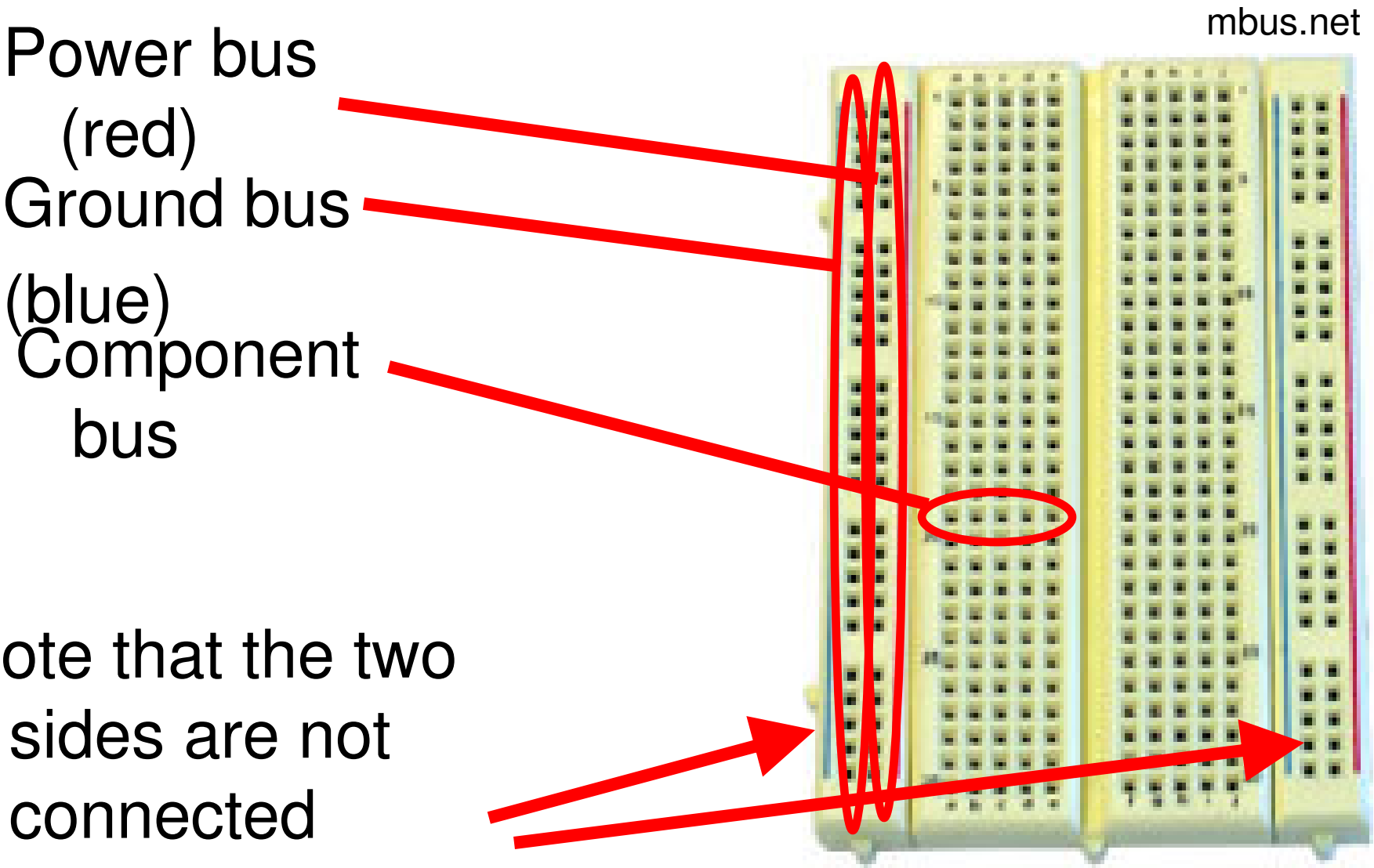
Solderless Breadboards



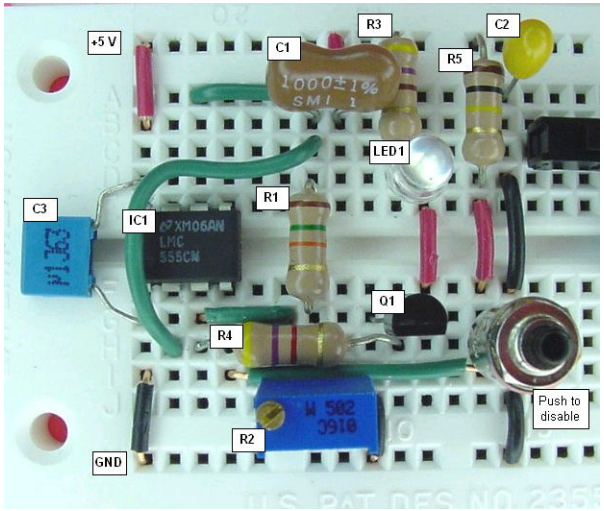
Wiring Standards

When possible, use wire colors for different types of signals:

