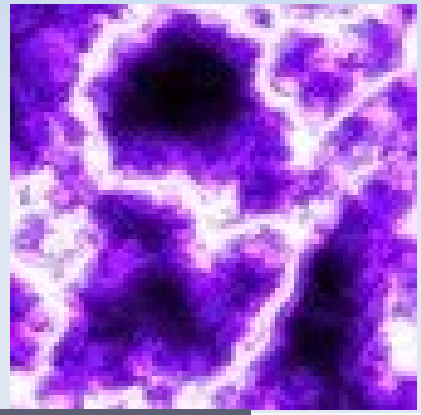
Introduction

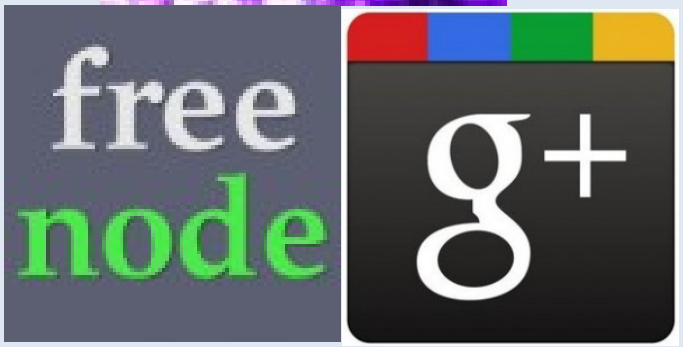
References and Presentation at:

http://www.elinux.org/elce-i2c

Introduction

- Dave Anders aka prpplague





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- Dave Anders aka prpplague
- Currently Contracted with TI

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- Partners in TinCanTools

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- Board Bring: You, Me, and I2C

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  - Communication Principles

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  - Communication Principles
  - Drivers and Software Tools

Introduction

- Dave Anders aka prpplague
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- Board Bring: You, Me, and I2C
  - Communication Principles
  - Drivers and Software Tools
  - Board Bringup Use Cases

Communication Principles

- Asynchronous Communication

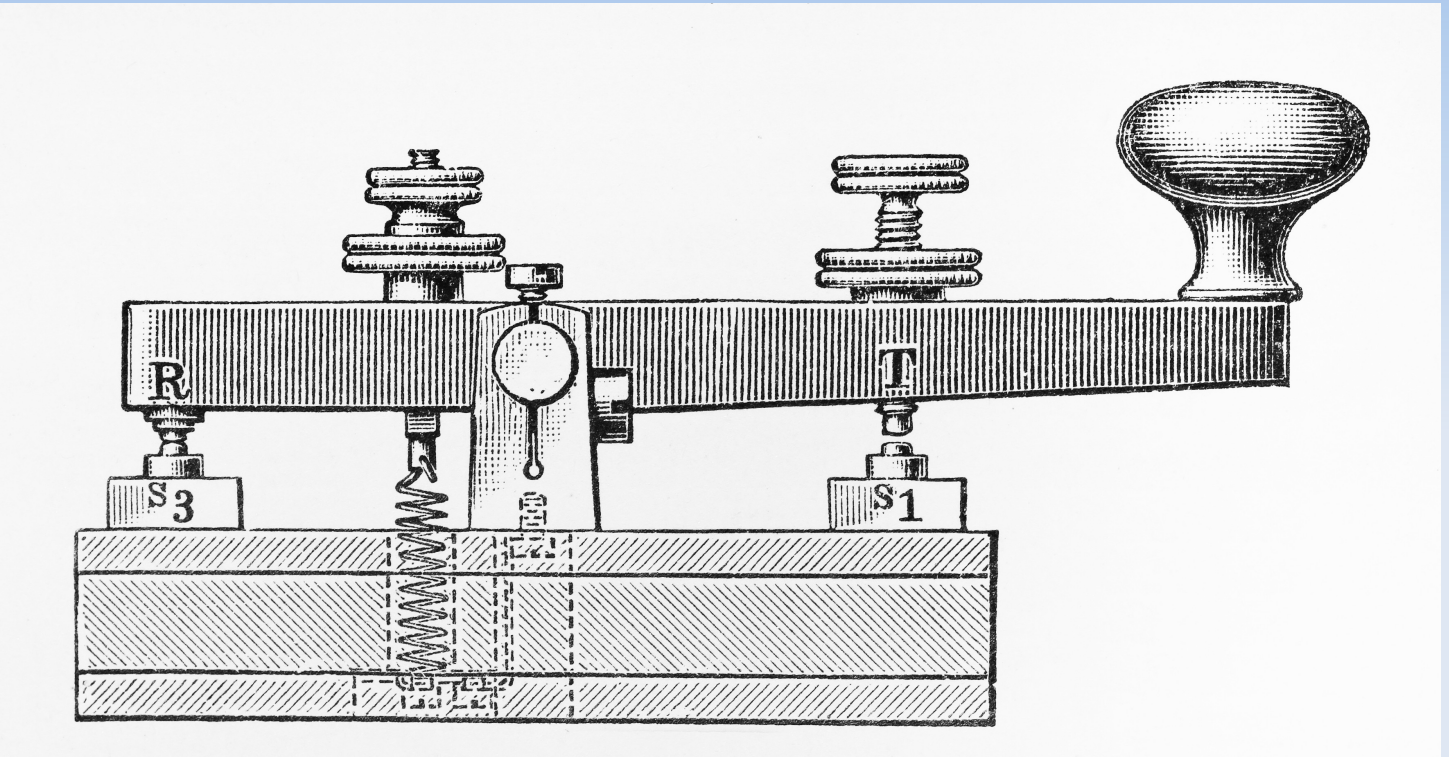
Communication Principles

- Asynchronous Communication
  - No External Clock Signal

Communication Principles

- Asynchronous Communication
  - No External Clock Signal
  - Morse Code / Telegraph

Communication Principles



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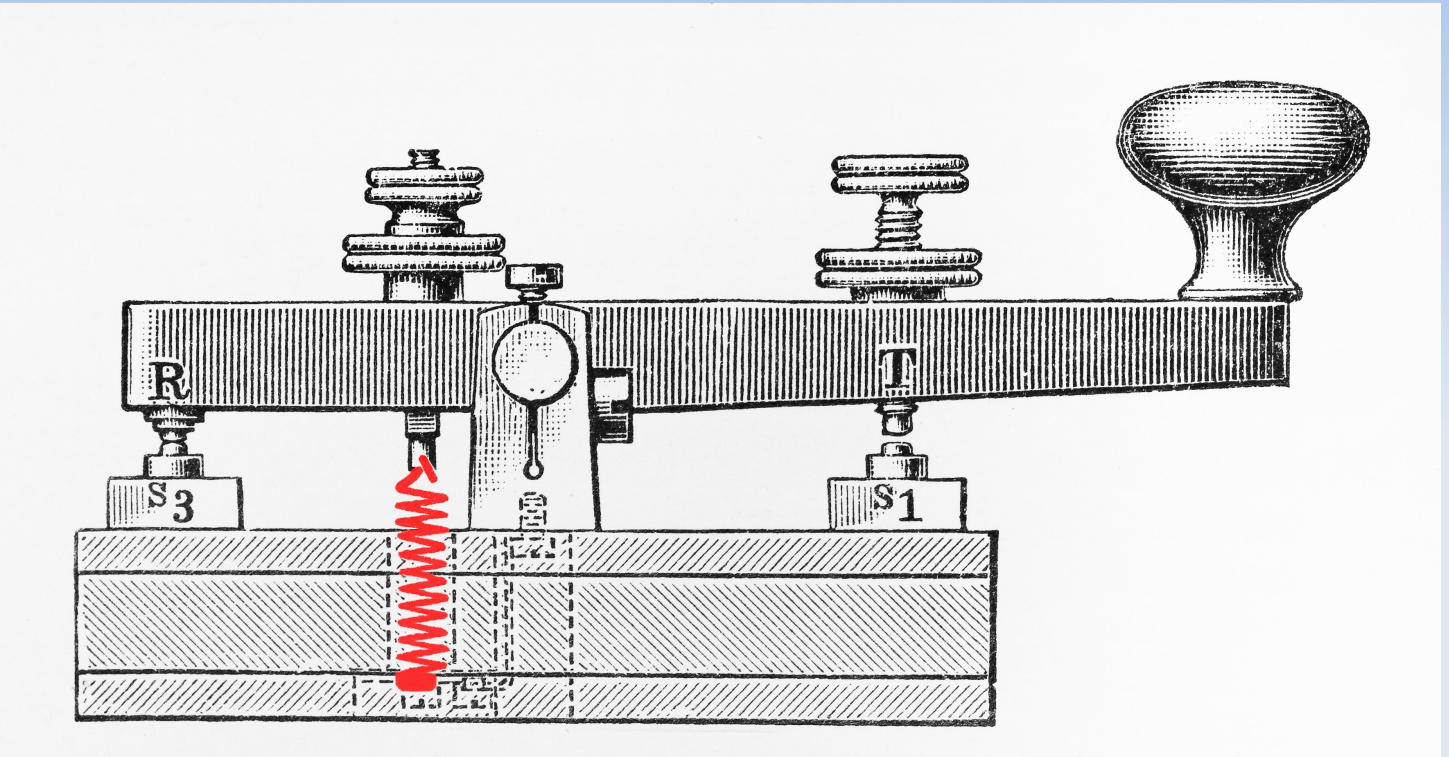

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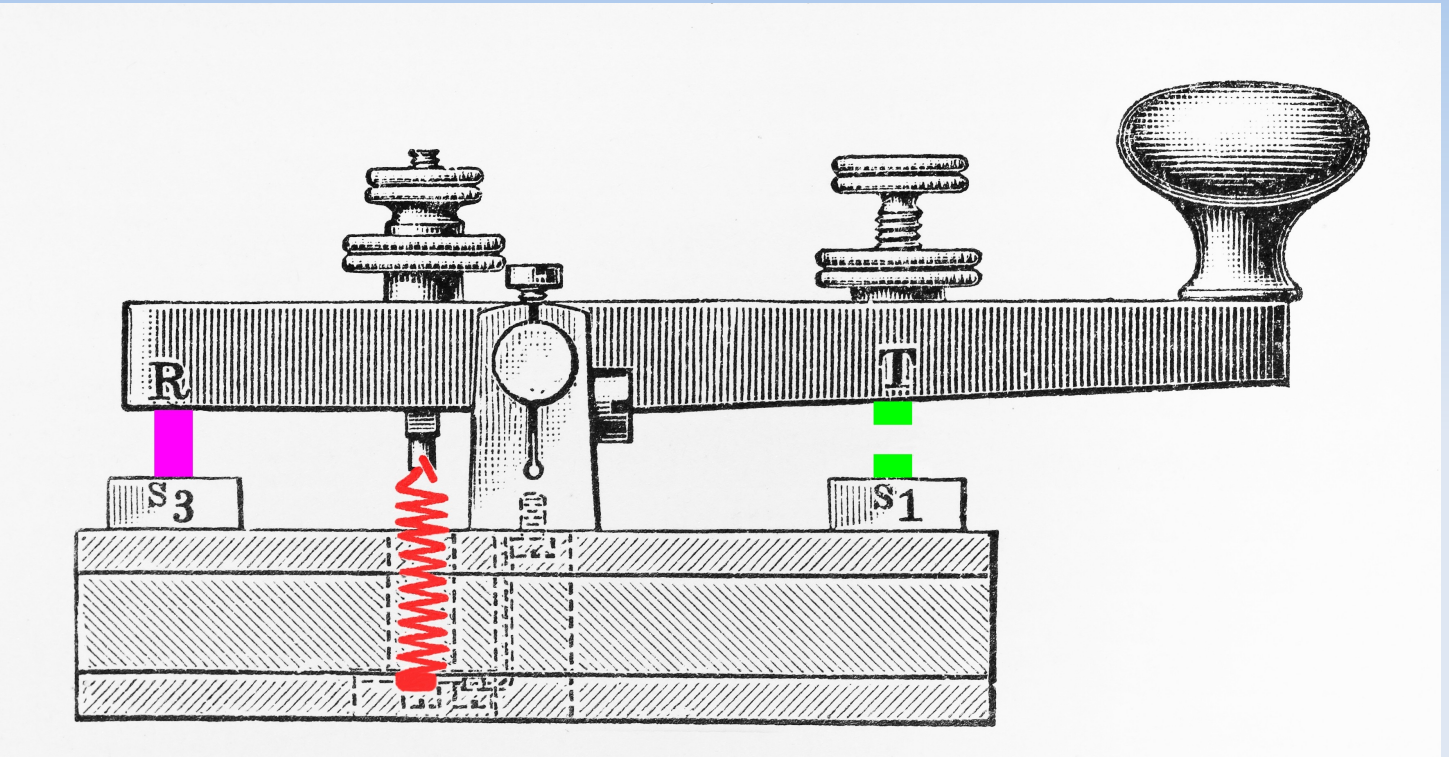

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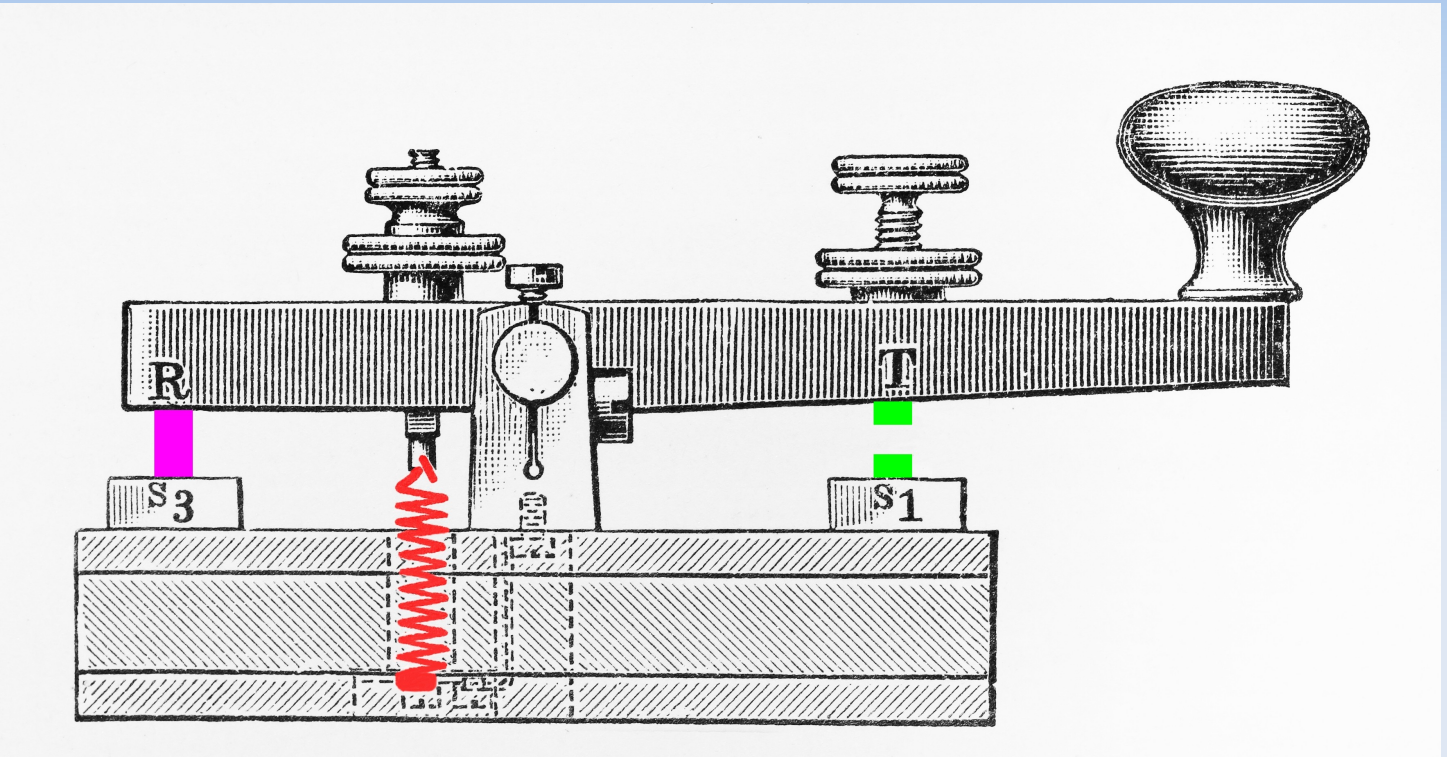

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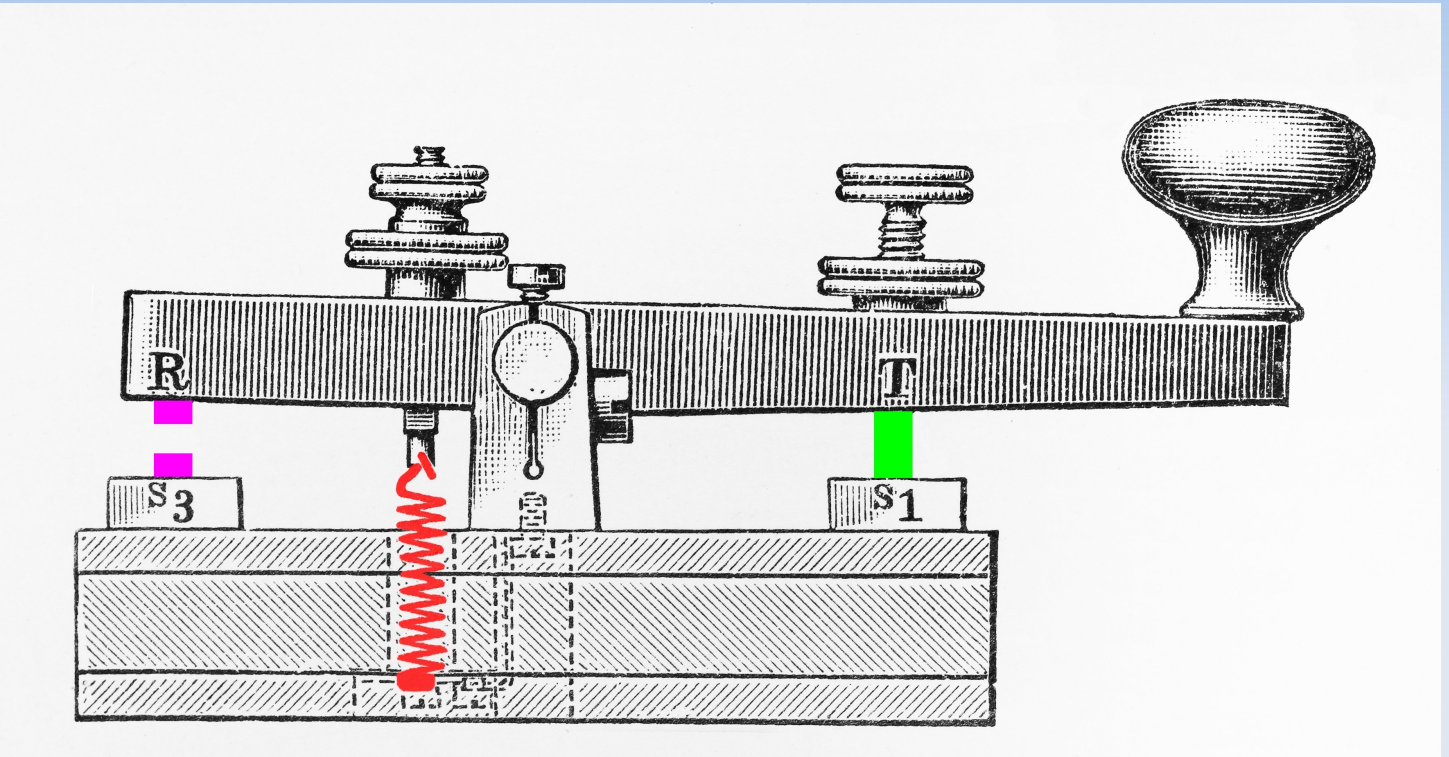

