

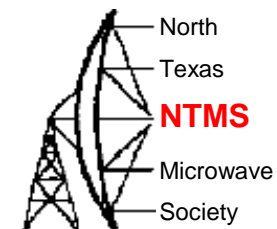
Arduino Controllers for the Microwave Operator

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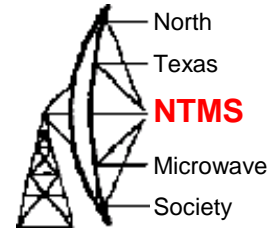
October 4-5, 2019

Why Microcontrollers?

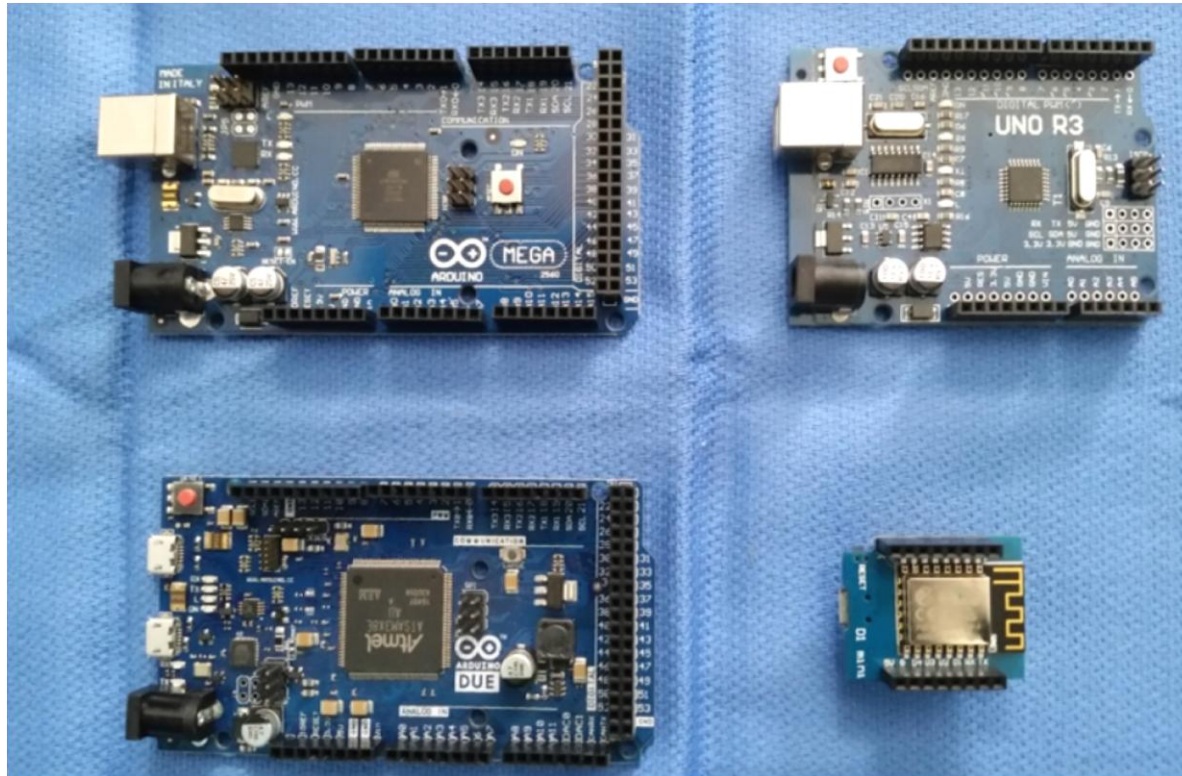


- Most modern frequency control devices are useless until programmed
 - PLL-based frequency synthesizers
 - Direct Digital Synthesizers
- Highly flexible and can be programmed for a wide variety of functions
 - Bus control
 - Serial Peripheral Interface (SPI)
 - I2C bus
 - Discrete lines
 - Morse code generator/beacon
 - Relay control
 - Position indication.....
- Inexpensive
- Wide range of supporting devices available
 - Displays
 - Switches
 - Relays.....