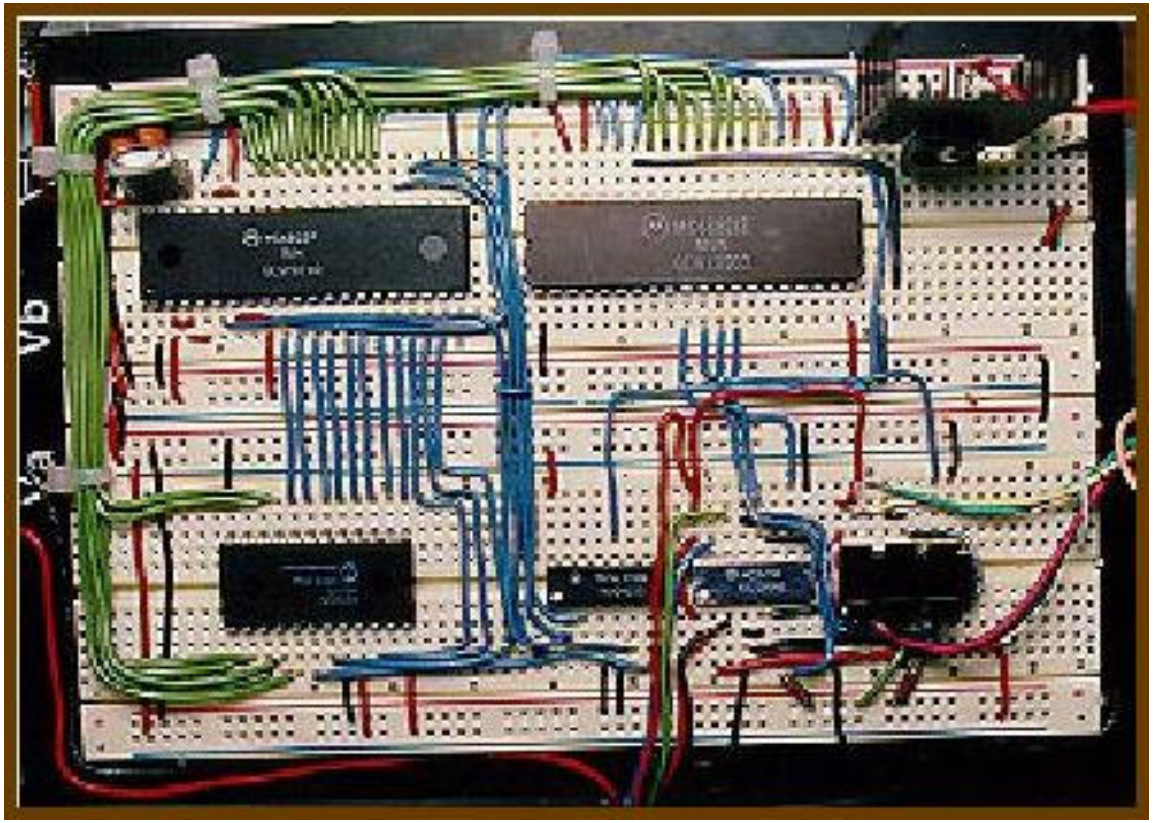
- Black: ground
- Red: power
- Other: various signals

Clean Wiring

A clean breadboard will make debugging easier – and it makes circuits more robust



www.linefollowing.com



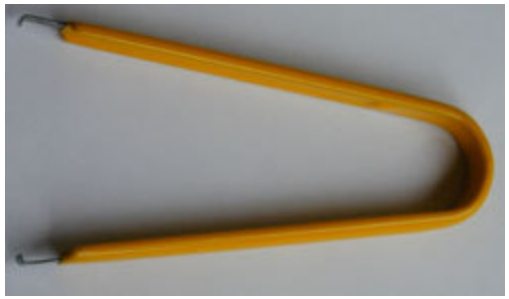
tangentsoft.net

Care with Power

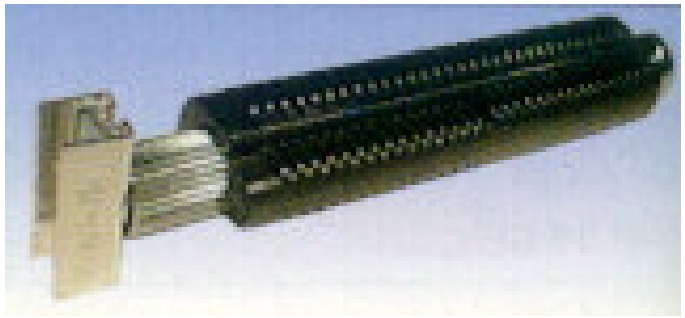
- Only insert components and wires into the breadboard when power is disconnected
- “Wire, check-twice, then power”
  - Never reverse power and ground (this is a very common mistake)
- Most chips that we will use expect +5V
  - More can destroy the chips
  - We will use DC/DC converters to step battery voltages down to +5V

