



#### **Raspberry Pi 4 Automation**

NANNA

# **DAY 5 : Electromechanical Relay Control**

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# Don Wilcher

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# Agenda:

- Electromechanical Relay Construction
- Transistor Relay Driver Circuit
- Lab: A Basic RPi4 Electromechanical Relay Controller







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#### **Electromechanical Relay Construction**

An electromechanical switch that can be turned ON and OFF by a low current signal is called an electromechanical relay.





#### Source:

https://www.omron-ecb.co.kr/relay-basics/basic





#### **Electromechanical Relay Construction...**





#### Source:

https://www.circuitstoday.com/working-of-relays





**Electromechanical Relay Construction...** 



# How do we take...







# Question 1



# What is the name of the moveable part on an electromechanical relay?





**Electromechanical Relay Construction...** 

# How do we take...





#### Source:

https://www.allaboutcircuits.com/textbook/digital/chpt-5/relay-construction/





**Electromechanical Relay Construction...** 



**Double Pole-Double Throw (DPDT) device** 

#### Source:

https://www.electronics-notes.com/articles/electronic\_components/electrical-electronic-relay/whatis-a-relay-basics.php





**Transistor Relay Driver...** 

# **Controlling a High Current Electrical Load...**







**Transistor Relay Driver...** 

# Controlling a High Current Electrical Load...







### Question 2



# What are the common switching contacts on an electromechanical relay?





#### **Transistor Relay Driver Circuit...**

# **Controlling a High Current Electrical Load with Low Current Switching**



Transistor

Equation 1:  $B = \frac{I_C}{I_B}$  or  $h_{fe} = \frac{I_C}{I_B}$ Equation 2:  $I_C = BI_B$ 

where:

B = Beta

 $I_c =$ Collector Current

 $I_B$  = Base Current





# Transistor Relay Driver Circuit... Controlling a High Current Electrical Load with Low Current Switching...



https://components101.com/articles/understanding-bjt-transistor-and-how-to-use-it-in-your-circuit-





#### **Transistor Relay Driver Circuit...**

# **Example of a Partial Transistor Datasheet**



#### ELECTRICAL CHARACTERISTICS (Ta=25°C, unless otherwise specified)

| PARAMETER                            | SYMBOL        | TEST CONDITIONS  | MIN | TYP | MAX | UNIT |
|--------------------------------------|---------------|------------------|-----|-----|-----|------|
| Collector-Base Breakdown Voltage     | В∨сво         | Ic=100μA,IE=0    | 30  |     |     | V    |
| Collector-Emitter Breakdown Voltage  | BVCEO         | Ic=1mA,IB=0      | 20  |     |     | V    |
| Emitter-Base Breakdown Voltage       | <b>B</b> VEBO | IE=100μA,Ic=0    | 5   |     |     | V    |
| Collector Cut-Off Current            | Ісво          | VCB=30V,IE=0     |     |     | 1   | μA   |
| Emitter Cut-Off Current              | IEBO          | VEB=5V,Ic=0      |     |     | 100 | nA   |
| DC Current Gain(note)                | hFE1          | VCE=1V,Ic=1mA    | 100 |     |     |      |
|                                      | hFE2          | VCE=1V,Ic=150 mA | 120 | 110 | 400 |      |
|                                      | hFE3          | VCE=1V,Ic=500mA  | 40  |     |     |      |
| Collector-Emitter Saturation Voltage | VCE(sat)      | Ic=500mA,IB=50mA |     |     | 0.5 | V    |
| Base-Emitter Saturation Voltage      | VBE(sat)      | Ic=500mA,IB=50mA |     |     | 1.2 | V    |
| Base-Emitter Saturation Voltage      | VBE           | VCE=1V,Ic=10mA   |     |     | 1.0 | V    |
| Current Gain Bandwidth Product       | fT            | VCE=10V,Ic=50mA  | 100 |     |     | MHz  |
| Output Capacitance                   | Cob           | VCB=10V,IE=0     |     | 9.0 |     | pF   |
|                                      |               | f=1MHz           |     |     |     |      |





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### **Question 3**



# Using the transistor relay driver circuit on slide 16, determine the base voltage (Vb) with an input control voltage of 3.3V?





#### Lab Project: A Basic RPi4 Electromechanical Relay Controller









#### Lab Project: A Basic RPi4 Electromechanical Relay Controller...

#### **Big IDEAS:**



- Learners will be able to wire an electronic controller using a few off the shelf components.
- 2. Learners will be able to build a solid-state driver for relay control using Physical Computing concepts.
- 3. Learners will be able to make small changes to the code for personalization.





Lab Project: A Basic RPi4 Electromechanical Relay Controller... A RPi4 Electromechanical Relay Controller Block Diagram













### Lab Project: A Basic RPi4 Electromechanical Relay Controller... Major Components









#### Lab Project: A Basic RPi4 Electromechanical Relay Controller...

#### **Electrical Wiring Diagram**







#### Lab Project: A Basic RPi4 Electromechanical Relay Controller...

#### Pinout of the HK4100F Electromechanical Relay











#### Lab Project: A Basic RPi4 Electromechanical Relay Controller...

#### Electronic Circuit Schematic Diagram









**Question 4** 



# What type of transistor is used to drive the electromechanical relay in the controller project?





#### Lab Project: A Basic RPi4 Electromechanical Relay Controller... Circuit Breadboard Complete









#### Lab Project: A Basic RPi4 Electromechanical Relay Controller...





Demo

https://youtu.be/nf-nPPIniy8





#### Lab Project: A Basic RPi4 Electromechanical Relay Controller...

#### **Processing Code**









### Lab Project: A Basic RPi4 Electromechanical Relay Controller...

### Processing Code...









# Lab Project: A Basic RPi4 Electromechanical Relay Controller... Processing Code...



| 16 | GPIO.digitalWrite(ledPin, GPIO.LOW);                    |
|----|---|
| 17 | background(102);  |
| 18 | }   |
| 19 | }   |
| 20 |   |
| 21 | <pre>void mouseClicked() { //if the mouse Clicked</pre> |
| 22 | <pre>ledState = !ledState; //Change the led State</pre> |
| 23 | }   |





**Question 5** 



# Write the Processing code of instruction for toggling the electromechanical relay state.





### Thank you for attending

Continuing Education

Center

Please consider the resources below:

- Electromechanical Relay Construction
   <a href="https://www.omron-ecb.co.kr/relay-basics/basic">https://www.omron-ecb.co.kr/relay-basics/basic</a>
- Physical Computing O'Sullivan, D., & Igoe, T. (2004). Physical computing: Sensing and controlling the physical world with computers. Boston, MA: Thompson.
- Freenove Ultimate Starter Kit for Raspberry Pi

http://www.freenove.com/tutorial.html

 The HK4100F Datasheet <u>https://www.mpja.com/12VDC-SPDT-3A-Relay-Hui-Ke/productinfo/31935+RL/</u>





# Thank You





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