Example Microcontrollers



Arduino
Mega 2560

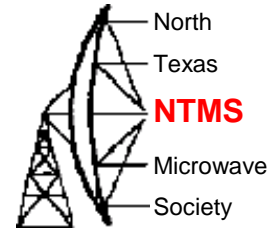


Arduino
Uno R3

Arduino
Due

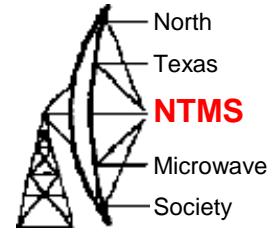
WeMos
D1 Mini

Specifications

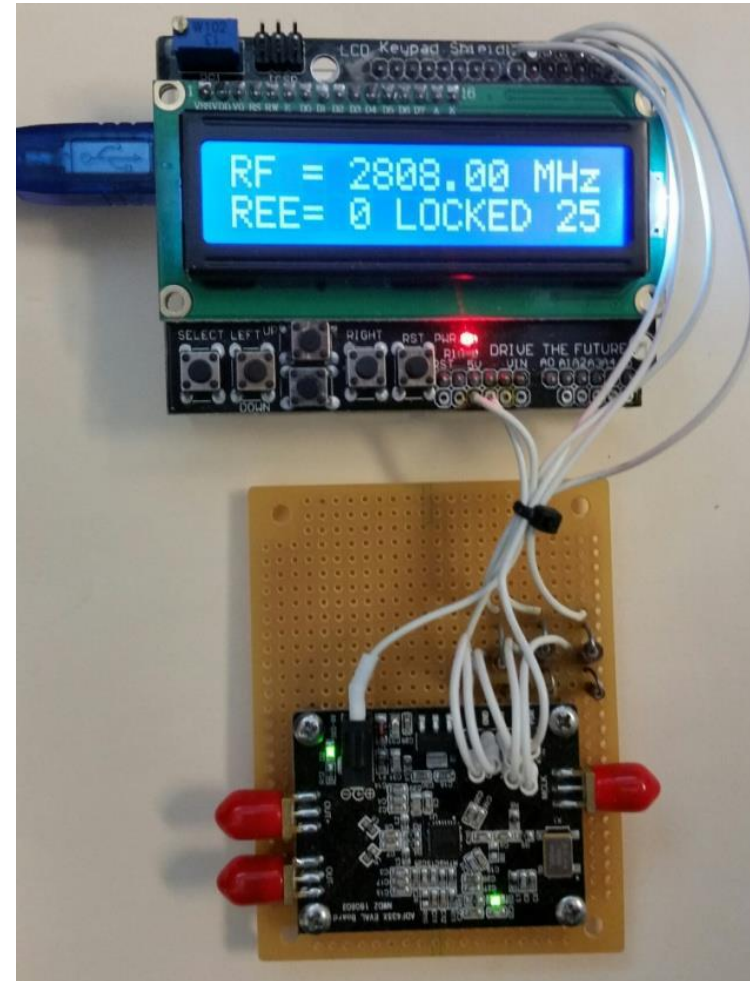


Board	Mega 2560	Uno	Due	D1 Mini
Processor	ATmega2560	ATmega328P	ATSAM3X8E	ESP8266
Clock Speed (MHz)	16	16*	84	80/160
Word Length (bits)	32	8	32	32
I/O Logic Voltage	3.3	5	3.3	3.3
Analog I/O (in/out)	16/0	6/0	12/2	1/0
Digital (I/O or PWM)	54/15	14/6	54/12	11
EEPROM (KB)	4	1	0	512 bytes
SRAM (KB)	8	2	96	4 MB
Flash (KB)	256	32	512	4 MB
SPI Bus Interfaces	1	1	2	1
USB Interface	1-Regular	1-Regular	2-Micro	1-Micro

