



**DesignNews**

PLC-HMI Automation Applications

# DAY 5 : HMI Fundamentals Part 2: TFT LCD Touch Screen

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## Webinar Logistics

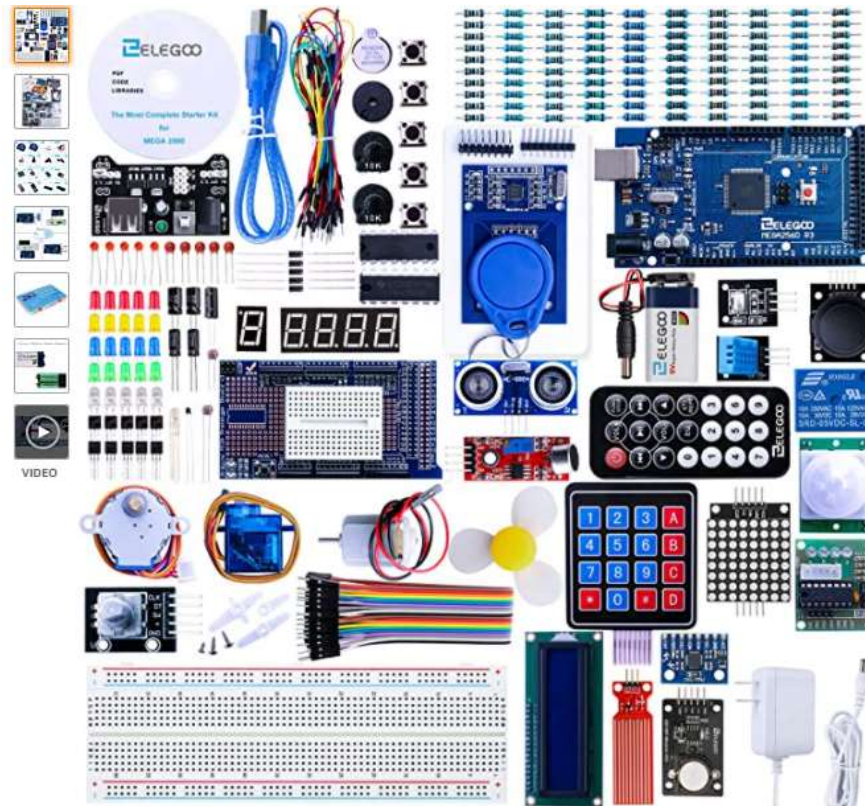
- Turn on your system sound to hear the streaming presentation.
- If you have technical problems, click “Help” or submit a question asking for assistance.
- Participate in ‘Group Chat’ by maximizing the chat widget in your dock.



## Don Wilcher

Visit 'Lecturer Profile' in your console for more details.

# Course Kit: The ELEGOO Mega 2560 Project: The Most Complete Starter Kit w/Tutorial



## Course Components:

**ELEGOO UNO R3 2.8 Inches TFT Touch  
Screen with SD Card Socket w/All  
Technical Data in CD for Arduino UNO R3**

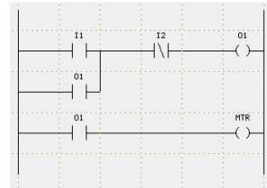


**TWTADE SSR-40 DD 40A DC  
3-32V to DC 5-60V SSR Solid  
State Relay + Heat Sink**



## Agenda:

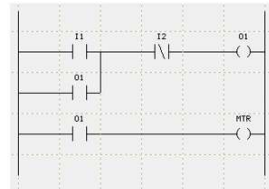
- TFT LCD Touch Screen Basics
- TFT LCD Touch Screen Types
  - a) Resistive
  - b) Capacitive
- Mini Lab activities:
  - a) graphics
  - b) text
- Lab Project: TFT LCD Touch Screen Controller



## TFT LCD Touch screen Basics

A TFT LCD Touch screen is:

- a Thin Film Transistor (TFT) screen with a touch technology.
- designed to be active matrix. Active matrix:
  - a) can retain certain pixels on the screen
  - b) able to address other screen pixels using minimum
- able to display content and act as an interface device .
- an optoelectronic component that used organic LEDs (OLEDs) for touch screen illumination (backlighting).
- able to deliver sharp images.





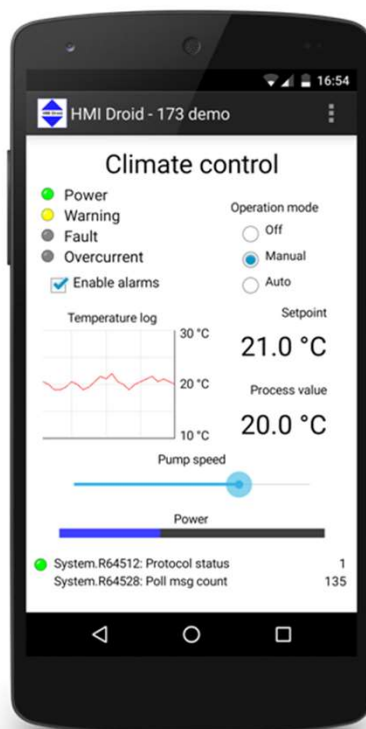
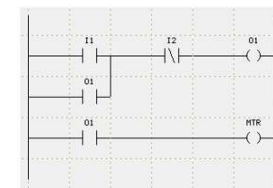
## Question 1

**Thin Fast Transistor is embedded within a touch screen.**

- a) True**
- b) False**

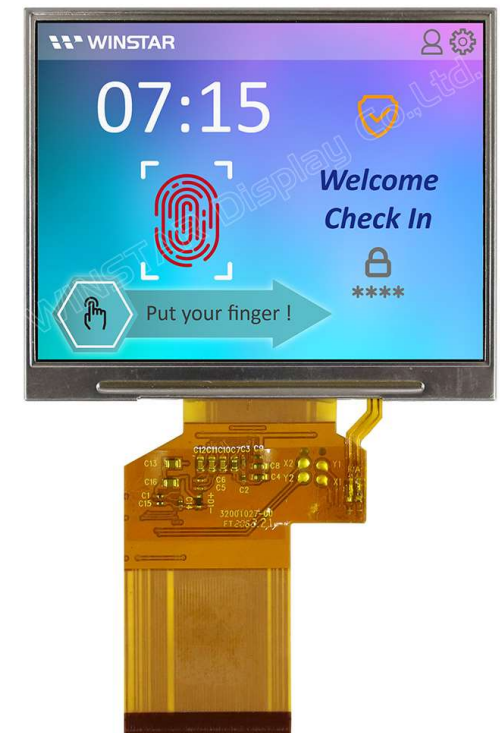
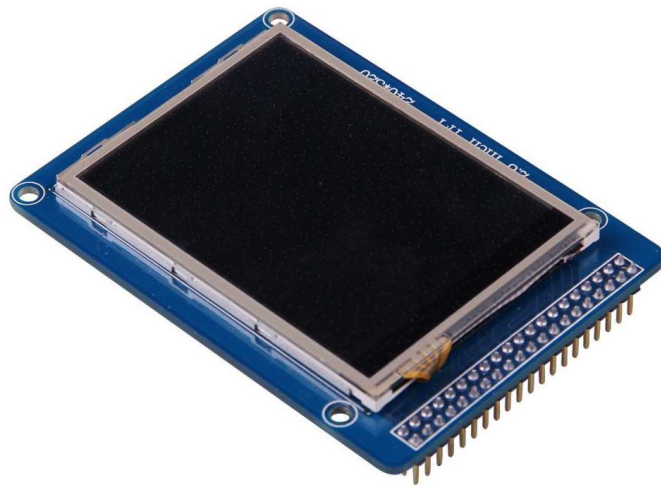
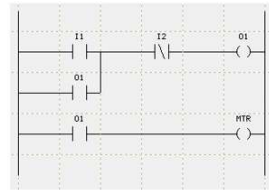


