EE4800-03
Embedded Systems Design

Lessons 23-26

Distributed Processing Systems

msCAN

Overview

- Networks
- Controller Area Network (CAN) Protocol
- msCAN12 Controller Unit
  - Operational Modes
  - Transmit Module
  - Receive Module
  - Interrupt Module
- Networking with CAN Controller

Networks

- What is a network?
  - interconnection of multiple, independent, distributed processors
- Why network processors?
  - Share resources, data
  - Allows fast exchange of related data
  - Facilitate communications between related processors

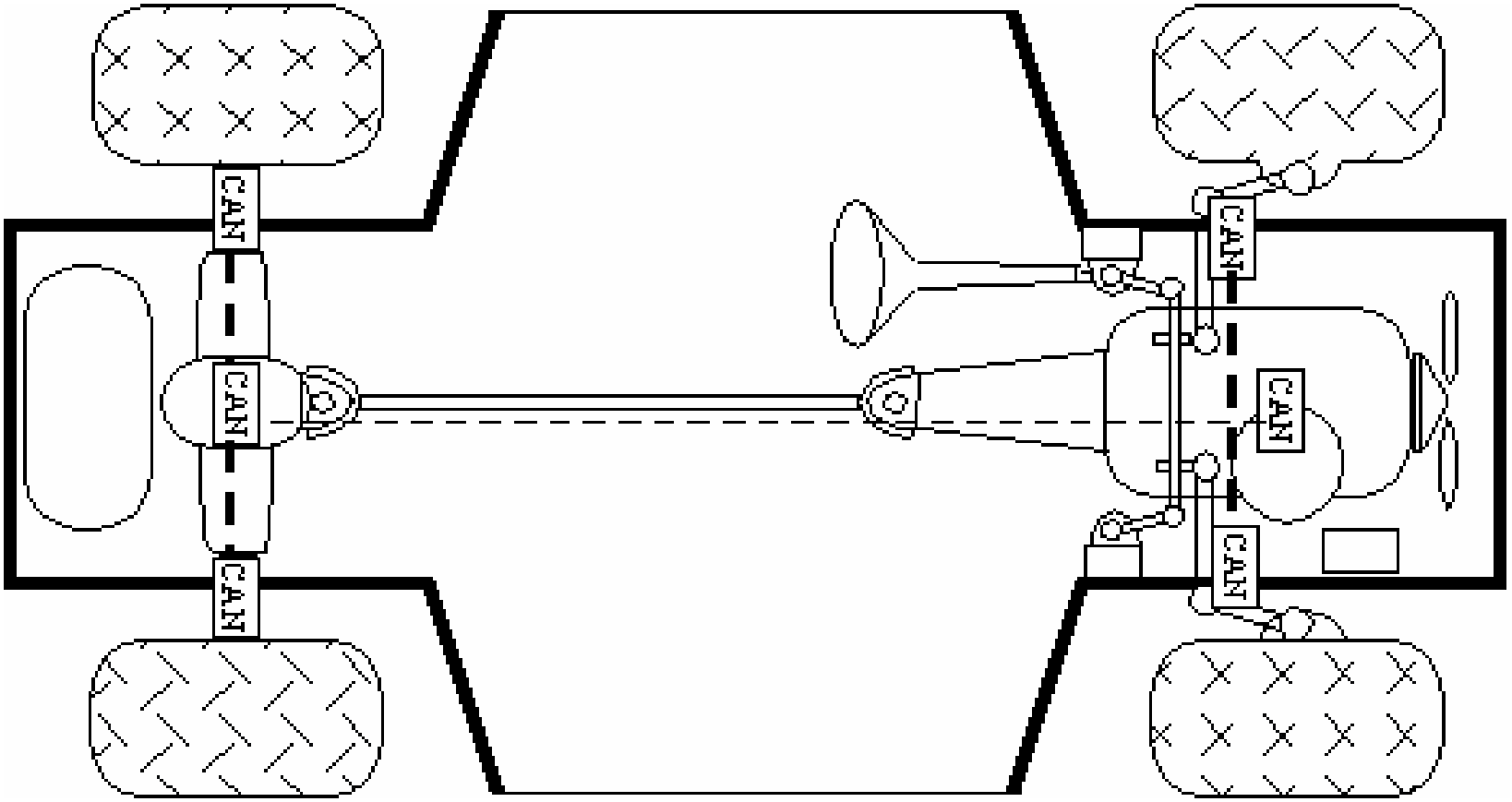
Networks

- Wide Area Network (WAN) - encompasses large area. e.g. Internet
- Local Area Network (LAN) - exists within an institution, company, or organization
- Small Area Network (SAN) - network within small office or home
- Controller Area Network (CAN) - network of multiple microcontrollers

Controller Area Network

- Originated in automotive industry 1980's