Care of Chips

- Use insertion and extraction tools: never your fingers
- Minimize your contact with pins: static electricity can destroy a chip
- Use a wrist strap when you handle chips



www.a7vtroubleshooting.com



www.chantronics.com.au

Andrew H. Fagg: Embedded Real-Time Systems: Digital Practice

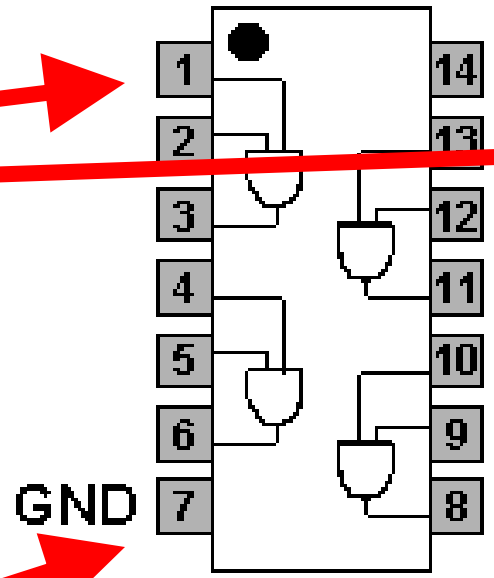
www.hvwtech.com

TTL Chips: 2-Input AND Gates

Chip number: 7408

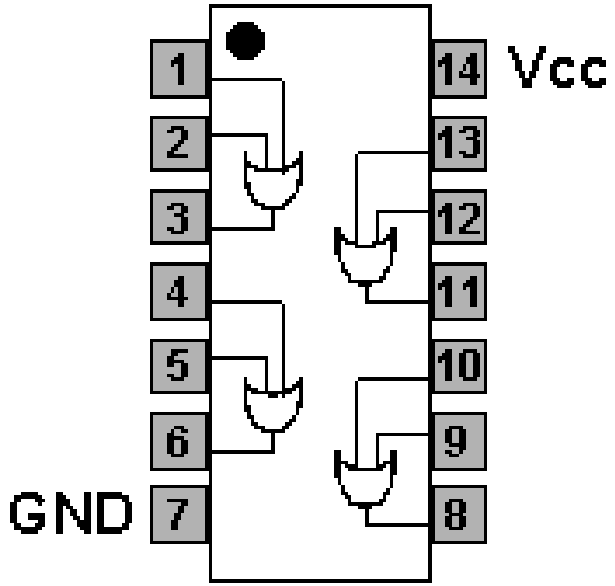
Power

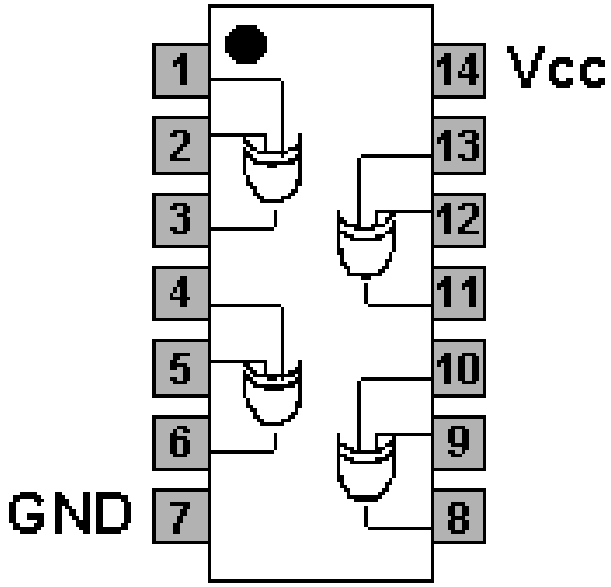
Pin 1 is marked on the chip



Ground

TTL Chips: 2-Input OR/XOR Gates





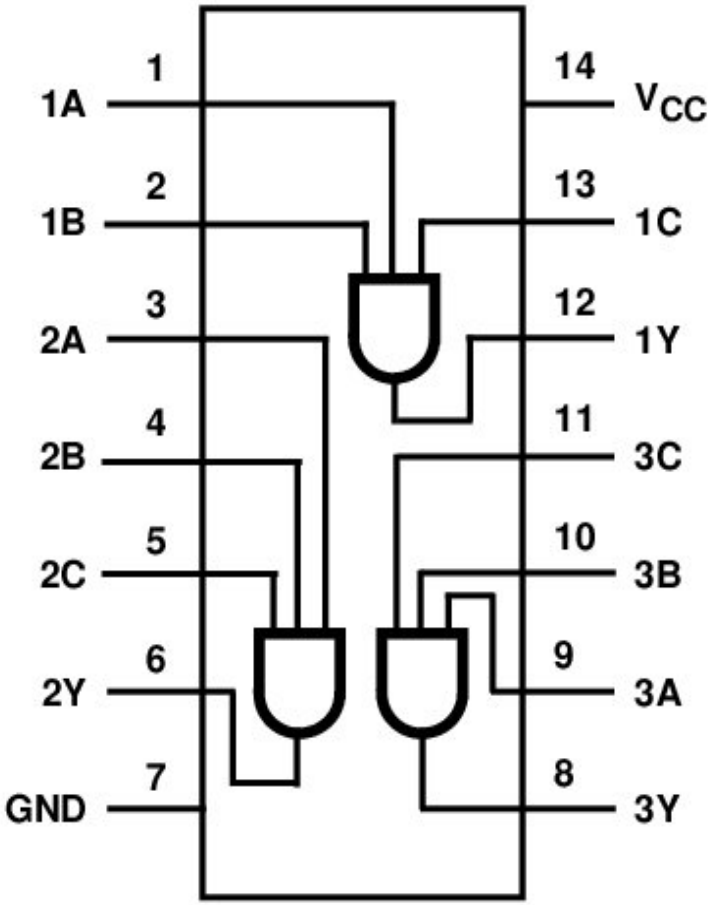
7432 or 74LS32

7486 or 74LS86

www.dcs.warwick.ac.uk

TTL Chips: 3-Input AND Gates

7411



digikey.com

Constant Inputs