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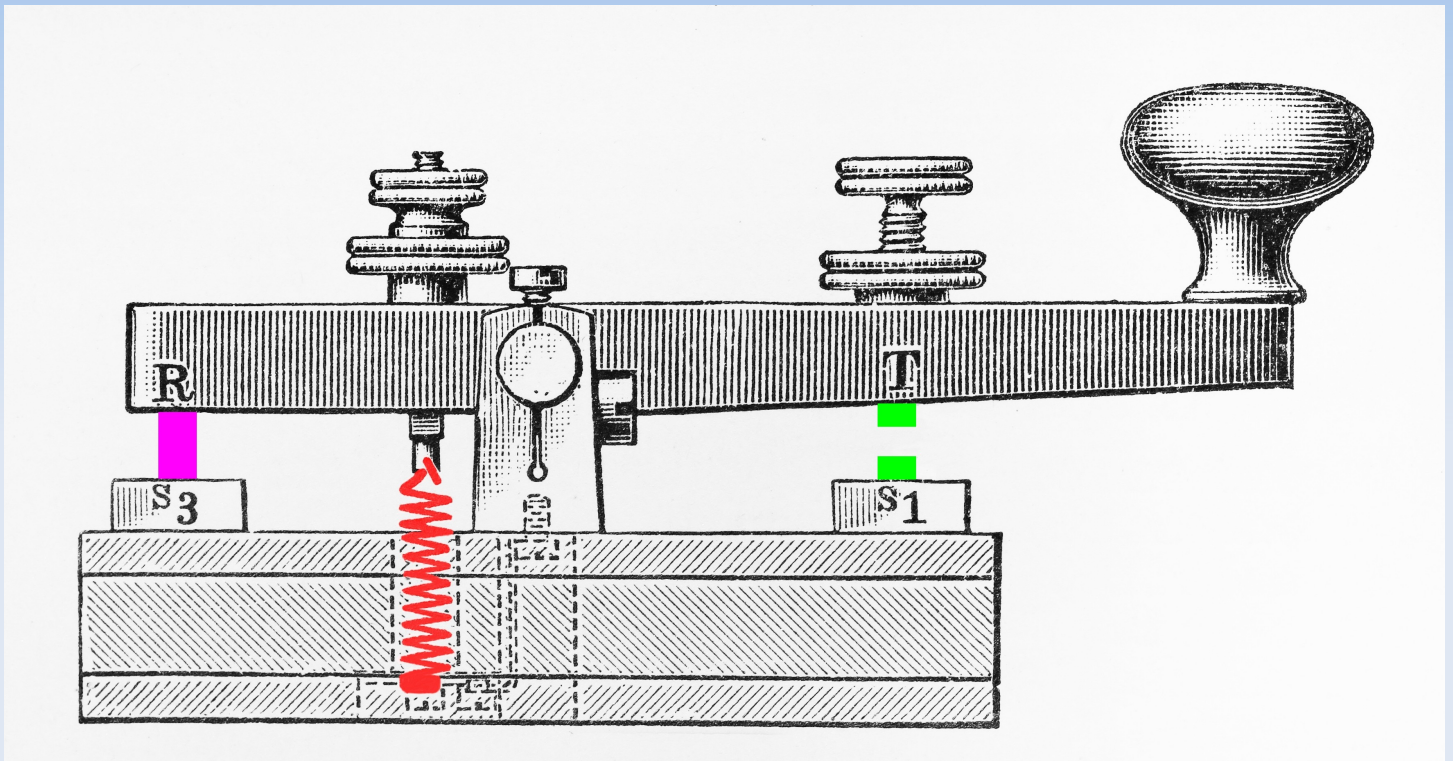

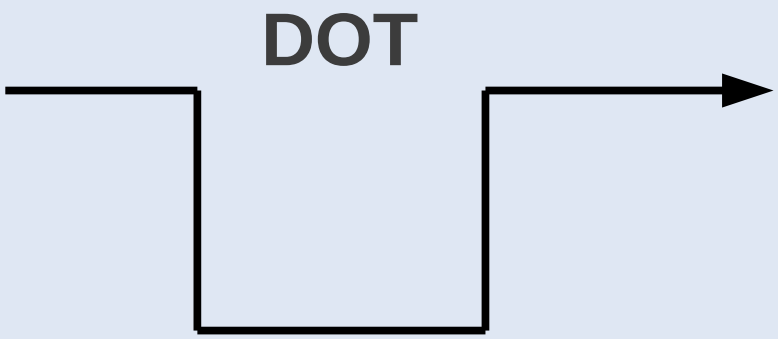

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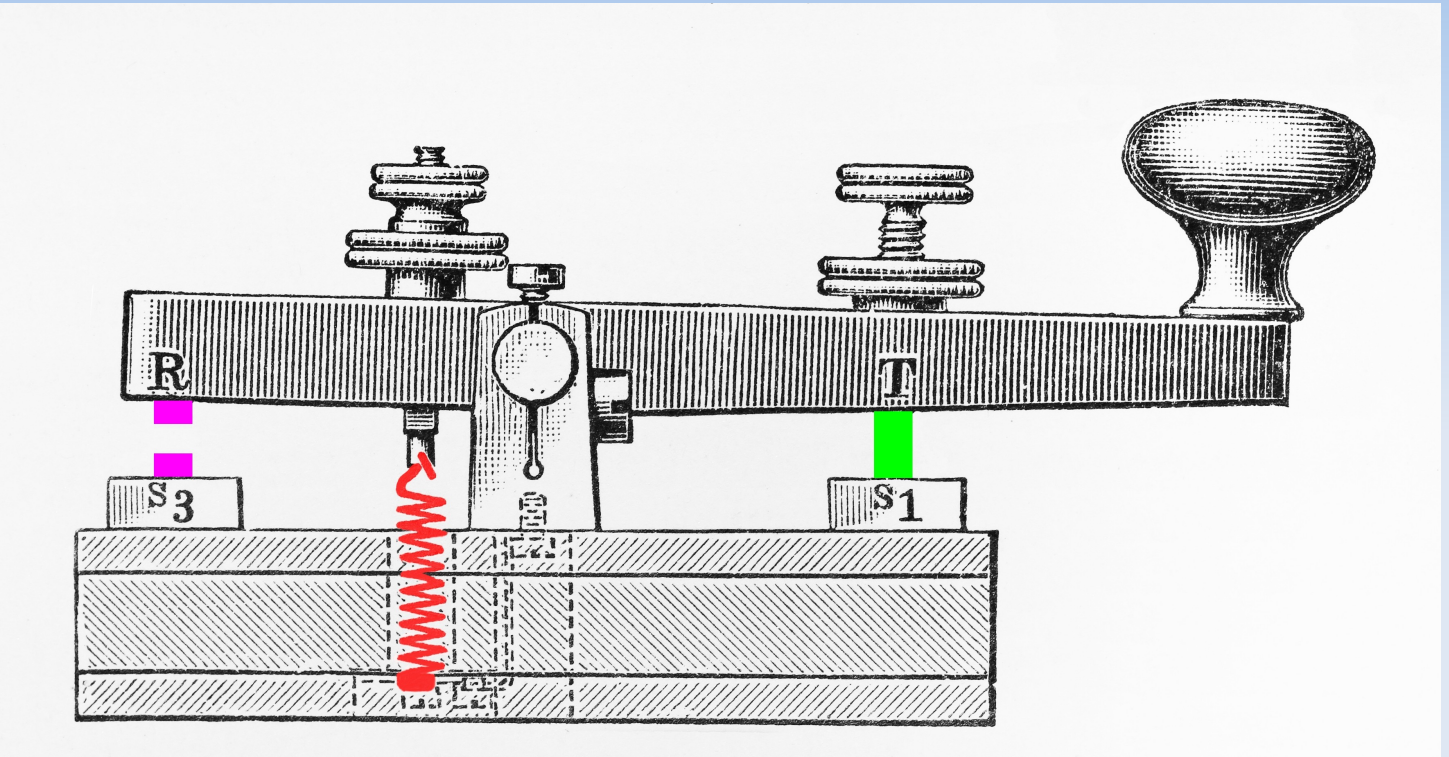
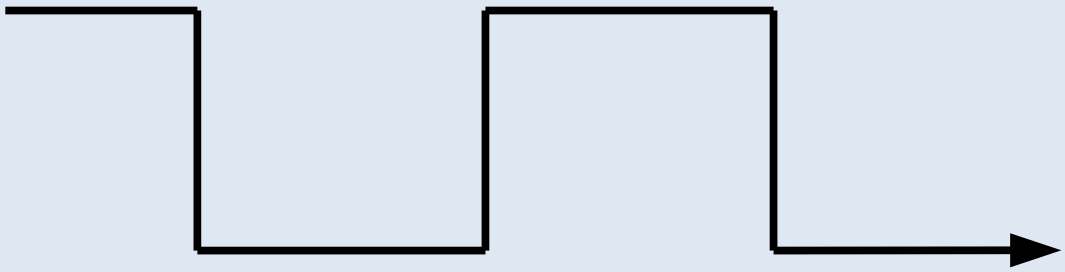


DOT



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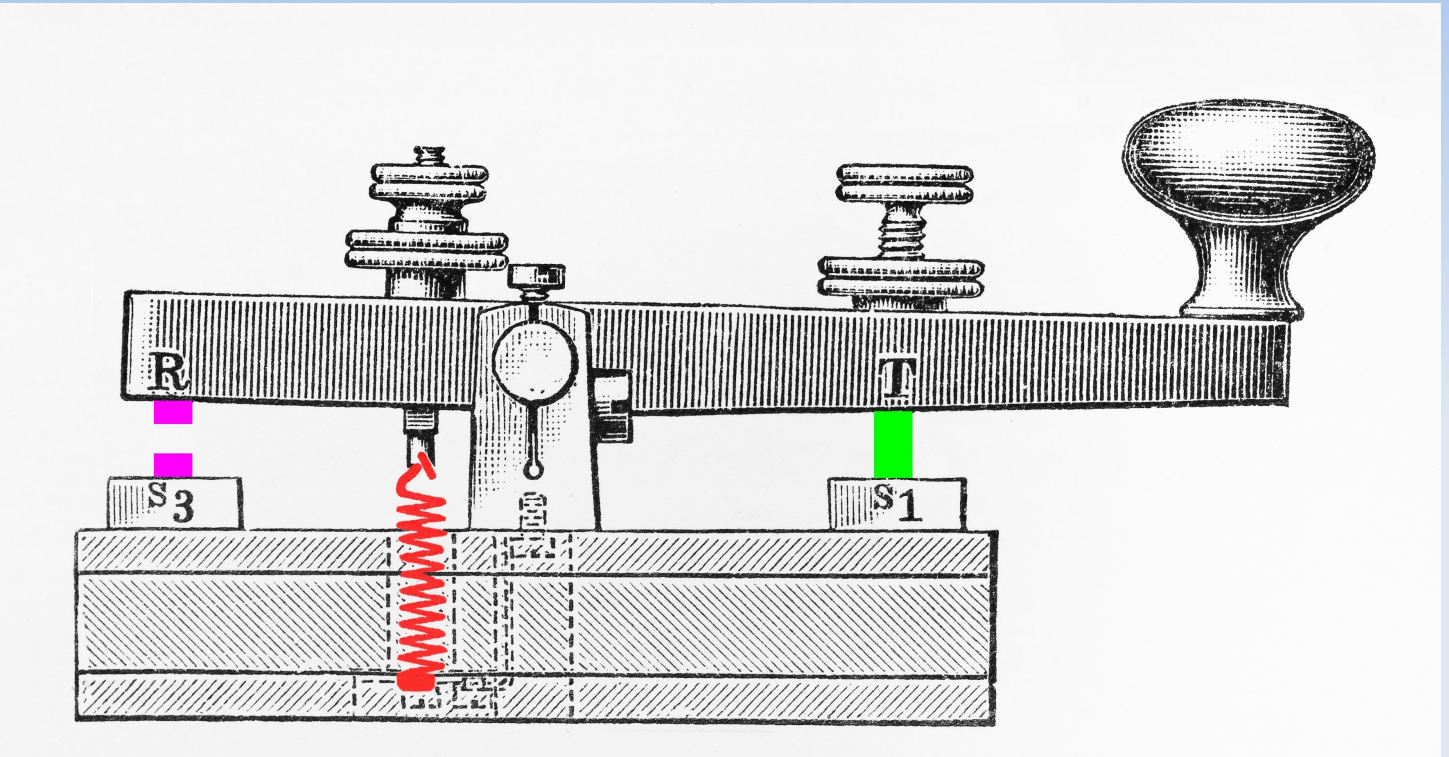

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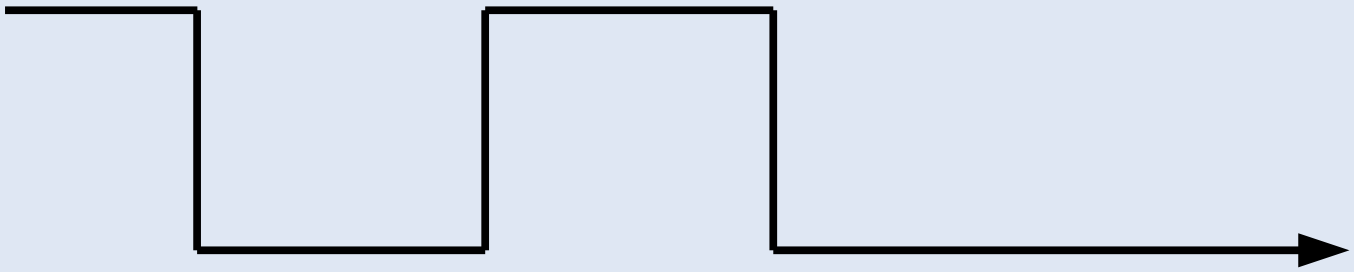

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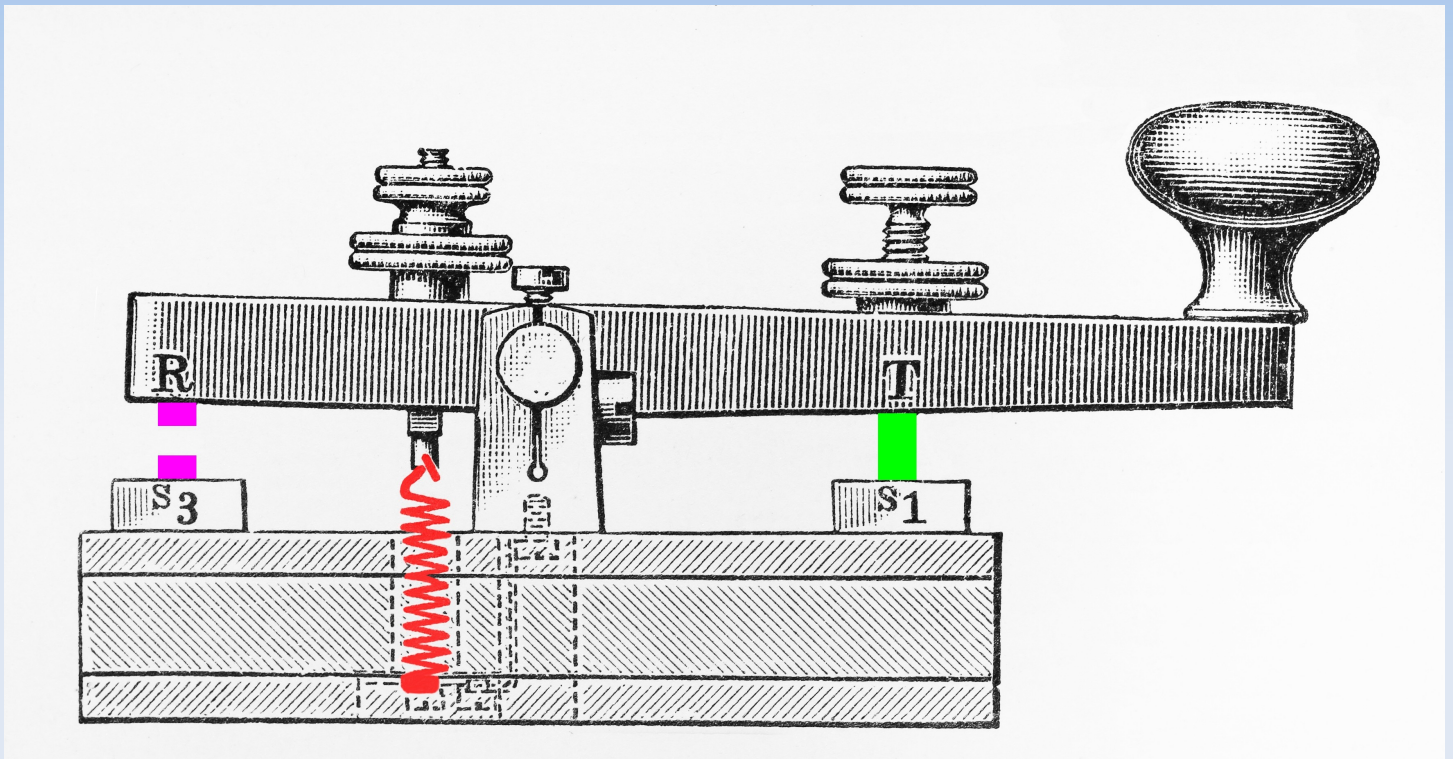

