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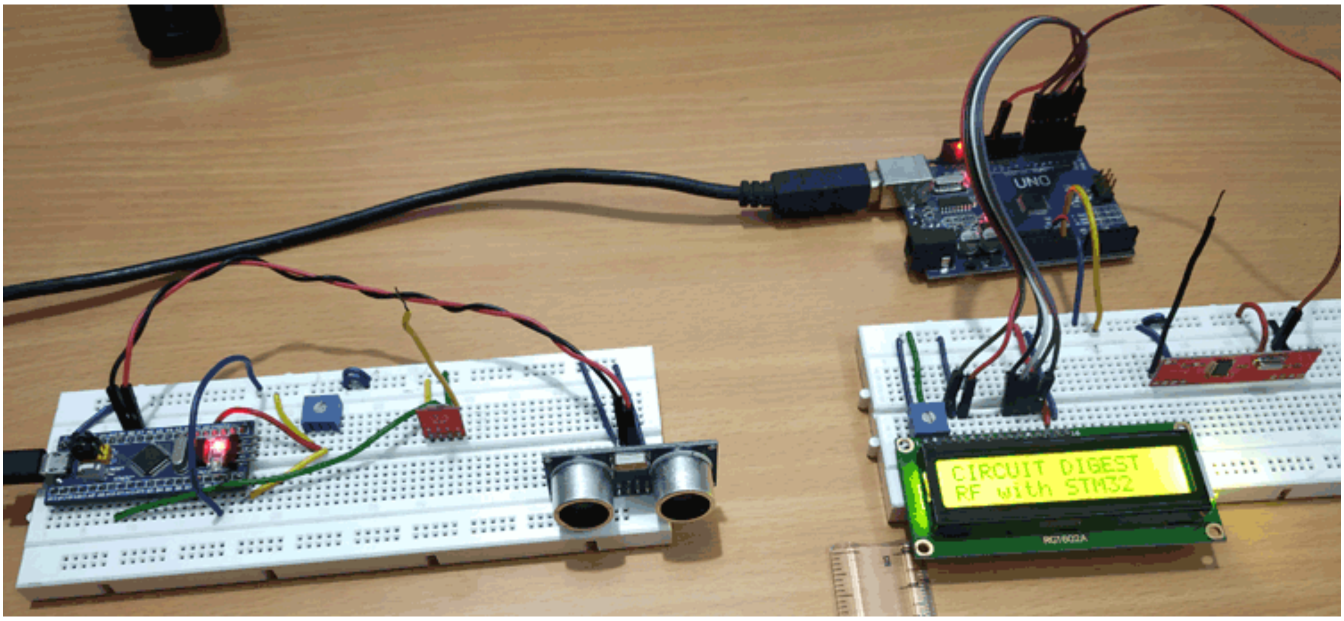
Interfacing 433Mhz RF Module with STM32F103C8 (/microcontroller-projects/interfacing-433mhz-rf-module-with-stm32f103c8-microcontroller)

By (page_author.html)Pramoth Thangavel (/users/pramoth-thangavel) Apr 12, 2019 0



Interfacing 433Mhz RF Module with STM32F103C8

Making wireless projects in embedded electronics (https://circuitdigest.com/embedded) becomes very important and helpful as there are no jumbled wires all over which makes the device more handy and portable. There are various wireless technologies such as Bluetooth (https://circuitdigest.com/tags/bluetooth), WiFi (https://circuitdigest.com/esp8266-projects), 433 MHz RF (https://circuitdigest.com/tags/rf) (Radio Frequency) etc. Every technology has its own advantages and disadvantages such as cost, distance or range transfer, speed or throughput etc. Today we will use **RF module with STM32 to send and receive the data wirelessly**. If you are new to STM32 Microcontroller then start with Blinking LED with STM32 using Arduino IDE (https://circuitdigest.com/microcontroller-projects/getting-started-with-stm32-development-board-stm32f103c8-using-arduino-ide) and check all other STM32 projects here (https://circuitdigest.com/stm32-projects-and-tutorials).

Apart from this, we have also used RF 433Mhz Wireless Module with other microcontrollers to build some wireless controlled projects, such as:

- RF Controlled Home Appliances (https://circuitdigest.com/electronic-circuits/rf-home-automation)
- RF Remote Controlled LEDs Using Raspberry Pi (https://circuitdigest.com/microcontroller-projects/rf-remote-controlled-leds-using-raspberry-pi)
- RF Controlled Robot (https://circuitdigest.com/electronic-circuits/rf-controlled-robot-without-microcontroller)
- Interfacing RF module with Arduino (https://circuitdigest.com/microcontroller-projects/interfacing-nrf24l01-with-arduino-transmitter-and-receiver-tutorial)
- PIC to PIC Communication using RF Module (https://circuitdigest.com/microcontroller-projects/pic-to-pic-communication-using-rf-module)