# TFT LCD Touch screen Basics. . .



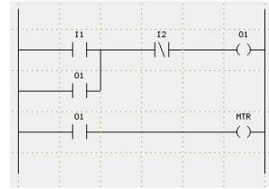
TFT LCD Touch screen examples

## TFT LCD Touch screen Basics . . .



TFT LCD Touch  
screen examples

## TFT LCD Touch screen Basics. . .



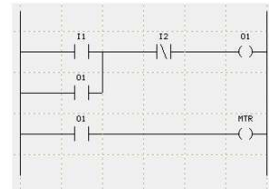
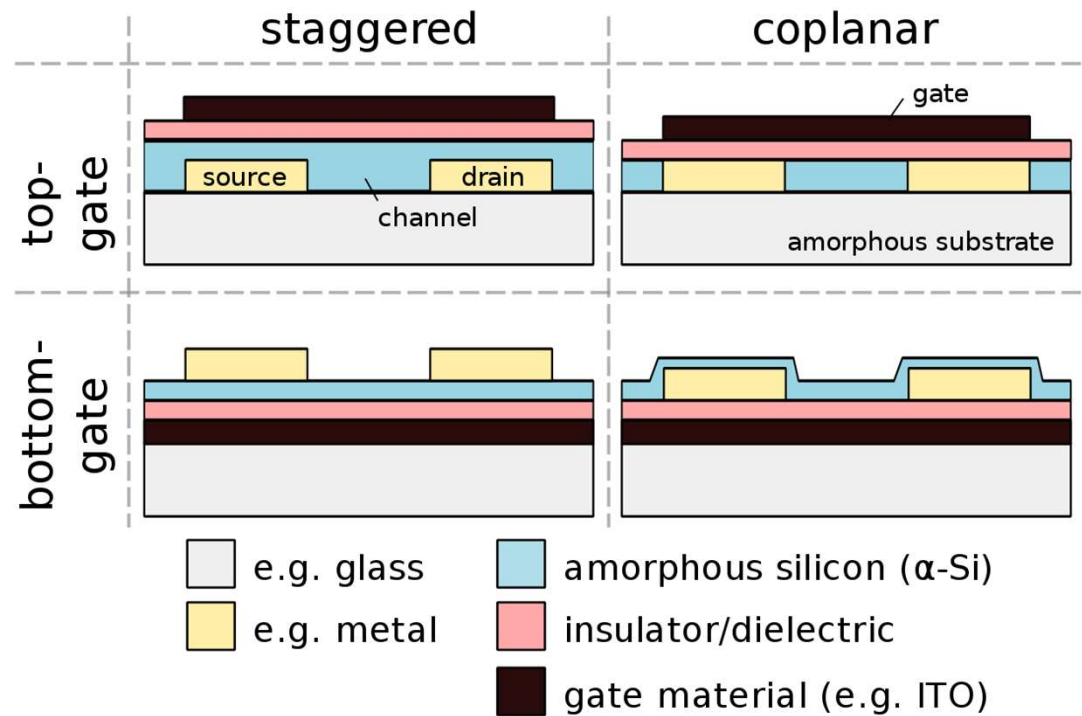
A Thin Film Transistor is:

- a special type of metal oxide semiconductor field-effect transistor (MOSFET).
- made by depositing thin films of an active semiconductor, dielectric layer, and metallic contacts over a supporting substrate.

Glass is a common substrate used in TFT based LCDs.

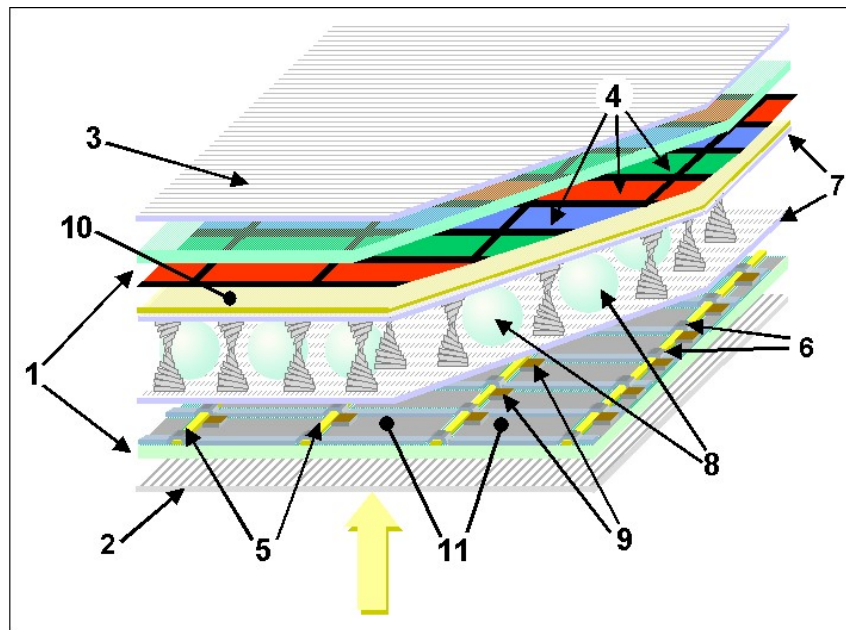
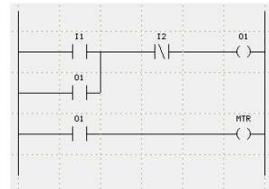
## TFT LCD Touch screen Basics...

### A TFT Construction



## TFT LCD Touch screen Basic. . .

### A TFT LCD Construction



- 1 - Glass plates
- 2/3 - Horizontal and vertical polarisers
- 4 - RGB colour mask
- 5/6 - Horizontal and vertical command lines
- 7 - Rubbed polymer layer
- 8 - Spacers
- 9 - Thin-film transistors
- 10 - Front electrode
- 11 - Rear electrodes