How do we configure a chip input as a constant?

Constant Inputs

How do we configure a chip input as a constant?

- For a constant 0: connect to ground
- For a constant 1: use a pull-up resistor to +5V (e.g., 10K ohm)

Wiring Procedure (Suggested)

- Power supply
- Power/ground buses
- Insert primary components
- Wire power/ground for components
- Add signals and remaining components
- Test incrementally

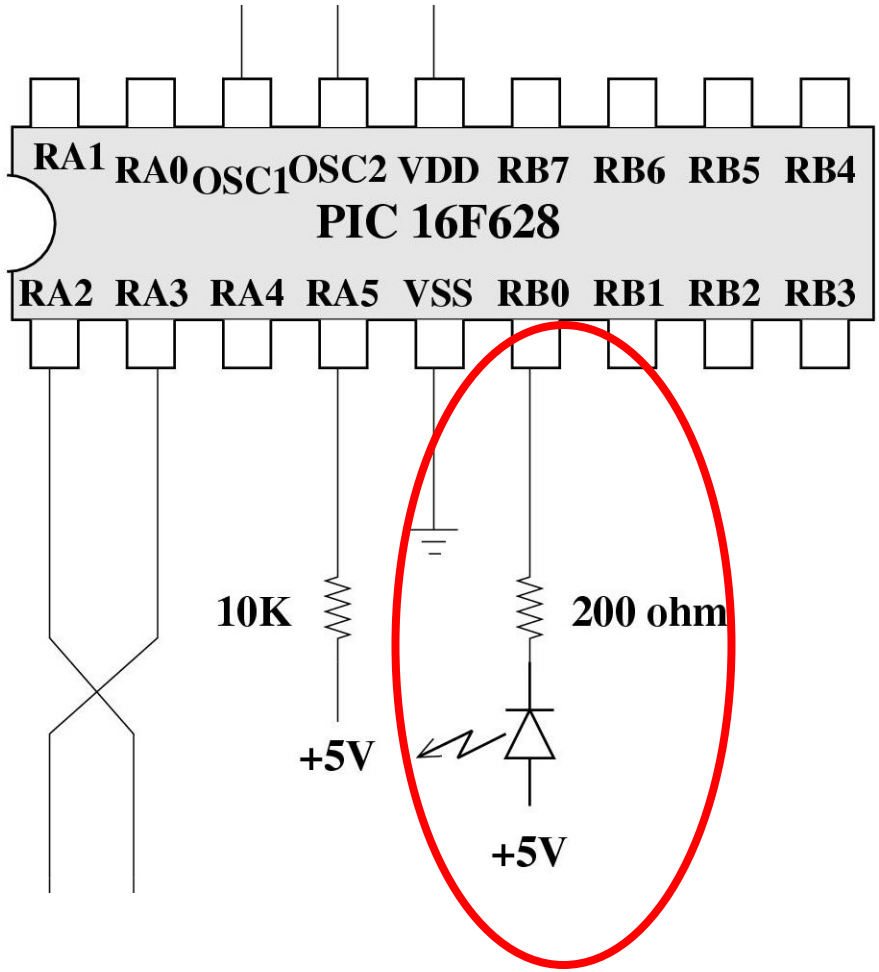
Debugging Techniques

- Multimeter:
  - Use *voltage mode* to check logic levels
  - Use *continuity mode* to confirm connections (but never with power turned on)
- Oscilloscope:
  - View voltage as a function of time on 2 channels
- Test incrementally
- Test intermediate sub-circuits

