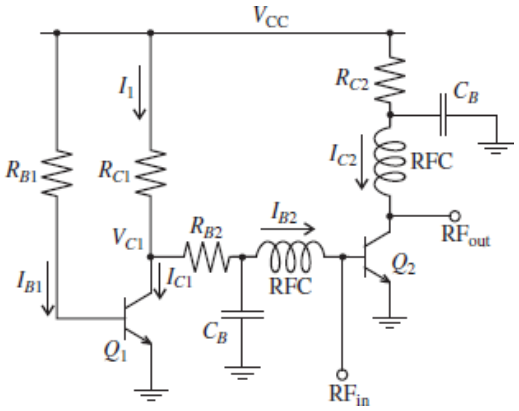
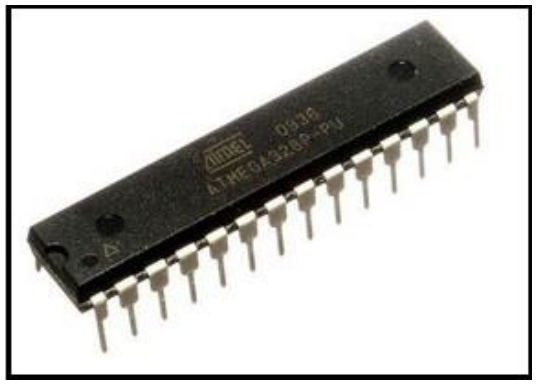
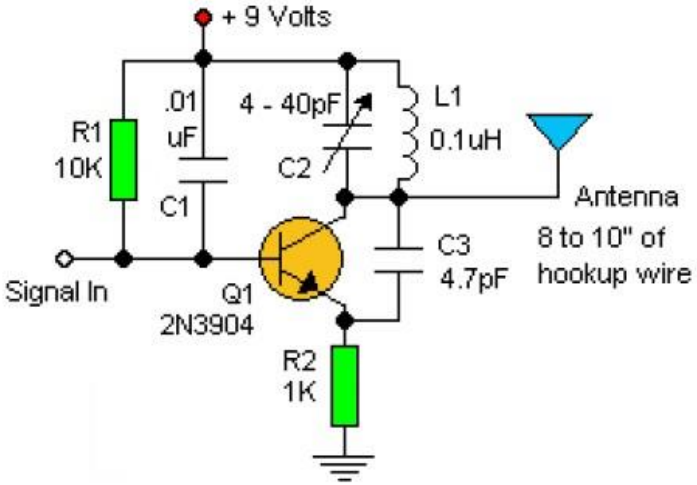
Building Wireless Interfaces for Microcontrollers

Class 1: Traditional RF Circuits for Microcontrollers







May 22, 2017

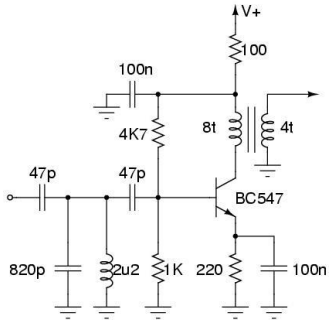
Don Wilcher

DesignNews

CEC CONTINUING EDUCATION CENTER

Presented by: Digi-Key ELECTRONICS

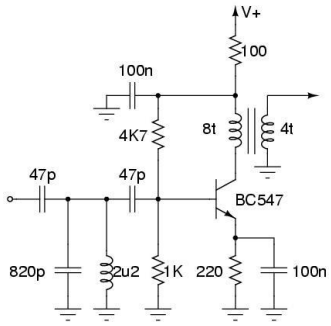
Traditional RF Circuits for Microcontrollers



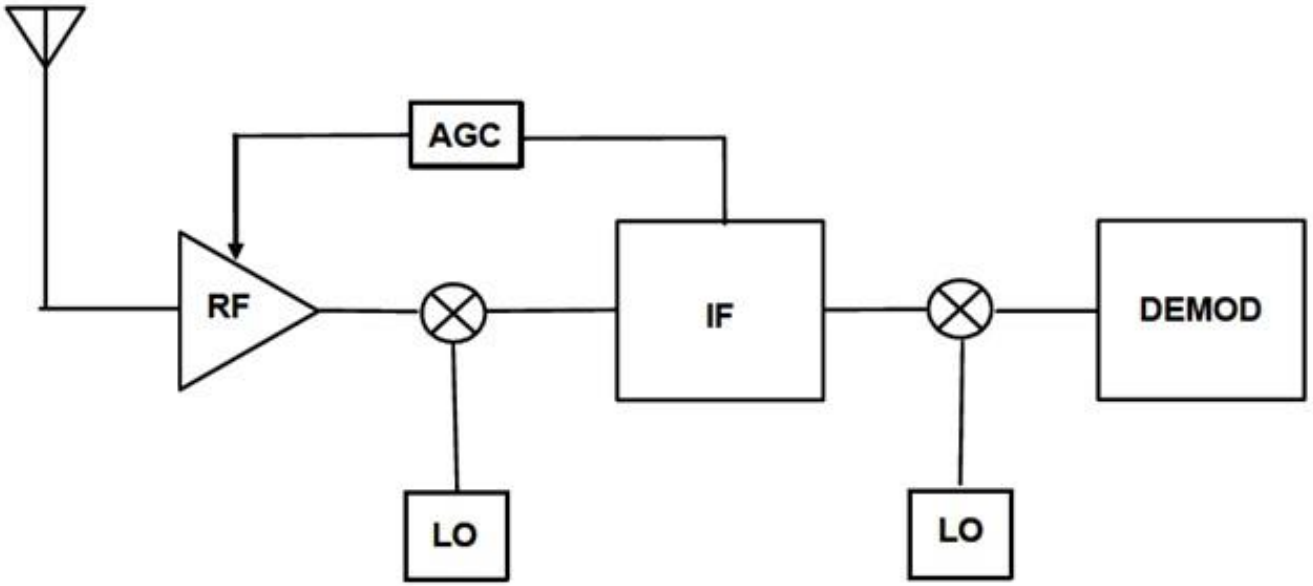
Topics

- What is an RF Amplifier?
- RF Amplifier Circuit Examples
- RF Modules and Examples
- Hands-On Project: A Wireless 7 Segment LED Display Controller

What is an RF Amplifier?

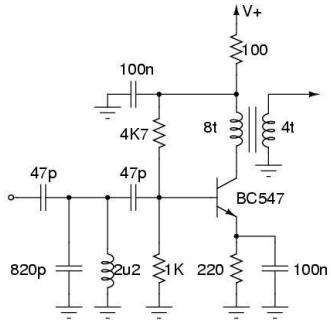


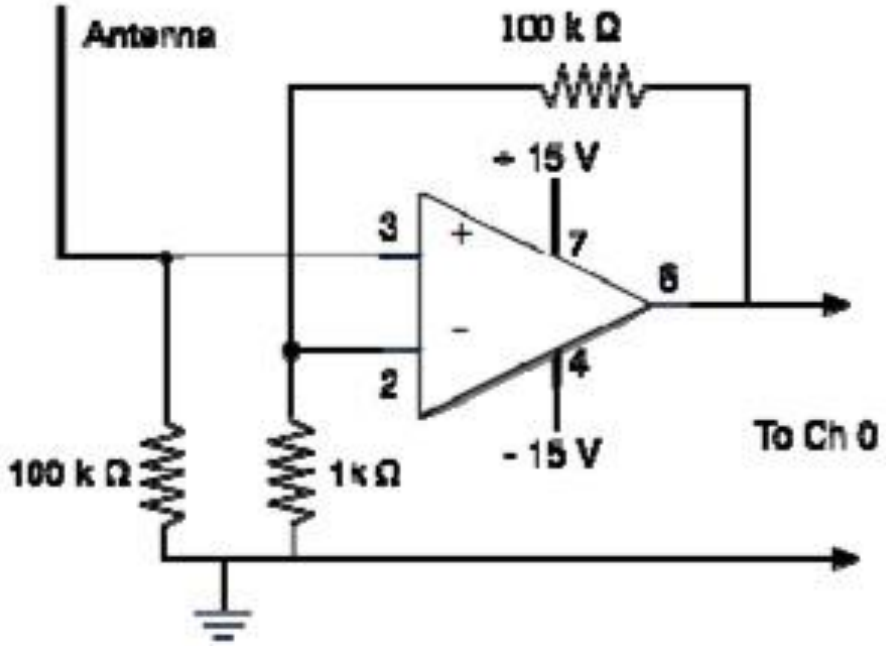
- A Tuned Amplifier
- Amplifies High-Frequency Signals
- Used in radio communications