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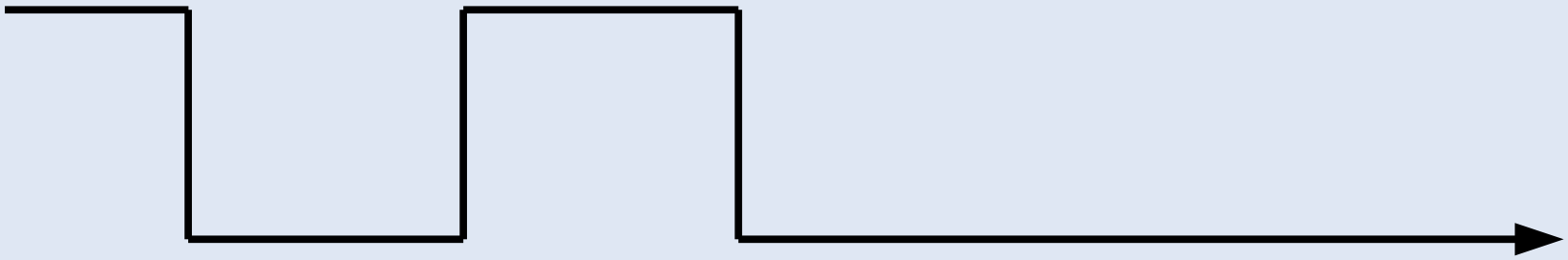

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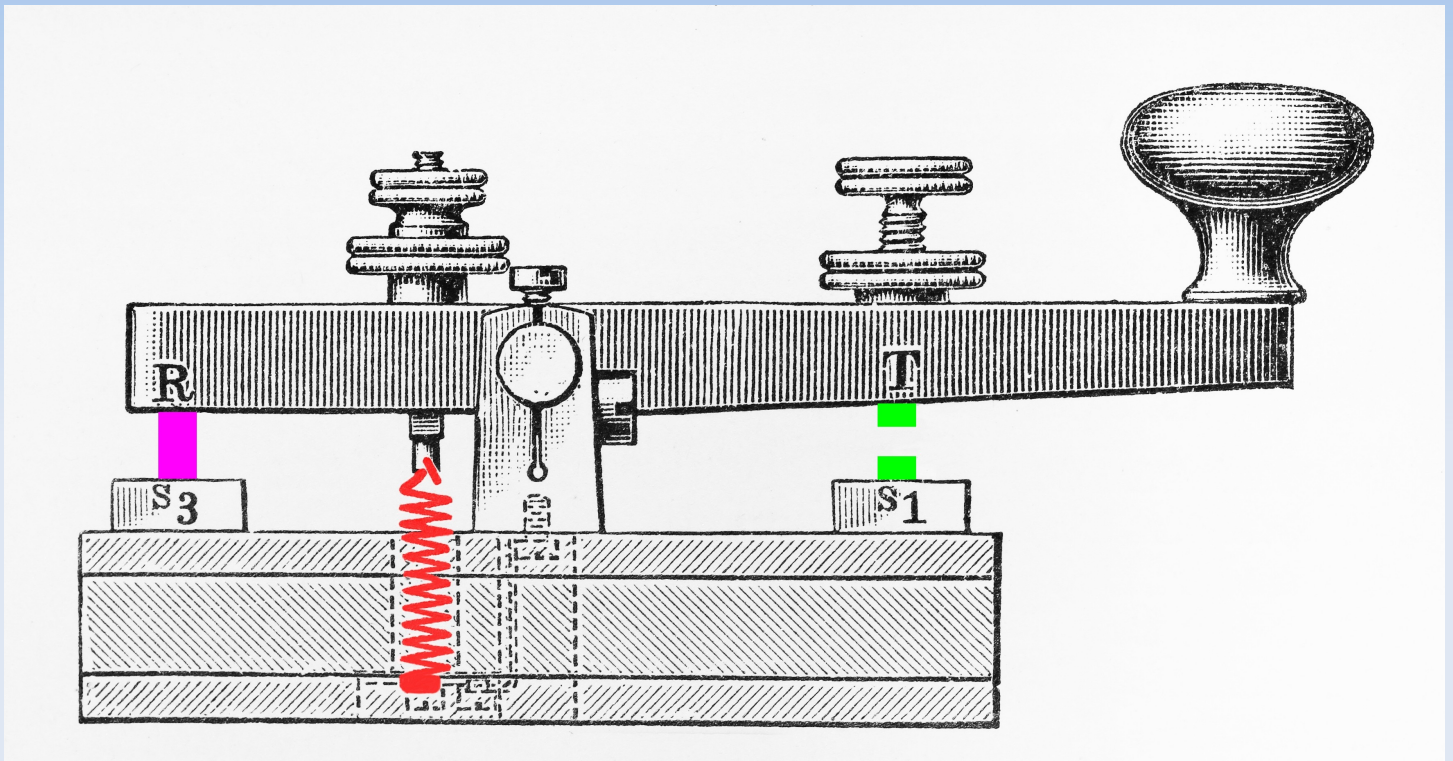

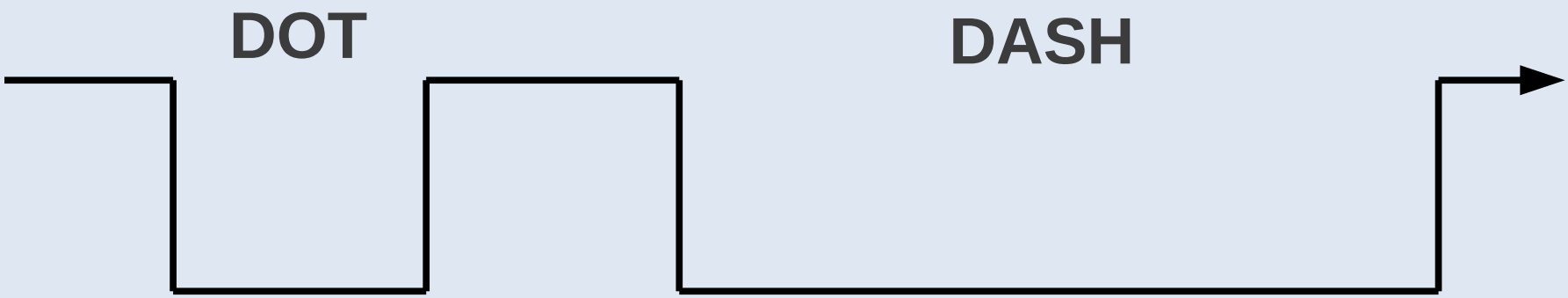

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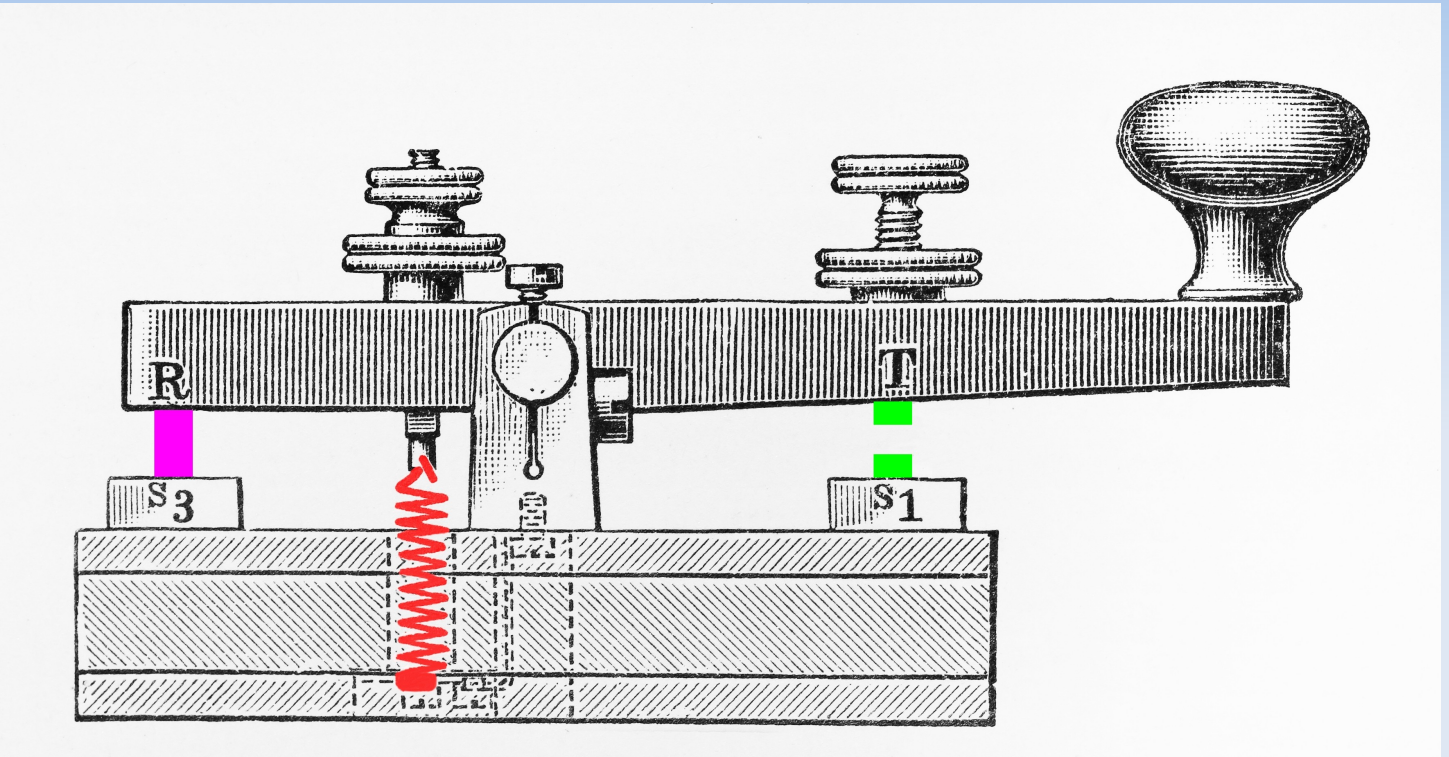

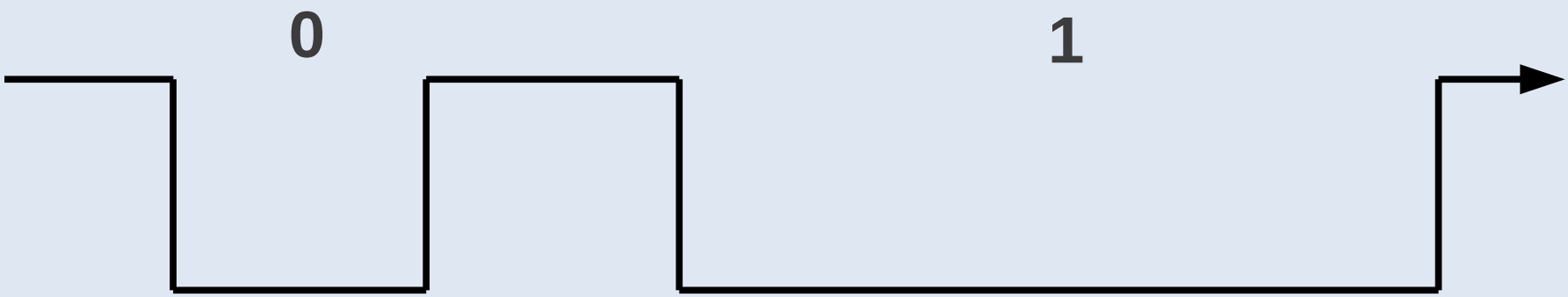

Communication Principles

- Asynchronous Communication
  - No External Clock Signal
  - Morse Code / Telegraph
  - RS-232/UART

Communication Principles

- Asynchronous Communication
  - No External Clock Signal
  - Morse Code / Telegraph
  - RS-232/UART
    - Universal
    - Asynchronous
    - Receiver
    - Transmitter

Communication Principles

- Asynchronous Communication
  - No External Clock Signal
  - Morse Code / Telegraph
  - RS-232/UART
  - Agreed Upon Period Length
    - DOT / DASH
    - Baud Rate

Communication Principles

- Asynchronous Communication
  - No External Clock Signal
  - Morse Code / Telegraph
  - RS-232/UART
  - Agreed Upon Period Length
  - Accurate Timing Device

Communication Principles

- Asynchronous Communication
  - No External Clock Signal
  - Morse Code / Telegraph
  - RS-232/UART
  - Agreed Upon Period Length
  - Accurate Timing Device
    - Crystals
    - Oscillators
    - System Clock Dividers
      - Atmel AVR with 10MHz clock
      - 10MHz / 20 / 4 = 125000
      - 115200 vs. 125000 = 8.5% error

Communication Principles

- Asynchronous Communication
- The Problem

Communication Principles

- Asynchronous Communication
- The Problem
  - Simple peripherals
  - Reduced external components
  - No need to set period length
  - Wide range of frequencies

Communication Principles

- Asynchronous Communication
- The Problem
- Synchronous Communication

Communication Principles

- Asynchronous Communication
- The Problem
- Synchronous Communication
  - Uses Dedicated Clock Signal

Communication Principles

- Asynchronous Communication
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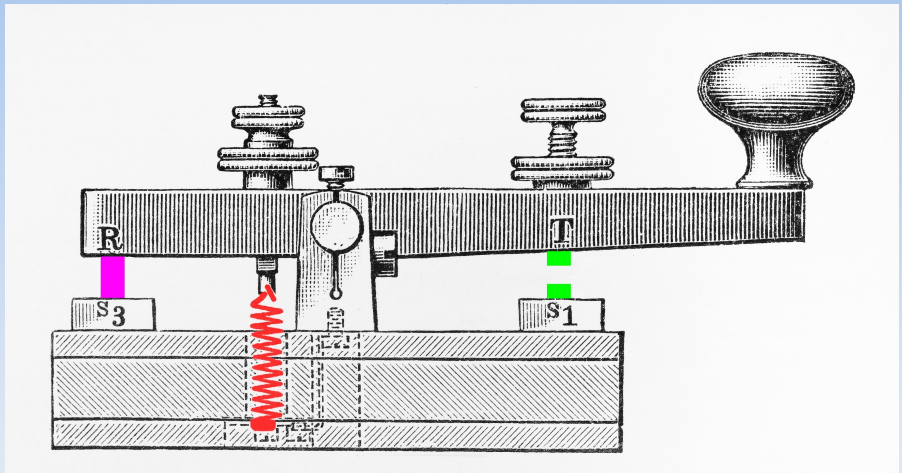
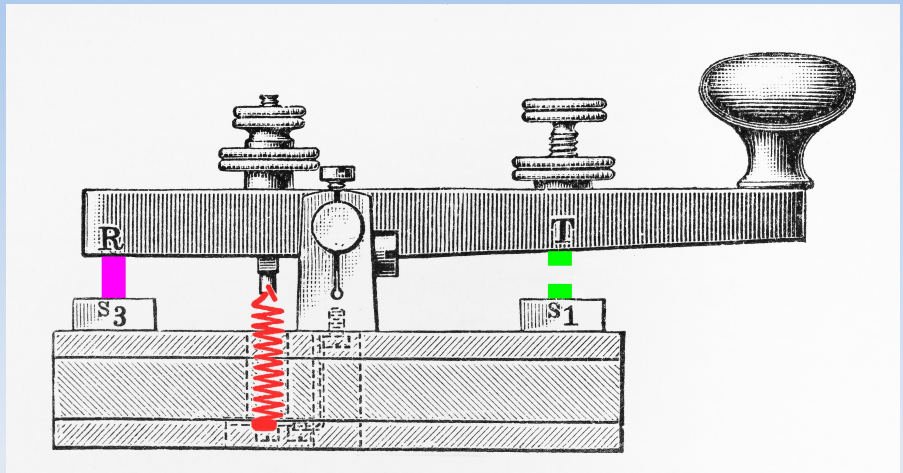
- Synchronous Communication
  - Uses Dedicated Clock Signal
  - Edison Stock Quotes