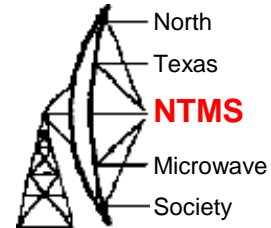
ADF4351 Controller



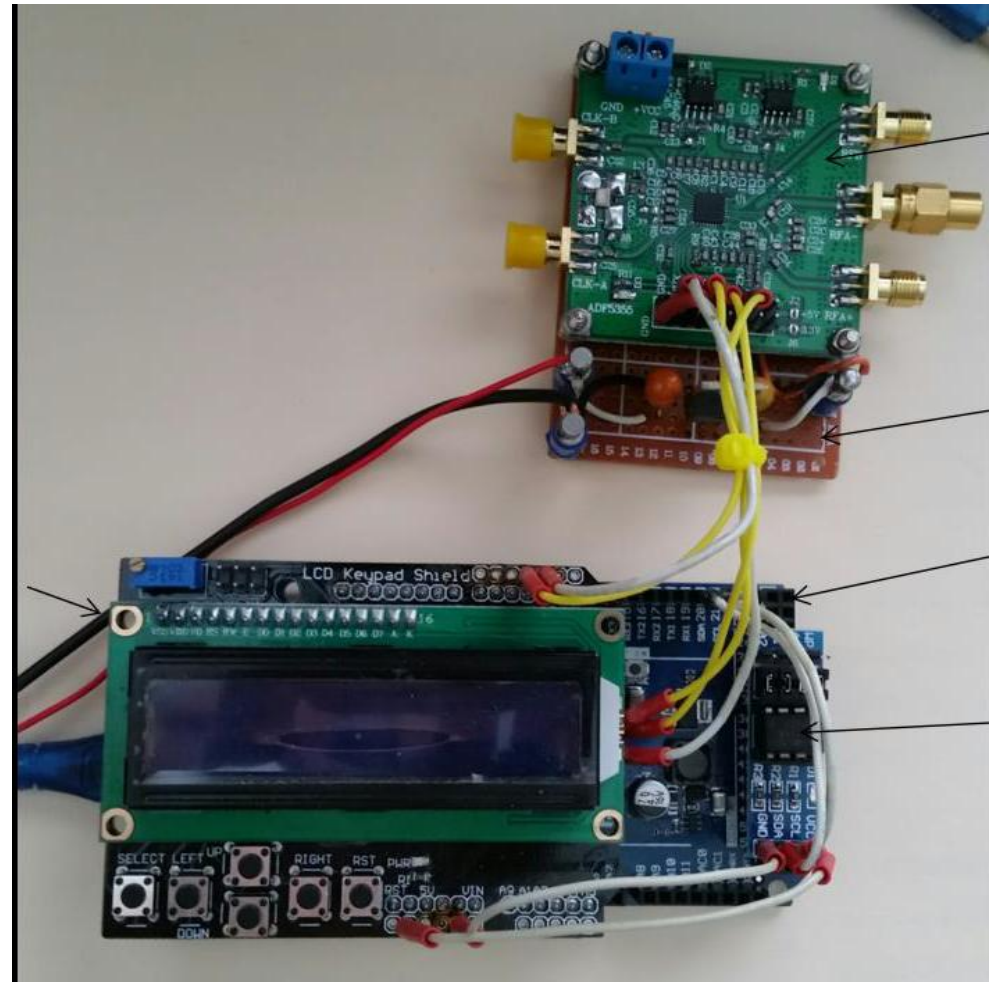
- Analog Devices ADF4351
 - 35 MHz to 4.4 GHz Synthesizer
 - SPI Bus Controlled
 - Programmable features
- Evaluation Board
 - Mounted part
 - 3.3V Regulator
 - On-board reference oscillator
- Interface Board
 - 5V to 3.3V logic conversion
 - Breadboard space
- Arduino Uno R3 Controller
 - SPI bus control
 - Frequency selection
 - Reference selection
 - Display