- Multiple microcontrollers networked to enhance automobile performance
- Today found in:
  - anti-lock brake system
  - Four-wheel drive controller
  - Panel display controller
  - Audio systems
  - Home theaters
  - Military systems

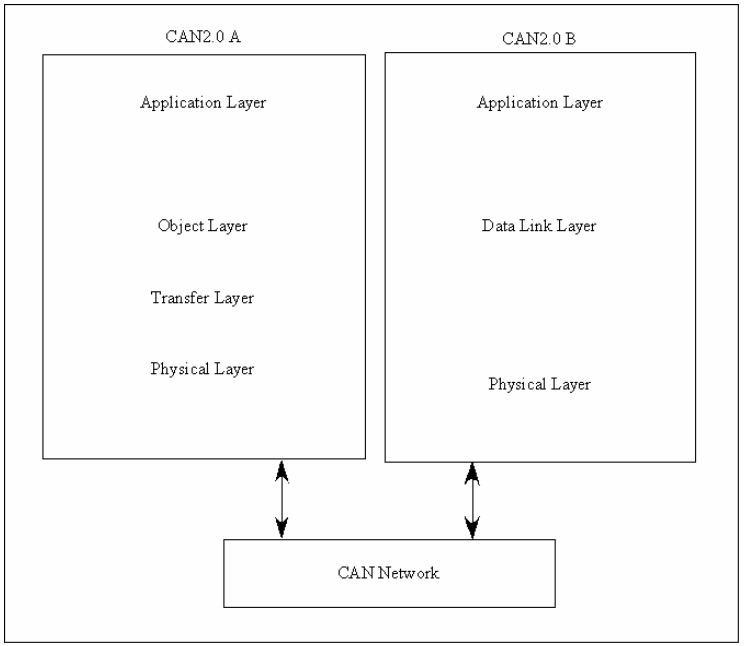
Controller Area Network



Protocols

- All networks must have standardized rules - protocols
- Govern communications among members of network
  - common data length
  - timing of bits transmitted and received
  - receipt verification
  - methods to accommodate multiple members transmitting simultaneously

CAN Protocol - Version 2.0 A(standard)/B(Extended)



- A: Object, Transfer, and Physical Layers
  - Object Layer: handles messages - selects transmit/receive messages
  - Transfer Layer: assures messages adheres to protocol
  - Physical Layer: sends and receives messages
- B: Data Link Layer and Physical Layers

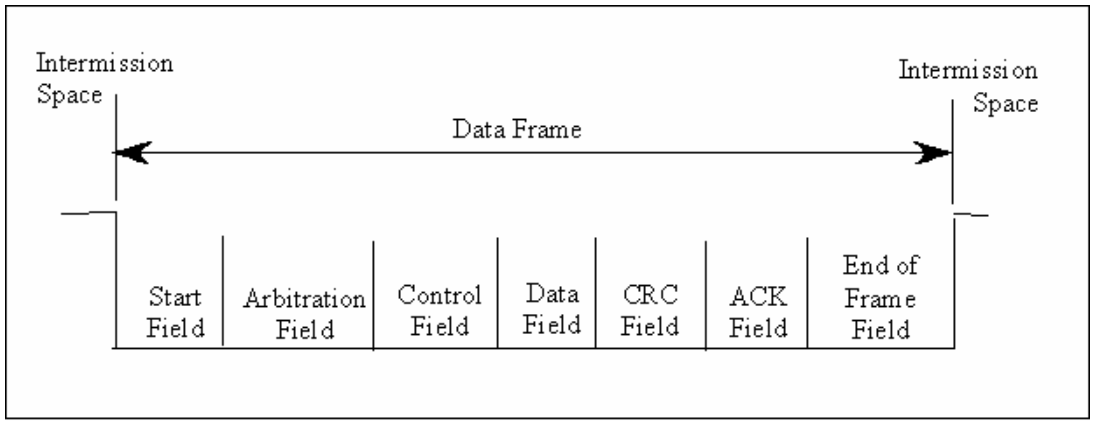
CAN Protocol - Version 2.0 A(standard)/B(Extended)