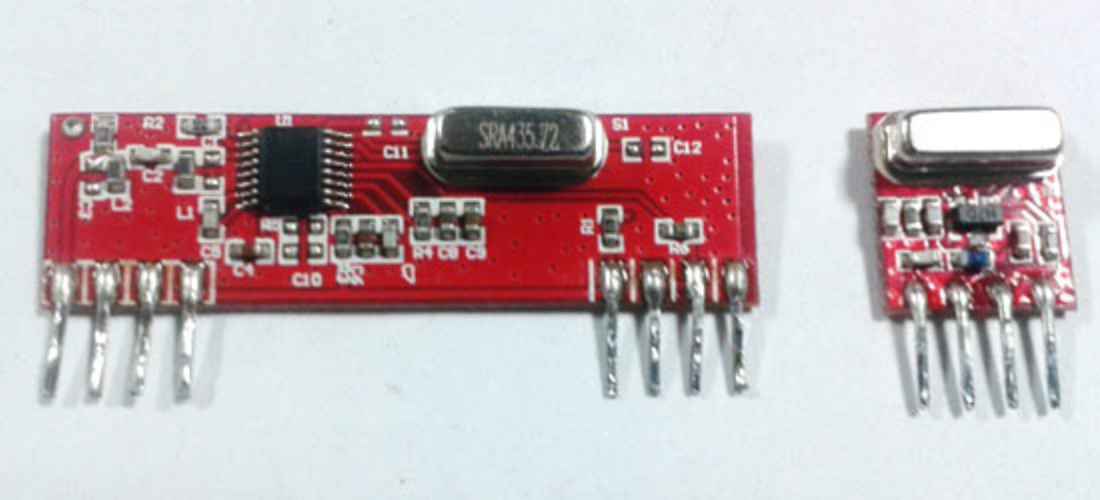
Here we will **interface a 433MHz RF wireless module with STM32F103C8 microcontroller.** The project is divided into two parts. The **transmitter will be interfaced with STM32** and the **receiver will be interfaced with Arduino UNO**. There will be **different circuit diagram and sketches** for both transmitting as well receiving part.

In this tutorial, **RF Transmitter** sends two values to Receiver side: the distance measured using ultrasonic sensor (https://circuitdigest.com/tags/ultrasonic-sensor) and the potentiometer ADC (https://circuitdigest.com/tutorial/what-is-adc-analog-to-digital-converters) value (0 to 4096) which is mapped as number from (0 to 100). The **RF receiver** of Arduino receives both the values and prints those distance and number values in 16x2 LCD display (https://circuitdigest.com/article/16x2-lcd-display-module-pinout-datasheet) wirelessly.

Components Required

- STM32F103C8 Microcontroller
- Arduino UNO
- 433Mhz RF Transmitter & Receiver
- Ultrasonic Sensor (HC-SR04)
- 16x2 LCD display
- 10k Potentiometer
- Breadboard
- Connecting Wires

433Mhz RF Transmitter and Receiver Module)



RF Transmitter Pinout:

433Mhz RF Transmitter	Pin Description
ANT	For connecting Antenna
GND	GND
VDD	3.3 to 5V
DATA	Data to be transmitted to receiver is given here

RF Receiver Pinout:

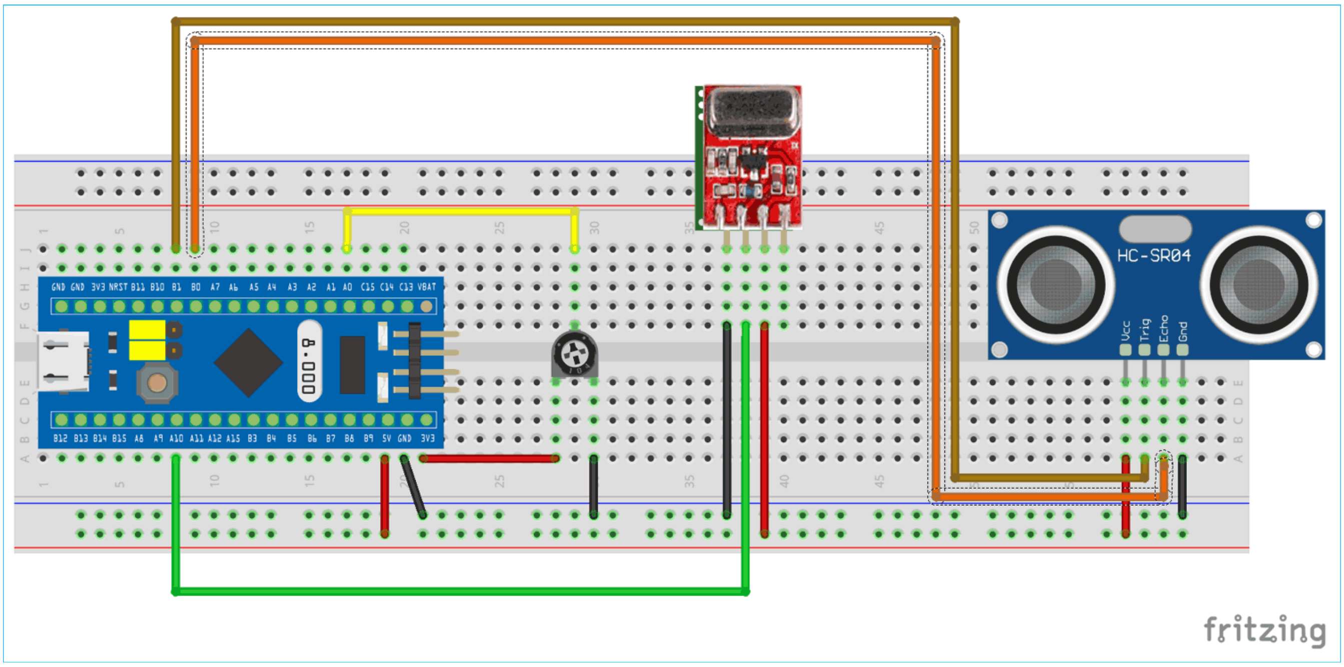
433Mhz RF Receiver	USE
ANT	For connecting Antenna
GND	GND
VDD	3.3 to 5V
DATA	Data to be received from Transmitter
CE/DO	It is also a Data pin