Superheterodyne Receiver Block Diagram

RF Amplifier Circuit Examples





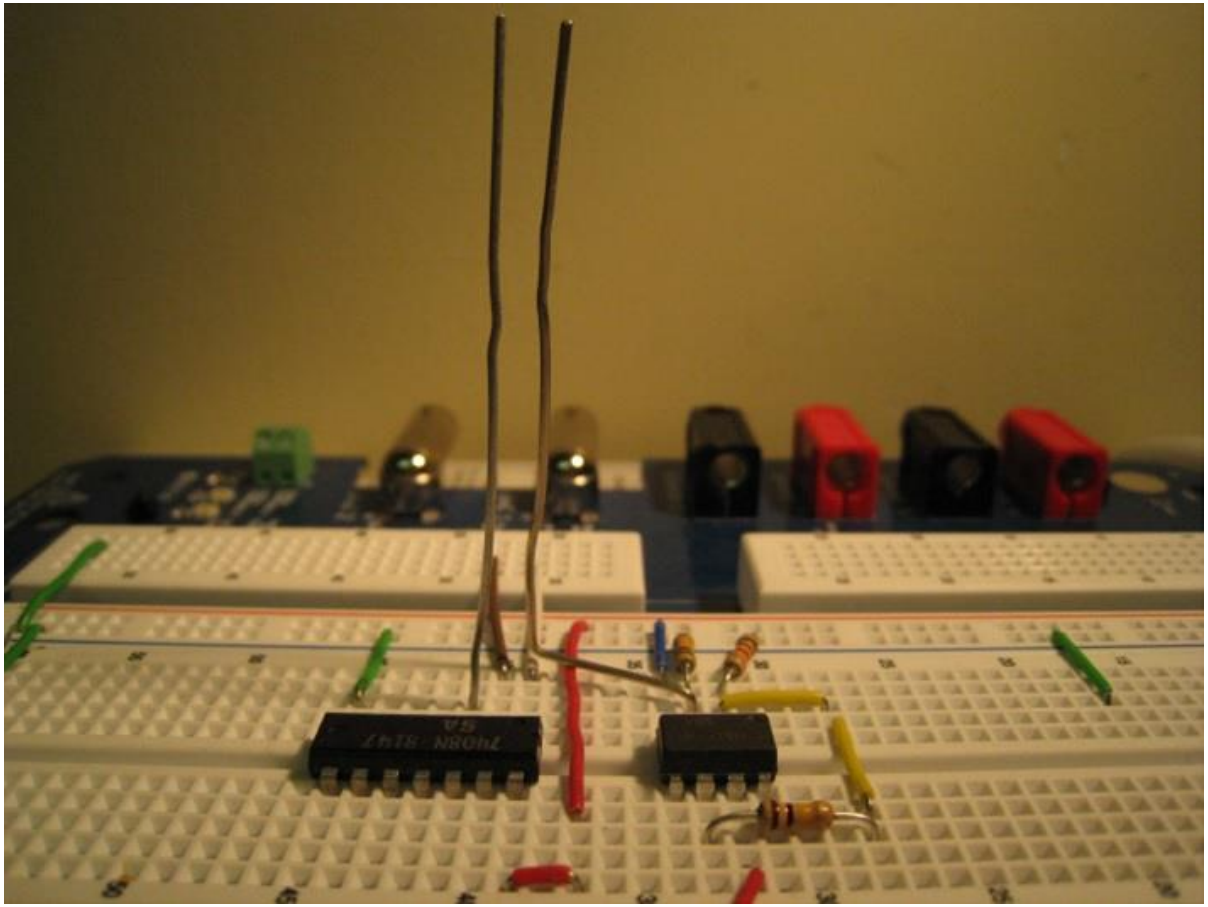
741 Operational Amplifier-RF High Gain Amplifier

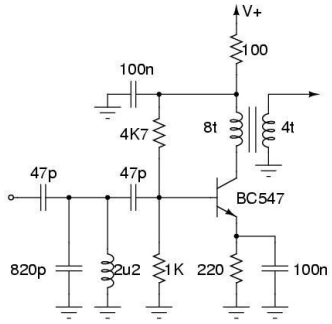
Source:
http://download.ni.com/pub/devzone/tut/lab9_wireless_comms.pdf

Question 1

What known radio receiver technology uses an RF Amplifier?

RF Amplifier Circuit Examples…

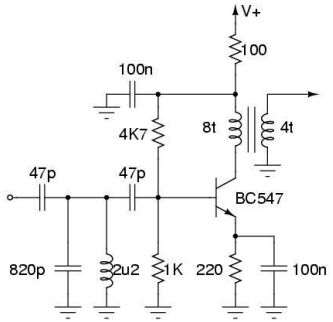


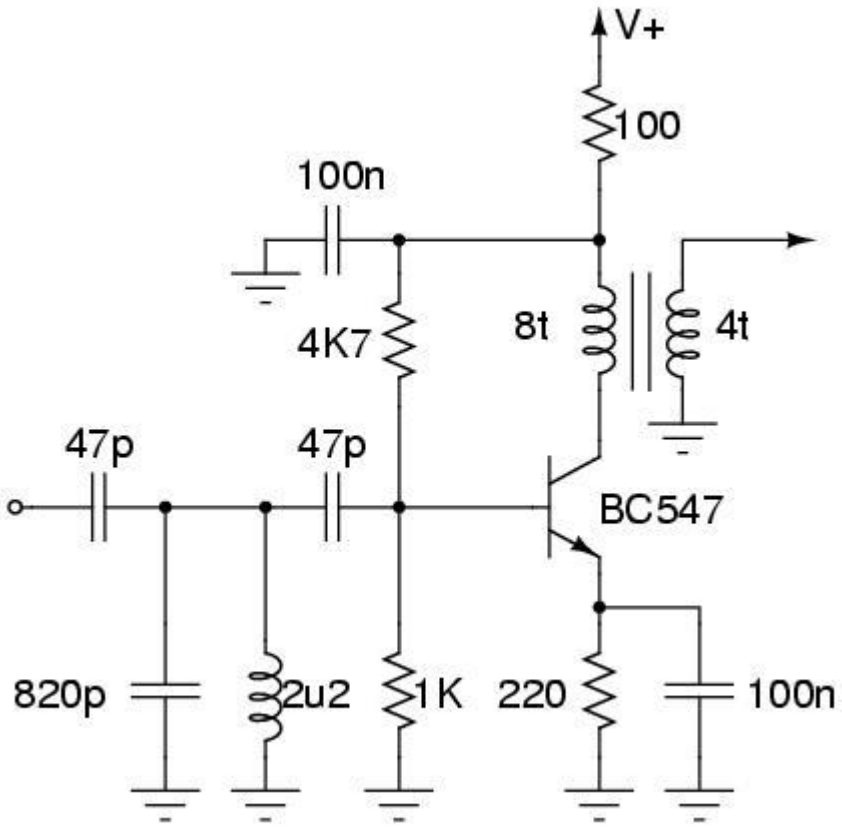


741 Operational Amplifier-RF High Gain Amplifier: Test Circuit Lab Setup

Source:
http://download.ni.com/pub/devzone/tut/lab9_wireless_comms.pdf

RF Amplifier Circuit Examples…





RF Front End Amplifier

Source:
http://www.vk2zay.net/article/46

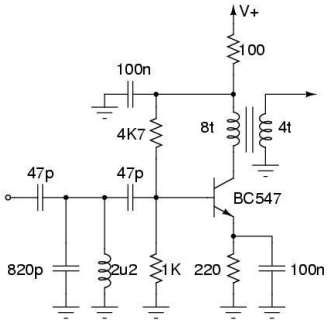
Question 2

A Tuned Amplifier is a key attribute of a RF Amplifier.

a) True

b) False

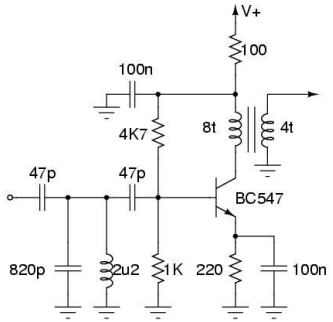
RF Amplifier Circuit Examples…



Complete PTO (Power Transmitter Output) VFO (Variable Frequency Oscillator) Receiver

Source:
http://www.vk2zay.net/article/46

RF Modules and Examples…

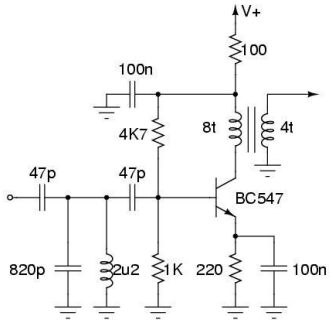


Simple RF T4 and L4 Receivers:

Simple RF Receivers provide the following features.

- There's no programming
- No configuring
- No addressing
- Receiver operates from 5-10VDC voltage supply

RF Modules and Examples…



Simple RF T4 and L4 Receivers:

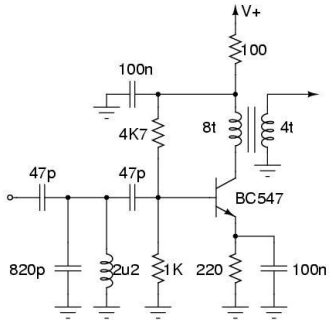
- The T4 Toggle Receiver – alternates output switching.

Example: Activate A output - goes High, Activate A output again – goes Low.