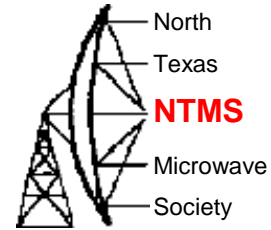
ADF5355 Controller



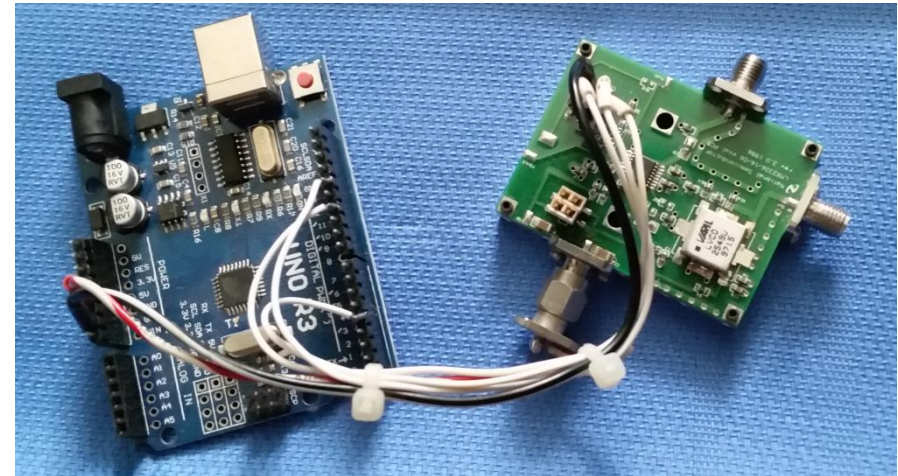
- Analog Devices ADF5355
 - 54 MHz to 13.4 GHz Synthesizer
 - SPI Bus Controlled
 - Programmable features
- Evaluation Board
 - Mounted part
 - 3.3V and 5V Regulators
 - On-board reference oscillator
- Interface Board
 - Regulator
 - Breadboard space
- Arduino Due Controller
 - SPI bus control
 - Frequency selection
 - Reference selection
 - Display



Legacy Part Control



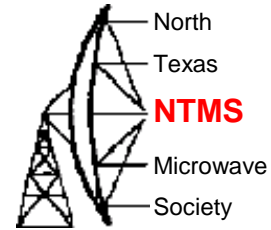
- National LMX2316
 - Up to 1.2 GHz Synthesizer
 - SPI Bus Controlled
 - 21-bit registers
 - Programmable features
 - Late 1990s part
- Evaluation Board
 - Mounted part
 - VCO
 - External Reference Input
- Arduino Uno R3 Controller
 - SPI bus control



Serial Peripheral Interface Bus

- Originally Developed By Motorola in the Mid-1980s
- 32-bit words now a common standard