- Unique feature of CAN protocol is the lack of originating and destination addresses for messages
- Identifier embedded in message
- Node can be added to network without altering existing network hardware or software
- Multiple nodes can act upon the same message, allowing multi-casting capabilities
- Any member of the network can transmit and request messages over the network

CAN Protocol - Version 2.0 A(standard)/B(Extended)

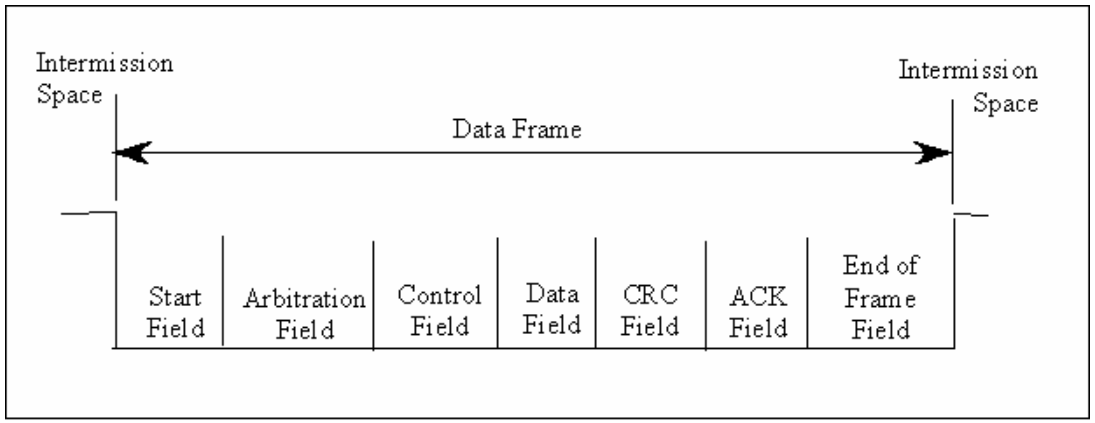
- Four different message (frames) exist on a CAN network:
  - data frame
  - remote frame
  - error frame
  - overload frame

CAN Protocol - Version 2.0
CAN Data Frame



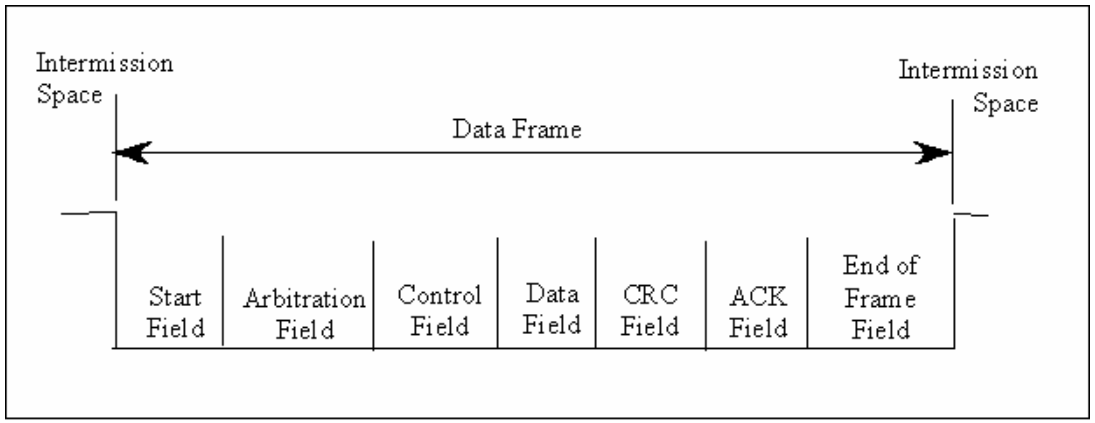
- Contains seven subfields:
  - Start: single dominant (0) bit - used to synchronize
  - Arbitration: contains identifier number of message
    - Used by receiving nodes to determine to accept or reject a particular data frame