Communication Principles

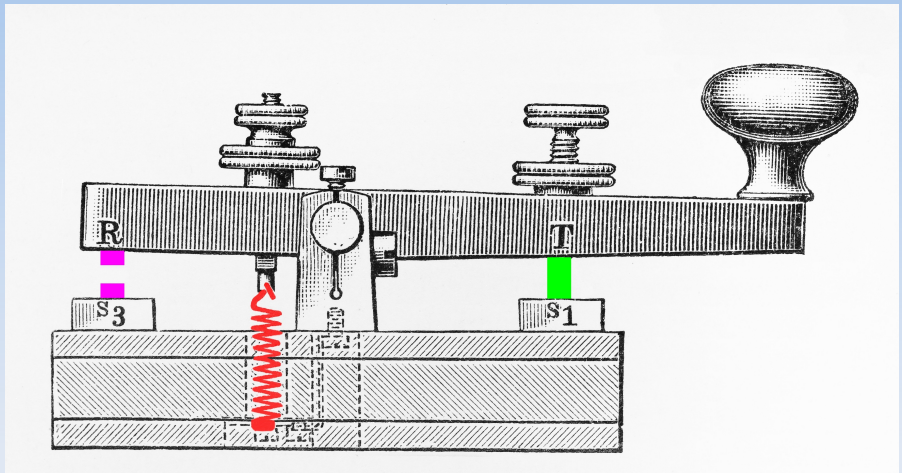


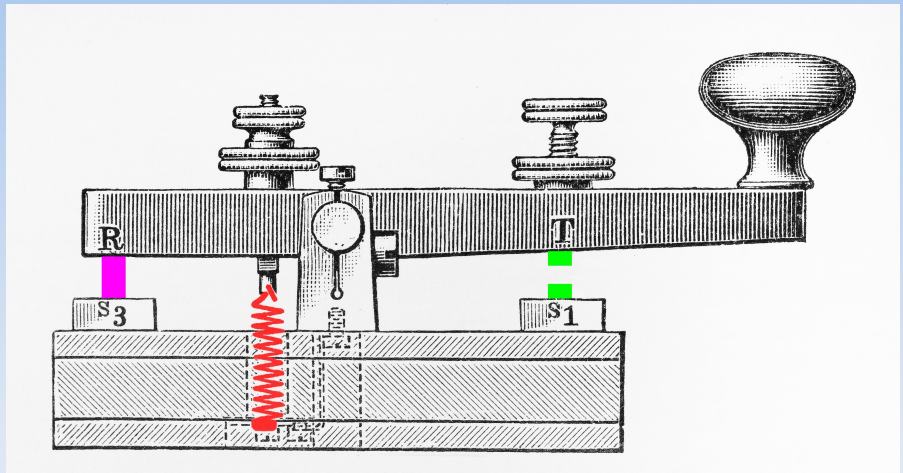


CLOCK

DATA

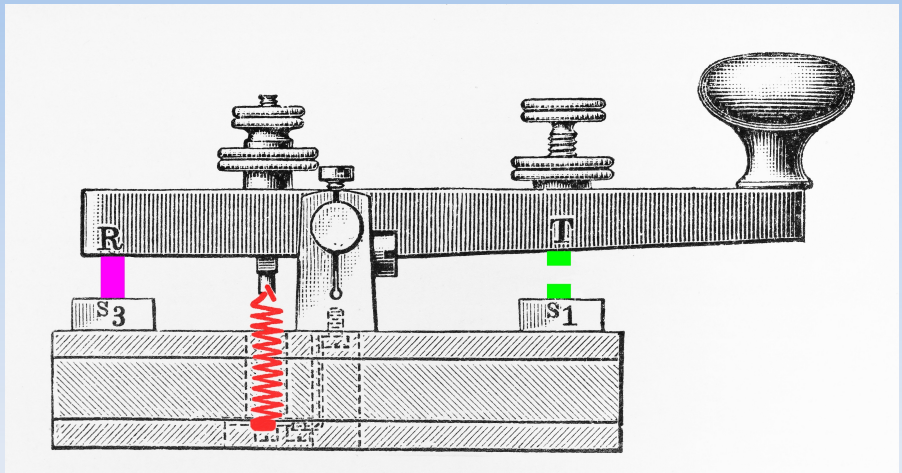
Communication Principles

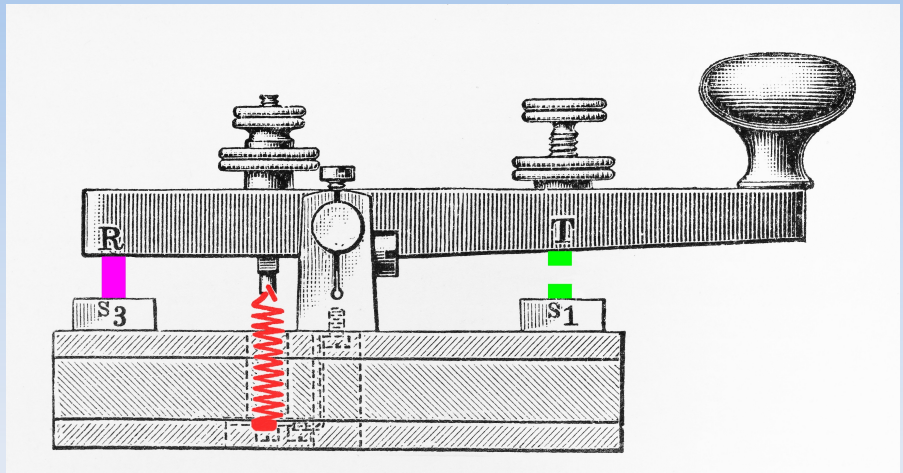


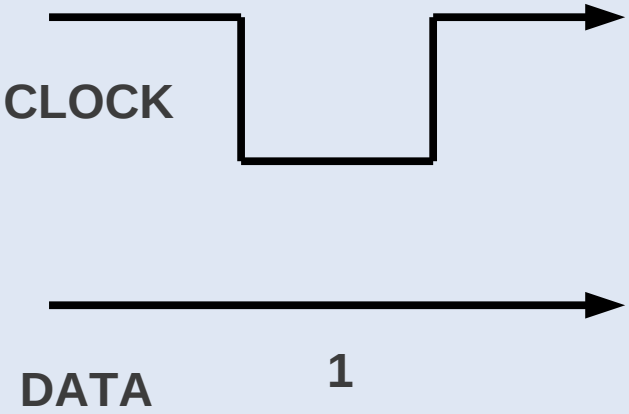


DATA

Communication Principles







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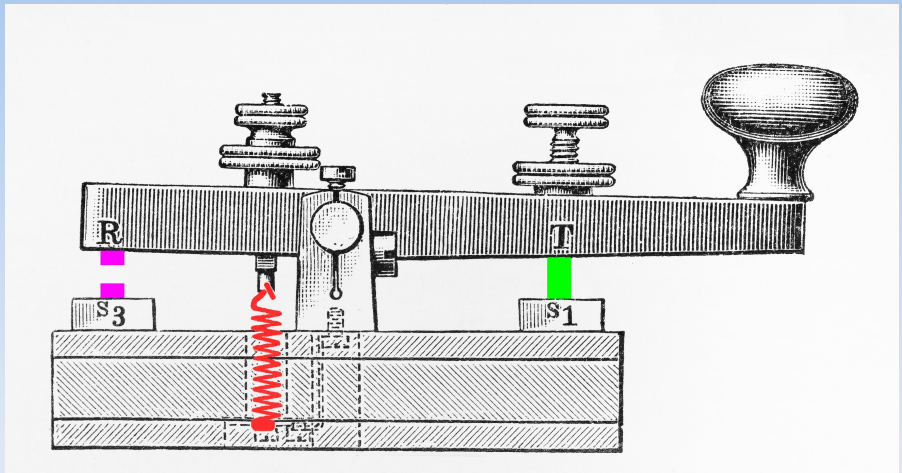

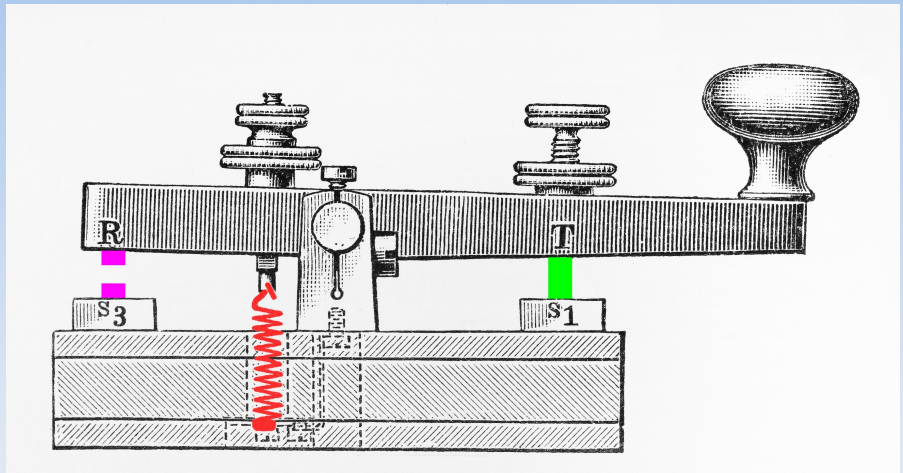

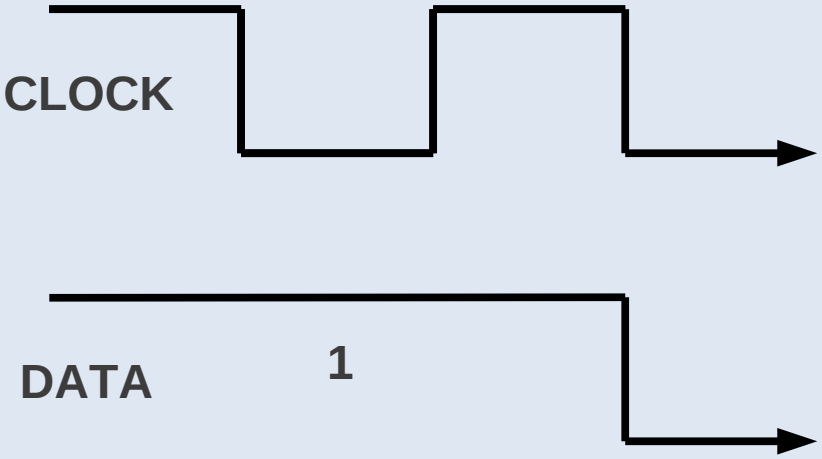

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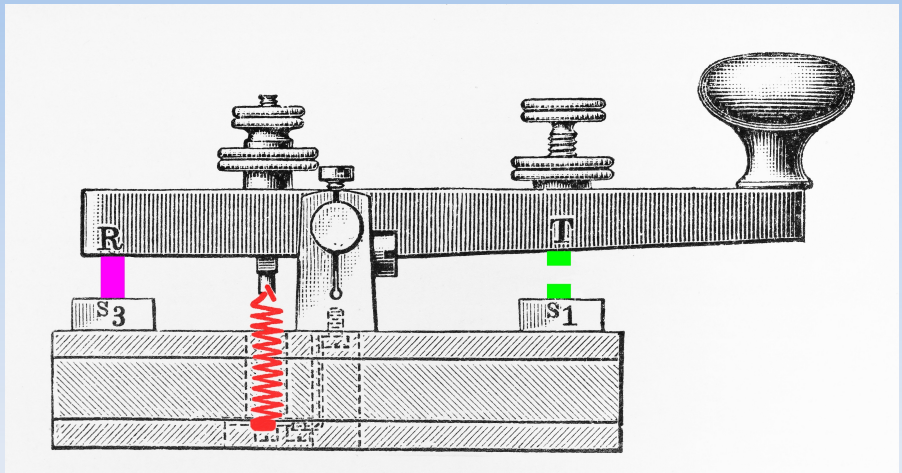

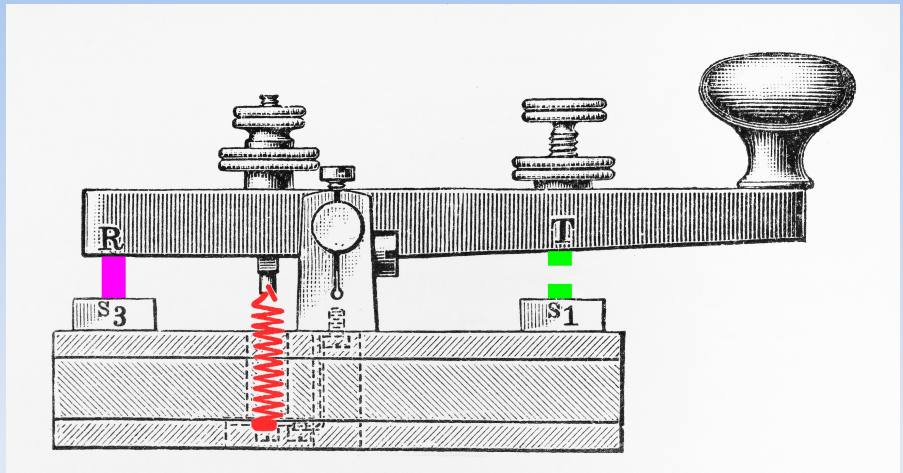

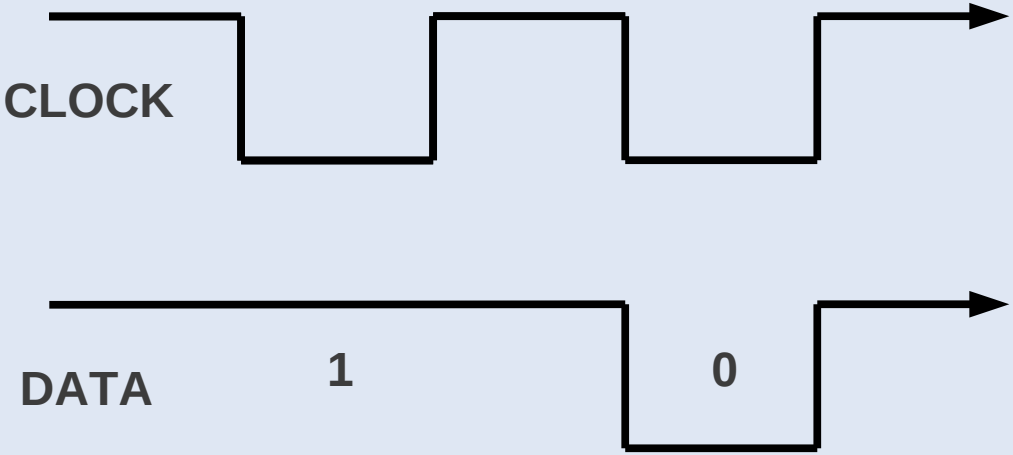

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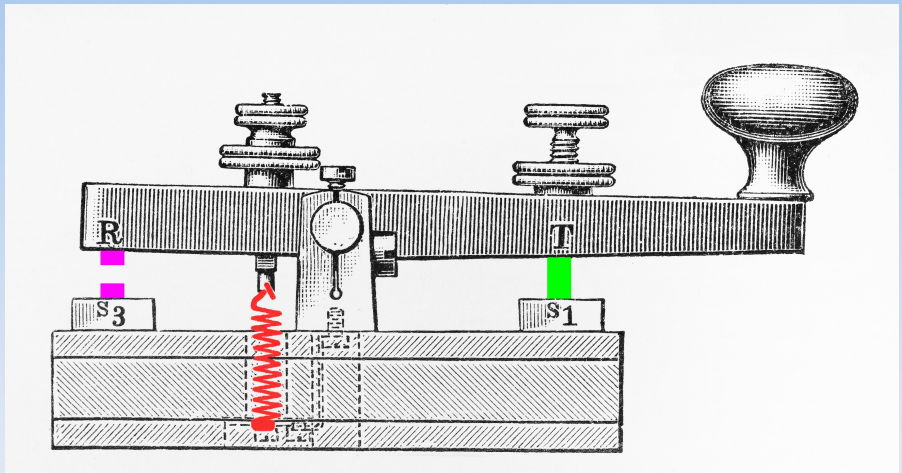

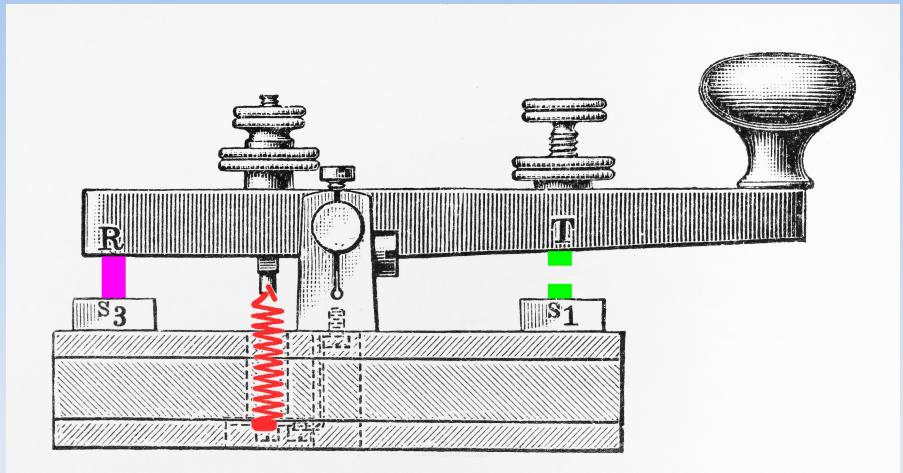

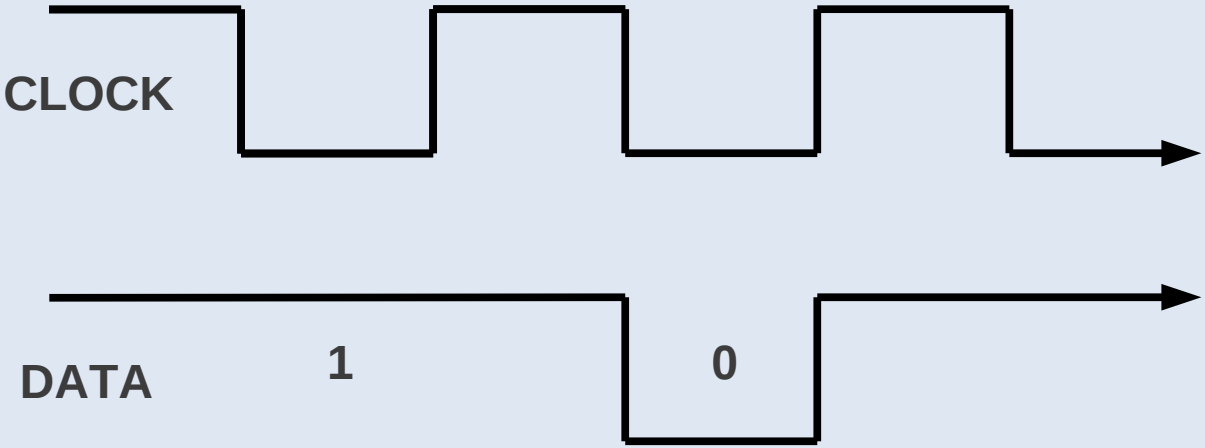

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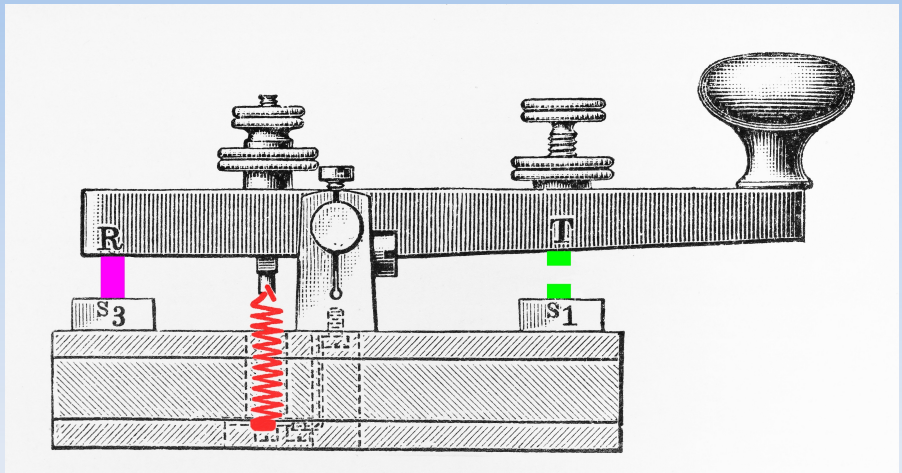