Debugging Techniques

Wire in LED to indicate logic level on a line

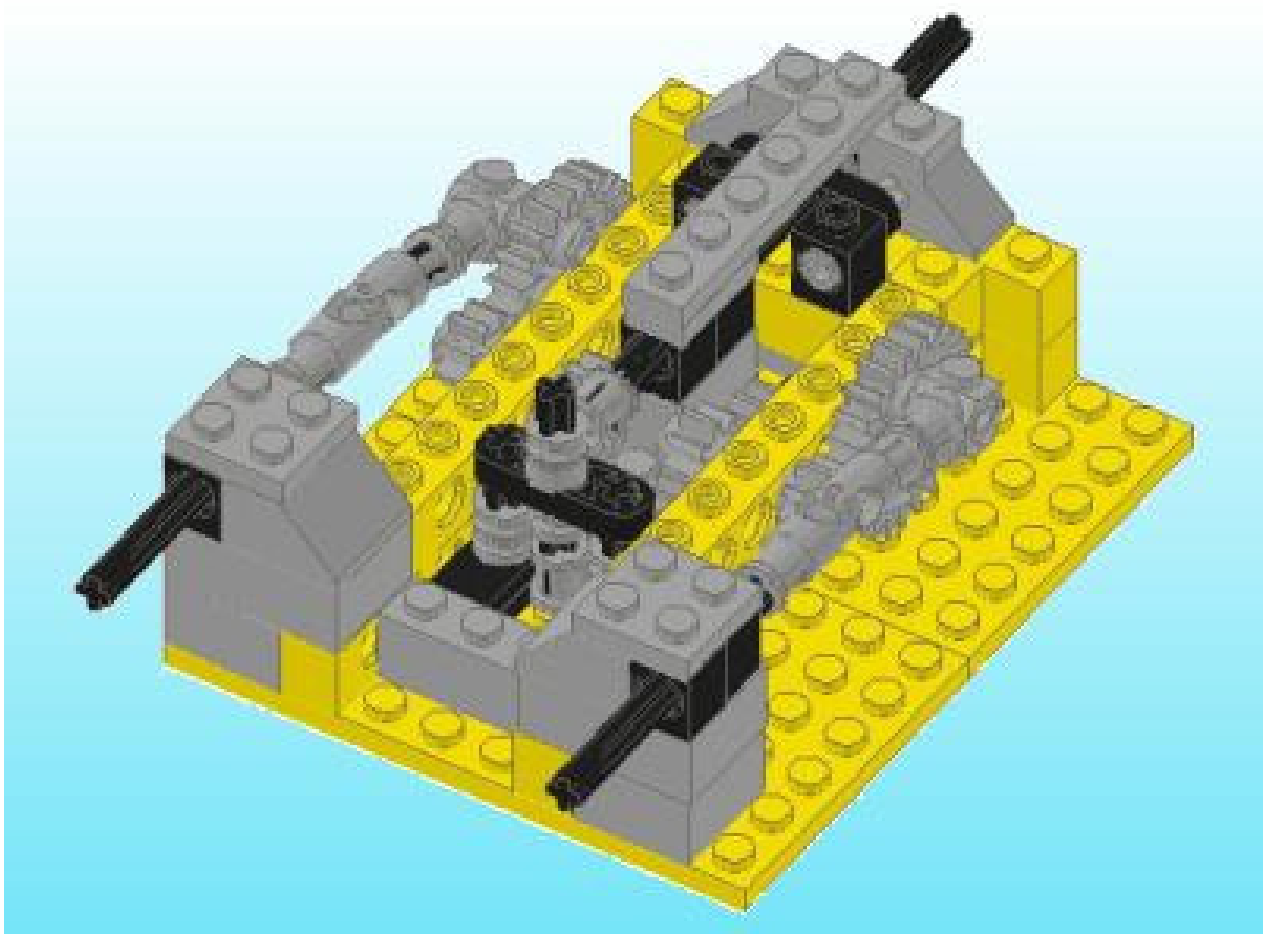
- For most components, do not allow the line to be driven by more than 20mA (check the specs if in doubt)
- Note that in this circuit, the LED turns on when logic level is LOW



