# CAN Extended Format and CAN FD (Flexible Data Rate)

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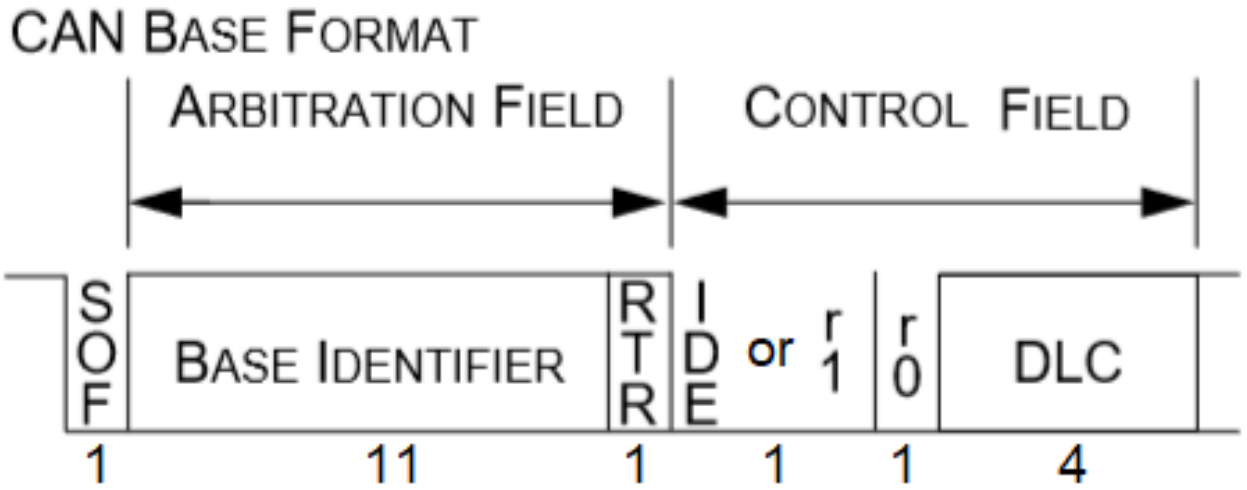
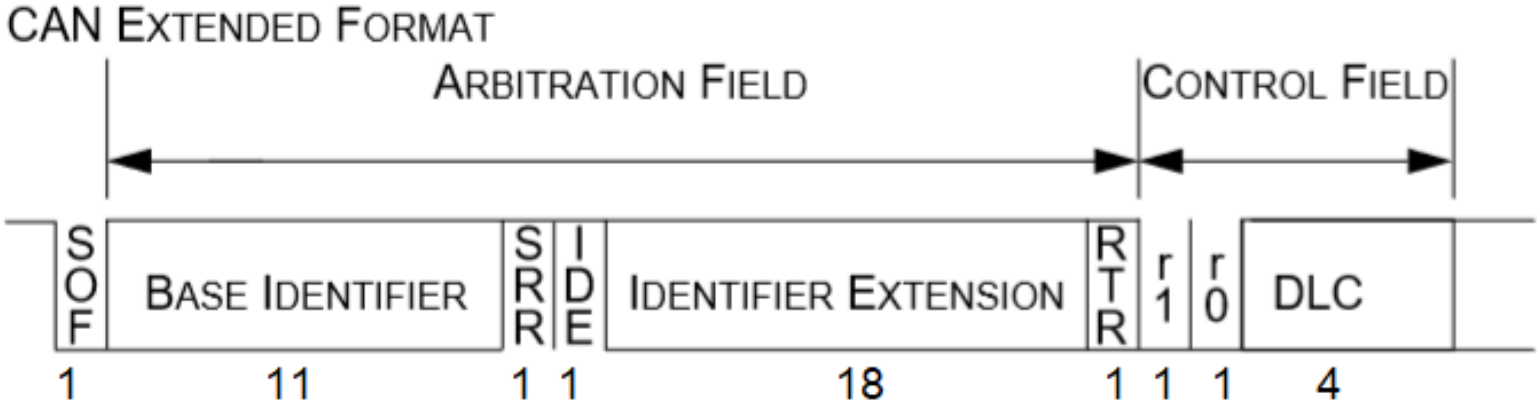
# Review of CAN Base Format
## (11-Bit Identifier)

- This is what we have learned so far.
- The control field has 6 bits. The first two bits r1 and r0 are reserved, and the transmitter always sends these two bits as *dominant* bits.
- Bit r1 is also knows as IDE (*Identifier Extension Flag*).