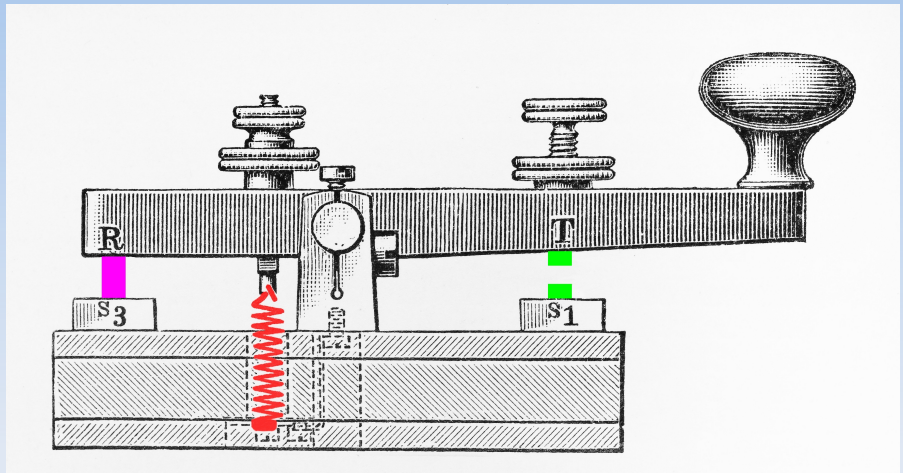

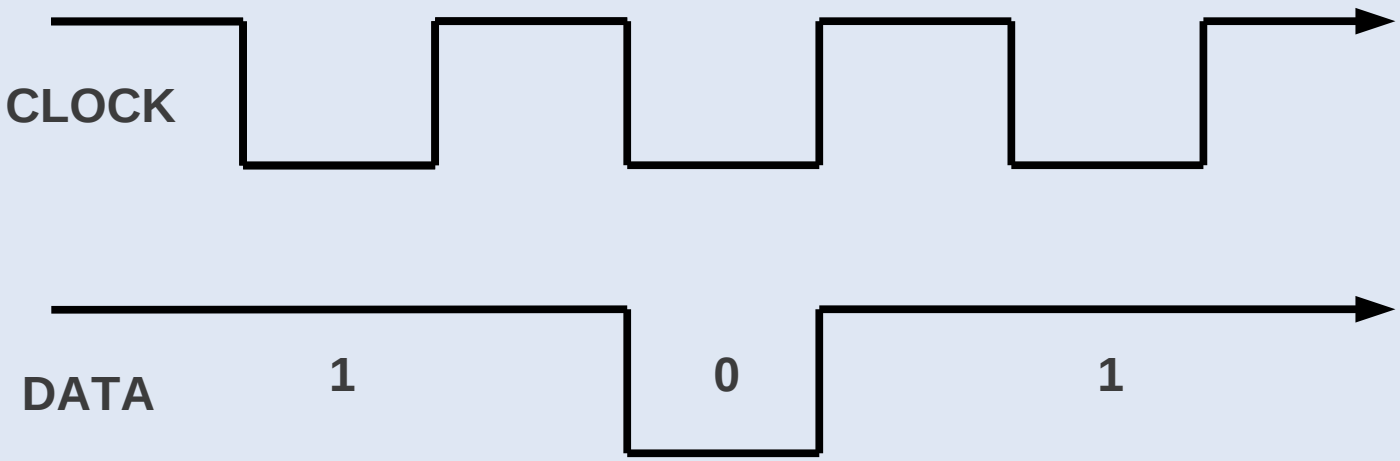

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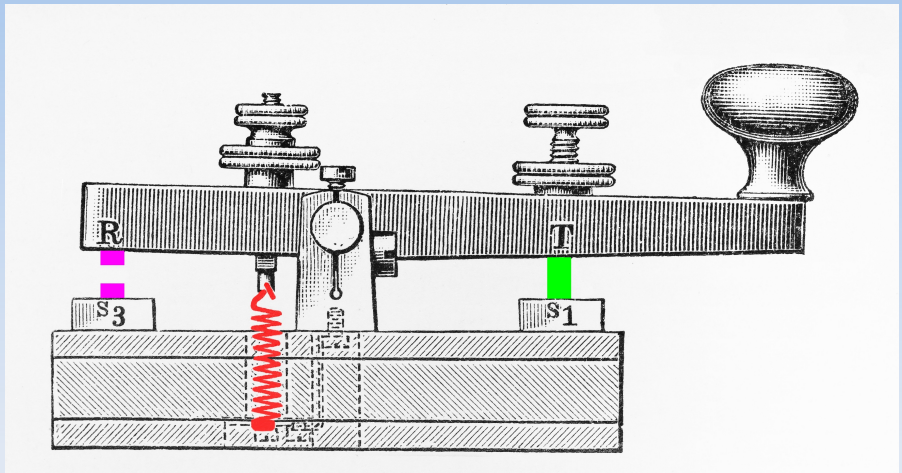

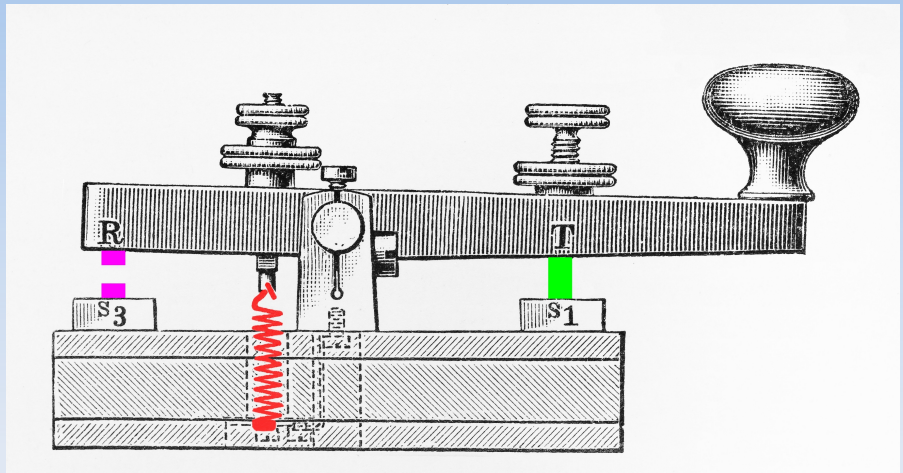

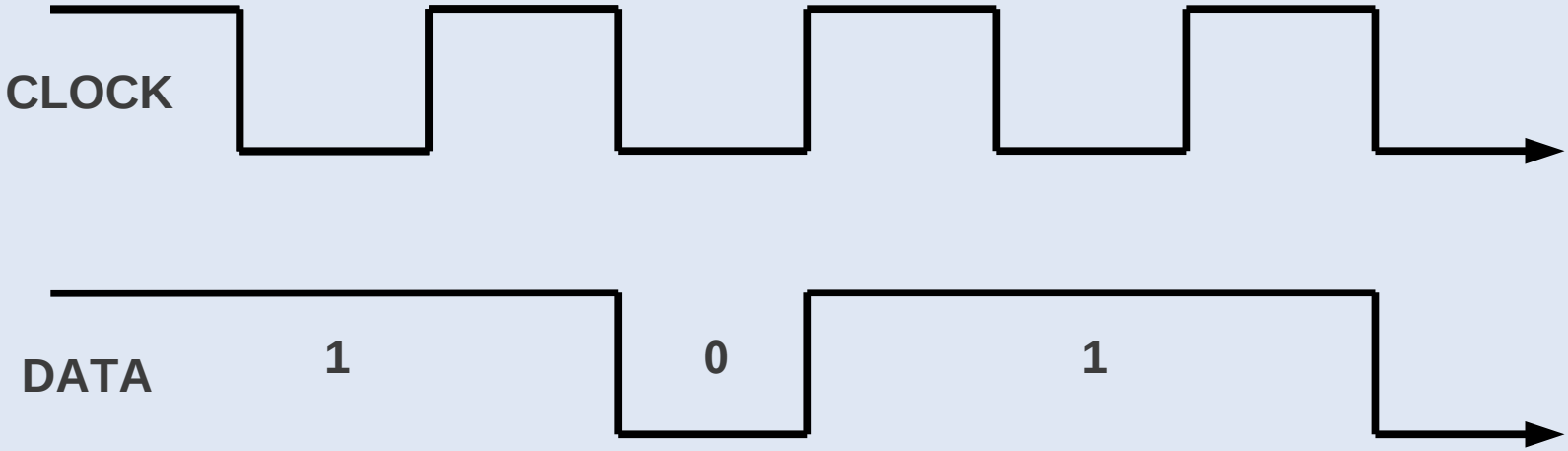

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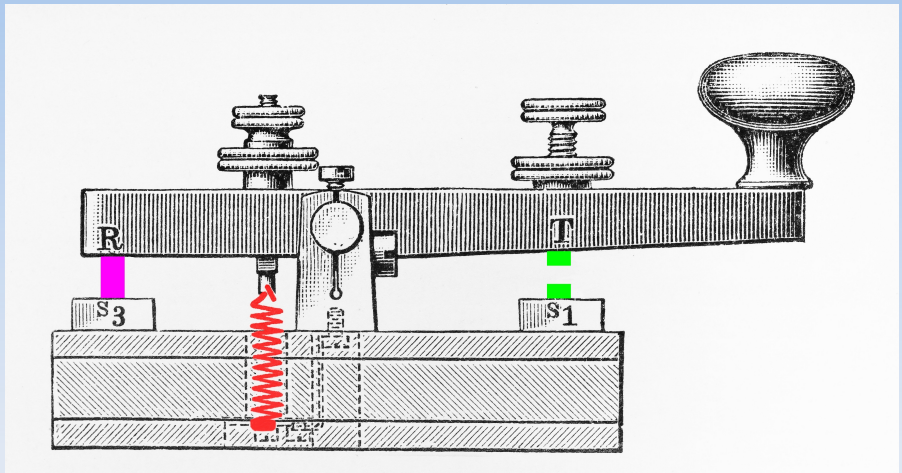
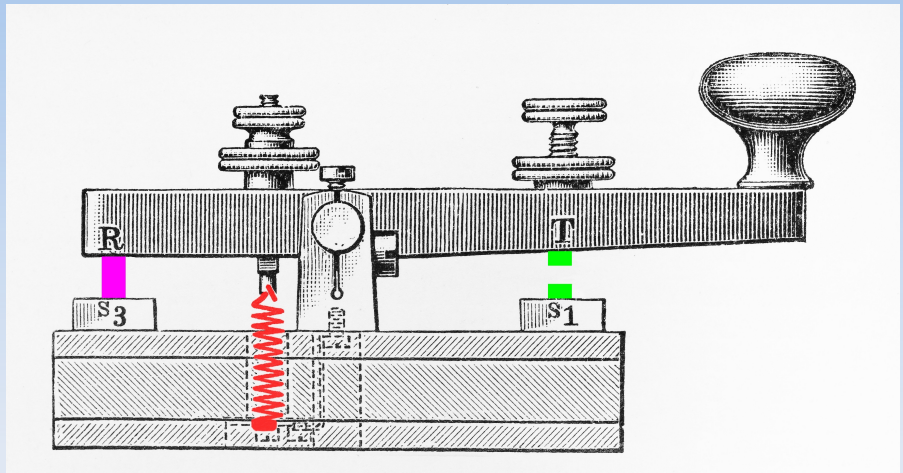
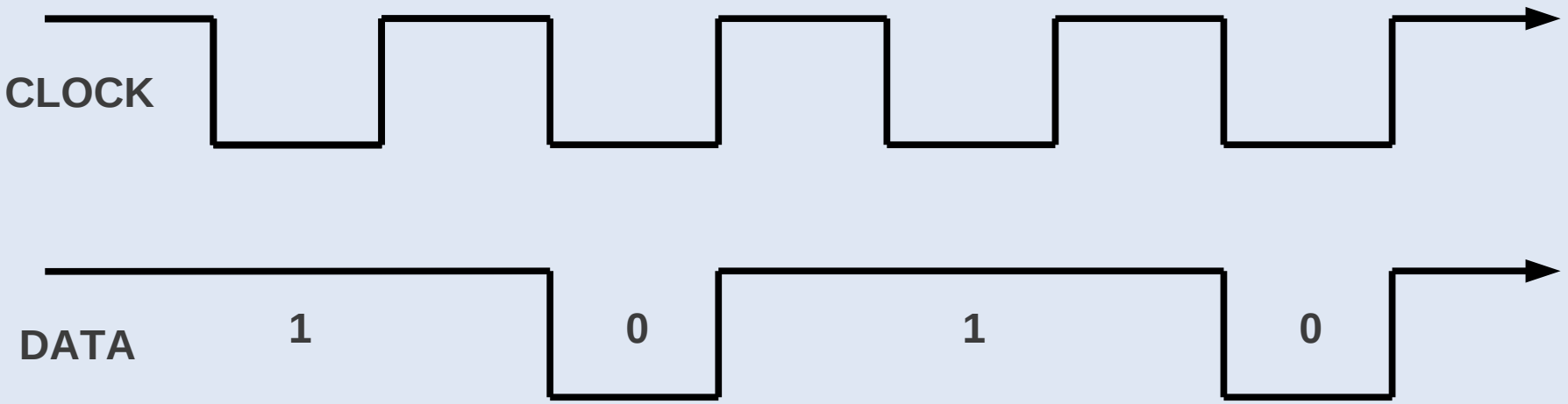
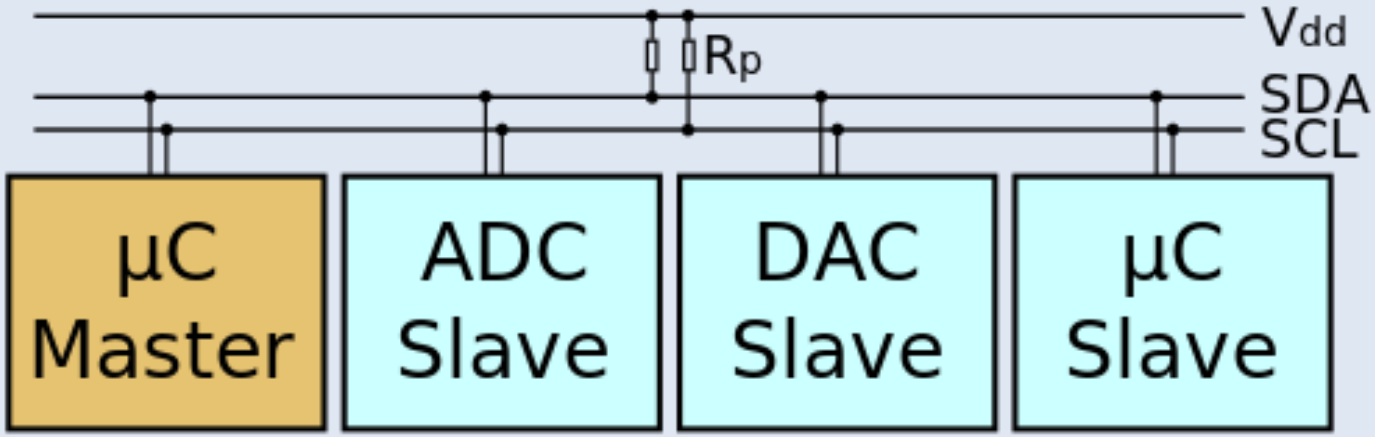






Communication Principles

- Asynchronous Communication
- The Problem
- Synchronous Communication
  - Uses Dedicated Clock Signal
  - Edison Stock Quotes
  - NXP Developed I2C



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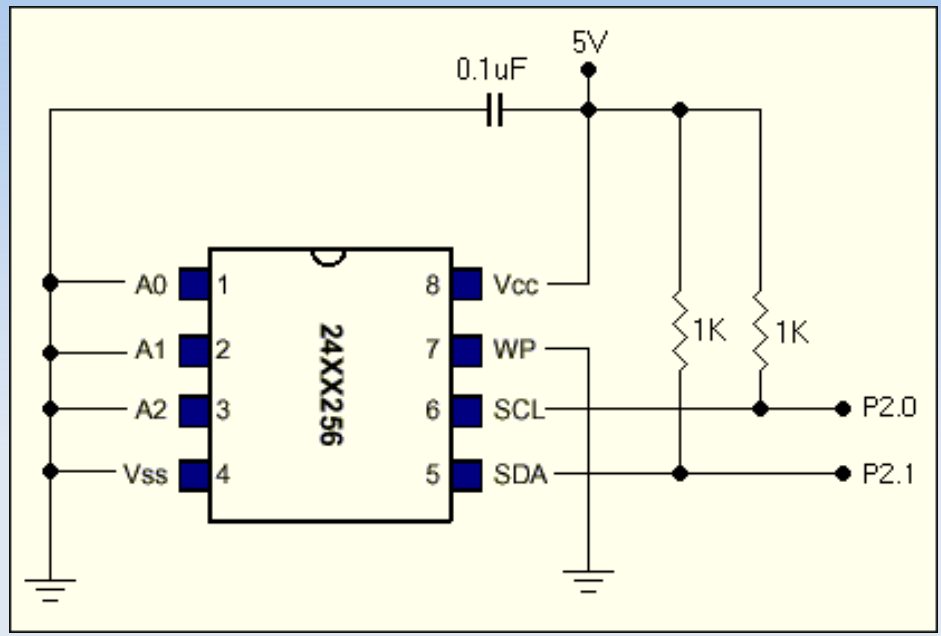
- Synchronous Communication
  - Uses Dedicated Clock Signal
  - Edison Stock Quotes
  - NXP Developed I2C
  - Intel Refined with SMBus

