

Panel 1

Prior to Le03

# Transistors:

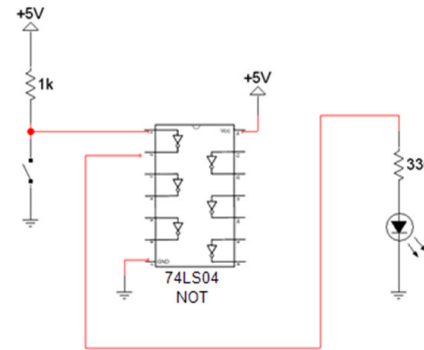
Why do we need 'em and how do we use 'em.

1

ME430 Mechatronics

Panel 2

Connect the LED via a NOT gate



2

Panel 3

To see how much current we've got we need datasheets!

1. Where do to find them

- 
- 
- 
- 

2. How do we read them

- 
- 
- 
- 

3

Panel 4



<http://www.digikey.com/>

4

Panel 5



<http://www.jameco.com>

5

Panel 6



<http://www.datasheetcatalog.com/>

6

Panel 7



<http://www.google.com/>

7

Panel 8

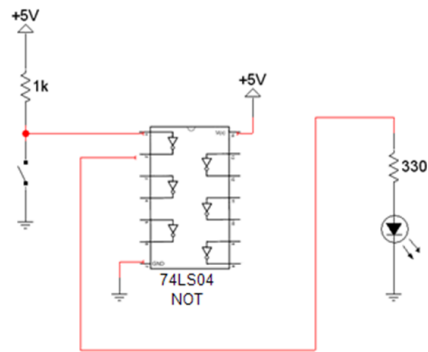


<http://www.rose-hulman.edu/ME430>

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Panel 9

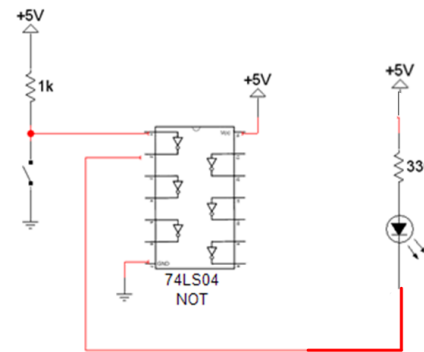
### Hex Inverter sourcing the current



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Panel 10

### Hex Inverter sinking current



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Panel 11

For you to fill in:

How much current does our LED draw?

\_\_\_\_\_

How much current does the 74LS04 source?

\_\_\_\_\_

How much current does the 74LS04 sink?

\_\_\_\_\_

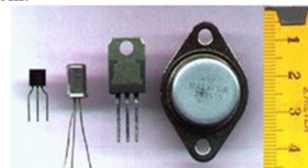
What is the difference between sinking and sourcing current?

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Panel 12

#### Transistor:

While not a mechanical switch, a transistor can be thought of as an electrically controlled switch.



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Panel 13

Types of Transistors:

Bipolar Junction Transistors - BJT

Metal Oxide Semiconductor Field Effect Transistors - MOSFET

Other types of transistors



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Panel 14

The first transistor invented at Bell Labs in 1947.

The transistor was used to amplify electrical currents. Before it was developed, electron tubes (also called vacuum tubes) were common. But they were too large and delicate for many uses.

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Panel 15

## Just how many transistors are there in the world?

*When people talk about big numbers they sometimes talk about **ants**.*

*Biologist Edmund Wilson has estimated that there are about **100 quadrillion ants** on Earth.*

*In a single year there are about **100 times as many transistors produced** — and the trend is accelerating.*

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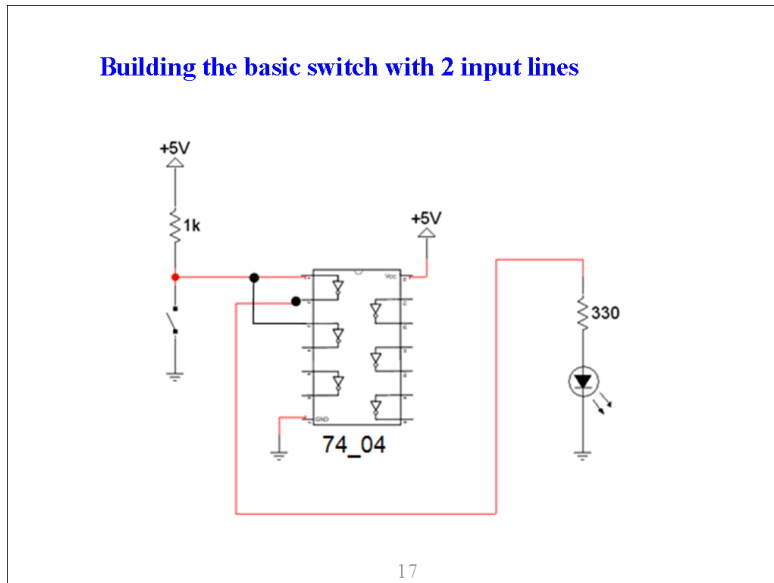
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Things we'll build in lab:

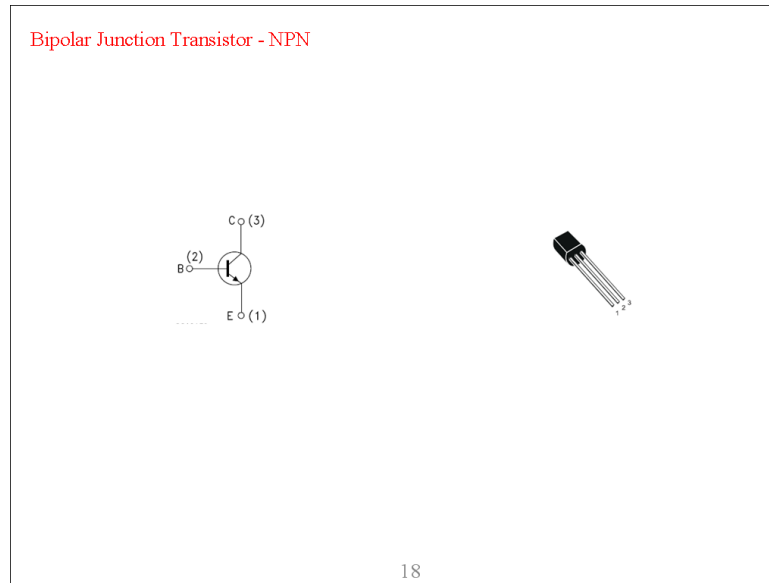
- #1. Functional circuit with only LED
- #2. Potentially functional circuit with 7404 powering a motor (pin 4) and LED (If it doesn't turn at all try to start it by hand. It may work fine or may not work at all!)
- #3. Potentially functional circuit with 7404 **sinking** current to the motor. (Note: To make the 7404 sink motor current connect one wire of the motor to 5 volts and the other wire to the 7404 pin 4. Now current goes from the supply into the chip. When is the motor on?)
- #4. Functional circuit using a NPN transistor (use pin 4, keep the LED circuit)
- #5. Functional circuit using an N-channel MOSFET
- #6. Functional circuit using a Darlington

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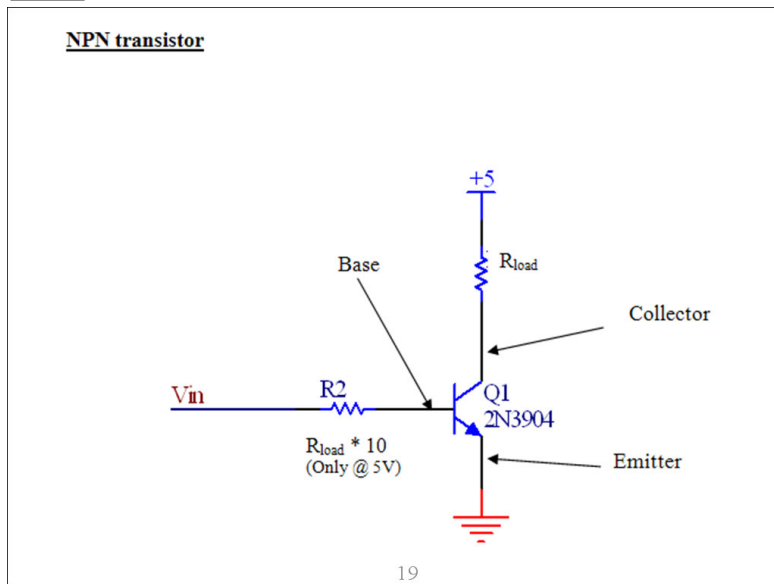
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Panel 18



Panel 19



Panel 20

2N3904

**SMALL SIGNAL NPN TRANSISTOR**

PRELIMINARY DATA

Type	Marking
2N3904	2N3904

- SILICON EPITAXIAL PLANAR NPN TRANSISTOR
- TO-92 PACKAGE SUITABLE FOR THROUGH-HOLE PCB ASSEMBLY
- THE PNP COMPLEMENTARY TYPE IS 2N3906

**APPLICATIONS**

- WELL SUITABLE FOR TV AND HOME APPLIANCE EQUIPMENT
- SMALL LOAD SWITCH TRANSISTOR WITH HIGH GAIN AND LOW SATURATION VOLTAGE

TO-92

INTERNAL SCHEMATIC DIAGRAM

6510130

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Panel 21

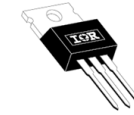
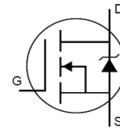
Draw the NPN transistor, label the legs, and write yourself a note about what that leg does.



