Control Area Network (CAN) Bus

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CAN Network

http://www.arm.com/community/partners/product_images/4668.jpg

History

- First introduced in February of 1986 by Robert Bosch GmbH
- Developed because existing serial buses in the early 1980s were not able to fulfill all the requirements to be used in passenger cars
- Intel released the first CAN controller chip in 1987
- In November 1993 the CAN ISO standard was published
- First applications included use by an elevator manufacturer and some textile machine manufacturers
- Multiple higher level protocols for CAN have been developed since 1994

Applications

- Most common use is in the automobile industry
  - Used to connect subsystems within an electronic control unit as well as connect electronic control units together
  - Typically the largest control unit in a vehicle is the engine control unit
  - Modern automobiles may have up to 70 electronic control units
  - Many devices in cars use CAN including the radio, transmission, airbags, ABS, cruise control, and power steering
- CAN is also used in both railway and aerospace applications
- Other applications include use in hospital equipment, elevators, and even coffee machines

http://gallery.novylen.net/d/24119-2/camaro02.jpg
## Wires / Pinout

*required wires are highlighted

http://www.interfacebus.com/Can_Bus_Connector_Pinout.html
Topology

Wikipedia
Data Transmission

- Serial communication
- Asynchronous
- Message frames
- Baud Rate (bits/s)
  - all nodes same rate
  - 1Mbit/s max
Frames

- ID
- Data
- Frame Types
  - Data
  - Error
  - Remote
  - Overload
Data Frame

Number of Bits: 1 11 1 6 0...64 15 1 1 1 7 3

Start of Frame
Remote Transmission Request
Delimiter Bits
Intermission Field
Acknowledgement Field

Bit Stuffing
CRC Sequence
End of Frame Field
CAN Data Frame

Bus Idle Message Identifier Control Field Data Field CRC Sequence ACK EOF IFS Bus Idle
**Arbitration**

- Zero Dominant
- Similar to I2C

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<th>Recessive 1</th>
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Data Transmission Example

- Gear Box
- Temp. Sensor
- ECU
- CAN Bus

Message ID Data
1 0 1 0 1 1 1 0 0 0 0 0 0 ......
1 0 1 1 1 0 1 0 0 0 0 0 0 ......
Data Transmission Example

Gear Box

Temp. Sensor

ECU

CAN Bus

Message ID: 1 0 1 0 1 1 0 0 0 0 0 0
Data: ...

Message ID: 1 0 1 1 0 1 0 0 0 0 0 0
Data: ...

Message ID: 1
Data: ......
Data Transmission Example

- Gear Box
- Temp. Sensor
- ECU
- CAN Bus

Message ID: 1010110000000
Data: ......
Data Transmission Example

- Gear Box
- Temp. Sensor
- ECU

Message ID: 10101100000000
Data: 

Message ID: 10110100000000
Data: 

Message ID: 101
Data: 

CAN Bus
Data Transmission Example

- Gear Box
- Temp. Sensor
- ECU
- CAN Bus
Data Transmission Example
Physical Layers

http://www.eeherald.com/section/design-guide/esmod9.html
Special Features

- CAN network
  - multi-master
  - nodes
    - each node can send/receive
    - differential signalling
  - noise cancelling
Differential Signalling

http://canbus.pl/images/iso11898-levels_en.png

Differential Signal (Two Wires)

Noise on Line

CAN Physical Layers

● High Speed CAN
  ○ 2 wires and a transfer rate of up to 1 Mb/s (dependent upon wire length)
  ○ Most common physical layer

● Low-Speed/Fault-Tolerant CAN Hardware
  ○ 2 wires and a transfer rate of up to 125 kbit/s
  ○ Used in door wiring and in brake lights

● Single-Wire CAN Hardware
  ○ 1 wire and a transfer rate of up to 33 kbit/s
  ○ Used in comfort devices (mirrors, seats, etc.)

● Software-Selectable CAN Hardware
  ○ Can be configured to use any of the layers
Interfacing with the CAN bus

- Sparkfun Arduino Shield
  - Microchip MCP2515 CAN controller
  - MCP2551 CAN transceiver
  - interfaces with SPI to microcontroller
- Many other CAN interface chips
  - TI
  - Maxim
  - AMI semi

http://www.sparkfun.com/products/10039
Advantages

- reliability
  - differential signalling
- priority
  - easily prioritize messages
- low wire count
- node independence
  - can add / remove nodes
  - node breakdown doesn't bring down network
Disadvantages

- regulate wire length
  - particularly for high speeds
- requires termination
  - resistor
Questions?
References

http://en.wikipedia.org/wiki/CAN_bus
http://zone.ni.com/devzone/cda/tut/p/id/2732
End