# CAN Extended Format
## (29-Bit Identifier)

**SRR:** Substitute Remote Request
SRR bit is *recessive*. It is transmitted in Extended Format at the position of the RTR bit in Base Format. Therefore, collisions of a frame in Base Format and a frame in Extended Format, the Base Identifier of which is the same in both frames, are resolved in such a way that the frame in Base Format prevails the frame in Extended Format.

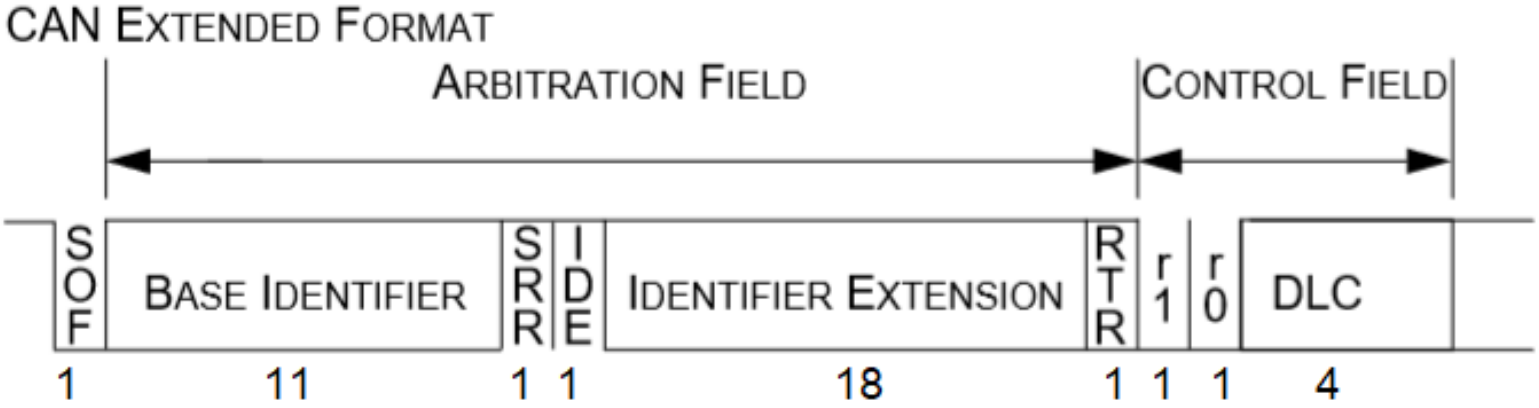


# CAN Extended Format
## (29-Bit Identifier)

**IDE:** Identifier Extension Flag

- In Base Format, this is a *dominant* bit, and it is the same bit as r1, one of the two reserved bits of the Control Field of Base Format. In Extended Format, this is a *recessive* bit.
- In Extended Format, the reserved bits r1 and r0 of Control Field are *dominant* bits.

