# The new can Wake up flow

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# WUP
# The new bus wake up concept

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# Current situation

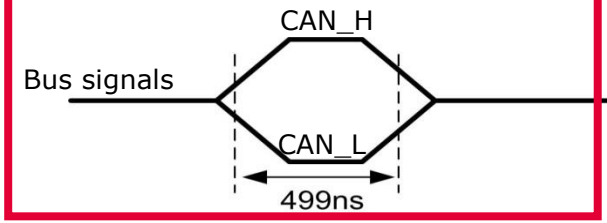
- In the ISO 11898-5 the bus wake up behavior is described the first time
- In this specification a dominant level on the bus longer than 5µs is able to wake up the transceiver
- This was not robust enough against noise and spikes for future needs
- A new wake behavior is specified in the new ISO 11898-2 (edition 2016)

# ISO 11898-2 Wake up Pattern

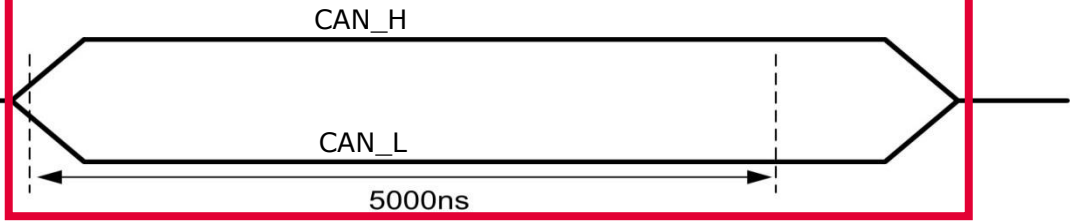
› ISO specification CAN activity filter time

| Parameter | Min | Max | Unit | Condition |
|---|---|---|---|---|
| CAN activity filter time, long | 0,5 | 5 | µs | 1,2V ≤ Vdiff ≤ 3V<br>-10,8V ≤ $V_{CAN\_H}$ ≤ 12,0V<br>-12,0V ≤ $V_{CAN\_L}$ ≤ 10,8V |

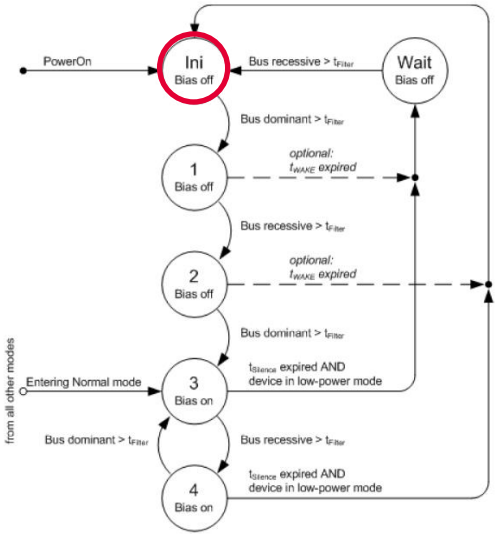
› A dominant or recessive level shorter than 500 ns will be ignored




› A dominant of recessive level longer than 5 µs will be detected



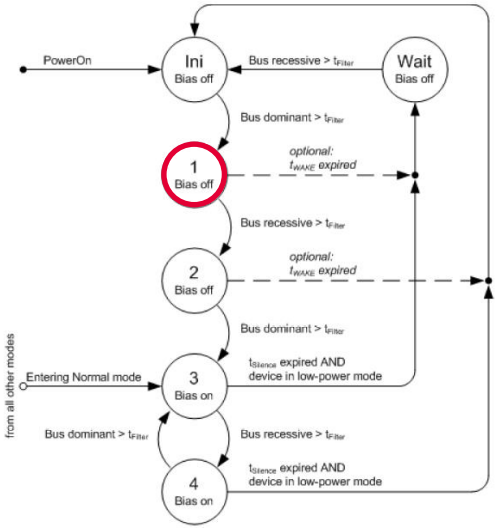
# Wake Up Pattern Flow

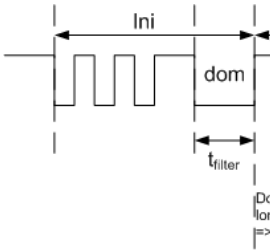



## State Ini:

- Bus recessive; no communication
- CAN activity dominant filter time detection unit is active
- Dominant levels on the bus shorter than 500(150)ns will be filter out
- Dominant levels on the bus longer than 5000(1800)ns will be detected as dominant condition
- If dominant condition is fulfilled Transceiver will jump to State 1