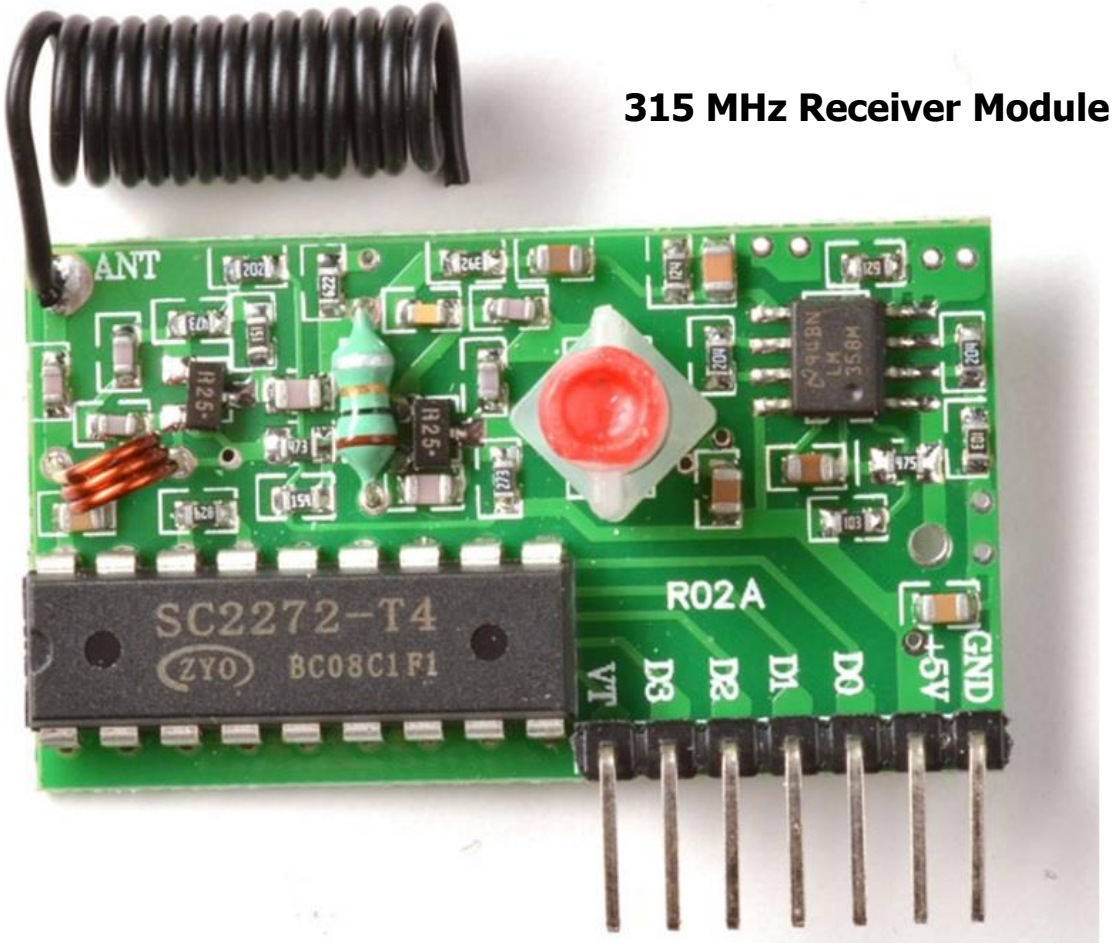
- The L4 Latch Receiver – output sequencing

Example: Activate A output – goes High, Activate A output again – goes Low, B output goes High.

RF Modules and Examples…



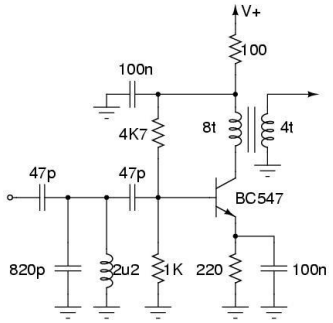
315 MHz Receiver Module

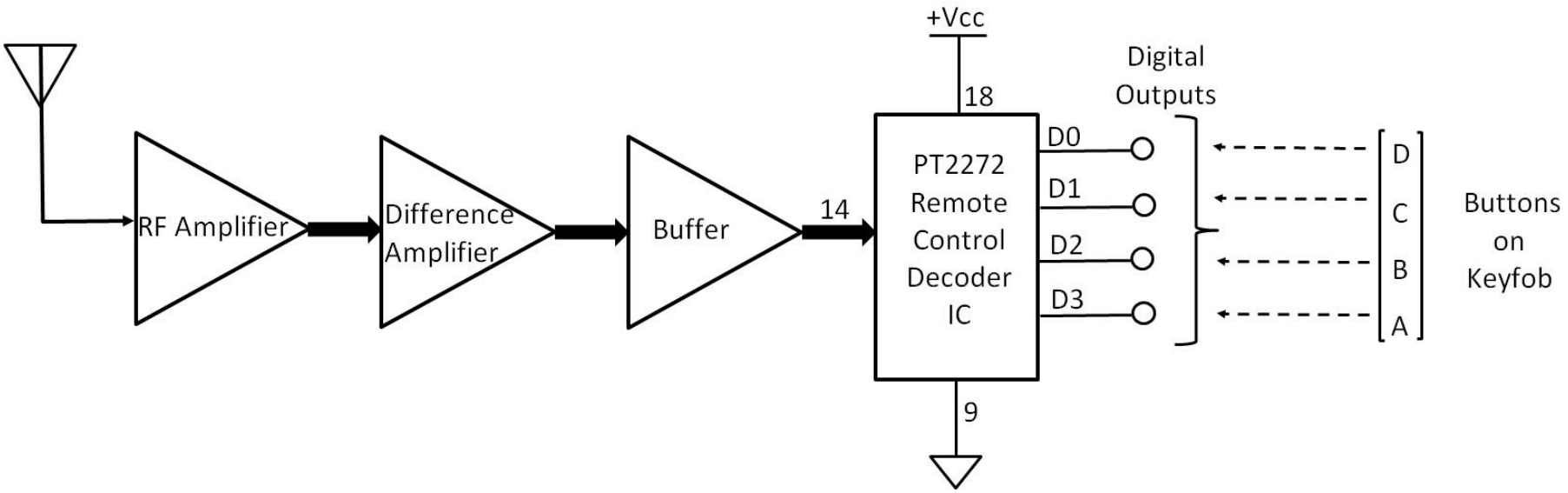


Source:

https://www.adafruit.com/product/1097

RF Modules and Examples…



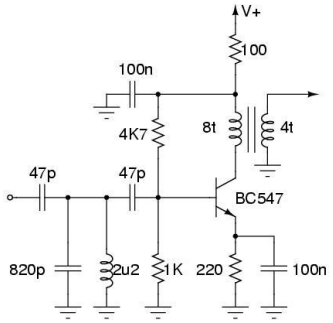


315 MHz Receiver Module: Block Diagram

Question 3

What 315 MHz receiver module latches its digital output pins?