**IDE = 0** means 11-bit ID, **IDE = 1** means 29-bit ID



# CAN FD (Flexible Data Rate)

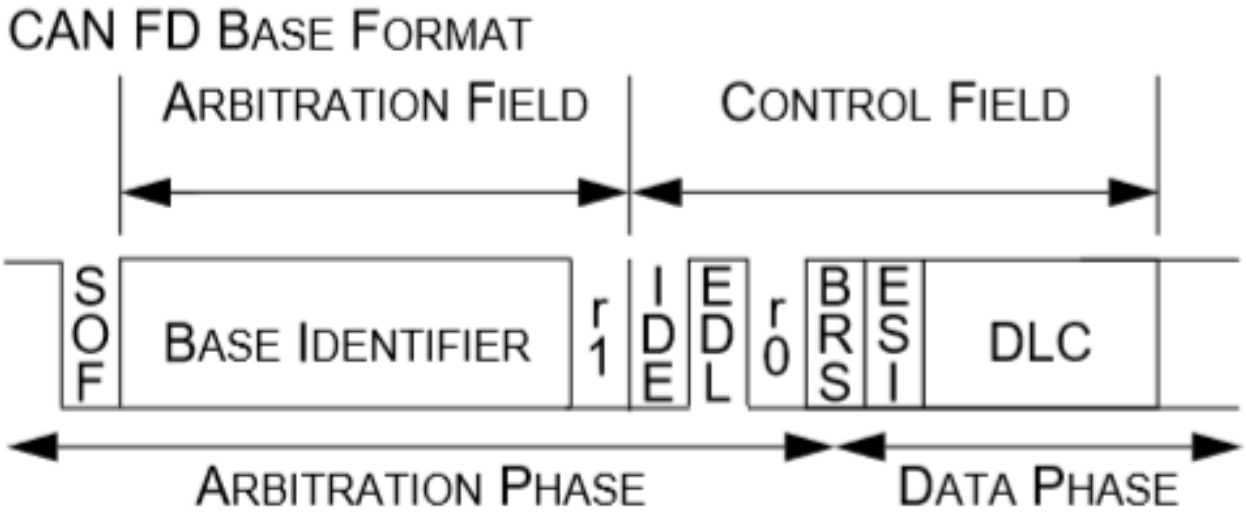
- In CAN FD, the Data Field can contain from 0 to 64 bytes, as oppose to 0 to 8 bytes in Classical CAN.
- In CAN FD, the data can be transmitted at a higher bit rate.

**Classical CAN:** 0 to 8 bytes of data
**CAN FD:** 0 to 64 bytes of data with higher bit rate.

# CAN FD Base Format
## (11-Bit Identifier)

- In CAN FD, there is no Remote Frame. Therefore, there is no RTR bit. Bit r1, a *dominant* bit, is used instead of RTR.
- Just like in Classical CAN, IDE bit indicates whether the message has 11-bit or 29-bit ID.

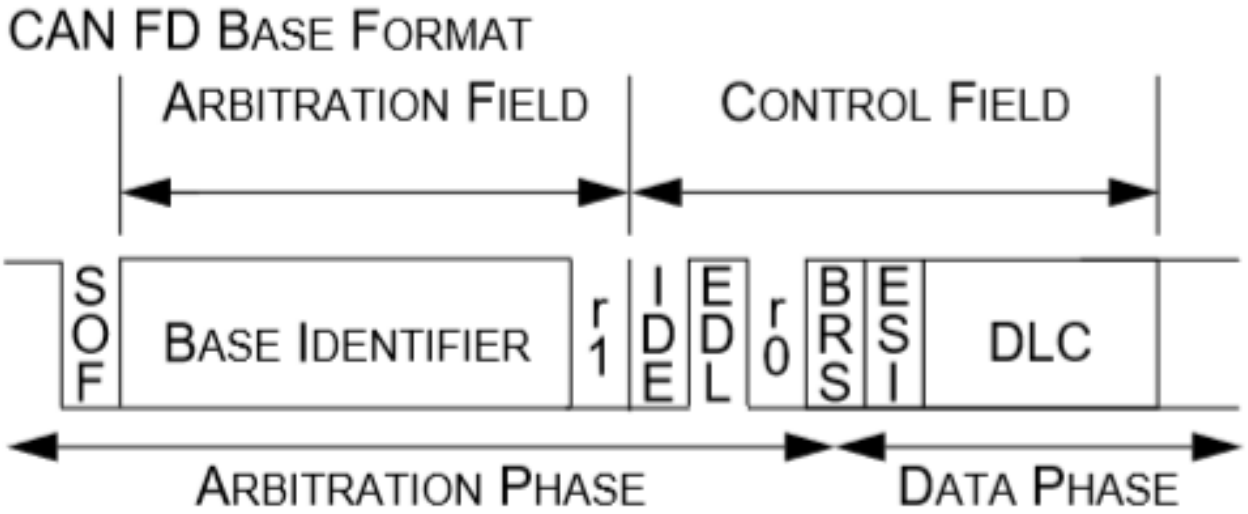
**IDE = 0** means 11-bit ID, **IDE = 1** means 29-bit ID