CAN Protocol - Version 2.0
CAN Data Frame



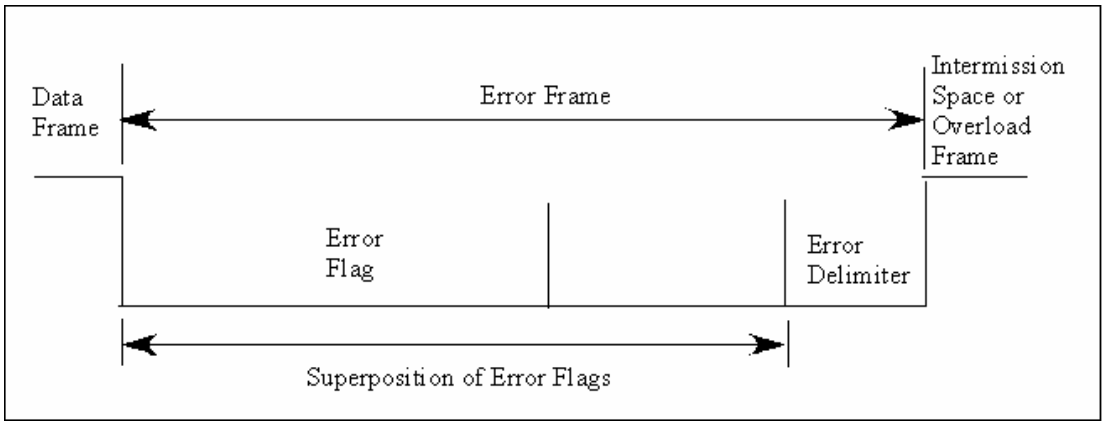
- Contains seven subfields (continued):
  - Control: four bits that specify data length in bytes (1-8)
  - Data: actual message
  - CRC: Cyclic Redundancy Check - error detection
  - ACK: Acknowledge

CAN Protocol - Version 2.0
CAN Remote Frame



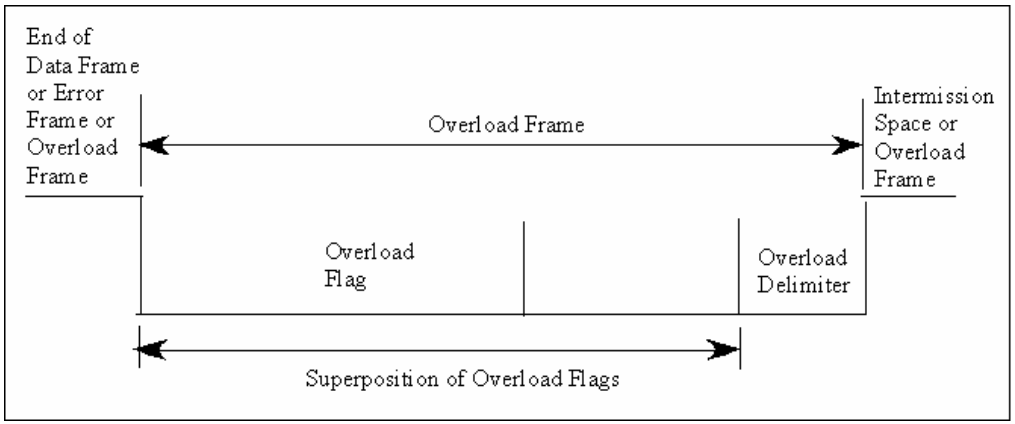
- Remote frame used by receiving node to request a retransmission of a data frame
- Identical to data frame except it contains no data field