433 MHz Module Specifications:

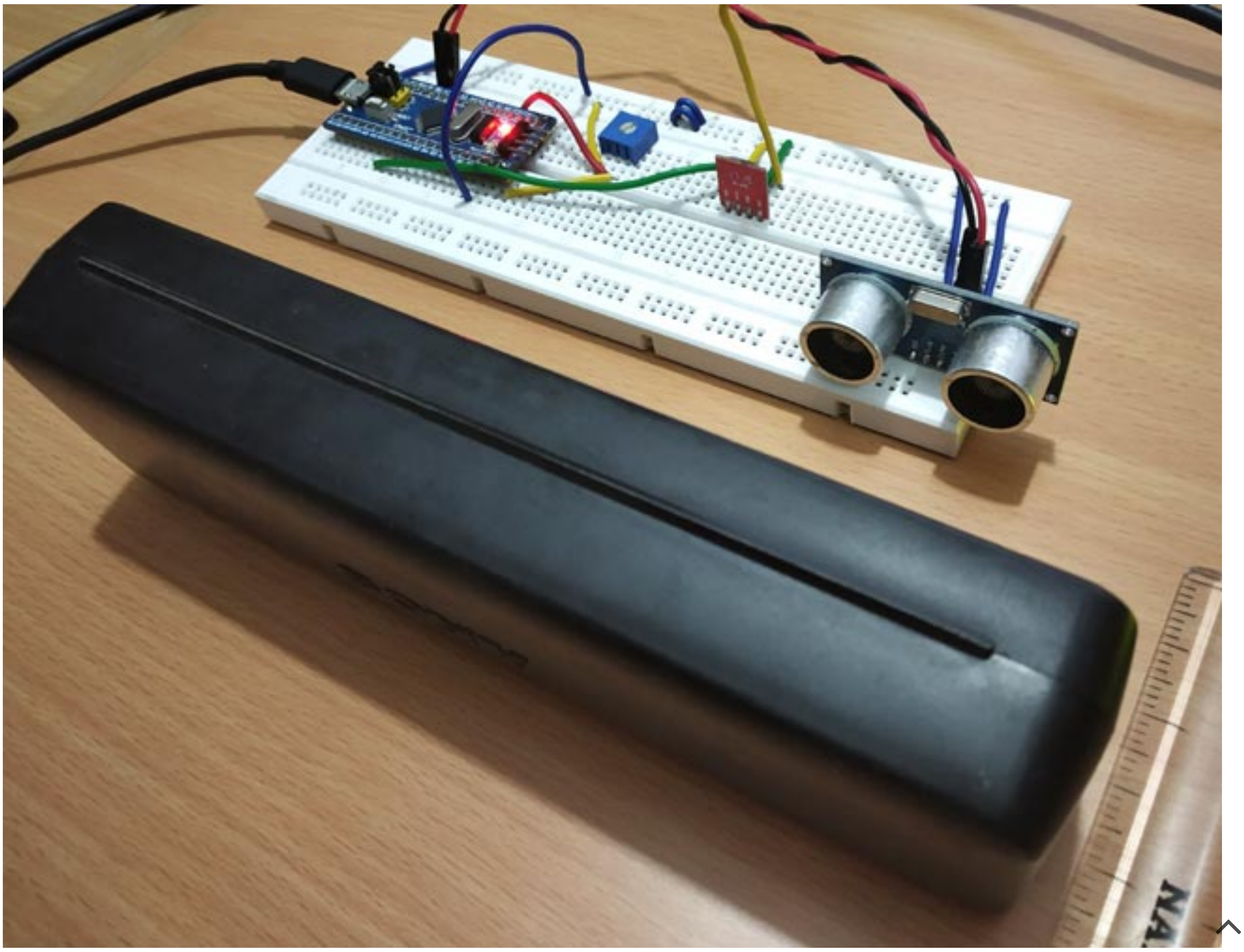
- Receiver Operating Voltage: 3V to 5V
- Transmitter Operating Voltage: 3V to 5V
- Operating frequency: 433 MHz
- Transmission Distance: 3 meters (without antenna) to 100 meters (maximum)
- Modulating Technique: ASK (Amplitude shift keying)

- Data Transmission speed: 10Kbps

Circuit Diagram of RF Transmitter with STM32F103C8


GND GND 3V3 NRST B11 B10 B1 B0 A7 A6 A5 A4 A3 A2 A1 A0 C15 C14 C13 VBAT
B12 B13 B14 B15 A8 A9 A10 A11 A12 A15 B3 B4 B5 B6 B7 B8 B9 5V GND 3V3
HC-SR04
Vcc
Trig
Echo
Gnd
fritzing

(/fullimage?i=circuitdiagram_mic/Transmitter-Side-Circuit-Diagram-for-Interfacing-433Mhz-RF-Module-with-STM32F103C8.png)



Circuit Connections between RF Transmitter & STM32F103C8:

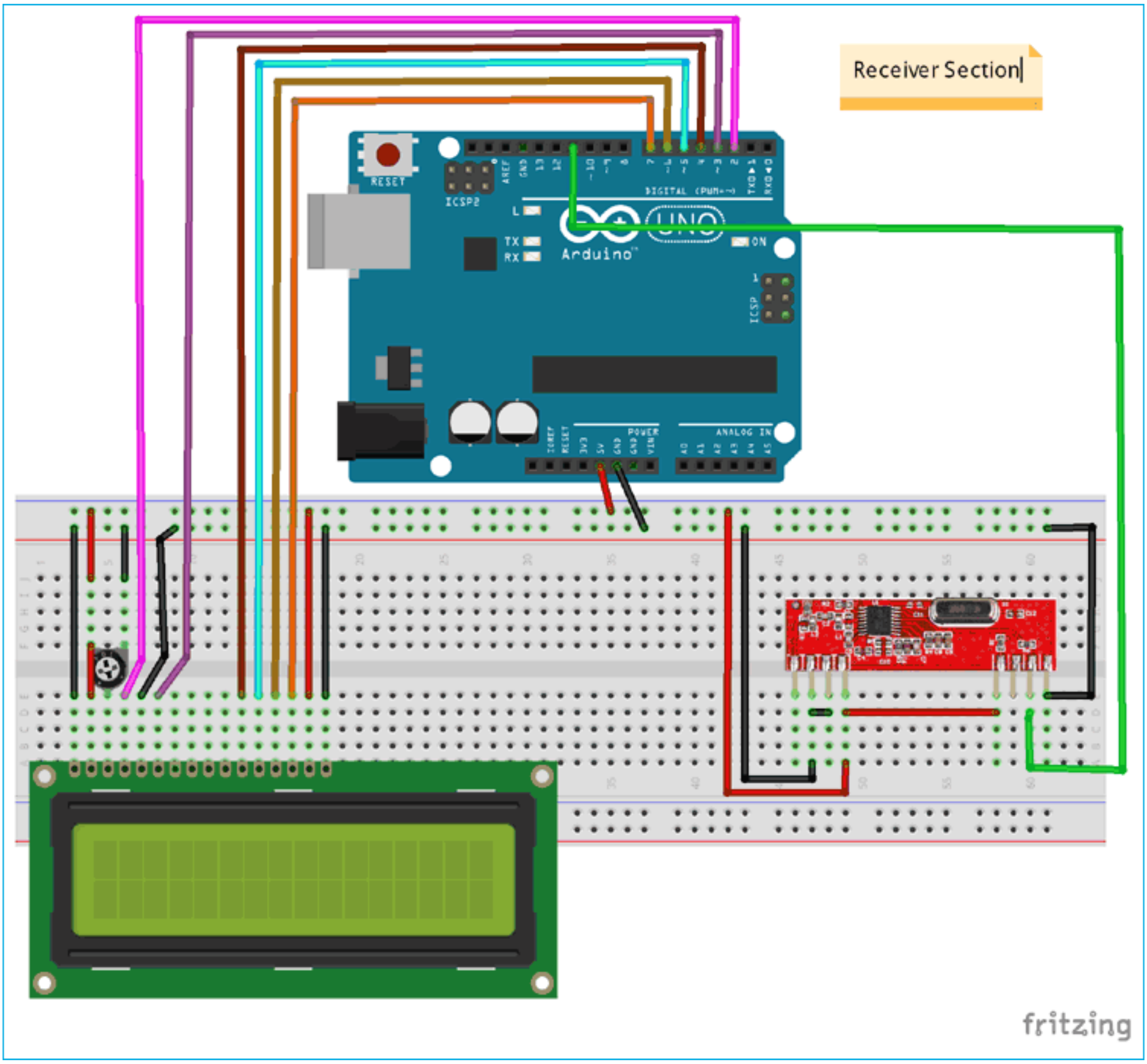
STM32F103C8	RF Transmitter
5V	VDD
GND	GND
PA10	DATA
NC	ANT

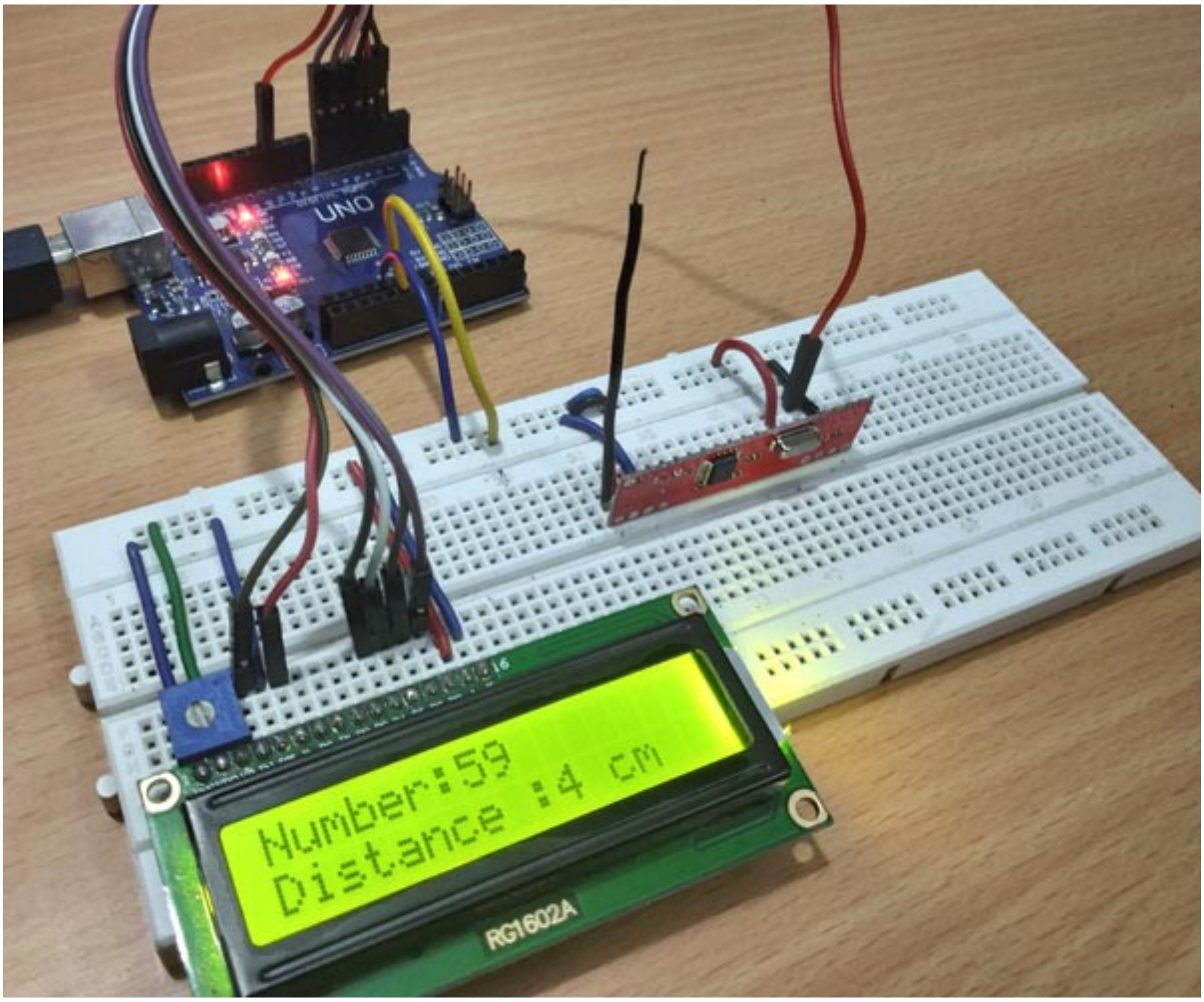
Circuit Connections between Ultrasonic Sensor & STM32F103C8:

STM32F103C8	Ultrasonic Sensor (HC-SR04)
5V	VCC
PB1	Trig
PB0	Echo
GND	GND

A **10k potentiometer** is connected with the STM32F103C8 to provide input Analog value (0 to 3.3V) to the ADC pin PA0 of STM32.

Circuit Diagram of RF Receiver with Arduino Uno


Receiver Section
RESET
ICSP2
AREF
GND
13
12
~10
~9
8
7
~6
~5
4
~3
2
TX▶1
RX◀0
DIGITAL (PWM=~)
L
TX
RX
UNO
Arduino
ON
ICSP
1
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
ANALOG IN
A0
A1
A2
A3
A4
A5
fritzing



Circuit Connections between RF Receiver & Arduino UNO:

Arduino UNO	RF Receiver
5V	VDD
GND	GND
11	DATA
NC	ANT

Circuit Connections between 16x2 LCD & Arduino UNO:

LCD Pin Name	Arduino UNO Pin Name
Ground (Gnd)	Ground (G)
VCC	5V
VEE	Pin from Centre of Potentiometer for Contrast
Register Select (RS)	2

Read/Write (RW)	Ground (G)
Enable (EN)	3
Data Bit 4 (DB4)	4
Data Bit 5 (DB5)	5
Data Bit 6 (DB6)	6
Data Bit 7 (DB7)	7
LED Positive	5V
LED Negative	Ground (G)

The coding will be explained in brief below. There will be two parts of the sketch where first part will be transmitter section and another will be receiver section. All sketch files and working video will be given at the end of this tutorial. To learn more about interfacing RF module with Arduino Uno (https://circuitdigest.com/microcontroller-projects/interfacing-nrf24l01-with-arduino-transmitter-and-receiver-tutorial), follow the link.

Programming STM32F103C8 for wireless RF Transmission

STM32F103C8 can be programmed using Arduino IDE. A **FTDI programmer or ST-Link** is not needed to upload the code to STM32F103C8. Simply connect to PC via USB port of STM32 and start programming with **ARDUINO IDE**. You can learn Programming your STM32 in Arduino IDE (https://circuitdigest.com/microcontroller-projects/programming-stm32f103c8-board-using-usb-port) by following the link.

In the transmitter section the distance of the object in 'cm' is measured using ultrasonic sensor (https://circuitdigest.com/tags/ultrasonic-sensor) and the number value from (0 to 100) set using potentiometer which is transmitted via RF transmitter interfaced with STM32.

First the Radiohead library is included, it can be downloaded from here (http://www.airspayce.com/mikem/arduino/RadioHead/). As this library uses the ASK (Amplitude Shift Keying Technique) to transmit and receive data. This makes the programming very easy. You can include library in sketch by going into **Sketch->include library->Add .zip library.**

```
#include <RH_ASK.h>
```

As in this tutorial in the transmitter side an ultrasonic sensor is used to measure the distance so the trigger and echo pins are defined.

```
#define trigPin PB1
#define echoPin PB0
```

Next the object name for the RH_ASK library is set as rf_driver with the parameters such as speed (2000), RX pin (PA9) and TX pin (PA10).

```
RH_ASK rf_driver(2000, PA9, PA10);
```

Next the Strings variable needed in this program are declared.

```
String transmit_number;
String transmit_distance;
String transmit;
```

Next in the void setup(), the object for RH_ASK rf_driver is initialized.

```
rf_driver.init();
```

After that the trigger pin is set as OUTPUT pin and the PA0 (connected to potentiometer) and echo pin is set as INPUT pin. Serial communication is begin at baud rate of 9600.

```
   Serial.begin(9600);
    pinMode(PA0,INPUT);
    pinMode(echoPin,INPUT);
    pinMode(trigPin,OUTPUT);
```