## Question 2

**What transistor is used for a TFT?.**

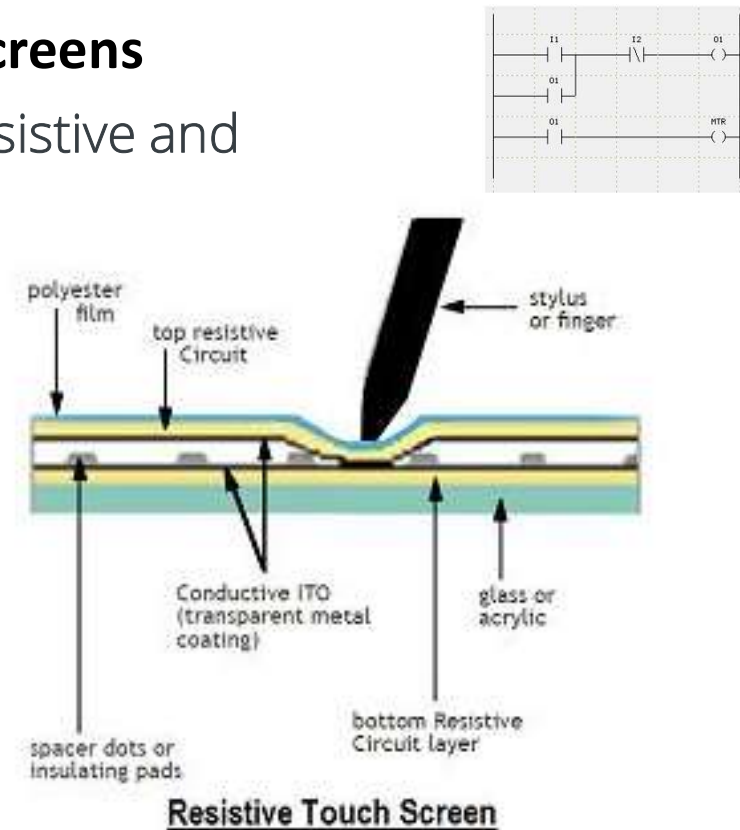
- a) MOSFET**
- b) BJT**
- c) none of the above**

## Types of TFT LCD Touch screens

There are two variations of TFT LCD Touch screens: Resistive and Capacitive.

Resistive TFT LCD :

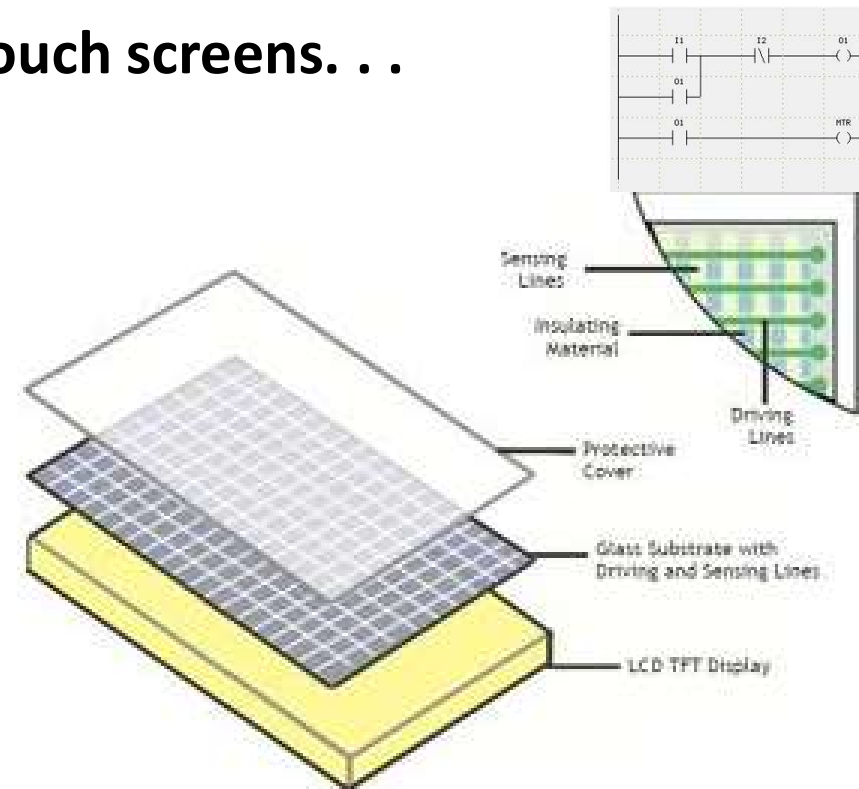
- touch screens consists of several very thin layers
- pressing the touch panel, top layer bends thus making contact with the bottom layer.
- Touch action closes a circuit thus allowing current flow.
- Effective as simple panel controls or keypad replacements.



## Types of TFT LCD Touch screens. . .

Capacitive TFT LCD :

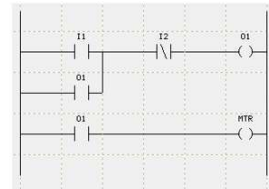
- a) typically made of two layers
  - i. surface insulator
  - ii. Transparent conductive layer
- b) human body (finger) is a conductor, when touch panel is touched, panel's electrostatic field is distorted.
- c) Touch screen's controller can determine the distortion – sends instructions to the system accordingly.
- d) Capacitive Touch screens can accept Multitouch controls.



**Capacitive Touch Screen**



## Types of TFT LCD Touch screens. . .



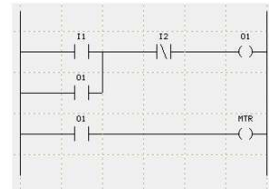
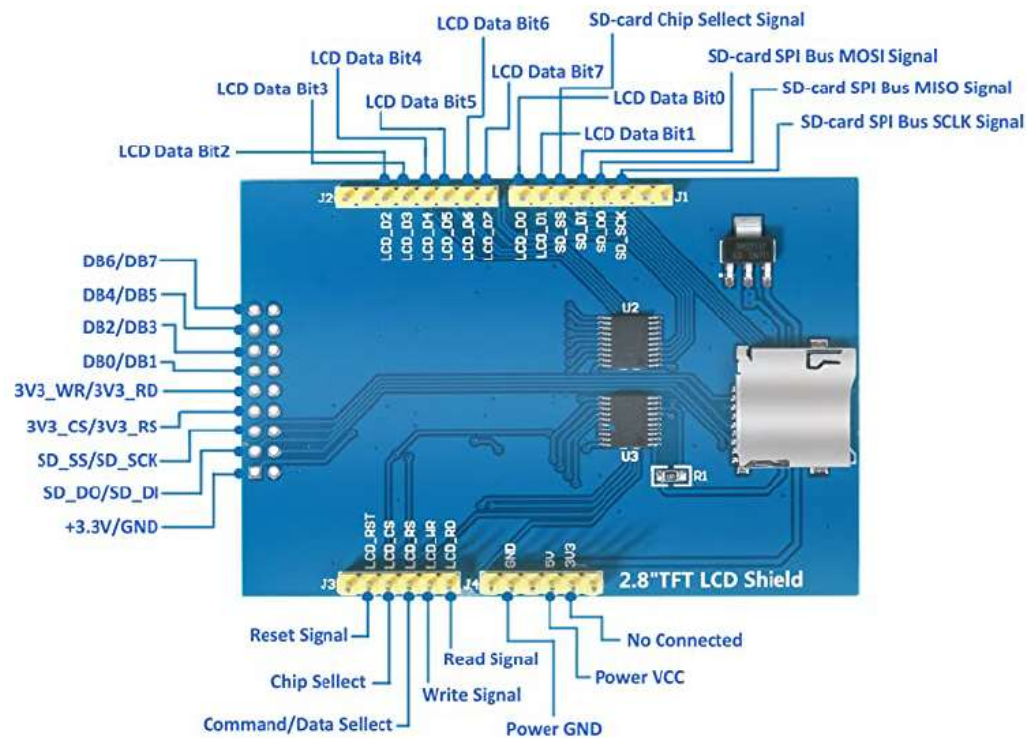
Comparisons:

	<b>Resistive Touch Screen</b>	<b>Capacitive Touch Screen</b>
<b>Advantages</b>	Inexpensive	Higher touch sensitivity
	Better resistance to dust and water	Supports multi-touch
	Can be used with gloves	Good visibility even in sunlight
<b>Disadvantages</b>	Low touch sensitivity	Cannot be used with most gloves
	Unable to support multi-touch	More expensive
	Poor visibility in sunlight	Does not work well with pointed objects

## Types of TFT LCD Touch screens . . .

Example: Resistive Type

**ELEGOO UNO R3 2.8 Inches TFT LCD Touch Screen with SD Card Socket**

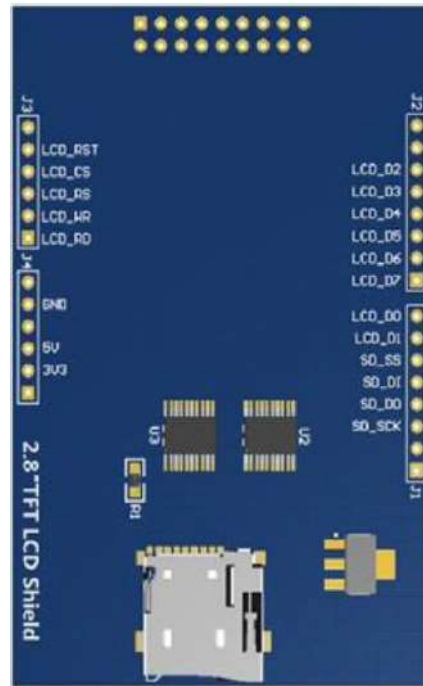


Source: Elegoo TFT Touch Screen: <https://www.elegoo.com/products/elegoo-2-8-inches-tft-touch-screen>

## Types of TFT LCD Touch screens . . .

Example: Resistive Type

**ELEGOO UNO R3 2.8 Inches TFT LCD Touch Screen with SD Card Socket**



LCD Pins	instruction
LCD_RST	Reset Signal
LCD_CS	Chip Seselect
LCD_RS	Command/Data Seselect
LCD_WR	Write Signal
LCD_RD	Read Signal
GND	Power GND
5V	Power VCC
3V3	No Connected
LCD_D0	LCD Data Bit0
LCD_D1	LCD Data Bit1
LCD_D2	LCD Data Bit2
LCD_D3	LCD Data Bit3
LCD_D4	LCD Data Bit4
LCD_D5	LCD Data Bit5
LCD_D6	LCD Data Bit6
LCD_D7	LCD Data Bit7
SD_SS	SD-card Chip Seselect Signal
SD_DI	SD-card SPI Bus MOSI Signal
SD_DO	SD-card SPI Bus MISO Signal
SD_SCK	SD-card SPI Bus SCLK Signal

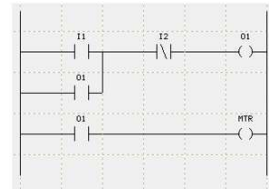


Figure 1. Interface Definition Elegoo.(2017, p.1)

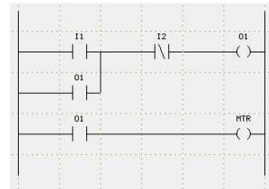
Source: Elegoo.(2017). *Elegoo 2.8 inches touch screen user manual – Arduino version*. Elegoo.

## Types of TFT LCD Touch screens. . .

### ELEGOO UNO R3 2.8 Inches TFT LCD Touch Screen with SD Card Socket

Item	Description
Display Type	2.8 inch a-si TFT LCD Module
Glass Type	TFT
Display Resolution	240XRGBX320 Pixels
Back light	4 chip HighLight white LEDs
Control IC	ILI9341
Interface	8 Bit parallel interface
PCB Module size	78.22mmX52.7mm
LCD Area(WxHxT)	50mmX69.2mmX2.5mm
Active Area(WxH)	43.2mmX57.6mm
Module weight	TDB

Table 1. Basic Specifications Elegoo.(2017, p .1)

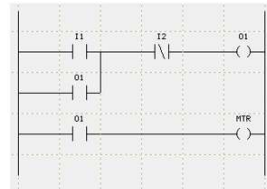


## Types of TFT LCD Touch screens. . .

### ELEGOO UNO R3 2.8 Inches TFT LCD Touch Screen with SD Card Socket

Specification	Min	Type	Max	Unit
Power Voltage(VDD/VCC)	3.3	5	5.5	VDC
IO Pins Voltage	MCU Voltage = 3.3V	3	3.3	V
	MCU Voltage = 5V	4.5	5	
BackLight Voltage	2.8	3.2	3.3	V
Current Consumption	-	120	-	mA

Table 2. Electronic Specifications Elegoo.(2017, p .1)



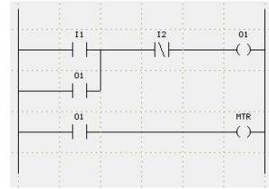
## Question 3

**Which statement is correct.**

- a) Resistive Touch Screen has good visibility even in sunlight.**
- b) Resistive Touch Screen is expensive.**
- c) Resistive Touch Screen has better resistance to dust and water**
- d) none of the above**



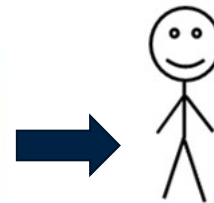
## Mini Labs



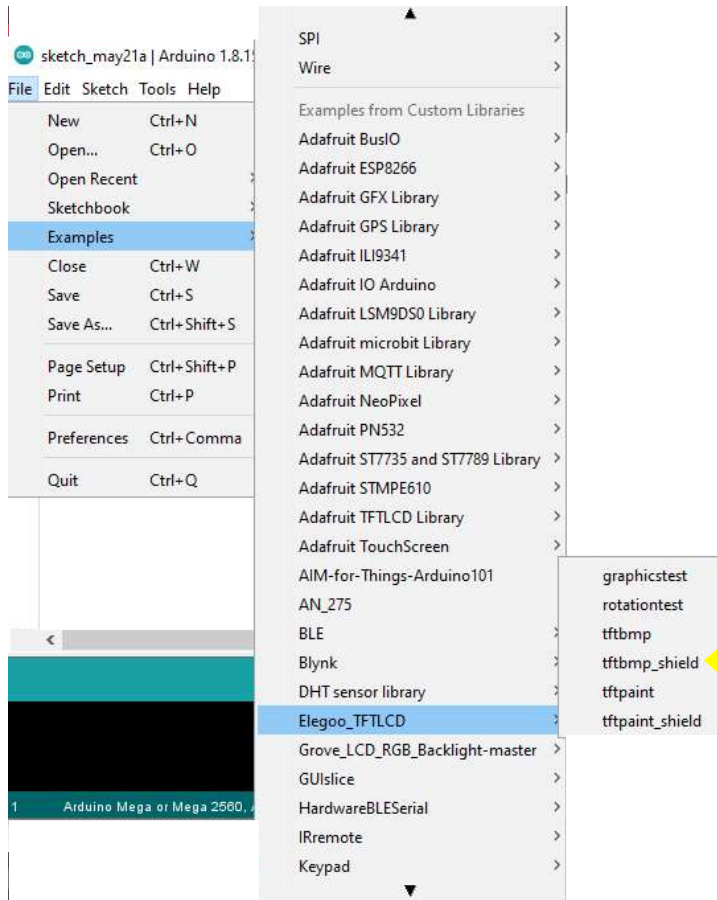
Learning Objectives:

Mini Labs will explore the following resistive TFT LCD Touch screen characteristics:

- a) graphics
- b) text



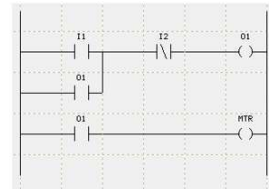
Hello World!!