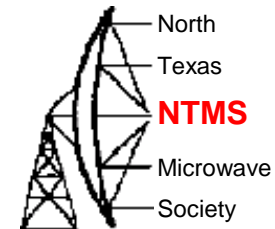
AA5C 902 MHz to 10 GHz Transverters



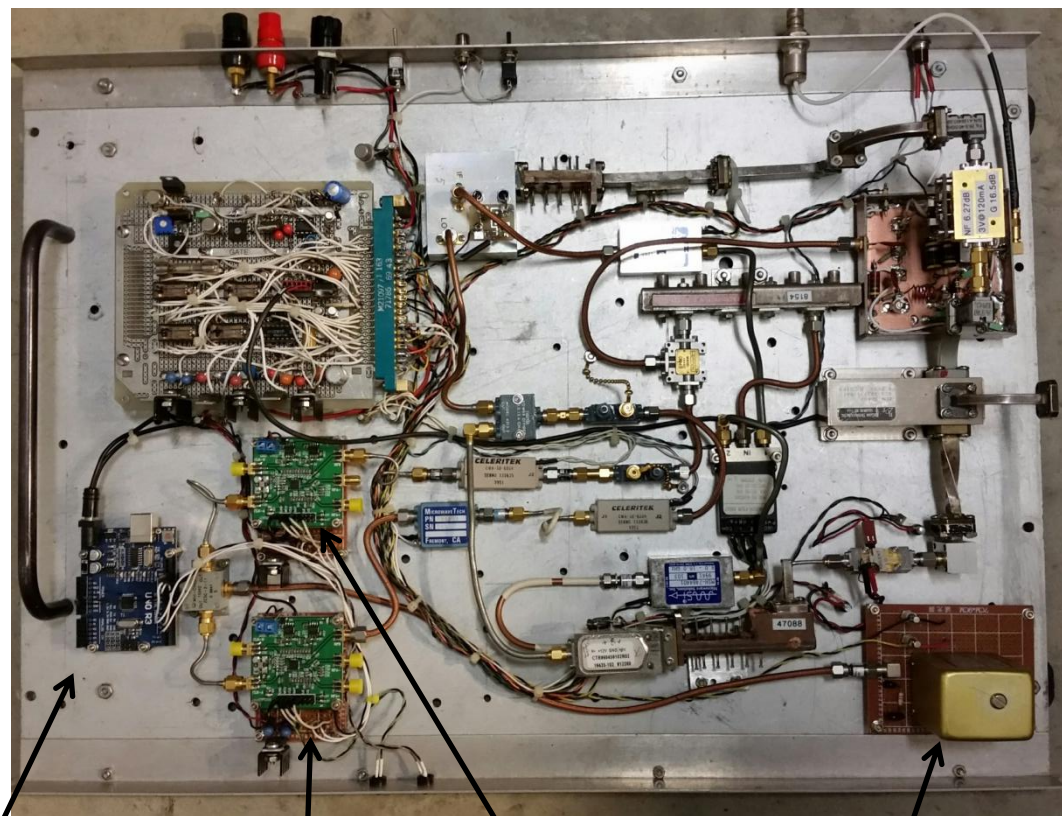
- All XVTRs Locked to 10 MHz GPS Disciplined Oscillator (GPSDO)
 - 902 MHz (758 MHz) - Apollo 32
 - 1296 MHz (1152 MHz) - Apollo 32
 - 2304 MHz (2160 MHz) - Apollo 32 with 2X Multiplier
 - 3456 MHz (3312 MHz) – ADF4351
 - 5760 MHz (5616 MHz) – ADF5355
 - 10368 MHz (10224 MHz) – ADF5355
- Apollo 32 Boards Have Built in Microcontroller
- ADF4351 and ADF5355 programmed by an Arduino Uno
 - No display or Switches
 - Loads PLL on power up



AA5C 47 GHz Transverter



- Single Arduino Uno R3 Loads Both ADF5355s
- Started with a 10 MHz Reference and with a Small Matter of Programming (SMOP) changed to a 32 MHz Reference



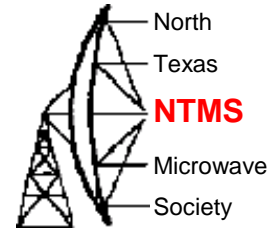
Arduino Uno

12.978 GHz LO

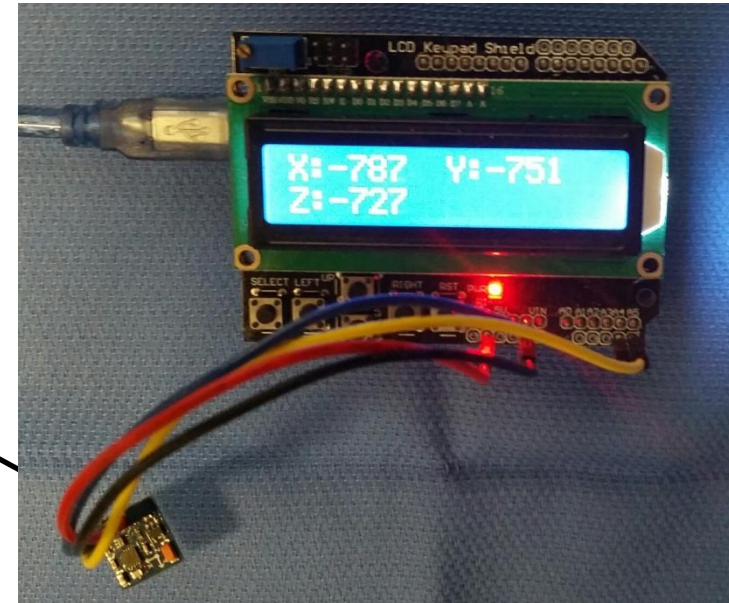
8.010 GHz LO

32 MHz Reference

Position Indication



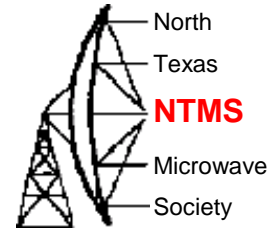
- HMC5388L 3 Axis Magnetic Compass
 - GY-271 module
- UNIK MPU-9250 9DOF Module
 - Nine-axis Attitude Gyro
 - Compass Acceleration
 - Magnetic Field Sensor
- Both Modules Controlled via an I2C Interface



