Embedded Systems

Ch 11A
Network Interface

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Overview

- *1. Introduction*
- *2. RS-485*
- *3. Controller Area Network (CAN)*
- *4. Ethernet*

Network Interface

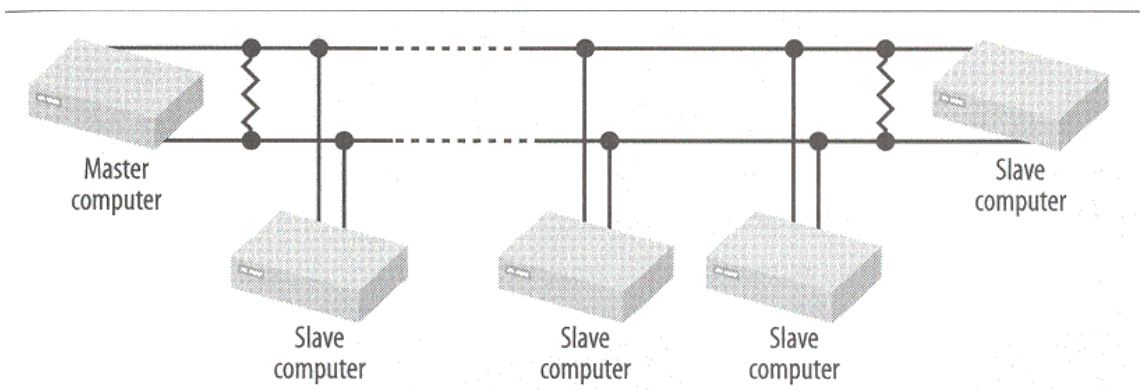
1. Introduction

- Local Area Network (LAN)
  - RS-485
    - A simple network for connecting small computers
    - Low cost, simple implementation
  - CAN (Controller Area Network)
    - A network for industrial applications
    - Suitable for electrically noisy and harsh conditions
  - Ethernet
    - Intranet network that connects desktop computers, hosts, and other devices such as routers, gateways, printers, and other peripherals

2. RS-485

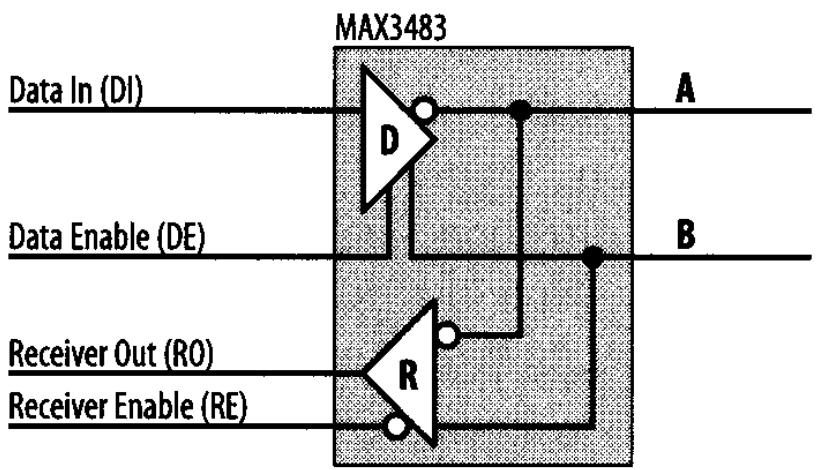
- Features
  - A variation on RS-422
  - Used for low-cost networking
  - Commonly used in many industrial applications
  - One of the simplest and easiest network to implement.

- RS-485 network
  - Multiple systems (nodes) to exchange data over a single twisted pair ->



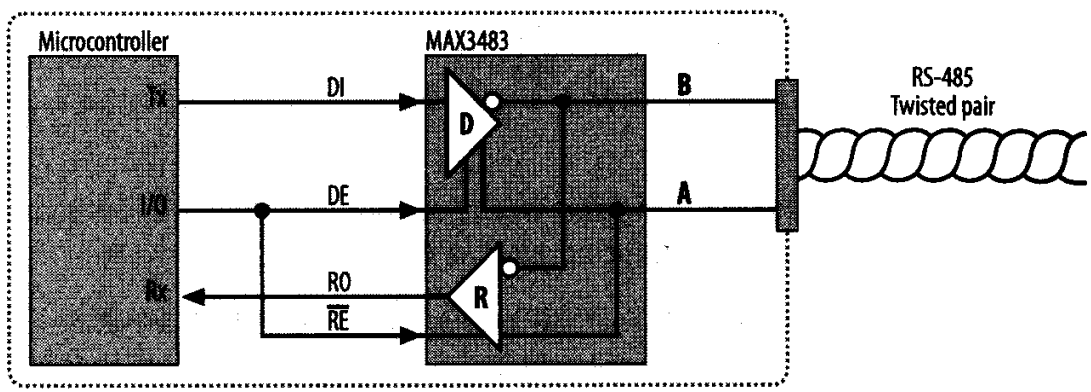
RS-485 (II)

- Architecture
  - Master/slave architecture
    - All transactions are initiated by the master
    - A slave will transmit only when specifically instructed to do so.
  - Protocols
    - Many different protocols run over RS-485.
    - Can create own protocol specific to the application at hand.
  - RS-485 transceiver ->
    - RS-422 transceiver with enable inputs