RF Modules and Examples…

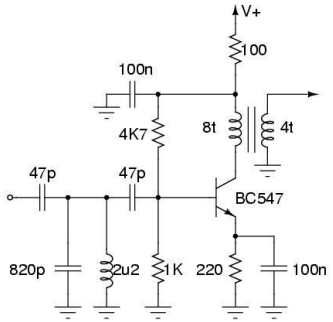


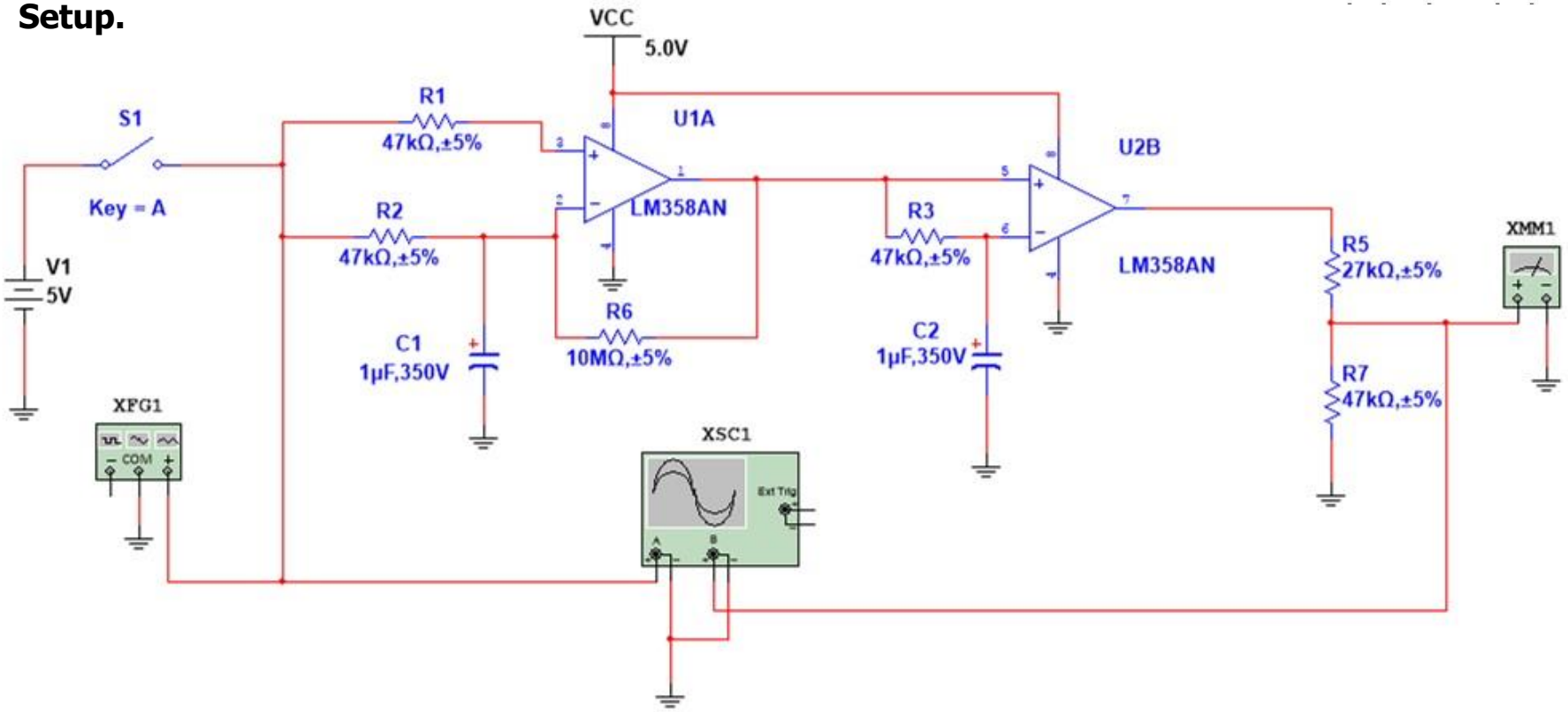
315 MHz Receiver Key Fob

Source:
https://www.adafruit.com/product/1095

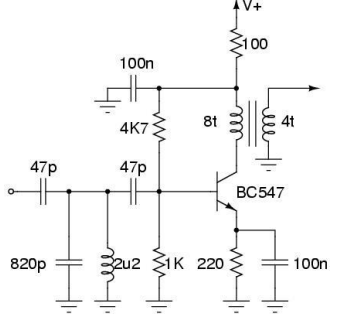
RF Modules and Examples…

315 MHz Receiver Module: Difference Amp and Buffer Circuit Simulation Analysis Setup.

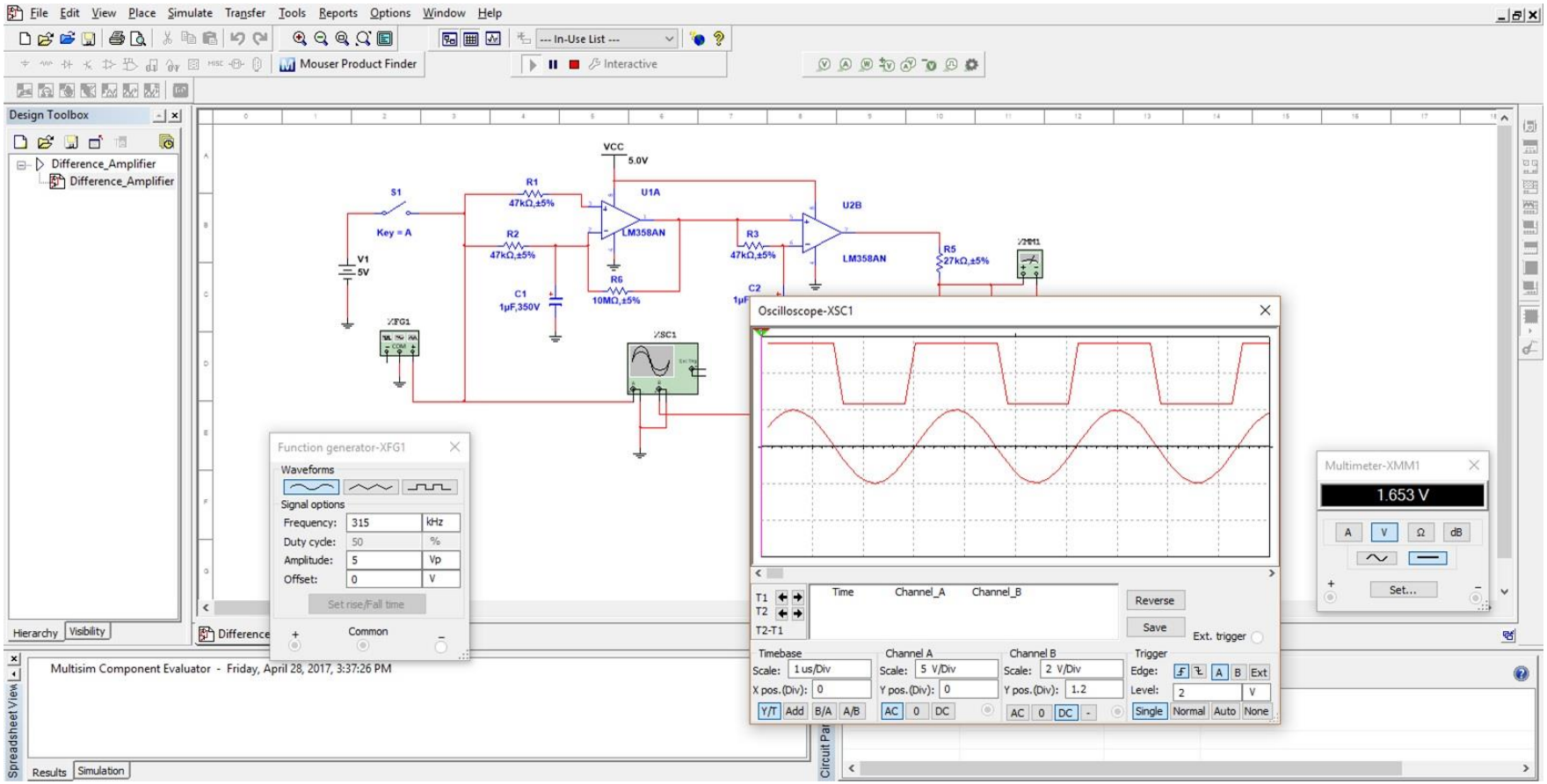




RF Modules and Examples…



315 MHz Receiver Module: Difference Amplifier and Buffer Circuit Simulation Analysis Solution.

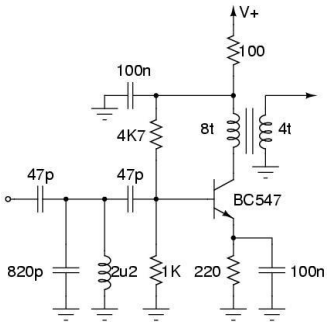


Question 4

On the 315 MHz Receiver Module, what op-amp circuit is wired to the RF Amplifier's output signal?

RF Modules and Examples…

315 MHz Receiver Module: Difference Amplifier and Buffer Circuit Simulation Analysis Solution…



Digital Data

Carrier Frequency

Oscilloscope-XSC1

T1
T2
T2-T1

Time Channel_A Channel_B

Reverse
Save
Ext. trigger

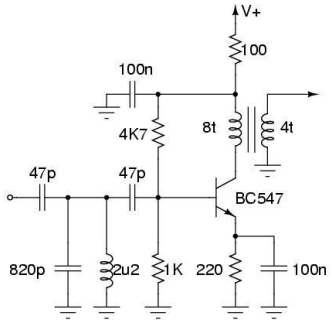
Timebase
Scale: 1 us/Div
X pos.(Div): 0
Y/T Add B/A A/B

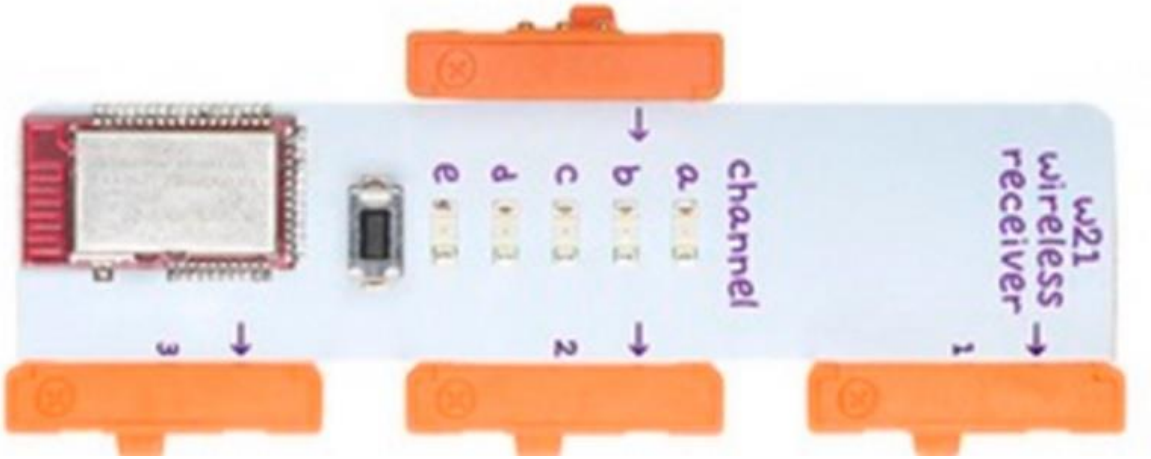
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
AC 0 DC