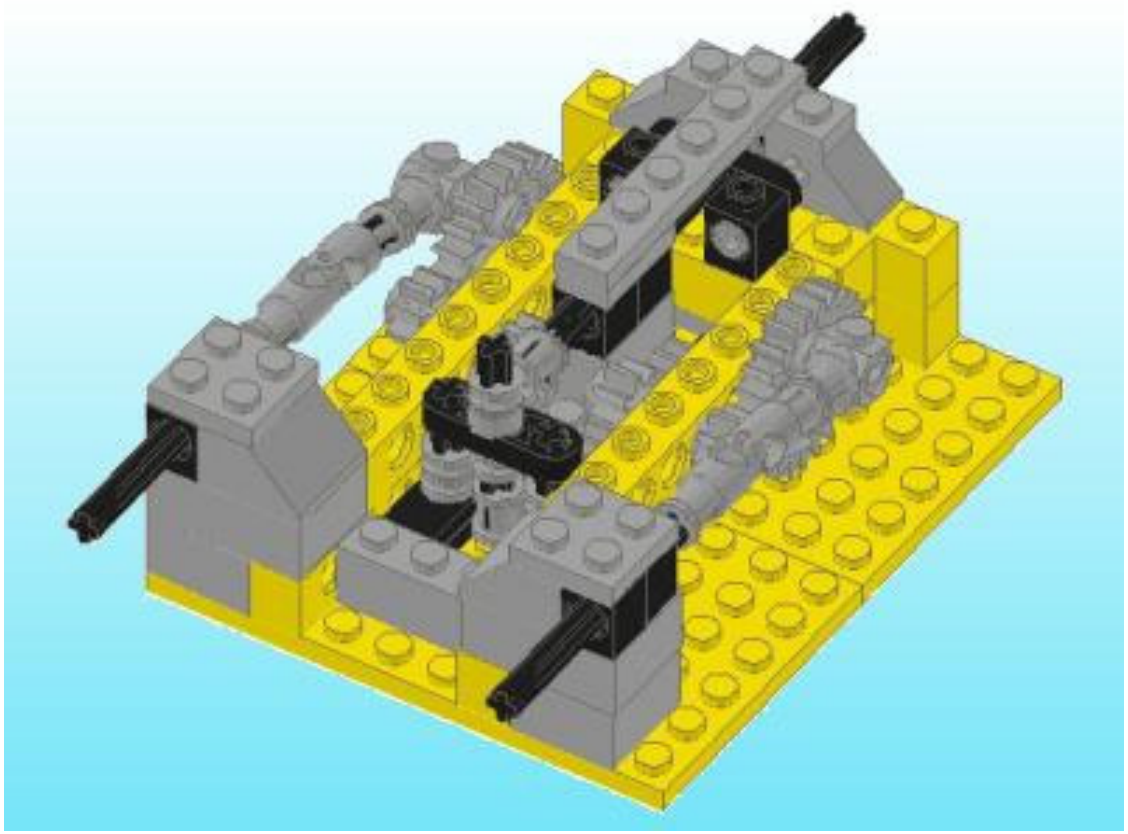
Next Time

- Homework 1 discussion
- Central Processing Units

What Is It?