# CAN FD Base Format
## (11-Bit Identifier)

**EDL**: Extended Data Length

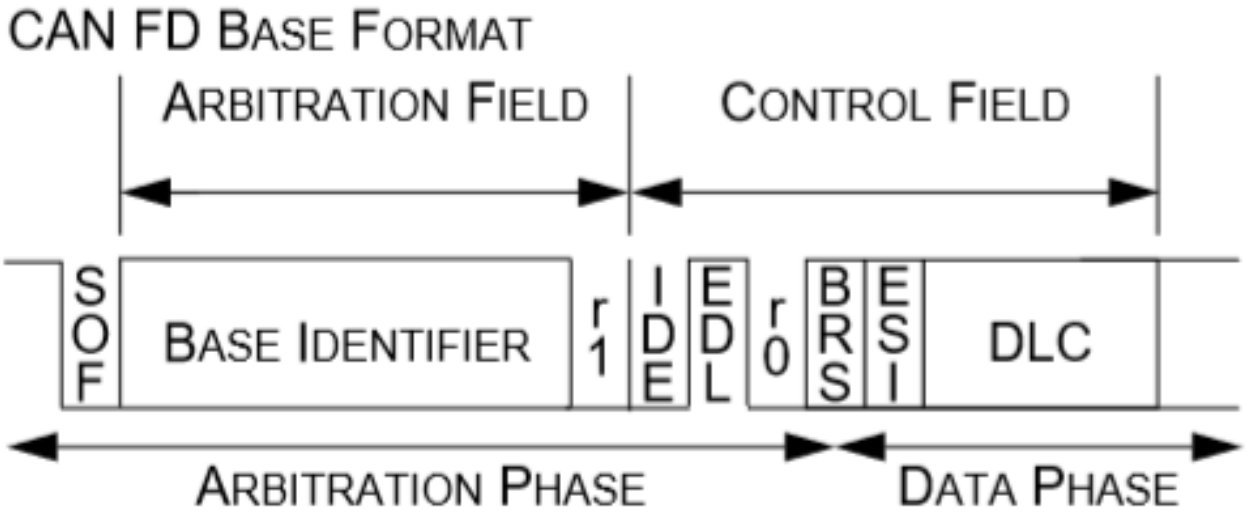
- This is a *recessive* bit. It only exists in CAN FD format.
- In Classical CAN, IDE is followed by r0, a *dominant* bit. In CAN FD, IDE is followed by EDL, a *recessive* bit. That's how the receivers know whether the transmitter is sending a Classical CAN or a CAN FD message.



# CAN FD Base Format
## (11-Bit Identifier)

**r0**: Reserved for Future Use

- Bit r0 is *dominant*, and it's reserved for future use.