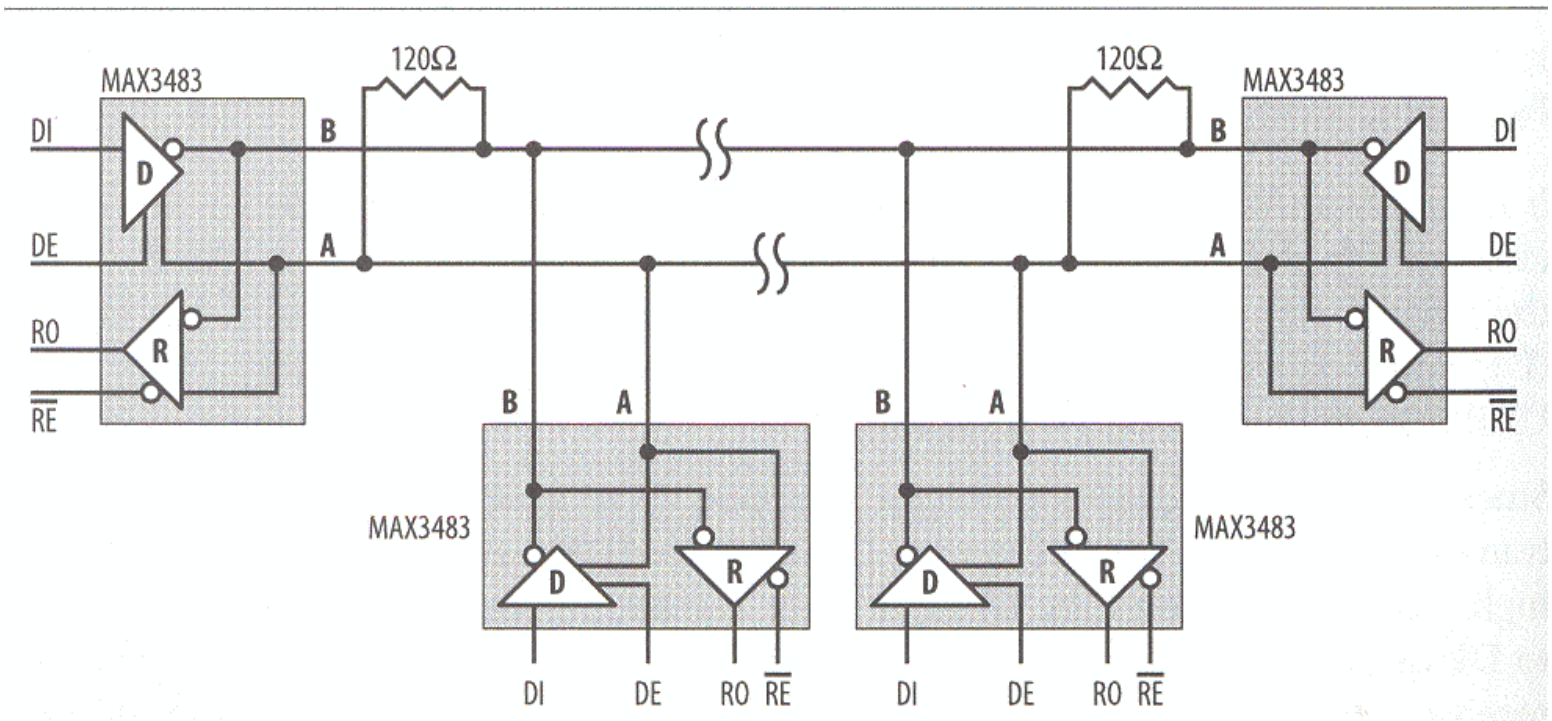
RS-485 (III)

- Control inputs
  - DE (Data Enable)
    - A high input to DE allows the DI input to be transmitted on the network.
  - REb (Receiver Enable)
    - A low input to REb enables the receiver.
  - Only either the transmitter or the receiver should be active at any one time.
    - The control for the transmitter is therefore the logical opposite of the control for the receiver.
    - A single control line can be used for both ->