CAN Protocol - Version 2.0
CAN Error Frame



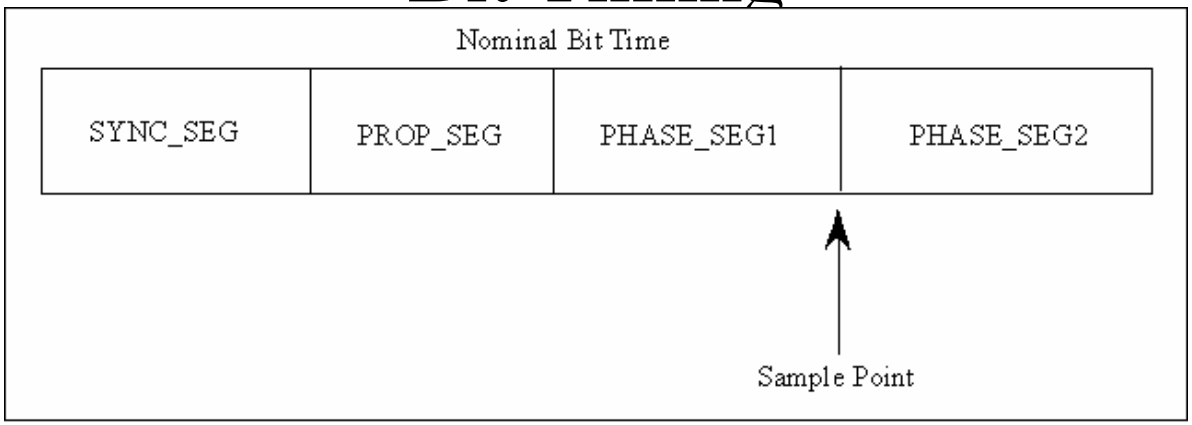
- Used to indicate error has occurred on CAN bus
- Frame contains error flag field and delimiter field

CAN Protocol - Version 2.0
CAN Overload Frame



- System indicates overload when:
  - Receiving node can not process valid frames in allocated time and requires time delay

CAN Protocol - Version 2.0
Bit Timing



- Each bit time period divided into four different regions:
  - synchronization: edge used to synchronize nodes on bus
  - propagation time: accommodates delays within bus
  - phase buffer segment 1
  - phase buffer segment 2

msCAN12 Controller Unit Operational Modes

- 68HC12 operational modes:
  - Run, Wait, Stop
- msCAN12 modes:
  - Normal, Soft Reset, Sleep, and Power Down
- Twelve different combinations

msCAN12 Controller Unit
Transmit Unit

- Transmit unit responsible for message transmission
- Contains three separate 13-byte buffers
  - first four bytes: message ID
  - next eight: message
  - last: message length

Transmit Unit

Address	Register Name
0150	Identifier Register 0
0151	Identifier Register 1
0152	Identifier Register 2
0153	Identifier Register 3
0154	Data Segment Register 0
0155	Data Segment Register 1
0156	Data Segment Register 2
0157	Data Segment Register 3
0158	Data Segment Register 4
0159	Data Segment Register 5
015A	Data Segment Register 6
015B	Data Segment Register 7
015C	Data Length Register