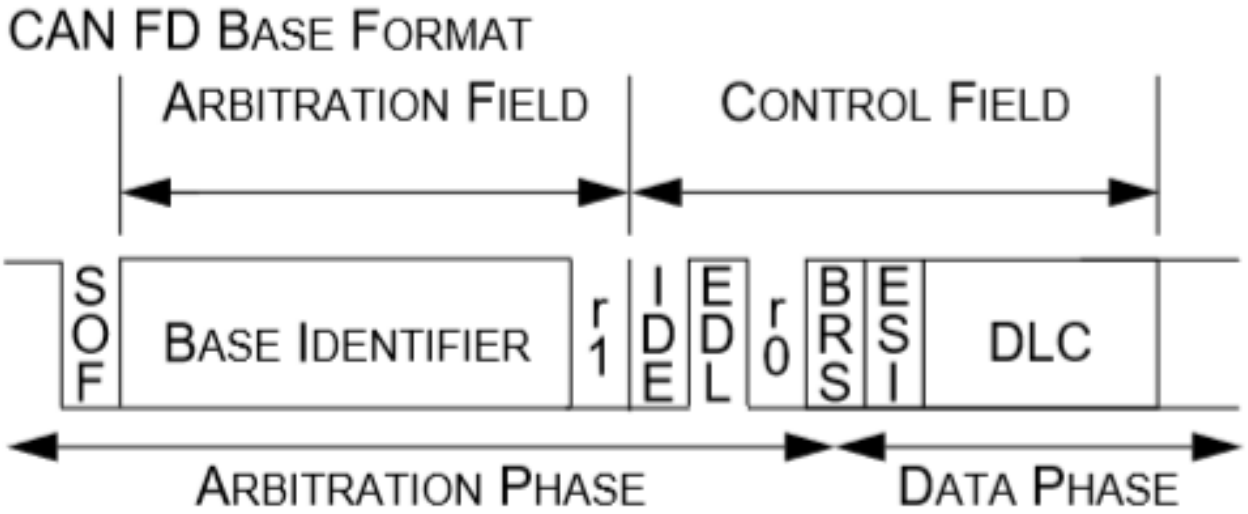


# CAN FD Base Format
## (11-Bit Identifier)

**BRS**: Bit Rate Switch

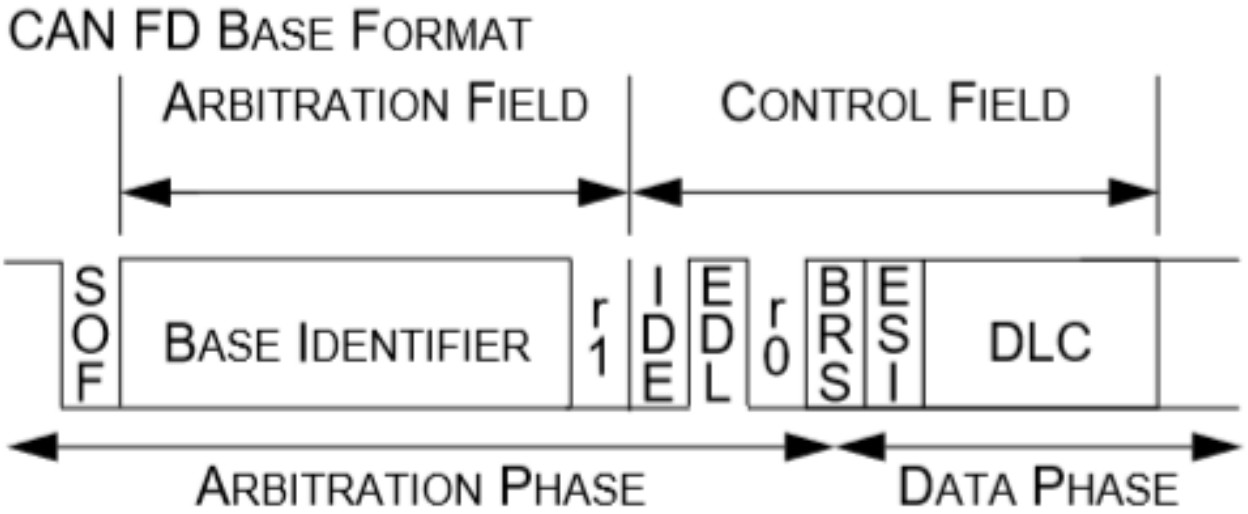
**BRS = 0** means the same bit rate is used for both the Arbitration Phase and Data Phase