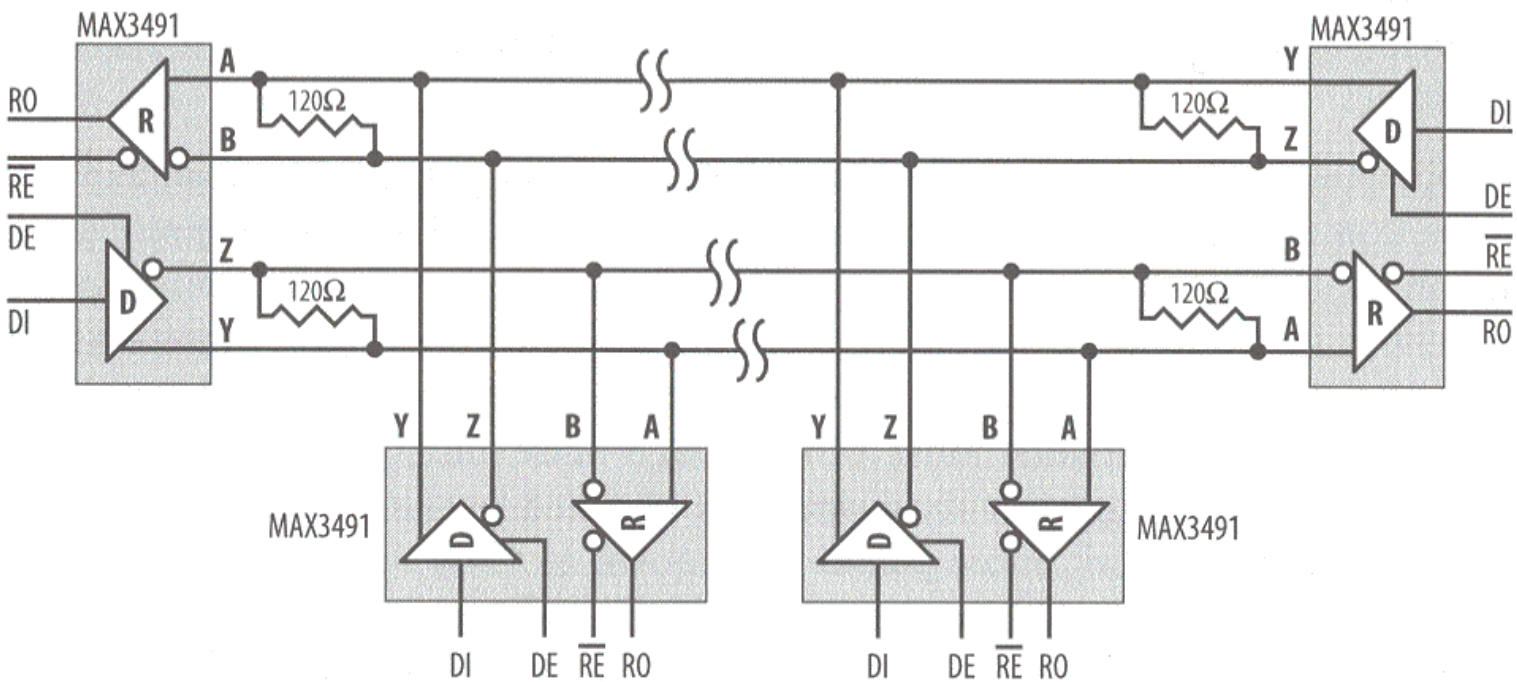
RS-485 (IV)

- Half-duplex implementation
  - A single twisted pair serves for both transmission and reception ->



RS-485 (V)

- Full-duplex implementation
  - A separate twisted-pairs are used for each direction ->
  - Four-wire mode
  - MAX3491: Dual network interface



RS-485 (VI)

- Operation
  - All systems connected to the RS-485 network have their receivers enabled and listen to the traffic.
  - Only when a system wishes to transmit does it enable its driver.
  - A number of formal protocols use RS-485 as a transmission medium.
- Caution
  - AVOID the possibility of two nodes on the network transmitting at the same time.
  - Designate one node as a master node and the others as slaves.
  - Only the master may initiate a transmission on the network.
  - A slave may respond directly only to the master, once that master has finished.
- Number of nodes on the network
  - 32 normal (512 with some chips).

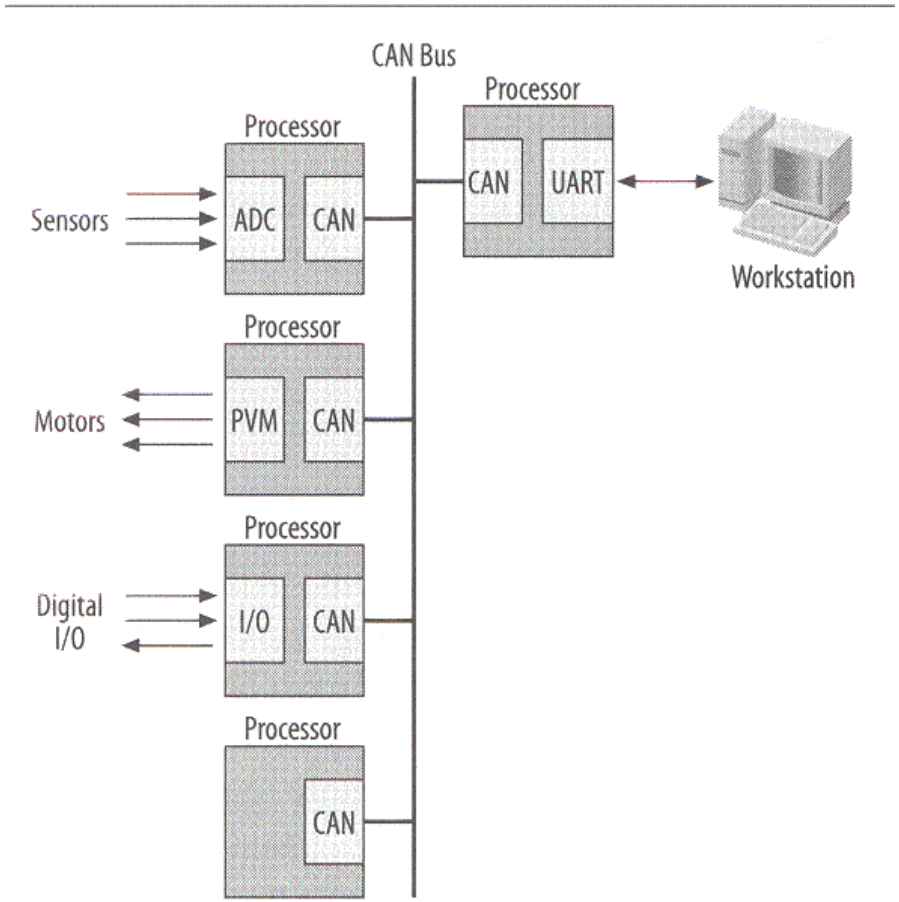
3. Controller Area Network (CAN)