M68HC(9)12BC32 Transmit Buffer 0

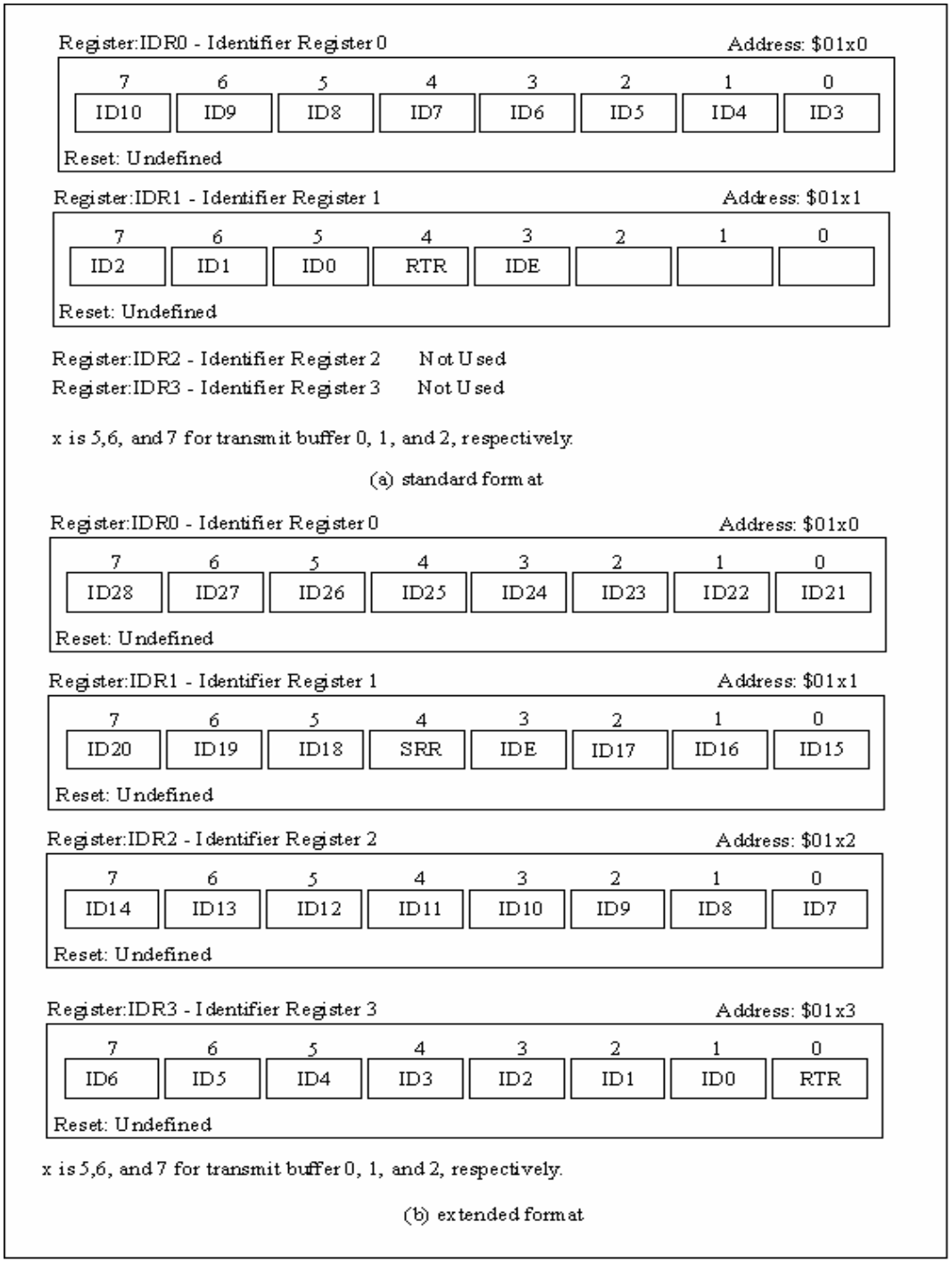
Address	Register Name
0160	Identifier Register 0
0161	Identifier Register 1
0162	Identifier Register 2
0163	Identifier Register 3
0164	Data Segment Register 0
0165	Data Segment Register 1
0166	Data Segment Register 2
0167	Data Segment Register 3
0168	Data Segment Register 4
0169	Data Segment Register 5
016A	Data Segment Register 6
016B	Data Segment Register 7
016C	Data Length Register

M68HC(9)12BC32 Transmit Buffer 1

Address	Register Name
0170	Identifier Register 0
0171	Identifier Register 1
0172	Identifier Register 2
0173	Identifier Register 3
0174	Data Segment Register 0
0175	Data Segment Register 1
0176	Data Segment Register 2
0177	Data Segment Register 3
0178	Data Segment Register 4
0179	Data Segment Register 5
017A	Data Segment Register 6
017B	Data Segment Register 7
017C	Data Length Register