# Wake Up Pattern Flow

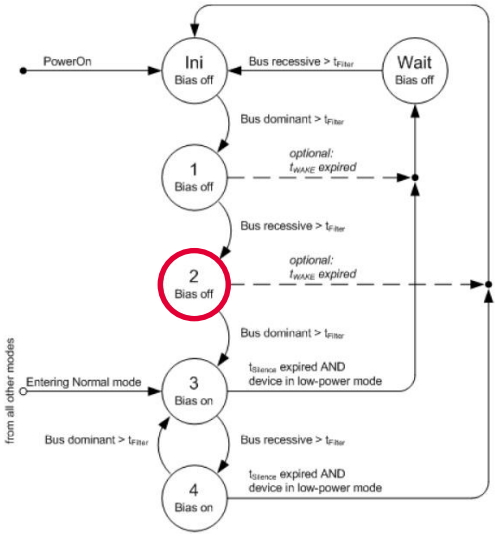



## State 1:

- Communication on the bus
- CAN activity recessive filter time detection unit is active
- Recessive levels on the bus shorter than 500(150)ns will be filter out
- Recessive levels on the bus longer than 5000(1800)ns will be detected as recessive condition
- If recessive condition is fulfilled Transceiver will jump to State 2

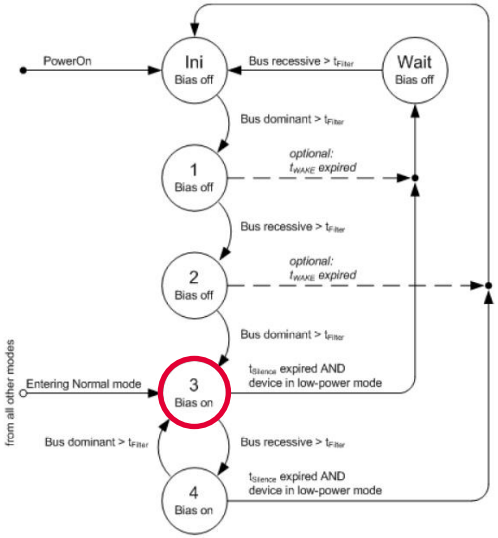
# Wake Up Pattern Flow




## State 2:

- Communication is running
- CAN activity dominant filter time detection unit is active
- Dominant levels on the bus shorter than 500(150)ns will be filter out
- Dominant levels on the bus longer than 5000(1800)ns will be detected as dominant condition
- If dominant condition is fulfilled Transceiver will jump to State 3
- Transceiver will be woken up and switch on the bus biasing and flags this event on RxD pin and/or INH pin.

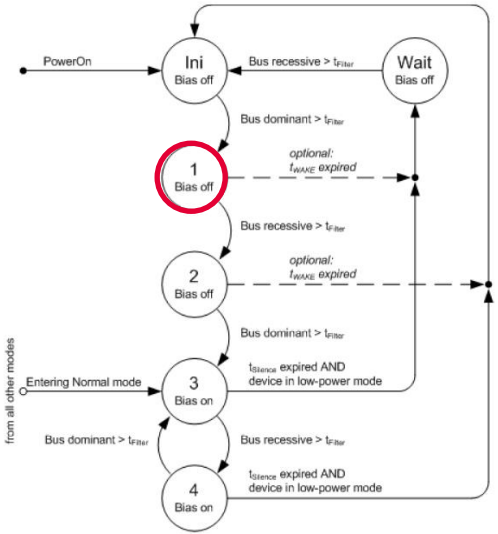
# Wake Up Pattern Flow




## State 3:

- Communication is running
- Transceiver is active
- Transceiver is in normal operation mode or low power mode bus biasing active
- If device change into low power mode with bus biasing active and there is no communication on the bus, the transceiver will change into state INI