- Complexity of automotive electronics
  - Engine management systems, ABS braking, active suspension, electronic transmission, automated lighting, air-conditioning, security, and central locking
  - Each is part of an integrated whole.
    - A considerable amount of information exchange is required.
    - Point-pt-point wiring inadequate:
      - wiring/connector cost
      - Unnecessary weight, reduced reliability, servicing a nightmare.
- Solution
  - Intersystem communication using a low-cost digital network.
    - High noise immunity required: 400V transients
  - Controller Area Network (CAN)
    - A real-time communication up to 1 Mbps over a two-wire serial network
    - Specifies only the physical and data-link layers of the ISO-OSI model.

CAN (II)

- Progress of CAN
  - Developed by Bosch, late 1980s
  - Robustness
    - Expanded beyond automotive
    - Industrial automation, trains, ship navigation and control systems
    - Medical systems, photocopiers, agricultural machinery, household appliances, office automation, and elevators.
  - International standard under ISO11898 and ISO11519-2.

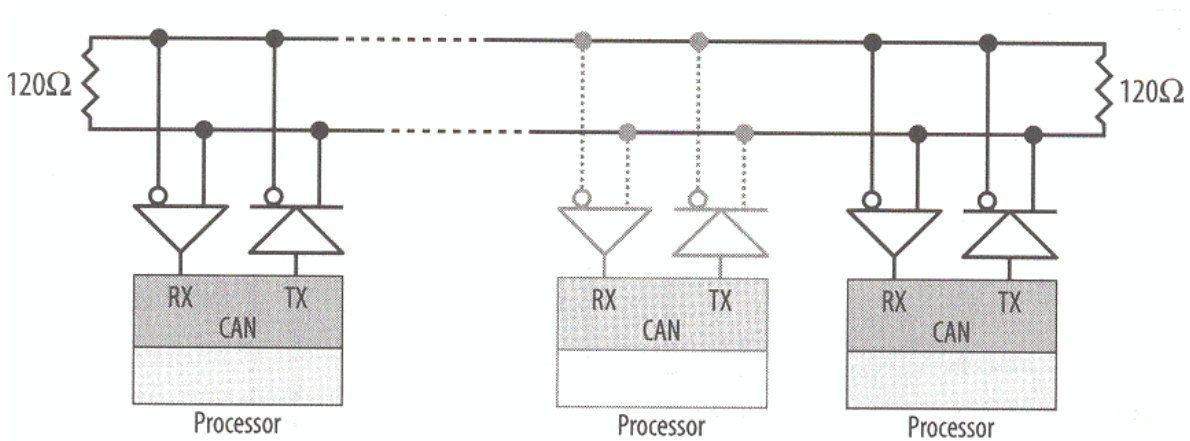
CAN (III)



- CAN distributed system
  - Supports multiple masters on the network
  - Each master responsible for local sensing and control within the distributed system ->
  - CAN packet
    - Contains address information and priority as part of the header
  - The nodes may connect to and disconnect from the network, without affecting network traffic between other nodes.

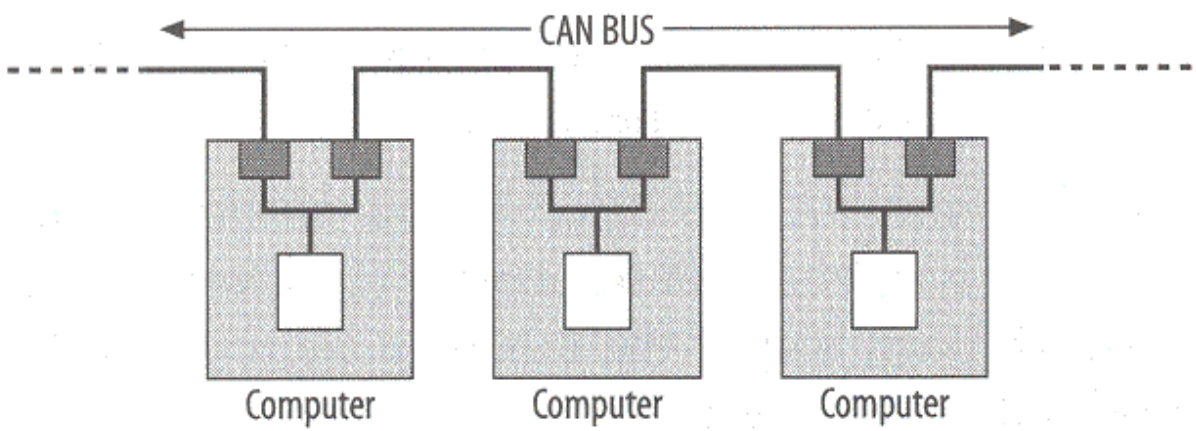
CAN (IV)