M68HC(9)12BC32 Transmit Buffer 2

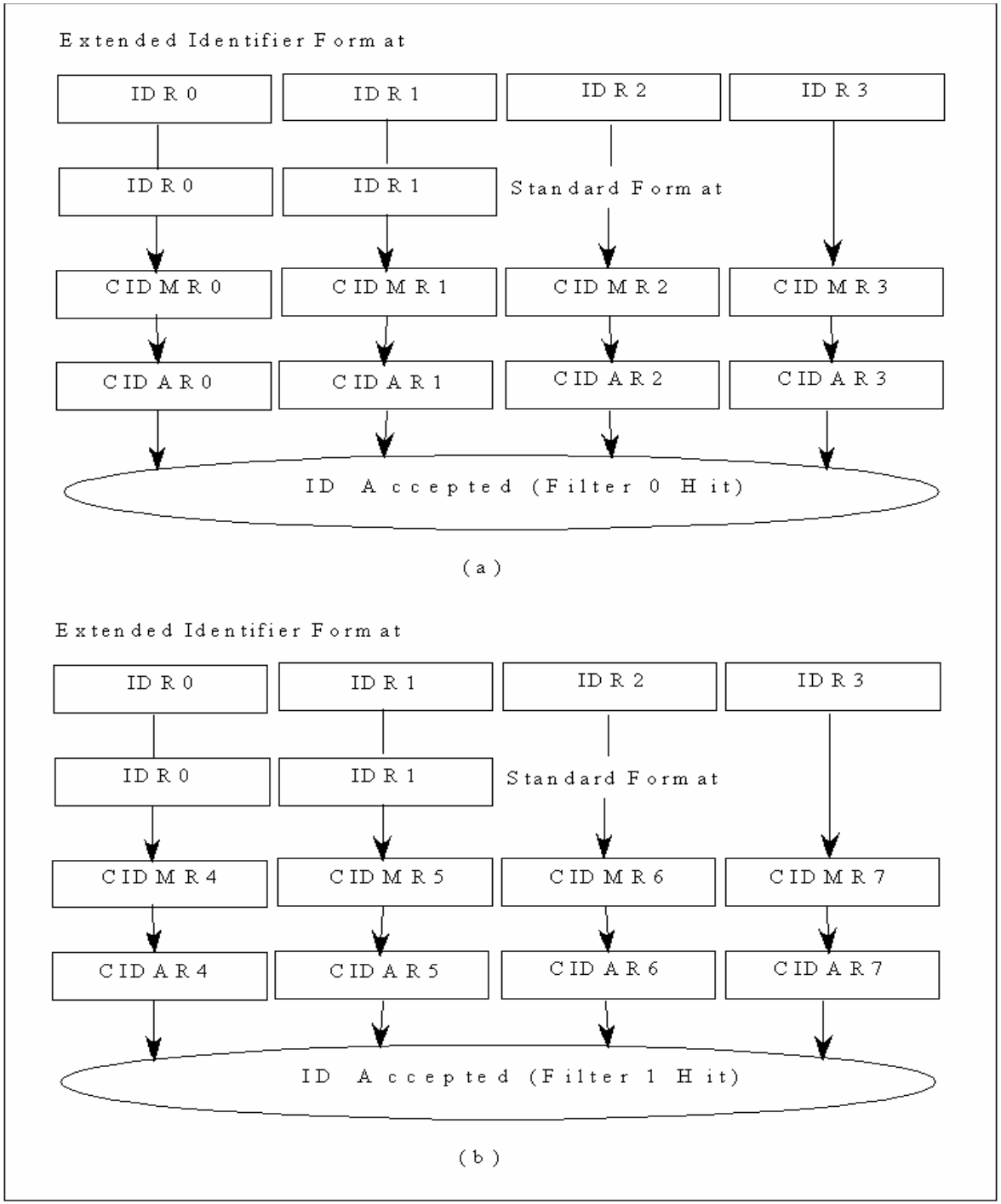
Transmit Unit



msCAN12 Controller Unit
Receive Unit

- Consists of two 13-byte buffers
- Eight Identifier Acceptance Control Registers
- Eight Maskable Identifier Acceptance Filters