Interfacing

- Physical Connections

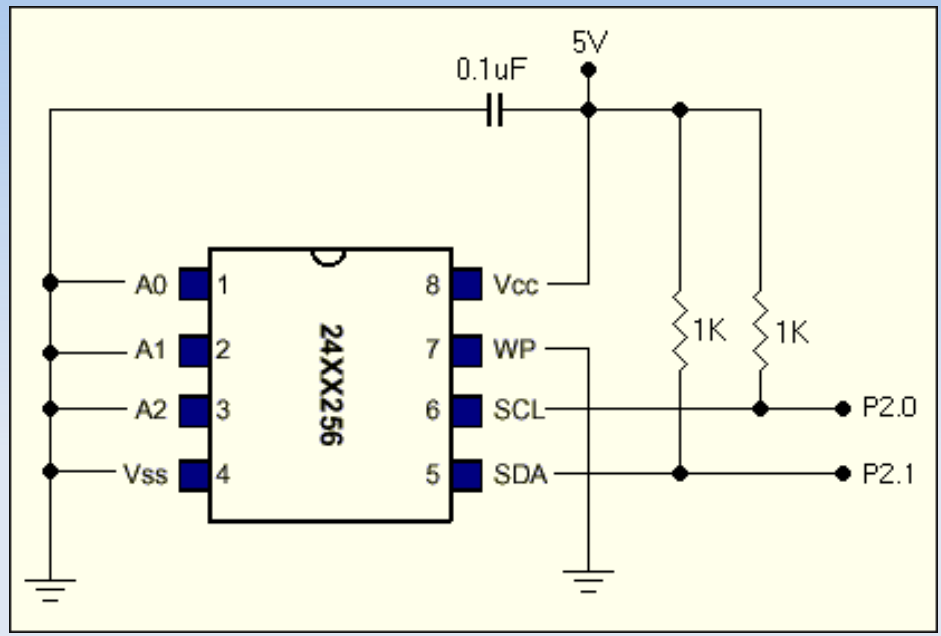
Interfacing

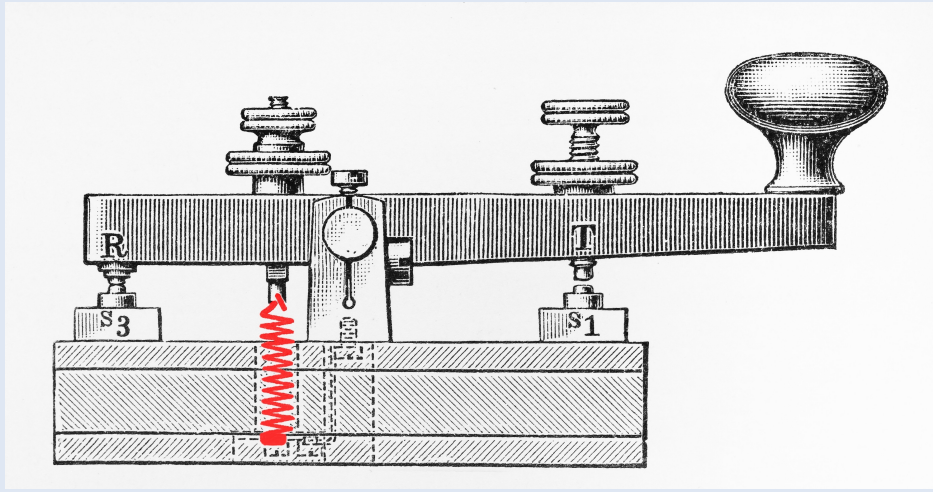
- Physical Connections
  - VCC, SCL, SDA, VSS



Interfacing

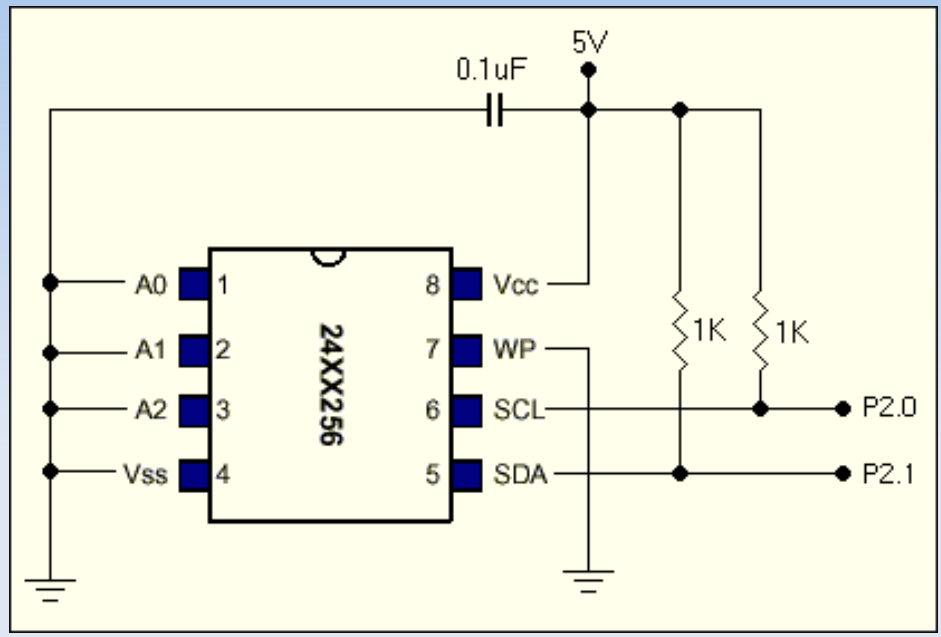
- Physical Connections
  - VCC, SCL, SDA, VSS
  - Pull-Ups

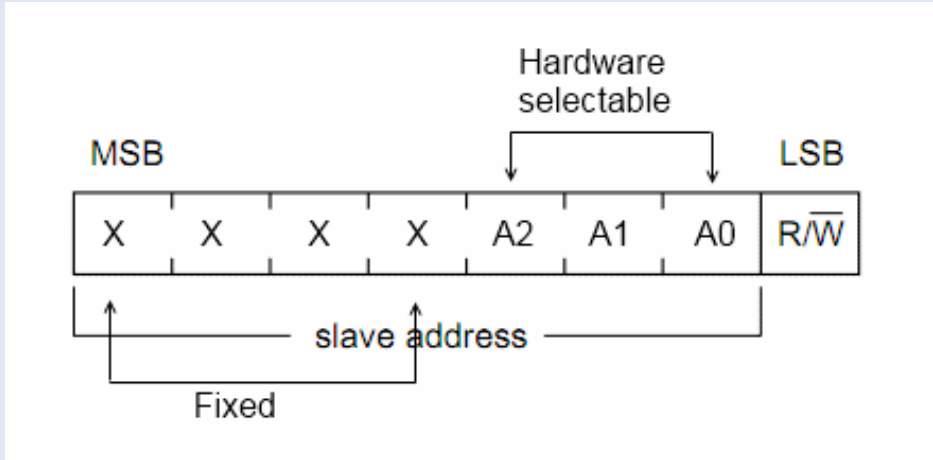




Interfacing

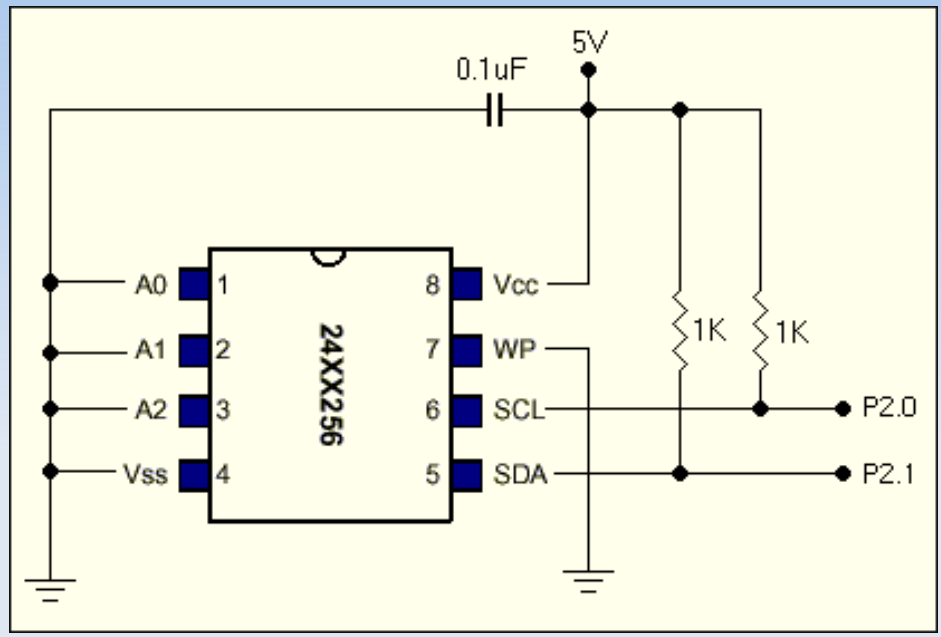
- Physical Connections
  - VCC, SCL, SDA, VSS
  - Pull-Ups
  - Address

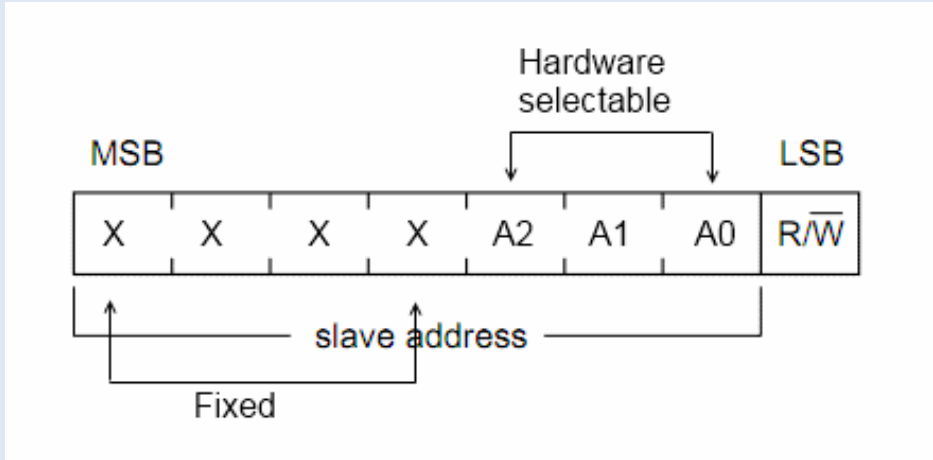




Interfacing

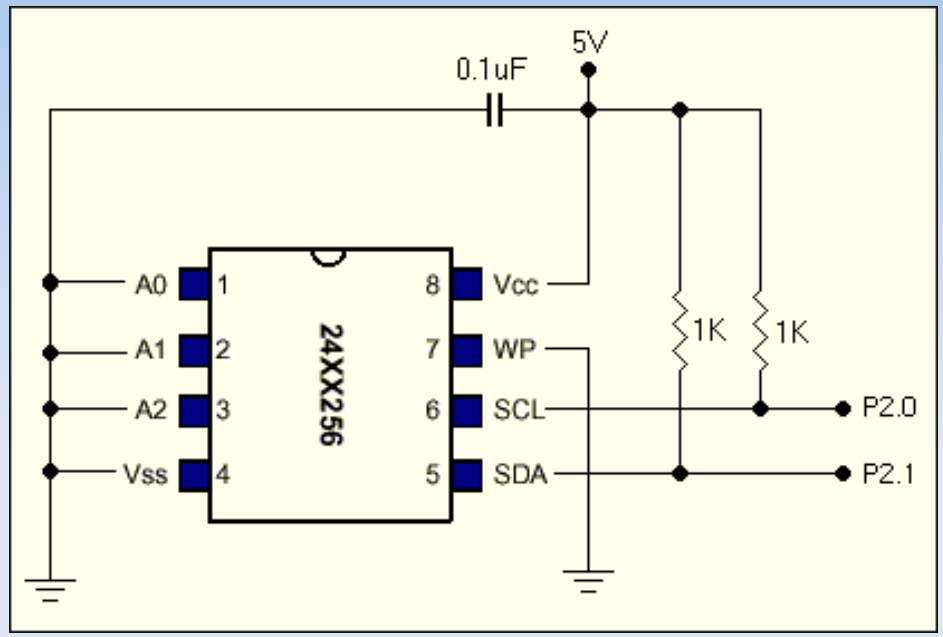
- Physical Connections
  - VCC, SCL, SDA, VSS
  - Pull-Ups
  - Address
    - 7-bits
    - LSB Read/Write





Interfacing

- Physical Connections
  - VCC, SCL, SDA, VSS
  - Pull-Ups
  - Address
  - Level Shifters



Interfacing

- Physical Connections
- Drivers

Interfacing

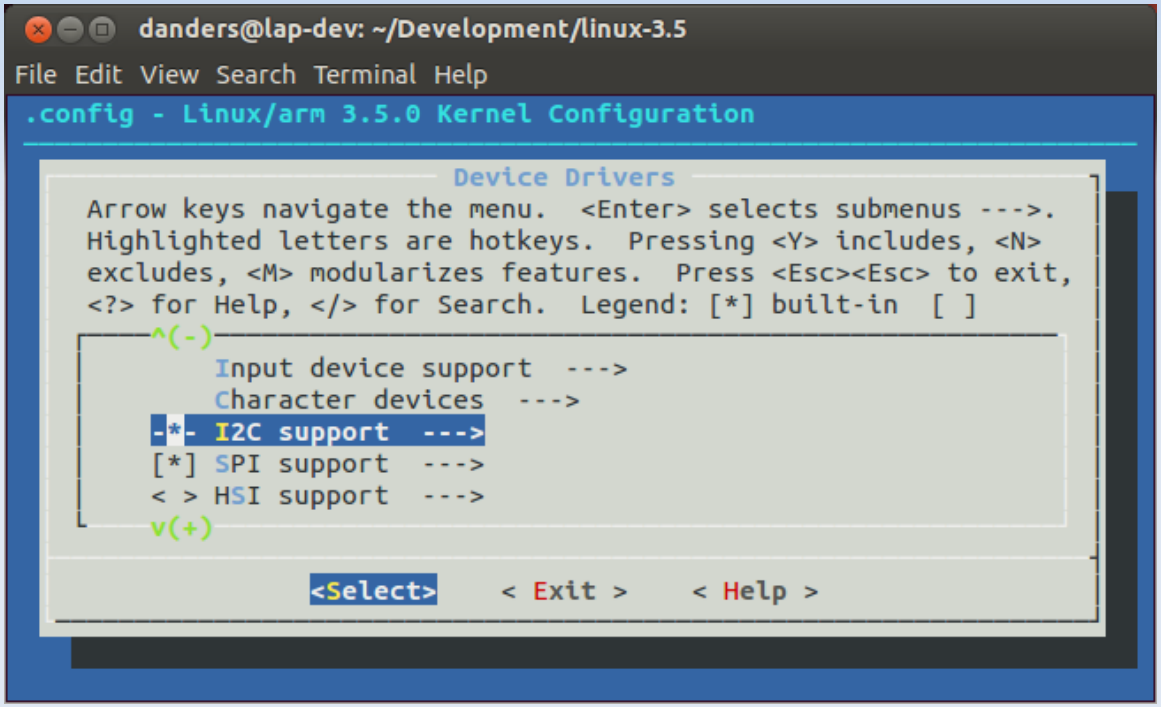
- Physical Connections
- Drivers
  - Bootloaders

Interfacing

- Physical Connections
- Drivers
  - Bootloaders
  - Linux Kernel

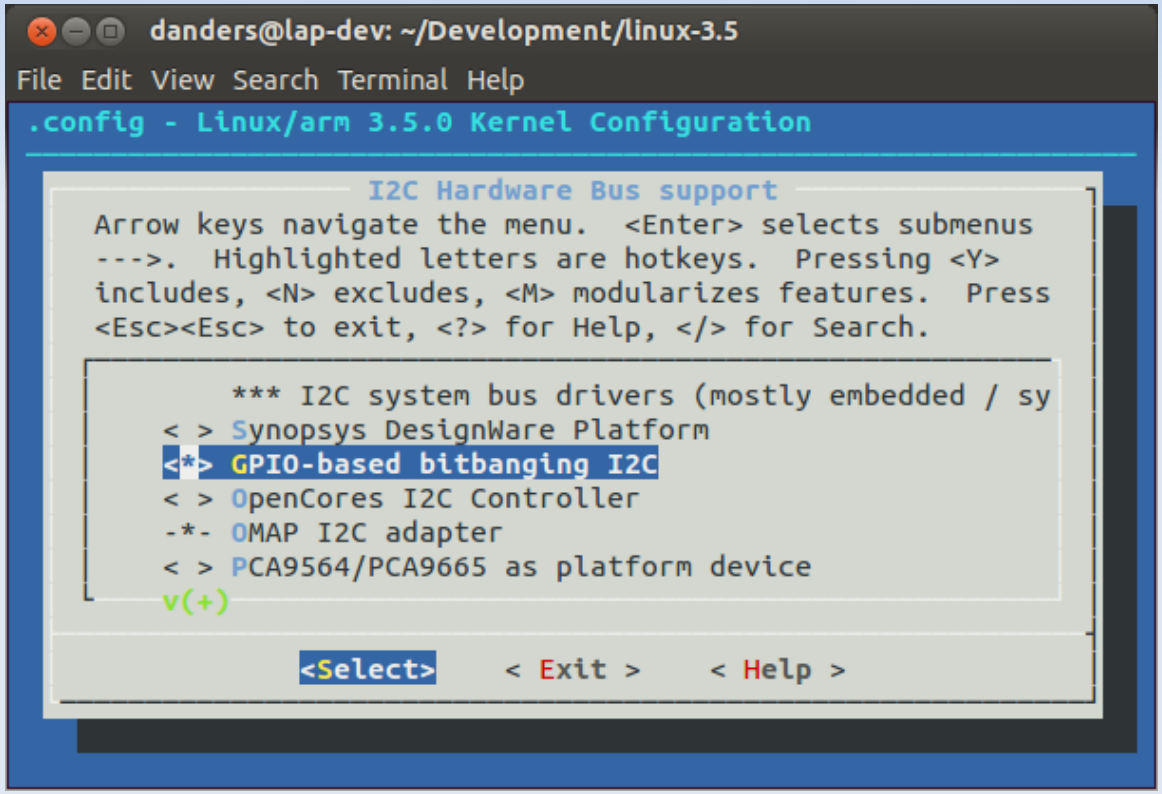
Interfacing

- Physical Connections
- Drivers
  - Bootloaders
  - Linux Kernel



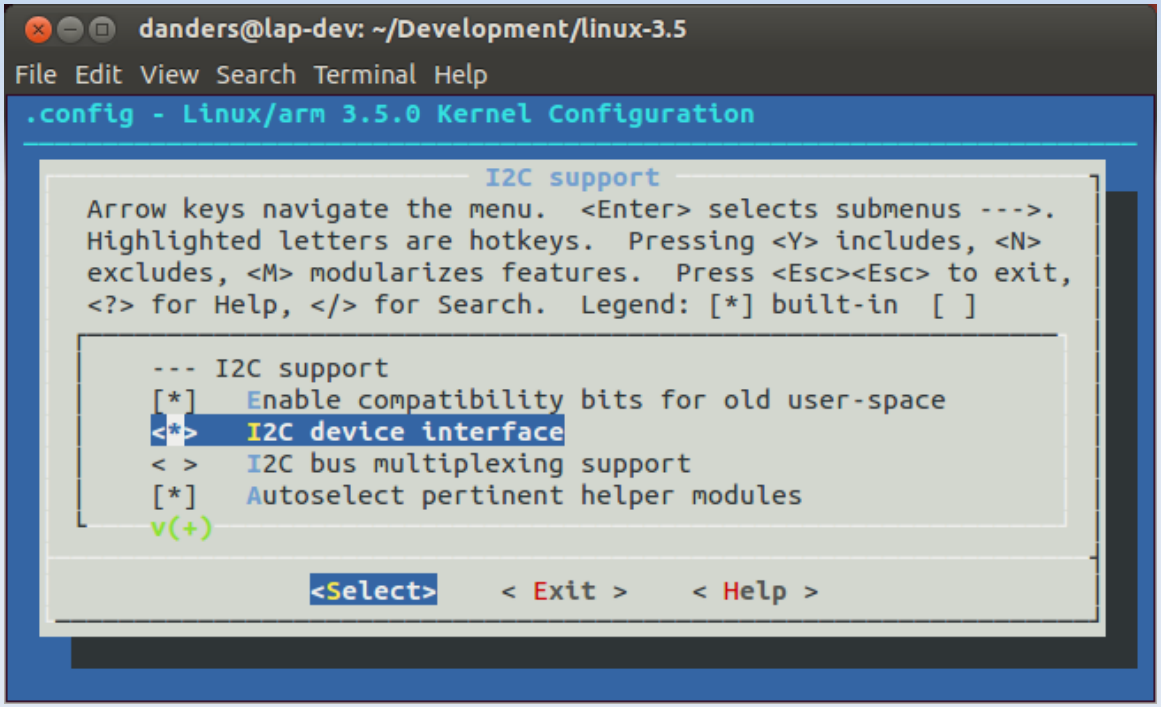
Interfacing

- Physical Connections
- Drivers
  - Bootloaders
  - Linux Kernel
  - GPIO Bit-Bang