- CAN network
  - Wired-AND logic
  - Maximum bus-length of
    - 1000 meters (3300 feet) at 10 kbps
    - 40 meters (133 feet) at 1 Mbps
  - Termination
    - Each end of the bus requires termination resistors to prevent transmission reflections ->



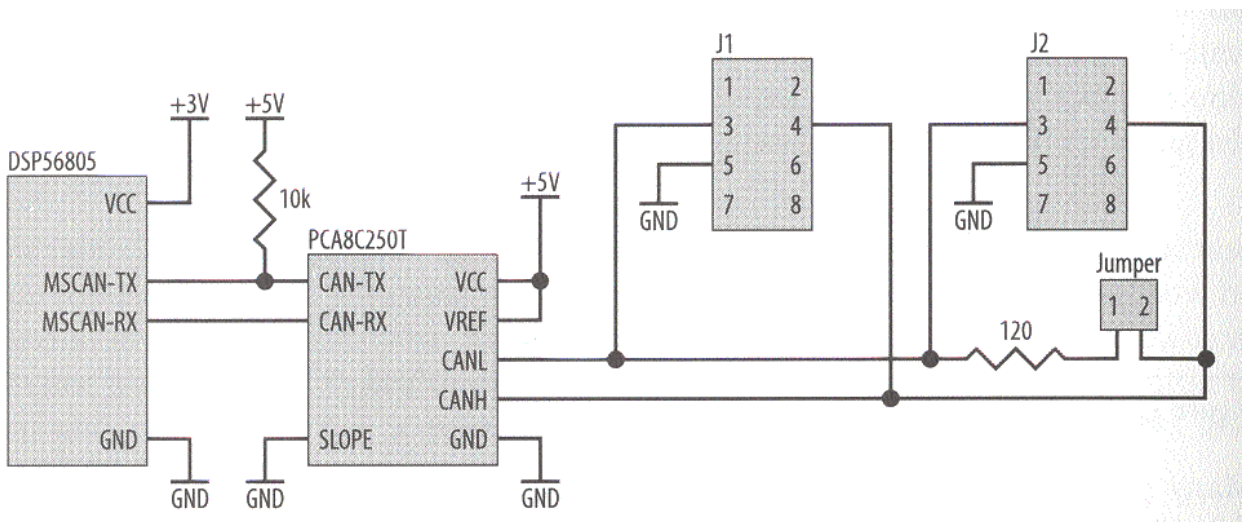
CAN (V)

- CAN module
  - Contained in
    - Many Philips microcontrollers, Few PICs, DSP56805
  - Microchip MCP25120
    - CAN module with SPI host interface
- CAN driver
  - Philips PCA82C250T
- Physical attachment ->



CAN (VI)

- CAN interface for a DSP56805 processor ->
  - Power consideration
    - DSP56805: 3.3V
    - PCA82C250T: 5V
    - Pull-up resistor at MSCAN-TX
  - Jumper
    - Pull-up resistor option (120 ohm)
    - For bus-ends only.



CAN (VII)

- CAN connector
  - 9-pin Sub-D connector (Same as RS-232C)
    - Pin 1, 4, 5, 8: Reserved
    - Pin 2: CAN_L
    - Pin 7: CAN_H
    - Pin 3, 6: Ground
    - Pin 9: V+ (Optional power source)
  - DO NOT connect a CAN bus and RS-232C together!

4. Ethernet

- Ethernet
  - Developed at Xerox PARC in 70s
  - Local area networking standard
  - Wireless networks (802.11) to gigabit Ethernet

- Capabilities of Ethernet
  - Gain access to a network
  - Send data to a host computer
  - Access printers, file servers, databases, and Internet
  - Monitor and control embedded system
  - Weather station: Sensor, ADC, AT90S8515 AVR, and Ethernet interface
  - Gateway, firewall, bridge, switch, etc.