## Mini Labs. . .

### Arduino IDE Setup:

- Software preparation in User Manual (Elegoo 2017, p. 6)
- Import Libraries in User manual (Elegoo 2017, p. 7)



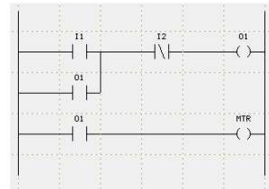
graphicstest  
 rotationtest  
 tftbmp  
 tftbmp\_shield  
 tftpaint  
 tftpaint\_shield



## Mini Labs. . .

### Arduino IDE Setup:

- Software preparation in User Manual (Elegoo 2017, p. 6)
- Import Libraries in User manual (Elegoo 2017, p. 7)



### Example Files on CD

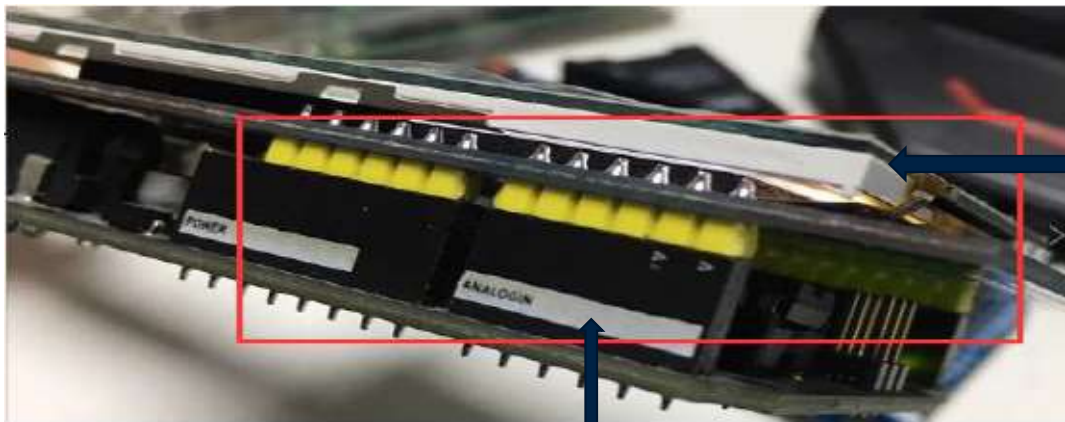
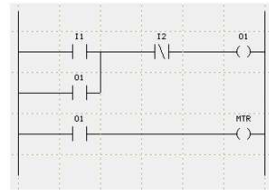


#### Name

- Example01-Simple test
- Example02-DisplayString
- Example03-graphicstest
- Example04-Touch
- Example05-ShowBMP
- Example06-Phonecal

## Mini Labs. . .

Mating TFT LCD Touch screen to Mega 2560 (Elegoo 2017, p. 11)

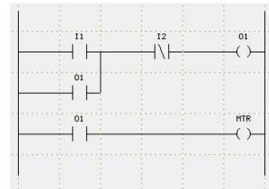


TFT LCD Touch screen

Mega 2560

## Mini Labs. . .

Example 2: DisplayString Text (Elegoo 2017, p. 9)



```
COM7
TFT LCD test
Using Elegoo 2.4" TFT Breakout Board Pinout
TFT size is 240x320
Found 0x9341 LCD driver
```

Autoscroll  Show timestamp

Newline 9600 baud Clear output

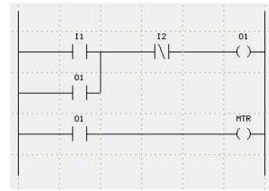


## Question 4

**In reviewing slide 27, the TFT size is.**

- a) 640 x 320**
- b) 240 x 330**
- c) 240 x 320**
- d) none of the above**

## Mini Labs. . .



Example 2: DisplayString Text (Elegoo 2017, p. 9)

Code activities to explore:

```
tft.println("Hello World!");  
tft.println(01234.56789);  
tft.println(0xDEADBEEF, HEX);
```



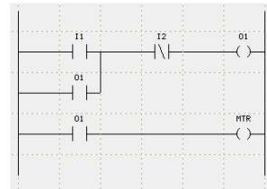
Change the text and display on the TFT LCD Touch screen

Line 112: `tft.setTextColor(GREEN); tft.setTextSize(2);` Code used to change the color and the size of the text.

Lines 133 – 146 with the DisplayString Text code can be explored.

Lines 147: Change the timing of displaying the text with this line of code with the DisplayString Text code can be explored.

## Mini Labs. . .



Example 2: DisplayString Text (Elegoo 2017, p. 9)

Code activities to explore:

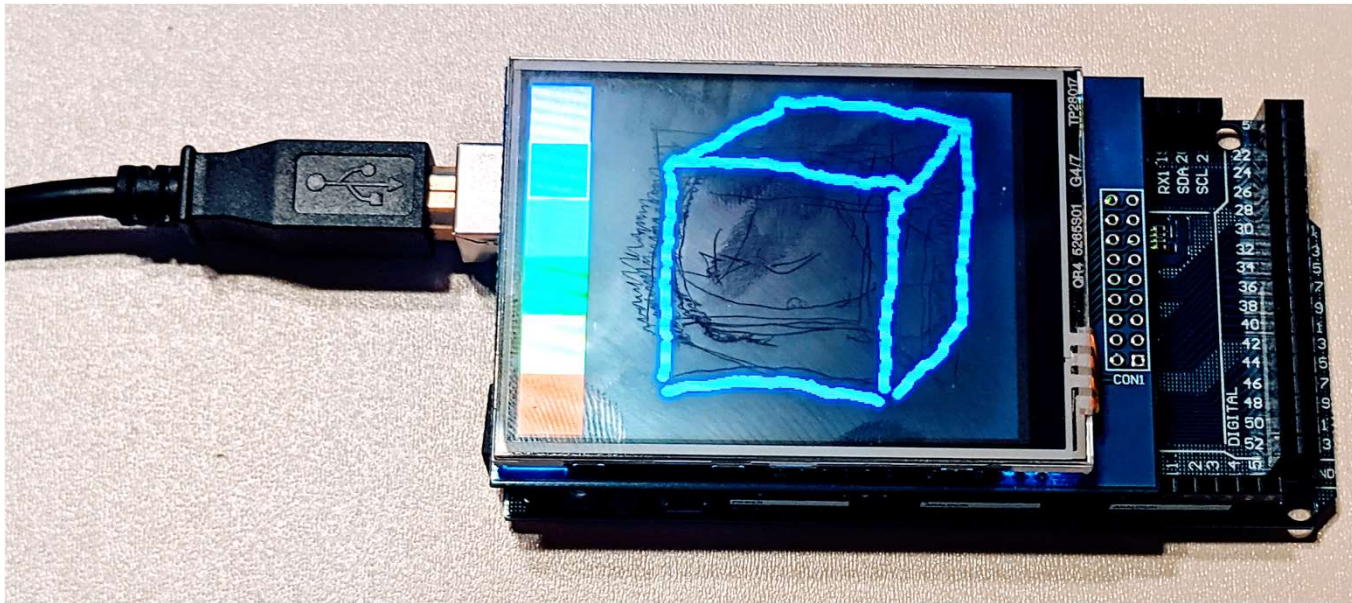
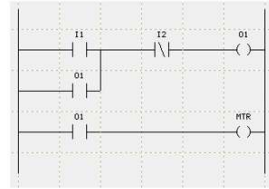
Lines 133 – 146 with the DisplayString Text code can be explored.

```
133 tft.println();  
134 tft.setTextColor(GREEN);  
135 tft.setTextSize(5);  
136 tft.println("Groop");  
137 tft.setTextSize(2);  
138 tft.println("I implore thee,");  
139 tft.setTextSize(1);  
140 tft.println("my foonting turlingdromes.");  
141 tft.println("And hooptiously drangle me");  
142 tft.println("with crinkly bindlewurdles,");  
143 tft.println("Or I will rend thee");  
144 tft.println("in the gobberwarts");  
145 tft.println("with my blurglecruncheon,");  
146 tft.println("see if I don't!");*/
```

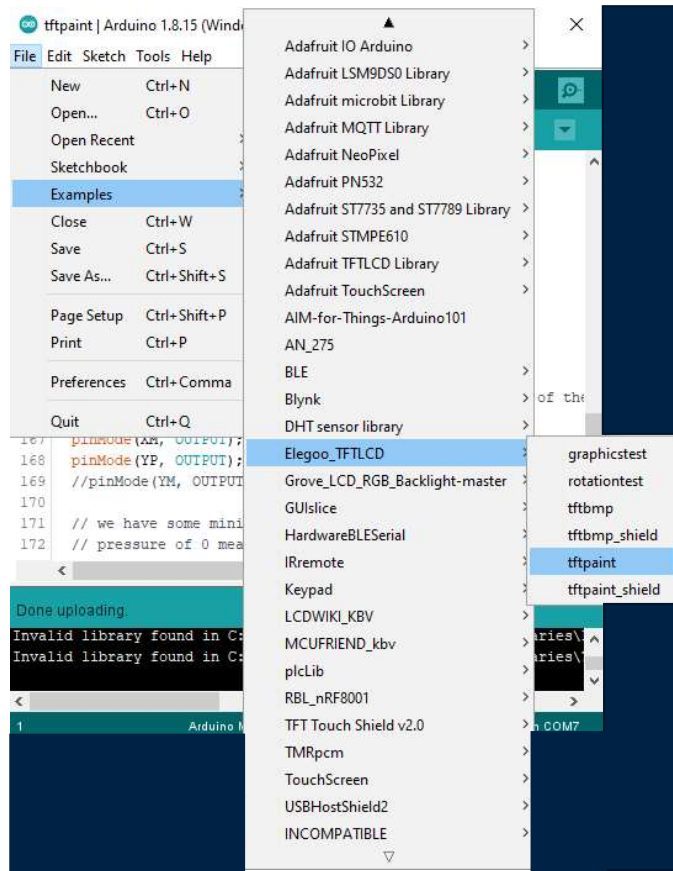
Source: Elegoo.(2017). *Elegoo 2.8 inches touch screen user manual – Arduino version*. Elegoo.

## Mini Labs. . .

Example 4: Touch (Elegoo 2017, p. 11)

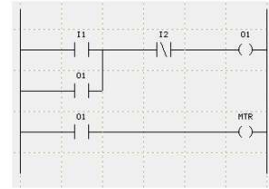


Source: Elegoo.(2017). *Elegoo 2.8 inches touch screen user manual – Arduino version*. Elegoo.



## Mini Labs. . .

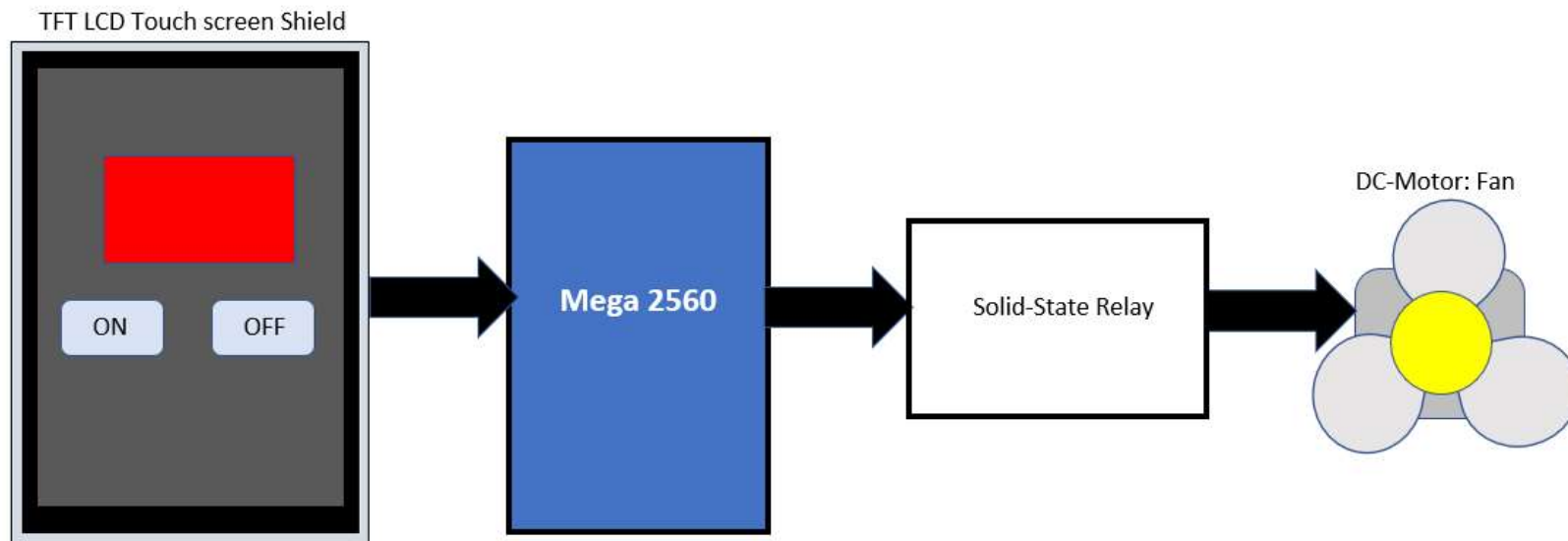
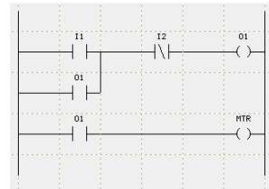
Touch application can be found through:  
Examples>Elegoo>TFTLCD>tftpaint