# Wake Up Pattern Flow




## Bus short:

- Short CANH to Vbat
- Permanent dominant level on the bus may occur
- CAN activity recessive filter time detection unit is active
- Permanent dominant level on the bus for a time longer than $t_{wake}$

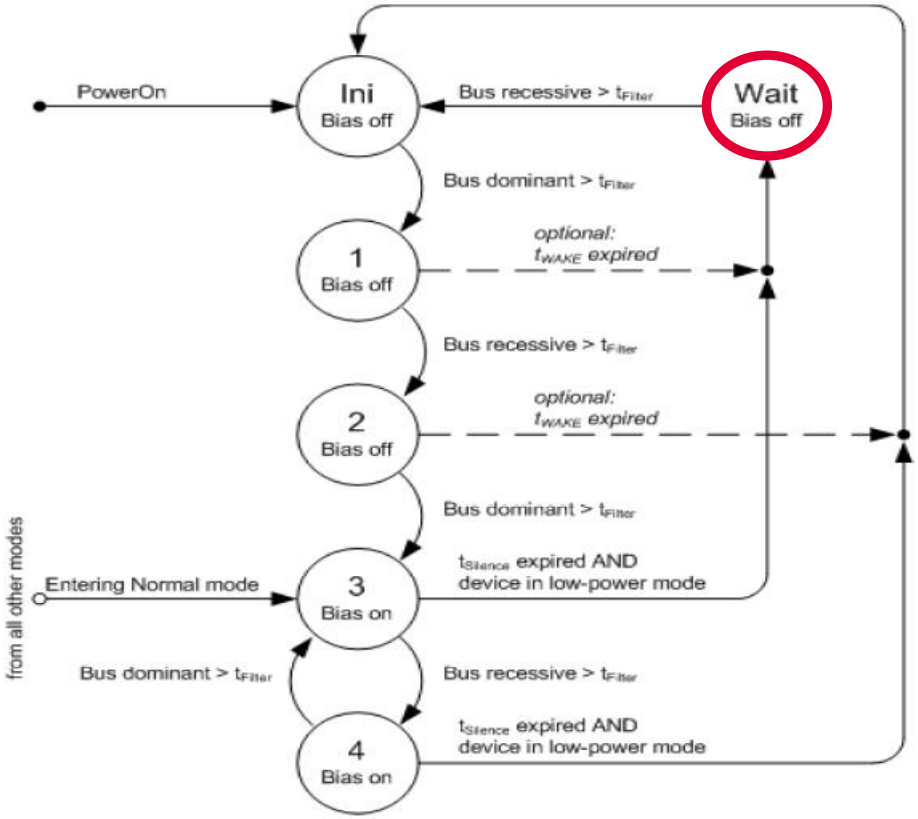
  -> the unit will jump to state Wait

- If the recessive condition is fulfilled longer than $t_{Filter}$

  -> the unit will jump to state Ini

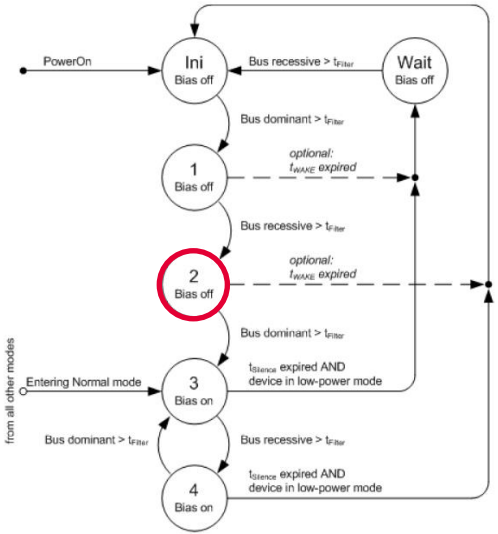
- This is implemented to reduce the current consumption in low power mode in case of a Short