Channel B
Scale: 2 V/Div
Y pos.(Div): 1.2
AC 0 DC -

Trigger
Edge: A B Ext
Level: 2 V
Single Normal Auto None

RF Modules and Examples…



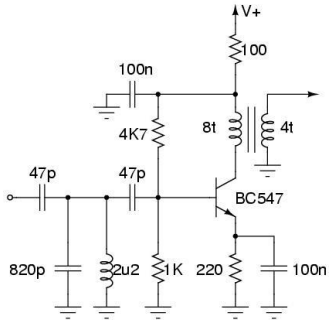


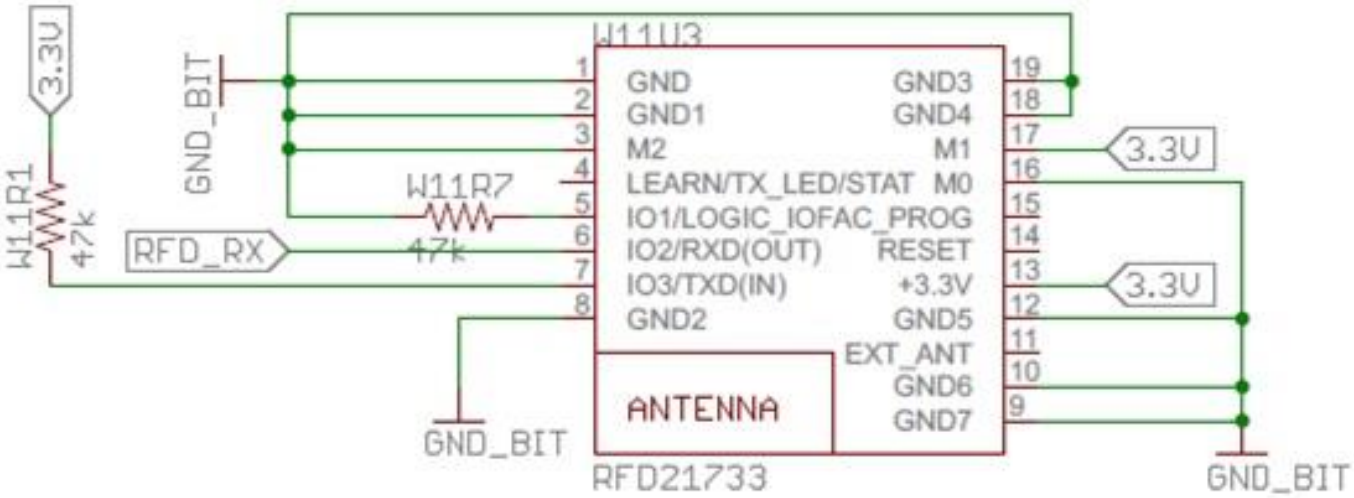
littleBits Wireless Receiver, 5 Channel

Source:

http://littlebits.cc/bits/wireless-receiver-5-channels#specs

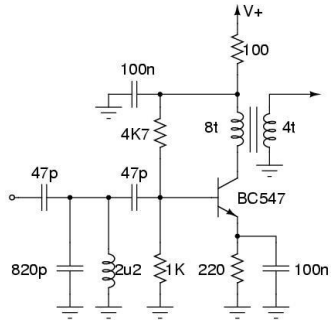
RF Modules and Examples…





RFD21733 2.5GHz RF Transceiver Module with built in RFDP8 Protocol

RF Modules and Examples…

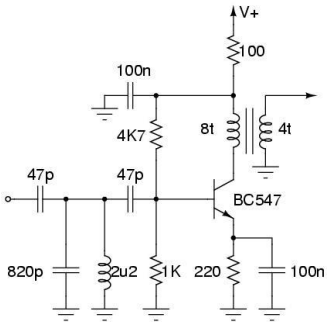


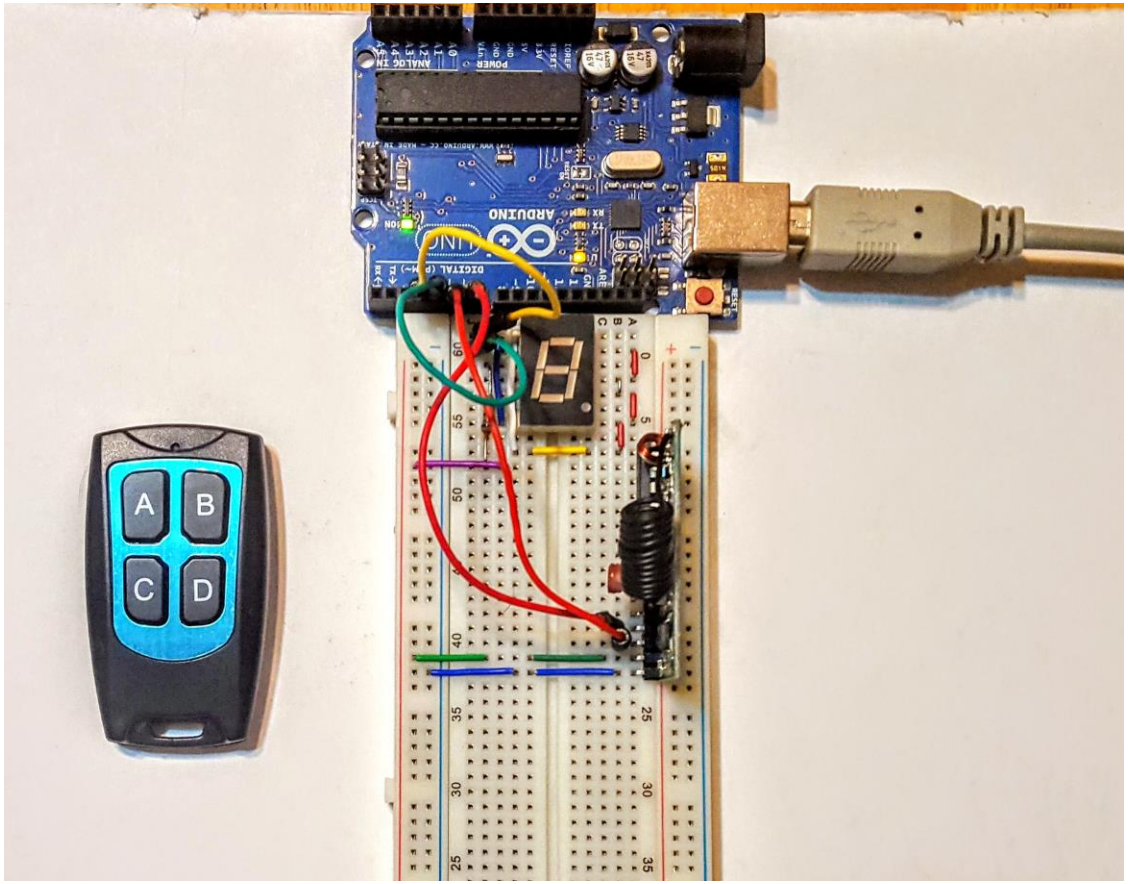
RFDP8 Application Protocol • Mode Selector Chart

RFDP8 Standard Mode Chart
© RF Digital Corp. 07.05.11 10:07 PM

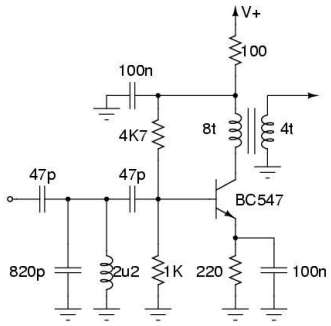
		Mode Select Inputs						Learn / Status	
Mode	Description	2	1	0					
0	Active RFID Transmitter	0	0	0	IN 3	IN 2	IN 1	TX LED	
1	3 Input Switch Logic Transmitter	0	0	1	IN 3	IN 2	IN 1	TX LED	
2	Serial UART Transceiver, 9600, N, 8, 1	0	1	0	TXD IN	RXD OUT	LOGIC I/O	X	
3	Serial UART Transceiver, 9600, N, 8, 1	0	1	1	TXD IN	RXD OUT	LOGIC I/O	ESN LEARN	Network
4	3 Output Switch Logic Receiver - 500ms	1	0	0	OUT 3	OUT 2	OUT 1	X	
5	3 Output Switch Logic Receiver - 500ms	1	0	1	OUT 3	OUT 2	OUT 1	ESN LEARN	Network
6	3 Output Switch Logic Receiver - 20ms	1	1	0	OUT 3	OUT 2	OUT 1	X	
7	3 Output Switch Logic Receiver - 20ms	1	1	1	OUT 3	OUT 2	OUT 1	ESN LEARN	Network
Module RFD21733 / RFD21735 Pin Number:		3	17	16	7	6	5	4	
RFDANT RFD21742 / RFD21743 Pin Number:		7	6	5	11	10	9	8	

Hands On Project: 7 Segment LED Display Controller





Hands On Project: 7 Segment LED Display Controller…

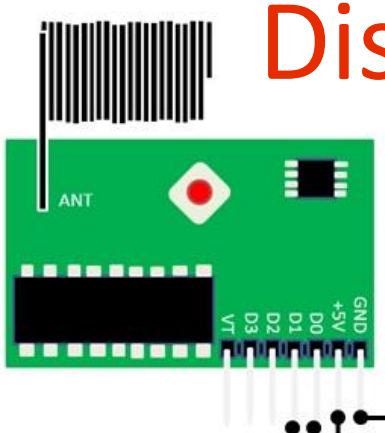


Project Objectives

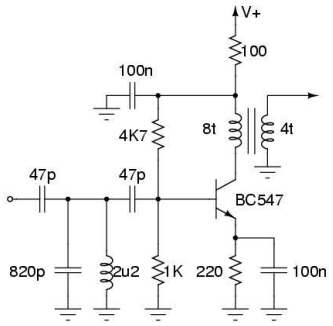
Build a wireless Arduino controller that

