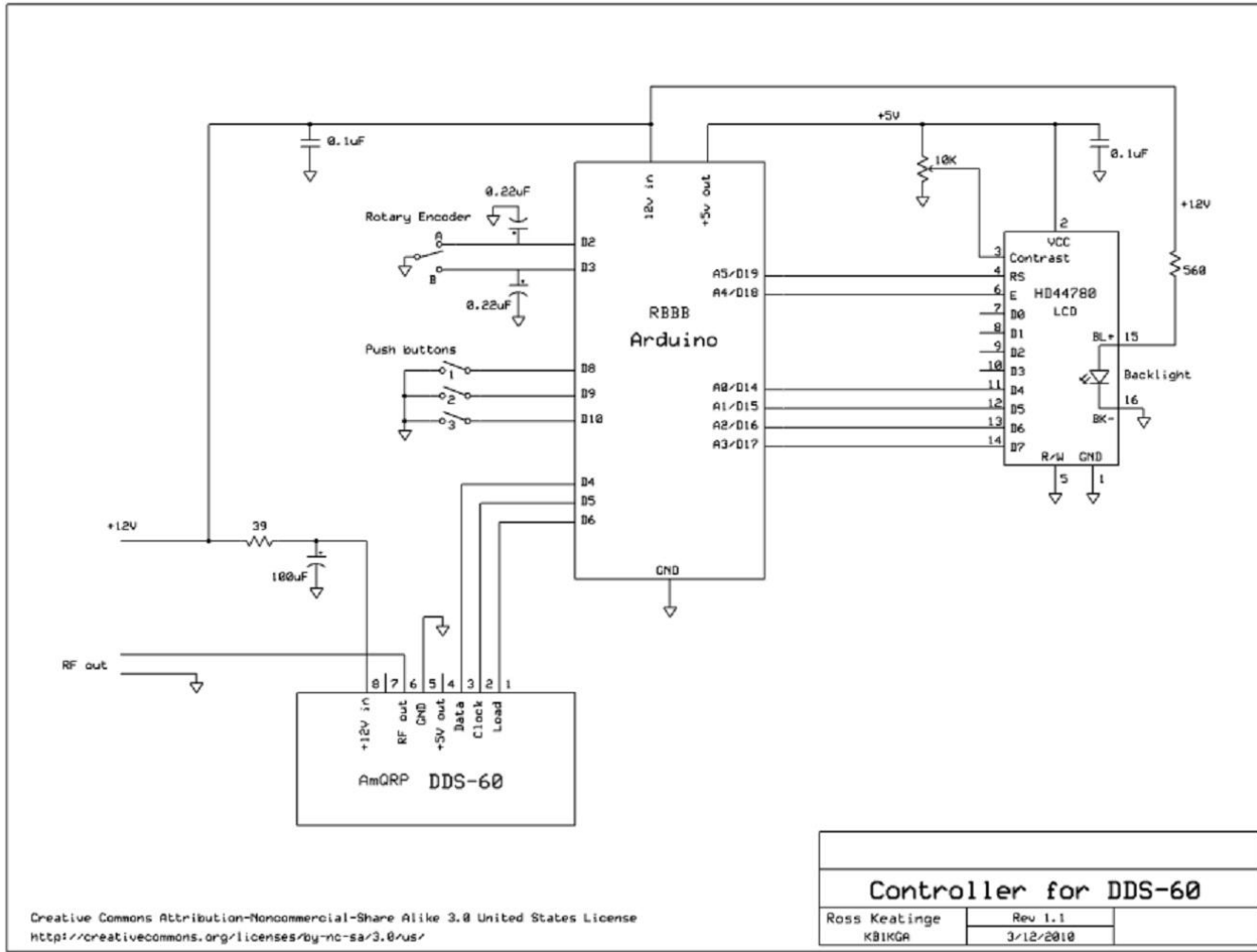
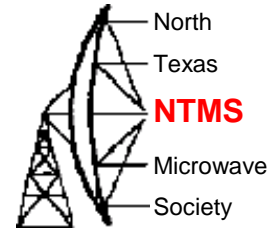
- Setting 60,000,000 frequency settings
 - Keypad
 - Mechanical Encoder
 - 100 KHz, 10 KHz, 1 KHz, 100 Hz, 10 Hz, and 1 Hz step sizes selected with a push button switch
- Calibration
- Mode control
 - Push button switch

KT1F Software

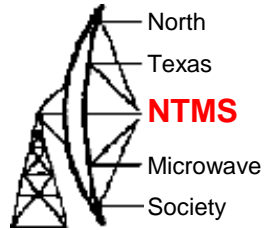


- Ross Keatinge, KT1F wrote software for controlling the DDS-60 with an Arduino RBBB (really bare bones board).
- Code compiles and loads on the Arduino Uno and available at <http://www.theladderline.com/node/10>
- Latest Version on web is version 1.4
- 34 pages when printed out!
- Modes
 - Normal
 -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