Next in the void loop(), frst the potentiometer value that is the input Analog voltage is converted into digital value (ADC value is found). As the ADC of STM32 (https://circuitdigest.com/microcontroller-projects/how-to-use-adc-in-stm32f103c8-stm32-blue-pill-board) has 12-bit resolution. So, the digital value varies from (0 to 4096) which is mapped into (0 to 100).

```
    int analoginput = analogRead(PA0);
    int pwmvalue = map(analoginput,0,4095,0,100);
```

Next the distance is measured using ultrasonic sensor by setting the trigger high and low with a delay of 2 microseconds.

```
    digitalWrite(trigPin, LOW);
    delayMicroseconds(2);
    digitalWrite(trigPin, HIGH);
    delayMicroseconds(10);
    digitalWrite(trigPin, LOW);
```

The echo pin senses the reflected wave back, that is the time duration that triggered wave is reflected back is used in calculating the distance of object using the formula. Learn more **how ultrasonic sensor calculates distance,** by following the link.

```
    long duration = pulseIn(echoPin, HIGH);
    float distance= duration*0.034/2;
```

Now both the data number and distance measured is converted into string data and stored in respective string variables.

```
    transmit_number= String(pwmvalue);
    transmit_distance = String(distance);
```

Both the string is added as one line and stored in string called transmit and comma "," is used to separate two strings.

```
  transmit = transmit_pwm + "," + transmit_distance;
```

The transmit string is converted into character array.

```
    const char *msg = transmit.c_str();
```

The data is transmitted and wait till it is sent.

```
    rf_driver.send((uint8_t *)msg, strlen(msg));
    rf_driver.waitPacketSent();
```

The string data sent is also displayed in the Serial Monitor.

```
    Serial.println(msg);
```

Programming Arduino UNO as RF Receiver

Arduino UNO is programmed using the Arduino IDE. In the receiver section the data that is transmitted from the transmitter section and received by the RF receiver module and the string data received is split into respective data (distance and number) and displayed in the 16x2 LCD display.

Let's see the receiver coding in brief:

Like in the transmitter section first the RadiohHead library is included. As this library uses the ASK (Amplitude Shift Keying Technique) to transmit and receive data. This makes the programming very easy.

```
#include <RH_ASK.h>
```

As LCD display is used here so the liquidcrystal library (https://github.com/arduino-libraries/LiquidCrystal) is also included.

```
#include <LiquidCrystal.h>
```

And the 16x2 LCD display pins connected with Arduino UNO are specified and declared using lcd as object.

```
LiquidCrystal lcd(2,3,4,5,6,7);
```

Next the String data variables to store string data are declared.

```
String str_receive;
String str_number;
String str_distance;
```

The object for the Radiohead library is declared.

```
      RH_ASK rf;
```

Now in the *void setup()*, The LCD display is set in 16x2 mode and a welcome message is displayed and cleared.

```
    lcd.begin(16,2);
    lcd.print("CIRCUIT DIGEST");
    lcd.setCursor(0,1);
    lcd.print("RF with STM32");
    delay(5000);
    lcd.clear();
```

After that, the ***rf* object is initialized**.

```
rf.init();
```

Now in the ***void loop(),*** the Array buf[] is declared with size as 7. As the data sent from transmitter has 7 including the ",". So, change this according to the data that is to be transmitted.

```
    uint8_t buf[7];
    uint8_t buflen = sizeof(buf);
```

If the string is available at the rf receiver module the if function checks the size and it executes. The *rf.recv()* is used to receive data.

```
if (rf.recv(buf, &buflen))
```

The *buf* has the received string so then received string is stored in a *str_receive* string variable.

```
str_receive = String((char*)buf);
```

This *for* loop is used to split the received string into two if it detects the ',' in-between two strings.

```
      for (int i = 0; i < str_receive.length(); i++)
      {
      if (str_receive.substring(i, i+1) == ",")
      {
      str_number = str_receive.substring(0, i);
      str_distance = str_receive.substring(i+1);
      break;
      }
```

Two char arrays for two values are declared and the String that is split into two is stored in respected array by converting string into character array.

```
      char numberstring[4];
      char distancestring[3];
      str_distance.toCharArray(distancestring,3);
      str_number.toCharArray(numberstring,3);
```

After that convert the character array into integer using atoi()

```
      int distance = atoi(distancestring);
      int number = atoi(numberstring);
```