- allows the numbers "1" and "3" to be displayed on a 7 Segment LED Display.
- pressing the "C" key on the Fob will display the number "1"
- pressing the "D" key on the Fob will display the number "3"

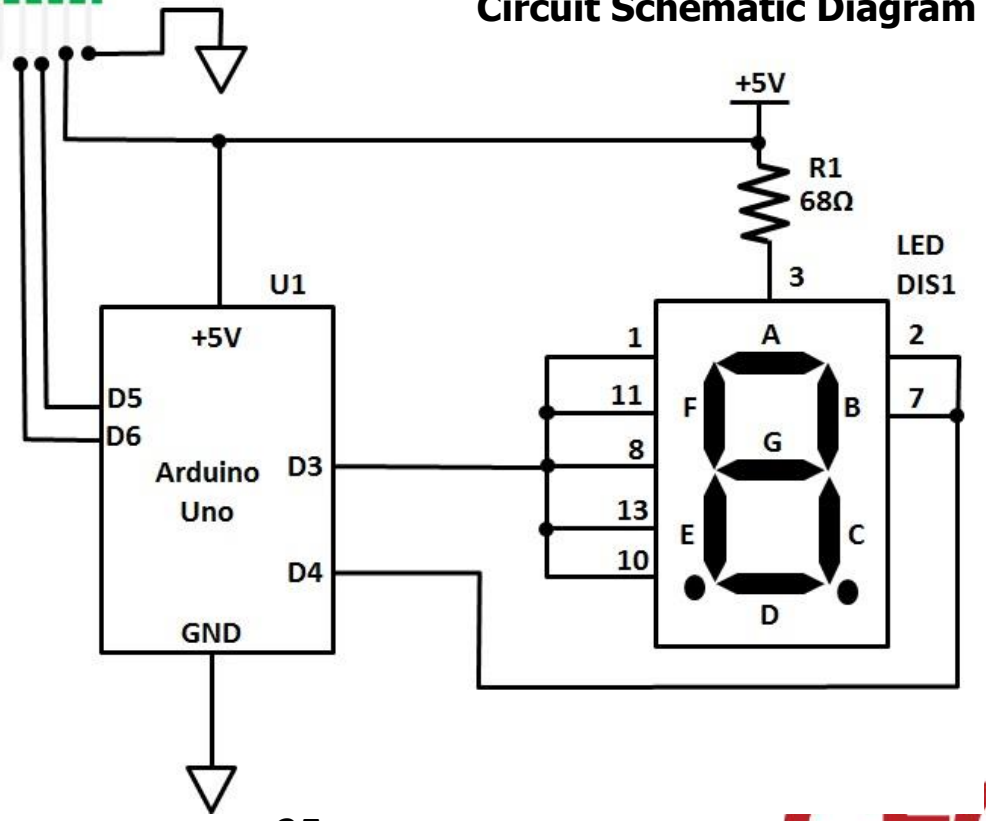
Hands On Project: 7 Segment LED Display Controller…



RFM1
315 Receiver T4 Module



7 Segment LED Display Controller Circuit Schematic Diagram



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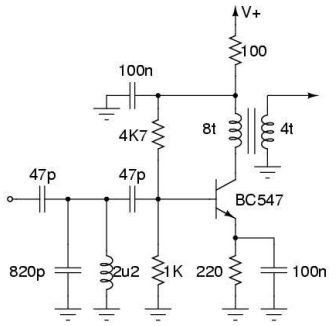
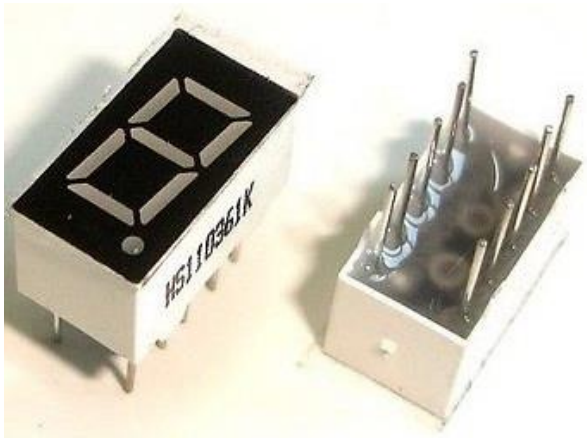
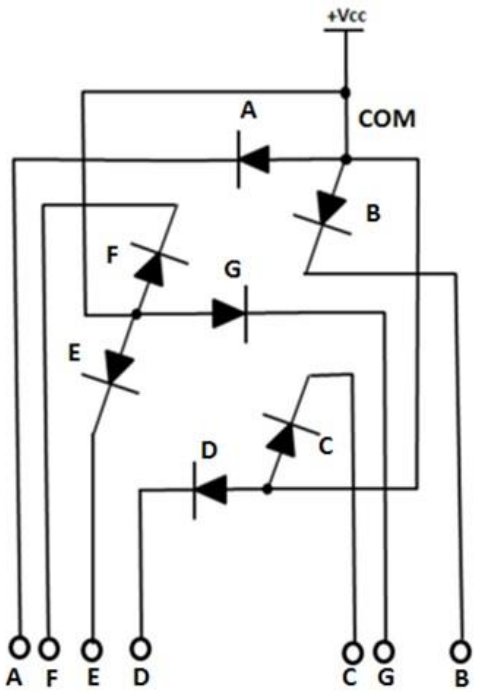
Hands On Project: 7 Segment LED Display Controller…







Pin no.	Electrical connection
1	Cathode A
2	Cathode F
3	Common Anode
4	No Pin
5	No Pin
6	Cathode D. P.
7	Cathode E
8	Cathode D
9	No Connection
10	Cathode C
11	Cathode G
12	No Pin
13	Cathode B
14	Common Anode

Common Anode 7 Segment LED Display

Question 5

The common pin on a 7 segment LED Display refers to

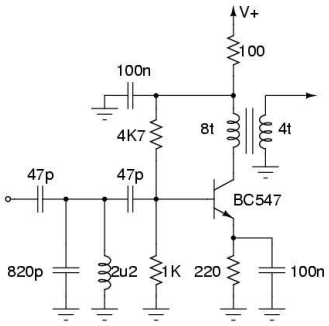
a) all LED segment's cathodes or anodes wired together

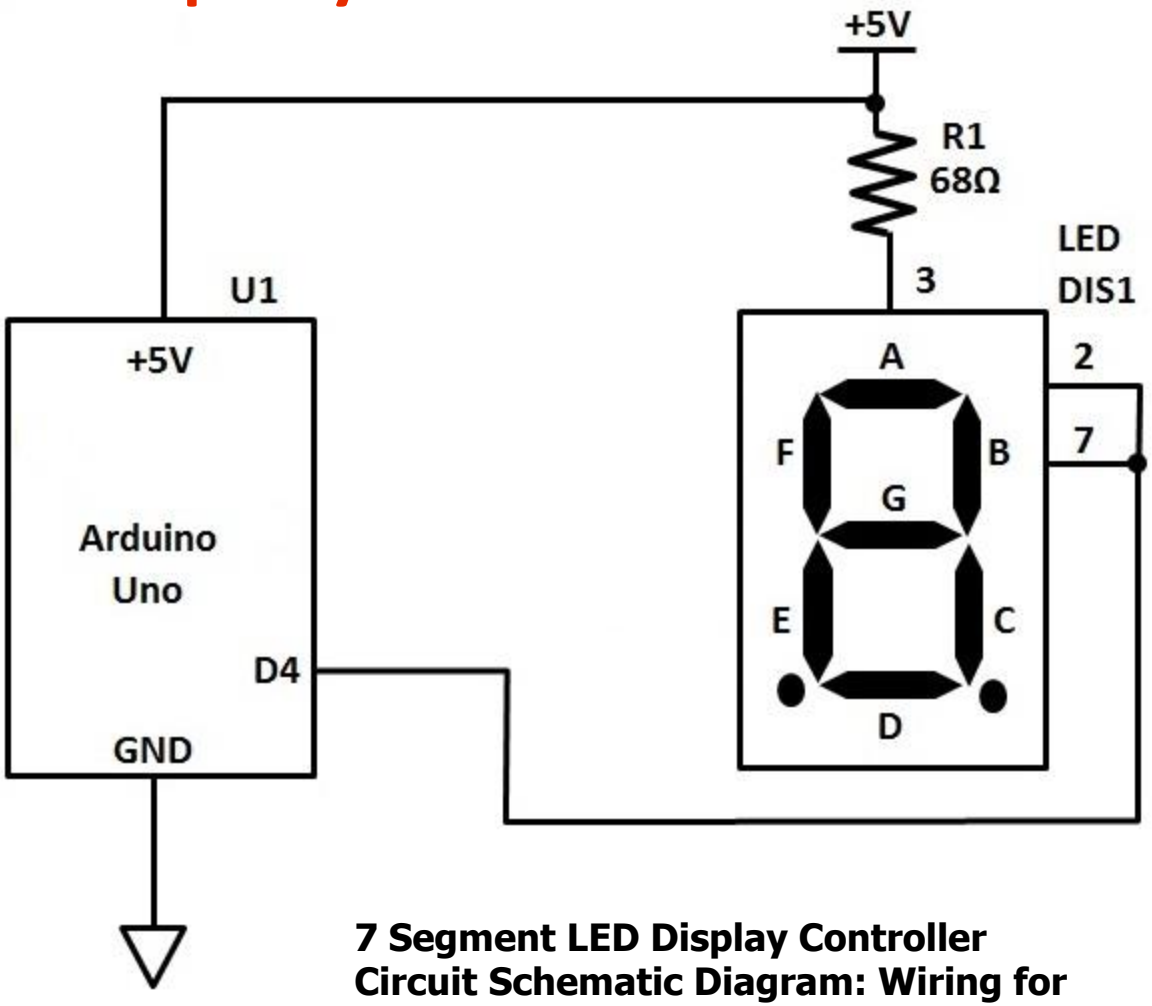
b) the ground pin of the 7 segment LED Display