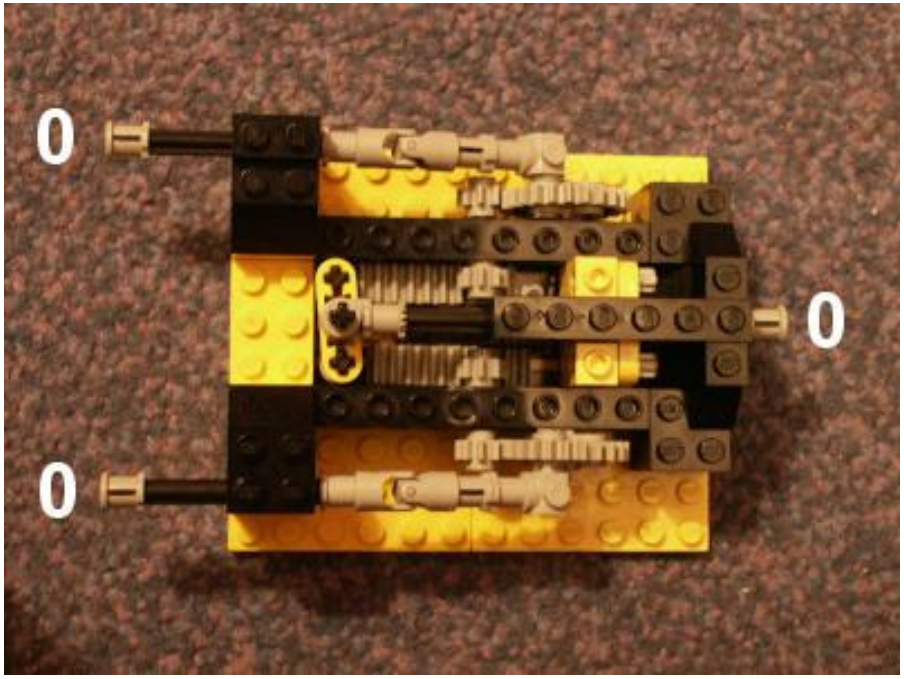


A Mechanical Implementation of an OR Gate

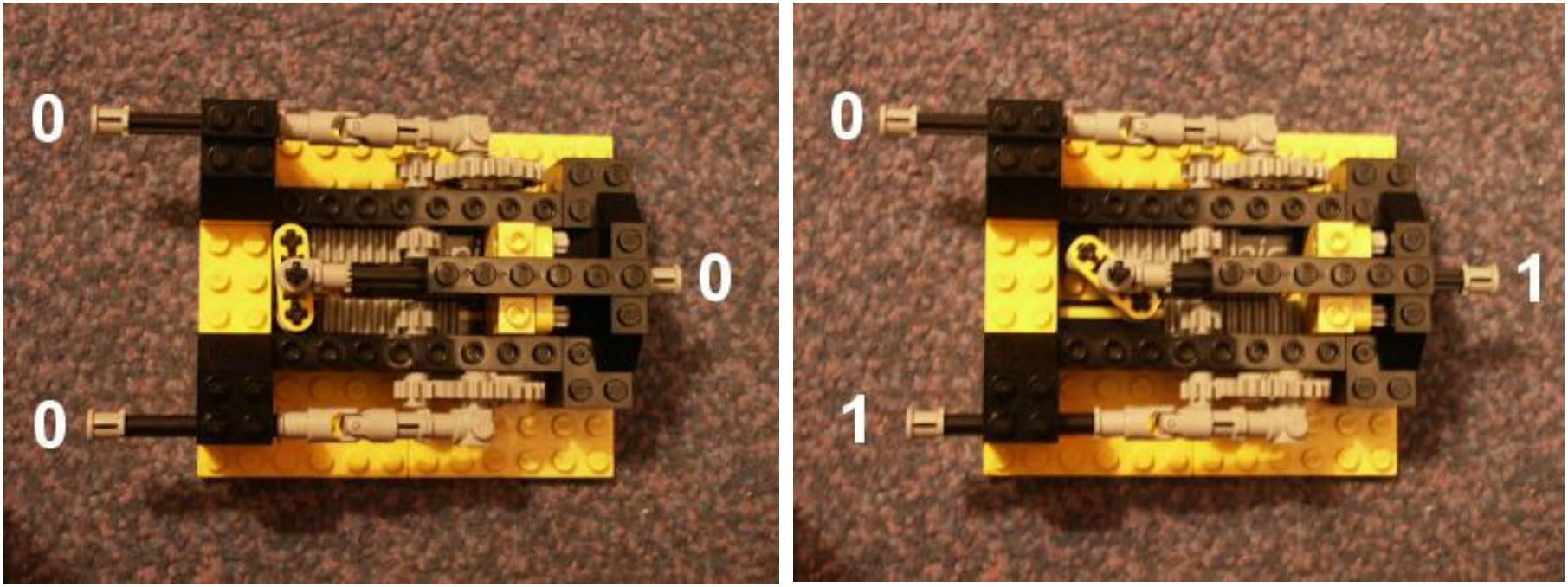


goldfish.ikaruga.co.uk/logic.html

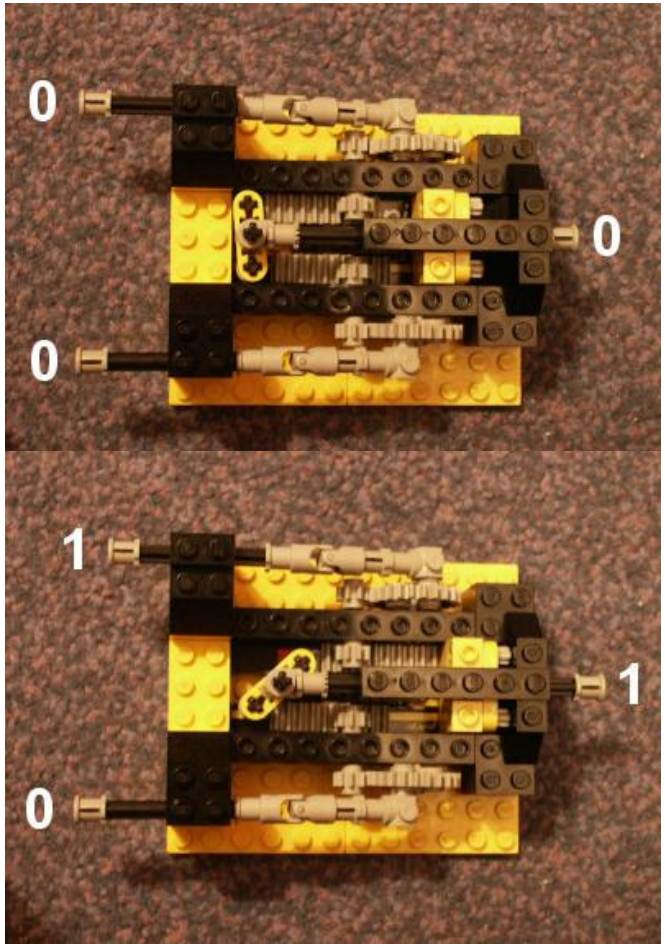
A Mechanical Implementation of an OR Gate

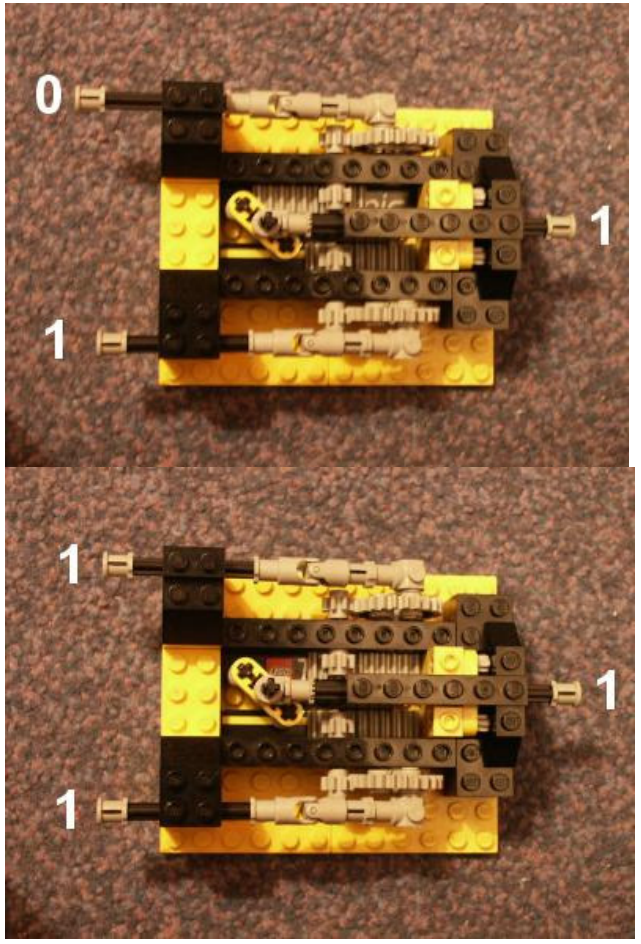


A Mechanical Implementation of an OR Gate



A Mechanical Implementation of an OR Gate





Last Time

- Demultiplexers
- Tristate buffers
- Digital logic in practice:
  - Chips with gates
  - Power
  - Constant inputs