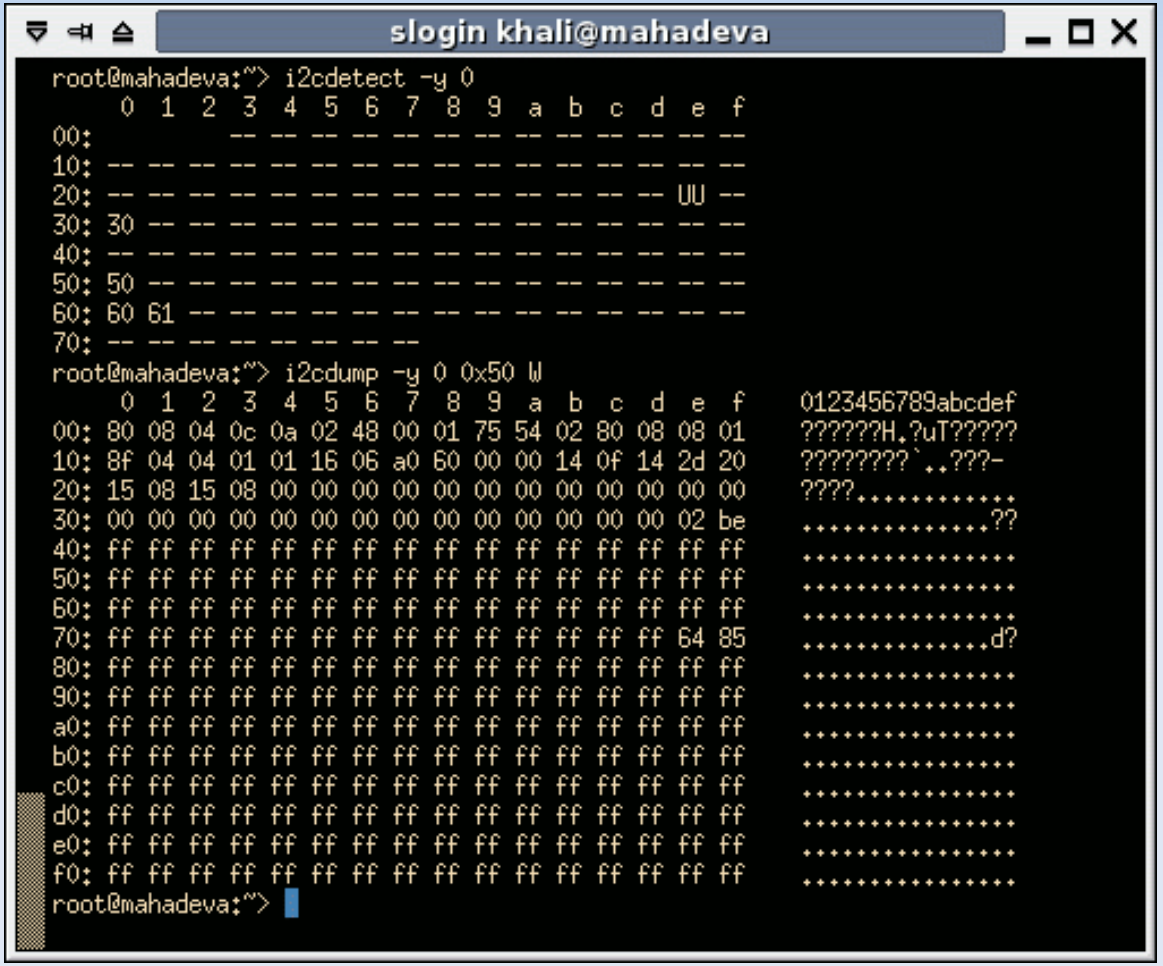
Interfacing

- Physical Connections
- Drivers
  - Bootloaders
  - Linux Kernel
  - GPIO Bit-Bang
  - I2C CharDev



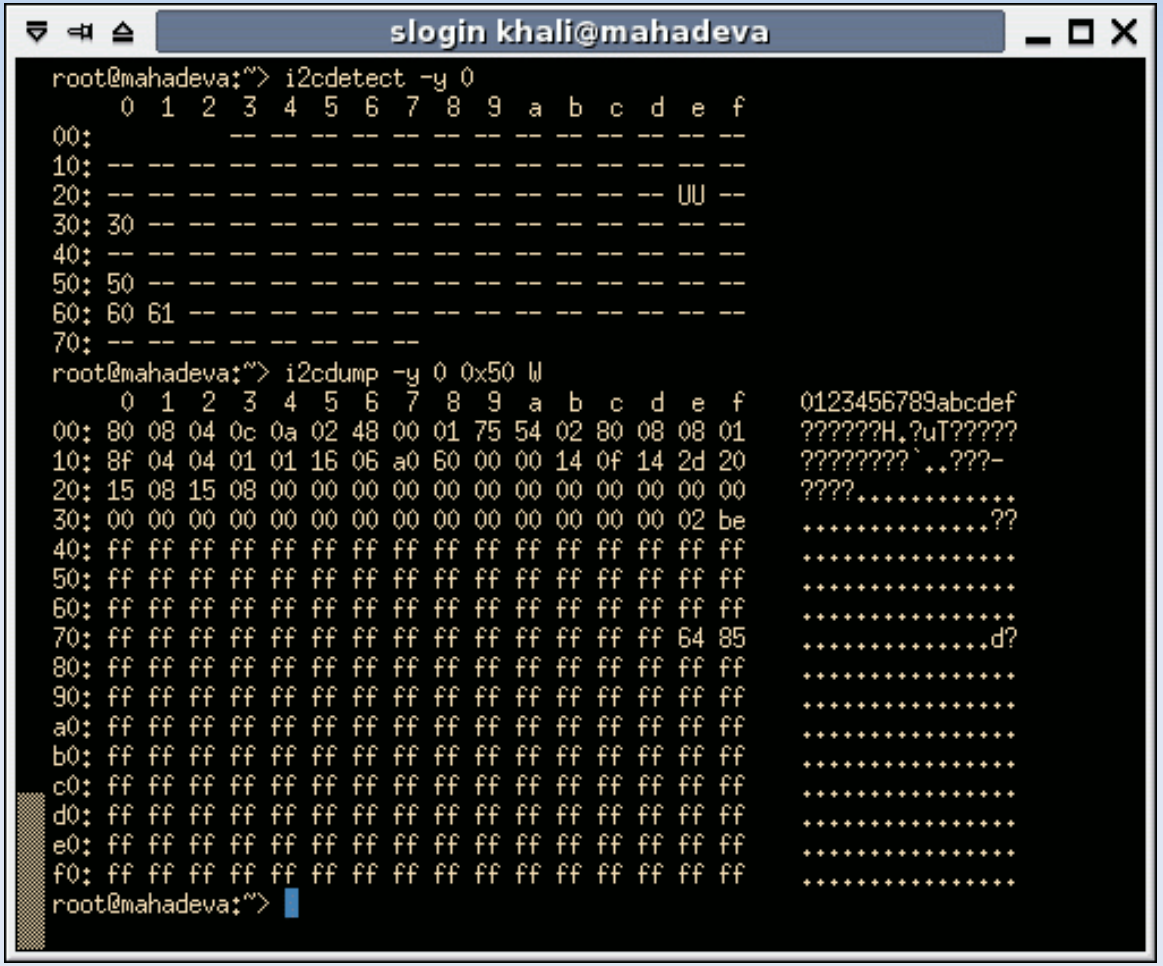
Interfacing

- Physical Connections
- Drivers
- I2C Tools



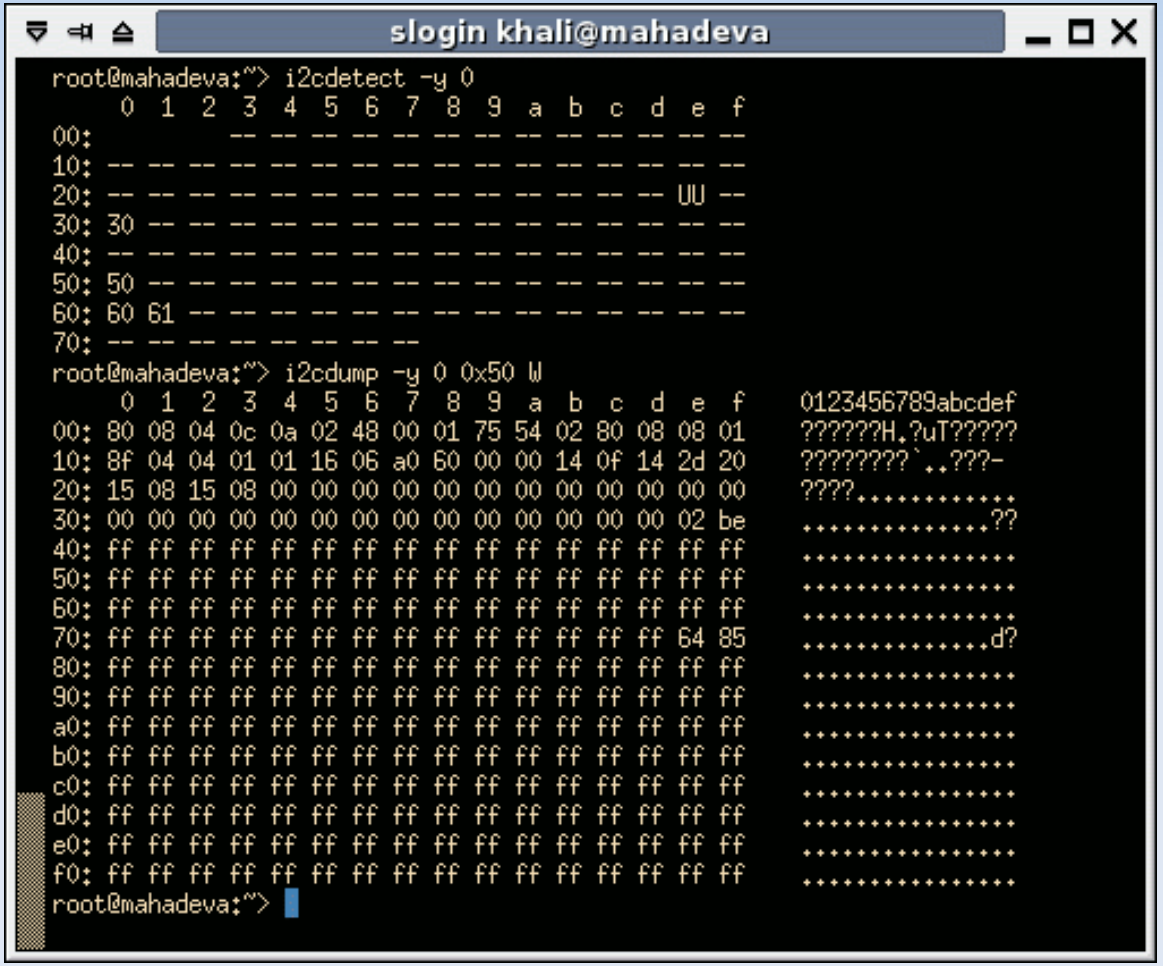
Interfacing

- Physical Connections
- Drivers
- I2C Tools
  - i2cdetect



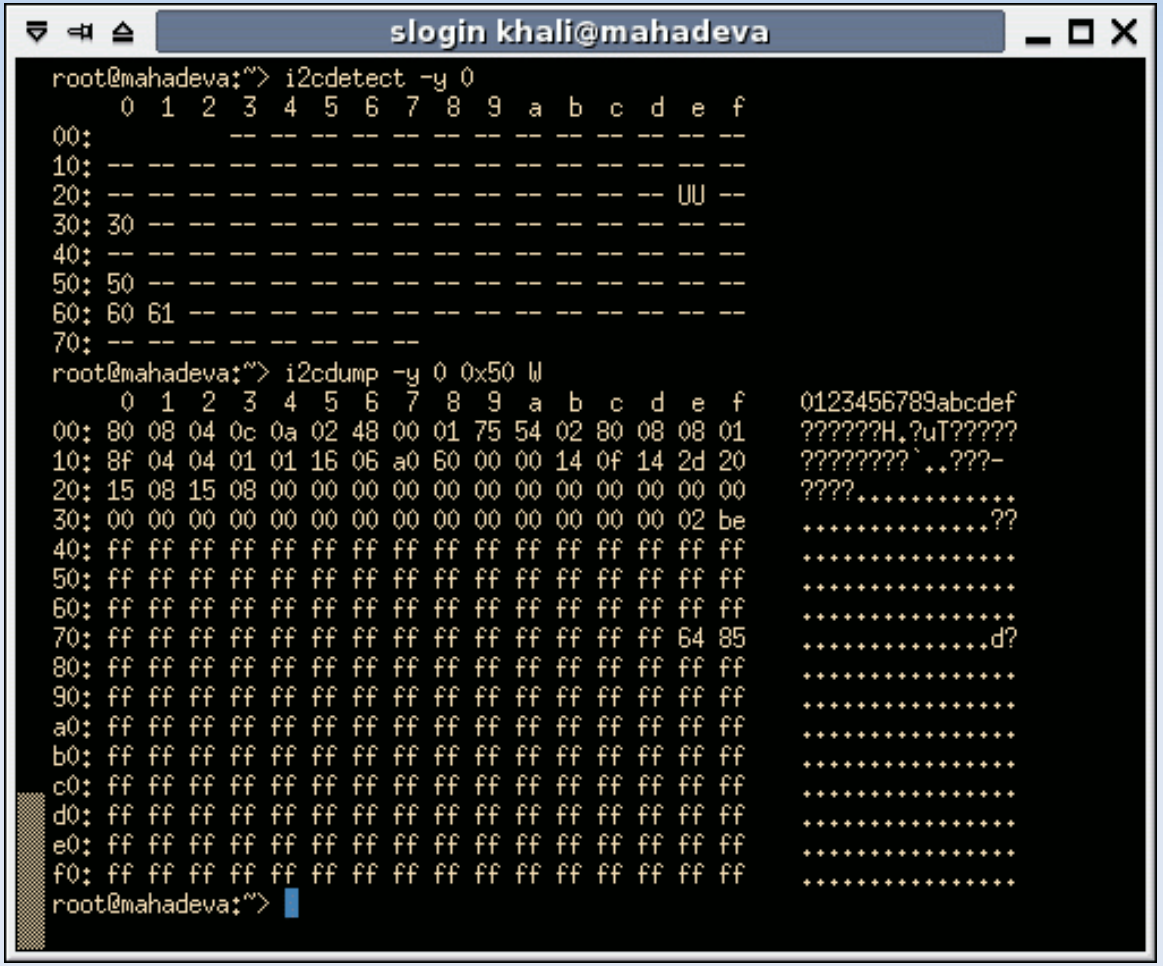
Interfacing

- Physical Connections
- Drivers
- I2C Tools
  - i2cdetect
  - i2cdump



Interfacing

- Physical Connections
- Drivers
- I2C Tools
  - i2cdetect
  - i2cdump
  - i2cget
  - i2cset