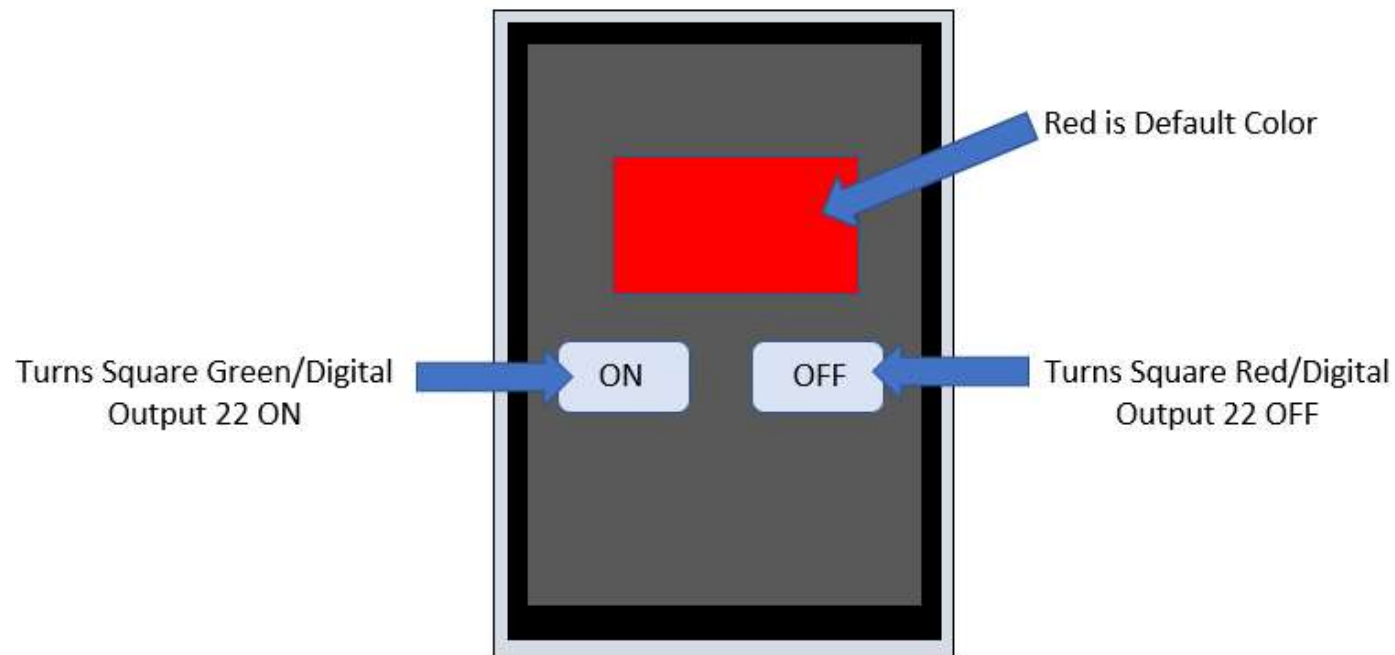
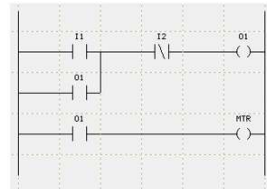
## Lab Project: TFT LCD Touch Screen Controller. . .

### Block Diagram



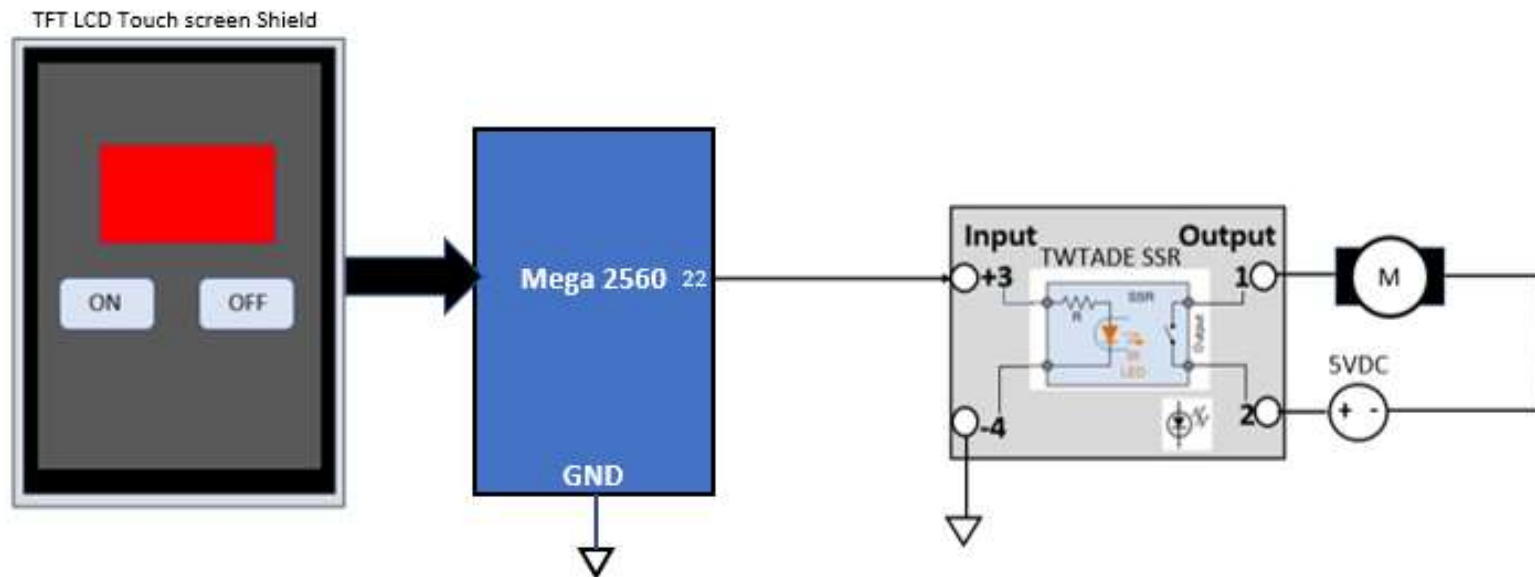
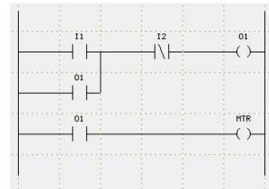
## Lab Project: TFT LCD Touch Screen Controller. . .

### Button Simple: TFT LCD Touch Screen Controller Operation



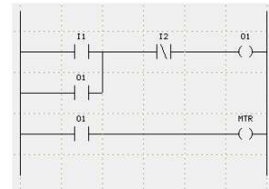
## Lab Project: TFT LCD Touch Screen Controller. . .

