References and Presentation at: http://www.elinux.org/ALS-i2c
Introduction

- Dave Anders aka prpplague
Introduction

- Dave Anders aka prpplague
- Currently Contracted with TI
Introduction

- Dave Anders aka prpplague
- Currently Contracted with TI
- Partners in TinCanTools
Introduction

- Dave Anders aka prpplague
- Currently Contracted with TI
- Partners in TinCanTools
- Board Bring: You, Me, and I2C
Introduction

- Dave Anders aka prpplague
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- Partners in TinCanTools
- Board Bring: You, Me, and I2C
  - Communication Principles
Introduction

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- Board Bring: You, Me, and I2C
  - 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
Communication Principles
Communication Principles
Communication Principles

DOT
Communication Principles

DOT
Communication Principles

DOT
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
- The Problem
- Synchronous Communication
  - Uses Dedicated Clock Signal
  - Edison Stock Quotes
Communication Principles

CLOCK

DATA
Communication Principles

CLOCK

DATA
Communication Principles

- CLOCK
- DATA

1
Communication Principles
Communication Principles
Communication Principles

CLOCK

DATA 1 0
Communication Principles

CLOCK

DATA 1 0 1
Communication Principles

CLOCK

DATA

1 0 1
Communication Principles

CLOCK

DATA

1 0 1 0
Communication Principles

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

- Asynchronous Communication
- The Problem
- 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
  - 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
    - 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 Removed when Done
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
    - Average 256 Bytes
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
    - Average 256 Bytes
    - Can be Write Protected
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMs
  - Devices
    - Average 256 Bytes
    - Can be Write Protected
    - Low Cost
Board Bringup

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
    - Average 256 Bytes
    - 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
Board Bringup

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

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

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

- I2C GPIO Expanders
- I2C EEPROMS
  - Devices
  - Versioning
  - Debugging
  - Four Wire Connection
    - Power
    - Data
    - Clock
    - Ground
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 Removed when Done
Conclusion

- Communication Principles
Conclusion

- Communication Principles
- Drivers and Software Tools
Conclusion

- Communication Principles
- Drivers and Software Tools
- Board Bringup Use Cases
Conclusion

Questions?