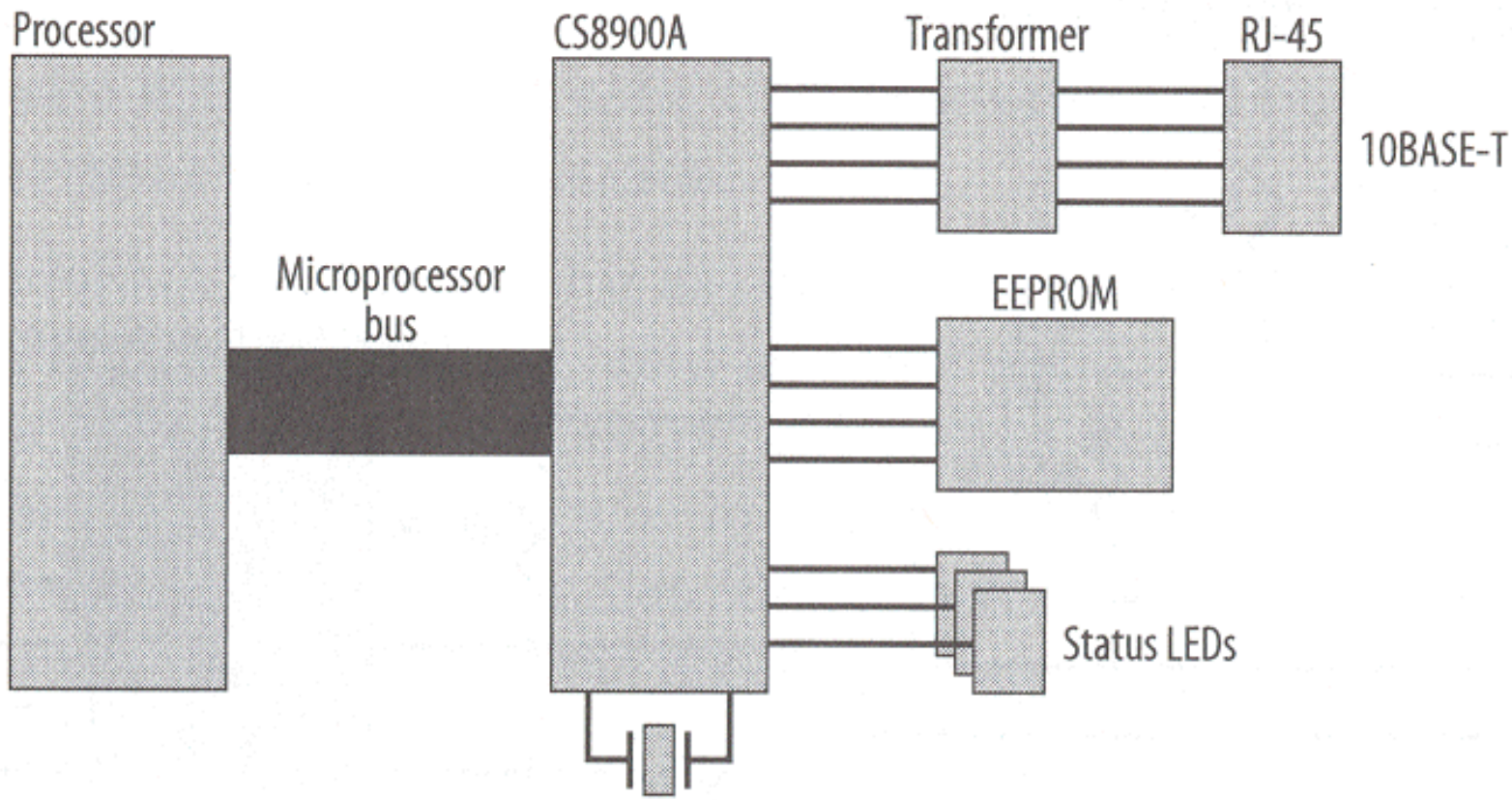
Ethernet (II)

- Adding an Ethernet interface
  - CS8900A
    - Single-chip Ethernet controller by Cirrus Logic (http://www.cirrus.com), formerly Crystal Semiconductor.
    - A simple and low-cost 10Mbps Ethernet interface
    - Supports 10BASE-2, 10-BASET, and AUI (Attachment Unit Interface) Ethernet ports.
  - RJ-45 connector
    - Uses UTP (Unshielded Twisted Pair) category 5 cable (CAT5)
    - Four wires are used: Tx pair, Rx pair.
    - Pinouts:

Pin	Signal name	Purpose	Wire color
1	TD+	Transmitted data	White/orange
2	TD-	Transmitted data	Orange
3	RD+	Received data	White green
4	NC		Blue
5	NC		White/blue
6	RD-	Received data	Green
7	NC		White/brown
8	NC		Brown

Ethernet (III)