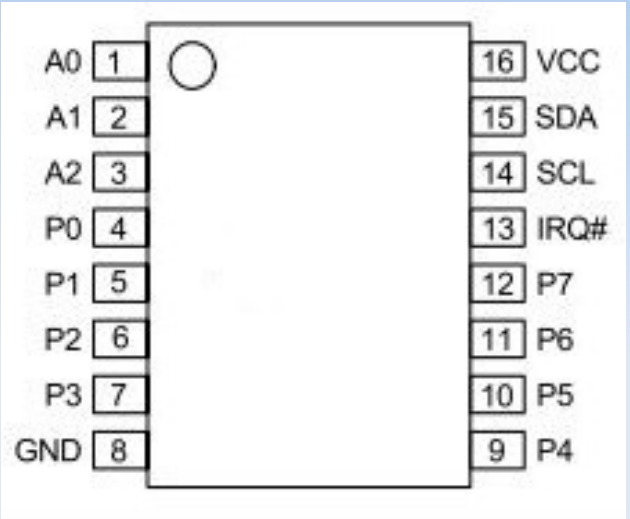


Board Bringup

- I2C GPIO Expanders

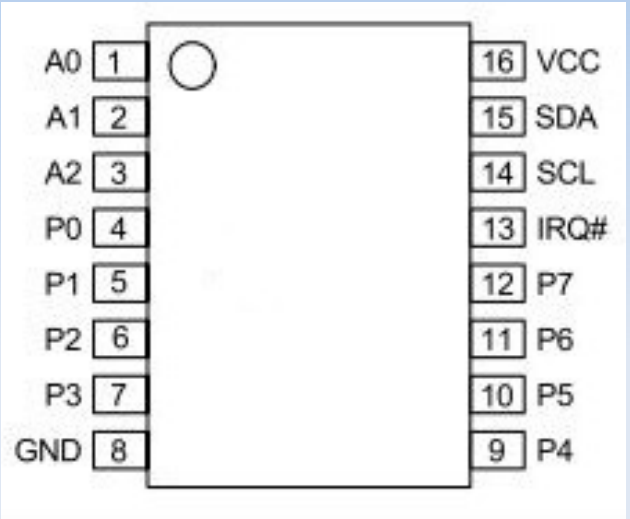
Board Bringup

- I2C GPIO Expanders
  - Devices



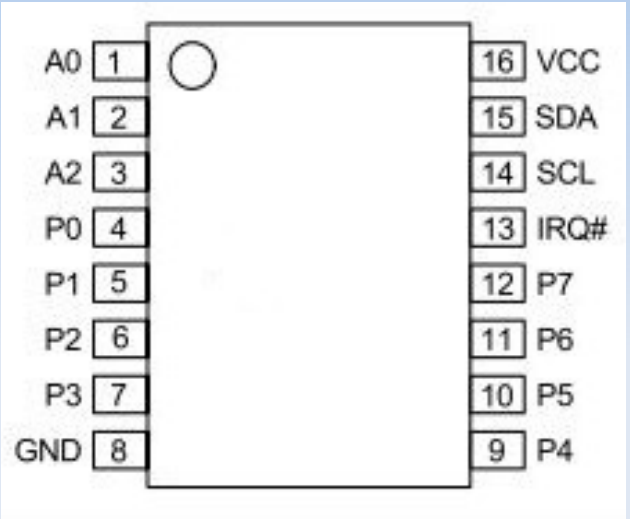
Board Bringup

- I2C GPIO Expanders
  - Devices
    - 4 to 24 Inputs or Output



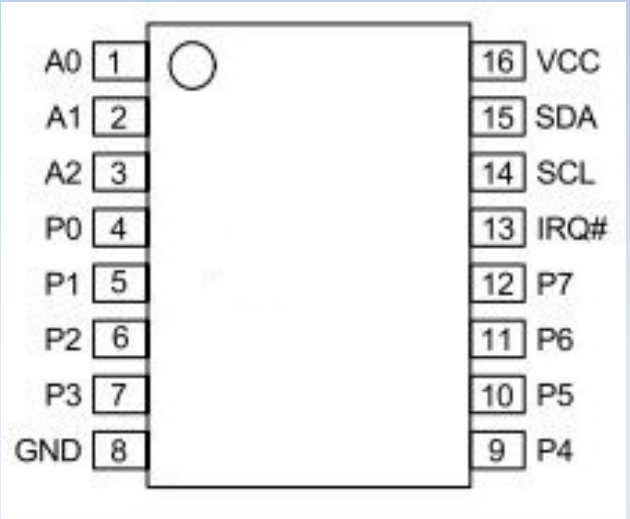
Board Bringup

- I2C GPIO Expanders
  - Devices
    - 4 to 24 Inputs or Output
    - IRQ for input events



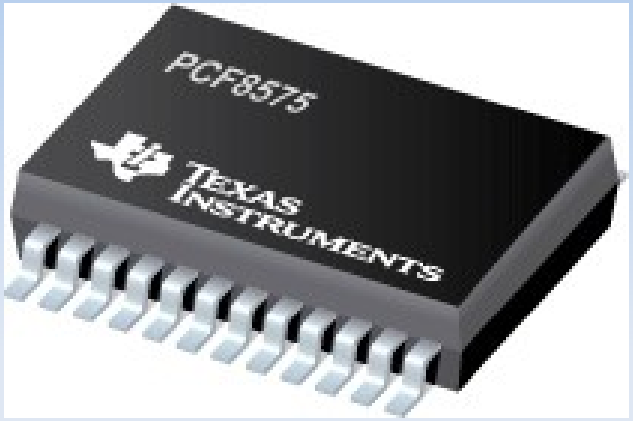
Board Bringup

- I2C GPIO Expanders
  - Devices
    - 4 to 24 Inputs or Output
    - IRQ for input events
    - Voltage range support



Board Bringup

- I2C GPIO Expanders
  - Devices
    - 4 to 24 Inputs or Output
    - IRQ for input events
    - Voltage range support
    - Generic PCF857X



Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit

Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit
    - Only needs 2 GPIOS from Host

Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit
    - Only needs 2 GPIOS from Host

Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit
    - Only needs 2 GPIOS from Host
    - Different Voltage Levels

Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit
    - Only needs 2 GPIOS from Host
    - Different Voltage Levels
    - New GPIOs are Transparent

Board Bringup

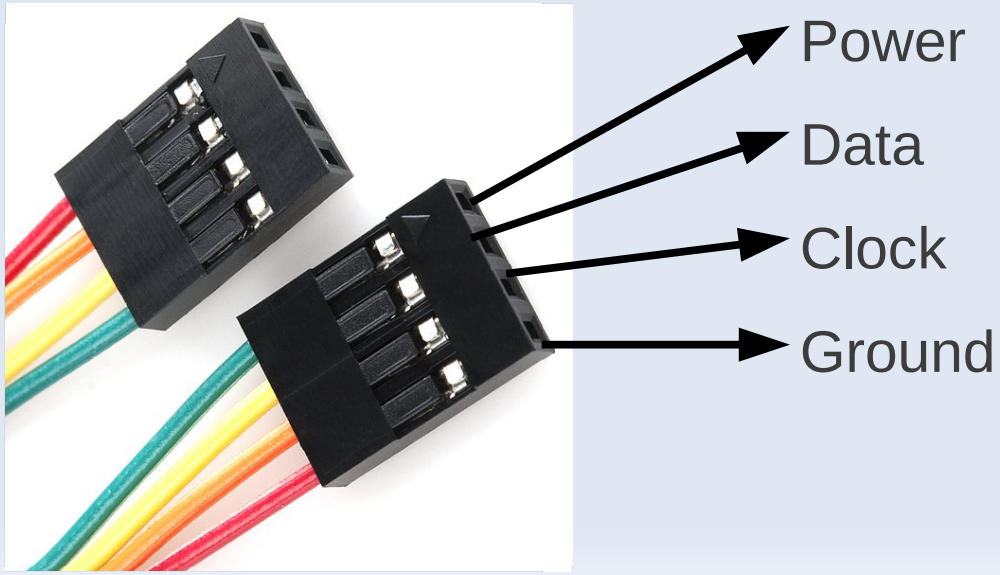
- I2C GPIO Expanders
  - Devices
  - Retro-fit
    - Only needs 2 GPIOS from Host
    - Different Voltage Levels
    - New GPIOs are Transparent
    - Inputs used for versioning

Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit
  - Debugging

Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit
  - Debugging
    - Four Wire Connection



Board Bringup

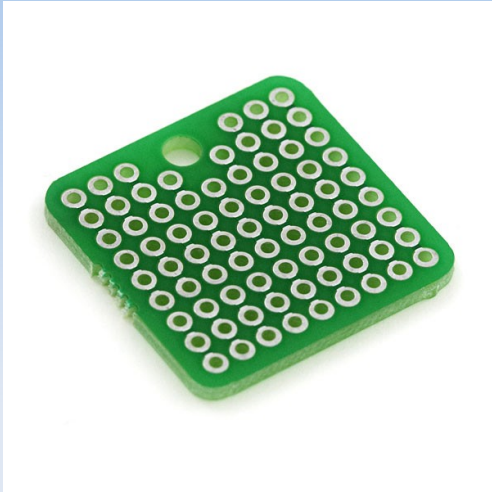
- I2C GPIO Expanders
  - Devices
  - Retro-fit
  - Debugging
    - Four Wire Connection
    - Provide Buttons for Test Modes

Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit
  - Debugging
    - Four Wire Connection
    - Provide Buttons for Test Modes
    - Provide LEDS for Low Level Feedback

Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit
  - Debugging
    - Four Wire Connection
    - Provide Buttons for Test Modes
    - Provide LEDS for Low Level Feedback
    - Easily Prototyped



Board Bringup

- I2C GPIO Expanders
  - Devices
  - Retro-fit
  - Debugging
    - Four Wire Connection
    - Provide Buttons for Test Modes
    - Provide LEDS for Low Level Feedback
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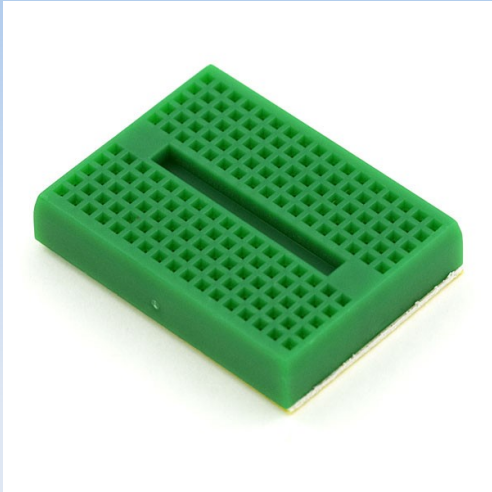
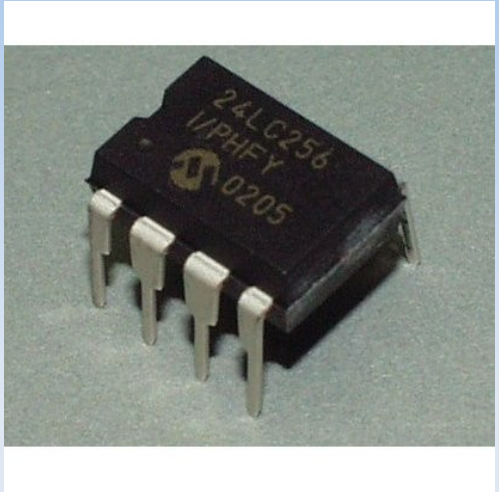


Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS

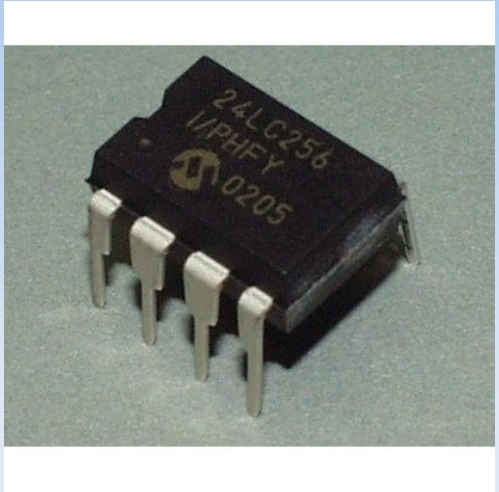
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices



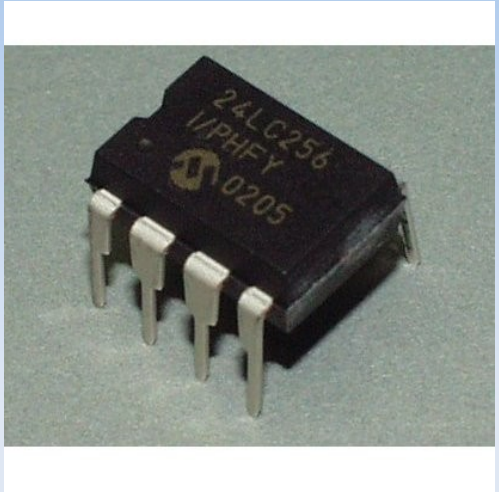
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
    - Typical 256 KBytes



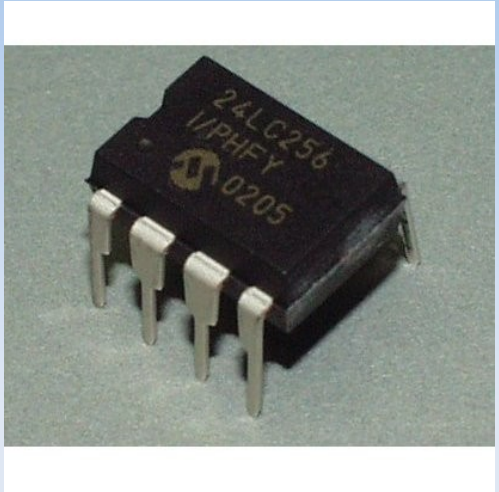
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
    - Typical 256 KBytes
    - Can be Write Protected



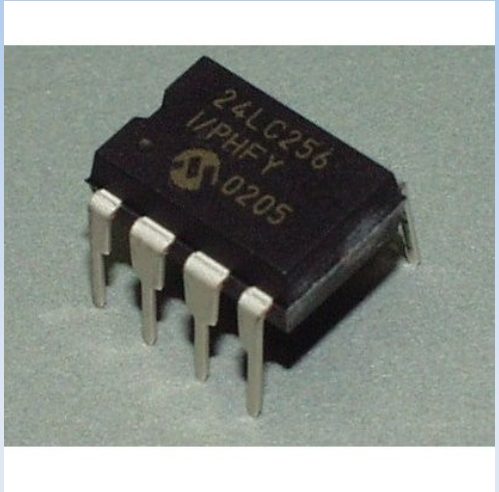
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
    - Typical 256 KBytes
    - Can be Write Protected
    - Low Cost



Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
    - Typical 256 KBytes
    - Can be Write Protected
    - Low Cost
    - Multiples per System



Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning

Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
    - EDID
      - Extended
      - Display
      - Identifcation
      - Data

Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
    - EDID
    - BeagleBone Capes

Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
    - EDID
    - BeagleBone Capes
    - Part/Board Identifications

Board Bringup

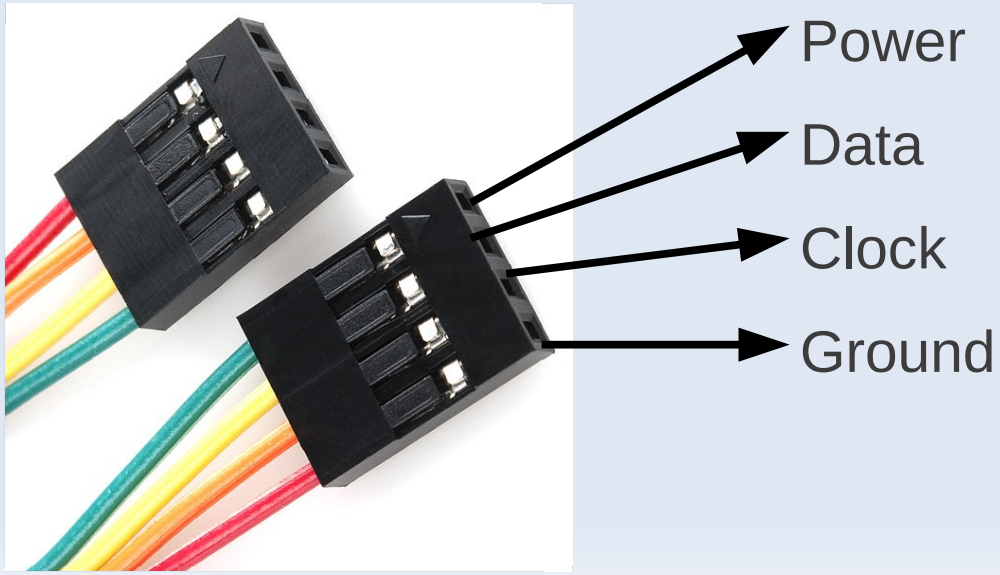
Name	Offset	Size (bytes)	Contents
Header	0	4	0xAA, 0×55, 0×33, 0xEE
EEPROM Format Revision	4	2	Revision number of the overall format of this EEPROM in ASCII =A0
Board Name	6	32	Name of board in ASCII
Version	38	4	Hardware version code for board in ASCII
Manufacturer	42	16	ASCII name of the manufacturer
Part Number	58	16	ASCII Characters for the part number
Number of Pins	74	2	Number of pins used by the daughter board
Serial Number	76	12	Serial number of the board. This is a 12 character string which is: WWYY4P13nnnn where: WW = 2 digit week of the year of production YY = 2 digit year of production nnnn = incrementing board number

Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
  - Debugging

Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
  - Debugging
    - Four Wire Connection



Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
  - Debugging
    - Four Wire Connection
    - Store Testing Cycle Data

Board Bringup

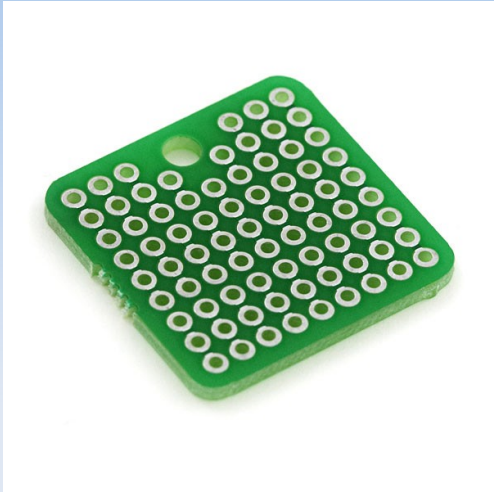
- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
  - Debugging
    - Four Wire Connection
    - Store Testing Cycle Data
    - Collect Board Interaction Data

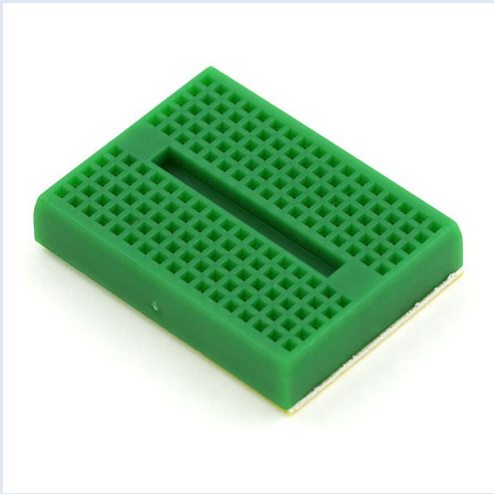
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
  - Debugging
    - Four Wire Connection
    - Store Testing Cycle Data
    - Collect Board Interaction Data
    - Configure Test/Boot Modes

Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
  - Debugging
    - Four Wire Connection
    - Store Testing Cycle Data
    - Collect Board Interaction Data
    - Configure Test/Boot Modes
    - Easily Prototyped





Conclusion

- Communication Pricinples

Conclusion

- Communication Pricinples
- Drivers and Software Tools

Conclusion

- Communication Pricinples
- Drivers and Software Tools
- Board Bringup Use Cases

Conclusion

Questions?