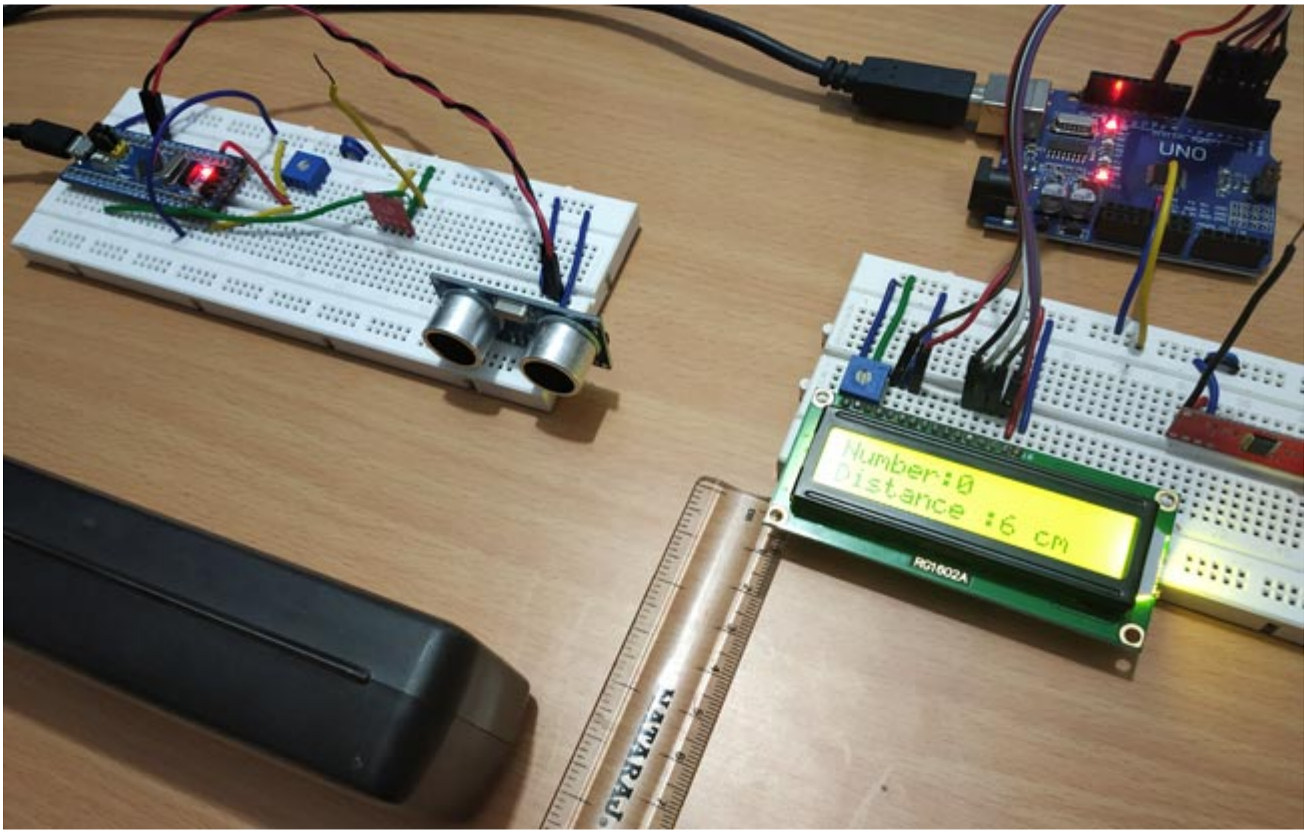
After converting into integer values the values distance and number is displayed in 16x2 LCD display

```
        lcd.setCursor(0,0);
        lcd.print("Number:");
        lcd.print(number);
        lcd.setCursor(0,1);
        lcd.print("Distance :");
        lcd.print(distance);
        lcd.print(" cm");
```

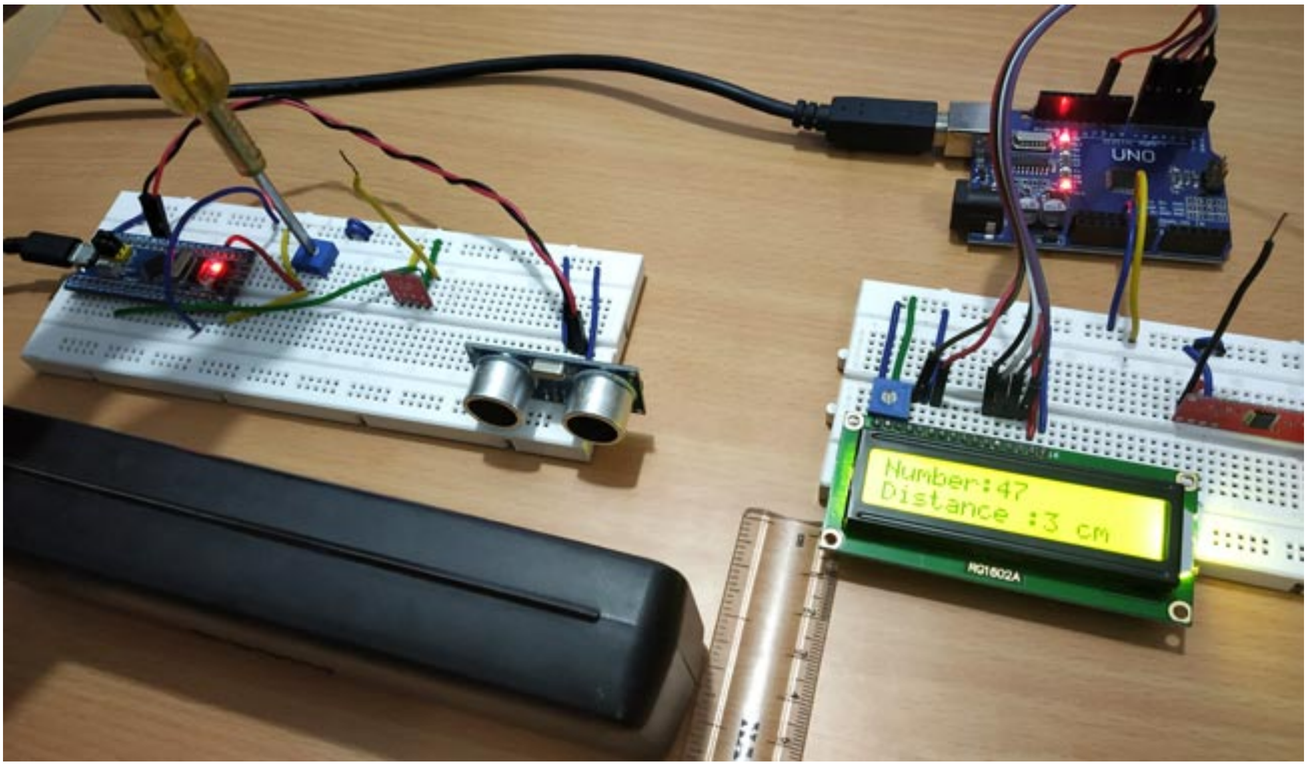
After uploading both the codes i.e. transmitter and receiver in the STM32 and Arduino UNO respectively, the data such as number and object distance measured using the STM32 is transmitted to the RF receiver via RF Transmitter and the values received are displayed in the LCD display wirelessly.