- Block diagram of a CS9800A implementation ->



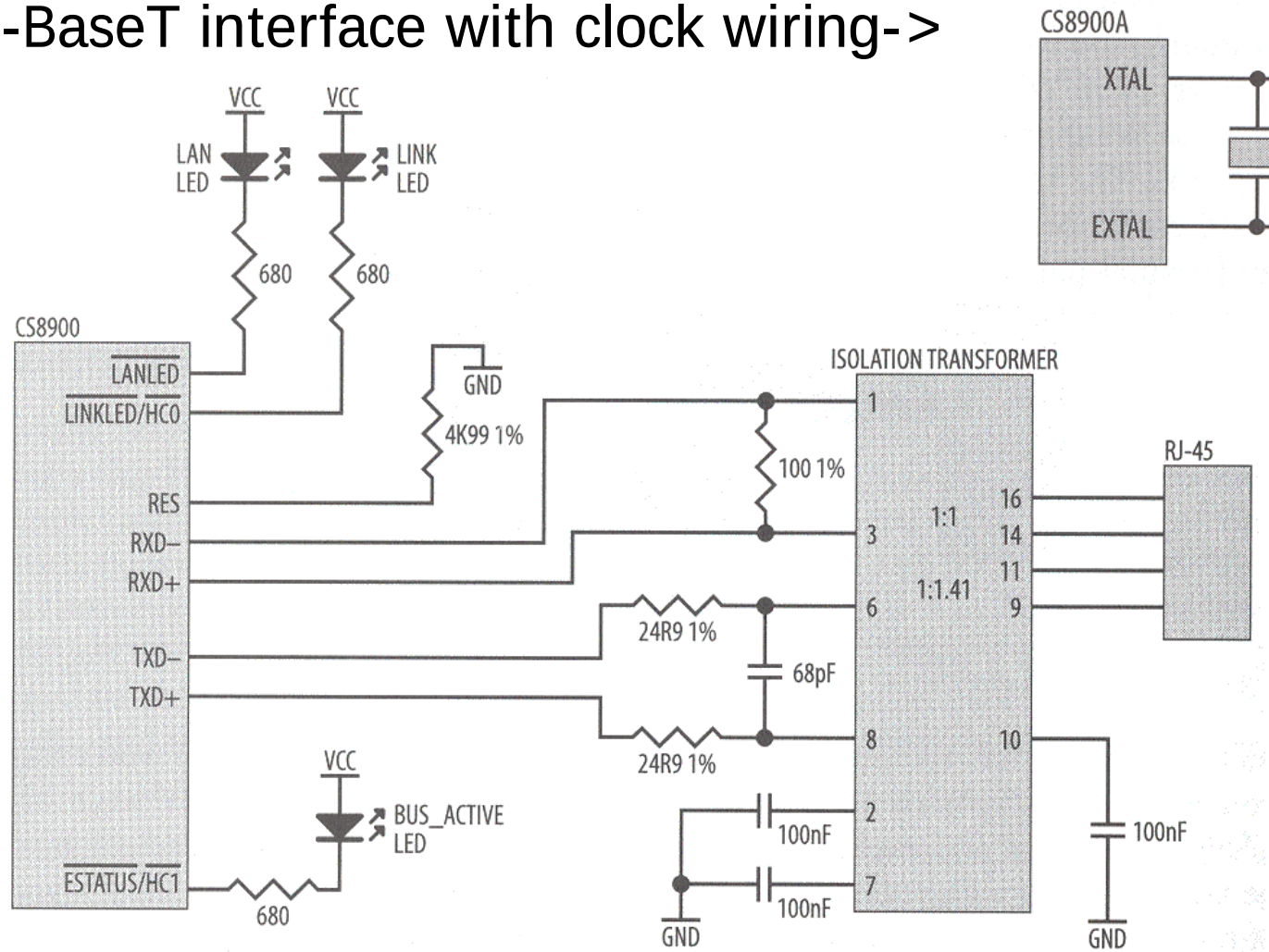
Ethernet (IV)

- Isolation transformer
  - Winding ratio 1:1 for the receiver, 1:1.41 for the transmitter for 5V supply
  - 1:2.5 for the transmitter for 3.3V supply
  - Maker: Valor, PCA, YCL, and Bel.
  - Packaged as chips.

- Passive components
  - Transmitter series-termination resistor: 24.9 ohm, +-1%
  - Transmitter differential pair decoupling: 68 pF capacitor each.
  - Receiver's differential pair: 100 ohm, +-1%
  - LED drive: Ethernet link status, bus and network activity
  - Pull-down on RES pin: 4.99 kohm, +-1%

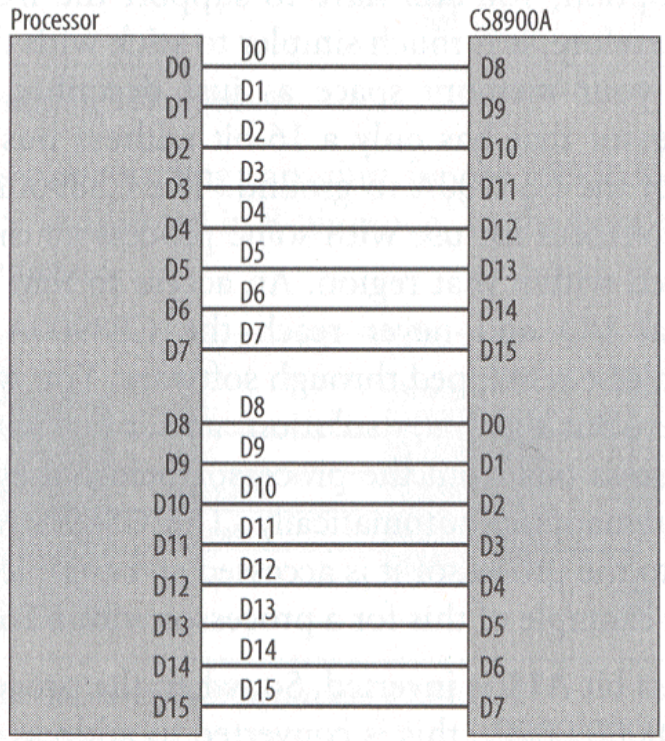
Ethernet (V)