**BRS = 1** means a higher bit rate is used for Data Phase



# CAN FD Base Format
## (11-Bit Identifier)

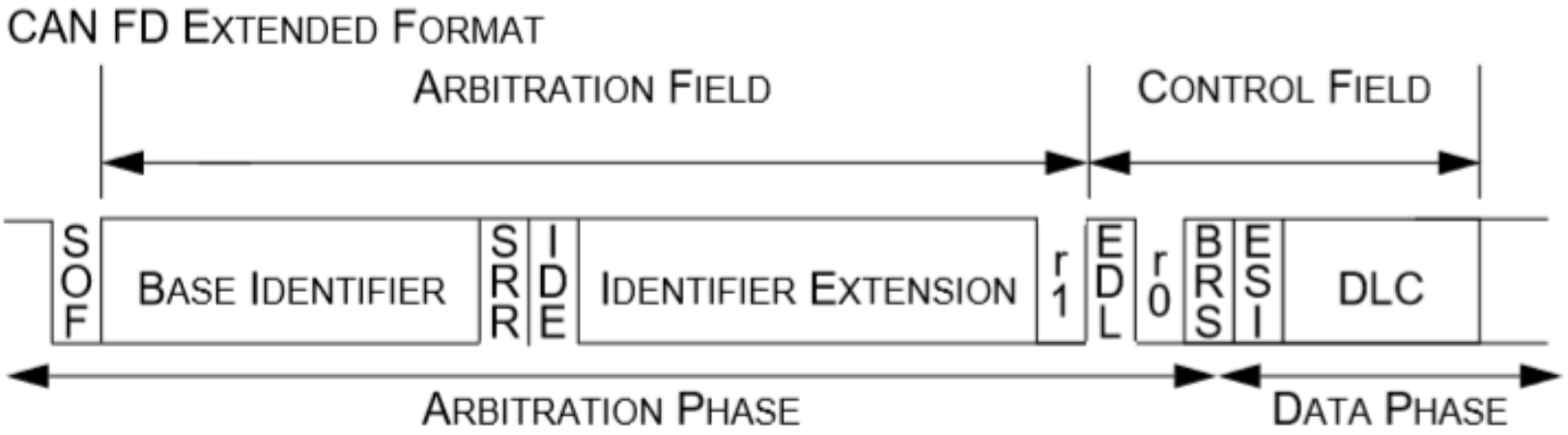
**ESI**: Error State Indicator
- **ESI = 0** means the transmitter is an error active node
- **ESI = 1** means the transmitter is an error passive node



# CAN FD Extended Format
## (29-Bit Identifier)

SRR = 1, IDE = 1 for Extended Format in both Classical CAN and CAN FD
r1 = 0, EDL = 1 and it's present only in CAN FD, r0 = 0

BRS=0: Same bit rate is used for both Arbitration and Data Phases
=1: Higher bit rate is used for Data Phases
ESI=0 means the transmitter is an error active node,
=1 means the transmitter is an error passive node.



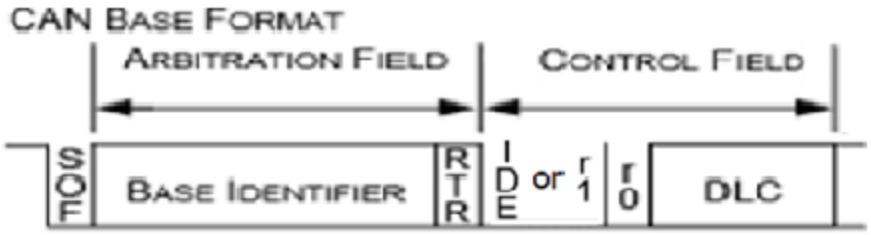
# Data Length Code

| | Number of Data Bytes | Data Length Code | | | |
|---|---|---|---|---|---|
| | | DLC3 | DLC2 | DLC1 | DLC0 |
| Codes in CAN and CAN FD Format | 0 | 0 | 0 | 0 | 0 |
| | 1 | 0 | 0 | 0 | 1 |
| | 2 | 0 | 0 | 1 | 0 |
| | 3 | 0 | 0 | 1 | 1 |
| | 4 | 0 | 1 | 0 | 0 |
| | 5 | 0 | 1 | 0 | 1 |
| | 6 | 0 | 1 | 1 | 0 |
| | 7 | 0 | 1 | 1 | 1 |
| CAN Format | 8 | 1 | 0/1 | 0/1 | 0/1 |
| Codes in CAN FD Format | 8 | 1 | 0 | 0 | 0 |
| | 12 | 1 | 0 | 0 | 1 |
| | 16 | 1 | 0 | 1 | 0 |
| | 20 | 1 | 0 | 1 | 1 |
| | 24 | 1 | 1 | 0 | 0 |
| | 32 | 1 | 1 | 0 | 1 |
| | 48 | 1 | 1 | 1 | 0 |
| | 64 | 1 | 1 | 1 | 1 |

# CRC

- 15-Bit CRC is used for Classical CAN
- 17-Bit CRC is used for CAN FD with the up to 16 bytes of data in the Data Field
- 21-Bit CRC is used for CAN FD with the more than 16 bytes of data in the Data Field
- At the start of the frame, all three CRC Sequences are calculated concurrently, in all nodes including the Transmitter. The node that wins the arbitration sends the CRC Sequence selected by the values of the frame's EDL bit and Data Length Code (DLC). The receiver uses only the selected CRC to determine CRC error.