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Panel 22

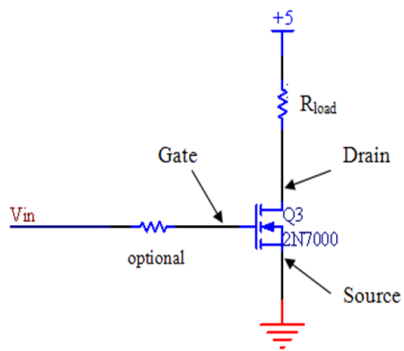
MOSFET - N channel



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Panel 23

N-Channel



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Panel 24

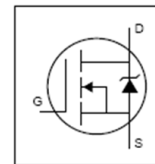
International  
**IR** Rectifier

PD - 9.1307B

**IRLZ34N**

HEXFET<sup>®</sup> Power MOSFET

- Logic-Level Gate Drive
- Advanced Process Technology
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated

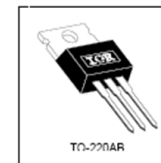


$V_{DS} = 55V$
$R_{DS(on)} = 0.035\Omega$
$I_D = 30A$

**Description**

Fifth Generation HEXFETs from International Rectifier utilize advanced processing techniques to achieve the lowest possible on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that HEXFET Power MOSFETs are well known for, provides the designer with an extremely efficient device for use in a wide variety of applications.

The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.



TO-220AR

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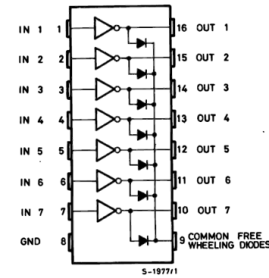
Draw the N Channel MOSFET, label the legs, and write a note about what that leg does.



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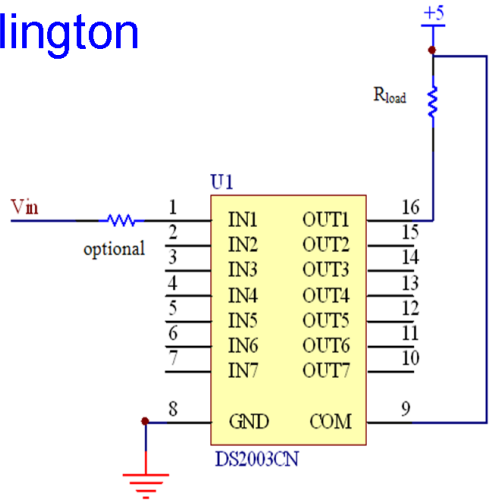
Darlington



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Panel 27

Darlington



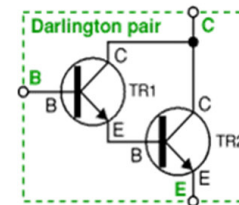
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ST  
ULN2001A-ULN2002A  
ULN2003A-ULN2004A

SEVEN DARLINGTON ARRAYS

- SEVEN DARLINGTONS PER PACKAGE
- OUTPUT CURRENT: 100mA PER DRIVER (50mA PEAK)
- OUTPUT VOLTAGE: 50V
- INTEGRATED SUPPRESSION DIODES FOR INDUCTIVE LOADS
- OUTPUTS CAN BE PARALLELED FOR HIGHER CURRENT
- TTL-CMOS/PMOS/DTL COMPATIBLE INPUTS
- INPUTS PINNED OPPOSITE OUTPUTS TO SIMPLIFY LAYOUT

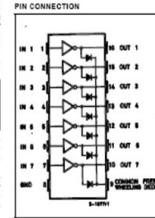


DESCRIPTION

The ULN2001A, ULN2002A, ULN2003 and ULN2004A are high voltage, high current Darlington arrays each containing seven open collector Darlington pairs with common emitters. Each channel rated at 100mA and can withstand peak currents of 500mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout. The four versions interface to all common logic families.

Part Number	Output Current	Output Voltage	Package
ULN2001A	100mA	50V	16-Pin PDIP
ULN2002A	100mA	50V	16-Pin SO
ULN2003A	100mA	50V	16-Pin CMOS
ULN2004A	100mA	50V	16-Pin CMOS

These versatile devices are useful for driving a wide range of loads including solenoids, relays, DC motors, LEDs, displays, filament lamps, thermal printers and high power outputs. The ULN2001A-2002A, 2003A and 2004A are supplied in 16 pin plastic DIP packages with a copper padframe to reduce thermal resistance. They are available also in small outline packages (SO-16) as ULN2001D, ULN2002D, ULN2003D and ULN2004D.



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Other topics relating to Transistors

H-Bridge circuits

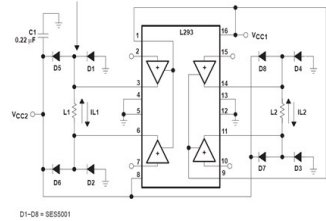


Figure 6. Bipolar Stepping Motor Control

Relays