# Wake Up Pattern Flow




- State Wait:
- Short CANH to vbatt
- Permanent dominant level on the bus
- CAN activity recessive filter time detection unit is active
- Recessive levels on the bus shorter than 500(150)ns will be filter out
- Recessive levels on the bus longer than 5000(1800)ns will be detected as recessive condition
- If the recessive condition is fulfilled longer than $t_{Filter}$
  -> the unit will jump to state Ini

# Wake Up Pattern Flow

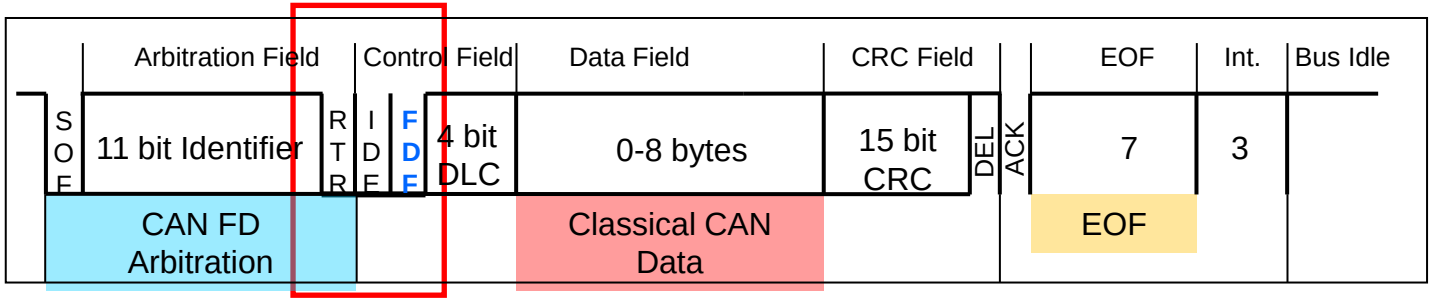



## State 2:

- No communication on the bus
- CAN activity dominant filter time detection unit is active
- Dominant levels on the bus shorter than 500(150)ns will be filter out
- dominant levels on the bus longer than 5000(1800)ns will be detected as recessive condition
- If there is no communication on the bus (permanent recessive level) for a time longer than $t_{wake}$
  -> the unit will jump to state Ini
- This is implemented to guarantee a robustness against spikes
- Normally a dominant level should be detected faster than $t_{wake}$

# Frame format analyses (1)

› CBFF (Classical base frame format)



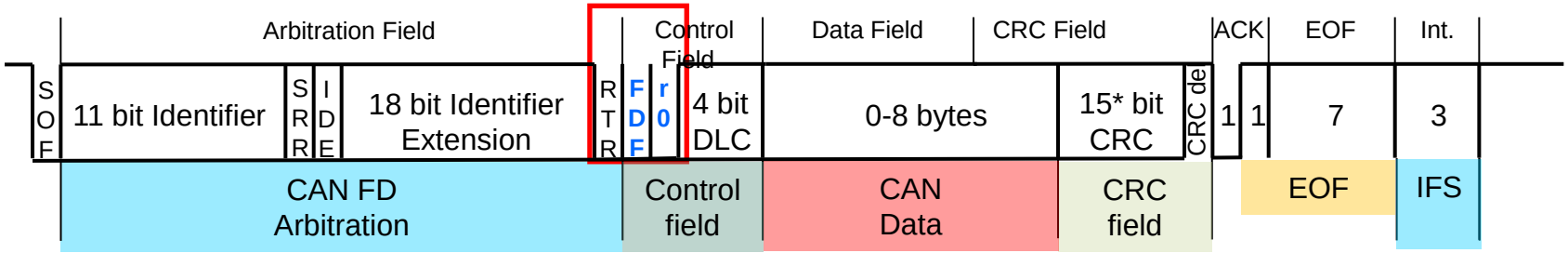

› RTR, IDE, FDF are dominant

WUP can be realized with

› RTR, IDE, FDF (1. Frame) = dominant => dominant condition fulfilled
› EOF = recessive => recessive condition fulfilled
› RTR, IDE, FDF (2nd Frame) = dominant => dominant condition fulfilled