- 10-BaseT interface with clock wiring->



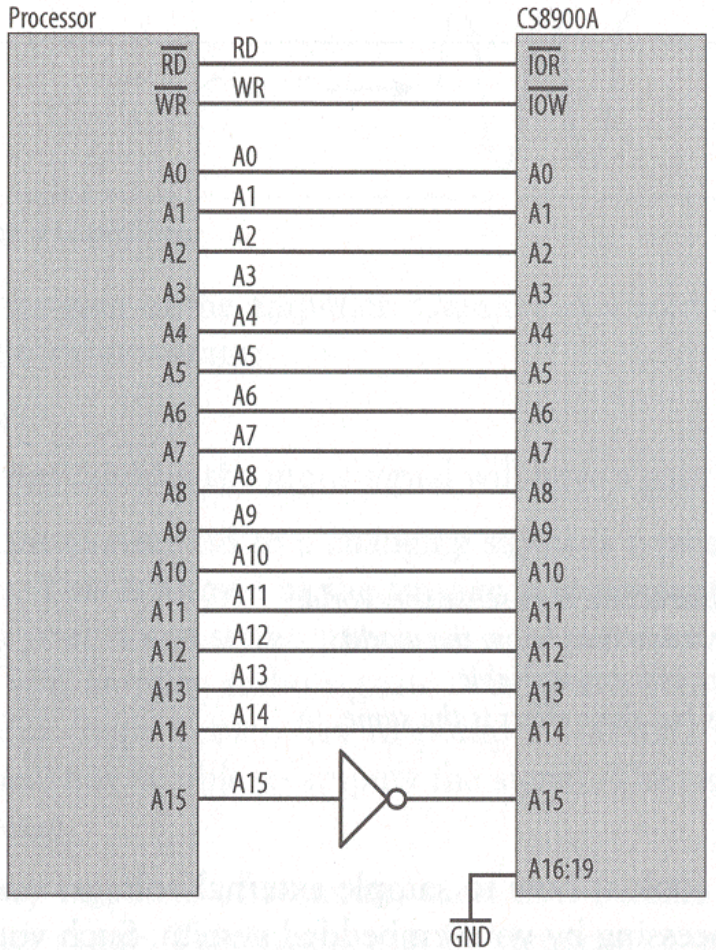
Ethernet (VI)

- Host interface
  - Supports 16-bit ISA bus architecture
  - Easily adapted to work with non-ISA processors
  - Also supports 8-bit data bus
  - Any activity on SHBEb input will place the CS8900A in 16-bit mode. (Ex: Connect to A0)
    - Tie SHBEb to ground for 8-bit operation.
      - Interrupt disabled: Use polling by software.
  - Little-endian operation
    - Big-endian processors (Motorola, DSP56805)
      - Byte-swap in software
      - Byte-swap in hardware ->



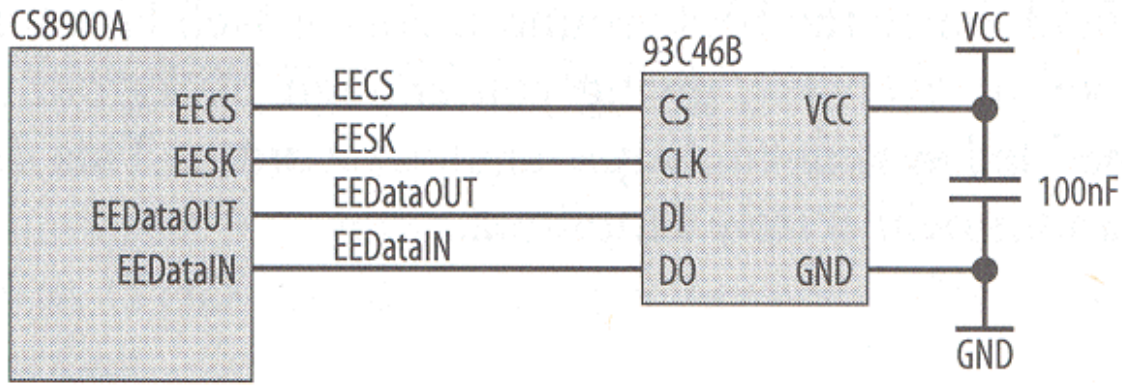
Ethernet (VII)

- Host interface (Cont'd)
  - 20 address inputs
    - ISA-bus device
      - Supports separate memory and I/O address spaces
    - CHIPSELb low: memory-mapped device
      - Controlled by MEMRb and MEMWb
    - CHIPSELb high: I/O space device
      - Expected to do their own address decoding
      - Default to I/O address 0x00300
      - Controlled by IORb and IOWb
  - Address remapping in hardware ->
    - CPU address 0x8300 to I/O address 0x0300



Ethernet (VIII)

- Serial EEPROM
  - Used to store CS8900A configuration information and Ethernet address
  - Optional: The host processor can store this data elsewhere in the system.
  - Standard SPI interface ->



- Unused pins
  - Should be tied inactive (tied to Vcc/ground)

References

- John Catsoulis, “Designing Embedded Hardware”, O’Reilly, 2002.