c) a reference for the 7 segment LED Display

d) none of the above

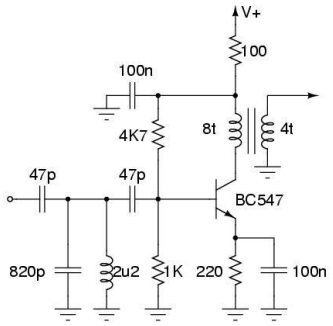
Hands On Project: 7 Segment LED Display Controller…



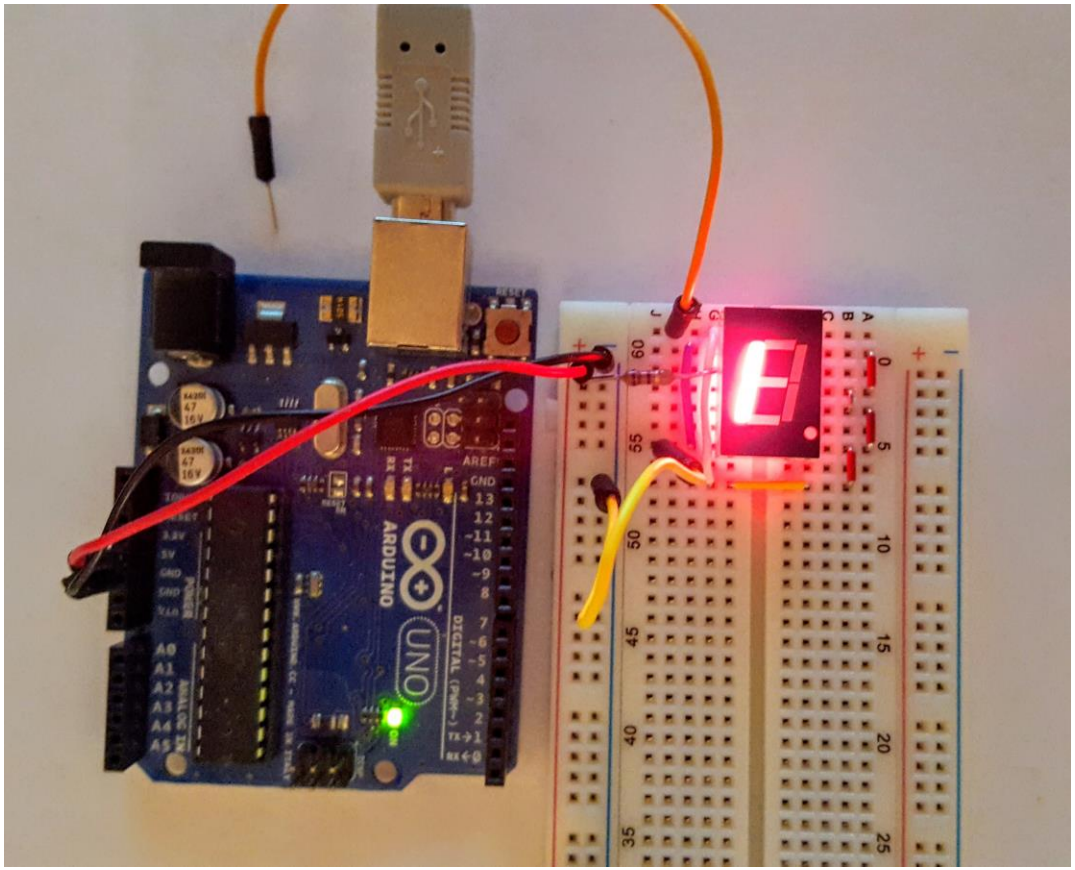


7 Segment LED Display Controller Circuit Schematic Diagram: Wiring for the number "1".

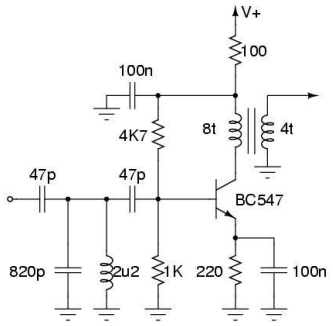
Hands On Project: 7 Segment LED Display Controller…

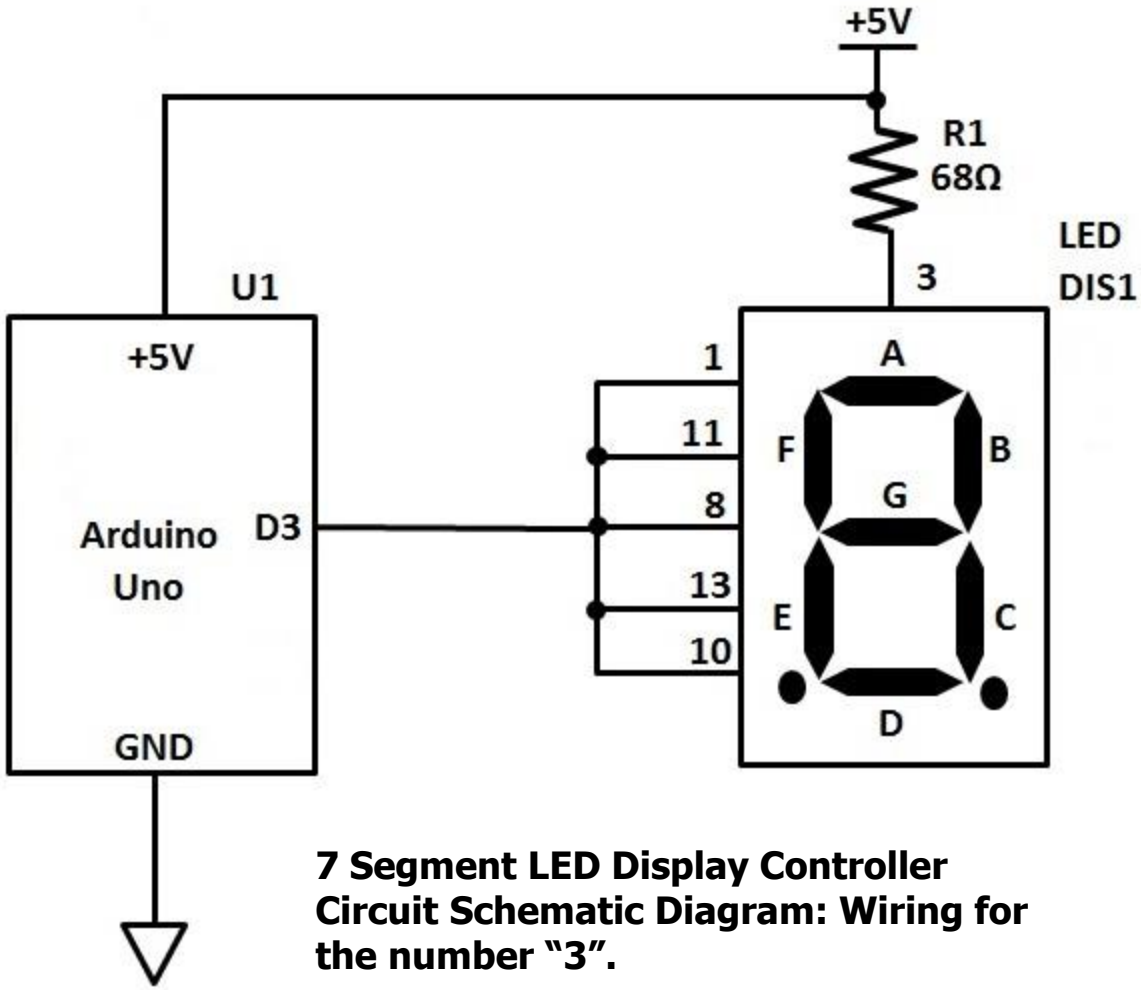


7 Segment LED Display Controller Circuit Schematic Diagram: Testing display wiring for the number "1".



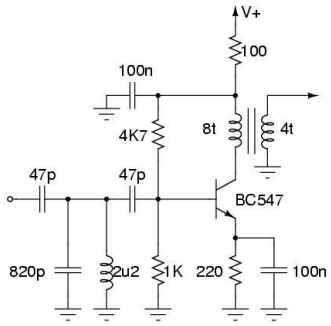
Hands On Project: 7 Segment LED Display Controller…