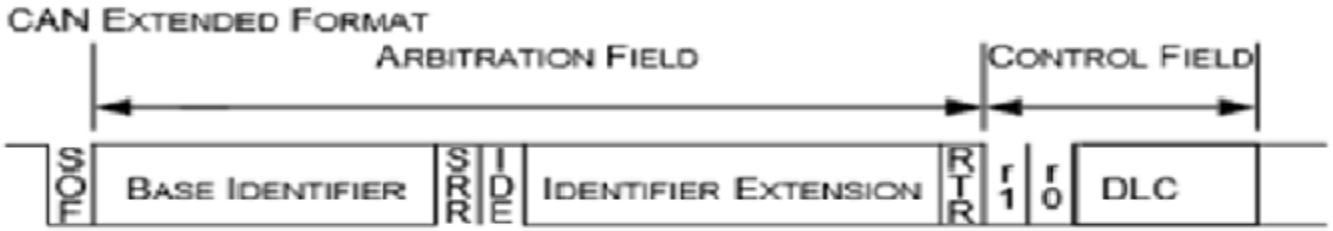
# Formats for CAN and CAN FD




RTR = 0, Data Frame

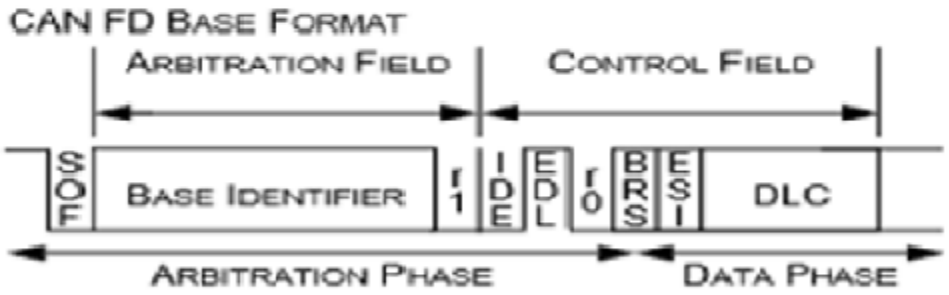
RTR = 1, Remote Frame

IDE = r1 = 0, r0 = 0




SRR = 1

IDE = 1



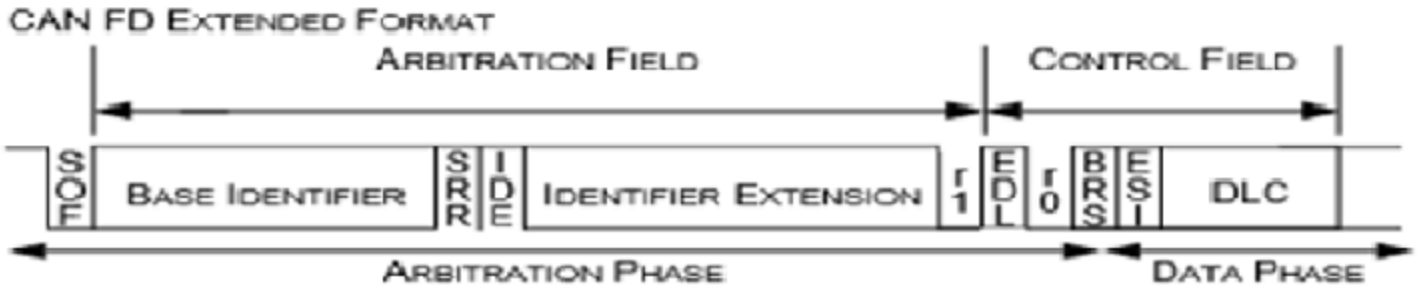

r1 = 0 IDE = 0 EDL = 1

BRS = 0, same bit rate for
Arbitration and Data Phase

BRS = 1, Higher bit rate for Data

ESI = 0, Transmitter is Error Active Node

ESI = 1. Transmitter is Error Passive Node




SRR = 1

IDE = 1

# Examples of Data Frames in Various Formats

***1. CAN Base Format***

ID = 43C, Length of Data = 4 bytes

| SOF | BASE ID | RTR | r1 | r0 | DLC | DATA |
|---|---|---|---|---|---|---|
| 0 | 10000111100 | 0 | 0 | 0 | 0100 | - - - - - |