# Frame format analyses (2)

- CEFF (Classical extended frame format)



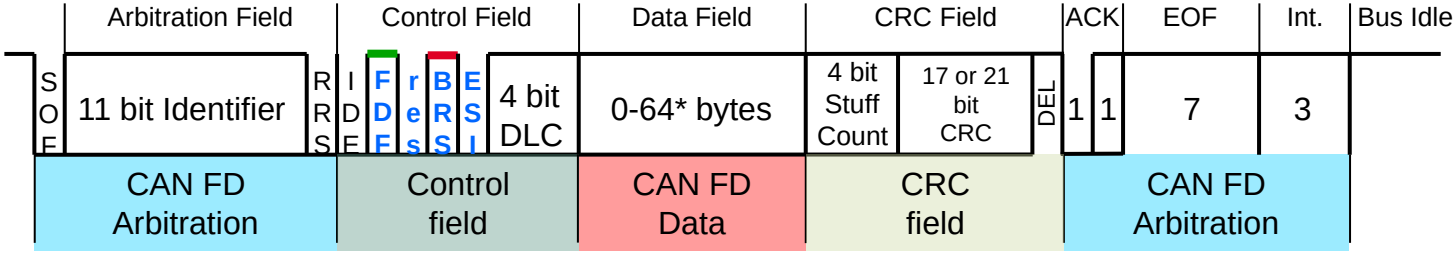

- RTR, IDE, FDF are dominant

WUP can be realized with

- RTR, FDF, r0 (1.Frame) = dominant => dominant condition fulfilled
- EOF = recessive => recessive condition fulfilled
- RTR, FDF, r0 (2nd Frame) = dominant => dominant condition fulfilled

# Frame format analyses (3)

## FBFF (CAN FD base frame format)



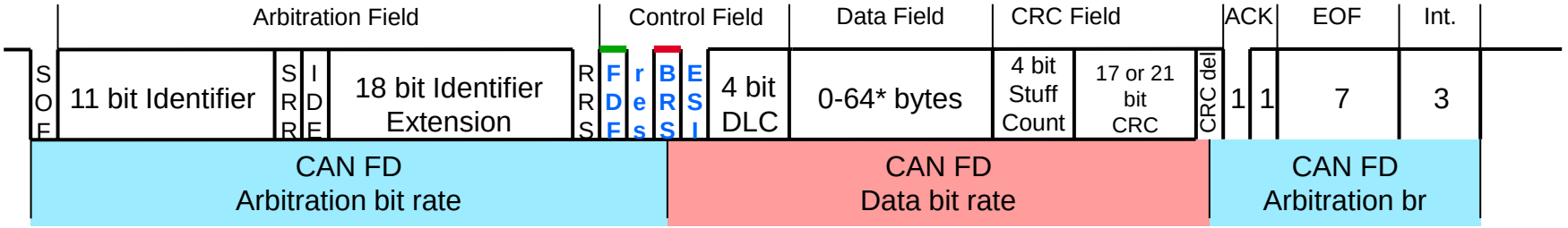

- RRS, IDE are dominant

WUP cannot be guaranteed for bit rate higher than 400kBit/s (Bit time = 2.5µs)

- => The CAN activity filter time has to be reduced

# Frame format analyses (3)

- FEFF (CAN FD extended frame format)




- Only one dominant bit guaranteed RRS, or res, od Identifier

WUP cannot be guaranteed for bit rate higher than 200kBit/s (Bit time = 5µs)