Testing STM 32 based RF Transmitter and Receiver

1. When number at 0 and the distance of object is at 6cm.



2. When number 47 and distance of object is at 3cm.



Code

Transmitter code (STM32F103C8):

```
//433MHZ RF Trasmitter with STM32F103C8

//Transmitter Code

//Circuit Digest

#include <RH_ASK.h>                    //RadioHead library

#define trigPin PB1                    //Sets the Trigpin of Ultrasonic sensor as PB1

#define echoPin PB0                    //Sets the echoPin of Ultrasonic sensor as PB0

RH_ASK rf_driver(2000, PA9, PA10);          //Sets Pin PA9 as receiver and PA10 as transmitterand 2000 as Speed

String transmit_pwm;                    //Strings to store string value

String transmit_distance;

String transmit;

void setup()

{
  // Initialize ASK Object

  rf_driver.init();

  Serial.begin(9600);

  pinMode(PA0,INPUT);

  pinMode(echoPin,INPUT);

  pinMode(trigPin,OUTPUT);

}

void loop()

{

  int analoginput = analogRead(PA0);                  // ADC value from pin PA0 connected to Potentiometer

  int pwmvalue = map(analoginput,0,4096,0,100);        // Converts 0 to 4096 into 0 to 100

  digitalWrite(trigPin, LOW);                          //Makes TrigPin of Ultrasonic LOW

  delayMicroseconds(2);

  digitalWrite(trigPin, HIGH);                         //Makes TrigPin of Ultrasonic HIGH

  delayMicroseconds(10);

  digitalWrite(trigPin, LOW);                          //Makes TrigPin of Ultrasonic LOW

  long duration = pulseIn(echoPin, HIGH);              //Receives the Echo signal reflected

  float distance= duration*0.034/2;                    //Calculates distance in CM of object

  transmit_pwm = String(pwmvalue);                     //Convert value into string

  transmit_distance = String(distance);                //Convert value into string

  transmit = transmit_pwm + "," + transmit_distance;    //Adds two String in one line

  const char *msg = transmit.c_str();                  //

  rf_driver.send((uint8_t *)msg, strlen(msg));         //Sends the String

  rf_driver.waitPacketSent();
  Serial.println(msg);                            //Serial Print value for debug

  delay(1000);

}
```

Receiver Code (Arduino UNO):

```
//Receiver Arduino Code

//433MHZ RF with STM32F103C8 as Transmitter

//Circuit Digest

#include <RH_ASK.h>                //Includes RadioHead Library

#include <LiquidCrystal.h>         //Includes the LCD display Library

LiquidCrystal lcd(2,3,4,5,6,7);    //Initialize lcd with Pins connected to Arduino

String str_receive;                //Strings to Store Value

String str_number;

String str_distance;

RH_ASK rf;                         //rf as object for RG_ASK

void setup()

{

  lcd.begin(16,2);               //Lcd set as 16x2 Mode

  lcd.print("CIRCUIT DIGEST");   //Display Welcome message

  lcd.setCursor(0,1);

  lcd.print("RF with STM32");

  delay(5000);

  lcd.clear();

  rf.init();                     //Initialize rf Object

}
```

```
void loop()
{
  uint8_t buf[7];
  uint8_t buflen = sizeof(buf);
  if (rf.recv(buf, &buflen))
  {
   str_receive = String((char*)buf);                    // Receive String from the Transmitter
   for (int i = 0; i < str_receive.length(); i++)          // Split string into two string
   {
   if (str_receive.substring(i, i+1) == ",")
   {
   str_number = str_receive.substring(0, i);
   str_distance = str_receive.substring(i+1);
   break;
   }
  }
   char numberstring[4];
   char distancestring[3];
   str_distance.toCharArray(distancestring,3);            //Convert String into Char Array
   str_number.toCharArray(numberstring,3);
   int distance = atoi(distancestring);                 //Convery Array into integer value
   int number = atoi(numberstring);
   lcd.setCursor(0,0);
   lcd.print("Number:");
```

```
    lcd.print(number);                          //Display number value at LCD display

    lcd.setCursor(0,1);

    lcd.print("Distance :");

    lcd.print(distance);                        //Display distance value at LCD display

    lcd.print(" cm");

    delay(1500);

    lcd.clear();

}

}
```

Video

Interfacing 433Mhz RF Module with STM32F103C8

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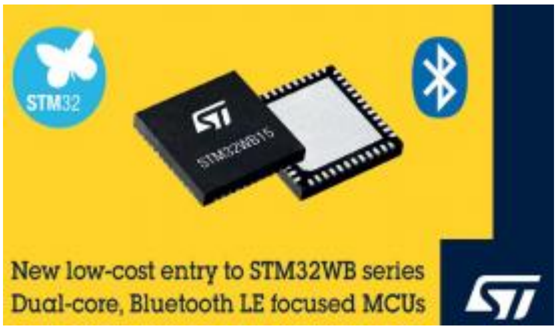
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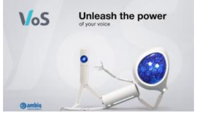

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