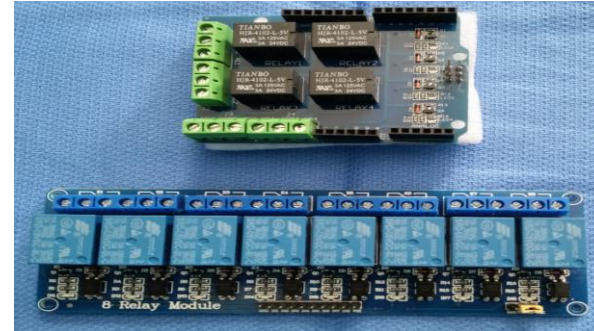
Calibration in the Target Application Required

- Sensitive to Ferrous Materials

Shield Examples



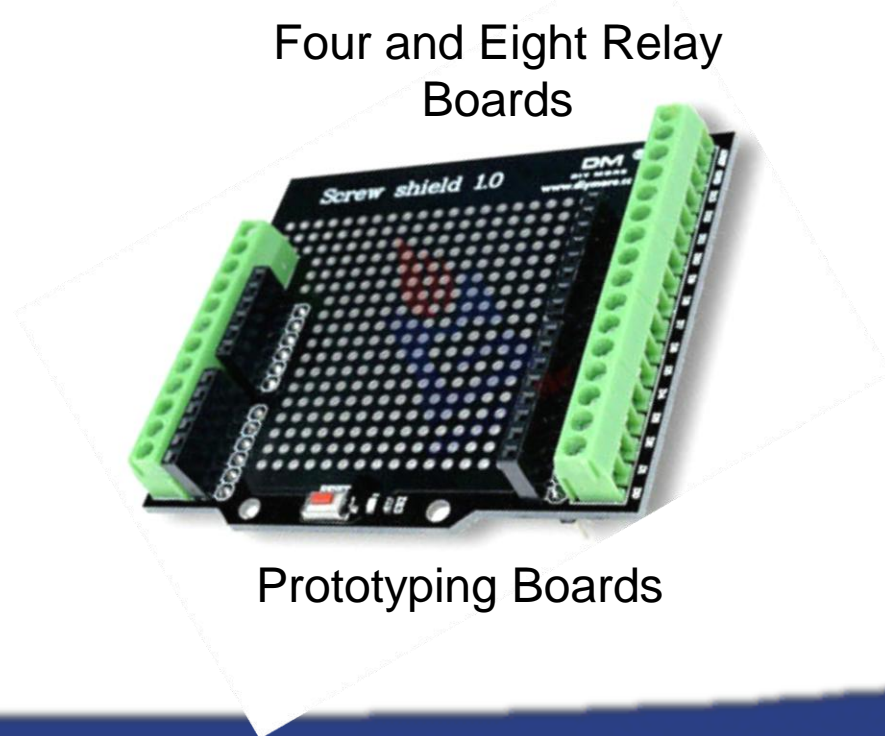
LCD Display With Switches and I/O Breakouts



Four and Eight Relay Boards

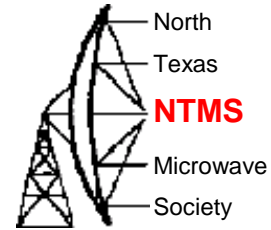


Ethernet with SD Card Reader



Prototyping Boards

Summary



- Low Cost Microcontrollers Can Be Used for a Wide Range of Functions
 - Controllers
 - Indicators
 - Sensors
- Many Different Supporting Hardware Devices/Shields Available
- Large Number of Open Source Sketches are Available
 - Minimizes the Amount of Unique Programming Required
 - Generic Functions, e.g.,
 - SPI bus control, I2C bus control
 - External EEPROM
 - Application Specific Functions, e.g.,
 - Synthesizer Control
 - Rotor Control
 - Az/EI Indicators