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***2. CAN Extended Format***

ID = 10F32456, Length of Data = 4 bytes

| SOF | BASE ID | SRR | IDE | ID EXTENSION | RTR | r1 | r0 | DLC | DATA |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 10000111100 | 1 | 1 | 110010010001010110 | 0 | 0 | 0 | 0100 | - - - - - |

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***3. CAN FD Base Format***

ID = 43C, Length of Data = 4 bytes, Same Bit Rate for Arbitration and Data Phases, Transmitter is Error Active Node

| SOF | BASE ID | r1 | IDE | EDL | r0 | BRS | ESI | DLC | DATA |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 10000111100 | 0 | 0 | 1 | 0 | 0 | 0 | 0100 | - - - - - |

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***4. CAN FD Extended Format***

ID = 10F32456, Length of Data = 4 bytes, Higher Bit Rate for Data Phase, Transmitter is Error Passive Node

| SOF | BASE ID | SRR | IDE | ID EXTENSION | r1 | EDL | r0 | BRS | ESI | DLC | DATA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 10000111100 | 1 | 1 | 110010010001010110 | 0 | 1 | 0 | 1 | 1 | 0100 | - - - - - |

# Identify the CAN or CAN FD Frame

## Problem-1

Identify the following CAN or CAN FD frame. Show the values of ID and DLC.

01011011110011110010010101010110000010100 00 - - - - - -

| | | RTR/ SRR/ | |
|---|---|---|---|
| SOF | BASE ID | r1 | - - - - - - |
| **0** | **10110111100** | **1** | - - - - - - |

If **RTR/SRR/r1 = 0**, then the Frame belongs to either CAN or CAN FD Base Format

If **RTR/SRR/r1 = 1**, then the Frame belongs to either CAN or CAN FD Extended Format. Also it could be a **Remote Frame** in CAN Base Format.

**This is the case for Problem-1.**

**Now let's check the next bit: r1/IDE.**

| | | RTR/ SRR/ | r1/ | |
|---|---|---|---|---|
| SOF | BASE ID | r1 | IDE | - - - - - - |
| **0** | **10110111100** | **1** | **1** | - - - - - - |

If **r1/IDE = 0**, with **RTR/SRR/r1 = 1** then it's a Remote Frame in CAN Base Format.

If **r1/IDE = 1**, with **RTR/SRR/r1 = 1** then the Frame belongs to either CAN or CAN FD Extended Format.

**This is the case for Problem-1.**

# Identify the CAN or CAN FD Frame (continued)

**Now let's check the next bit: RTR/r1.**

| SOF | BASE ID | SRR | IDE | ID EXTENSION | RTR/ r1 |
|---|---|---|---|---|---|
| **0** | **10110111100** | **1** | **1** | **11001001010101010110** | 0 |

If **RTR/r1 = 0**, then it's a Data Frame either in CAN or CAN FD Extended Format. **This is the case for Problem-1.**
If **RTR/r1 = 1**, then it's a Remote Frame in CAN Extended Format.

**Now let's check the next bit: r1/EDL.**

| SOF | BASE ID | SRR | IDE | ID EXTENSION | RTR/ r1 | r1/ EDL |
|---|---|---|---|---|---|---|
| **0** | **10110111100** | **1** | **1** | **11001001010101010110** | 0 | 0 |

If **r1/EDL = 0**, with **RTR/r1 = 0** then it's a Data Frame in CAN Extended Format. **This is the case for Problem-1.**
If **r1/EDL = 1**, with **RTR/r1 = 0** then it's a Data Frame in CAN FD Extended Format.

**All the Fields of the Data Frame in CAN Extended Format**

| SOF | BASE ID | SRR | IDE | ID EXTENSION | RTR/ r1 | r1/ EDL | r0 | DLC | DATA |
|---|---|---|---|---|---|---|---|---|---|
| **0** | **10110111100** | **1** | **1** | **11001001010101010110** | 0 | 0 | 0 | 0101 | 0000 - - - - - - |

**Answers:** ID = **10110111100110010010101010110** and DLC = 0101

# Source

Can with Flexible Data-Rate, BOSCH, Specification, Version 1.0, April 17th, 2012