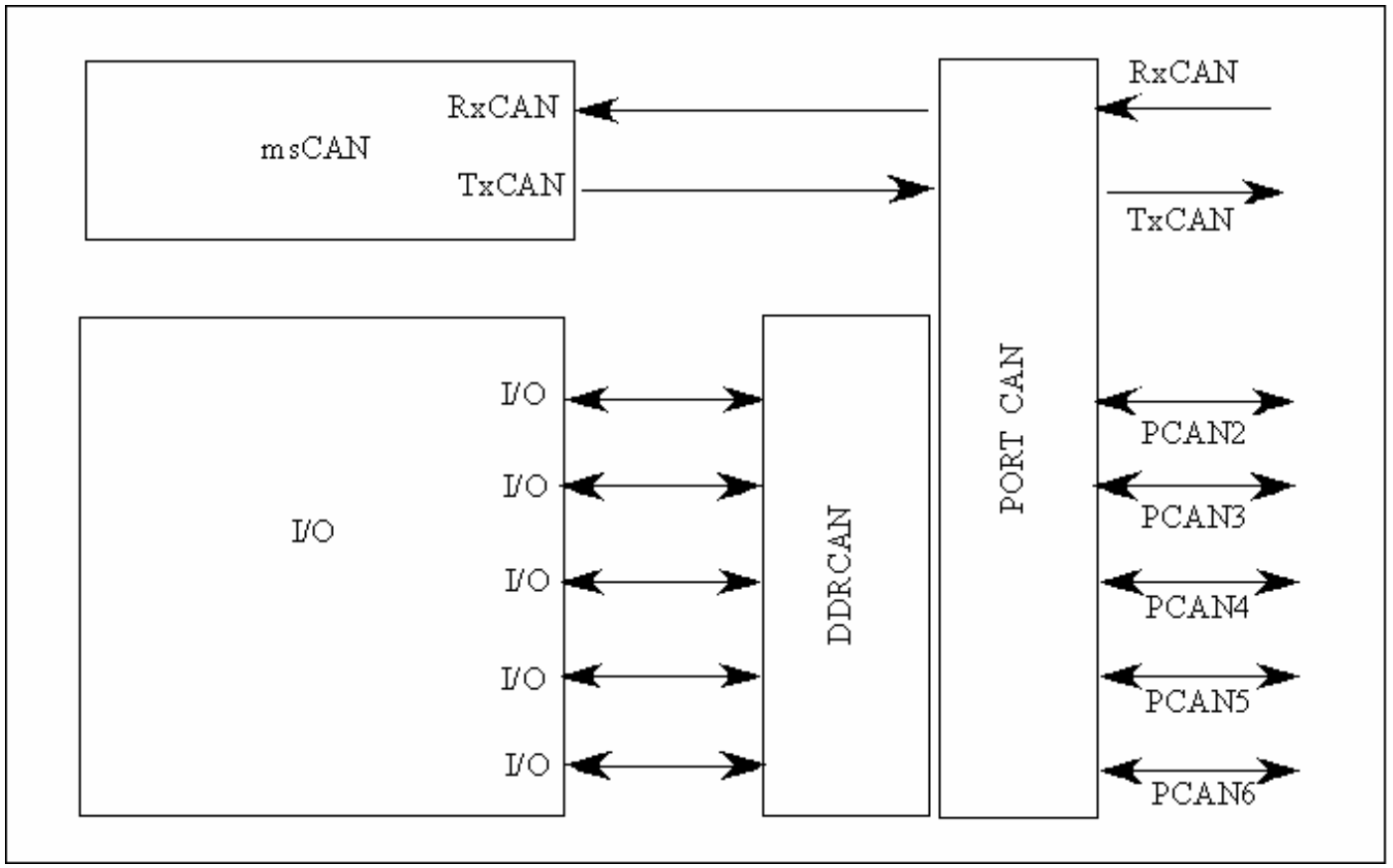
Receive Unit



msCAN12 Controller Unit Interrupts

- Four different types of interrupts:
  - Wakeup
  - Error
  - Receiver Buffer Full
  - Transmitter Buffer Empty

Networking with CAN Controller



Networking with CAN Controller