- => The CAN activity filter time has to be reduced

# ISO 11898-2 Wake up Pattern

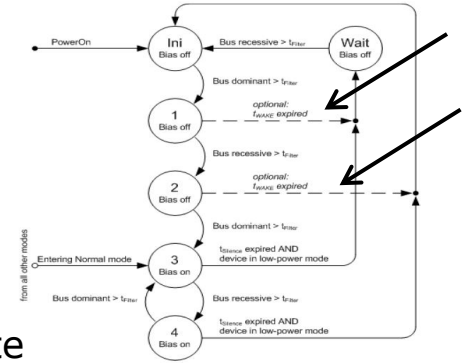
› New ISO specification for CAN activity filter time

| Parameter | Min | Max | Unit | Condition |
|---|---|---|---|---|
| CAN activity filter time, long | 0,5 | 5 | µs | 1,2V ≤ Vdiff ≤ 3V<br>-10,8V ≤ $V_{CAN\_H}$ ≤ 12,0V<br>-12,0V ≤ $V_{CAN\_L}$ ≤ 10,8V |
| CAN activity filter time, short | 0,15 | 1,8 | µs | 1,2V ≤ Vdiff ≤ 3V<br>-10,8V ≤ $V_{CAN\_H}$ ≤ 12,0V<br>-12,0V ≤ $V_{CAN\_L}$ ≤ 10,8V |

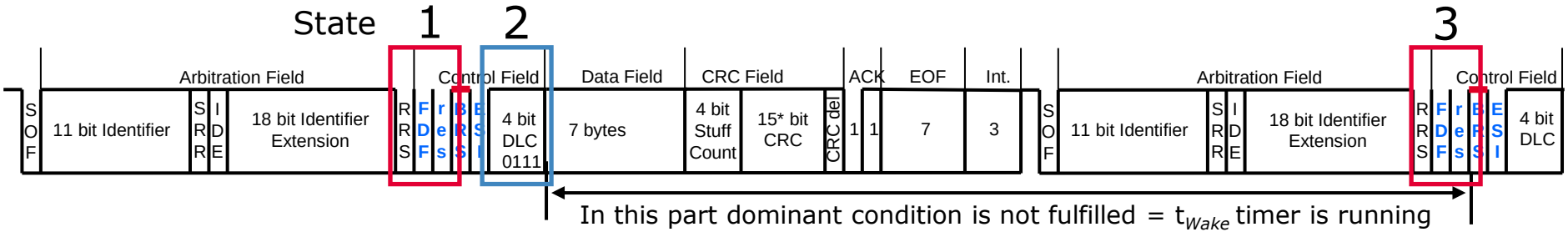
› With the add parameter CAN activity filter time , short bit rates up to 500kBit/s can be used for bus (remote) wake up)

# Wake up time

| Parameter | Min | Max | Unit |
|---|---|---|---|
| Wake up time, short | 350 | 10000 | µs |




- Critical Scenario in CAN FD Frames:
  - dominant condition fulfilled in the RRS, FDF, res field only
  - Recessive condition fulfilled in the DLC (0111)
  - Dominant condition is not fulfilled in data phase due to high bit rate
  - Next Dominant condition fulfilled in the RRS, FDF, res field




- Longest distance between recessive condition and dominant condition
- CEFF min number of bits = 123; max number of bits = 152 @ 500kBit/s = 304µs
- 304 is close to 350µs min Wake up time
  => Wake up time long is recommended

# Add parameter $t_{Wake\_long}$

| Parameter | Min | Max | Unit |
|---|---|---|---|
| Wake up time, short | 350 | 10000 | µs |
| Wake up time, long | 800 | 10000 | µs |

› With $t_{Wake\_long}$ the new WUP mechanism is prepared for CAN_FD

# Summary

- The new WUP wake up mechanism to make sure a more reliable bus wake up mechanism
- $T_{wake\_long}$ and $t_{filter\_short}$ allows arbitration bit rates up to 500kBit/s
- All parameters are specified in the new ISO 11898-2 (ed 2016)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