### Circuit Schematic Diagram



## Lab Project: TFT LCD Touch Screen Controller. . .

### MCUFRIEND\_kbv-master files



MCUFRIEND\_kbv-master

Name

- aspect\_kbv
- button\_simple
- diagnose\_TFT\_support
- diagnose\_Touchpins
- drawBitmap\_kbv
- Font\_simple
- GLUE\_Demo\_220x176
- GLUE\_Demo\_320x240
- GLUE\_Demo\_400x240
- GLUE\_Demo\_480x320
- GLUE\_Demo\_800x480
- graphicstest\_kbv
- graphicstest\_slim
- LCD\_ID\_readnew
- LCD\_ID\_readreg
- readpixel\_kbv
- scroll\_kbv
- showBMP\_kbv\_Uno
- showBMP\_not\_Uno
- testcard\_kbv
- Touch\_shield\_new
- TouchScreen\_Calibr\_native

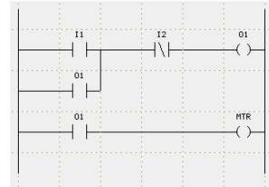
### button\_simple code

```
1 #if 1
2
3 #include <Adafruit_GFX.h>
4 #include <MCUFRIEND_kbv.h>
5 MCUFRIEND_kbv tft;
6 #include <TouchScreen.h>
7 #define MINPRESSURE 200
8 #define MAXPRESSURE 1000
9
10 // ALL Touch panels and wiring is DIFFERENT
11 // copy-paste results from TouchScreen_Calibr_native.ino
12 const int XP = 6, XM = A2, YP = A1, YM = 7; //ID=0x9341
13 const int TS_LEFT = 907, TS_RT = 136, TS_TOP = 942, TS_BOT = 139;
```

Source: MCUFRIEND\_kbv - [https://github.com/prenticedavid/MCUFRIEND\\_kbv](https://github.com/prenticedavid/MCUFRIEND_kbv):

## Lab Project: TFT LCD Touch Screen Controller

### Modifying Button Simple code (sketch)



Place cursor here  
and hit the enter  
key

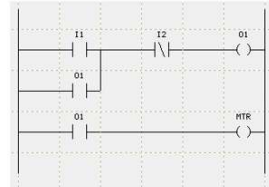
```
1  #if 1
2
3  #include <Adafruit_GFX.h>
4  #include <MCUFRIEND_kbv.h>
5  MCUFRIEND_kbv tft;
6  #include <TouchScreen.h>
7  #define MINPRESSURE 200
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9
10 // ALL Touch panels and wiring is DIFFERENT
11 // copy-paste results from TouchScreen_Calibr_native.ino
12 const int XP = 6, XM = A2, YP = A1, YM = 7; //ID=0x9341
13 const int TS_LEFT = 907, TS_RT = 136, TS_TOP = 942, TS_BOT = 139;
```

Type this code at line10

```
10 #define Out 22 // Digital Pin 22
```

## Lab Project: TFT LCD Touch Screen Controller. . .

### Modifying Button Simple code (sketch). . .



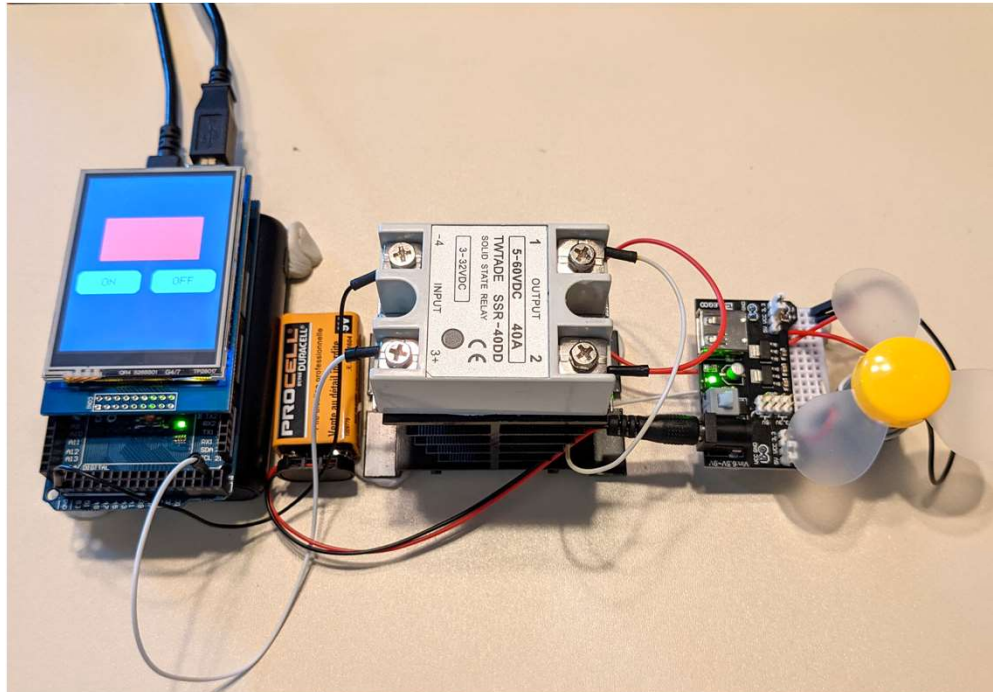
```
73 void loop(void)
74 {
75     bool down = Touch_getXY();
76     on_btn.press(down && on_btn.contains(pixel_x, pixel_y));
77     off_btn.press(down && off_btn.contains(pixel_x, pixel_y));
78     if (on_btn.justReleased())
79         on_btn.drawButton();
80     if (off_btn.justReleased())
81         off_btn.drawButton();
82     if (on_btn.justPressed()) {
83         on_btn.drawButton(true);
84         tft.fillRect(40, 80, 160, 80, GREEN);
85         digitalWrite(Out, HIGH); // turn on pin 22
86     }
87     if (off_btn.justPressed()) {
88         off_btn.drawButton(true);
89         tft.fillRect(40, 80, 160, 80, RED);
90         digitalWrite(Out, LOW); // turn on pin 22
91     }
```

Type this code  at line 85

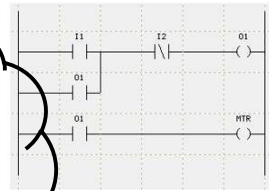
Type this code  at line 90

# Lab Project: TFT LCD Touch Screen Controller.

## Final Build



Click here to  
check out the  
Final Build video!



YouTube



## Question 5

**Instruction code `digitalWrite(Out, HIGH)` will turn the Mega 2560 digital pin 22\_**

- a) toggle**
- b) off**
- c) on**
- d) none of the above**



## Thank you for attending

Please consider the resources below:

- Techwalla  
<https://www.techwalla.com/articles/what-is-a-tft-touch-screen>
- Thin Film Transistor  
[https://en.wikipedia.org/wiki/Thin-film\\_transistor](https://en.wikipedia.org/wiki/Thin-film_transistor)
- Digi-key Tech Forum  
<https://forum.digikey.com/t/resistive-touch-vs-capacitive-touch-whats-the-difference/1063>
- Elegoo TFT Touch Screen  
<https://www.elegoo.com/products/elegoo-2-8-inches-tft-touch-screen>
- Elegoo.(2017). *Elegoo 2.8 inches touch screen user manual – Arduino version*. Elegoo.
- Final Build YouTube Video  
<https://www.youtube.com/watch?v=OwwsFdxcz4A>



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