Today

- Homework 1
- More circuit details
- Project groups
- Sequential logic

Administrivia

- Homework 2 due on Tuesday @5:00

- Appendix B:
  - Note gate symbol errors on page 596 (in particular, AND and OR)

Homework 1

- Mean: 88.37%
- Median: 89.59%
- Standard deviation: 10.35%

Proposed Groups

Group 1:
- Hawkins
- Edwards*
- Hopkins
- ?

Group E:
- Watson
- Ritz

- Barajas Cortes
- Thompson
- Nicholas

Group 2:
- Littlefield
- Torres
- Goepfert
- ???

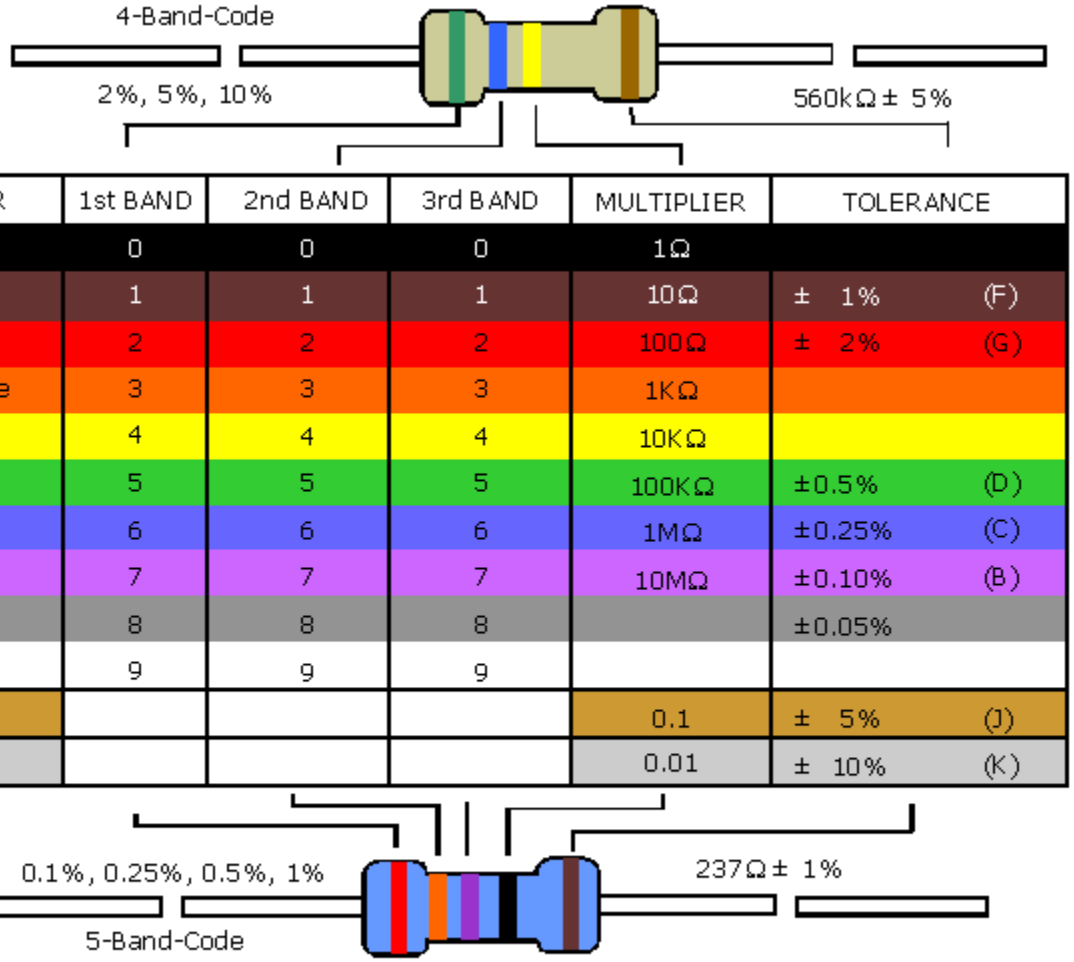
Group 3:
- Valentas
- Nakajima
- Sullivan
- Nelson

Group 4:
- Moerbeek
- Habib
- Murphy

Group 5:
- Striz
- Imai
- Lucas
- Bent

Resistor Codes

Our resistors use the 4-band code



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

Electronix Express / RSR
http://www.elexp.com

1-800-972-2225
In NJ 732-381-8020

Next Time

Project 1:

- Specification
- Initial group work