Arduino Controls and Connections to the DDS-60 and LCD

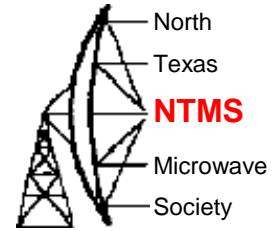


Software Modifications

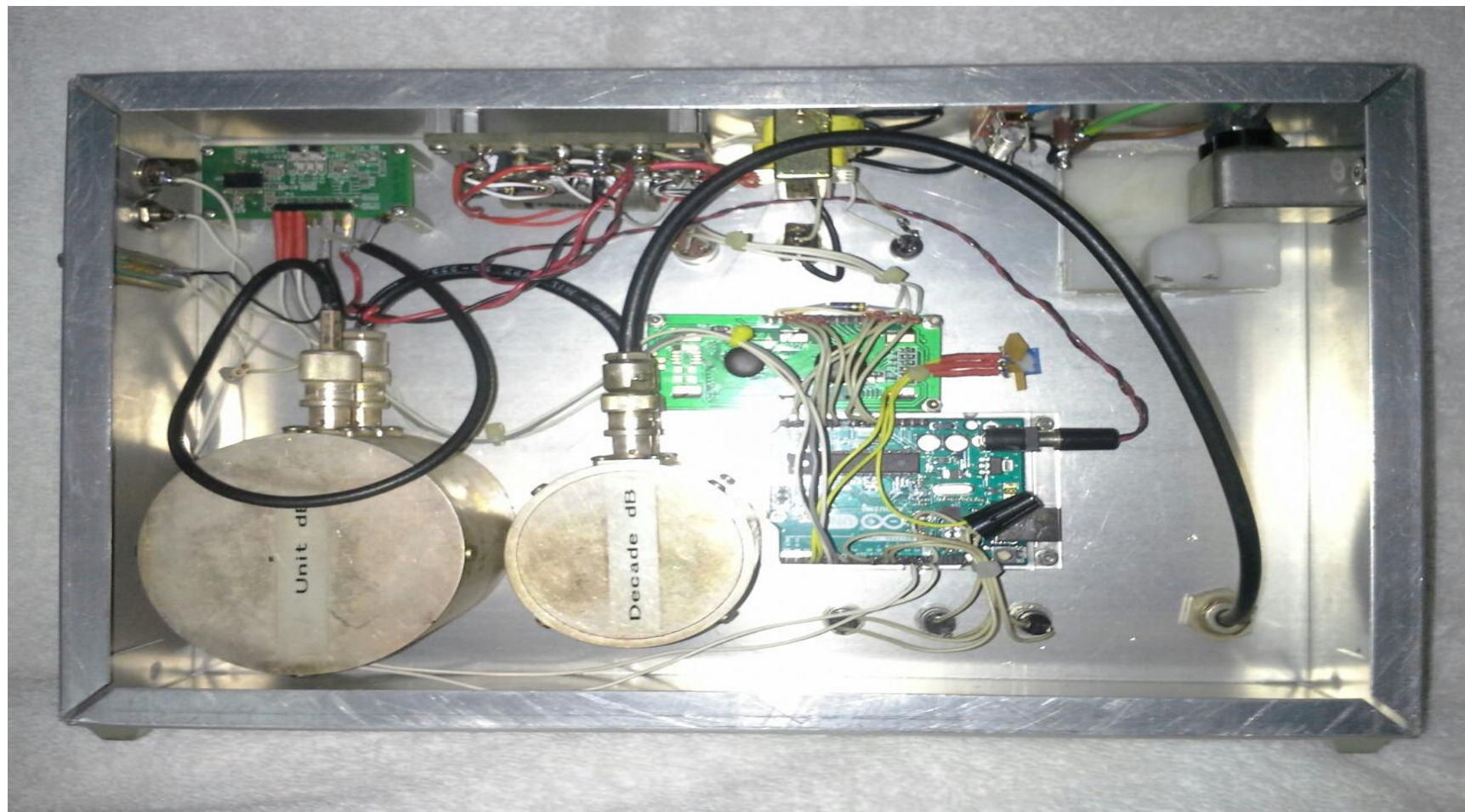


- LCD Display
- Frequency range
- Pull-ups on button ports

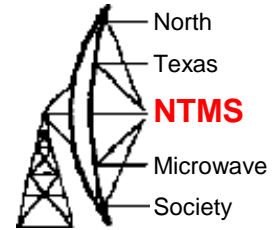
Front Side



Interior



Future Plans



- Signal Generator
 - Signal level to meter
 - Automatic Level Control (ALC)
- Broadband transmitter/RX LO
 - TX code not working right