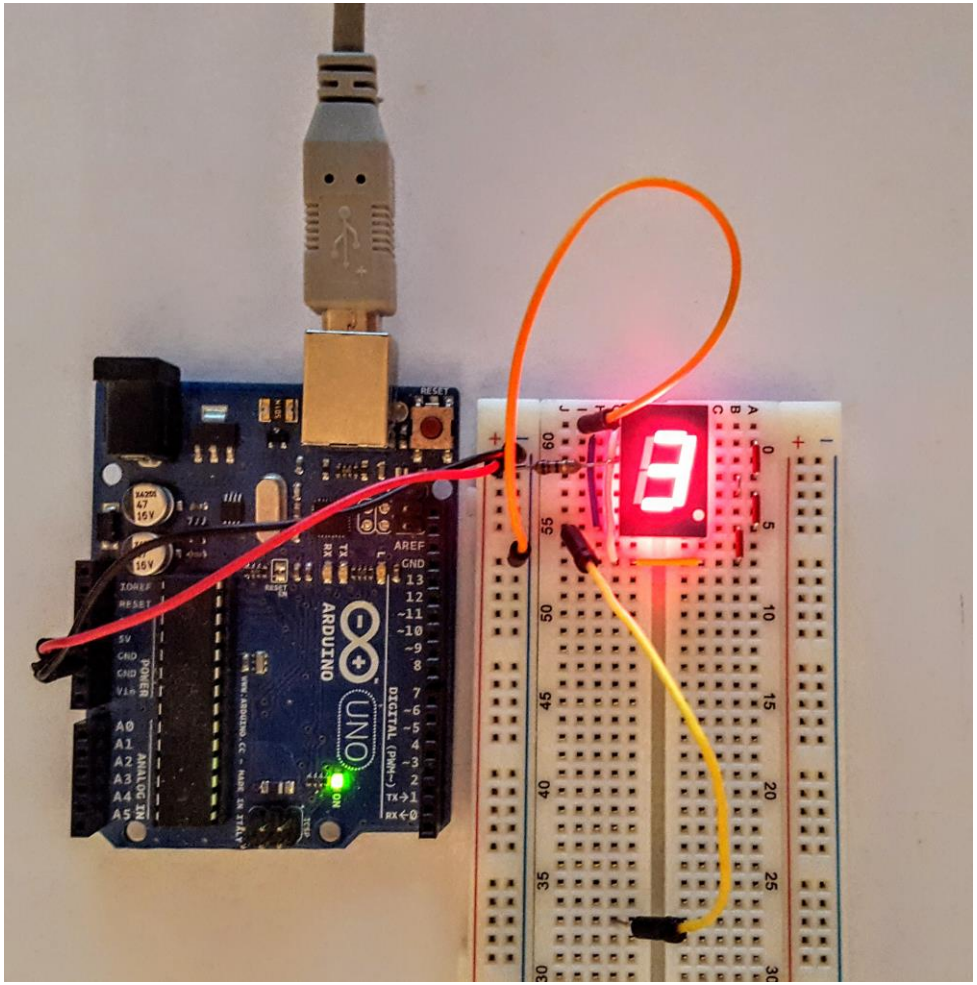


7 Segment LED Display Controller Circuit Schematic Diagram: Wiring for the number "3".

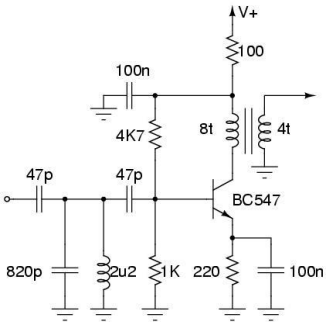
Hands On Project: 7 Segment LED Display Controller…



7 Segment LED Display Controller Circuit Schematic Diagram: Testing display wiring for the number "3".



Hands On Project: 7 Segment LED Display Controller…



Modify the Button code (sketch) to control the 7 Segment LED Display.

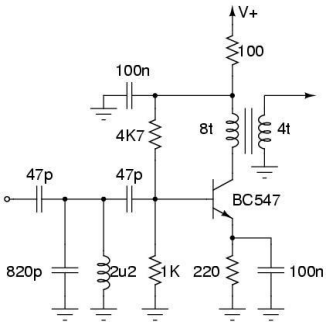
Button

```
http://www.arduino.cc/en/Tutorial/Button
*/

// constants won't change. They're used here to
// set pin numbers:
const int buttonPin = 2;     // the number of the pushbutton pin
const int ledPin =  13;      // the number of the LED pin

// variables will change:
int buttonState = 0;         // variable for reading the pushbutton status

void setup() {
  // initialize the LED pin as an output:
  pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}

void loop() {
  // read the state of the pushbutton value:
  buttonState = digitalRead(buttonPin);

  // check if the pushbutton is pressed.
```

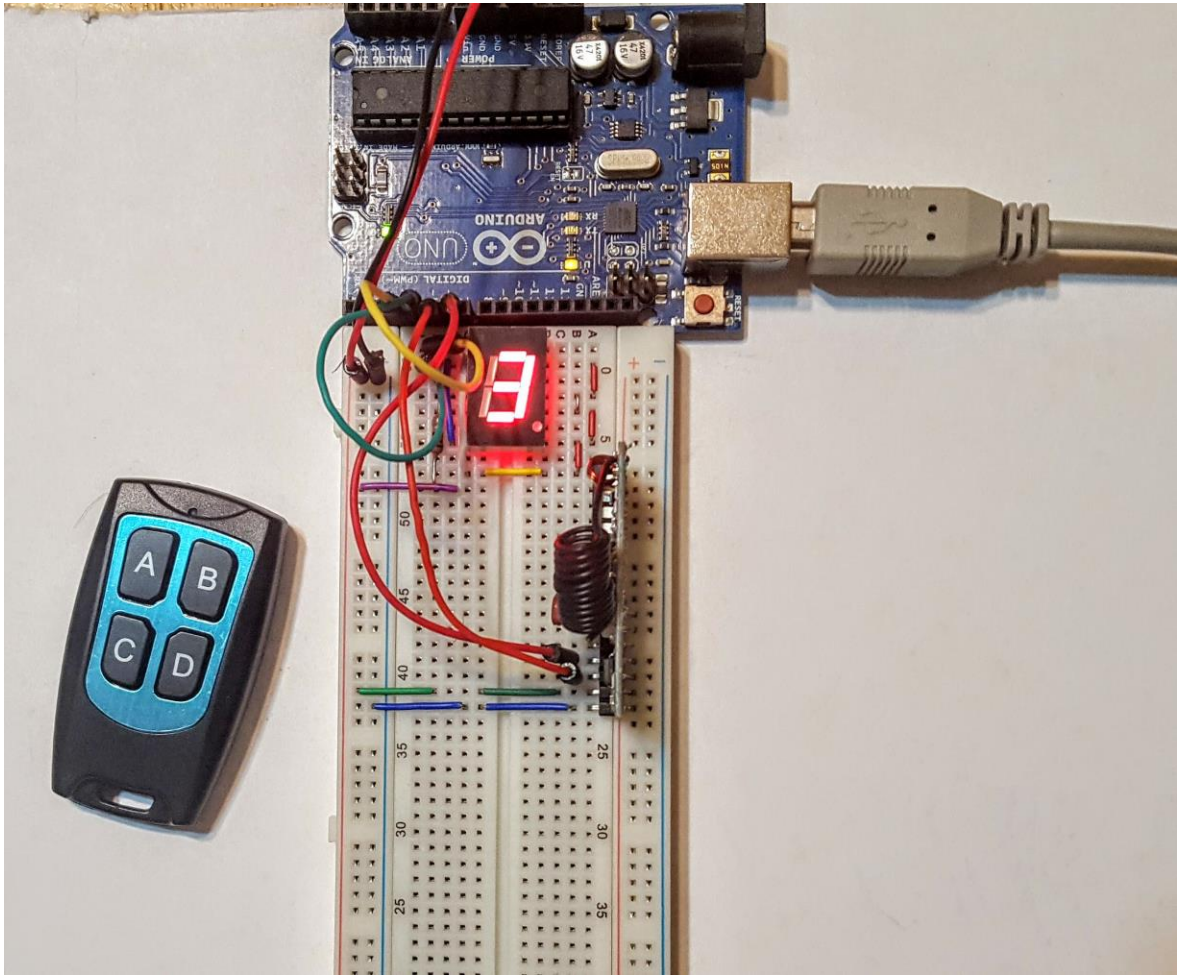
Question 6

What segment pins on the 7 segment LED Display are used to show a number 3?

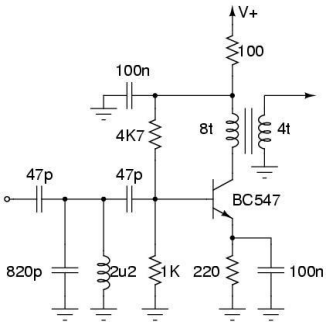
Hands On Project: 7 Segment LED Display Controller…



Displaying the number "3" by pressing the "D" key on the Fob.



Hands On Project: 7 Segment LED Display Controller…



Displaying the number "1" by pressing the "C" key on the Fob.